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Popular Mechanics



**1993
DESIGN &
ENGINEERING
AWARDS**
We Pick
The Best Of
The Best

PM EDITOR UNDER FIRE! MISSION TO SARAJEVO

Defying Danger Aboard A Mercy Mission
To This War-Torn City



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- Complete Insulation Buyers Guide
- Simple Plumbing Maintenance, And More

'93 CAMARO/FIREBIRD DRIVE REPORTS

First Of The New-Breed
American Muscle Cars

20 AMAZING NEW WONDER WATCHES

And Why Everyone's
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Escort GT



New Probe GT

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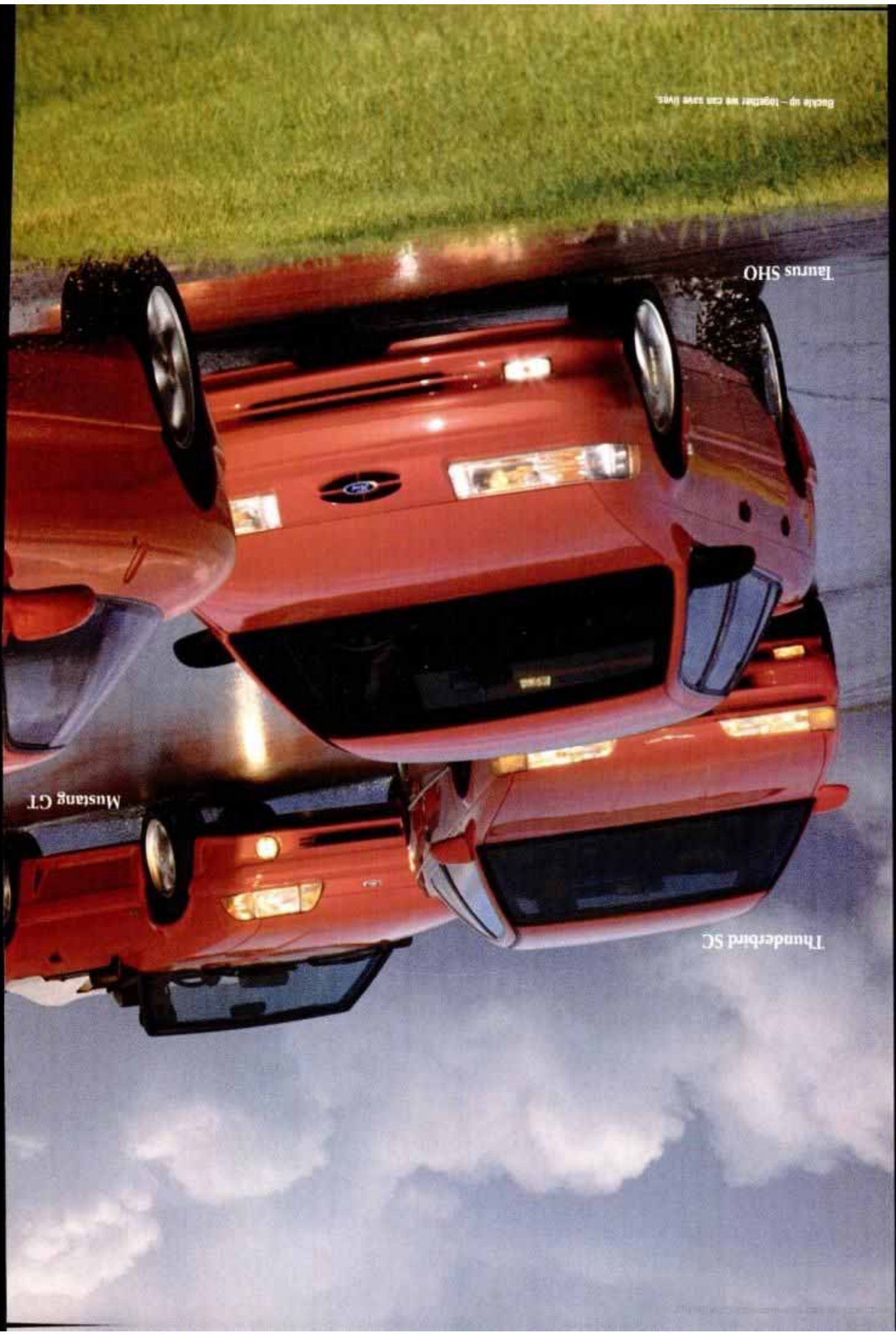
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WHO'S DRIVEN A FORD
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HORSEPOWER. REAL PERFORMANCE
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This One



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EDITOR'S NOTES

● When Science/Technology Editor Abe Dane came into my office and asked if he could spend \$672 for a high-tech, bulletproof flak jacket, the seriousness of his assignment hit home. I had reservations, lots of them, about sending Dane into war-torn Sarajevo on a mercy mission with the U.S. Air Force. It was dangerous. Very dangerous. In fact, the mercy missions had been halted altogether for several weeks after an Italian relief flight on final approach into Sarajevo Airport was downed by a missile from hostile forces. Once the flights resumed, Dane really wanted to go. And I relented with the promise that he would keep in close touch so that




Science/Technology Editor Abe Dane in war-torn Sarajevo.

I knew he was all right. His call from Rhein-Main, Germany, at the conclusion of his mission aboard a C-130, was one of the most welcome phone messages I have ever received. He was okay, the mission had gone well and he was coming back with a great cover story. He didn't lie, as you'll see starting on page 26. . . . Did you enter our Learn To Fly contest? If so, thank you. We received thousands of entries, from which we had to pick just 111 winners. If you're a winner, you've already been notified by mail. In fact, our first-prize winner has already started flight school (page 20). But I want to take this opportunity to publicly thank the people who assisted me in picking the winners—especially Tom Comeau, chairman of the General Aviation Taskforce, who helped organize and sponsor the contest. . . . To us, one of the most important programs we're involved with is our annual Design & Engineering Awards, where we get a chance to recognize the innovative, the creative and the unique. That's exactly what our '93 crop of award recipients represents. You can find our selections beginning on page 21. Let me know what you think of this year's Design & Engineering Award winners. Till next time.



The Learn To Fly contest judges, from left to right: Nigel Moll, senior editor of *Flying* magazine; James Haynes Jr., president of Janelle Aviation; me; Tom Frasca of Frasca Air Services Inc.; Martha and John King of King Video; Phil Boyer, president of the Aircraft Owners & Pilots Association; and Harold Buker, aviation director for the state of New Hampshire.


Joe Oldham

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LETTERS

Your written letters are always welcome. If we think your letter would be interesting to other readers, we might even print it in our Letters column (unless you request that it not be printed). Our editors are listed by department on the masthead printed in the front of the magazine next to Editor's Notes. Our address is 224 W. 57th Street, New York, NY 10019.

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TIME MACHINE

90 YEARS AGO: JANUARY 1903



Levitating Train

Locomotives routinely underwent levitation during the steam era, but they didn't float on magnetic cushions. Instead, cranes lifted the 80-ton iron horses for maintenance, at facilities like the Collinswood shops of the Lake Shore and Michigan Southern Railroad. Workmen rode the locomotives in midair and stripped off undercarriage components. Huge steel baskets would fill up with disassembled locomotive parts, destined for the cleaning vats.



Big Mo's Mama

While the Navy rebuilt for global force projection, it was still acquiring coastal-defense battleships. Under construction at Newport News, Virginia, was the old *Missouri*, with a mix of 12-

in., 6-in. and 3-in. guns. Close-in naval combat, however, was vanishing. Captains were now blasting away at long range with the big guns. *Missouri* and its mixed-battery sisters would see little action in WWI.

60 YEARS AGO: JANUARY 1933



Die Fledermaus

Although Northrop gets proper credit for pioneering the flying wing, Germany's Junkers had been toying with the concept as far back as 1910. In the '30s, the bat-like Junkers G-38 went into service between London and the Continent, carrying a crew of seven with 34 passengers in glassed-over wing cabins. The gigantic 4-engine monoplane cruised at a stately 115 mph. Inside the fuselage, a raised deck allowed passengers to peep over the enormous wings.



Gee! No, Gee Bee

Aviators were still buzzing over Maj. James Doolittle's latest exploit—notching a land-plane speed record of 294 mph in the *Gee Bee*. The

brawny monoplane owed its success to the huge 770-hp Pratt & Whitney Wasp engine and to a variable-pitch propeller that acted like an automotive transmission.

30 YEARS AGO: JANUARY 1963



All That Glitters

Brass-trimmed autos were status symbols in the days when cars were playthings of the rich—who could afford servants to polish away the tarnish buildup. But as soon as chrome became available, brass faded in popularity. In the early '60s, however, chemists hinted that brass-trimmed cars would gleam again. Tarnish-free brass was on the way, they prophesied, thanks to a novel lacquer coating. Somehow, this miracle material never materialized.

Early Whirly

When the Navy asked for a "flying motorcycle," it got the *Rotorcycle*, a curious 1-man helicopter from Long Island's Gyrodyne Co. Counterrotating rotors were a novelty then. The inverted V-tail lent stability, but all control went through the rotors. Although *Rotorcycles* weren't terribly successful, they did spawn the Drone Anti-Submarine Helicopter, a remote-control torpedo carrier. The Israelis later used this idea for their Helistar unmanned chopper. **FM**



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The practical two-

tiered bed has handy notches in the side for convenient double-stack loading. It also has six stake pockets that let you turn your standard bed into a stake bed whenever you need it.

As you can see, the all-new Toyota T100 is one big idea after another. But that's a story better told at your nearest Toyota dealer.

Call 1-800-GO TOYOTA if you'd like a Truck brochure or the location of your nearest dealer.

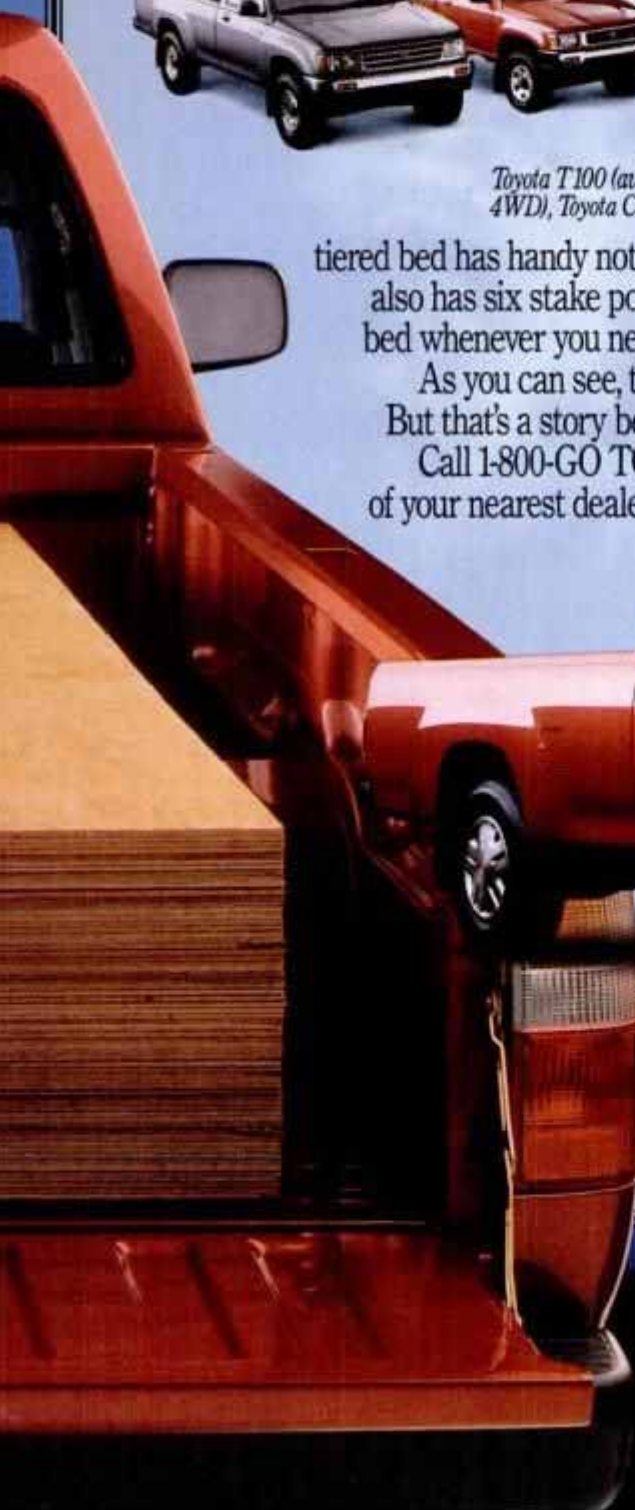
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LETTERS

Minivan Shootout



Isn't there some kind of law in your country about truth in advertising? If there is, I can't see how you can publish Chrysler's ads. Don't misunderstand me. I generally like Chrysler products. They're well designed, and apparently well made. But Chrysler claims to have invented the minivan. How stupid do they think we are? Assorted Japanese companies have been selling minivans outside of North America for years, and we haven't even seen some of them here yet (like Subaru's 4wd van). I rode in a Toyota minivan in Africa in 1982—a full two years before Chrysler claims to have “invented” minivans. This year in Africa, I spotted a Fiat minivan. It looked about 10 years old or more. But the granddaddy of them all is Volkswagen. If Chrysler really wants to claim a first, “first American-built minivan” might be more accurate.

GREG SLADE
BURNABY, CANADA

To compare *all* automatics against an arguable “van” (a Mitsubishi LRV that has a manual transmission) in your minivan shootout is deceptive and demonstrates poor editorial integrity. To show that it outperforms the rest (with approximately 1000 pounds less weight) is insulting to most of your readership. It's a totally different class of automobile. Also, the VW Bus should have been included. Sure it might not have been the latest model EuroVan, but the Astro and Caravan are also designs many years old.

Please don't let stupid tests like this slip by.

PRESTON PETTY
SYSTEMS 4 PC

Is it? If we had tested the old



Reader Steven Cimini's ornate porch design built from PM plans.

Volkswagen Bus, you would have been on our necks for testing the old model instead of the new EuroVan, which we could not get in time.

—Ed.

Lifesavers

“Life Flight” could have been an informative and commendatory article, but it was tainted by Dr. Carter's comment that “Any EMT can get you to the hospital with a shattered tibia. But if you have a heart arrhythmia or some other bad problem, you need the kinds of equipment and skills we have.” As president of the National Association of EMTs, the national professional organization for EMTs and paramedics, I am terribly troubled and dismayed by this statement. EMTs are the pre-hospital emergency health care professionals who respond to calls for emergency help. Our education and training is directed specifically toward the assessment and effective treatment of sudden illness and injury. Dr. Carter's statement is a throwback to the days of “ambulance drivers.” Today's EMTs are no more ambulance drivers than physicians are witch doctors. EMTs and EMS flight crews are valuable members of the emergency health care team. It is sad

that one physician has chosen to drive a wedge between the two with his thoughtless statement and sadder yet that a publication such as yours has printed it.

MARK LOCKHART
NAEMT PRESIDENT

In the interest of presenting a balanced view of the work of emergency medical technicians, we printed Dr. Carter's comments. While it's true that not everyone in the medical profession is in agreement as to the value of EMTs on the scene of an emergency situation, if we didn't think EMTs were courageous and provided an extremely valuable service, we wouldn't have made their efforts the subject of a cover story.

—Ed.

Porch Daze

Your “Traditional Porch” project in the June '91 issue was just the inspiration I needed to get started. I had been studying and photographing old porches in my area with the intention of building my own some day. The porch I built is a blend of your plans and a porch in my area, with similar design elements as on my house. I omitted the rails to allow access to the side yard. Thank you for the easy-to-follow plans and a consistently good magazine that I have looked forward to receiving each month for the past 15 years.

STEVEN CIMINI
GREENVILLE, RI

Correction

The correct phone number for Speedway Motors Inc., makers of the oil-filter cutter featured in Car Care in the November '92 issue, is: (402) 474-4411.

PM

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

TECH UPDATE

News Of Tomorrow's Technology Today



ILLUSTRATION BY PAUL DUNBAR

First Scramjet Could Piggyback On Blackbird

EDWARDS AFB, CA—Remember the X-15? The rocket-powered plane shattered all-time speed records as it blazed the trail for vehicles like the Space Shuttle.

Now NASA's Ames-Dryden Flight Research Facility has blueprinted a '90s version of the X-15, to pave the way for the X-30, the National Aero-Space Plane. HALO (High-Altitude Launch Option) is a 58-ft. rocket-boosted vehicle to be launched from an SR-71 Blackbird.

HALO's rockets would propel the aircraft to a speed of Mach 12 and an altitude of 145,000 ft. Then the plane would turn on its scramjet (the supersonic-combustion powerplant destined for the

X-30). HALO would test the engine for 2 minutes and glide back to Edwards.

Data from HALO flights, say Dryden engineers, could mesh with data from tests of SAPHYRE, a classified unmanned Mach-25 rocket vehicle developed at Sandia National Labs. The two vehicles could explore the high and low speeds of the X-30's flight regime separately.

How would HALO/SAPHYRE square with the X-30, itself an exploratory aircraft? The question is stirring debate, especially since budget cuts have stretched out the X-30's gen-

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributor: Mike Fillon

esis. Meanwhile, engineers plan wind-tunnel model tests for the HALO/Blackbird tandem this spring.

HALO scramjet testbed rockets away from SR-71, on its way to Mach-12 speeds in stratospheric proving ground.

Highlights This Month

- **Shoot The Moon**—NASA spells out long-layover lunar mission.
- **To Explore New Worlds**—Telescope array will search for alien planets.
- **Sell It To The Marines**—Rival amphibious vehicles square off.
- **World's Smartest Dummy**—Robotic mannequin models protective uniforms.
- **No Resistance**—Superconducting power lines are here.
- **Trial Balloon**—Star Wars missile watchers get lighter than air.



PH ILLUSTRATION BY MARK MACDONALD/ESA

Ballistics Via Balloon

KIRKLAND AFB, NM—Strategic Defense Initiative engineers have come up with a way to practice tracking missiles—lofting lasers and telescopes on huge unmanned balloons.

At the Air Force's Phillips Laboratories, the High-Altitude Balloon Experiment, or H ABE, will hoist three lasers to illuminate missiles. Engineers at Lawrence Livermore National Laboratories have an analogous system, called Kestrel, for collecting visual data on missiles. Each package will look at projectiles fired at test facilities such as White Sands Missile Range.

The balloons themselves are similar. Each has a small tow balloon to get off the ground. As the balloon rises, H ABE balloon lofts array of optical instruments to track missiles.

its helium expands and forces its way into the big balloon, which opens to a diameter of more than 200 ft.

Once at altitude—typically 80,000 ft. and above—the different payloads go to work. The Kestrel sensors look at the missile's exhaust plume in various wavelengths. H ABE's lasers and cameras will try to acquire, track and point a pencil-beam laser at the missile. The aim is to verify theories that predict where the missile's body lies with respect to the exhaust plume.

H ABE features a unique inline parachute to recover the payload package. The chute's canopy dangles from the balloon and quickly unfurls when released. Kestrel uses a conventional drogue-stabilized freefall chute.

The launches are scheduled to begin this summer.

Meeting With An Asteroid

BALTIMORE, MD—Although asteroids could tell us a lot about the formation of our solar system, NASA has never had more than a passing look at one. Now, under its Small Planetary Mission Plan, the space agency is proposing a Near Earth Asteroid Rendezvous (NEAR) spacecraft.

The mission would highlight the new NASA maxims of simplicity, reliability and low cost—in this case, less than \$150 million. Launched

on a Delta rocket, the spacecraft would take two years to reach the asteroid belt. There it would keep station with Nereus, a little-known chunk of space rock seen as a faint blur from Earth.

Instruments could measure the asteroid's size, gravity chemical makeup and magnetic fields. Johns Hopkins University, which is managing the NEAR studies, is also considering a camera capable of imaging 2-in.

details on the surface of Nereus. Engineers will have to pick out no more than three sensors for the spacecraft to carry.

Arriving at its target in the year 2000, NEAR spacecraft would spend a year acquiring data and relaying it back to Earth.

NEAR spacecraft would map out strange denizen of the asteroid belt.



PH ILLUSTRATION BY NASA

Navy's New Sea Watcher

BROOMFIELD, CO—Navy ships will soon have real-time access to satellite measurements of ocean topography.

That's because a new satellite will begin broadcasting data to 65 shipboard and shoreside downlink stations.

Called the GEOSAT Follow-On, or GFO, the 660-pound spacecraft will ride a Pegasus rocket into orbit in 1995. Its radar altimeter will measure sea-surface heights around the globe. Ships can apply the data to determine

GEOSAT Follow-On will deliver real-time measurements of sea surface right to ships' bridges.

ocean temperature and current conditions anywhere around the world—useful for antisubmarine warfare, for example.

The satellite will also feed the National Oceanic and Atmospheric Administration's computers, to help develop weather and global climate-change forecasts.

Two additional GFO's are in the planning.



PH ILLUSTRATION BY ED VANCE/ROK



Rocket-powered X-Rod homes in on enemy armor with the aid of millimeter-wave radar.

tivates a millimeter-wave sensor in its nose. Then a rocket motor ignites to boost X-Rod's kinetic energy.

The sensor looks for radar signatures that match those identified as viable targets in an attached memory unit. The round fires reaction-control jets to steer toward the target. At the last minute, a sabot flies off to expose a depleted-uranium penetrator that punches through armor.

Tank gunners would not require any additional training to shoot X-Rods.

Hercules Defense Electronics Systems, the contractor, plans guide-to-hit tests this year. Full demonstrations, with the rocket firing, aren't scheduled until 1994.

Seeing-Eye Tank Rounds

CLEARWATER, FL—Always seeking an edge in the duel between tank and tank, the Army aims to field a rock-

et-assisted main-gun round with a built-in radar seeker. The idea is to nail armored vehicles skulking beyond a

gunner's line of sight.

Known as X-Rod, the projectile shoots out of a standard 120mm tank gun. As it coasts into the general vicinity of its target, the round ac-

Six Strokes For Racing

COLLEGE STATION, TX—A 6-stroke engine, incorporating a purge cycle, offers benefits in performance and emissions, say its developers at HyTech Engine Technologies.

Unlike previous 6-stroke efforts, the HyTech powerplant's valve timing is optimized so that the engine can't function without the purge intake and exhaust strokes.

The engine stays cooler, supports much higher rpm levels and runs on lower-octane fuels than conventional engines.



HyTech's 6-stroke uses purge to increase rpm and prevent misfiring and fuel-air dilution.

New Amphibians Crawl Out Of Sea

CAMP PENDLETON, CA—The Marines are looking for a few good Advanced Amphibious Assault Vehicles, or AAVs, to replace their AAV7A1s, which are getting a bit long in the tooth. General Dynamics and FMC Corp. are vying to build the machines.

An AAV must haul 18 Marines, handle 8-ft. breakers, hit 20 knots in the water and keep pace with M1 tanks on land. The idea is to launch amphibious assaults from ships parked more than 20 miles offshore, with vehicles that can hit the beach in roughly an hour.

The General Dynamics option uses a concept developed by the Navy's research wing (see Tech Update, page 17, May '90). To sprint over the waves, the vehicle unfolds planing surfaces, one at the bow, one at the transom, and one along each chine. The tracks and suspension retract into the hull to reduce drag.

So far a full-scale propulsion demonstrator, powered by two waterjets, has hit 33



General Dynamics propulsion technology demonstrator hit 33 knots.

knots. A separate rig is testing the planing system's hydrodynamics.

Meanwhile, FMC's offering tiptoes across the water on two hydrofoils that swing down from the rear hull. In high-speed water mode, propellers drive the vehicle. FMC is exploring the possibility of electric drive, whereby an on-

board generator powers separate motors for land and sea.

FMC is currently testing a ¼-scale demonstrator at speeds above 25 knots. The hydrofoils smooth out the ride, cut power requirements and improve maneuverability, the company asserts.

The Marines will review the program next month. If the Pentagon gives the green light, a winner will emerge in 1994.

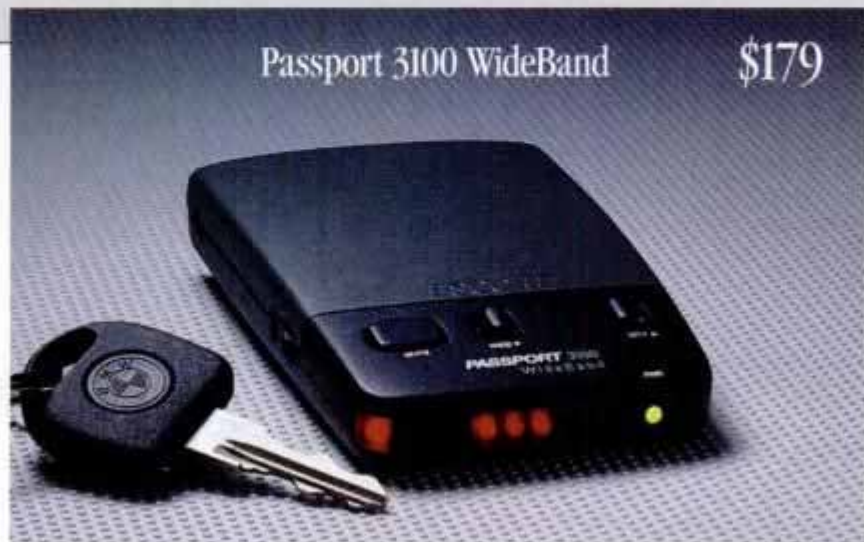


FMC's vehicle would rise on rear-mounted hydrofoils. Demonstrator is at right.



7 Ways To Delight

1



Passport 3100 WideBand

\$179

For Total Radar Coverage

Passport 3100 WideBand is the perfect choice for drivers who own a two-band detector and are ready to step up to the latest, most complete radar technology available. Passport 3100 WideBand detects every type of traffic radar currently used today, including X, K, Ka, Photo radar and Stalker.

All wide band detectors are not created equal. Some actually "miss" part of the broadcast signal at selected frequencies – like a radio that can't pick

up every station. But Passport 3100 WideBand doesn't miss a thing. If radar is there, you'll know it instantly.

Passport 3100 WideBand: radar detection at its best.

FEATURES: *Digital Signal Processing • Long range detection • Anti-falsing circuitry • Signal strength meter • Mute button • Band selector switch • Visual and audible alert system • City/highway switch*

2



\$199

Passport 3200 WideBand offers additional features and accessories. Call today for more information.

4



\$99

Passport 2200 is a full-featured X and K band radar detector. Combining incredible value with superior detection performance, Passport 2200 will delight the driver in your life.

FEATURES: *Digital Signal Processing • Long range detection • Visual and audible alerts • Dim switch • Signal strength meter • K-band indicator • Mute switch • City/highway switch*

5



\$79

Passport 2100 offers great X and K band performance at a very affordable price. Easy to understand and use, Passport 2100 is a perfect choice for the first-time user or for the person who's ready to step up to Escort quality.

FEATURES: *Long range detection • Visual and audible alerts • Signal strength meter • Mute switch • City/highway switch*

6



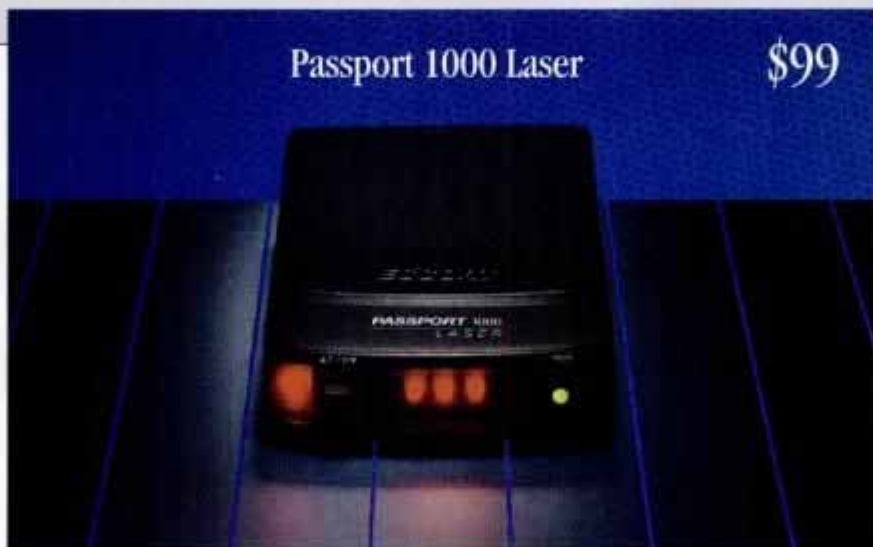
\$49

Passport 2000 is a good, basic X and K band radar detector. It doesn't come with a lot of fancy features, but it does have the quality for which Escort is known. And its price makes Passport 2000 the perfect stocking stuffer.

FEATURES: *Alert light • Audible alert tone • City/highway switch*

Your Favorite Driver

3



Passport 1000 Laser

\$99

The Worlds First – and Best – Laser Detector

Passport 1000 Laser provides complete protection from the new laser technology. If your favorite driver already owns a radar detector, this is the perfect gift.

A radar detector doesn't pick up laser. If your favorite driver doesn't have a laser detector, he's not fully protected. Passport 1000 Laser works with a radar detector to provide complete radar and laser protection.

While laser manufacturers have spent a lot of time claiming that laser is

undetectable, Passport's complex circuitry finds it easily. In fact, Passport 1000 Laser can detect a laser signal up to 2 miles from the source.

Passport 1000 Laser: innovative technology – available first from Escort.

FEATURES: Long range laser detection • Digital PRT detection • Pulse Width Discrimination • Signal strength meter • Dark mode • Adjustable volume • Compatible with most radar detectors

WHAT IS LASER?

Laser guns calculate speed by transmitting short pulses of light energy and measuring the time it takes for the reflection to return. Once transmitted, the laser signal is dispersed due to atmospheric particles such as dust, water vapor, and car exhaust. Passport 1000 Laser's complex circuitry easily detects this dispersed signal.

7

Total Security – For only \$249!

Give the ultimate holiday gift:

Buy both a Passport 1000 Laser and a Passport 3100 WideBand and we'll take \$29 off the total purchase price.

Your favorite driver can have total radar and laser protection for only \$249. That's less than others charge for a wide-band detector alone!

How to Order:

Call 24 hours, 7 days a week
1-800-433-3487

Our Holiday Guarantee:

We want you to be 100% satisfied with your purchase. We back each Passport with a 30-day trial period which will begin on December 25, 1992 – even if you buy right now! If your favorite driver isn't absolutely delighted with Passport, return it within 30 days and we'll refund your money. You can't lose.

For discounts, full product support and more, ask about our EscortPlus Club!

By Phone:

Call us toll-free at 1-800-433-3487

By Fax:

Fax your order to 1-513-247-4820

By Mail:

Mail your order to

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5200 Fields-Ertel Road
Cincinnati, Ohio 45249

Make check payable to Escort.
Shipping & handling is additional. OH res. add 6% tax.

*** Overnight shipping available**

ESCORT
The Innovative Edge.™



Smoke streams over forward fuselage of X-29 No. 2 to visualize vortex flow disrupted by gas nozzles (inset).

Latest Angle On The X-29

EDWARDS AFB, CA—The uncanny maneuverability of the X-29 got even more uncanny this summer, when pilots tested a new nose-mounted vortex-flow control system. Incredibly, the aircraft demonstrated repeatable yaw control at a 58° angle of attack.

Usually, at such an extreme nose-up attitude, the rudder becomes virtually useless and the pilot simply can't point the aircraft.

But the vortex-control system counters that tendency. Two nozzles blow nitrogen over either side of the forward fuselage. The gas discharge affects vortices flowing over the fuselage

enough to nudge the nose to one side or another.

Built into a future jet, a vortex-flow control system would draw engine bleed-air to power the nozzles. Air Force engineers would like to test the system on an operational fighter jet.



Vortex-control nozzles reside between cockpit and nosetip.

NASA's Plan For Lunar Pioneers

HOUSTON, TX—NASA has worked out a detailed new scenario for sending astronauts back to the Moon—this time for a 45-day sojourn.

Called First Lunar Outpost, the plan calls for a huge new heavy-lift rocket able to loft 1½ times as much as the *Saturn V*.

The lower stage of the booster would feature advanced versions of the *Saturn V*'s F-1 engine, possibly combined with a Shuttle-derived hydrogen-burning engine. For the upper stage, which rockets between low Earth orbit and the Moon, engineers might use nuclear thermal propulsion, as a try-out for future Mars missions.

One launch would send cargo and a self-deploying habitat on a lander. The other



First Lunar Outpost would rely on monster booster, featuring *Saturn V*-derived engines, to fly nonstop from Earth to Moon.

er would carry a returnable command module and a 4-person crew.

Instead of settling into lunar orbit and sending a separate lander to the surface, à la *Apollo*, the entire command module would land on the Moon. The landers would feature RL-10 engines modified for throttling.

First Lunar Outpost would probably require funding on the order of what it takes to keep the Space Shuttle flying every year.



Mission would require two landers—one bearing the habitat, the other carrying the crew in separable Earth-return module (left).



Smart Tires Talk Back

AKRON, OH—Several commercial trucking outfits are now rolling on Goodyear tires with built-in brains—computer chips embedded deep in the rubber.

Each chip stores data on when and where the tire was made and what tread it originally sported.

Integrated with the chip is a radio transponder that can broadcast the data when interrogated by a separate handheld device. Managers can use the information to decide when to retread or replace a tire, reducing tire fires and blowouts.



Radio interrogators read information from chips embedded in truck tires.

Search For Alien Worlds

MAUNA KEA, HI—How many planets are circling distant suns? A coming ground-based facility, incorporating the huge Keck Observatory, aims to find out.

The project, called Towards Other Planetary Systems (TOPS-0), consists of the 394-in. Keck telescope, its twin (now under construction) and four 60-in. "outrigger" telescopes.

The multi-telescope array will combine observations to create an optical interferometer, with a resolution equal to that of a 2755-in. telescope. That's sharp enough to spot Jupiter-size planets as far away as 50 light-years.



Twin Keck telescopes, with four smaller reflectors, will combine forces to find new planets.

The smaller telescopes will move about on railroad tracks, assuming different orientations to observe the same object. Computers will then reconstruct the signals

to create a single image.

The TOPS plan also calls for adaptive optics—flexible, computer-driven mirrors that would compensate for atmospheric twinkling.

NASA, partly funding the project, has ideas for a second optical interferometer in low Earth orbit (TOPS-1), followed by a third on the Moon (TOPS-2).



Tuning-Fork Gas Gauge

OAK RIDGE, TN—Oil companies still have trouble predicting how rich underground deposits might prove. Now chemists at Oak Ridge National Laboratories have invented a device that takes out the guesswork.

The vibrating densimeter features a U-shaped tube that fills with a sample of oil or gas. Temperature and pressure are then set to match downhole conditions. The tube is then vibrated, and equipment measures its



Vibrating densimeter settles into harmonic frequency characteristic of sample density. This frequency indicates the density of the fluid.

