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—PM photo by George Lange



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Ford	Chevrolet	
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 \*\*Based on manufacturers' suggested retail prices of F-150 (2WD) equipped with 5-speed manual transmission and Preferred Equipment Package 500A or 507A compared to MSRP of comparably equipped C-1500 Chevrolet models. Comparisons based on prices available at time of publishing, including destination and delivery charges and excluding title and taxes.  
 ‡Ask your Ford Dealer for a copy of this limited warranty.

**Buckle up—together we can save lives.**



# FORD PICKUPS

AMERICA'S TRUCK: BUILT FORD TOUGH



# EDITOR'S NOTES

# Popular Mechanics

**A**S PART of the fact-gathering process for this month's installment of our "Car Of The Future" series (page 66), Detroit Editor Jim Dunne and I had the opportunity to drive an experimental 1987 Corvette with an active suspension system at the General Motors Proving Grounds in Milford, Michigan. Engineers Ken Hanchett and Chris Fulton of the CPC Advanced Vehicle Engineering Group explained how it works. We first drove a stock '87 Corvette coupe over a course that included bumps, cobblestones and a tremendous dip. We then repeated the course in the active suspension Corvette. The difference was truly incredible.



Fulton, Oldham, Hanchett and Dunne at Milford.

In the stock Vette, we stormed the bulge in the road at 60 mph. Despite cinching up my seatbelt and tucking my head into my shoulders, I still rammed my head against the roof as I crested the bump. In the active suspension Corvette, instinctively, I cringed as I crested the bump, bracing myself for the trip against the roof. As I hit the crest...nothing. The active suspension computer had automatically compensated for the wheel movement and we just coasted over. Later, on the high-speed banked oval, Fulton programmed the suspension to bank through the turns like a boat, instead of heeling through them as cars normally do. Through the same turns again, Fulton programmed the car to remain absolutely flat. Then once again, and we heeled through in conventional fashion. It was great fun. But the leaking hydraulic fluids, and whirrings and buzzings of various motors and servos in the active suspension car confirmed Ken Hanchett's assessment that a real-world active suspension system is still years away from production. . . . **Never let it be said that POPULAR MECHANICS editors aren't hands-on guys.** We could have written a desk-bound article on what it takes to make a pickup truck stand up to the rigors of the world's longest road—the Pan American Highway, which runs from the very tip of South America up to the northernmost point in Alaska. But that's just not our way. Instead, Outdoors Editor Joe Skorupa teamed up with Gary Sowerby and Tim Cahill and literally attacked the road with a GMC Sierra pickup and a vengeance. The result is not only a terrific article on page 77 but a new entry in the Guinness Book Of World Records. Way to go guys! . . . **With Super Bowl Sunday** just days away as you read this, football mania is running wild in our land. Since the stadium in San Diego holds only about 70,000 people, most of us will watch the greatest spectacle in sport on TV. The fact is, football has grown up on television, and the way TV covers a game today bears about as much resemblance to the old days as Joe Namath's style does to Joe Montana's. Electronic technology has taken over on the field, in the control truck and in the broadcast booth. And who better to explain today's TV wizardry than Frank Gifford, who uses that wizardry every Monday night and will be using it on Super Bowl Sunday. Gifford, a former running back and wide receiver for the Giants, has become one of the premier sports broadcasters of our day. I think you'll find his tour of today's technology fascinating (page 70). . . . **It's hard to think** of warm sun and blue water on Super Bowl Sunday if you live in the frozen North. However, if you're among about half of our readers who live in the southern part of the country, you may even watch the game on your boat. And for the rest of us, we can dream about warmer climes and good boating days ahead. Our 1988 Boating Guide (page 89) will start you off right. 'Til next time.

  
Joe Oldham

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# LETTERS

## Perfect Poolside Fence



Board-and-lattice design is ideal for enclosing the Wood's pool.

**W**E HAD been searching in vain for an appropriate fence to enclose our newly constructed swimming pool, when your June '87 issue arrived. We saw "First-Class Fence," (page 98) and knew instantly that our search was over. It's a great design and easy to build. We've received many compliments. Thanks to PM and authors Gene and Beth Thompson. **DAVE WOOD**  
TERRE HAUTE, IN

*Photocopy of the fence story showing plans and dimensions, are available for \$3 at POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101.*

## Explosive Theory

I enjoyed your article on the *Titanic* in December (page 64). I remember reading about it in 1912 and have read everything about the ship since. I think the explosion in the coal bunker is unlikely. If it was a coal-gas explosion it would not concentrate on one spot and blow a 11 x 14-ft. hole in the hull against the weight of seawater on the outside. It would take a very high-powered explosive located at that spot to do it. A bomb, nitroglycerine or dynamite, though, would do it. That's my sabotage theory. I wonder if there were any se-

rious disagreements during construction of the ship. The sinking of *Titanic* could have been somebody's revenge.

**E.L. KLECKNER**  
ROCKFORD, IL

## Not Just Cars

You should know how I feel about your magazine. A friend has given me a PM subscription for the past dozen years. But this year I considered suggesting not continuing this tradition. The reason? PM seemed to be directed more toward the car bug than us dedicated woodworkers. But then you come out with a fantastic special section: The "Woodworking Guide," page 95, Nov. '87! Thanks for changing my mind. The articles are good, instructions are clear, information is down to Earth, plans are readable and projects are practical. So, I think I'll keep on enjoying PM.

**D.C. MARTIN**  
PHOENIX, AZ



PM's how-to project photos are the next best thing to having a master craftsman at your side.