The densimeter has proven more precise than mathematical models traditionally used to predict density.

Superconducting Cables

WATERTOWN, MA—American Superconductor Corp. has overcome two problems that shorted out high-temperature superconductor research two years ago. Their new superconducting wires are flexible and can also carry currents hundreds of times as high as equivalent copper wire.

The wire consists of a silver sheath that encases thousands of microscopic filaments, each 1/12th of a hair's width, made of a bismuth-oxide ceramic, which loses all electrical resistance

New superconducting power cable can bend readily without losing electrical properties.

at a temperature just above that of liquid nitrogen.

Lately, working with Pirelli Cable Co., they have manufactured prototype power-transmission cables that can handle 500 amps.



Army's Intelligent Dummy

DUGWAY PROVING GROUND, UT—The \$3.4 million mannequin named Manny is now ready to begin service as the Army's chemical-defense guinea pig. Modeling protective garments, Manny will work inside a stainless-steel test chamber with real nerve gas and other chemical agents.

No other dummy can do what Manny can. The mannequin can maintain an even 98.6° F body temperature. Complex internal plumbing will allow him to sweat if his outfit proves too hot.

He has a voice synthesizer to alert his human colleagues to his well-being. Sensors in his rubber skin can detect as little as a billionth of an ounce of poison gas.



Manny can strike lifelike poses assisted by a support arm that plugs into his back.



ILLUSTRATION BY ED VALIGORSKY

AMERICAN SUPERCONDUCTOR CORP. PHOTO

ARMY PHOTOS

THE HOTTEST THING TO HIT AMERICA SINCE THE CHILI PEPPER.

It's beautiful. It's spicy. It's hot. 🌶️

It'll make you put on your shades and head for the 🌶️ nearest body of water.

It's the new 1993 Ford Ranger.

Ranger's sizzling new 🌶️ shape can be powered by an available 4.0 liter V-6.



Buckle up—together we can save lives.

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Combine that with push-button four-wheel drive, a wider stance, improved steering and an interior full of

refinements and you've got one hot truck. With its extra room and seats,

the best
never
rest

the SuperCab makes storage and travel a cinch. Now no matter where

THE NEW 1993 FORD RANGER.

you go, no matter what the weather is, the new Ford Ranger is the truck that's sure to make temperatures rise.



THE BEST-SELLING AMERICAN TRUCKS
ARE BUILT FORD TOUGH



CONTEST WINNERS

LEARN TO FLY

BY CLIFF GROMER

● Who hasn't peered into an intensely blue sky on a balmy spring day and harbored an inner desire to soar up toward the heavens and gaze down at landbound mere mortals below? Everyone has flown wondrous missions in their imaginations, but the thought of driving down to the local airport and enrolling in flight school to earn a private pilot's license seems somehow involved and intimidating.

Not so.

Back in 1991, representatives from the General Aviation Market Expansion (GAME) Plan—an industry promotional effort designed to increase awareness, understanding and usage of General Aviation products and services—came to us with a challenge: Send us one of your editors and we'll turn him into a licensed private pilot in 21 days. This was their way of demonstrating that learning to fly really is not an involved, intimidating process at all. Science/Technology Editor Abe Dane was the PM pick for pilothood, and he successfully completed the course and his qualifying FAA exams in the allotted time frame. Dane shared his pilot training experience with our readers in the January 1992 issue.

For those not familiar with the intimate relationship between private pilot and plane, Dane's adventure was a revelation. It included clambering over and under the wings checking the fuel supply and sediment/contamination, plying his fingers over the metal skin searching for popped rivets as part of the preflight check, pushing foot rudder pedals to steer the plane on the ground, marking up checklists, controlling radio commu-

nications, monitoring gauges, experiencing turbulence, training in a simulator and, of course, actually flying the airplane.

And for those readers who wished they could trade places with Abe Dane and realize their own dream of flying, we ran a Learn To Fly On Us contest. The rules were simple: In 50 words or less, say why you'd like to learn to fly. The first prize winner would receive complete expenses-paid flight training leading up to the acquisition of a private pilot's license at a participating General Aviation

Thomas—a fifth-grade elementary school teacher from Atascadero, California. Thomas always has had an interest in flying and uses flight themes in his science classes, building and launching everything from 5-ft.-high hot-air balloons to gliders and rockets. We imagine it must be quite a sight walking past the school and witnessing the barrage of projectiles and equipment issuing from the science room window. On his entry, Thomas wrote that he had been teaching the principles of flight for years and that his students always asked him if he

was a pilot. His reply was always, "Not yet." So, said Thomas, why don't you make me one? No stranger to airplanes (as a passenger), Thomas quickly discovered that throttling a small plane into the air, keeping the wings level, maintaining prescribed altitudes, flying a designated heading and the most challenging technique of all—landing the plane—took a little more coordination than he had imagined, certainly more than required by his classroom dabbings

into the world of flight.

Thomas began his flight training at the end of August with instructor Lee Palmer Neel III at Air San Luis in San Luis Obispo, California. As of this writing, he had recently soloed in the Cessna 152 and had some 2 or 3 solo flying hours under his belt. Thomas had also just completed some night flying with his instructor, and he says he is "still in the white-knuckle stage." To all the thousands of you who took the time to make our contest a huge success, we say thank you. And to all 111 of our winners, we say congratulations and keep 'em flying. **PM**



Learn To Fly contest winner James E. Thomas (left) with flight instructor Lee Palmer Neel III. Thomas beat out almost 10,000 other entrants for the pilot training course.

Market Expansion flight school in his or her area. Ten second prize winners would receive an introductory 1-hour flight at a participating GAME Plan flight school, and a videotape of King Video's "Let's Go Flying." One-hundred third prize winners would also receive the King Video.

Talk about response! Our contest struck a chord with our readers, drawing almost 10,000 entries which were judged by some of the most prominent people in general aviation. The final winners were selected by PM Editor-in-Chief Joe Oldham.

First prize went to James E.



PM PHOTO BY BRIAN KOSOFF

1993 DESIGN & ENGINEERING AWARDS

● The innovative. The creative. The unique. The significant. The 1993 POPULAR MECHANICS Design & Engineering Award winners represent all this and more.

Each year, our editors review and select only a few of the thousands of new ideas, new products and new innovations that cross our desks. These very few are deemed worthy of receiving a Design & Engineering Award.

What's our criteria? There is none. Simply, it is the expertise of each POPULAR MECHANICS editor in his particular area—automotive, science and technology, home improvement, boating and outdoors, and electronics—allowing him to make a judgment as to what is significant and what isn't.

This year, we received many nominations from readers and we thank you for participating in our selection process. We invite you to watch for our next call for entries, then let us hear from you with a nomination.

Now, turn the page and join us in congratulating this year's winners.

DESIGN & ENGINEERING AWARDS



CHEVROLET CAMARO/ PONTIAC FIREBIRD Chevrolet Motor Division Pontiac Motor Division

A total redesign of GM's venerable front-engine/rear-drive ponycars, now in their 26th year of production, shows the way to the future of American sports car design. Now the F-body cars are mature, sophisticated and pack close to 300 horsepower. They'll run with anything in their class and look good doing it.



CADILLAC NORTHSTAR SYSTEM

Cadillac Motor Division

Cadillac's new Northstar engine is so advanced, its first scheduled tuneup is at 100,000 miles. The 295-hp 32-valve all-aluminum V8 is packed with technical innovations, as is the dry-sump electronically shifted transmission. It makes '93 Cadillacs equipped with this powertrain the most refined, most powerful front-drive cars in the world.



MAZDA RX-7 Mazda Motor of America

Aside from the adrenaline rush that comes from the sequentially fuel-injected twin-turbocharged boosted 255-horsepower rotary engine, Mazda's latest version of its senior sports car offers drivers reduced weight, a stiffened chassis and race-bred brakes. Yes, the RX-7 has graduated to the world-class sports car league, but with a price tag about half that of the competition.

CHRYSLER CONCORDE DODGE INTREPID EAGLE VISION Chrysler/Plymouth Division Dodge Division Jeep/Eagle Division

While Chrysler's family of LH sedans is obviously of great significance to Chrysler, these cars are also the most important cars designwise to come out of Detroit since the Taurus. The innovative cab-forward design, manufacturing techniques, attention to detail, roominess, comfort and excellent performance put these cars at the head of their class.



TOYOTA COROLLA/Geo PRIZM

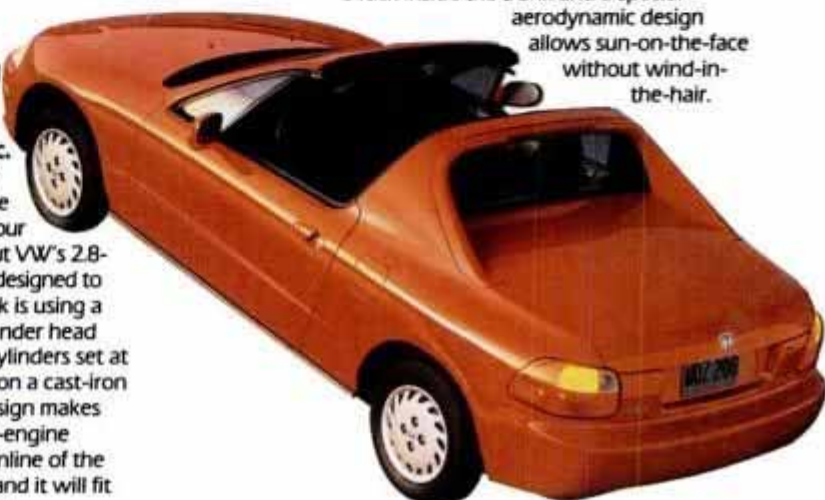
Toyota Motor Sales USA
Chevrolet Motor Division

The Toyota Corolla and Geo Prizm quite simply set new standards for quietness, performance and comfort in the compact car class. Sisters under the skin, the Corolla and Prizm each have completely different body panels right down to the fuel-filler door. And they both look great.



HONDA CIVIC DEL SOL American Honda Motor Co.

Honda's new fun machine rates as a first for bringing a targa top to this size vehicle. The unique liftoff roof stows on a rack inside the trunk and a special aerodynamic design allows sun-on-the-face without wind-in-the-hair.



VOLKSWAGEN VR-6 ENGINE Volkswagen United States Inc.

Stuffing a 6-cylinder engine into an engine bay designed for a Four takes some doing. But VW's 2.8-liter dohc VR-6 was designed to do just that. The trick is using a single aluminum cylinder head over two banks of cylinders set at a narrow 15° angle on a cast-iron block. The clever design makes the VR-6 the only V-engine about as slim as an inline of the same displacement and it will fit just about anywhere.



FREEDOM SPORT Boat Mobile Corp.

The amphibious Freedom Sport integrated boat/camper combination offers the totally unique combination of luxury accommodations on land and high performance on the water. This is truly the ultimate recreational vehicle.



OMC COBRA EFI STERNDRIVE Outboard Marine Corp.

OMC scoops the competition with the industry's first electronically fuel-injected sterndrive system. Available on both 351- and 460-cu.-in. Ford blocks, electronic fuel injection promises boating enthusiasts the same performance and efficiency gains it has delivered for years in automobiles.

DESIGN & ENGINEERING AWARDS

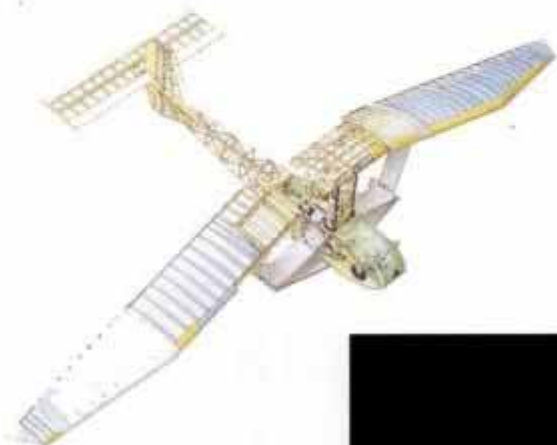


FOUR WINNS STABLE-V HULL Four Winns Corp.

Special pods under the integrated swim platform are the secret to this new hull design. The pods, normally submerged, rise above the waterline at speed, preventing bow rise during hard acceleration and sliding in fast, hard corners. The hull does for boats what wheelie bars do for dragsters.

MERCUISER BRAVO THREE OUTDRIVE Mercury Marine Corp.

The latest twist in a dual counterrotating prop outdrive, the Bravo Three, with 300 V8 horsepower, offers more top-end speed than the competition, as well as improved handling and reduced on-plane time. This new system has to be the biggest news of the year in marine engines.



FIRST ENGINE-POWERED ORNITHOPTER TO ACHIEVE SUSTAINED FLIGHT Institute for Aerospace Studies, University of Toronto

In essence, it's an airplane that flaps its wings. But on its second flight, this 8.8-pound, 1-horsepower, radio-controlled ornithopter took off and achieved a 1 minute 46 second flight, making the history books as the first machine that really flew like a bird.



ARTHUR HOLLEY COMPTON GAMMA RAY OBSERVATORY TRW Inc.

At 17 tons, the heaviest unmanned NASA spacecraft yet launched, this super-telescope is on a mission to peer at black holes and other sources of gamma rays in the heavens. The observatory will help scientists view cosmic cataclysms and is truly one of the biggest eyes we have on the universe.



USS Arleigh Burke (DDG-51) Bath Iron Works Corp.

The Navy's newest destroyer is a cutting-edge combat ship boasting stealth elusiveness, submarine battering missiles, all-steel construction and high-tech damage-control systems. This is the new face of naval power for the next century.

THERMOS THERMAL ELECTRIC GRILL Thermos Co.

Barbecuing takes on a futuristic look with Thermos's new electric-powered grill. The insulated dome improves energy efficiency, and nonstick cooking surfaces make for easy cleanup. Now you can grill in places you wouldn't even consider when using either gas or charcoal.



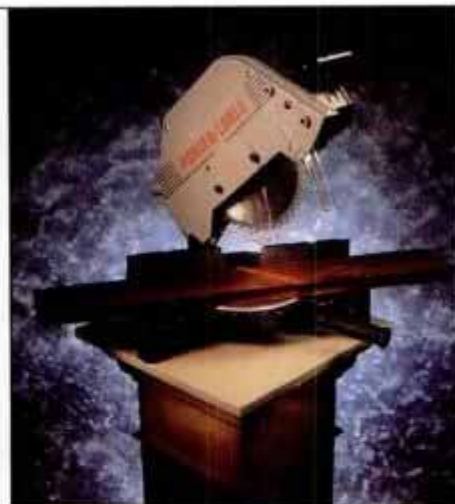


ELKAY DELUXE WATER CENTRE
Elkay Manufacturing Co.

About the size of a dishwasher, the Water Centre filters and dispenses water any way you want it—at room temperature or chilled to 45° F. It heats water to 190° F and also produces 5 pounds of ice per cycle. It is one appliance that really lives up to its name.

PORTER-CABLE LASER LOC MITER SAW

Porter-Cable Corp. While miter saws are known for making precise cuts, there's been no sure way to align the blade with the cutline—until now. The Laser LOC Miter Saw uses a laser beam to project a line of light on the workpiece at exactly the correct blade position. It's a high-tech touch that can make you a better craftsman.



KOHLER PRECEDENCE WHIRLPOOL BATH
Kohler Co.

The Kohler Precedence comes with an inward-swinging door to allow easy entry for those who have difficulty stepping over the side of a conventional tub. And the gasket around the tub's door inflates with air automatically when the tub begins to fill, preventing leakover. It's one tub that gives the industry a whirl in pointing the way to future bath design.



BOSCH PLUNGE ROUTER MODEL 1613EVS
Robert Bosch Power Tool Corp.

The most sophisticated plunge router available comes with a 2-horsepower motor, and a dial speed control from 12,000 to 23,000 rpm. A micro-fine adjustment regulates cutting depths in .004-in. increments. The tool can handle just about any routing job in a range of materials and a myriad of styles.



EASTMAN KODAK PHOTO CD PLAYER
Eastman Kodak Co.

The latest wrinkle in photography is to store your photos on ordinary compact discs and view them on your television. The new picture disc technology is from Kodak, and it's a whole new way to look at your family album.



SONY MINI-DISC WALKMAN PERSONAL STEREO PLAYER/RECORDER
Sony Corp. of America

The Walkman of the future is a small portable player that reads a 2½-in. optical mini-disc packed with a full album of music. And now, you can also record onto the disc—something you can't do at present.



PHILIPS DC-900 DIGITAL COMPACT CASSETTE PLAYER/RECORDER
Philips Consumer Electronics Co.

This is the future of the audio-tape format. A digital compact cassette provides the audio quality of a CD, but with the ability to record. The player also handles your present cassettes, making it the rare new format that doesn't make your old music obsolete. **PM**





COVER STORY

SARAJEVO DIARY

We fly aboard U.N. One One on a treacherous run to save a desperate city.

BY ABE DANE,
Science/Technology Editor
PM Photos by Sebastian Bolesch

● "Doesn't look good for the home team, guys," Capt. Andy Childers murmurs over the interphone. Ahead through the multipaned glazing of the C-130's flight deck we can see only solid white. But we know that rising into the mist on each side of us is a row of jagged peaks. Directly below, threading between the mountains, is the long valley that will lead us straight into the embattled city of Sarajevo, Bosnia-Herzegovina.

We're 9 miles out, descending and looking for a break in the clouds. "Not even a sucker hole," Childers laments to his copilot, Capt. D.J. Anderson, as they strain to catch a glimpse of Earth. The C-130 rumbles deeper into the valley and cockpit chatter dwindles to a steady stream of position updates from navigator Capt. Mike Hathaway: "Six and a half miles out . . . I've got the field on radar . . . We're lined up on it." Still, nothing is visible through the clouds.

What we're contending with this gray October morning are the first misty tendrils of a winter that promises to hit Sarajevo harder than anything it has yet endured. The incessant shelling and sniper fire of the past six months have not only killed thousands outright, but have laid the city open to this much greater peril. Windows are gone from nearly every building and supplies of basic necessities are cut off. Now the cold that once brought flocks of skiers to Sarajevo may bring death on a scale not seen in Europe since World War II.

Pitted against this grim specter is a small, international fleet of military airlifters organized by the United Nations. Aircrews and ground personnel from around the world have been putting their lives on the line daily for a humanitarian cause that transcends national boundaries. So far, one Ital-Childers banks for a hole in the clouds while Anderson drops the gear to burn off airspeed.

ian G-222 transport has been lost to a surface-to-air missile, and several other aircraft have been damaged by small-arms fire.

Our plane, callsign U.N. One One, is a 30-year-old Lockheed C-130E Hercules. It's on loan to the Air Force's 37th Airlift Squadron from the West Virginia Air National Guard especially for this mission. Aged though it may be, the C-130 is still one of the few aircraft in the world capable of doing what will have to be done today, and this particular example has a few high-tech tricks up its sleeve.

Most important of these is a system called Snowstorm, which automatically detects and decoys heat-seeking missiles by launching flares as they approach. "If Snowstorm doesn't work, we don't go," Capt. Carl Hunter, a navigator with the 37th, told me before our flight. "That Italian plane opened a lot of eyes."

Lashed to four pallets in our cargo bay are 26,000 pounds of military rations known as Meals Ready to Eat, or MREs. On past assignments, I've heard soldiers gripe about them, but given the situation in Sarajevo, there's little doubt that our cargo will save lives.

We depart Rhein-Main Air Force Base in Frankfurt, Germany, at 9 am local time. Approaching the border of Slovenia a little less than an hour later, flight engineer Master Sgt. Carl Fowlkes reads off the combat entry-point checklist, configuring the C-130 for battle, arming the Snowstorm system and telling us to put on our flak jackets. At this point, crew members also don helmets, 9mm pistols and vests packed with survival gear.

At 10:09 am, we cross into what used to be Yugoslavia. From now on, we're officially in the Area of Operations (AOR). If we deviate by more than 3 miles from the ground track that's been prearranged among the combatants and the U.N., we're fair game for whoever might want to take a shot at us.

To stay out of harm's way, we fly

SARAJEVO DIARY

southeast down the edge of the Adriatic Sea, not turning inland until we pass over the coastal city of Split at 11:02. Here begins the most dangerous part of the journey, the northeasterly run into Sarajevo. Loadmaster Master Sgt. Bo Sloan and crew chief Tech. Sgt. Scott Householder take up positions by windows in the cargo bay, holding pistol grips that will trigger flares manually in case they spot a threat that Snowstorm's electro-optical sensors somehow miss.

"Starting our descent," calls Childers, letting Sloan know to get things squared away in back. The approach to Sarajevo is tricky under the best of circumstances. The field lies at the bottom of a basin ringed by mountains on all but the northwest side, where a valley enters. The field's single airstrip is lined up with this valley, making it the only really safe avenue for air traffic.

We pick up the valley about 15 miles from the field and turn inbound. Then begins the delicate process of feeling our way down into the clouds. At 8500 ft., about 1000 ft. above the



Capt. Childers briefs the crew before takeoff at Rhein-Main Air Force Base.

tallest mountain in the vicinity, Childers stops the descent until we can catch sight of something solid to confirm our position.

Normally, getting a plane on the ground in this kind of weather is no big deal. The pilot just tunes in the field's instrument landing system (ILS), then flies the needles until he's a couple of hundred feet above the

runway. But Sarajevo's ILS transmitter was long ago knocked out. In fact, we haven't had contact with a working navigation beacon since passing Split half an hour ago. What's more, there's no radar on the field, the control tower has been badly shot up and the simple radar aboard the C-130 is intended for weather avoidance, not precision navigation.

That's where one of the more interesting new black boxes aboard this particular C-130 comes in. Gleaming like an emerald among the beat-up knobs and dials of navigator Hathaway's panel is the CRT screen of a new Smiths Industries Self-Contained Navigation System (SCNS). SCNS couples a ring laser gyro inertial measurement unit with a Doppler radar that gauges velocity over the ground. By merging information from these two sensors, SCNS can keep track of its location without wandering by more than .25 miles per hour of flight.

Normal procedures at Sarajevo call for the pilot to declare a missed approach and abort his landing if he can't see the field when he's a mile out. We're now within 4 miles, and Childers is seconds from having to decide. Hathaway feeds him the pertinent data: "Course good on radar . . . winds 328 at 13 . . . 2 miles out . . . 1 mile."

But Childers doesn't want to give up yet. "We'll cruise in toward the field, just in case," he says. Then Hathaway reports: "We're overhead," and that's the end of it. Childers banks left into a climbing 180-degree turn. We'll go back to Split, refuel and try again.

At least that was the plan when we left Rhein-Main. But all along, there have been signs of some higher authority watching over us and occasionally stepping in to revise things. A couple of times I've heard the pilots on the radio with someone they call "Magic," which turns out to be the



Antimissile system uses four Loral AAR-47 electro-optical sensors (top and left), to trigger Tracor ALE-40 flare dispensers (middle right). Sloan acts as backup lookout.

FRANKFURT

MERCY MISSION PROFILE



Flights are confined to a narrow corridor that keeps off the coast as long as possible. We re-traced the route for our second attempt into Sarajevo and the return to Frankfurt.

callsign for an AWACS radar plane orbiting somewhere in the AOR. Apparently, someone thinks it's worth keeping a lookout for hostile aircraft.

Then there are the two mysterious communications specialists operating a temporarily installed radio on the flight deck. When I first went aboard, they refused to give their names or even say what unit they were with. All they would tell me is that they were in touch with someone by satellite link. They wouldn't say who.

Orders apparently came from this unnamed entity that we should fly straight to Zagreb for refueling, rather than stopping at Split. So we retrace our steps out to the Adriatic, then up the coast and inland, landing at Zagreb at about 12:45 pm.

Zagreb is headquarters for U.N. operations in former Yugoslavia. Roughly 200 U.N. personnel are stationed there, and mercy flights from all nations pass through, picking up fuel and cargo for the run into Sarajevo. Still, despite warnings of landmines in the grass and trigger-happy Croatian guards, the field has a sleepy, pastoral feel to it.

While waiting for the crew to work out their flight plan, I pay a visit to Mike Aitchison, an Englishman who coordinates the whole airlift out of a cramped office in one of the airport's hangars. With a crushed U.N. ballcap set negligently on his graying scalp, and chain-smoking Rothmans, he is the picture of disheveled efficiency. As I enter he is speaking rapidly into the phone: "I could do with an ILS there, I could do with runway lighting, I could do with something to blow the bloody clouds away."

Aitchison doubts that the weather will favor our second attempt. "Funny sort of day," he sighs, aware that the problem will only get worse as

winter draws on. He gets on the phone with Sarajevo: "Should I cancel out completely? I would rather cancel than make a lot of abortive attempts."

A hulking Canadian ranger walks in carrying a C-7 rifle. "Can't you put that thing in your trousers or something?" asks Aitchison, seeming uncomfortable with such a large weapon in his small office. The Canadian, a major by the name of Appleton,



Hathaway's nav station includes radar and Snowstorm controls. SCNS console (left) lets him guide the plane to 65 electronically stored waypoints.



laughs. It turns out he's head of the U.N. engineering operation in Sarajevo, and is on his way back in to try to restore water and electricity to the city. Past efforts, he says, have been fruitless. "Technically, we could fix Sarajevo quite easily, but the problem transcends technology. Our repair teams have been shot at, ambushed, we've taken casualties."

We depart Zagreb at about 2:20 pm, with assurances that the weather over Sarajevo is improving. We won't arrive for more than an hour, so I step back into the cargo bay to get to know more about that dark, cavernous and thunderously loud part of the aircraft.

Lined with naked hydraulic lines, structural members and tiedown hardware, this is the utilitarian domain of loadmaster Sloan. His big moment will come when the rear cargo ramp drops in Sarajevo, and the scramble begins to offload. Three levers at the forward end of the bay let him control the locks that hold the pallets in place. Once released, the pallets move freely on rollers built into the floor, and can be pushed out onto a forklift by ground personnel.

If things get really hot while we're on the ground, Childers will order a combat offload. That means Sloan releases all the locks at once, then Childers revs the engines, so everything rolls out the back in a matter of seconds. "Not recommended for glassware," quips Senior Airman Phillip Ulmer, our public affairs escort.

In front of the pallets, is a clear area, where the crew's gear is stowed. The two crew chiefs, Householder and Tech. Sgt. Kenneth Burkhardt are sacked out here on nylon troop seats. For them, the tough part of the mission won't come until we're home. As a rule, there's about 8 hours of maintenance and repair work to be done after each flight. "Sometimes you put in long days, sometimes you don't. It depends on how bad it's broke," says Householder.

Out over the Adriatic at 2:45, we go through the combat entry-point checklist again. Fowlkes dumps the fuel remaining in the wing manifolds after our recent fillup to prevent it from exploding if we're hit. Also on the checklist are lowering cabin pressure to reduce potential damage from sudden decompression, and bumping up engine power by closing the bleed



air valves that normally provide air conditioning.

We head down the coast, past Split, and inland. Below, the blanched terrain grows steadily more mountainous, and the clouds more dense. At 3:22, about 10 minutes short of our estimated arrival time, we pick up the French-accented voice of Sarajevo tower: "U.N. One One, you're number one for visual approach. Descend at your convenience." And back into the clouds we go.

A few minutes later, we're leveled off at 9500 ft., lined up with the valley and 17 miles out. Conditions seem unchanged from our first attempt. We step down to 8500 ft., and still see nothing. Hathaway begins his countdown, "Ten miles to the field . . . 8½ miles out."

With 4 miles to go, and the field on radar, Childers decides the widening valley gives him a bigger margin for error. "I'll ease her down a little more," he says, and we descend through 8000 to 7800, and then 7500—barely 100 ft. above the mist-covered mountains. "Two miles out . . . one-

half," and then Hathaway says we're over the field. Nothing to do but give it up and head for home.

But now a warbling tone comes over my headset. The missile warning! "Threat right front," calls Hathaway. But Childers can't turn into the missile the way he should. In the tight confines of the valley, he's got to turn left, exposing our four hot turboprops to the missile's infrared seeker. "Launch a flare," says Childers, but it's already away, fizzing lazily downward behind us. All we can do is hope it works, or that the warning is a false alarm.

A moment later, Childers' gaze shifts abruptly. "Hold it!" For a second, the uninterrupted whiteness below gives way to a watery dark gray, then streets, houses and . . . "I've got the field in sight," he says, staring nearly straight down through a window by his left foot. Now all he has to do is get us out of the clouds without losing his precarious fix on the field.

To do it, he'll have to show why this old C-130 is still one of the best tactical airlifters around.

Childers yanks out the power, deploys full flaps, and lets down the landing gear to slow us down. We begin to drop like a rock. Heeled over in a 60° bank, we go into a spiraling, 6000-ft.-per-minute dive pilots call a "max performance descent." In no time, we've broken out of the clouds, but Childers doesn't pull up until we've lost more than 5000 ft. By the time he levels off, we're set up comfortably on the downwind leg of a normal traffic pattern.

We stay high until the last minute to minimize the danger from small-arms fire, then we settle sharply toward the runway in a 6° final approach. That's about twice as steep as normal, but the landing is tolerably smooth. We're down! Suddenly we're in the midst of a war, taxiing past heavily dug-in armored personnel carriers, and being marshalled to a





Crack U.N. crews handle the offload. Armored cars (above) will escort supplies to the city. Happy to be home after the 10-hour trip are (left to right) flight surgeon Col. Earl Ferguson, Childers, Sloan, unidentified, Fowlkes, Edsill, Hathaway, Dane and Anderson.



stop by a blue-helmeted U.N. soldier in body armor.

Photographer Sebastian Bolesch and I know we'll have only minutes on the ground, so we scramble back to the cargo ramp and wait. It falls and the dull gray light of Sarajevo floods in. Sloan jumps out to put a support under the ramp, then clambers back in to man the locks. A forklift is already waiting.

Ulmer and I make for the terminal to have a few words with the small U.N. contingent stationed here. The first person we buttonhole is a tall, flak-jacketed young Frenchman named Marc Vachon. Shouting above our still-running engines, his description of the situation displays a remarkable command of English obscenities.

"The problem is a sniper living in the house down there. And the mother—'s shot at us all the times. You never know when they shot at you or not . . . 2 o'clock today they hit the

car. This morning again. Three days ago, two shots over my head, a meter over my head . . . But this is okay. You're used to that."

The impression I get is that although fighting in the city has been intense the past few days, the airport itself has come mostly under harassing fire. Vachon had praise for the French battalion protecting the airport, but thought they were perhaps too tolerant of the local sniper, "I mean before, Canadian people was there shot him back. French are more diplomatic."

A few minutes more and we get the signal that our plane is ready to depart. We cut the interview short and run across the apron. Childers has already explained that he'll have no hesitation in leaving without us.

Ulmer, Bolesch and I jump in and the ramp comes up. The offload has gone smoothly, completed in less than 18 minutes, but now a hitch develops. Another plane is inbound, and we

can't leave until it lands.

Agonizing minutes later, we're cleared. Childers, eager to blast us out of here in short order, lines us up for an assault takeoff. The engines wind up to full power and he releases the brakes. Now empty of cargo, the Herc bolts forward and a scant 2000 ft. down the runway Childers yanks us into a steep climb. The missile warning sounds again. "Launch 'em," says Childers. We wait. Nothing. No impact. No shattering explosion. We spiral up into the clouds.

Breaking into the sunlight, the shadowy grimness of Sarajevo melts into a memory. We take up a course for the Adriatic coast, the setting Sun low in the sky ahead of us, radiant puffs of cloud suffused with its light. Sgt. Troy Edsill, one of the mysterious communications people who has by now overcome his wariness of the press enough to identify himself, offers a big hazelnut chocolate bar around the flight deck. Childers comes on the interphone, "Good job, crew. Way to hustle and get that thing done." **FM**





*Based on M.S.R.P. of Preferred Equipment Group BAA6 versus equipment purchased separately. Maximum savings on 2WD model \$1900. Maximum savings on 4WD model \$1484. See your dealer for details. †On 4WD models anti-lock brakes operate in 2WD only. **Based on full-line truck company registration data 1982-1991. Excludes other GM products. Chevrolet, the Chevrolet Emblem and S-10 are registered trademarks and Chevy and Tahoe are trademarks of the GM Corp. ©1992 GM Corp. All Rights Reserved. Buckle up, America!

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LIKE A ROCK





MODERN M

The new Chevrolet Camaro and Pontiac Firebird set the tone for high-performance cars of the '90s.

BY JOE OLDHAM, Editor-In-Chief

● The first thing you have to swallow is that the Camaro and Firebird aren't kids' cars anymore. Gone are the hard ride, the tires bulging out of the fenderwells and the rubber-burning macho swagger that made Chevrolet's Camaro and Pontiac's Firebird the cars of choice for young men and women suffering from slight ego problems. Hey, you've grown up and matured and so have the GM F-cars.

What you'll find now is a maturity, a sophistication that has been unknown in these cars. You don't have to be embarrassed to be seen driving a '93 Camaro or Firebird, even if you're older than 30. These are adult cars for

adults. But they're also very fast and handle like world-class sports cars.

The sheetmetal—and, on vertical surfaces, sheet plastic—is all new. So are the interiors, the front suspension, the rack-and-pinion steering and the powertrains. On the other hand, though substantially revised, the chassis is familiar—front engine, rear drive, live rear axle. So is the body-on-frame construction. And the wheelbase is identical to the old.

What emerges is GM's interpretation of the ponycar for the rest of the century—a blend of proven concepts,

contemporary styling and a kinder, gentler style of high performance.

Driving the Firebird Trans Am

If you equate kinder and gentler with tepid, better check the powertrain. The new Trans Am offers lots more scoot than its predecessor, thanks to its 5.7-liter Corvette LT-1 V8. The Trans Am's exhaust plumbing, constrained by engine-bay dimensions, trims a few ponies off top-end output, but 275 hp and 325 ft.-lb. of torque is more grunt than you could get in any previous-generation Trans Am.

Bolted to the superb new Borg-Warner 6-speed manual transmission (a 5-speed manual is standard on the basic Firebird, powered by GM's 160-





MUSCLE

hp 3.4-liter V6; a 4-speed automatic is also available), this is enough go-power to put the new Trans Am squarely in the middle of, or ahead of, its competition. Cars like the Nissan 300ZX 2+2, Dodge Stealth and Mitsubishi Eclipse are raw meat for the brawny V8 Trans Am. Among its competitors, only the Mustang 5.0 can out-accelerate the Trans Am.

Stung by incessant criticisms about a bone-jarring ride, Pontiac's chassis team dialed more compliance into the Firebird's suspension. With new upper and lower control arms replacing the old front struts, the setup provides a much more civilized ride, with hardly a trace of the harshness and wheel hop of the past generation.

That's the gain. The loss is in abso-

lute handling. The new Trans Am doesn't attack turns with the enthusiasm of the old. Improved compliance equals increased understeer, and while the new car is easier to drive quickly, and is more forgiving, it lacks the old car's sense of race-readiness.

But how many of us prefer the occasional rush of hard-edged handling to everyday comfort? The goal of the chassis tuning, the swoopy new skin, the improved sound-deadening and the beautifully contoured interior is to give the Firebird refinement and grace that it previously lacked.

Driving the Camaro Z28

We tested two instrumented LT-1-powered Z28s at the Canadian Automotive Test Centre, the Canadian

government's test facility near Montreal. The bright red automatic ripped off 0-to-60 mph runs of 6.7 seconds consistently, while a 6-speed equipped car was able to knock that down to 5.9 seconds. Quarter-mile times for the automatic were 14.94 seconds at 95.7 mph while the 6-speed was quicker at 14.74 seconds and 96.6 mph. Top speed for both cars was exactly 145 mph, where the ignition cutout activated due to the car's P245/50R16 tires being speed-rated to "only" 150 mph.

What's more important than all of our track testing, though, is the fact that we could drive the Camaro very fast on regular roads and still feel safe and stable. And isolated. The cockpit is quiet, the suspension is smooth, your butt is pampered by the new seats. Yet, you're storming around slower traffic and attacking freeway on-ramps. It's all very, well, Japanese-like. Guess this is the future of the American muscle car. Ah so. **PM**

Automotive Editor Tony Swan contributed to this story.



AUTOMOBILES

CARS OF THE

A parade of presidential cars reflects the evolution of the office—and of America as a whole.

BY DAVID W. FREEMAN



Taft's 1911 White Steamer was among the last steam cars made in the U.S.



● Sometime within the next decade, perhaps on a winter's day not unlike today, the president's sleek, black limousine will be driven to a classified location somewhere along the East Coast and blown to kingdom come. Not as the result of an awful mistake. Not by a terrorist bomb. But in a hail of bullets and explosive rounds unleashed by federal agents demonstrating their loyalty to the president.

"It's a means we use to protect the vehicle's confidentiality," explains Secret Service armored vehicle specialist Don Worley, "plus a learning tool we use on the retired cars." In other words, by firing on the vehicle with an arsenal of weapons, Secret Service agents find out just how effective its sophisticated armor really is. At the same time, they're ensuring that top-secret technology contained

within the limo will never fall into the hands of kooks or would-be assassins.

Trying to obtain information about presidential limousines—especially limos still used to transport the president—is a study in frustration. Fearful that loose lips will jeopardize the president's safety, no one in the know will talk specifics. Not the automobile companies that build the cars, not the coachbuilders that armor them and certainly not the Secret Service. What sort of armor is used? Classified information. How much does the car weigh? Classified. Do the windows roll down? Ditto.

Fortunately, with the assistance of the Henry Ford Museum, where conservators have had the chance to scrutinize several presidential limos retired before implementation of the kingdom-come policy, POPULAR ME-

CHANICS has managed to piece together a history of our chief executives' automobiles.

Years after the first horseless carriages began plying the nation's roads, America's chief executives remained loyal to the traditional "carriage-and-four" horse-drawn carriage. In fact, no sitting president even rode in an automobile until July 13, 1901, when William McKinley was taken for a brief spin in a Stanley Steamer.

President McKinley's successor, Theodore Roosevelt, had cultivated an image as a rough-riding horseman and was disinclined to make the switch to motorized travel. Roosevelt did, however, permit Secret Service agents to trail behind his horse-drawn carriage in a 1907 steam-powered vehicle manufactured by the White



Packard took Harding to inaugural.



Hoover rode a Pierce-Arrow to his swearing in.

PRESIDENTS



A 1989 Lincoln Town Car is the newcomer in the presidential garage. Security concerns keep all but the most general information off limits.

FORD MOTOR CO. PHOTOS

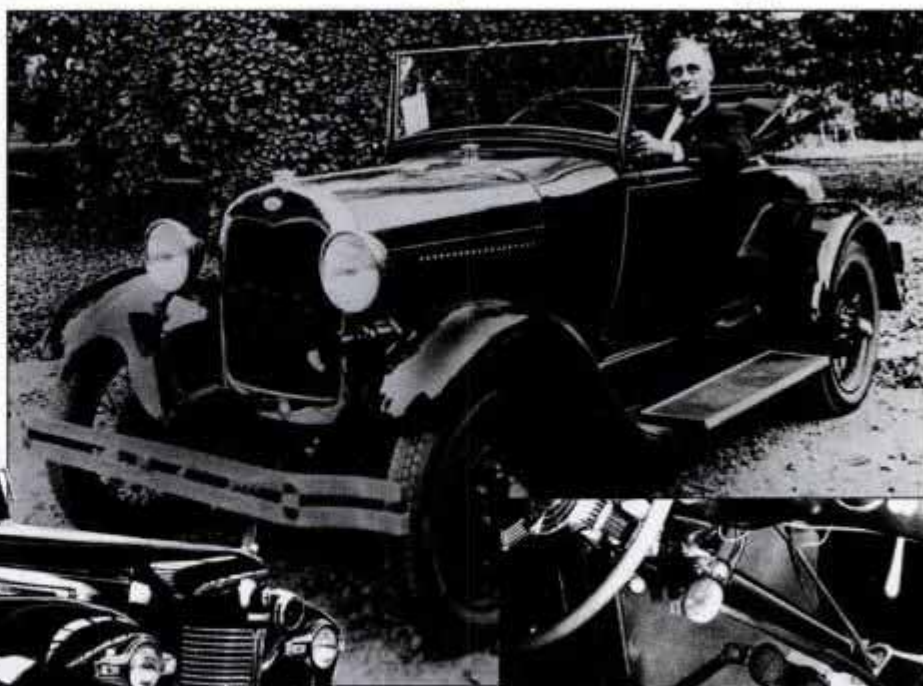
Sewing Machine Co. of Cleveland, Ohio.

President William H. Taft changed things. Soon after his 1909 inauguration, the new President hired a chauffeur and converted the White House stables into a garage, installing a large gasoline tank where feed bins had been and replacing horseflesh with mechanical horsepower. Using \$12,000 appropriated specifically for the purpose, Taft's chauffeur assembled a 4-car fleet: two luxurious Pierce-Arrows, a zippy little Baker electric car (favored by Mrs. Taft) and a 1911 White Steamer, among the last of the steam-powered cars produced in the United States. The \$4000 Steamer became a favorite of the camera-shy president when he discovered

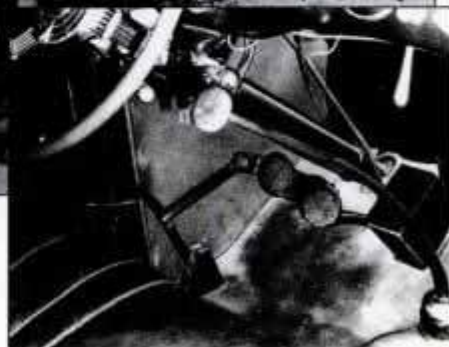


he could conceal himself from pesky press photographers with a carefully timed burst of steam.

Although Woodrow Wilson rode to his 1913 inauguration in the traditional horse-drawn carriage, once in office



F.D.R.'s fleet included the Sunshine Special (above) and a Ford Model A. Hand controls (inset) let him drive his Ford Phaeton.

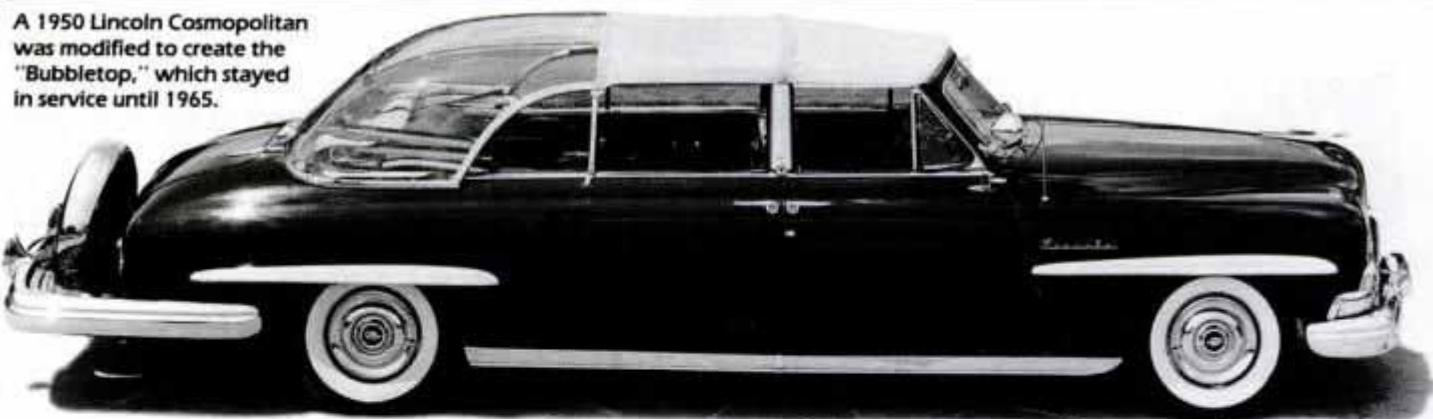


FRANKLIN ROOSEVELT LIBRARY PHOTOS

CARS OF THE PRESIDENTS

A 1950 Lincoln Cosmopolitan was modified to create the "Bubbletop," which stayed in service until 1965.

HENRY FORD MUSEUM PHOTO



he proved an enthusiastic advocate of automobile travel—even going so far as to join the American Automobile Association. In 1916, Wilson bought three Pierce-Arrows, including a right-hand-drive sedan built in 1916. The president grew so fond of this automobile that he bought it for \$3000 upon leaving office.

Although Warren Harding died only two years into his term, he gets credit for two important automotive firsts. He was the first president-elect to ride to his inauguration in a car (a Packard Twin-Six) and the first qualified driver elected president.

During his 12 years in office, Franklin D. Roosevelt procured a dizzying array of vehicles, including a 1933 Cadillac and a 1936 Packard Twin-Six. In 1936, defying Secret Service rules strictly forbidding sitting presidents from getting behind the wheel, F.D.R. bought a Ford Phaeton (coupe) and had it equipped with hand controls. (F.D.R.'s legs had been crippled by polio.) In December of 1939, Roosevelt took delivery of a 1939 Lincoln V12 convertible—the Sunshine Special. This car, built by Lincoln Motor Co. in Detroit and Brunn & Co. coachbuilders in Buffalo, New York, was to become the president's best-known steed—the one that would accompany him to historic wartime summits at Yalta, Casablanca, Tehran and Malta. It was also the first presidential limousine built to Secret Service specifications and the first to be leased rather than bought.

Built on a massive 160-in. wheelbase, the Sunshine Special boasted room for 11 occupants, rear doors hinged at the rear rather than the center post, heavy-duty suspension, twin side-mounted spare tires and, to accommodate the ubiquitous Secret Service agents, external standing platforms and extra-wide running boards. In 1941, the car returned to Buffalo, New York, to have its top lowered 3 in.—a concession to prevailing tastes in automotive design.

In 1942, following the attack on

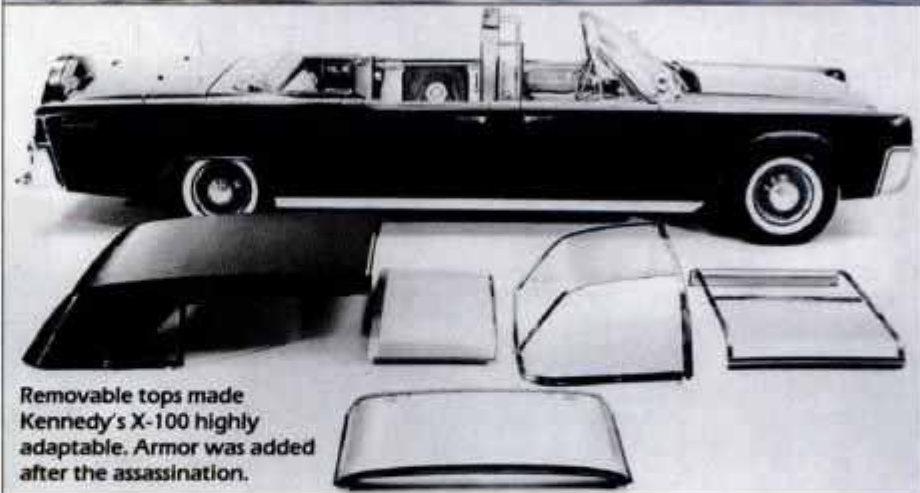
Pearl Harbor and America's entry into the war, the Sunshine Special returned to Lincoln's Dearborn, Michigan, factory for the addition of protective armor. There the car received, not only concealed steel plate and inch-thick bulletproof glass, but also metal-clad flat-proof inner tubes, a radio transceiver, a siren, red warning lights and a compartment for sub-machine guns. Upon completion of these modifications, the car was 6 ft. longer than before and weighed a formidable 9300 pounds.

convertible prepared especially for President Harry Truman. The president's elegant, low-slung Cosmopolitan convertible was 20 ft. long and 6½ ft. wide. It weighed almost 6500 pounds, roughly 1700 pounds more than a stock Cosmopolitan.

In 1954, at the suggestion of President Eisenhower, the Cosmopolitan convertible was fitted with a dome-shaped plexiglass roof. The "Bubbletop," as the car quickly came to be known, carried President-elect John F. Kennedy to his inauguration and



WHITE HOUSE PHOTO



Removable tops made Kennedy's X-100 highly adaptable. Armor was added after the assassination.

HENRY FORD MUSEUM PHOTO

In 1950, the White House leased a fleet of 10 custom-built 1950 Lincoln Cosmopolitans. All the cars were painted black, and all were built with extra headroom to accommodate the tall silk hats popular at the time. Nine of the cars had enclosed bodies, built by the Henney Motor Co. of Freeport, Illinois, a coachbuilder better known as a builder of ambulances. The 10th car was an armored 4-door

remained in service until 1965.

In June of 1961, President Kennedy took delivery of a highly modified 1961 Lincoln Continental, costing almost \$200,000.

Assigned the Secret Service code name X-100, the dark blue car was, at the time, the most sophisticated presidential limo ever built. Inside, the car was equipped with a heavy-duty heater and air conditioner, a pair of



1983 Cadillac's raised greenhouse made Reagan highly visible.

radio telephones, a fire extinguisher, a first-aid kit and a siren. Stowed in pockets alongside the rear seats were two lap robes, each embroidered with the presidential seal. Outside, there were the now-familiar retractable foot stands and detachable grip handles, a grab rail for the president and spotlight-illuminated flagstuffs on the front fenders. Flashing red lights were recessed into the front bumper.

Capping the X-100's long list of unique features was a set of three removable roofs—a standard cloth con-

In the aftermath of the Kennedy assassination, the X-100 underwent a redesign that was to cost more than \$500,000. When the car returned to Washington on May 11, 1964, it had a new black paint job, improved telecommunications gear, a more powerful engine and flat-proof tires made of rubber-coated aluminum. The gasoline tank had been protected against explosion not by sheathing it in heavy armor, but by filling it with a porous foam matrix that minimized spillage in the event of a tank rupture. A pro-

deck received structural reinforcements—a measure made necessary after a playful leap by President Johnson caused the original deck to collapse.

In 1974, the White House took delivery of yet another Lincoln limo, a 22-ft. version of the standard 1972 Lincoln Continental. This 6-passenger car, leased from Ford Motor Co. for \$5000 a year, had a 460-cu.-in., 214-horsepower V8 engine and was equipped with external microphones that enabled the occupants to hear sounds outside. In addition to full armor plate and bullet-resistant glass, the car had built-in racks designed to hold Secret Service submachine guns.

Ironically, it was this heavily defended vehicle President Ford was using the day a shot fired by Sara Jane Moore narrowly missed him on a San Francisco street. It was also the vehicle that rushed President Reagan to a Washington, D.C., emergency room after he was shot by John Hinckley.

The next presidential limousine to join the White House fleet was not a Lincoln, but a 1983 Cadillac. This car, delivered on Jan. 30, 1984, is 17 in. longer than the stock model. Like many of its predecessors, it is clad in armor and bulletproof glass and is distinctively styled, with a raised roof and a large rear greenhouse. To accommodate the weight of the armor, the Cadillac has oversized wheels and tires and is equipped with special heavy-duty brakes and an automatic leveling system. In addition to the now-standard external foot stands, the car features a rear grab rail that folds down into the rear deck when not in use. This car and a sister vehicle remain in service to this day.

In January, 1989, the White House took delivery of the latest presidential vehicle—a highly modified 1989 Lincoln Town Car. The car is 22 ft. long and more than 5 ft. tall. In the interest of the president's security, the Secret Service has released very little information about this vehicle. "It is armored," allows Don Worley. "However, the degree and area of armoring are classified." **PM**



1972 Lincoln was present at attempts on the lives of Ford and Reagan.

vertible top plus one of lightweight metal and another of transparent plastic. The hardtops, each consisting of multiple removable panels, could be used separately or in various combinations, depending upon the weather and the president's wishes. The idea was to make the president more visible to onlookers as the motorcade sped by. To enhance visibility even more, the rear seat was equipped with a hydraulic lift that raised the bottom cushion 11 in. off the floor. These modifications did make the president easier to see, but they also exposed him to needless danger—a fact made catastrophically apparent on Nov. 22, 1963.

tective cocoon now was formed around the passenger compartment by 1600 pounds of armor. The three removable tops had given way to a fixed glass roof, costing more than \$125,000. The new glass roof consisted of 13 separate pieces of glass, ranging in thickness from 1 in. to 1¹³/₁₆ in. The massive rear window alone weighed 1500 pounds. At the time, it was the largest piece of curved bullet-resistant glass ever cast.

In 1967, the X-100 got another paint job, an upgraded air conditioning system, and the right rear door window—which had been fixed in place—was converted to a roll-down window. At the same time, the rear

GERALD R. FORD LIBRARY PHOTO

EXHIBIT

POSSIBLE DREAMS

Restoring America's classic treasures has always been a favorite national pastime.

BY MARY SEELHORST

● By 1912, **POPULAR MECHANICS** had already developed a reputation for celebrating progress. So readers may have been surprised to see "The Great Gift Of Gasoline," a sarcastic article that lambasted gasoline while lamenting the horse. To most enthusiasts of the new mechanical age, Old Dobbin was merely an unfortunate victim of progress, not a romantic symbol of bygone days. And **POPULAR MECHANICS** rarely reveled in the past—until recently, that is.

As America prepared for its 1976

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

Bicentennial, **PM** and its readers began looking to the mechanics of the past with the kind of enthusiasm usually reserved for the technology of the future.

Don't get me wrong—**PM** still makes predictions and covers the latest trends. But in the midst of today's electronic revolution, increasing numbers of enthusiasts are embracing older, more familiar technologies in their hobbies, workshops and lifestyles. And their interests are reflected in **PM's** pages—a retro revival that stands out from **PM's** usual forward spin like The Old

Grey Mare at Bonneville.

In Henry Ford Museum's exhibit "Possible Dreams: **POPULAR MECHANICS** and America's Enthusiasm for Technology," the "Recycling The Classics" section takes a look at America's recent rage for preservation, restoration and traditional craftsmanship.

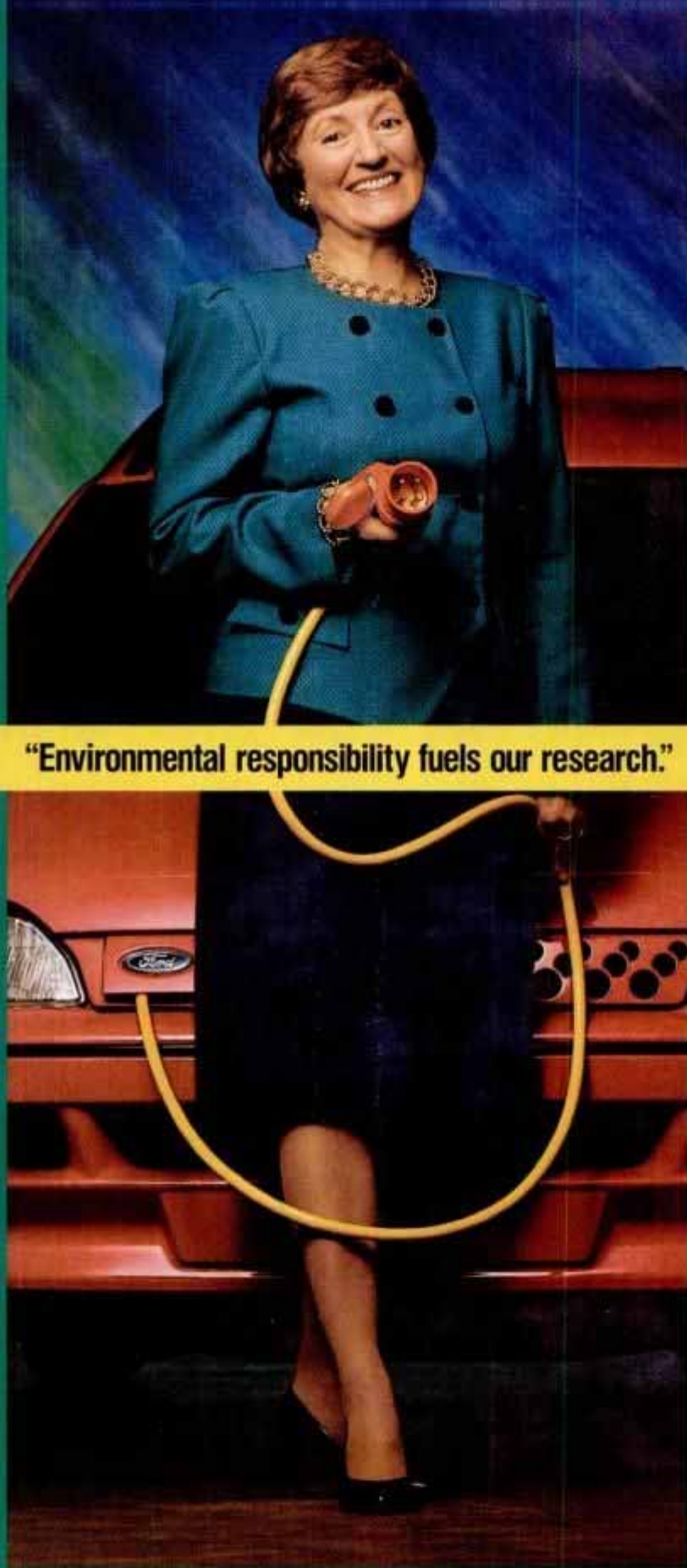
Back to "The Great Gift Of Gasoline" for a moment. Besides cursing the car and the motorboat, the author asked his readers to "consider, first of all, the farmer's little stationary engine. Time was when handsome, finely dressed, perfectly spoken gentlemen toured the country elegantly, selling treadmill threshers and such. Where are they today? Dead, perchance, of starvation . . . hurled out of business and activity and income by the onrushing tide of gasoline!"

What a difference a few decades

makes. The same little engines that drew curses in 1912 are today lovingly restored by dedicated enthusiasts. A bright red 1905 portable gasoline engine, restored by the Early Engine Club of Southeast Michigan, is on display in

(Please turn to page 101)





Roberta J. Nichols, Ph.D.
Ford Environmental Engineer

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HOW TO RESTORE



Part 6: Interior And Convertible Top

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

● The smartest—or luckiest—part of this whole Camaro restoration project was choosing a Camaro in the first place. If we were working on some ancient Bugatti, for example, at this point we'd be sitting with a \$10,000 stack of cowhides, trying to figure out how to turn them into an interior. Naturally, there would be no patterns to follow.

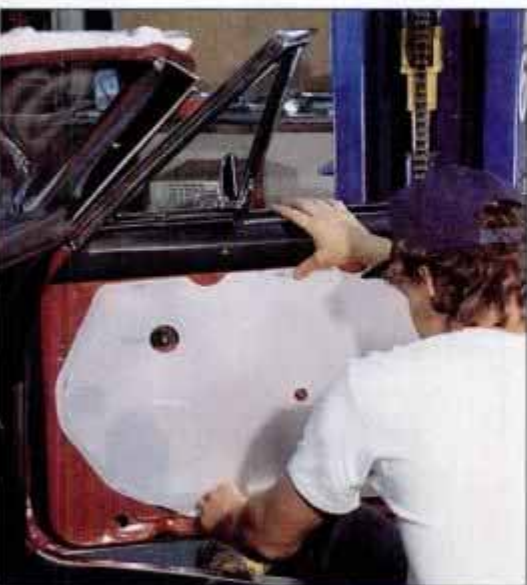
Restoring a Camaro is a snap by comparison. One call to Steve Drucek at D&R Classic Automotive and we received a box via UPS containing: One (1) Interior, Deluxe, Camaro, 1967, Parchment. All we had to do was install it.

Well, there was a little more to it than that. We started with the dashboard—this had already been sprayed the proper semigloss black. We cleaned up the stock instruments, reset the odometer to zero and reinstalled the instrument binnacle.

While we were in that corner, we put new pads on the brake and throttle pedals, new knobs on the dash controls and a reproduction urethane dash pad across the top edge of the dash. We also installed reproduction sun visors, a reproduction interior rearview mirror and the chrome trim that covers the inside of the windshield pillars.

D&R sent us to Custom Autosound in Anaheim, California, for a radio. These clever folks sell modern car radios, but with faceplates and controls that replicate those found in old cars. We got a model USA-04. This is an AM/FM/cassette stereo with a built-in 40-watt amplifier, but styled to look like the original radio that came in our Camaro 25 years ago. A pair of small stereo speakers fit beneath the stock dashtop 6 × 9-in. cutout, and a pair of Pioneer TS/TRX40 3-way speaker systems bolt into the trunk beneath the well for the convertible top. The result? A completely hidden stereo system that provides 1993 sound qual-

AN OLD CAR



PM Contributing Editor Rich Taylor and buddy Ken Barnes tag-team staple the rear window to the top bow (above left). Ken installs new door weatherproofing panels and doorsills (above).

ity in our classic 1967 car.

We progressed to the power top. These Camaros use a very standard General Motors top mechanism with a hydraulic top cylinder at each side, pump/reservoir in the center behind the rear seat and clear plastic lines filled with ATF connecting the pump and cylinders. It's a simple and relatively foolproof design. Our rebuilt system came from Kanter Auto Products in Boonton, New Jersey.

The convertible top frame must be bolted in before the interior trim panels are installed and hide the top frame pivots. We cleaned and repainted the top frame gloss black before in-

stallation. The surprisingly heavy top frame bolts to the car in three spots on each side—it's easier to install if two people put the folded top frame in position.

You start by bolting the fixed pivot on each side to its mount. Then you swing the frame forward until you can bolt the front pivot to the extended hydraulic piston on each side. Finally, unfold the top frame and bolt the adjustable pivot to its mount on each side. Adjust the top frame fit by moving this pivot point up or down as needed.

Wise restorers stay away from convertible top work on these old General Motors cars. Fools rush in. After we tested the hydraulic top mechanism, we put the top frame up. Step one was to align the top frame. Then we ran new padding pockets from the front bow to the rear, stapled them in place and added two layers of padding.

Probably the silliest bit of engineering in this whole Camaro is the convertible top/rear window. The top well boot, the rear window and the top all staple to three pieces of metal channel containing compressed paper. Honest! This channel is then bolted to the car, which, in theory, stretches all three pieces of cloth-backed vinyl to the proper tension. Right!

Just to complicate matters, the top well boot goes over the top of the channel, hiding it from view when installed—and hiding it from the installers as they're trying to bolt it in. It literally takes all day for two people to fit and adjust the convertible top. There's nothing difficult about it, but as you're juggling three different pieces of vinyl, a hair dryer for smoothing the vinyl and the staple gun, you're thinking: "In 15 minutes I could come up with five better top designs than this!"

Next, we laid out our sound-deadening pads for the floor, followed by the molded carpet. Compared to tag-team wrestling the convertible top, this is a dead cinch.

Once the carpet was in place, we installed new doorsills from D&R as well as our center console. The console was stripped and repainted and

the trim polished. Then the unit was reassembled and installed as a sub-assembly. With the console in place, we could add the stock console gauges and our new shifter.

Obviously, the stock 2-speed Powerglide shifter would not work with our TH700R4 4-speed automatic transmission. But B&M came up with a cable-operated MegaShifter that fits into our console perfectly and looks very much like the stock '67 shifter. We did have to fabricate an aluminum adapter plate to mount the shift lever in the console, but that was a minor chore.

Next came reproduction rear side panels and ashtray panels from D&R. These arrive preformed and install easily with a half-dozen trim screws



USA-04 '60s-style radio and Pioneer TS/TRX40 speaker systems came from Custom Autosound. The radio perfectly matches the dash. Trunk-mounted speakers are hidden by top well boot.

each. The new door panels were more trouble. These reproduction Deluxe panels are molded plastic, surprisingly expensive and not made as well as we would have liked. We had to modify the molded backing with a heat gun in order to fit them to our doors. Then we had to move all the mounting brackets to line up with the mounting holes in our doors.

Surprisingly, Camaro door panel trim is not available in reproduction. We had to remove the trim from our old panels, clean it up and then install it on our new panels before hanging the whole assembly on the doors. Be-

HOW TO RESTORE AN OLD CAR



Ken neatly reupholsters seats using a kit from D&R Classics. Premade vinyl covers are installed using traditional hog rings. Our Parchment interior is totally new, but also completely authentic.

fore hanging the door panels, we securely glued repro weatherproofing panels over the inner doors and sprayed the window sills the proper semigloss black. With the interior panels in place, we then installed new door handles and window cranks.

Camaro seats are a snap to restore. The rear bench seat is made up of two simple pieces—the bottom and the back—each built around a metal frame with padded flat springs, foam rubber cushioning and vinyl surfaces held in place by the time-honored use of upholstery hog rings. With the seat frames stripped, it's an easy matter to clean up the springs, lay out new foam padding, fit reproduction Deluxe seat covers, stretch them tight and fasten them with new hog rings. We installed new rear seatbelts, then snapped the two pieces of the reupholstered seat into place.

Camaro front buckets are equally

easy. We took each apart, cleaned up the frames, repainted the mounting feet, installed new molded foam seat forms from D&R, hog-ringed the vinyl in place, spray painted the steel seat backs, bolted the complete back to the complete bottom and bolted the whole unit into place along with new seatbelts.

It would be literally impossible for even a professional restorer to recreate molded door panels, for example, or many of the other plastic parts that go into the makeup of a modern automotive interior, even one from 25 years ago. And searching junkyards often results in little more than muddy shoes. Thanks to the easy availability of reproduction parts, however, restoring a popular model like our '67 Camaro couldn't be any easier. With only a few annoying exceptions, everything you need is available—albeit at a price.



Hydraulic top pump/reservoir hides behind the rear seat. Rich and Ken adjust the fit of the convertible top frame by moving mounting point of top frame pivot (above).



SOURCE LIST

Some of the suppliers for this project:

- Auto Body Specialties, P.O. Box 455, Middlefield, CT 06455; (203) 346-4989 (Body parts)
- B&M Automotive Products, 9152 Independence Ave., Chatsworth, CA 91311; (818) 882-6422 (Engine and drivetrain components)
- 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)
- Classic Industries, 17832 Gothard St., Huntington Beach, CA 92647; (714) 847-6887 (Full line of Camaro parts and accessories)
- Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; (800) 251-6336 (Repro tires)
- Custom Auto Sound, 808 West Vermont, Anaheim, CA 92805; (800) 888-8637 (Replacement car radios)
- 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 Schmeman Rd., Warren, MI 48089; (800) 521-0628 (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)
- Echlin/Accel, Box 142, Branford, CT 06405; (203) 481-5771 (High-performance ignition products)
- 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; (800) GM USE US (Body, suspension and trim parts)
- Goodyear Tire and Rubber Co., P.O. Box 9125, Akron, OH 44305; (216) 796-2490 (Contemporary tires)
- Jones Racing Products, Route 611 and Annawanda Rd., Ottsville, PA 18942; (215) 847-2028 (Engine accessory drives)
- 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 (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)
- Rallye Wheel Components, 3633 Lancaster Dr., Eugene, OR 97404; (508) 689-6867 (Rallye wheels and trim)
- TIP Sandblast Equipment, P.O. Box 649, Canfield, OH 44406; (800) 321-9260 (Sandblaster, bead blast cabinet, paint sprayer)
- Walker Manufacturing, 1201 Michigan Blvd., Racine, WI 53402; (800) 767-DYNO (Exhaust system)
- Wurth USA, 93 Grant St., Ramsey, NJ 07446; (800) 526-5228 (Fasteners)

At this point, our Camaro is 95% finished. We're still fiddling with a few little things under the hood—like the heater hoses and alternator brackets, the damn hideaway headlights still aren't working perfectly and we're waiting for the transmission "TV cable" to arrive at the local Chevy dealer. We also have some minor exterior detail work—touch up a couple of paint chips and buff out the whole car.

But if all goes according to plan, within two weeks we'll be cruisin' down the road in a better-than-new 1967 Camaro—a Camaro we put together ourselves. We're expecting to like that feeling. Like it a lot. **PM**

ELECTRONICS

TECH WATCH

Having the right time means having the right watch for the occasion.

BY FRANK VIZARD, Electronics Editor

● Time began at night. The ancient Egyptians gave us the 24-hour day by first marking a 12-hour cycle across the night sky. Each hour marked the time between each major star or group of stars rising on the eastern horizon. A 12-hour day was added to balance the cycle.

We still mark the passage of time in 12-hour cycles but for most of us, the movement of stars across the night sky has been replaced by the movement of the second, minute and hour hands across the face of a watch worn around our wrist.

Today's watches, though, tell more than just time. For the Swatch fan, they're collectibles. For the Rolex and Breitling crowd, they're 4-, 5- or



KRIEGER LUNAR
CHRONOMETER

PHOTO BY BRUNO WISCHOFF; BACKGROUND PHOTO BY DON CHAFFIN/LUMINAGE BANK

TECH WATCH



Casio's digital G-Shock watch monitors temperature changes.

even 6-figure status symbols—a complement to the fancy car in the parking lot that's just a little too big to bring to the restaurant table.

Move past the glitz, however, and you'll learn there are numerous watches that mark time in many unique and precise ways, often in a fashion suited to a specific application or purpose.

Among the most unusual and one of the application-specific watches is the lunar chronometer designed for hunters and fishermen made by Krieger Watch Corp. Unlike other "Moon watches" that only tell you the phase of the Moon, the Krieger Lunar Chronometer is programmed to track the movement of the Moon in the visible sky and at the opposite end of the Earth. The watch also provides the time of the Moon's transit over the

meridian and shows the changing nature of the visible Moon as lunar days progress.

This lunar information is valuable to outdoorsmen who've noticed the effect of the Moon's gravitational pull on animal life. When the Moon's gravitational pull is strongest, animal life tends to be more active. During these optimum periods, fish catches and game kills may be significantly increased, says Krieger. The Lunar Chronometer makes determining these peak periods of activity easy. The Lunar Chronometer is ruggedly constructed and is water resistant to 330 ft. List price for this Krieger watch is \$725.

Boaters and surfers, meanwhile, might prefer Krieger's Tidal Chronometer, listing for \$735. This watch displays the state of the tides for whatever port or beach you're presently visiting. You can also count the



Krieger's Tidal Chronometer shows high and low tides in any port of call.

might need to be reminded when to start shutting down an atomic reactor." The Ingenieur comes with seven hands and two step motors, among other features. List price for this precise wakeup call is \$4500.

Chronographs abound for less stressful uses, the latest of which have analog rather than digital displays. Chronographs are generally distinguished by additional smaller dials on the face and a rotating bezel keyed to numbers around the edge of the watchface. Pulsar's \$295 Navichron model, for example, has three miniature dials—a dual time indicator for keeping track of time in another time zone, a tenths of a second indicator and a 24-hour or military time indicator. The second hand, used in the timing mode, points to the date



Precision timing is the hallmark of IWC's Ingenieur Chrono-Alarm watch.

number of hours until the next high or low tide. Each Krieger watch, like other Swiss watches, carries its own serial number and is individually certified by Swiss authorities.

If you want a watch that'll tell you more than just the time of day, a chronometer is the watch of choice. Chronometers, or chronographs, are basically stopwatches, but manufacturers have tailored these watches to measure time in specific ways and with various levels of precision. Today's chronometers routinely measure time in tenths and hundredths of a second.

How much precision you need depends on the chronometer's use. The Ingenieur Chrono-Alarm from the International Watch Co. (IWC), for example, is made for "individuals who



The \$13,500 Star Wheel from Audemars Piguet drops the 12-hour cycle.

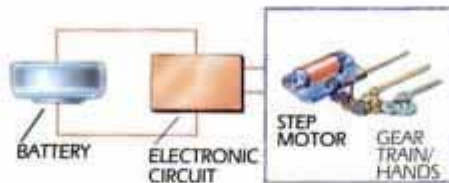


Pulsar's F1 Chrono can count up to 60 laps and recall the fastest from memory.

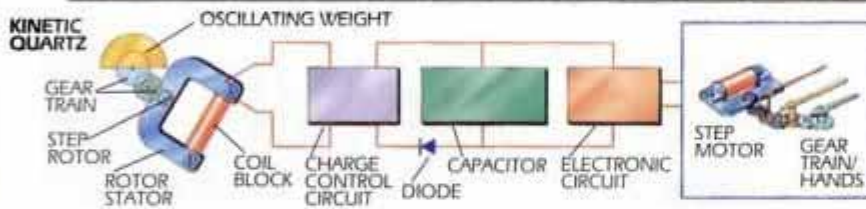
QUARTZ VERSUS KINETIC QUARTZ

SOURCE OF ENERGY	POWER SYSTEM	CONTROL SYSTEM	TRANSMISSION SYSTEM
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CONVENTIONAL QUARTZ



KINETIC QUARTZ



Seiko currently offers three kinetic quartz watches costing between \$495 and \$595.

In Seiko's new kinetic quartz watch, arm movement rotates an oscillating weight to generate electricity. This energy is stored in a capacitor and is regulated by an electronic circuit. In a conventional quartz watch, electricity is from a battery, which eventually must be replaced.

only when the current time is being displayed.

Timing functions are available for use once you've rotated the crown so that the desired mode appears on the watchface. In the "chrono" mode, the watch performs like a stopwatch. Two buttons on either side of the crown act as start/stop and reset controls. Elapsed times and split times for one or two competitors can be measured. In the timer mode, the watch can be used as a countdown timer, counting backward from as much as 60 minutes. There's also an alarm that can be set in 1-minute increments.

Other chronographs offer additional specialized features. Pulsar's analog F1 Chrono counts up to 60 laps and can recall the fastest lap and total number of laps completed from memory. This handy tool for racers, with a second hand that makes one revolution per second, lists for \$250. Travelers, by contrast, might like Pulsar's World Time Chronograph. Listing for \$300, the World Time Chronograph is billed as the first analog watch that can display time in 24 different time zones.

Most of the other tasks you can do with a chronograph depend upon the bezel, the ring around the dial of a watch that holds the crystal in place. On the Navichron, for instance, the rotating bezel ring acts much like a slide rule, making it easy to calculate speed and distance information. You can also make easy conversions between kilometers, nautical mile and statute mile scales.

Bezel ring markings vary from model to model. A tachometer scale lets you determine the average speed of a vehicle simply by timing the distance it takes to travel 1 kilometer. Similarly, fuel-consumption rates, remaining cruising time, climbing rates

and hourly rates of operation for repetitive tasks can be calculated.

The appropriate bezel markings can also allow you to measure a person's pulse, calculate how far away lightning is and de-

termine direction. Some models get incredibly specialized. Seiko, for example, has chronographs that will help you track orbiting satellites (the \$595 Flight Computer) while another analog racing model (the \$395 SHW-008) utilizes a "centihand" that makes 10 revolutions per second to display time in hundredths of a second.

Chronometers can also be very sport specific. Timex offers a digital model, the Nassau Scoremaster, designed for golfers. The Nassau features an 18-hole scorekeeper, can be used to help a four-

some keep pace and

(Please turn to page 100)



In addition to timing functions, Pulsar's Navichron lets you do calculations by using the outer bezel ring.



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FROZEN ROPE

New tools of the trade for the kings of ice mountain.

BY JOE LENTINI



Secure purchase is the goal and crampons, ice axes and ice screws attain it. Believe it or not, when properly equipped, this is fun.

PHOTO BY BILL HATCHER/
ADVENTURE PHOTO

● Standing on my front points, I scan the icy gully for the next pitch. Wearing wool pants and sweaters piled on top of each other, my climbing partner and I look like turn-of-the-century polar explorers. It's the early 1970s, a time when constant shivering is considered a normal part of ice climbing.

Thinking that the top must be just around the bend, we climb rope length after rope length, but every time we look it appears to be just one more pitch. In the midst of a vertical ice ascent, a small spindrift avalanche nearly sweeps me off the climb. I'm scared, tired, cold and a long way from home. But after what seems like an eternity, we sight the top. At last, we're safe. We remove our belay anchor and climb the last 100 ft.

Halfway up something stops me and I suddenly see the surroundings in a new way. We're in the middle of an avalanche slope that's primed and ready to go. It's scary, but with only 50 ft. to go we'll be okay.

Our next step proves to be the trigger. A crack opens between us and the top. Everything begins moving in slow motion and then builds speed. A wave of snow hits me in the face and knocks me down. Roped together, my partner and I tumble toward a 500-ft. drop. For the first time, I actually think I'm going to die.

In desperation, I roll into the slope and drive the ice axe into the snow. Amazingly, it catches just as the avalanche debris launches over the lip. We're safe, but not unhurt. Something has torn a hole in my partner's leg and he's losing blood fast.

Three hours later, I

FROZEN ROPE



The ice climber's tools of the trade. Outer items, clockwise from top right: 50 meters of Bluewater Everdry Rope, a Wild Things Jazz harness, a Black Diamond Kevlar-palm glove, a 2-piece Koflach Arctis Expedition Boot with Lowe Footfang crampon, Black Diamond ice screws, an EMS Bivy Sack emergency outer shell, a Black Diamond Superlock Carabiner, Black Diamond carabiners, EMS Willoughby Gore-Tex Gaiters, an Edelrid Lightweight helmet and a Black Diamond carrying sling. Inner items, from left to right: the Black Prophet and X-15 Ice axes (both by Black Diamond), EMS Topo Optics sunglasses and a chemically activated hand warmer.

carry my friend into the hospital emergency room. He's in bad shape, but he'll be all right. As they wheel him away, my heart sinks. We nearly died because we were unprepared for the conditions and made some very bad decisions.

I was 19 years old when this happened. I've continued ice climbing for more than 20 years since, but the lessons of that day always stay with me. Here's what I learned.

Hit the ice

Do people really climb hostile, frozen, vertical wasteland for fun? As a veteran instructor of eager novices, I can emphatically answer, yes. Believe it or not, the motivation is recreation and pleasure, and that's what you get when you place safety and comfort as your top priorities.

Every choice regarding clothing and equipment should reflect these twin concerns. Ice climbing is done in temperatures that can range from 40° F to -40° F. Wind can gust to 60 mph. Activity can range from extreme exertion to an easy climb. Your equipment and clothing must be able to take all of it in stride.

Setting yourself up is as basic as starting with the right underwear—two sets, with the thinnest layer worn next to the skin. One of the best fabrics for heat retention and moisture siphoning is Polartec (by Malden Mills). EMS Bergelene uses the polyester-based Polartec in underwear that ranges from \$45 to \$87 for complete sets.

The next layer should be made of a thicker fleece-type material that also has good wicking values. An EMS Pinnacle jacket and pantsuit that uses polyester-based Polartec Fleece costs about \$125. To complete the intermediate layering, climbers should wear two pairs of synthetic-fiber socks and a balaclava hat (an EMS Pinnacle Fleece model costs about \$15).

These insulation layers are then covered by an outer shell that's both breathable and waterproof. The best known of these microporous fabrics is Gore-Tex. An EMS Rainier System Parka and matching bib-style pants (about \$505) offer Gore-Tex protection in the most extreme weather conditions.

Ice climbing gloves or mittens must be warm, tough and flexible. Black Diamond Equipment has developed an \$85 model for ice climbers that has

a unique precurved palm made of super-tough Kevlar. Inside a thick, dual-density nylon pile mitten.

Although these are very warm gloves, many climbers also use an EMS chemically activated heat packet (6-pack of handwarmers is \$3). Insert the packet into your gloves and it will stay warm for 6 to 8 hours.

Next, we need to protect the head and feet. A hard-plastic helmet is essential, and the Edelrid Lightweight

gaiters and crampons. Gaiters are spats that keep snowmelt from entering boots. EMS Willoughby Gore-Tex Gaiters cost about \$54.

A crampon is a spiked metal frame that fits on the boot's sole and helps to dig into hard, blue ice. The Lowe Alpine System Footfang (\$149) is one of the best with a 20-tooth frame made of chromoly steel and aluminum.

Every climber needs an ice axe, of course, and many carry two. The typical ice axe has a pick on one side

of the head and a hammer or adze on the other. The unusual reverse curve of the pick ensures that it will penetrate the ice at a downward angle for superior holding power. Two of the best are the new Black Prophet (\$190) and the X-15 (\$180). Both are made by Black Diamond with bonded carbon fiber and rubber grips cored with aluminum.

Climbers also need a rope. The Bluewater Everdry Rope (50 meters long and 10.5mm in diameter) costs about \$140.

One end of the rope gets tied to a sturdy harness (\$63 for the Wild Things Jazz) worn around a climber's waist and the other to a similarly outfitted partner. To anchor itself to the ice, the team must use screws and pitons. Ice screws, like those from Black Diamond (\$48), for example, are hollow threaded shafts of chromoly steel with cutting teeth on one end and an oval attachment point on the other.

Several other items that are needed to complete the ice climbing picture include: glacial sunglasses (EMS Topo Optics with Summit Lens \$139), a bivouac sack to form an emergency shelter (EMS Bivy Sack \$99), carabiners (Black Diamond \$7 to \$9 each, plus a Superlock Carabiner \$20), a belay device (Black Diamond ATC \$13) and a gear sling (Black Diamond \$5).

Even though modern ice climbers are equipped with state-of-the-art gear, they will still find themselves struggling

for purchase on a frozen waterfall, occasionally in the midst of a howling gale. Some things never change. The difference is that today they can do it more comfortably and safely, and pursue goals never dreamed possible by the polar explorers of old, or the 19-year-old boy who almost got swept away a long time ago in an avalanche.

PM

Joe Lentini is the director of Eastern Mountain Sports Climbing School.

THE BIG CHILL



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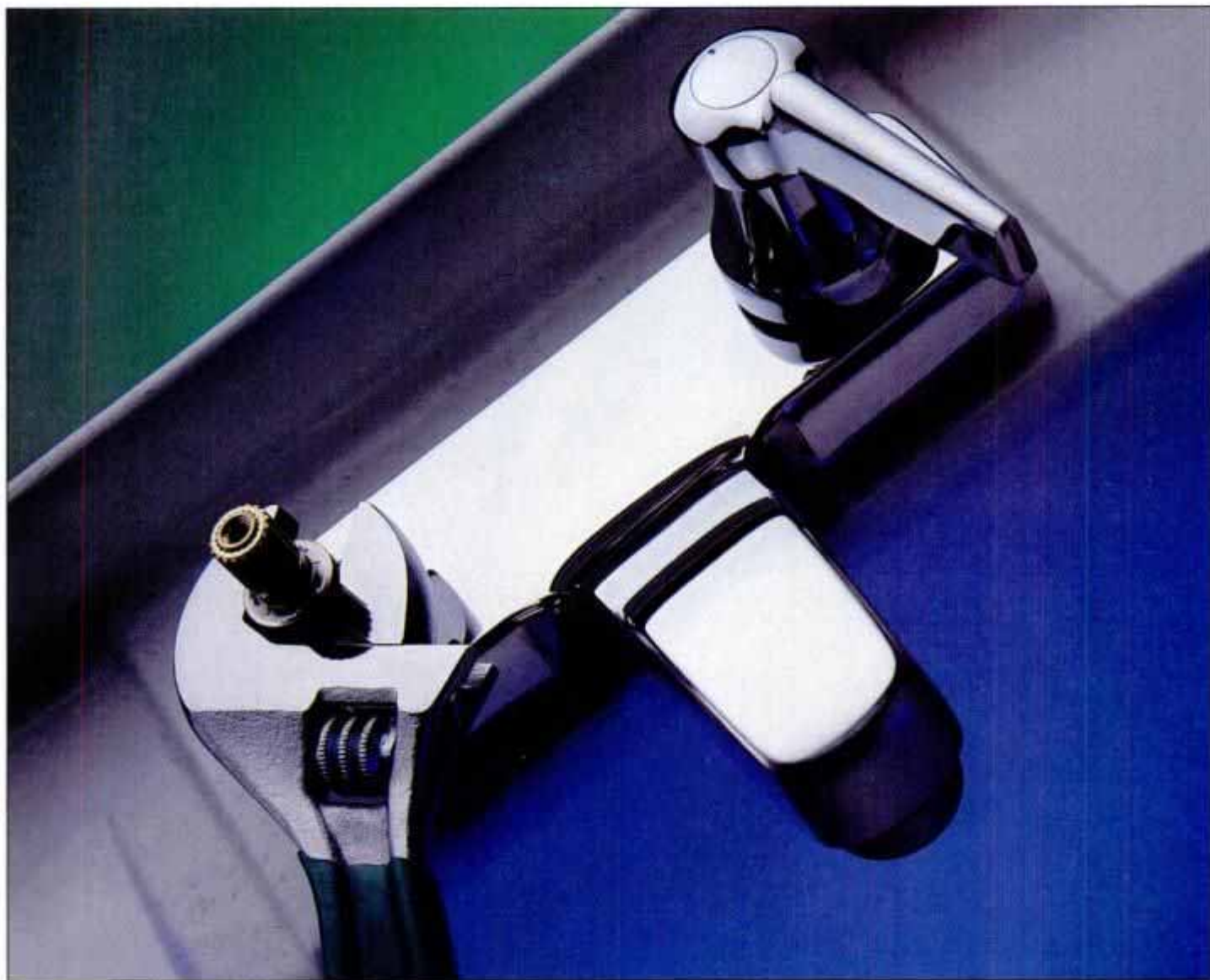
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HOME&SHOP JOURNAL



HOME IMPROVEMENT

PLUMBING SYSTEM MAINTENANCE

With a few simple tools and some helpful advice, plumbing problems go right down the drain.

TEXT AND PHOTOS BY MERLE HENKENIUS

● Unlike your car, VCR, home computer and countless other high-tech components of modern living, the plumbing system that services your home runs on technology that's pretty

much the same today as it was in your grandfather's day. The materials and fixtures may be new, but the idea is the same. And, keeping the system in shape requires little more than a few

basic skills with a wrench and screwdriver and the resources of your local hardware store.

Most residential plumbing systems hold up remarkably well, given the amount of work they do. Even so, some maintenance is occasionally required. As with all maintenance projects, prevention is the key. A little work now can save a lot of work, and expense, later.

The good news is that maintenance is always cheaper than replacement and repair. This is especially true of plumbing, where faucet washers cost only a few pennies and toilet repairs a few dollars. A little attention now will save you plenty down the road.

Extending The Life Of A Water Heater

With two exceptions, functioning water heaters are best left alone. The first will cost nothing and save you plenty. It's simply this: Turn the thermostat down to 130° F or less. A heater that runs hotter, say 150° to 160° F, puts unnecessary stress on the tank and costs more to operate.

Use a cooking thermometer to test the temperature at your faucets and adjust the heater thermostat accordingly. With a gas heater, simply turn the temperature control knob. With an electric heater, remove the electrical access panels to reach both thermostats (Photo 1). Be absolutely certain that the fiberglass insulation is



1 To change the temperature setting on an electric heater, first remove the panel covers to access the thermostats.



3 The thermostats on an electric heater have temperature indicators and adjustment knobs with screwdriver slots.

returned to its position over the thermostat before you replace the panel cover so ambient room temperature won't affect heater operation (Photo 2). After resetting the thermostat (Photo 3), wait several hours before testing the temperature again.

The second exception involves your heater's built-in rust protector. Every heater (except the very latest nonmetallic models) contains a sacrificial magnesium anode in the form of a rod suspended from the top of the tank. It operates on the principle that all metals corrode at different rates. In this case, magnesium corrodes faster than iron. As the magnesium breaks down, it sheds electrons, which migrate to the pinhole flaws in



2 Remove the insulation under the panel cover. But, be sure to replace it so thermostat reads tank temperature accurately.



4 To remove a spent magnesium anode rod, first use a 1 1/16-in. socket wrench to loosen the anode rod nut.

the tank's glass lining. In such an electron-rich environment, the iron tank will not corrode. When the anode is spent, in four to five years, the tank begins to rust.

This is why standard, single-anode heaters come with 5-year warranties, and why 10-year-warranty heaters often have two anodes, or a larger, single anode. If you replace the anode rod (about \$30) before the tank starts leaking, you could coax another five years out of the heater.

In many cases, the anode nut is visible at the top of the heater. In others, the top of the anode appears as a 2-in. silver-colored nipple at the hot-side piping connection. Here, you'll need to disconnect the hot-water outlet pipe to back the anode from the outlet opening.

Assuming that there is a visible, top-side nut, shut off the water and power and drain about 2 gallons of water from the heater. Then, use a socket wrench to back the rod out of the tank (Photo 4). If the rod nut is stuck, heat the tank fitting slightly. When the rod spins freely, lift it out and slide the new one into place (Photo 5). Use only a light coating of pipe-joint compound on its threads—the threads must make metal-to-metal contact with the tank for the anode rod to be effective.



5 Lift the old anode rod from the heater, then slide in the new rod. Apply a light coating of joint compound to threads.

Resetting A Toilet

When water appears on the floor around the base of a toilet, it means the wax bowl gasket has lost its seal. While the leak may seem sporadic and small, don't put off replacing the gasket. Water that seeps between the subfloor layers can cause rot and major damage.

The only parts you'll need will be a bowl wax and a set of closet bolts (about \$4). Start by shutting off the water at the supply stop or at the water meter. Then, flush the toilet and sponge all water from the tank. Next,



6 Shut off the water at the stop and loosen the supply tube's compression nut before lifting the toilet from the floor.



7 Use a screwdriver to pry up the decorative caps that cover the closet bolts on each side of the toilet base.



8 Use an adjustable wrench to loosen the closet bolt nuts. Then, lay down newspaper to rest the toilet on after it's removed.



9 Lift the toilet by grasping the bowl only. Holding the tank can damage the seal between the bowl and the tank.



10 Use a putty knife to thoroughly scrape the old wax from the flange. Also check and remove wax from the toilet base.



11 New closet bolts make reinstalling the toilet easier. Slide the bolts into the flange slots and press a new wax over the flange.



12 Place plastic cap washers, metal washers and chrome nuts on the bolts. Then tighten and saw off excess bolt thread.



13 Reconnect the water supply tube by inserting it into the stop and tightening the compression nut.

dip all remaining water from the bowl with a paper cup.

With the toilet empty, loosen the compression nut on the supply tube (Photo 6). Then, pry up the plastic caps that cover the closet bolts at the base of the toilet (Photo 7) and remove the nuts and washers from each bolt (Photo 8). The toilet is now ready to lift from the floor.

Place newspaper on the floor next to the toilet. Then, grasping both sides of the bowl (not the tank), lift straight up and set the toilet on the newspaper (Photo 9). Use a putty knife to scrape the old wax from the piping flange (Photo 10). If you see only a little wax on the flange, tip the toilet on its side and scrape the remain-

ing wax from the toilet outlet horn.

You'll also need to replace the old closet bolts, as getting the nuts started on them once they've been used can be a chore. With the old wax and bolts discarded, insert new closet bolts into the flange slots and press a new wax onto the flange (Photo 11). For added leak protection, you can use a bowl wax with a built-in plastic sleeve. If the drainage line is larger than 3 in., however, stay with the standard wax, as the sleeve type can dislodge when set on 4-in. flanges.

With the wax and bolts in place, carefully lift the toilet to a position directly over the flange. Then, using the bolts as guides, set the toilet onto the new bowl wax. Make sure that the

toilet tank is parallel to the wall, and press down firmly on the bowl to seat the wax. Place the washers and nuts on each closet bolt and tighten them, then reconnect the supply tube (Photos 12 and 13).

Keep in mind, as you tighten the closet bolt nuts, that the toilet is made of vitrified clay. If you overdo it, you may break the bowl. Use a small wrench and tighten each side until it feels snug. Then, put your full weight on the bowl several times and take up the slack with another round or so. If you are still unsure, use the toilet for a week and then tighten each nut again. Finally, cut off the tops of the bolts with a small hacksaw and snap the caps in place.

Routine Toilet Repairs

Aside from being a nuisance, a toilet that doesn't work properly wastes water. And, when water bleeds past fill valves and flush valves in a relentless trickle, it deposits calcified minerals on the bowl and in the rim holes. All this leads to a toilet that can't be kept clean.

If you've noticed that you're cleaning your toilet more often lately, expect calcified minerals to be the problem. A calcite accumulation reveals some fairly obvious symptoms once you know where to look.

Check the water streaming from under the bowl rim with each flush. This water should scour the sides of the bowl in a rigorous, diagonal pattern. If, instead, it slips lazily down the sides, calcification has partially clogged many of the rim holes.

To remedy this problem, use a coat hanger to ream the hardened minerals from the openings. Simply poke the hanger into each hole repeatedly until the calcite breaks up and falls away (Photo 14). This done, it's time to move onto the source of the problem and check the fill and flush valves.



14 Use a coat hanger and hand mirror to clear bowl rim holes. Then flush and check for a good water flow down sides of bowl.

Replacing A Flush Valve Flapper

A defective flush valve seal is indicated when a toilet comes on by itself, runs for a few seconds, and then shuts off again. In most cases, the toilet will do this all day in half-hour increments. What is really happening is this: Water leaks slowly through the flush valve and into the bowl. As the water level in the tank recedes, the fill valve opens, adding water until the proper level is restored.

In most cases, simply replacing the flapper or tank ball (about \$3) will solve the problem. Just shut off the water, disconnect the old flapper or ball from the flush valve and snap a new one in its place (Photo 15). Then, attach the chain to the flush lever so that the chain has only about 1/2 in. of slack in it (Photo 16).

If this does not correct the problem, expect that mineral deposits have made the flush valve seat rough, thus preventing a good seal. In that case, remove the flapper or ball and sand the valve surface until it feels smooth. Then, replace the flapper.

If this still does not solve the problem, the flush valve is simply too pitted and rough to hold water. Until recently, this meant separating the tank from the bowl and replacing the entire flush valve assembly.

As this is a real chore, you might consider a retrofit kit made by Fluid-

master. It costs about \$8. This kit consists of a flapper-type seal attached to its own stainless-steel seat. You'll simply remove the old flapper and bond the new seat kit to the old

flush valve with an extra-sticky epoxy putty provided in the kit (Photos 17 and 18). After connecting the chain, wait about 15 to 30 minutes and then turn the water back on.



15 If a bad seal causes tank water to leak into the bowl, replace flapper valve with new valve attached to flush-valve pegs.



16 Finish installing new flapper valve by attaching the valve chain to the flush lever, leaving about 1/2 in. of slack.



17 If flush valve seat is severely pitted, install flush valve kit with new seat. First, press epoxy onto worn flush valve seat.



18 Press the new seat and flapper onto the epoxy putty, connect the chain and wait at least 15 minutes for epoxy to set.

Replacing A Fill Valve

A defective fill valve, or ballcock, is indicated when the toilet won't shut off completely. When this happens, a steady trickle of water hisses through the valve on a more or less continuous basis. While some fill valves are easily repaired, it's often difficult to find the parts. In many cases, it's just as easy to replace the entire valve.

To remove the old valve, you'll need to shut off the water and drain the tank completely, sponging the final

few cups from the bottom of the tank. This done, loosen the supply tube nut from the shank of the valve (Photo 19). Then, using an adjustable wrench or pliers, remove the jamb nut that secures the valve in the tank opening (Photo 20). This will allow you to lift the old valve up and out of the tank (Photo 21).

Before inserting the new valve (we show the Fluidmaster 400, about \$8) into the opening, coat its rubber gasket with pipe-joint compound or, lack-

ing that, liquid dish detergent (Photo 22). Then insert the shank of the new valve into the tank opening and tighten the jamb nut until it feels snug (Photo 23). Next, reconnect and tighten the supply tube nut.

Finally, attach the plastic fill-tube hose to the overflow tube of the flush valve (Photo 24) and turn the water back on. As the tank fills, adjust the float so that the valve shuts off with the water roughly 1 in. below the top of the overflow tube.



19 To replace a fill valve (ballcock), first remove all water from tank. Then, disconnect the fill valve supply tube nut.



20 Follow by undoing the fill valve's jamb nut with an adjustable wrench to free the fill valve from the bottom of the tank.



21 Finally, remove the old fill valve by disconnecting the fill tube and lifting the old assembly up and out of the tank.



22 Coat new fill valve's washer with pipe-joint compound to form a good seal with tank and insert through tank opening.



23 Tighten the new fill valve's jamb nut to lock the valve in place. If the jamb nut is round, use pliers to tighten it.



24 Feed the plastic fill-tube hose into the overflow tube and reconnect the tank water supply tube. Then, turn on water.

Cleaning Fixtures

If your water is even slightly hard, you can expect some precipitation of minerals to form on your faucets and shower heads. If left unchecked, your shower heads can actually become completely blocked.

When components such as shower heads, faucet handles and aerators can be removed, your most effective approach will be to soak them for 15 minutes in a bowl of hot vinegar. Most of the accumulation will fall off in the solution, and the remainder can be scraped away with a knife or fingernail (Photos 25 and 26).



25 To clear a clogged shower head of mineral deposits, unthread the shower head from the arm with an adjustable wrench.



26 Soak the shower head in hot vinegar for 15 minutes to soften the deposits. Then use a paper clip to clear the openings.

Basic Faucet Repair

Faucet repair is one area where prompt attention really pays off. While a dripping faucet will cost little to repair in the beginning, no amount of repair will help if you wait too long.

The problem is that once water leaks past a rubber O ring or washer, it begins to cut a channel across the brass half of the seal. When this happens, you may need to replace the entire faucet. Moreover, a dripping faucet can cost you hundreds of gallons of water each year.

The type of repair needed will depend upon which type and brand of faucet you have. There are two basic types, both with a myriad of design

variations. Yours will either be a compression faucet, with a brass stem and rubber washer, or a cartridge-type faucet, with either a single or double control.

With the traditional compression faucet, start by shutting off the water at the nearest valve and removing the index cap from the handle if it has one. Then, remove the handle screws and use a screwdriver to carefully pry under the handles to remove them.

If the handles won't budge, don't force them. Instead, use an inexpensive handle puller from any hardware store (about \$5). Insert the stem of the puller into the screwhole of the handle and slip the side grips of the

puller under the handle. Then, thread the stem down until the handle breaks free (Photo 27).

With the handle removed, use an adjustable wrench to loosen the bonnet nut that holds the stem in place (Photo 28). Thread the stem out of the faucet and loosen the screw that holds the washer to the stem (Photo 29). Find an exact replacement washer and fasten it to the stem using a new washer screw, if necessary. Coat the new washer with heat-proof faucet grease to prolong its life, and then tighten the stem back in place. Finally, replace the handle and move on to the other stem in the faucet.

Cartridge-type faucets are the



27 If you can't remove a faucet handle by gentle prying with a screwdriver, use a handle puller to free the stuck handle.



28 Once the handle is removed, use an adjustable wrench to loosen the bonnet nut that secures the valve stem.



29 To replace a worn compression washer, undo washer screw, slide off old washer and install a new one of the same type.

easiest of all to repair because you replace the entire cartridge without bothering with the minor components. With a 2-handle cartridge faucet, access the cartridge just as you would a compression faucet stem—start at the index cap and work your way down.

With a single-handle faucet, such as the Moen Chateau kitchen model that is shown in our photos, start by removing the handle. On the Moen faucet, the handle screw is concealed under a plastic hood. With other designs, you'll find a recessed handle screw on the front underside of the faucet handle.

In the case of the Moen faucet, simply lift the plastic hood from the handle in order to reach the handle screw. Loosen the screw and tip the handle back and then off (Photo 30). Beneath the handle, you'll find a bonnet nut that simply threads off. Remove this nut to reveal the top of the valve cartridge (Photo 31).

Looking closely, you'll find that the cartridge is locked in place by a U-shaped brass key. To remove the valve cartridge, pull this key out and then lift the cartridge out of the faucet body (Photos 32 and 33).

Moen offers two replacement cartridges, one brass and the other plastic. The brass unit is sturdier, but is not meant for every situation. If you have hard water, for example, a brass



30 To access the cartridge on this Moen faucet, take off the hood, remove the handle screw and tip handle back to free it.



31 Once the handle is off, use a pair of adjustable pliers to loosen the nut that conceals the valve cartridge.



32 To free the valve cartridge from its housing on this single-faucet unit, pull the small, U-shaped brass key from its slot.



33 Simply lift out the old cartridge and install a compatible replacement. Lock the new cartridge in place with the brass key.

cartridge will become stiff in operation within a few years. A plastic cartridge, by contrast, will remain smooth in operation for much longer and will cost several dollars less

(about \$12 to \$14) than the brass unit.

In any case, insert the new valve cartridge and secure it with the retaining key. Then replace the bonnet nut, handle and hood.

Fixing Spout Leaks

When a kitchen faucet spout leaks around its collar every time the water is turned on, you know it's time for a new set of spout-collar O rings. As the handle assembly must be removed in order to reach these seals, it's best to make this repair when you replace the cartridge.

With the handle assembly removed, grasp the spout and pull straight up until it comes free (Photo 34). With an exact, model-specific O-

ring replacement kit on hand, use a knife to cut the old O rings from the faucet column (Photo 35). Then, grease the new O rings with heat-proof grease or the small packet of food-grade grease that often comes with the kit, and roll the new rings into their slots (Photo 36). Finally, slide the spout collar back over the O rings until it seats properly.

Other faucet brands will have slightly different design features, but most are accessed in ways similar to

our Moen. And while it's possible to install new O rings on some cartridges, thus saving a few dollars, this doesn't always work as it should. Often a plastic cartridge becomes warped slightly, and imperceptibly, so that new O rings work no better than the old.

In most cases, it's better to discard the old cartridge completely and opt for a new replacement. That done, you can expect years of service from your existing faucet. **PM**



34 To remove the spout when replacing O rings, lift up firmly and twist the spout to release it from the faucet.



35 With new, appropriate O rings on hand, use a sharp utility knife to cut the old O rings from the faucet riser column.



36 Grease the new O rings and roll them over the column until they seat themselves. Then, reassemble the faucet.



SHOP PROJECT

CHINESE PUZZLE

An expert-level project for the truly dedicated amateur woodworker.

BY NEAL BARRETT

● Throughout the history of civilization, there are instances when the design of household objects rises above the mundane and enters the category of things we call "art."

The best of these objects display a sense of proportion, balance and

grace of line that make them timeless in their visual appeal while maintaining the function that defines their existence.

A great example of such an object is the Ming Dynasty continuous-arm chair. The plan provided here is not a reproduction of a particular chair, but it does take its inspiration from Ming

Dynasty designs. To build the chair, you will use a combination of machines and power tools, but you must also explore your hand tool skills. This is not a project for a beginner, but it is within reach for the accomplished enthusiast.

Traditionally these chairs were constructed of rosewood. However, to keep the costs within reason, we chose to build the piece using mahogany instead, and then gave the mahogany an ebonized finish.

Color photo: J.R. Rost
Black-and-white photos: Neal Barrett
Technical art: Eugene Thompson
Photo stylist: Gabe Herick

Making The Bow

Clearly the most distinctive feature of this chair is the arched back bow-arm which joins with the front legs in a sweeping curve. Although the bow looks difficult to make, it isn't. You don't have to resort to steam bending or complicated procedures since it is built of glued-together segments. The important thing is to get a good glue joint where the segments join together. Be sure to dry fit the bow segments together with splines before you try to glue them together.

Also, the bow is your introduction to the gradual shaping process that is necessary to build other parts for this chair. By making the bow, you'll develop your techniques for making the parts that come later. A few words of advice: You can remove wood, but you can't put it back. Shape the chair parts carefully, removing small amounts of wood at a time. Stop frequently to check your progress. Work

with razor-sharp cutting tools, and when you use a rasp, stop and clean it frequently. As you remove wood, you're liable to encounter changes in grain direction. Sharp tools reduce the possibility of tear-out, which could destroy the graceful curves that give this piece its distinctive character.

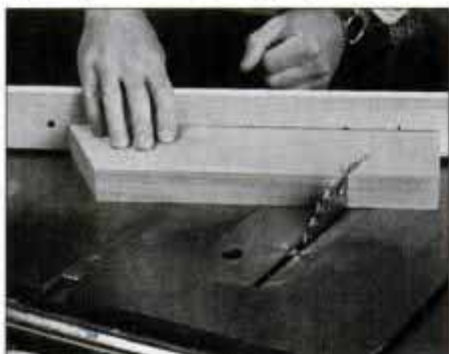
Begin bow construction by making a template of 1/4-in. plywood or hardboard for the shape of the outside profile of the bow. Using 6/4 stock, planed to 1 1/4 in. thick, cut the five segments of the bow to size using the miter gauge with an extended fence or the table saw (Photo 1). The segments are joined together with splines and glue. Use a 1/4-in. slotting cutter in the router to cut the spline grooves in the ends of each segment of the bow. Cut spline stock from solid mahogany so that the grain of the wood will run across the joint. Temporarily hot glue clamping blocks to the surfaces of the segments, then apply

glue to the joints and splines and clamp them together (Photo 2).

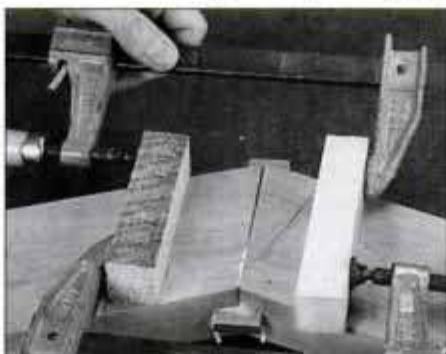
Let the assembly set overnight. Remove the clamping blocks with a chisel, and trace the outer profile of the bow from the template. Cut the outer bow shape on the band saw, staying on the waste side of the line (Photo 3). Refine the profile with a plane and spokeshave, then trace the inner profile with a pair of scribes set to 1 1/4 in. wide (Photo 4).

Cut the inner profile on the band saw and smooth it with a spokeshave. Rough out the circular shape of the bow by rounding over both faces on the router table. Use a 5/8-in.-rad. rounding-over bit (Photo 5). Don't round the last 6 in. of each bow end. The ends are left square to form the joint at the front legs, and this section will be carved to shape later.

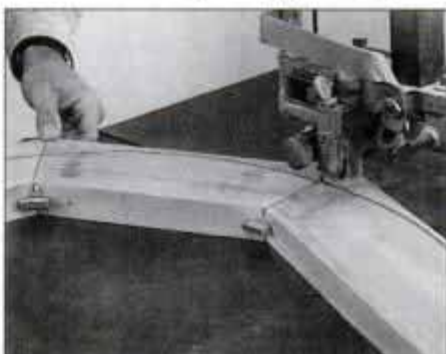
Clamp the bow in the vise and use a spokeshave and scraper to smooth for a uniform round profile (Photo 6).



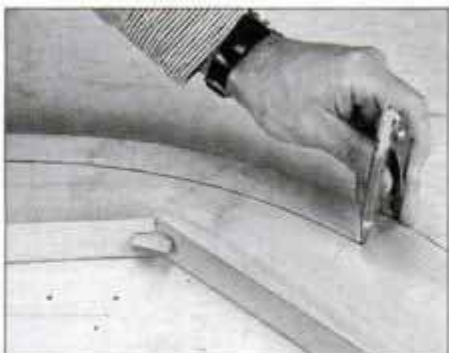
1 Cut the bow blanks on the table saw. Use a miter gauge with an extended fence to ensure an accurate cut.



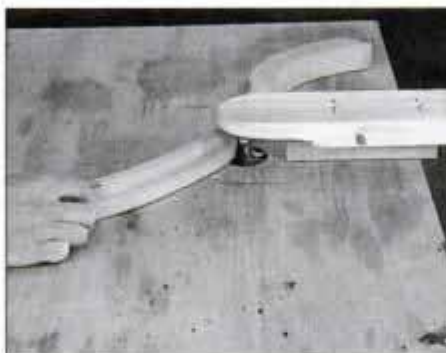
2 Hot glue clamping ears to the bow blanks. Clamp the blanks together with glue and splines at each joint.



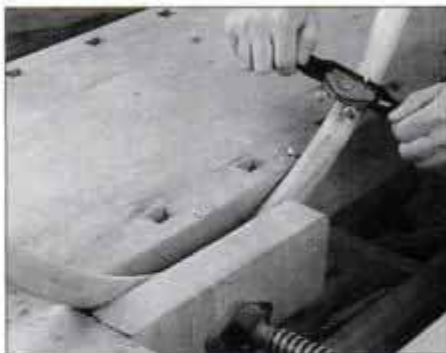
3 Trace the outer profile of the bow on the glued-up blank and cut just outside the line using the band saw.



4 Use a pencil compass or a pair of scribes to mark the inner edge of the bow. Cut just outside this line also.



5 Rough shape the bow by running all four corners over a 5/8-in.-rad. rounding-over bit on the router table.



6 Clamp the bow upright and smooth it with a spokeshave. Check your progress often by sighting along its curve.

MATERIALS LIST—CHINESE CHAIR

Key	No.	Size and description (use)
A1	1	1 1/4 x 4 x 10" mahogany (bow segment)
A2	2	1 1/4 x 4 x 9 3/4" mahogany (bow segment)
A3	2	1 1/4 x 4 x 17 1/2" mahogany (bow segment)
B	1	3/4 x 6 3/4 x 19 3/4" mahogany (splat)
C	2	1 1/2 x 1 1/2 x 28 3/4" mahogany (front leg)
D	2	1 1/2 x 1 1/2 x 37 1/4" mahogany (rear leg)
E	2	1/2 x 2 x 21 3/4" mahogany (apron)
F	2	1/2 x 2 x 15 3/4" mahogany (side apron)
G	8	1/2 x 2 1/4 x 5" mahogany (apron ends)

H	1	3/4 x 1 1/4 x 22 3/4" mahogany (stretcher)
I	2	3/4 x 1 1/4 x 17" mahogany (stretcher)
J	1	3/4 x 1 1/4 x 22 3/4" mahogany (stretcher)
K	1	3/4 x 1 1/2 x 22 3/4" mahogany (cap)
L	2	1 1/4 x 2 3/4 x 24 3/4" mahogany (seat rail)
M	2	1 1/4 x 2 3/4 x 19 1/4" mahogany (seat rail)
N	2	3/8 x 1 3/8" mahogany (spindle)
O*	2	1/4 x 1 x 24" mahogany (spline)
P	1	8-ft. piece of cane spline
Q	1	24" x 24" sheet of cane
R	8	No. 10 plates

S	2	1/2"-dia. x 2 1/4" mahogany (dowel, see misc.)
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* Cut pieces oversize, then pare to fit joint.

Misc.: Mahogany dowel, part No. MDW7; Constantine's, Eastchester Rd., Bronx, NY 10461; Behlen stain and wood filler: Woodworker's Supply, 5604 Alameda Pl. NE, Albuquerque, NM 87113, (800) 645-9232; Cane and spline: VanDyke's, Box 278, Woonsocket, SD 57385. Epoxy, wood glue, varnish.

Making The Splat And Legs

Rip and crosscut the splat blank, then cut it out on the band saw, staying on the waste side of the line (Photo 7). Clamp the splat to the bench and scrape its faces smooth. Cut its taper on the band saw.

Rip and crosscut blanks for the front legs from 8/4 stock. Trace the profile of the legs onto each blank. Note that the legs are angled inward 1°—all leg bottoms, tops and shoulder cuts must reflect that angle.

Cut the compound angle on the bottom of each leg blank using the table saw and miter gauge. Transfer the side and front leg profiles to the blank.

Cut the straight section of each leg on the table saw. Mark on the leg where to stop the cut. Mark the outer edge of the saw blade on the fence—when the marks line up, stop the cut (Photo 8). Use a backsaw to make a 1/8-in.-deep kerf, around the leg where the cut stops. Cut the compound angle on the top of each leg with the table saw and miter gauge (Photo 9).

Next, cut the front profile of the upper leg section on the band saw. Temporarily hot glue the cutoff piece back on the leg to cut the other profile (Photos 10 and 11). Leave a square step of wood at the back of the leg top to facilitate clamping later (the square step is visible in Photo 24).

Shape the first 2 in. of the round portion of each leg before assembly. Clamp each leg in the vise, and use rasps, chisels and a spokeshave to shape the leg (Photo 12). Check your work with gauge blocks (Photo 13).

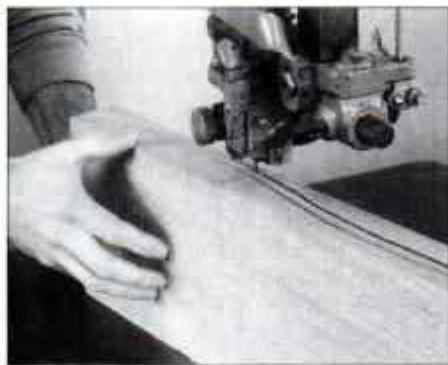
Rip the remaining leg blanks. Lay out the angled shoulder cuts at seat height, then use a backsaw to make the 1/8-in.-deep cuts around the legs.

Turning the back legs on a lathe requires a ball-bearing steady rest to support the blank as it spins (Photo 14). You can make this device from plywood. Otherwise, shape the legs with hand tools.

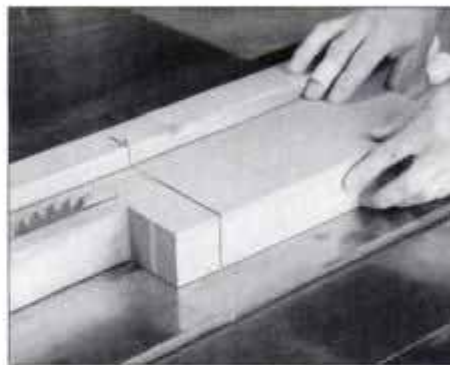
Use a chisel and rasp to shape the leg where it meets the square section. Crosscut the legs, and use the miter gauge on the table saw to cut the compound angle at the leg bottom.

Cut the mortises in each leg using a plunge router equipped with a 1/4-in.-dia. straight bit and edge guide. Chop the ends of the mortise square with a chisel.

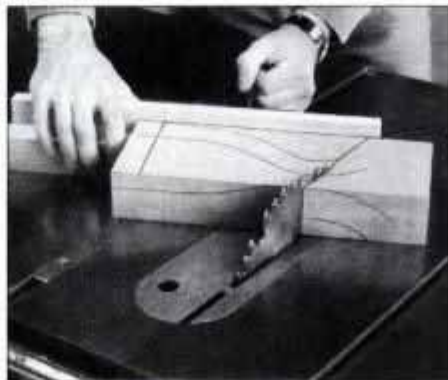
Round the edges of the square section of each leg with a 1/4-in.-rad. rounding-over bit fitted in the router table.



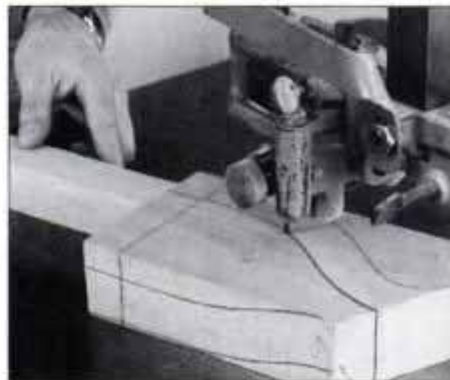
7 Mark the back splat's outline on the edge of the blank, then cut just beyond the lines on the band saw.



8 Cut the square portion of the front legs on the table saw. Mark where to stop the cut on the fence and the leg.



9 Use the miter gauge and extension fence on the table saw to make the compound angle cut on each front leg.



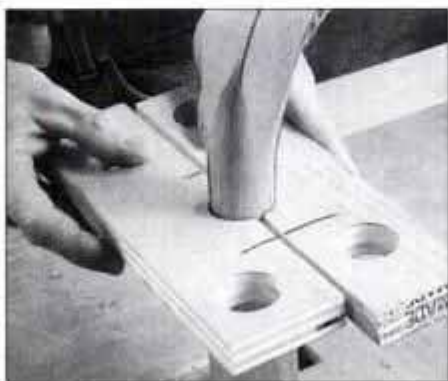
10 Cut the front profile of the legs on the band saw. Keep the blade to the waste side of the layout line.



11 Tack the cutoff piece back on the leg blank with hot glue to provide a guide for cutting the side profile.



12 Clamp the front leg in a vise and shape the round section of the front legs using chisels and rasps.



13 Use gauge blocks to check the round section. Work slowly and check the leg shape frequently.



14 Turn the round section of the rear legs by first using a gouge. The legs can also be shaped with a spokeshave.

Building The Base

Rip and crosscut the seat aprons. Since the legs are splayed 1° , the angle of the miter joint at each apron is $44\frac{1}{2}^\circ$ (not the usual 45°). Also, the aprons are cut to shape after they are assembled, so each one is slightly oversized when glued together.

Cut joining plate slots in each miter joint (Photo 15). Apply glue to each miter, the slot and the biscuit, then clamp it until the glue sets. Trace the aprons' shape on each blank, and use the band saw to cut them out. Smooth the apron curve with a drum sander on the drill press (Photo 16).

Rip and crosscut the stretchers. Next, use the dado blades in the table saw to cut the tenon cheeks on them, and readjust the saw to make the cheek cuts on the apron tenons. Use a backsaw to make the shoulder cuts at the top and bottom of each tenon.

Mark the profile on the stretchers and use the band saw to cut them. Scrape or sand the cuts smooth. Rip and crosscut the cap for the front stretcher, and lay out its end cuts. Saw the cap to shape on the band saw.

Rip and crosscut the seat frames and cut their miters with the table saw and miter gauge. Use a router with a slotting cutter to cut the spline groove in the end of each piece. Clamp the pieces to the drill-press table and bore the $1\frac{1}{4}$ -in.-dia. hole through each miter (Photo 17).

Cut the splat mortise in the rear frame using a $\frac{3}{8}$ -in.-dia. straight bit and router (Photo 18), and square the mortise ends with a chisel.

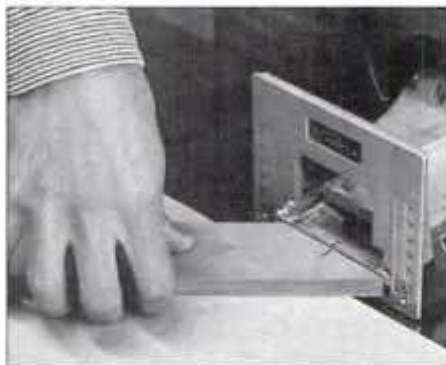
Cut the spline groove in each seat frame piece with a router and $\frac{1}{4}$ -in.-dia. straight bit. Then bore the $\frac{7}{8}$ -in.-dia. \times $\frac{1}{2}$ -in.-deep holes for the side spindles in the side members.

Use a block plane to slightly round the top outside and inside edges of all seat frame pieces.

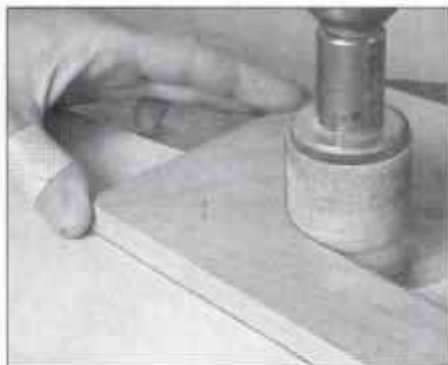
Rip and crosscut blanks for the side spindles. Trace the outline onto the blanks and cut to shape on the band saw. Hold each spindle in the vise and use a spokeshave and rasp for the tapering profile. Use gauge blocks to check the spindle ends (Photo 19).

Construct an angled plywood jig to hold the inverted bow in position for boring the holes for the spindles and the back legs (Photo 20). Use a hand-held drill to bore the holes and have an assistant help you sight the drill.

Next, using the jig, mark and bore out the bulk of the splat mortise. Pare the mortise into a rectangle using a sharp chisel (Photos 21 and 22).



15 Use the plate joiner to cut slots for the No. 10 joining plates in the mitered aprons. Then, glue and clamp the aprons.



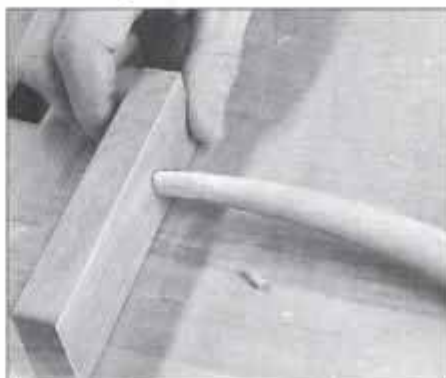
16 Use a drum sander in the drill press to smooth the curved inside edge of the aprons and remove saw marks.



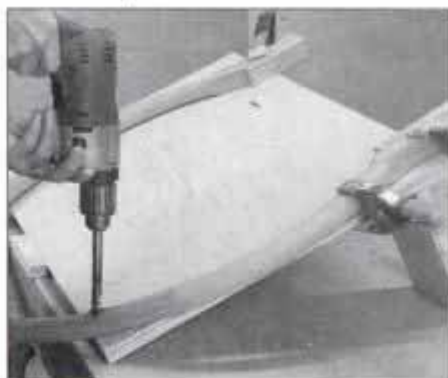
17 Clamp the seat frame pieces to the drill-press table, then bore $1\frac{1}{4}$ -in.-dia. holes through the miter.



18 Hold a seat frame to the workbench and use the plunge router and a straight bit to cut the splat mortise.



19 Test the spindle end diameters with gauge blocks. They should be snug in the hole but not too tight.



20 Make a plywood holding jig to keep the bow at the correct angle for boring spindle and leg mortises.



21 While the bow is still on the jig, bore a series of $\frac{3}{8}$ -in.-dia. holes to remove the bulk of the splat mortise.



22 Pare the sides of the splat mortise flat and its ends square using a chisel. Work down to the knife line.

Finish And Assembly

Sand all chair parts with 120-grit sandpaper. Glue and clamp the two rear legs, back stretcher and seat apron. The seat frame is positioned, but not glued, between the legs (Photo 23). Glue and clamp together the subassembly for the front legs.

Glue and clamp the subassemblies spanned by the side seat frames, aprons and stretchers (put glue on the seat-frame miters). Complete the base by driving glue-covered splines on the inside and outside of the miter joints. The spline face is curved to match the chair leg. Trim the splines flush after the glue has set.

Clamp the bow to the base, and trace along the bow with dividers to mark the tenon shoulders on the back legs. Remove the bow and carve the tenons down to the scribed line. Next, clamp the bow and bore a hole through the bow into each front leg (Photo 24).

Apply glue to all mortises and tenons, but use epoxy where the front legs and bow are joined (Photo 25). Clamp the chair until the glue sets.

Shape the transition between the bow and front legs using gouges and rasps. Check your progress with a gauge block (Photos 26 and 27). When you are finished, sand the chair with 120- and 220-grit sandpaper.

To avoid getting sealer in the seat's spline groove, cut and temporarily install four 1/4-in.-thick x 1/2-in.-wide strips in the groove.

Next, apply wood filler—we used Behlen's Medium Brown Mahogany Filler—and when the filler is dry, sand the chair with 220-grit paper. Wipe off the sanding dust, and apply the stain of your choice. We used two coats of Behlen's Medium Brown Mahogany Solar Lux stain. Let each coat dry before applying the next, and apply a sealer of 80% varnish and 20% paint thinner. Let the sealer dry.

We used a closed-weave cane for the seat because it is more durable than the more common open-weave type. Soak the cane in water for 4 hours before proceeding. About 20 minutes before caning the seat, soak the spline too. Use a chisel to cut and miter a piece of spline for each side of the seat, and guide the cut with a mitered hardwood block. Use heavy shears to cut the cane so it overhangs the spline groove by 1 in. on all sides.

Cut 10 wedges about 2 in. long from the extra spline. Partially drive the wedging blocks into the cane groove. Start at the center of the front and

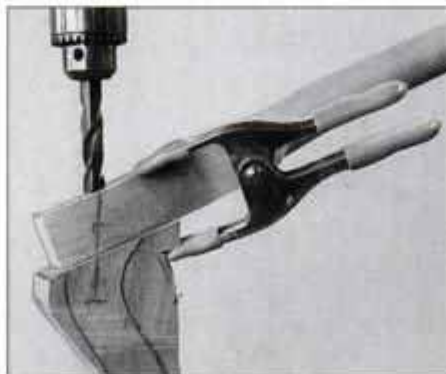
back grooves and work around (Photo 28). Keep the cane square to the seat. Use a knife to trim off the excess cane, and apply a water-soluble glue to the cane over the groove.

Remove the wedges from one side, and tap the spline into the groove with a wooden block under the hammer (Photo 29). Repeat this for each side. Keep the cane moist—until the glue on the spline has set—by placing a damp sponge in the center of the seat.

When the seat is dry, scuff the sealer with 320-grit sandpaper, dust off and apply two coats of undiluted varnish to the chair and cane. **PM**



23 Glue and clamp the rear legs, seat frame, apron and stretcher. Follow the same procedure for the front legs.



24 Clamp the bow to the front legs and bore the dowel hole into the leg. Note the clamping ear on the leg's top.



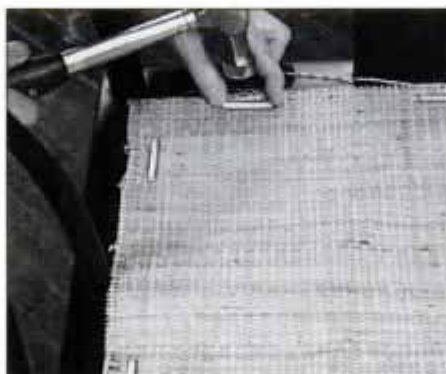
25 Apply epoxy where the bow front and legs meet and on the dowel. Clamp until the epoxy has cured.



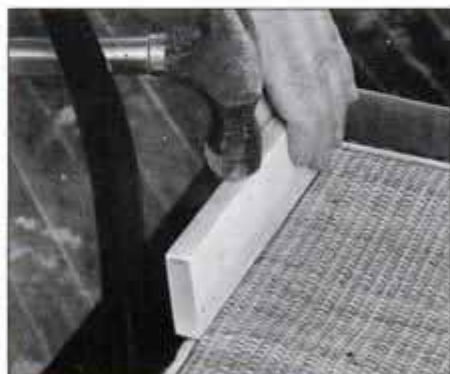
26 With the chair well supported on a padded surface, use gouges, chisels and rasps to shape the bow-leg joint.



27 Shape the joint removing small amounts of wood in many passes. Check the joint's shape with a guide block.



28 Cut the soaked cane oversize and tack it in place using small spline wedges. Keep the cane square to the seat.



29 Trim off excess cane and drive the spline into its groove. Protect the cane from hammer blows with a block.

APPLIANCE CLINIC

BY STEVE TOTH,
 Contributing Editor

How To Reset

I have a Kenmore washer model No. 110.7004703-Woo. Can you tell me how to reset the wash time dial? The cycles don't line up with the pointer.

ELSIE FONTANA
 WINFIELD PARK, NJ

The two Phillips-head screws that hold the timer dial to the metal extension on the timer have loosened, causing the timer dial to be in the wrong position relative to the knob. To adjust the dial, first unplug the washer from its power source then remove the timer knob by turning it counterclockwise. Spin the knob off the metal extension shaft.

Look down the center of the timer shaft. You will see a letter T stamped in the center of the shaft. Alongside the shaft will be two curving elongated slots in the plastic dial and two Phillips-head screws, holding the dial in place.

First, loosen both these screws just enough so you can turn the dial. Then try turning the dial a little at a time with the tip of a screwdriver.

On the dial you will see the letters A, B, C and so on. Position the bottom of the letter T so it points to the right of the letter A and at the 14-minute mark on the dial (as shown in the drawing).

Once you have moved the dial to the proper position, tighten the two screws that hold the dial in place. If you cannot tighten these screws enough to prevent the dial from turning, you will need to remove the front of the control panel.

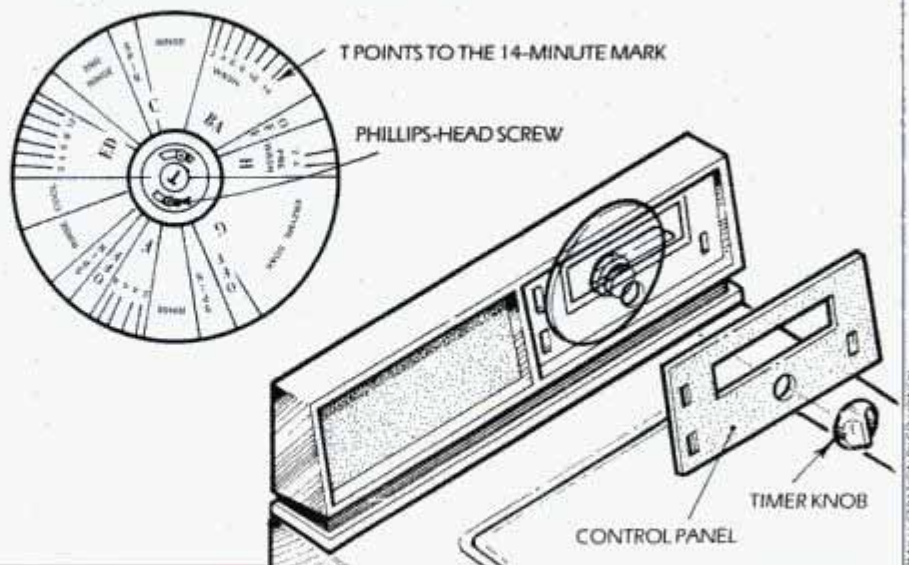
To do this, remove the two screws on each side of the console (four screws in all). Now pull the control panel forward until you can get at the plastic timer dial. Hold the dial, then tighten the two screws from the front of the control panel. Then, push the control panel back in place and re-install the four screws.

Install the timer knob then plug the machine back into its power supply and check the position of the indicator with the dial.

Not So Gentle

I have a GE clothes washer model No. WWA8350G that works fine except

TIMER DIAL IN WRONG POSITION



To reset the timer dial relative to the washer's knob, loosen the screws that fasten the dial and turn the dial to the correct position. Then, retighten the screws.

for the gentle cycle. If gentle is selected when the machine is stopped, the cycle starts out okay but after about 5 seconds it switches to the regular cycle. If gentle is selected while the machine is already running, nothing happens. This started shortly after the warranty expired.

I've had the washer's back off but could not locate the shifting solenoid or see anything obvious. Can you help?

DON DIEKER
 CLINTON, IL

I suspect the washer's shift assembly has been damaged. Your washer has a 2-speed centrifugal clutch. When gentle action or slow speed is selected, a solenoid on the clutch shifter assembly is energized. This raises a catch arm lever which prevents the lower carrier plate assembly on the clutch from turning, and this results in slower agitation.

If you moved the selector switch to gentle speed while the machine was running, you may have ripped the catch arm lever off the shifter mechanism or done some other damage to the shifter assembly. Wash speed should be selected before starting the washer. Check the appliance's instruction manual for more specific information.

If you intend to repair the washer yourself, I suggest you get the Step-By-Step Repair Manual For General Electric/Hotpoint Washers. The manual costs about \$8 at GE/Hotpoint parts distributors.

For technical information, or to or-

der a manual, contact the GE customer service department at (800) 626-2000.

Can't Find Timer

I need a timer for my Frigidaire washing machine model No. W1AS, serial No. 16FE4667. The service man I contacted can't find one in Richmond, Virginia.

MAYNARD BARDEN
 RICHMOND, VA

Unfortunately, a timer for your 1970 washer is no longer available from the manufacturer. This doesn't mean that you have to run out and buy a new machine, however. You can send it in to be rebuilt.

Remove the timer, being careful to label each wire as you remove it from the timer contact. Put the timer in a box with some protective packing material and include a note saying that you would like the timer to be rebuilt. Include in the note your name, address and phone number.

Along with the timer, send a check for \$65 to T & E Timers Inc., 53 E. 10 Mile Rd., Madison Heights, MI 48071. This will cover the repair as well as the shipping. Each rebuilt timer is guaranteed for one year from the date it is rebuilt. For more information, call the company at (800) 521-0258.

FM

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.

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Insulated Glass Windows

I would be indebted to you for life if you could solve my problem. We had a wonderful ocean view until our double-pane glass sliding doors clouded up. Is there any way to eliminate this awful haze?

JUDY KOLAR
 CORONA DEL MAR, CA

We frequently receive this question. Unfortunately, the problem is caused by a faulty seal between the two panes of glass. It cannot be corrected by the homeowner.

To solve this, you must replace the insulated glass. The frame of the door or window, however, normally does not have to be replaced. Depending on how old the window is, you may be able to get a replacement from the manufacturer. Most manufacturers guarantee their products for five to 10 years against failure caused by a faulty seal. They will replace a pane at no cost within the warranty's time limit. Some manufacturers have longer warranties. Andersen Corp., for example, has a full 20-year warranty.

The illustration here shows the construction in a cross section of a typical insulated glass window. The window consists of two panes of glass separated by a metal spacer usually made of aluminum. The spacer con-

tains desiccants that absorb moisture in the airspace.

The spacer corners are fused or bent to be air and gas tight. The glass panes and the spacers are held in position by at least two seals.

Finally, the airspace between the panes is filled with argon or air at atmospheric pressure. It is not under a vacuum. Argon, which is inert and chemically inactive, is used more often than air because it has a lower thermal conductivity. This means it has a greater resistance to heat flow.

Green Water Staining

There is a green stain on the wash basin and also on the tub in my summer home. The water is clear, but it leaves this stain. Would you know what causes this? Are the pipes too old?

ANDY PEZZICA
 JACKSON HEIGHTS, NY

The problem is not caused by the pipes, but by the water. Probably, the water is soft and has a high carbon-dioxide content, which makes it slightly acidic. This water leaches small amounts of copper from the pipes.

The stains are left from water that drips from a faucet. Each droplet evaporates, but it leaves a copper residue, and when the residue reacts with the air, it turns green.

Remove the stains with a weak

acid on a sponge. Try using lemon juice or vinegar. The stains can also be removed by gentle cleaning with a mild scouring cleanser.

Filter Change Info

The instructions on our air conditioner/heat pump called for a filter change once a month. We have done this every month and now, with the advent of the heating season and the use of our wood-burning fireplace, the filter seems dirtier than previously. Is there a method or instrument that can help us determine when it's time to change the filter?

HUGH McCLELLAND
 HEATHSVILLE, VA

Yes, there is such a device. Honeywell Inc. has an instrument called a Filter Flag Indicator, model No. S830A. The device costs about \$48, and it will do just what you want and maybe a little more.

The unit is contained in a small, molded plastic case and can be mounted either directly on the blower compartment or remotely mounted. When the air filter (disposable, washable or electronic) becomes clogged, it affects the suction pressure within the blower compartment. When the suction is greater than the set point of the device, it releases a red flag marked CHANGE FILTER.

Accessories are available through your Honeywell dealer that enable you to wire the device so a light flashes on your thermostat.

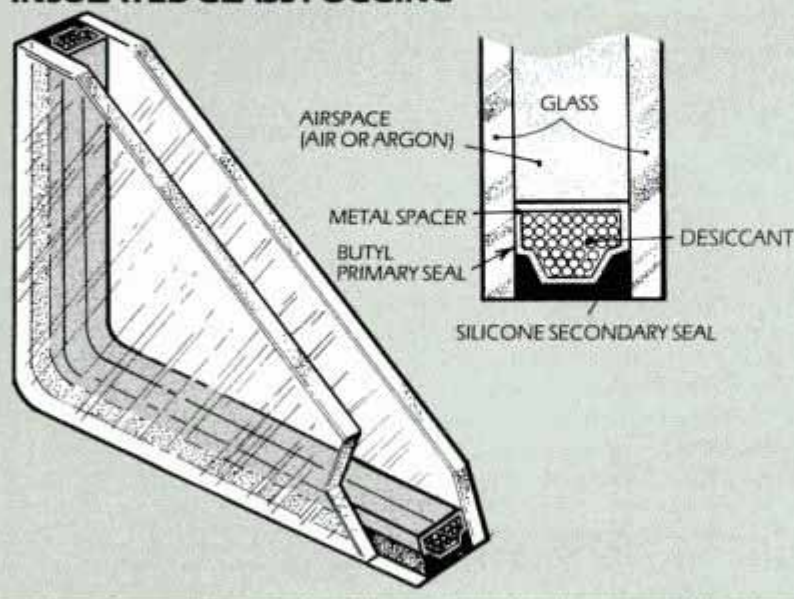
Lighting Design Tip

*If you are looking for lighting information, help is a phone call away. Dial (800) 274-4484 and a recorded message will tell you the name, address and phone number of the nearest lighting showroom that is a member of the American Lighting Association. The automated tollfree call only requires that you dial your own phone number (including the area code). If you happen to live in a city, the recording is designed to tell you about up to three ALA showrooms. For more information, contact the American Lighting Association, 435 N. Michigan Ave., Suite 1717, Chicago, IL 60611. **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.

INSULATED GLASS FOGGING



A broken seal on an insulated glass pane will allow moisture to condense between the panes. Unfortunately, the defective pane cannot be repaired.

HOME IMPROVEMENT

INSULATION BUYER'S GUIDE

BY FRAN DONEGAN
PM Illustrations by
George Retseck

● Insulation is one of those hidden home improvements that usually doesn't receive much attention. Few people even think about insulation unless they have to—when they're building a house, putting on an addition or if the cost of energy is going through the roof. But no matter what the circumstances, the amount and placement of insulation in your home helps determine your heating and cooling costs, as well as the comfort level of the house.

How much do you need?

If we learned anything from the energy crisis of the late '70s and early '80s it was the importance of making buildings energy efficient. Building codes now require insulation in new homes, and local utilities, government agencies and insulation manufacturers have spent the past decade spreading the word about the benefits of insulation in older homes. People who listened saved money on energy bills and, at one time, even earned a credit on their federal income tax.

But things are different now. Most people inclined to upgrade the energy efficiency of their homes have already done so. The question now is: Will adding more insulation make economic sense?

The answer is maybe. Certainly if you add insulation where none existed before, and probably if you increase existing levels to current Department of Energy guidelines. However, the answer is no if the cost of the upgrade exceeds projected savings.

To measure the energy efficiency of your house, take an insulation inventory to see where the insulation is and how much is in place. Your insulation should blanket all interior surfaces—walls, ceilings and floors—that are adjacent to a cold area (see drawing on page 68).

Where you find insulation, try to determine its R value—the rating it's given that indicates its resistance to heat conduction. Some insulation lists



this information on a paper or foil facing. If your insulation is unfaced fiberglass or loose-fill material, measure the thickness of the insulation and compare your findings with the Insulation Comparison chart on page 70 to make an estimate. Then, compare your estimated R value with what's recommended by the Department of Energy (see Recommended Insulation Based On Geographical Location chart, page 69).

For more specific information on R values for your area, the DOE has broken down its insulation recommendations by zip code. For a listing, contact the Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) at (800) 523-2929 and ask for the Insulation Fact Sheet DOE/CE-0180. CAREIRS is government funded and the fact sheet is free.

While it's a safe bet that installing insulation where there was none will save you money, the wisdom of adding more is trickier to figure out.

The way to decide is to calculate the

payback period of the new material. If it takes a reasonable amount of time to save enough in energy bills to recoup the investment in insulation, it makes sense to add more.

One way to figure this out is to ask your local utility company. Most utility companies will provide an energy audit of your home and estimate the savings you'll realize in one year based on an insulation upgrade. Then take the cost of the new insulation, along with the installation costs, and divide it by the savings per year to get the number of years it will take to pay back the investment.

Another way is to figure the present-value savings for additional insulation. The information in the Additional Attic Insulation Payback chart on page 70 was compiled by Oak Ridge National Laboratories and helps determine the economic sense of adding attic insulation for a number of geographic locations based on current costs. Find a location near you, pick the appropriate column and then mul-

tiply the value given by the square footage of attic area to be insulated. If the number is higher than the estimated cost of adding the insulation, it makes economic sense to do so. The table deals with a payback over a 25-year period and makes a lot of assumptions about the price of energy, efficiency of heating and cooling equipment and the like. For a more accurate reading, contact CAREIRS for the Radiant Barrier Fact Sheet DOE/CE-0335P.

Besides providing information on radiant barriers, this publication contains a worksheet for determining your precise Present Value of Energy Savings. Radiant barriers are reflective sheets often classified with insulation products. Their chief use is in lowering cooling costs by reducing the effect of radiant heat from the sun on your home's indoor temperature. (For more information on radiant barriers, see "Radiant Barriers," Home & Shop Journal, page 60, Sept. '92.)

The house tour

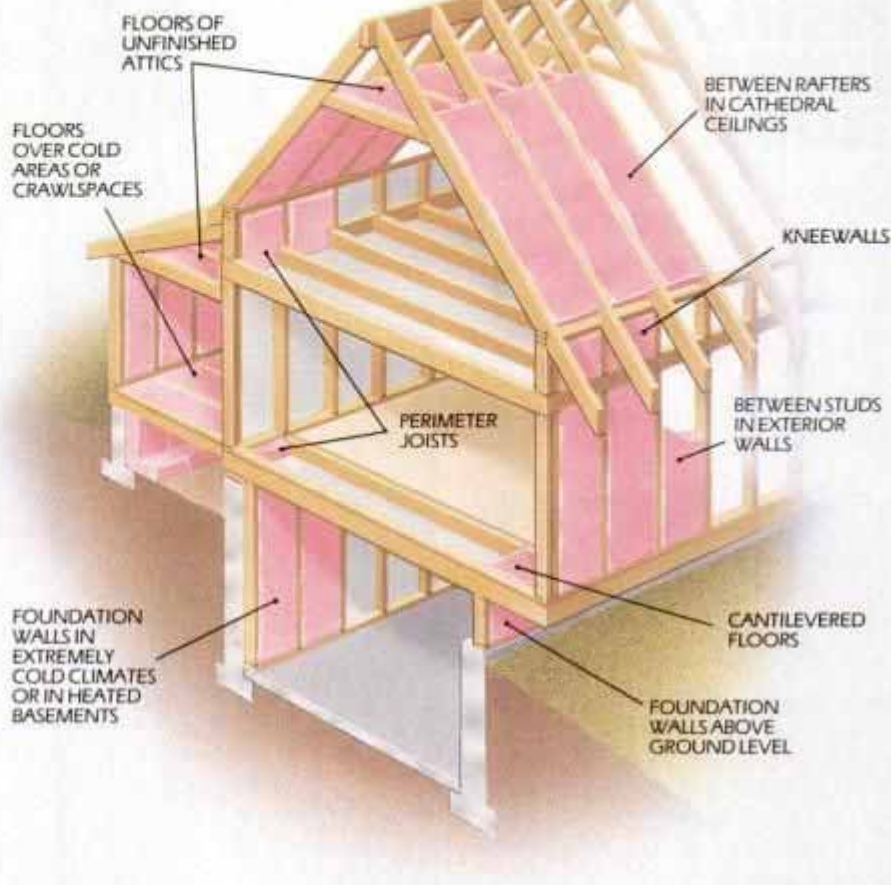
The place to start checking your home is at the top because if your house has insulation in only one location, it's safe to assume that it's the attic. Attics are easy to insulate and the materials commonly used there are inexpensive and readily available.

Mineral fibers—fiberglass and rock wool in batts, blankets and loose-fill material—are the insulations most often used in attics. To increase present levels, add new batts or blankets perpendicular to the material that is already there. This technique fills any gaps in the original installation and should cover the attic floor joists. Insulating the joists stops thermal bridging—heat loss by conduction across the solid wood joists. Adding new loose-fill material on top of the existing insulation accomplishes the same goal.

The job is straightforward, but there are two details to attend to when insulating attics: Keep insulation away from recessed light fixtures and provide adequate ventilation.

Electrical and building codes require a 3-in. airspace between recessed light fixtures and insulation, unless the fixture is rated IC (insulated ceiling) and designed to be covered with insulation. Even though mineral fibers won't burn, they can cause an unrated fixture to overheat and start a fire in the ceiling. Sheetmetal shields that surround the fixture are available to create the safety zone. Do not pile insulation above the fixture.

PLACES TO INSULATE



In a well-insulated home, the insulation acts as a blanket that covers surfaces adjoining cold areas. Special places to check are perimeter joists, crawlspaces and basements.

Day-to-day life in an average house produces a lot of moisture in the form of vapor. Cooking, washing the dishes, taking a shower and even breathing all raise the humidity of the indoor air. When moist air condenses on cold surfaces, such as the framing in an unheated attic, the water can cause structural damage. There are two strategies for controlling moisture: blocking it with a vapor barrier so it can't reach cooler areas where it will condense, and venting it to the outside through gable, soffit and ridge vents before it can condense. Plan on installing 1 sq. ft. of vent area for every 150 sq. ft. of attic floor space. When you calculate the vent space, be sure to take the solid area of louvers and screens into account and only measure the open area.

Walls

To insulate the wall cavities in an existing house, without removing the interior walls, it's necessary to drill holes through either the interior or exterior and blow in loose-fill fiberglass or cellulose. The goal here is to

completely fill every bay between the studs—a job that can be difficult because of fire stops and other blocking. This installation is best left to a contractor who has the proper pneumatic equipment.

When it's time to add new siding, many people take the opportunity to install rigid-board insulation before the siding goes on. This not only increases the R value of the wall, but it also insulates the studs, something fiberglass placed between the studs can't do. As when buying any insulation product, check the R value. Siding contractors have been known to pass off fiberboard-backed siding as insulated siding. And remember, when adding rigid-board insulation, it may be necessary to build up the trim around windows and doors.

The walls of a new addition offer the chance to achieve high R values in a number of ways. For example, framing with 2 × 6s rather than 2 × 4s allows for an extra R-6 when using fiberglass. You can also combine fiberglass with rigid-board insulations to get even higher R values.

Rigid insulations used on interiors must be covered with fire-rated drywall.

Basements and crawlspaces

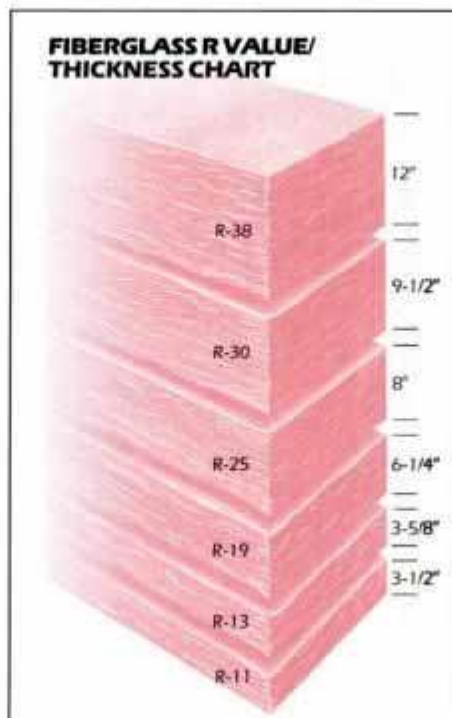
The walls of heated basements should be insulated. One method for doing this is to build a frame wall and install mineral fiber between the studs. Since the wall will not be load bearing, it can be pulled out a few inches from the foundation and the extra space filled with insulation. Another technique calls for attaching rigid-board insulation to the concrete walls with construction adhesive.

In new construction, extruded polystyrene can be attached to the exterior of foundation walls before the foundation is backfilled. Use extruded polystyrene because it stands up to the pressure of the backfill while expanded polystyrene will crumble.

In basements, the joist header, band or perimeter joist is often left uninsulated, providing an escape route for heat from the rooms above. Pack the sections between joists with fiberglass insulation to cut energy loss here.

The walls of crawlspaces should be insulated with either mineral fiber or rigid boards. Even after the walls are insulated, wrap pipes and heating and cooling ducts in crawlspaces with mineral or foam insulation.

The spaces between floor joists that are above unheated basements or crawlspaces should be packed with mineral fiber or insulated with a combination of mineral fiber and rigid board. Cover dirt floors in crawl-



The R value of any insulation is related to its thickness. This chart shows current R values for standard fiberglass batts.

spaces with a 6-mil polyethylene vapor barrier to prevent ground moisture from entering the house. Keep the barrier in place with bricks or stones.

Other places for vapor barriers

With the exception of covering the bare earth in crawlspaces, standard advice has always been to install a vapor barrier on the warm side of a wall or ceiling.

A vapor barrier is any material, such as polyethylene film or aluminum foil, that significantly resists the flow of vapor. Fiberglass insulation is available with a Kraft paper or foil backing that's intended as a vapor barrier. If you're going to use plastic film, or you're adding batts to existing insulation, unfaced fiberglass is all that's necessary.

By installing the vapor barrier on the warm side, it keeps moisture vapor from passing through the insulation and condensing on the cold surfaces beyond. This is why plastic film, or the paper backing on fiberglass batts, is installed facing the inside of a room. If paper-backed batts are installed in a floor over an unheated basement or crawlspace, the backing faces up.

Warm humid climates, however, often have outside relative humidities that are as high or even higher than the humidity levels inside houses. In these locales, the vapor drive, which is always from an area of high pressure to one of low pressure, is often from outside the house to the inside, rather than from the inside to the outside as it is during the winter months in cold climates.

To compensate, many insulators put a vapor barrier on both sides of the insulation, others omit the barrier altogether. The latest recommendation is to always put a vapor barrier on the warm side if the average January temperature is less than 35° F. If the average January temperature is higher than 35° F, no vapor barrier is necessary. To be on the safe side, though,

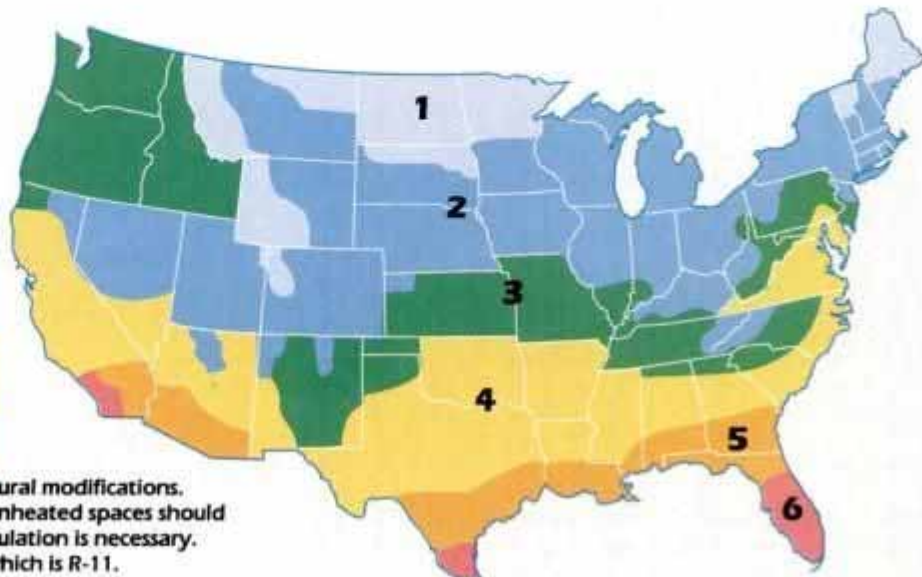
RECOMMENDED INSULATION BASED ON GEOGRAPHICAL LOCATION



INSULATION BELOW VENTILATED ATTICS

AREA	ELECTRIC HEAT	GAS, OIL OR HEAT PUMP
1	R-49	R-49
2	R-49	R-38
3	R-38	R-38
4	R-38	R-30
5	R-30	R-30
6	R-30	R-19

Insulation for existing homes with no structural modifications. Exterior walls should be R-11. Floors over unheated spaces should be R-19, except zones 5 and 6 where no insulation is necessary. Crawlspace walls are R-19, except zone 6 which is R-11.



ADDITIONAL ATTIC INSULATION PAYBACK BASED ON A 25-YEAR PERIOD

EXISTING INSULATION	R-11	R-11	R-19	R-19
ADDITIONAL INSULATION	R-8	R-19	R-11	R-19
Albany, NY	0.76	1.10	0.35	0.48
Albuquerque, NM	0.53	0.80	0.28	0.37
Atlanta, GA	0.50	0.71	0.21	0.29
Bismarck, ND	0.90	1.35	0.45	0.61
Chicago, IL	0.69	1.02	0.33	0.45
Denver, CO	0.64	0.96	0.32	0.44
El Toro, CA	0.33	0.48	0.15	0.20
Houston, TX	0.31	0.49	0.18	0.24
Knoxville, TN	0.53	0.78	0.24	0.34
Las Vegas, NV	0.47	0.70	0.23	0.32
Los Angeles, CA	0.22	0.33	0.11	0.15
Memphis, TN	0.52	0.74	0.22	0.31
Miami, FL	0.22	0.34	0.11	0.15
Minneapolis, MN	0.80	1.21	0.42	0.57
Orlando, FL	0.25	0.37	0.12	0.17
Phoenix, AZ	0.53	0.77	0.24	0.33
Portland, ME	0.73	1.09	0.37	0.50
Portland, OR	0.50	0.77	0.27	0.36
Raleigh, NC	0.50	0.72	0.22	0.31
Riverside, CA	0.49	0.70	0.21	0.29
Sacramento, CA	0.44	0.65	0.22	0.29
Salt Lake City, UT	0.65	0.97	0.32	0.44
St. Louis, MO	0.63	0.92	0.29	0.40
Seattle, WA	0.52	0.80	0.28	0.37
Topeka, KS	0.61	0.92	0.31	0.42
Waco, TX	0.41	0.62	0.21	0.28
Washington, D.C.	0.60	0.88	0.28	0.38

To calculate the potential payback of additional insulation based on present values, multiply the figure that corresponds to your insulation upgrade and a location near your home by the square-foot area of your attic floor. If the result is more than the cost of the upgrade, the insulation should pay for itself within 25 years.

it's best to check with your local building officials.

A new entry

Most of the insulation products on the market have been around for some time, but one of the newer products is called Air Krete. This is a cementitious foam that was developed to replace ureaformaldehyde foam in 1982. At that time, ureaformaldehyde was being withdrawn from the market because it shrank after curing, leaving gaps for energy to escape. But what was even more objectionable was that the material gave off fumes, called outgassing, which were harmful to some people.

According to Palmer Industries, the company that trains the Air Krete installers, this product corrects both problems. It is completely stable and there is no outgassing. It's a 2-part system that a trained installer pumps into the hollow cores of concrete block or into wall cavities. It has a 3.9 R value for each inch of thickness, it's fire-proof and shrink resistant and it's completely nontoxic.

On the down side, there simply aren't many trained installers, although Palmer says they will find one in your area or send someone to do the job. The material is also more expensive than other insulations. Contact Palmer Industries, 10611 Old Annapolis Rd., Frederick, MD 21701. **PM**

INSULATION COMPARISON

TYPE	R VALUE PER INCH	COST PER R VALUE PER SQ. FT. (CENTS)	COMMENTS
Fiberglass Batts, Loose Fill	2.9 to 3.2	1.0 to 1.9	Easy to work with, but can irritate skin, eyes and lungs—take proper precautions. Nonflammable, but paper facings can burn.
Loose Fill Mineral Wool	3.3	1.9	Uses and precautions similar to fiberglass.
Cellulose	3.2	1.4	Inexpensive, although professional installation can add significantly to cost. Must be treated with fire-retarding chemicals.
Extruded Polystyrene (rigid board)	5	7.7	Often used on exterior foundation walls and under slabs. Degrades in sunlight. Cover with fire-rated drywall when used inside. CFCs used in manufacturing.
Expanded Polystyrene (rigid board)	4	4.6	Not as strong as extruded type. Cover with fire-rated drywall indoors.
Polyisocyanurate (rigid board)	7	7.7	Commonly used as sheathing. R value may drop over time. CFCs used in manufacturing.
Air Krete	3.9	8	Foam applied by trained installer. Prices may depend on availability of trained personnel.

Costs are estimates and may vary depending upon geographical location and availability. CFCs are chlorofluorocarbons, which have been shown to have a negative environmental impact.

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CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Time's A Wastin'

The mechanic down at the corner says there's no reason to check the ignition timing on my new car. He says the computer sets the timing—and even if the timing is *wrong*, there's nothing he can do about it.

Unfortunately, my 1991 model car acts just like my old '70s model did when the timing was off—sluggish performance and poor mileage.

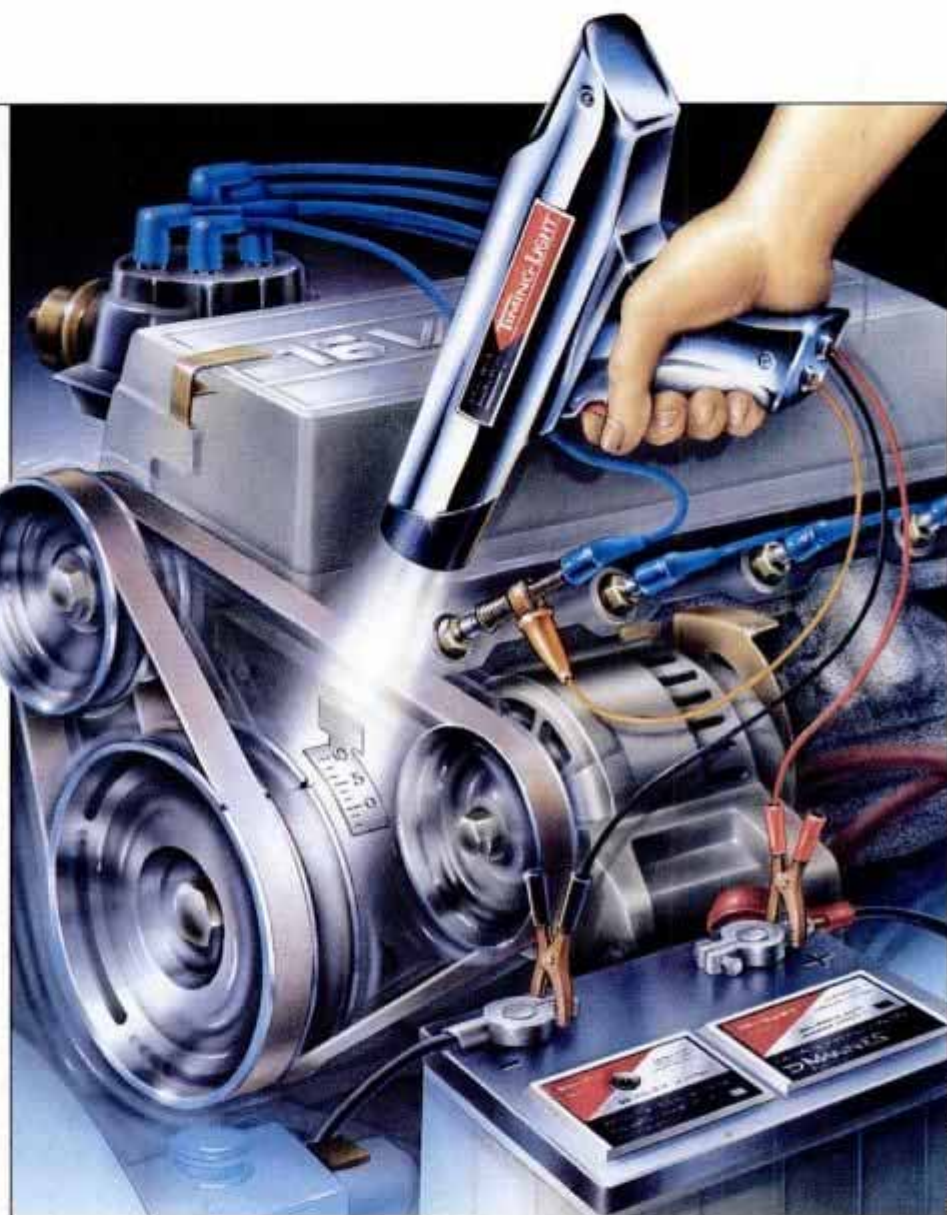
I actually borrowed a timing light from my brother-in-law, but I haven't any clue as to how to go about using it.

JOHN TREMAINE
MANHASSET, NY

Most late-model cars have ignitions that are not adjustable, per se. But in many instances (mostly cars that still have distributors), there is still good reason to check and adjust the timing if necessary. The engine computer will adjust the timing—but it assumes the base timing is correct. And if the computer has data from a bad sensor, it may incorrectly slew the timing around to (incorrectly) compensate. So checking the timing on vehicles with completely non-user-serviceable timing may be a valuable diagnostic aid.

For actually checking the timing, I'll have to refer you to a proper shop manual. You'll need to know the actual timing numbers—that is, at how many degrees before Top Dead Center the plugs are supposed to fire, at what speed the engine is supposed to be running—and whether any vacuum lines are supposed to be disconnected and/or plugged.

Hooking up the timing light is easy. Some use a spring connector that goes somewhere in the lead for the No. 1 plug. Just disconnect either end of the wire and hook the light's spring on the connector. More expensive lights use an inductive pickup that simply clamps anywhere over the wire. There is also a pair of



clamps that go to the battery, or any +12-volt source and ground, to power the light. Did I mention that you should shut off the engine while you're hooking up all this stuff?

Having said all of that—there are plenty of other things that are potential causes of your performance loss. Get an up-to-date manual for your car, and troubleshoot accordingly.

All Crossed Up

The brake lights on my 1991 Jeep Wagoneer don't always go off. Sometimes this can cause the battery to go flat.

The dealer says the problem is in the antilock braking system, and the least it would cost is several hundred

dollars. I don't see how he could know this from simply standing behind the car and looking at the lights. He says the warranty will pay for the repair—but not the diagnosis, which might be more than \$100.

JOHN BOSTONIAN
PORT CHESTER, NY

I looked through the schematic for your Jeep for about an hour. I can't imagine any way that a failure in the ABS system would make the brake lights stay on intermittently.

The problem is probably in the switch that turns on the brake lights when the pedal is depressed. It's mounted in the footwell and is nothing more than a spring-loaded nor-

CAR CARE

mally closed switch. It's held open by the pedal mechanism when your foot isn't depressing the pedal.

Go see a different mechanic or dealership. This one is setting you up for a big, unnecessary bill.

(I heard from J.B. later on this matter. He took the car to a mechanic he knew who replaced part of the switch mechanism for a few dollars. Problem fixed.)

Hail To The Chief

A couple of months ago a hailstorm left small dimples all over the hood and roof of my 1990 Taurus. Somebody told me that dry ice, applied to the dimples on a hot day, would remove them. Can this be true? Shouldn't I wrap the dry ice in something?

ANDY CAREY
EATONTOWN, NJ

Strange as it may seem, this works. Well, with a couple of caveats. It's best to do this as soon as possible after the hailstorm so the crystalline structure of the metal doesn't get used to the shape of the dimple. And this pro-

Tread Slowly

● An acquaintance of mine called me for advice on replacing her radiator, which had a smile-shaped gouge in the back exactly the size of her fan blades along the bottom 180° of the fan's travel. She had needed to drive through some deep water when the road was flooded, and followed the advice of a bystander who told her to hit the puddle at a good enough clip to carry her through even if the engine drowned.

Bad advice. She thought the fan had cut the radiator because the engine had shifted forward on its mounts when she splashed in. But we veteran off-roaders know better.

Any time you're in water deep enough to reach the fan, keep the engine revs at a minimum. The fan makes a crummy propeller—it's not stiff enough to keep from bending forward when it's submerged, and the blades will pull themselves right into the radiator.

Keeping revs at just above idle will prevent this. Most engines will run fine through a couple feet of water if you go slowly.

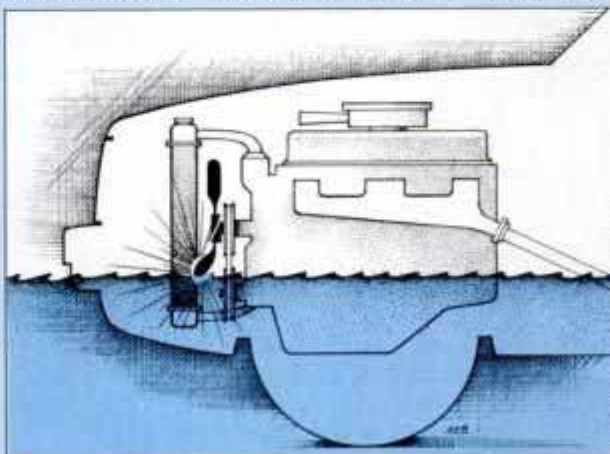


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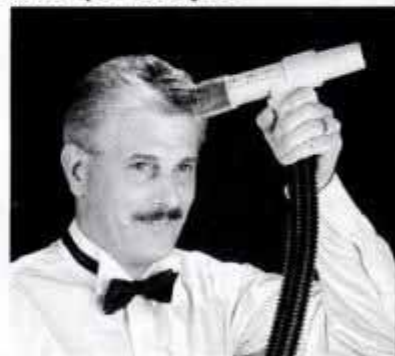
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CAR CARE

cess only works for small dimples.

You don't need a hot day, though. It's best to use a heated garage, but you can even work outside. Get some thick gloves to hold the dry ice. Break the dry ice into chunks roughly the size of the dents and boil a teakettle of water on the stove.

Pour the whole kettle over the dent to warm the metal. Immediately hold a chunk of dry ice over the dent. The intense cold will shrink the metal and pull up the dent—probably.

Needless to say, if you have a lot of dents, this might take a while, and a lot of teakettles full of boiling water. But it beats repainting the car.

Soft Machine

After driving a few miles, I lost my brakes. I coasted to a stop and realized that my parking brake was set. After cooling off for a few minutes, the brakes returned to normal. Experts explained to me that the loss of braking was due to bubbles of boiling brake fluid in the rear wheel cylinders. The vapor in the bubbles, being compressible, took all of the pedal travel. That all makes sense.

But I'm told modern cars have dual-circuit brakes. Why wasn't there some braking from the front brakes?

ADRIAN FREDRICKS
HACKETTSTOWN, NJ

SERVICE TIPS

- 1991 Ram Vans, pickups and Dakotas may have improperly calibrated fuel tank sending units. If your truck shows less than full on the gauge when the tank is full, the sending unit needs to be replaced with a new unit No. PN 52017992.

- Ford reports that many of the 1980-'91 vehicles they manufactured may give off a refrigerator or chemical odor from the air conditioning. This may be a result of the clutch cycling pressure switch allowing the evaporator temperature to become too low. Either replace the switch or recalibrate the existing switch.

- Chrysler has sent a bulletin to its dealers concerning several instances of multiple driveline failures on all-wheel-drive vehicles that have been traced to unequal tire diameters. They recommend that only tires of the same size and manufacturer be fitted at all four corners of any awd vehicle. The tire pressures should be maintained at the recommended pressures, and tires should be rotated on a regular basis to keep the sizes uniform.

Because your car probably has dual-diagonal brakes. This means that the brakes are paired diagonally, not by axle. Before the development of dual brakes, loss of brake pressure in the system for any reason meant complete loss of braking action. But the rear brakes only provide less than 20% of the braking. By interconnecting the brakes front and rear, if one circuit was lost, you'd at least get half of your stopping power. Doing so di-

agonally meant the car would slow down more or less straight. (Imagine a panic stop with only the brakes on one side of the car.)

You managed to overheat the brakes in both circuits. **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.

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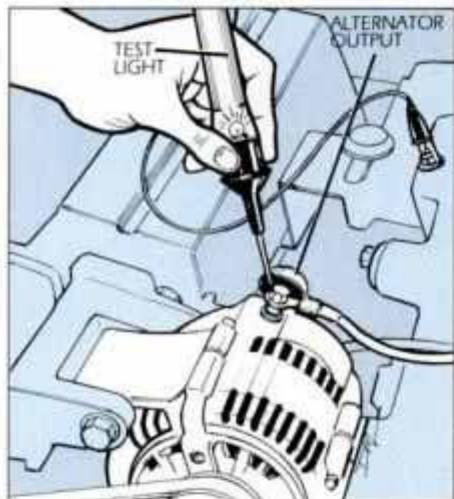
MAINTENANCE BASICS

CHARGING SYSTEMS

BY DON CHAIKIN,
Contributing Editor

• The electrical power for the ignition, electronic fuel injection, engine computer, lights, heater fan and sound system is all generated by the alternator. The alternator also charges the battery, which is needed to supply the electricity necessary to get the car started. You should check the charging system periodically.

While thorough testing requires a voltmeter, you may also make some simple but effective charging system



Check the connection between the alternator and battery using a grounded test light.

checks using a 12-volt test light.

Start at the battery, but be careful. The battery is filled with corrosive sulfuric acid and, when it is charging, it produces explosive hydrogen gas—do not smoke or bring an open flame near a battery.

• Make sure the cable connections at the battery are snug and corrosion free. An inexpensive battery-terminal cleaning brush does an excellent job of cleaning these connections.

• If the battery has removable cell caps, be sure that there is the correct amount of electrolyte in the cells. Add distilled water as necessary.

Also be sure the cables themselves and the connections to the starter and the engine or chassis are intact.

• Disconnect the battery's ground terminal and attach a voltmeter to the battery's two terminals.

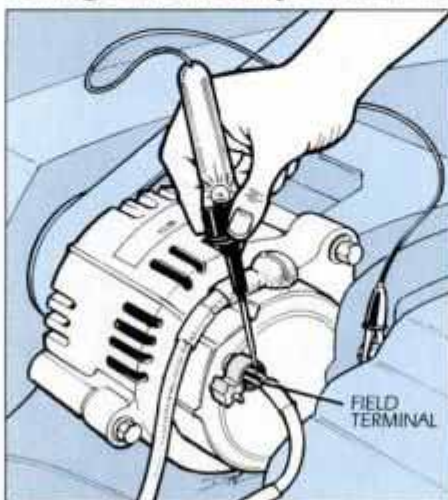
• When the outside temperature is



about 70° F, the voltmeter should read at least 12 volts. If not, the battery needs to be charged or replaced.

But first check the alternator.

• Inspect the alternator drivebelt for cracks, missing chunks and glazed surfaces. Also check the belt's tension. When tensioning an alternator belt, do not pry on the alternator housing. You can easily crack the al-



On GM cars, a test light should glow brightly at all terminals with the engine running.

ternator's soft aluminum housing.

Next check the alternator's output.

• If you have a voltmeter, connect it to the battery and start the engine. With the engine running at about 2500 rpm and all accessories off, the meter should read about 14-15 volts. If the reading is higher, the voltage regulator may be defective.

• With the lights and accessories on and the engine running at 2500 rpm, the meter should read 12-13 volts. If not, the alternator may be defective.

Double check by connecting the voltmeter's positive lead to the BAT terminal on the alternator and the negative to a ground on the engine.

• The voltmeter should read no less than 12.5 volts, engine running and accessories on. If it reads less, the alternator is defective. If it reads more than about 13 volts, there may be a problem with the voltage regulator.

• If you have a GM car or truck, a test light should glow dimly when touched to the alternator's Terminal 1 and brightly when touched to the BAT terminal with the engine off. With the engine running, the test light should glow brightly at all the terminals. **PM**

SATURDAY MECHANIC

DIAGNOSING HEATER PROBLEMS

BY PAUL WEISSLER

● It's a midwinter night as cold and as dark as an attorney's heart. You've scraped the windows clear while the car warmed up in the driveway—but you've gone several miles, the temp gauge has crept well above the peg, and you realize that even though the heater is on full blast, frost is creeping back across the windshield. It's also creeping up your leg from your totally numb toes. Your heater fan is blowing noisily—but the air issuing from it is

as cold as a meat locker.

Your heater has always worked fine before—time to get into a heated garage, make some hot coffee and find the problem.

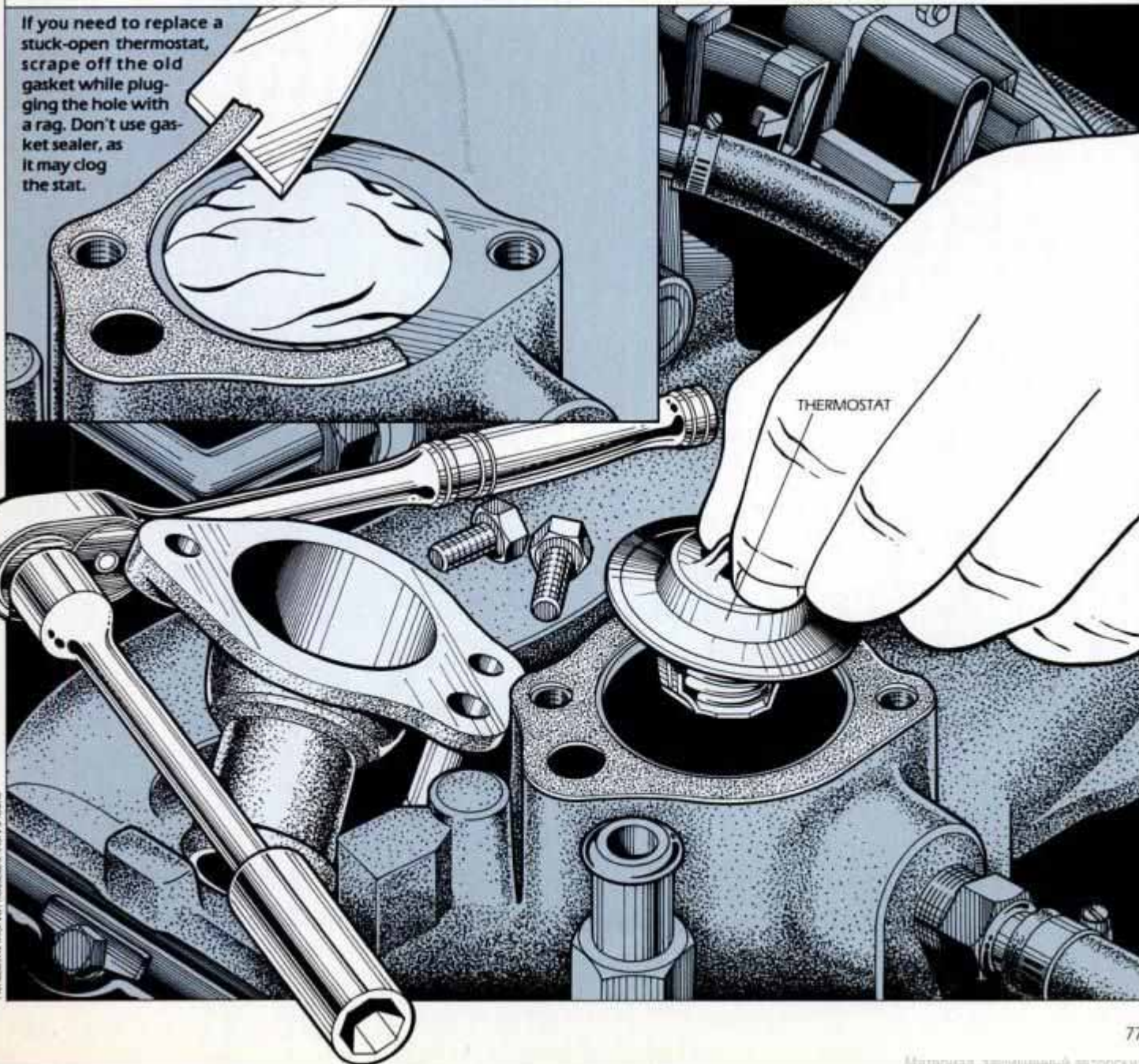
Easy stuff first

Even on a day with ambient temperatures close to zero, the temperature of the air in the floor register with a warmed-up engine should reach at least 120° to 130° F. Start with the

easiest items to check. The blast of cold air says the blower circuit is working, but if there is no airflow, start with a check of the fuse. Or the system may have a low-coolant-temperature lockout switch to keep the blower off, and this switch is misbehaving. If it has a lockout, quick-check the blower circuit by hitting DEFROST, which (usually) overrides it.

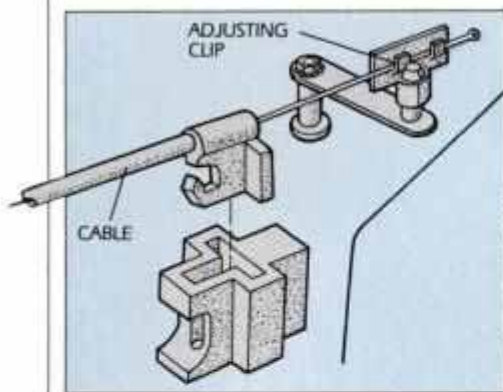
If the blower is working, check the floor heater outlet to see if hot air (or

If you need to replace a stuck-open thermostat, scrape off the old gasket while plugging the hole with a rag. Don't use gasket sealer, as it may clog the stat.



THERMOSTAT

CAR CARE



Adjust the heater control cable by moving the cable's end in its retaining clip.

any air) is really coming out. The outlet may be blocked by carpeting or a silencing pad that has slipped out of position, or an under-dash piece of duct work may have come out of its mating part.

Open sesame

Is the temperature door on the heater case swinging fully into the HOT position? Almost all cars have a flap door in the heater case that regulates heat by controlling airflow (a few, such as most VWs, control heat by modulating coolant flow through a heater valve on the inlet hose). With the cable setup, move the temperature lever from COLD to HOT and then feel for resistance and listen for flap-door movement in the heater/air-conditioning case. If there's no flap-door movement, the cable may have come off the retainer pin on the flap-door

link. On many vehicles, the door and its operating linkage and/or motor are accessible either by removing an under-dash acoustic panel or the glove-box.

If you hear the flap door move, but you don't hear it lightly slap against both ends at the COLD and HOT positions, it needs adjustment. There are almost infinite variations of temperature-cable adjustments, but usually the adjustment is something obvious, even if it's such a rare item as a turnbuckle. However, the most common setup—also used with cable-controlled heater coolant valves—is the cable housing in a retaining clip or bracket, either a spring type, a knurl on the cable housing (to hold it in the clip) or a U-bracket with a screw retainer. Readjust it by disengaging the cable housing, setting the flap door (or heater coolant valve shaft) in one extreme position (hot or cold, depending on the design), then reinstall the housing in the clip or bracket so there is no bowing or kinking.

Many domestic cars and some imports have a so-called self-adjusting cable clip for the temperature door. Move the temperature lever or rotary knob to the COLD or HOT position, depending on the design, then push the temperature door to the full COLD or full HOT position, and a pin on the flap-door link will carry the clip with it to the proper position.

If you're not absolutely sure which way to adjust a cable, refer to a service manual to get an exact sequence

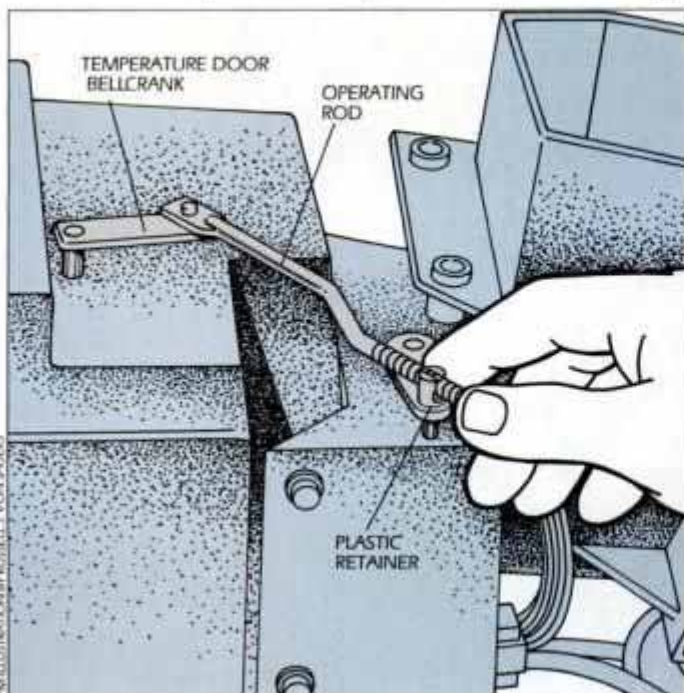
of operations. In some cases, the bellcrank has a second cable to the heater-coolant valve, so if you adjust one, you may have to adjust the other. This is common on Honda vehicles.

Remote control

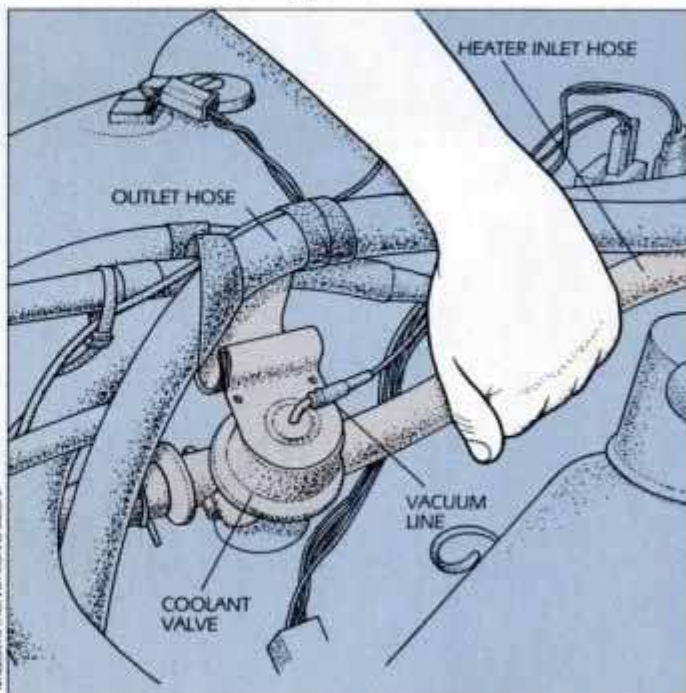
If the temperature door is operated by an electric motor, it usually either works or it doesn't, and is obviously silent and immobile when it doesn't. Occasionally there's a bad connection, but more often the motor has failed. However, problems with plastic gears in the motor assembly are possible and, even though the motor is alive, the defective gears will probably produce clicking or grinding noises. Replacing a defective motor is not just a matter of unbolting the old and installing the new. There may be an adjustment necessary and there often is an electronic calibration sequence, so refer to a service manual.

On GM cars, you may find that something as simple as an operating rod from the flap-door arm to the motor's arm has popped out of its plastic retainer. After making sure the door itself moves freely (by moving the rod in and out), just snap the rod back in so the threaded end protrudes about 1/4 in. from the end of the retainer.

On cars with automatic temperature control, a defective sensor could put the system out of control. Run the temperature setting up to the highest number possible, typically 85° to 90° F, where it should bypass the sensors and go into a maximum heat mode. If



Some vehicles adjust the heater's temperature doors by means of a plastic clip and an operating rod.



Check to see if the heater inlet hose is warm—if not, the coolant valve may be plugged or stuck.

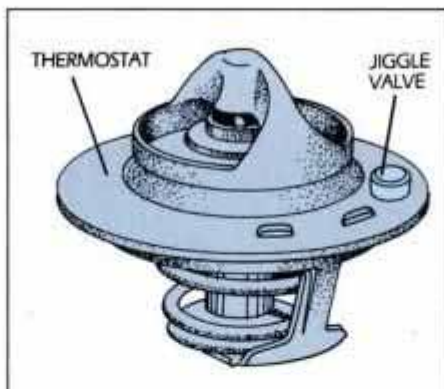
it now starts producing hot air, an ambient and/or in-car sensor is the problem. With the in-car sensor, the fault usually is a disconnected air supply hose (or a defective motor circuit for a tiny fan) that draws interior air over the sensor. A simple test: Locate the sensor grille in the dashboard and with the system turned on, place a small sheet of paper against it. The paper should be held in place by the air being sucked into the grille.

If the system passes these preliminary checks, next find out if the engine has warmed up, which it should do within a few miles even on a cold day. If you have a temperature gauge, fine. If you have only an overheat warning light, look instead at the electric radiator fan—if your car has one. If it goes on long before the engine is obviously warm, it will keep the coolant temperatures down. The usual reasons: a stuck relay or a defective coolant temperature switch or sensor.

On a car with a fan clutch, check to see if it's locked up. Start and run the cold engine for a few seconds, by which time it should free up. Stop the engine and try turning the fan by hand. If it's very difficult to turn, replace it.

If the fan operates normally, put your hand on the heater hoses close to the engine compartment firewall—the inlet hose anywhere after the heater coolant valve, if used. With the engine running long enough to be fully warmed up and the temperature lever at HOT, they both should feel hot, with the outlet hose (to the water pump or radiator) just slightly cooler. If neither is hot, feel the radiator's upper hose. If it isn't really hot, the engine isn't warming up and the thermostat is likely to be the problem.

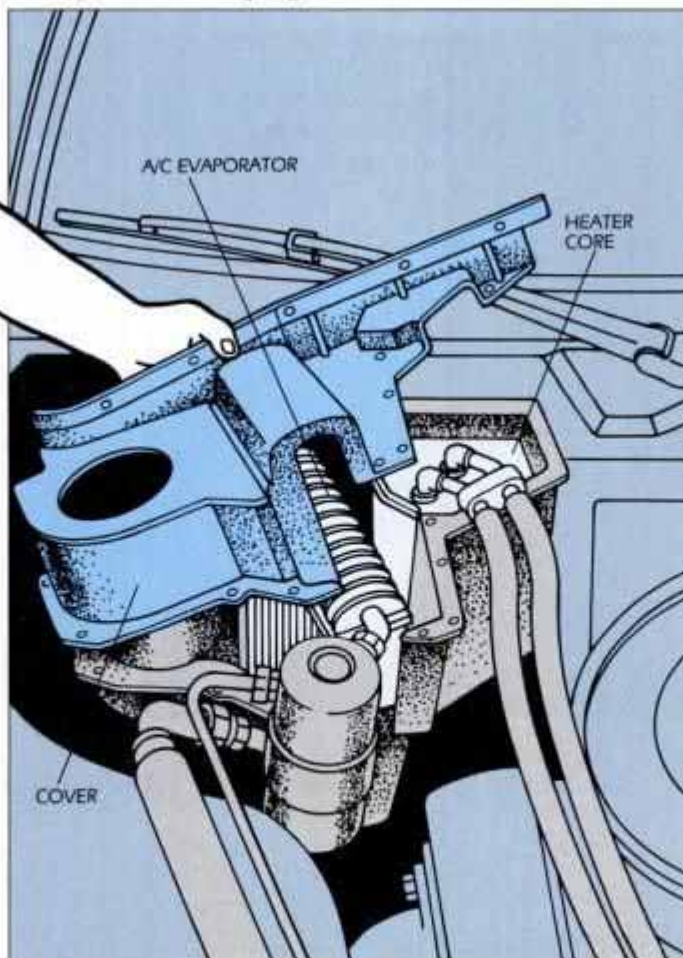
Remove the thermostat and suspend it by a piece of wire in a pot of water with a radiator thermometer in it. Heat the water and watch the valve in the stat. If it starts to open at more than 20° F (about 12° C) below the number stamped on it, replace it. If the stat is at the water pump inlet, it is supposed to be rated at 10° to 15° F below a stat that's located at the cylinder-head outlet



Replace the thermostat only with the correct type and temperature rating.

(typically around 180° F, 82° C) versus 195° F (88° to 89° C).

A replacement stat on a car today must duplicate the original, or the latest factory design, not just fit in. The correct thermostat may have a bypass valve to control a passage that regulates warmup. To ensure full warmup, the stat might use a rubber seal or a tight-fitting valve to prevent coolant "leakage" from the engine to the radiator. There may be a "jiggle valve" to help balance system pressures and purge air bubbles.



It may be necessary to remove a large access panel to get to the heater core, temperature doors and a/c evaporator.

To replace the thermostat without introducing problems or leaks, first carefully scrape the old gasket from the sealing surface. Use a rag to prevent bits of gasket from falling into the neck. If the manifold or head is aluminum, don't leave any scratches behind. If the old gasket is really stuck, try one of the spray-can gasket-loosening solvents. Use a new gasket when you torque down the bolts—but if you must use gasket cement, use it very sparingly or you could cement the thermostat shut with what squeezes out.

If you find that the coolant *does* get hot, find out why it apparently isn't going through the heater. Check both heater hoses for kinks and reposition them if necessary.

No kinks? Trace one heater hose to the engine and if there's a heater-coolant valve, move the temperature lever to HOT and with the engine warmed up and running, the hose should be hot on both sides. If it's hot on the engine side only, the valve isn't opening. If it's vacuum-operated, disconnect the hose and feel the hose end for vacuum with the temperature lever in the HOT and then the COLD positions

(there should be vacuum in one position, usually at COLD). If the vacuum supply is constant (on or off), there is a defect in the control-valve circuit. On many cars the feed is from a vacuum valve in the dashboard control head. On others, moving the temperature lever operates a cable to the temperature door in the under-dash heater/air-conditioning case, and at that door is a vacuum valve controlled by a link.

If you determine that the heater valve is not opening properly even though the vacuum feed is correct, replace the valve, which typically is just spliced into the heater inlet hose and held in place by clamps.

If there's a cable control, look at the heater-coolant valve for an adjuster, often just a curved bracket holding the cable housing. Slide the cable housing in or out, whichever you have to do to eliminate any bows or kinks, so the lever movement turns the valve shaft enough to open the valve. Then reinsert the cable housing in the bracket.

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CAR CARE

Is the heater inlet hose hot and the outlet hose much cooler? The heater either is plugged or loaded with trapped air. Here's a test you should run only briefly so only a small amount of coolant comes out of the system. Disconnect the heater outlet hose from the water pump (or radiator bottom tank), aim the end into a large pail and plug the hose fitting with a rubber stopper (or a piece of hose, pinched off with a clamp). Run the engine with the heater on and the temperature lever set to WARM or HOT. You should see a heavy, solid flow of coolant from the hose end. If the flow starts out as a trickle, then increases to a steady flow, air has been trapped in the cooling system. Reconnect the hoses and fill the system carefully, opening any coolant air bleeds.

Many cars are notorious for trapping air, and you may have to follow a specific procedure to get the system full—and then repeat it several times. Filling with the front of the car jacked up (so it's clearly the high point of the cooling system) often helps, but is not always a complete answer.

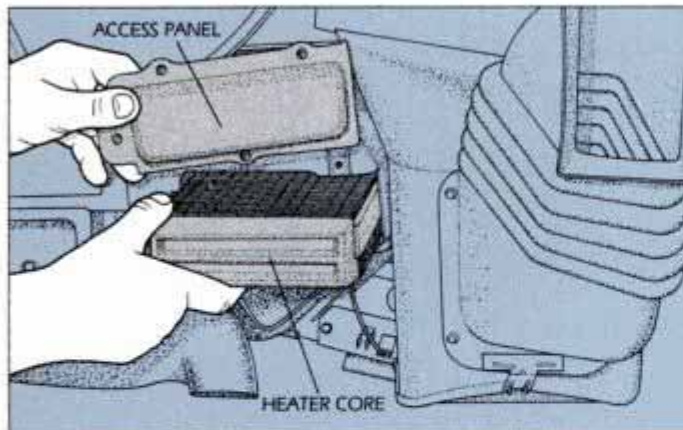
If you can get the system filled, but the problem recurs, it could be combustion gases leaking past the head gasket into the cooling system, forcing coolant out and filling its space. There are inexpensive testers that go into the radiator neck and make any bubbling (indicating exhaust gas) easier to spot, but a professional mechanic's chemical-type combustion leak detector is a much surer indicator.

If the light/intermittent flow from the heater outlet doesn't get better quickly, the heater core is plugged. The heater has smaller tubes than a radiator, so if the cooling system has been neglected, it could clog first.

Many GM and some Ford cars have heater cores that are not difficult to replace. The core may be in the engine compartment, where removing a large plastic cover provides access. Or, although it's under the dash, there's an easy-to-remove access panel. It's worth checking a repair manual to find out. Of course, if the a/c must be discharged and the evaporator removed first, see a professional, who can pull the CFC-based (Freon) R-12 into a recycling machine instead of venting it to the atmosphere.

Before you commit yourself to replacing a clogged heater core, however, try to backflush it. Clamp spare pieces of heater hose to the necks, aiming the inlet neck hose away from the engine. Force a garden hose gun

CAR CARE

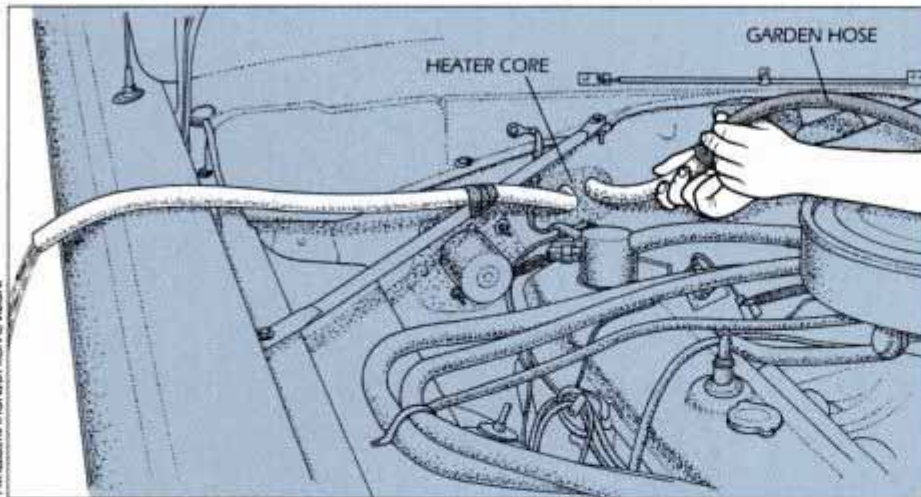


Some vehicles make the heater core accessible from inside the passenger compartment, underneath the dashboard.

tip into the outlet neck, and let water flow through, varying the pressure at the household bibcock. Hopefully, this will dislodge enough dirt to clear the tubes, and you'll see a reasonable flow from the heater inlet neck.

Don't use compressed air, because heater core tubes can't take a lot of pressure. Even pros will try it only as a last straw, warning that the heater could end up leaking.

Occasionally, there will be good flow with a garden hose, but after you reconnect everything, the heater still barely performs. There could be a hot coolant supply problem, even if the heater hoses are routed smoothly. How can you tell? Warm up the engine and repeat the check with only



Backflush the heater core with water to remove any flow-restricting blockage.

the heater outlet hose disconnected and aimed into a pail. Still a weak flow? Either the cooling system itself is plugged or the water pump is weak. If sharply revving the engine improves the flow, the water pump is suspect. If it doesn't, try flushing the cooling system. But if the flow is not improved, either a slipping, loose or eroded impeller on the water pump is

a likely problem on a high-mileage car, particularly if the cooling system has been neglected (unless you're in a cool area, the engine probably overheats in warm weather). Some radiator shops can test coolant flow rate on the car, but where the pump is suspect and it's accessible, many will pull it for inspection.

Good flow of hot coolant from the heater? And the temperature door checked out? Now you're into tough diagnosis. One not-so-rare answer is a dislodged heater-core seal or baffle inside the heater case, allowing cold air to bypass, instead of going through, the heater. If the heater core ever was replaced, someone may not have secured the seals properly.

Still searching? You may find your car has an unusual heating system design feature that isn't working. Many 1986-'88 GM cars with manual a/c, for example, have what is called a "slave door," an additional flap door that opens to allow extra airflow through the heater. If the flap door doesn't move, perhaps because the vacuum

hose from the dashboard control head to the diaphragm unit is kinked or disconnected, that could cause a major-league drop in hot-air output.

Also, many late-model cars include separate ducts to provide heat for the rear-seat passengers. This draws a lot of heat from the front registers, which makes it important for the entire system to work at peak efficiency. **PM**

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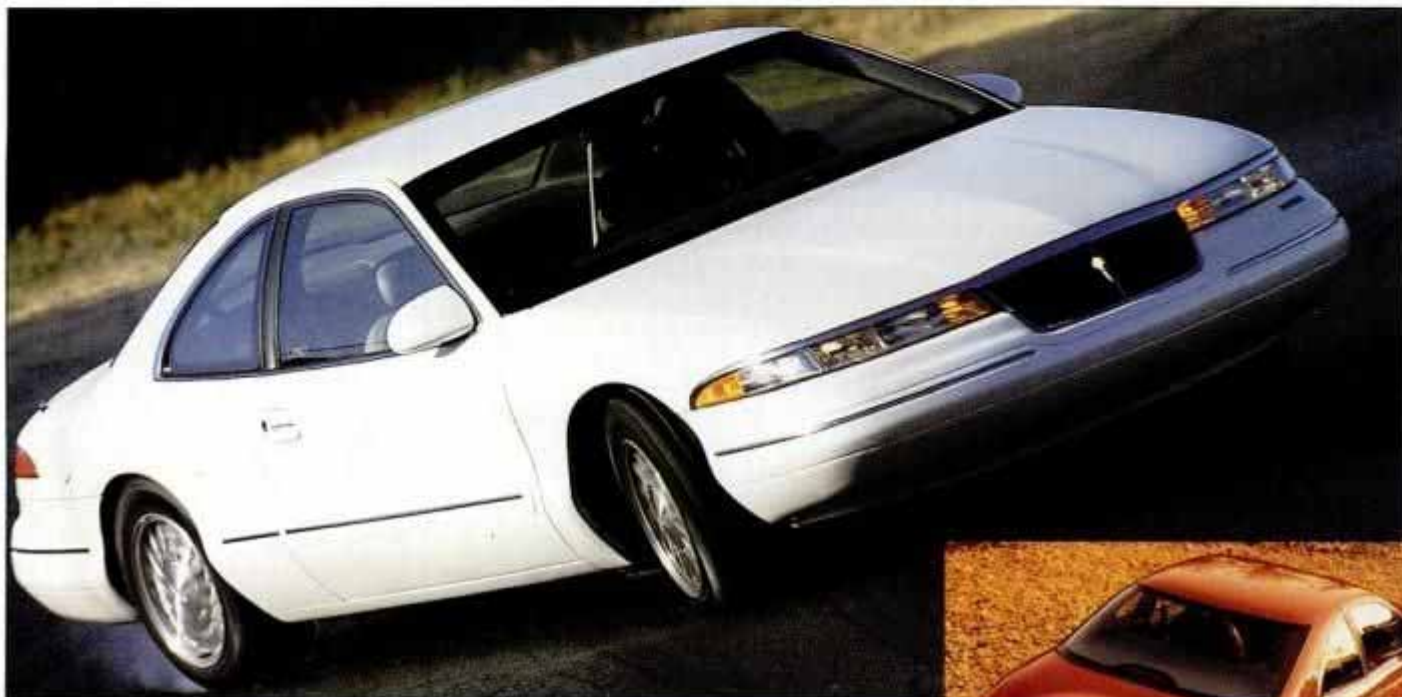
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NEW CARS



Lincoln's All-New Mark Of Excellence

● Lincoln has lost some ground on the luxury sport coupe battleground during the past few years, but Ford's prestige division is betting big money that this car—the all-new Mark VIII—is going to put on a counter offensive that'll leave the other guys wondering what hit them.

Based on our initial experiences, we're inclined to agree. The new Mark VIII is improved in every category—interior and exterior design, handling, powertrain—and rates as a must-drive for anyone thinking along the lines of, say, a Cadillac Eldorado TC or Lexus SC 400.

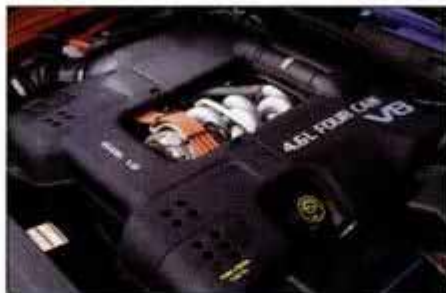
In fact, part of Lincoln's marketing strategy will be to challenge potential buyers to drive the competition be-



All-new driver command center provides cockpit-style sense of intimacy and control.

fore buckling up in a new Mark VIII.

While the new fighter cockpit control and instrument layout is sure to win some hearts before the ignition is even switched on, the trait that's going to create the most converts is what happens when the driver tramps



New dohc 32-valve aluminum version of Ford 4.6-liter modular V8 makes 280 hp.

on the gas pedal. The Mark VIII is propelled by the long-awaited dohc 32-valve all-aluminum version of Ford's 4.6-liter modular V8, driving the rear wheels through a new 4-speed automatic with an 11.25-in.-torque converter. Besides its relatively low weight and adrenaline-generating throttle response, the aluminum 4.6 promises to deliver good durability, thanks in part to its quintet of 6-bolt main bearings.

With 280 hp and 285 ft.-lb. of



torque, the new Mark VIII motor hustles this big (3752 pounds) coupe down the road as quickly as anything in its class, and quicker than most. And the redesigned chassis—certainly the best in the current Ford Motor Co. stable—is equal to the increased horsepower. The old live-axle setup has been scrapped in favor of an all-independent suspension system, with Lincoln's automatic air springs at all four corners, and rigidity has been improved. Like the Mark VII, the new Mark has big disc brakes all around, ventilated in front, with a 4-channel antilock system. Like the dual front airbags, the Mark's ABS feature is standard equipment.

Although the Mark VIII retains a vestigial bump on the trunklid to commemorate the series lineage—dating back to the original Lincoln Continental of 1939—the new car's exterior is more contemporary and aerodynamically efficient, with a coefficient of drag rating of 0.33.

It comes in one model only—no



Trim variations distinguish new Geo Prizm from Toyota Corolla. Well-designed instrument panel is reminiscent of Toyota Camry.



sporty LSC version, at least for now—with a very short option list. The only extra cost options are a power moonroof, an electronic traction assist system, a JBL premium sound system, auto dimming for inside and outside mirrors, a CD player and a voice-activated cellular telephone. The rest of the luxury inventory—including leather upholstery, 6-way adjustable power seats, automatic climate control, power windows, dual power mirrors and Lincoln's new front seat Autoglide system which allows no-hassle access to the rear seats—is included in the basic manufacturer's suggested retail price of about \$38,000.

That's a significant jump from the

base price for the Mark VII, but it's competitive versus the luxury sport coupes Lincoln is targeting. And if it's hard to call any car in this class a bargain, it's easy to call this one the most sophisticated product Ford has ever offered.

—Rick Titus

—and the availability of a station wagon in the Corolla line—we'd have to say there's a small edge in Prizm availability since there are more Chevy/Geo dealers spread around the country than there are Toyota dealerships.

Aside from that, the two new cars, both assembled at the Chevrolet/Toyota joint-venture plant in Fremont, California, are fraternal twins and excellent small cars. Both share the same front-drive platform, with its longer (by 2 in.) wheelbase, and both have grown



New Acura Legend Coupe gets longer legs with 230 hp and a 6-speed transmission.

enough to climb from the subcompact to the compact class.

The Prizm's standard powerplant is a 108-hp dohc 16-valve 1.6-liter Four, and a 115-hp dohc 16-valve 1.8-liter Four is optional. A 5-speed manual transmission is standard for all models, with a 3-speed automatic optional for 1.6-liter Prizms. And a 4-speed automatic is offered with the 1.8-liter edition.

Basic safety equipment includes a driver's airbag and 3-point active seatbelts with 5-position adjustability for shoulder height. Antilock braking is available as an option.

Refined in every respect, the new Prizm looks and feels even bigger than it is. There's more interior room in every dimension, and the longer wheelbase provides impressive ride quality.

The Prizm is available in two trim levels—standard and LSi—with pricing ranging from about \$11,500 to \$16,000.

Legend Super Coupe

It's hard to see the difference between the '93 Acura Legend Coupe and its predecessor. The only real visual distinction is a new set of alloy wheels.

But it's easy to feel the difference. With 230 hp on tap—versus 200 in the '92 model—the new coupe is much

Geo Prizm

What's the biggest difference between the new Geo Prizm and the new Toyota Corolla? Aside from some small distinctions in exterior trim



The Kias Are Coming

● When the 1994 model year rolls around, Hyundai will face a new challenger in the entry-level end of the market from Korean rival Kia. Kia's U.S. door-opener will be this basic transportation sedan, snapped during hot-weather testing in Death Valley.

Known as the Sephia in Korea, this front-wheel-drive 4-door subcompact figures to be a direct competitor for Hyundai's Excel, sharing an emphasis on value and low operating costs. Power will come from a straightforward sohc 4-cylinder en-

gine of modest output in the 1.6 to 1.8-liter displacement range.

It seems safe to predict that Kia will find a new name for the car when it's introduced in the United States.

Kia is expected to follow up the Sephia with a compact sport/utility vehicle, probably in the 1995 model year.

Although Kia will be new to the U.S. market, its cars aren't. The Korean firm currently supplies the subcompact Festiva to Ford.

—Tony Swan

livelier than the old. Even with some 3500 pounds of elegant car to haul around, it now ranks as one of the hotter entries in its increasingly competitive class, favorably comparable with the Lexus SC 300.

Honda's Acura engineering team achieved the improved output without resorting to increased displacement or adding Honda's relatively exotic VTEC (Variable Valve Timing and Lift Electronic Control) technology. It's still the same smooth 3.2-liter sohc 24-valve V6, but with larger intake valves, modified induction, altered cam timing and revised camshaft profiling.

For drivers who want to make the most of the increased power, there's also a new 6-speed manual transmission. Honda was able to add the extra gear without the expense of designing a whole new gearbox. The sixth gear was simply added at the back of the existing transmission, and the powertrain team tightened the ratios of the other cogs. Since the Legend's engine and gearbox are longitudinally mounted, this solution avoided the severe packaging problems that would have gone with a more traditional transverse engine mounting.

Other changes associated with the power increase include a new clutch that makes smooth getaways easy and slightly harder suspension bushings. Like with all members of the Legend family, antilock brakes are standard, as are dual front airbags, and there's also a driver-select traction-control system.

Acura has eliminated fabric upholstery from the coupe's interior—leather is standard—and an upgraded Acura/Bose sound system has been added for '93.

Big Bad Dodge

This backlit profile is Dodge's first official teaser photo for its new line of full-size pickup trucks, due to roll into dealer showrooms this fall. While Dodge is keeping mum about details, it's apparent that the new Rams will combine traditional brawny Ameri-



Due for introduction this fall, the new Dodge full-size pickup line may offer V10 muscle.

can truck styling—note the muscular fender flares—with a rounded, aerodynamic appearance in the front end.

The key element in Dodge's drive to capture full-size truck market share, however, is likely to lie under the hood. Besides the recent power gains in Dodge's Magnum V8 truck engines, insiders suggest that a cast-iron version of the 8.0-liter Viper sports car V10 may be available for the new trucks, a suggestion that tallies with the long hood in this teaser shot.

Although the cast-iron V10 won't be tuned to produce the kind of peak horsepower that stirs the Viper, torque output will probably be as high—450 ft.-lb.—if not higher, making the new Ram one tough hauler.

Scheduled for unveiling in early January at the Los Angeles and Detroit auto shows, the new Ram pickups will be available this fall in 1500, 2500 and 3500 models, in both 2- and 4-wheel-drive editions.

Maxton Rollerskate

If you catch yourself yearning for the fresh-air fun of an old British roadster, but find the Mazda Miata either too civilized or too tepid, here's a

Available ready to roll or as a partially completed kit, the Maxton Rollerskate is designed to use a Mazda rotary. Low weight makes for peppy performance.



unique alternative. The Maxton Rollerskate conjures up the glory days of the Triumph TR-3 and Lotus Super 7, complete with spartan amenities, lively handling and a stimulating power-to-weight ratio.

The Rollerskate's fiberglass body rides on a tube steel frame with a 90-in. wheelbase. Suspension is a mix of adapted pieces and purpose-fabricated components: Ford front uprights with Maxton's own double A-arms and rear trailing links and a Panhard rod locating a Mazda RX-7 live axle, equipped with a Racing Beat limited-slip differential. The 9.3-in. vented front brake rotors are Mustang II, the rear drums are old RX-7, and there are antiroll bars at both ends.

Designed around Mazda's RX-7 rotary engine, the Rollerskate weighs in at just 1680 pounds ready to roll, which makes for pretty brisk acceleration. With a 13B rotary in 180-hp tune, Maxton claims 0-to-60 times of about 5.5 seconds, and quarter-miles of about 14.5 seconds at 92 mph.

Safety features include a rollover bar and competition-style 4-point seatbelts. The no-frills interior includes a heater, but even with the optional "emergency

softtop and side curtains," it's plain that the Rollerskate, like those old British roadsters, is strictly a fair-weather flyer. It would be hard to love this car in the winter.

If you think the Rollerskate looks like a kit car, you're only half right. It's available in several levels of completion, up to and including ready to run. Pricing for a turn-key Rollerskate starts at \$26,500. A rolling chassis—complete except for engine and exterior finishing—sells for about \$20,000.

For further information on the Rollerskate, contact Maxton Concessionaires Ltd., 3774 S. Lipan St., Englewood, CO 80110; (303) 781-1945. **PM**



Maxton Rollerskate's open cockpit revives the glory days of British sports cars.

OUTDOORS

THE GAME OF SPORTING CLAYS

BY JAY CASSELL



● When you first step into the cage on a sporting clays course, you never know what to expect. Sure, you just watched the gunner before you hit six or eight out of the standard 10 shots per round. But now it's your turn.

Stepping up, you lay your shells on the shelf in front of you. You load two into the 12-gauge over-and-under shotgun and position the butt just below your armpit. The muzzle points in the direction from which the clay target will appear. *Pull!* you yell, and the trap machine ejects the target. Suddenly, a black "rabbit" comes bouncing out of the bushes on your left. You shoulder the gun, get the bead on the target, swing through and pull the trigger. The target disintegrates in mid-bounce.

On the report of your shotgun blast, an orange clay target suddenly comes shooting out of the trees to your right. You quickly get the bead on this passing duck target, pull slightly in front and squeeze the trigger while still moving the gun. It disintegrates into oblivion.



Well done. But there are eight more shots to go at this sporting clays station. And there's nine more stations after that. What will your score out of 100 eventually be? If you're a pro, you might hit 90 or more. If you're a beginner, you might hit 20 to 30. Welcome to the world of sporting clays.

Shotgun golf

The popular shotgun game of sporting clays was first imported from Great Britain to the United States about a dozen years ago, first gaining popularity in the Northeast. Today, there are more than 600 registered sporting clays courses in the United States, and that number is increasing almost daily.

For lack of a better comparison, sporting clays is similar to playing golf with a shotgun. You walk a course, shoot at different locations and keep score. And, as in golf, every course is different.

The clay targets (there are six different sizes) used in sporting clays approximate the sizes of the various game species that hunters encounter afield. Each station is set up to imitate hunting conditions. At one station you might stand on a small wooden bridge and shoot at two targets propelled up a creekbed: flushing wood ducks. Next could be two incoming mallards settling over a pond. This could be followed by a high-flying goose station, where targets are a good 25 yards away over the treetops. Others you are likely to encounter are driven pheasants, flushing grouse, springing teal, overhead doves, far-flushing chukars, fur and feathers, decoying crows and settling pigeons.

When getting started in sporting clays, don't be intimidated by sto-

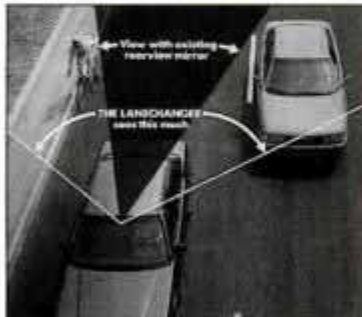
(Please turn to page 86)



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OUTDOORS (Continued from page 85)

ries you may have heard that Range Rovers, \$8000 shotguns and knickers are required accouterments. You don't need fancy clothes and gear to shoot. Instead, use the equipment and clothes that you would take hunting. To give yourself a fair chance at hitting your share of targets, a 12-gauge shotgun is recommended. Side-by-sides, over-and-unders, pumps and autoloaders are all acceptable. If you're not shooting in a competition, either screw-in or fixed barrel chokes will more than suffice. When buying ammunition, choose No. 8s or 9s, which are target loads.

A note on clothing: Wear something that's comfortable. Bulky shirts or jackets are a no-no, as they can hang up the gun butt as you raise it to your shoulder to shoot. If you have a shooting vest, with a shoulder pad for protection, wear it. And by all means use earplugs or muffs, as unprotected ears can take a real pounding by day's end. Shooting glasses are recommended, and are required on most courses.

There are basically four types of shots you should be prepared to make while shooting sporting clays: right to left, left to right, incoming and outgoing. Always watch the person shooting before you, to see where the birds are coming from, and where they're headed. Ask the course pro what types of leads you should make for the various shots.

In general, left-to-right and right-to-left shots should be led anywhere from 1 to 6 ft., with special care taken not to shoot over the targets. On incoming shots, hit the target before it begins to drop. A dead-on lead, or slightly over, works in most situations. Same for outgoing, although you will have to be careful if the target veers left or right. If two targets fly at the same time, shoot for the trailing target, then swing through for the leading one. Don't take your cheek off the gun stock until the second shot has completed its mission.

After you've become hooked on the game—and it's easy to do—you may want to join a sporting clays club. Prices differ depending upon geography (some top-shelf clubs in the Northeast will run you \$3000 a year, and that doesn't include ammunition or course fees), but you should be able to find one that doesn't charge more than \$1000.

The right shotgun

Although most shooters on the sporting clays circuit favor 12-gauge over-and-under shotguns, you don't have to have one. Pumps, autoloaders and side-by-sides work just fine. As you



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start to get involved in this sport, though, you may find that the additional motion of the pump shotgun slows your second shot. Autoloaders may jam on occasion. And side-by-side shooters may find that their guns are balanced too far back and the barrels impair the vision out of one of the shooter's eyes.

Over-and-unders have none of these problems. O/Us allow for two quick shots. They are reliable and are balanced more toward the muzzle—a plus when shooting at crossing and distant targets. O/Us also give a clear, unimpeded picture and tend to reduce gun wobble. Pricewise, O/Us are reasonably affordable, especially when compared with side-by-sides.

If you're considering buying a 12-gauge over-and-under shotgun, two good candidates are Browning's GTI Citori and Beretta's 687EELL. The GTI is the more affordable of the two, retailing for approximately \$1350. With back-bored 28- or 30-in. barrels (back boring reduces recoil and improves patterns), the GTI is chambered for 2¾-in. shells. It has side-ventilated ribs and a low, wide (13mm) top-ventilated rib, which helps the shooter acquire his target quickly. The GTI also features a walnut stock and checkered fore-end, front and center ivory beads and three interchangeable trigger shoes. It's a versatile, yet comfortable, gun to shoot and comes with Browning's Invector Plus screw-in choke system. Total weight is 8 pounds.

Beretta's 687EELL sporting clays gun (about \$4000) is available with 28- or 30-in. barrels and is chambered for 3-in. shells. A ventilated top rib tapers slightly toward the muzzle and gives you a clear sight picture for quicker front bead alignment and target acquisition. Once you get used to this rib, you'll find that the gun practically points itself. The stock and fore-end are walnut, with a non-glare finish. Detailed engraving on the side plates helps set this gun apart. It comes equipped with Beretta's Mobilchoke stainless-steel choke tube system (fixed choke barrels are available). Total weight is 7 pounds.

If there is a gun club or public shooting facility near your home, it probably has a clays course of some sort. If not, the proprietor of the club or your local gun store owner may be able to point you in the right direction. You can also obtain lists of ranges from the U. S. Sporting Clays Association, 50 Briar Hollow, Suite 490E, Houston, TX 77027, (713) 622-8043; or the National Sporting Clays Association, P.O. Box 680007, San Antonio, TX 78268, (800) 877-5338. **FM**

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The Alternative

BACK TO MARS

BY ABE DANE, Science/Technology Editor

● Billions of years ago, when Mars was a young planet, it was in many ways the spitting image of its neighbor, Earth. A thick atmosphere kept temperatures moderate, and water flowed freely over the surface. Volcanoes regularly burst through the crust, exposing the molten layers below. But, at some point, the two planets' paths diverged. Life took root on Earth. We don't know what happened on Mars, only that there is no sign of anything living there now.

Much of what we do know has come only recently, with man's first tentative steps out into interplanetary space. The *Mariner 4* probe's flyby in 1965 produced the first close-range pictures. Since then, three more *Mariners* have beamed back data, and landers deployed by *Vikings 1* and *2* gave us a firsthand view of the planet's barren surface. Then the exploration stopped.

That was 17 years ago. By now, all the planets except for Pluto have been visited by probes of one kind or another. So on September 25 of last year, it was time for round two of Mars exploration to begin. A Titan III rocket leapt skyward from Cape Canaveral carrying the 5672-pound *Mars Observer* spacecraft. With it, rode a new generation of sensors that should nail down the answers to mysteries that earlier probes only hinted at.

This time, the idea is to perform a comprehensive survey of the planet, providing a roadmap for more ambitious missions to come. During the period of one 687-day Martian year, the probe will orbit about Mars's poles every 118 minutes. The planet's rotation will eventually bring every acre of the surface almost exactly beneath the probe twice, once at 2 am and once at 2 pm Mars time. The result will be a complete set of readings that will show what changes and what stays the same over the whole planet as it goes through its full cycle of seasons.

Mars Observer's seven instruments are similar to those on satellites now orbiting Earth. Four of them are fixed to the spacecraft's



main baseplate, which keeps them all aligned toward Mars. Among these is a dual-mode camera system with resolution better than that on any previous civilian spacecraft, and 10 times better than on any previous Mars mission. Focused on narrow points of interest, it can pick out details as small as 10 ft. across from its 230-mile-high orbit. In low-resolution mode, it covers a wide swath which will be used to produce daily weather maps.

Also mounted on the baseplate is a thermal emission spectrometer which will gather information on surface ice and minerals by analyzing the heat they give off. A pressure modulator infrared radiometer will take sidelong glances at the planet's horizon to see the layering of the atmosphere. Topographic information will be determined down to a few meters by pulses of light bounced off the surface by a laser altimeter.

On a 20-ft., folding instrument boom is a gamma-ray spectrometer that will analyze emissions from the surface to determine its chemical composition. Another boom holds instruments that will seek to detect and measure Mars's magnetic field, which has so far eluded scientists completely.

As this is written, *Mars Observer* has been speeding toward its objective for a little less than a month and a half, and all appears to be going smoothly. Traveling at an average of 40,000 mph, it should complete the 450-million-mile journey by this October. Then it will fire its thrusters to enter an elliptical transition orbit, and gradually phase down into its circular mapping orbit.

Then it will set to work, beginning a 24-hour-a-day observation marathon that should go a long way toward answering scientists' questions about current conditions on Mars, and how those conditions came about. In the process, the spacecraft is likely to shed light on why it is that Mars and Earth became such different places, and thus help tell us why our own planet is the way it is.

MOTORSPORTS

24 HOURS OF ROTARY

BY TONY SWAN, Automotive Editor



● One of the few consistent raps against the Mazda rotary engine over the years is that its otherwise bullet-proof durability goes away the minute someone bolts on a turbocharger. Turbos generate lots of heat, which is precisely what rotary engines don't like. High temps make the apex seals give up, and blown apex seals in a rotary are like blown rings in a reciprocating engine.

The turbo rotary heat phenomenon doesn't show up much in street use, but in endurance racing it's been the implacable enemy. This made the invitation to join Peter Farrell's RX-7 effort at the 1992 Longest Day of Nelson Ledges irresistible. Would the new RX-7—with two turbochargers and vastly increased power output

—stand up to the demands of round-the-clock racing? Strictly in the interests of pure research, we said we'd go.

Since it was a Peter Farrell show, we expected to see a very well prepared RX-7. We also expected supercar speed and agility. And we weren't disappointed. In nine Nelson Ledges 24-hour runs, including our own winning Mustang in 1988, I've never been in anything that could get around Nelson as quickly as this RX-7.

By way of illustration, Farrell went out and won the first real qualifying battle the Longest Day has seen in years, lopping 2 seconds off the previous record (set by a Corvette in 1986) in the process. This is pretty serious record lopping. His hot lap was about a half-second quicker than the best

from the new—and much improved—Consulier GTP—and a full second better than a Caterham Super 7, which had come all the way from England for the race. (More about the amazing Super 7 in a minute.)

Shod with BFG's excellent R1 radials, the RX-7's performance was simply superb. More important, the car's coolant and oil temps stayed well within the normal operating range.

For all its formidable capabilities, though, the RX-7 didn't find its way into the Nelson Ledges winner's circle. We ran into several small delays unrelated to durability, and a cracked wheel late in the race relegated us to 10th overall. We hasten to add that the wheels employed in this race were prototype wheels. The production casting is significantly stronger.

First overall went to the Caterham Super 7, a replica of the Lotus Super 7 that dominated its sports car racing class during the late '50s and '60s. When Lotus discontinued the car, Caterham bought up the factory tooling and made innumerable improvements. Of the many Super 7 replicas available, the Caterham is arguably the best, and it was certainly in top form at Nelson Ledges, threading its way through the Nelson Ledges traffic like a ghost.

For more info on the Caterham Super 7, write to Caterham Cars Ltd., Seven House, Town End, Caterham Hill, Surrey, England CR3 5UG.

Which brings us to 1993. We can't tell you what we're planning for this year's Longest Day, but we can tell you PM will be there and we have a little surprise in store. Stay tuned. **PM**



Caterham Super 7 came all the way from England to take Longest Day overall honors.

SOUND STYLE

BY FRANK VIZARD, Electronics Editor

● While home hi-fi systems are fixtures in many homes, more than one music lover has complained about the aesthetic cost: big, rectangular boxes with black grilles that do nothing to enhance a room's decor. The problem can be particularly acute with a home theater system requiring four or five speakers.

There have been alternatives, of course. One very popular move has been to replace the two primary speakers with three smaller ones. With these 3-piece systems, such as Boston Acoustic's Subsat 6 Series II model, listing for \$500, the largest element—the subwoofer—can be hidden out of sight. This is because the low bass notes produced by the subwoofer are omnidirectional, which means that the placement of the speaker in the room is not critical. What you're left with is two



smaller speakers, often not much bigger than half-gallon milk containers, producing the more directional middle and upper frequencies.



Jamo's speaker/sconce lamp (top) and its Converta model give speakers a new look.

Lately, however, other companies are trying different configurations. Helping to lead the way is Jamo, a Scandinavian speaker maker with offices in Northbrook, Illinois. While Jamo makes traditional black boxes and 3-way systems, two of the company's new models feature an eye-catching design. One model, the Atmosphere, looks like a sconce light from a movie theater. The Atmosphere is, in fact, a lamp that uses a 20-watt halogen bulb. It's also a 2-way bass reflex speaker incorporating a 5¼-in. woofer and a 1-in. dome tweeter. List price is \$399 each.

The second model, the Converta, is a semispherical enclosure that can hang overhead like a café lamp (but there's no bulb) or be positioned more

conventionally. Also a bass reflex speaker, the Converta uses a 4-in. woofer and a 2-in. tweeter. Converta's list price is \$199 each.

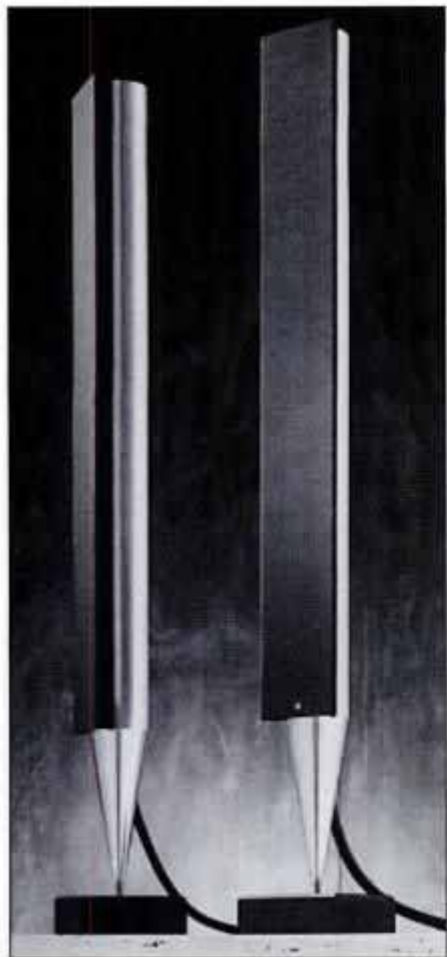
Of course, the size and shape of these speakers limit their use. Additionally, their power handling capability is limited—50 watts for the Converta and 35 watts for the Atmosphere. They are, however, well-suited for surround-sound applications, as they should be able to handle most rear channel demands adequately, and unobtrusively.

If you're looking to make more of an architectural statement, then consider the Beolab 8000 speakers from Bang & Olufsen, another Scandinavian company. The Beolab 8000 design is reminiscent of an organ pipe with the lower section resting on a point about

a half-inch in diameter. The entire tubular-shaped aluminum cabinet, meanwhile, rises to a height of 52 in. A heavy, cast-iron base prevents the speakers from tipping over.

Perhaps more remarkable is the fact that each speaker also incorporates two amplifiers, one for bass notes and the other for treble notes, each rated at 80 watts. Each speaker uses two 4-in. woofers and a ¾-in. tweeter. The speakers are magnetically shielded so they can be placed near a television without affecting picture quality. And, unlike many other Bang & Olufsen products, these speakers can work with audio components from different manufacturers. List price is \$3000 per pair. A slightly smaller version will soon be available for \$2000 per pair.

But if it's height you like, then take a look at the 6-ft.-high golden oak panels flanking a 48-in. ribbon driver on



Bang & Olufsen's Beolab 8000 speakers rest on a point that's 1/2 in. in diameter.

Carver's AL-III speakers. Listing for \$1500, the ribbon driver is backed up by a 10-in. woofer that reproduces low bass notes.

Complexity, however, need not look terribly exotic. While rather conventional looking, the Philips DSS930 amplified speaker allows you to make a direct digital connection between it and a compact-disc player, for example. The idea is to eliminate small errors that can creep in during analog reproduction. All speakers reproduce sound in an analog fashion. But, by making the digital to analog conversion in the speaker, Philips design engineers feel they have greater control over the procedure. In any event, the speakers do reproduce sound nicely. List price for the DSS930 speakers is \$1200 each.

The Biggest Tube

How big can a picture tube be? Mitsubishi is extending the limits of cathode ray tube (CRT) technology by introducing a television with a 40-in. picture, the largest direct-view size ever offered for sale to consumers. The \$5000 TV, model CS-40FX1, provides a screen surface of 768 in.—31% bigger than a 35-in. TV, the next largest size.

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MOTORSPORTS

TRANS-AM WRAPUP

BY TONY SWAN, Automotive Editor

● Like baseball, pro racing produces all sorts of statistics that help sort the contenders from the guys who merely showed up.

For example: Even though the 1992 SCCA Tide Trans-Am driver's championship went to Camaro driver Jack Baldwin, who nipped defending champ Scott Sharp by four points, Tommy Archer came home a solid third in the final standings, ahead of 61 other drivers who scored points in '92. He also emerged as the '92 Rookie of the Year.

Bobby Archer, hampered by four non-finishes, wound up finishing in ninth place overall.

Another index of performance was the finishing record posted by the Shellzone/POPULAR MECHANICS Dodge Daytonas. Tommy was one of only eight drivers to win one or more Trans-Am races in '92, and both brothers were in the top five on five different occasions. Besides leading the points battle for a time, Tommy wound up with nine top-10 finishes (in 11 events), while Bobby scored seven.

Tommy was among the Kenwood Fast Five qualifiers nine times, twice on the front row. Bobby was in the



Sears Point celebrants included (left to right) '92 series champ Jack Baldwin, race winner Darrin Brassfield, PM Automotive Editor Tony Swan and series runner-up Scott Sharp.

Fast Five on seven occasions, and was also one of the very few to take a pole position away from Scott Sharp.

Sears Point showdown

Both brothers were in the Fast Five for the season's final race—the Kenwood/POPULAR MECHANICS Trans-Am Classic at Sears Point, in California. Tommy shared the front row with Sharp's Camaro, while Bobby started next to points leader Baldwin on the second. A third Archer Brothers' entry, driven by Mitch Wright, was gridded eighth.

another Camaro in his only Trans-Am start of '92, was marching up from his ninth-place starting position.

Sharp led the first half of the race before Brassfield, winner of three straight Sears Point Trans-Am races, muscled his way into the lead. Baldwin climbed to third, with Tommy and Bobby just behind, followed by the Camaro of George Robinson. And that's the way they ran almost to the checkered flag—six cars with very little air between, and sometimes none at all.

Wright, meanwhile, fought off a charge by Canadian Ron Fellows that put both cars in the dirt, then came back to finish seventh—a memorable debut in one of the more memorable Trans-Am races on record.

As the teams packed up, the Archers weren't exactly ecstatic, but were far from morose.

"We're not in this to run third or fourth," said Bobby. "Our goal is the same as it's been in every kind of racing we've ever done—to win."

"Still, for a first-year effort, I guess you could say it wasn't too bad. I think we got their attention."

PM



Tommy Archer's Sears Point finish nailed down third in the '92 driver's standings.

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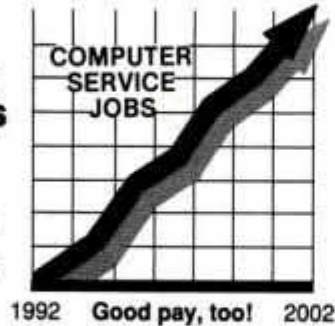


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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Ford Suburban

● This Ford version of the GM Suburban has been spotted running around Ford's test tracks in Dearborn, Michigan. Does that mean Ford plans to get into the Suburban business? Could be. General Motors sells more than 50,000 Suburbans a year at a profit that should figure to more than \$6000 per unit. Ford needs a 4-door towing vehicle. So a Ford Suburban makes sense. But it's more than two years away, say insiders at Ford.

Powerful Thunderbird

Ford will give the 1994 Thunderbird a nose job. Hood and grille will be altered to make room for the 200-plus-horsepower modular V8 that Ford plans for this car. The engine is the same one that Ford uses in the Crown Victoria, Town Car and Grand Marquis. In 1995, Ford reportedly will install its 275-horsepower dohc V8 engine in the Super Coupe Thunderbird.

Corvette/Camaro

Talk of combining the two Chevy sports cars into one series is heating up again. Those at General Motors in favor of the combination say that it's a money-saving idea whose time is now. Build the Corvette and Camaro on the same chassis, and you can close one assembly plant and save all the development costs of separate chassis. Those against, including rabid Corvette boosters, say no way. Leave the

Vette alone as America's premium sports car. You can look for a final solution within a year when the next-generation Corvette is scheduled for a go/no go decision. My guess: Combine the two on a Camaro chassis with unique styling and ultra drivetrain for the Corvette.



Next-generation T-bird gets new nose to hold modular V8 from Crown Vic.

Nosy Van

General Motors will change its 1994 Astro van styling by extending the nose slightly and raising the hoodline. Prototypes show the Astro van altered for more room up front. This could mean room for a bigger engine—or the addition of airbags for the driver and front-seat passenger. Although the front is changed, the cab and box on this prototype are identical to the 1993 models.



The '94 Astro will have at least the nose job shown on the

Bulck Riviera

Heavy disguises on the front and rear of this 1994 Riviera can't hide all of its new body lines. In front, between pinched-in fender lines, is a small, oval-shaped air intake and a sloping hoodline. A hunched rear fender is partially covered by a fake C pillar. But you get the idea of a pinched rear shape, too. Look for a 200-plus-horsepower supercharged 3.8-liter V6 engine as standard.

Aurora Delay

Olds may be late out of the starting gate with its 1994 4-door sports sedan—Aurora. First scheduled for introduction next fall, the car may be delayed until the spring of 1994. Delays have more to do with shuffling the car to a new assembly plant, than with problems in development. Like the 1994 Seville, Aurora will use a 4.0-liter version (sohc) of the Cadillac Northstar V8 engine. It will also have the same front-drive "K" chassis as the Seville.

Riding On Air

Ford appears to be strongly committed to air springs. You see them on luxury Lincolns, Fords and Mercurys. In a short time, Explorer will feature the same adjustable-height suspensions. But GM plans to stick with metal springs, at least for the time being. The big advantage GM sees in air springs is the ability to level a car



Riviera gets super-charged 3.8-liter V6 and major reskinning for '94.

clean-air standards. Of course, the dirty air must be of a certain type. Saab demonstrated the Trionic system using the exhaust of a 2-cycle engine as the intake air. Most of

body when it's overloaded. GM can do that now with its air shocks. But the raise-and-lower ability of the air springs may win out after all. It is especially useful for off-road vehicles where road clearance is critical.

Clean Engines?

Not only clean, but engines that will purify the air while you drive your car? Yes, kind of. Saab demonstrates a version of its turbocharged 2.3-liter 4-cylinder engine that actually exhausts cleaner air than it takes in. With the help of a Trionic computer, developed by Saab and General Motors, incoming air to the engine is treated so precisely, that dirty air is burned down to California's 1997

the hydrocarbons and carbon monoxide in that exhaust was reduced to California levels by the Trionic controls. Does all this mean that future drivers will be asked to keep their engines running as part of a clean-air program?

Dodge Cherokee?

At one time, Chrysler planned for a Dodge version of the Grand Cherokee. But, for now, that's dead. Instead, Chrysler is looking for other truck types for Dodge, including variations of the Dakota—like a dualie or another sport/utility. Meanwhile, Dodge dealers are aching for a Cherokee, and putting pressure on Chrysler to deliver one. But Jeep dealers are

selling all the Cherokees they can get their hands on. So Dodge has to wait.

Switch Off

That's the attitude at more than one GM division when you mention electric vehicles. GM is getting close to assigning one of its divisions to sell the Impact electric car. This is slated as a 1995 project. But at least Olds and Pontiac are not interested. They don't want the complication of a new type of car interfering with the sales of their current models. Electricians will mean special training for dealers, mechanics and sales forces. And, they mean few sales outside of California where "zero emissions" vehicles will be required by law.

Airbags Required

That's the word among automakers. Either you offer airbags, or you lose customers. Car dealers are seeing shoppers leave the showrooms once they hear a model does not have airbags. Look for bags to be a big selling point in the coming months. In two years, virtually all new vehicles will have dual airbags. They'd have them now if it weren't for the short supply. Bag manufacturers are pressed to keep up with demand. **PM**

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TECH WATCHES

(Continued from page 47)

will settle arguments back in the clubhouse for a list price of \$40.

Climb every mountain

Also in the sporting vein is the Timex Matterhorn, a digital alti-depth meter. This \$90 watch measures altitudes up to 13,120 ft. in 20-ft. increments, barometric pressure and depths up to 98 ft. Casio offers a similar product, the ALT-6100-IV, which measures altitudes up to 19,680 ft. and lists for \$150. An analog climbing watch from Citizen measures altitudes up to 17,000 ft. and costs \$625.

If you want to go down instead of up, you might try a diving watch. Aqualand II from Citizen is billed as the first diving watch with an analog indicator. The watch is accurate to a depth of 55 meters, says Citizen. Features include a preset depth alarm and a rapid ascent warning alarm. List price is \$695.

Casio's digital diving watch, the Depth Meter, uses sensor technology to determine the maximum depth reached and the duration of the dive. A hundredths-of-a-second stopwatch is also included as a feature with this watch, which lists for \$130. Analog watches are generally more expen-

sive than digital models because they're more complex to manufacture and often tend to use more costly materials.

The weather-conscious, meanwhile, can wear Casio's digital G-Shock watch. Listing for \$90, this watch keeps track of temperature changes, sunrises and sunsets. Aside from diving watches, many chronometers are also very water resistant. Look for a water-resistance level of at least 330 ft. (100 meters) if you want to go swimming wearing your watch. A water-resistance level of 660 ft. (200 meters) is needed for serious diving. Watches with water-resistance levels of 165 ft. (50 meters) are okay for wearing in the shower or in a heavy rain. These levels are set by the Federal Trade Commission.

Not every watch with a specialized function or feature is a chronometer. Nor does every specialty watch have to be complex. Timex, no stranger to complexity as demonstrated by its best-selling Ironman Triathlon models, is offering a new line of analog IndiGlo watches with one handy feature—the faceplate lights up blue at the touch of a button for easy reading at night. List prices start at \$40.

Another source of specialty watches are mail-order catalogs like those from Hammacher Schlemmer. Here,

you'll find solar-powered watches (\$150) and even a Sunwatch (\$40) that tells you when to get out of the sun once your skin type and tanning lotion strength are entered into memory. Also available by mail order is the Jet-Lag Watch (\$69) which adjusts itself as you fly through different time zones, thereby acclimating the wearer in the process, says the developer. (For more information, call (800) 7-JETLAG.)

The motion notion

While watchmakers continue to develop new applications for watches, most models still rely on batteries and electronic chips for operation. Nostalgia fans, of course, can still buy a mechanical watch that embodies the best of 19th-century technology.

One new alternative, though, is the kinetic quartz watch developed by Seiko. In a conventional watch, an electronic circuit controls the electrical energy generated by the battery so that the step motor and hands operate accurately.

Seiko's kinetic quartz watch, by contrast, uses the natural movement of the arm to rotate an oscillating weight. This motion causes the generating system to work. Electrical energy is stored by the capacitor and the electronic circuit controls it so the step motor and hands work accurately. A fully charged capacitor can power the watch for 72 hours, even if the watch is left unused. If the watch stops completely, approximately 100 swings will restart it. With the kinetic quartz watch you never have to worry about changing a battery. List prices for the 3-model kinetic quartz line range from \$495 to \$595.

Kinetic quartz watches represent a big improvement over mechanical watches also powered by the wearer's arm movement. Quartz watches, which use an electrically stimulated sliver of synthetic quartz vibrating 32,768 times per second, are far more accurate than mechanical watches. This is why quartz watches have come to dominate the market since their introduction in the 1960s.

Whatever the technology being used, most watches still use the 12-hour cycle invented by the ancient Egyptians. One exception is the Star Wheel made by Audemars Piguet. Across the top of the watchface are numbers up to 60. Each time the indicator reaches the 60-minute mark, three sapphire discs rotate so that the correct hour is displayed under the sweeping minute indicator. Being different will cost you, however. The Star Wheel lists for \$13,500. Time passes more expensively for some than it does for others. **FM**

EXHIBIT (Continued from page 40)

the "Possible Dreams" exhibit. Nearby visitors can see PM's 1977 article on the booming hobby of restoring old stationary engines.

Whether you listen, look or do it yourself, PM has published an article to fulfill your retro dreams. For instance, the 1989 title article, "Recycling The Classics," explores the process of bicycle restoration.

The beautifully streamlined 1950 Schwinn Black Phantom bicycle in the exhibit was not always as shiny and seductive as it appears today. The owner hoped that having the bike restored would correct a youthful chop job. "Just because a bike is still in the hands of the original owner doesn't mean it's been well cared for," PM reported, calling the selfsame bicycle "a basket case." (And who was the original owner? I'll give you a hint. His adolescent bicycle modification was a harbinger of his career path. Think about it and keep reading.)

Bicycles also remind us of "our first exposure to mechanical possessions, a device that needed regular maintenance, occasional repairs and hopefully survived well-intentioned modifications." (Here's another clue to the identity of the Mystery Bike Butcher. His job involves showing others how to buy, maintain, repair and modify mechanical possessions. Think you know? Read on!)

Another path to the past is practicing a traditional handicraft. One of the most famous amateur craftsmen of recent years is former President Jimmy Carter, who was featured on a 1984 POPULAR MECHANICS cover building a hickory chair with a woven bark bottom. Henry Ford Museum borrowed one of his handcrafted chairs for the exhibit. Be sure to look for his signature on one of the back legs when you come to Dearborn, Michigan.

My favorite PM comment comes from a 1989 article on rehabilitating steam trains. "The steam locomotive is the antithesis of today's microchip technology. She is the spiritual shrine of the days when improving technology simply meant to build something bigger and stronger."

I suppose that every generation has its microchip—some frustratingly complex new device that changes the comfortable rhythms of life. Someday, perhaps we too will yearn—not for Old Dobbin, but for the good old microchip.

Despite all this nostalgic longing, you needn't trade in your state-of-the-art power tools just yet. As Joe Oldham—editor of this magazine and owner of that '50 Schwinn—would probably tell you, new tools work just great on old parts. **PM**

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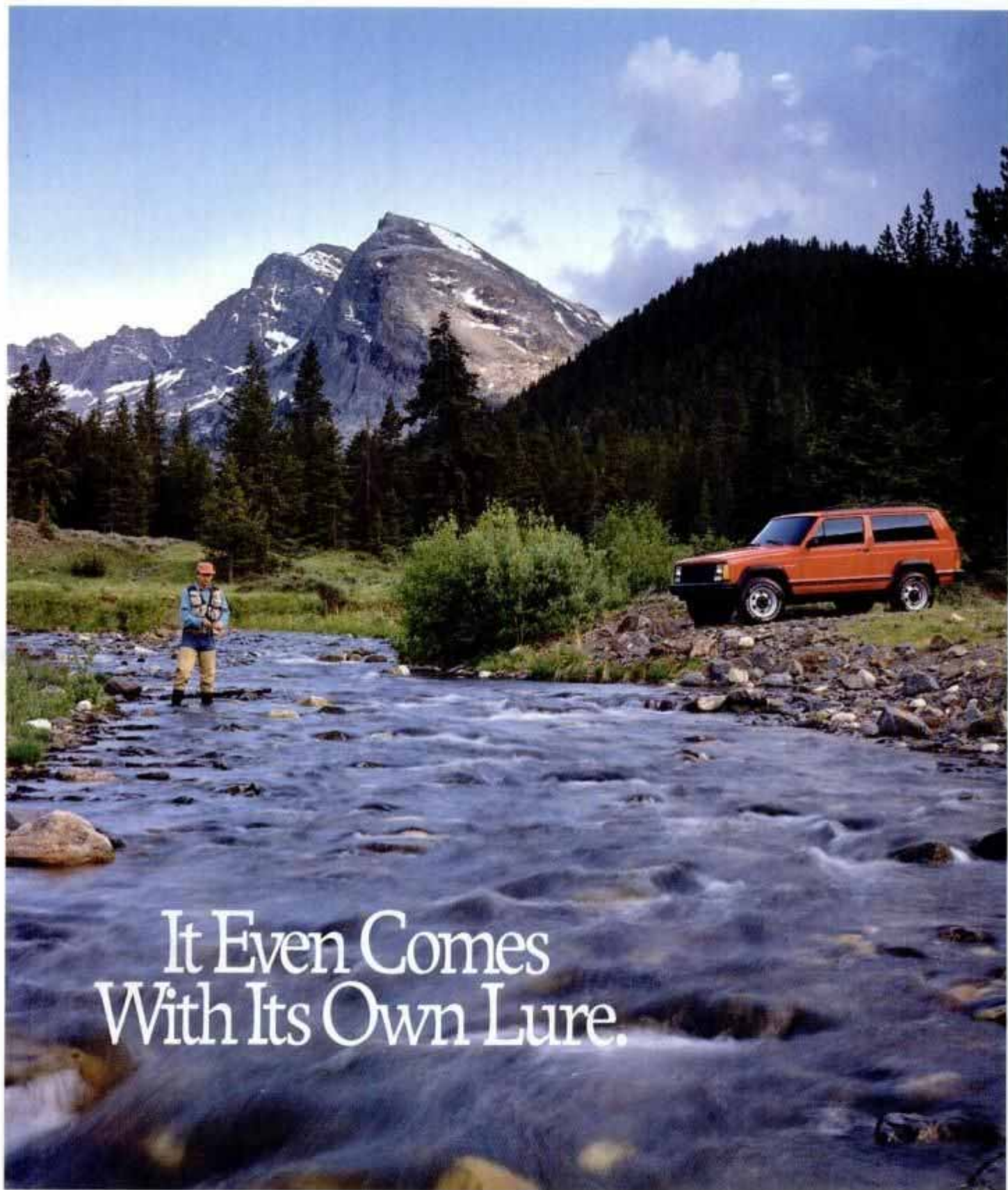


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