## Eye Of The Beholder

The BMW Z1 roadster ("Imports," page 14, Dec. '87) is certifiably ugly. Despite its speed, inconspicuous roll-over bar and fade-proof plastic skin, I'll pass on this ugly duckling.

**BRIAN MCKAY**  
BRANDON, FL

## Kitchen Cabinets

Our kitchen is due for a remodeling ("Kitchen Kudos," page 76, Oct. '87) and I'd like a list of cabinet manufacturers. **ROGER R. CHENAULT**  
BRIARCLIFF MANOR, NY

*It's difficult to go right to the source. So start with local Yellow Pages under "Kitchen" to find suppliers. Lumberyards and home centers carry cabinet displays and can be good sources of information. Also, check your local newspaper ads in the home section. A showroom is an excellent place for getting a feel for the types of cabinets available, especially when you're just getting started on a remodeling design.*

## Which Watch?

As a serious recreational runner and marathoner, I read with interest your article on sport-tech watches ("Best Of Times," page 64, Sept. '87). Especially suited for rigorous athletic use, and affordable are Casios and Seikos. I've always thought of running as a sport that can be pursued inexpensively.

**LEO UZYCH**  
WALLINGFORD, PA

I'm one of those watch freaks always looking for the latest on the market. I do a lot of windsurfing, sailing and watersports and need a dependable stopwatch. You neglected to mention two of my favorites: The Seiko 100 (LCD) Sports Chronograph (similar to the Training Timer in your article) has served me well for the past five years in all types of weather with the same battery. And,

while in Switzerland 12 years ago, I bought a Tudor Submariner, which is made by Rolex and is identical to the Rolex Submariner (with the same features as the Sea-Dweller minus the helium valve) and it is by far the best all-around sportswatch I have owned. If you can find one in the U.S., they're a bargain at \$650. **JOSEPH DENNO**  
MIAMI, FL

## 4ws Simplified

Funny as he is, Jackie Mason describing how 4-wheel steering works is not exactly the Great Communicator. I'll take your Assistant Auto Editor Mike Allen whose description of Mazda's 626 speed-sensitive arrangement was clear and concise ("Mazda 626/MX-6, First-hand Report," page 120, Oct. '87). The next best feature in your super October new-car issue was the description of



Oct. '87: Stories about Mazda's 4ws and active suspension.

Lincoln Continental's active suspension system ("Engineering The New Cars," page 135). Four-wheel steering and active suspension are two features I wish were on our future-styled Sable.

**MARGE ELKIN**  
NEW YORK, NY

*Readers who missed our description of the mechanical 4ws system on Honda's 1988 Prelude can get the whole story technical in "Freewheeling," page 20, Sept. '87. **PM***



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## WATCH FOR THIS MARK

## IT MEANS THE PRODUCT HAS BEEN FEATURED IN PM



# IMPORTS

BY BILL HARTFORD



Convertible version shows family resemblance to the current Volante.

## New Aston Martin

**J**AMES Bond is forever—even though we've seen several actors come and go since 1969. Now it's time for another legend—the Aston Martin model made famous as the indestructible Bondmobile—to get a fresh face. The 19-year-

recognizable. The coupe will be shown later this year, with the convertible to follow early in 1989. Smoother, lighter bodywork wrapped around the 5.3-liter V8 will improve power-to-weight ratio over the current 320-hp Volante.



V8 Coupe will be introduced as an '89 model.

old British sports car is getting a contemporary, aerodynamic look, but the Aston Martin tradition is still very

recognizable. The coupe will be shown later this year, with the convertible to follow early in 1989. Smoother, lighter bodywork wrapped around the 5.3-liter V8 will improve power-to-weight ratio over the current 320-hp Volante. Hp will jump when the 5.3 gets four valves per cylinder. Production of all Astons is about 225 cars per year. The number we get—about 80—will go up due to a recent purchase by FoMoCo. Price of arriving in the current V8 coupe for your James Bond screen test is \$112,000.

## Saab 9000: Soon, A Notchback

A new notchback version of Saab's big 9000 goes on sale in Europe this spring. For us, the more formal—and stiffer priced—CD, with its 160-hp, 16-valve, 2-liter, turbo Four, will be an '89 model. With willing powerplant and huge interior, this sedan is sure to be praised for its vroom.



CD sedan will become luxurious flagship of Saab's 9000 series.

## Pure Joy Ride: Mazda Transforms 323 With 16 Valves, Turbo And 4wd

Among members of the car species, clawing ahead on all fours is the highest form of evolution. Full-time 4-wheel drive is what gives Mazda's 1988 323 GTX its fantastic footing. Natural selection for adding muscle to the 1.6-liter was to let each cylinder breathe through four valves

per cylinder. Fill those four lungs by adding an inter-cooled turbocharger to the respiratory system, and the result is an engine and drivetrain that are fit to survive whatever you or the road can throw their way.

In several hundred miles of driving—that took us from the road circuit at Lime Rock Park, Connecticut, to slippery, wet, steel plates that cover road construction sites in Manhattan—we consistently put all 132 hp available directly to the pavement: No burning rubber in the dry, and no spin-

ning tires in the rain. Acceleration of the 2600-pound 323 is all grip and go. And we even appreciated the "get-ready!" time that is usually considered a turbocharger's built-in disadvantage: Driv-

ing the GTX, you'll find that turbo lag is nature's way of preventing whiplash.

It really is a jungle out there, but in the highly evolved 323 GTX you'll leave all the monkeys behind. **PM**



\$13,000 GTX has 5-speed, differential lock, and 4-wheel discs.



Alloy wheels, 185/60R14 radials, dual rear spoilers are included.



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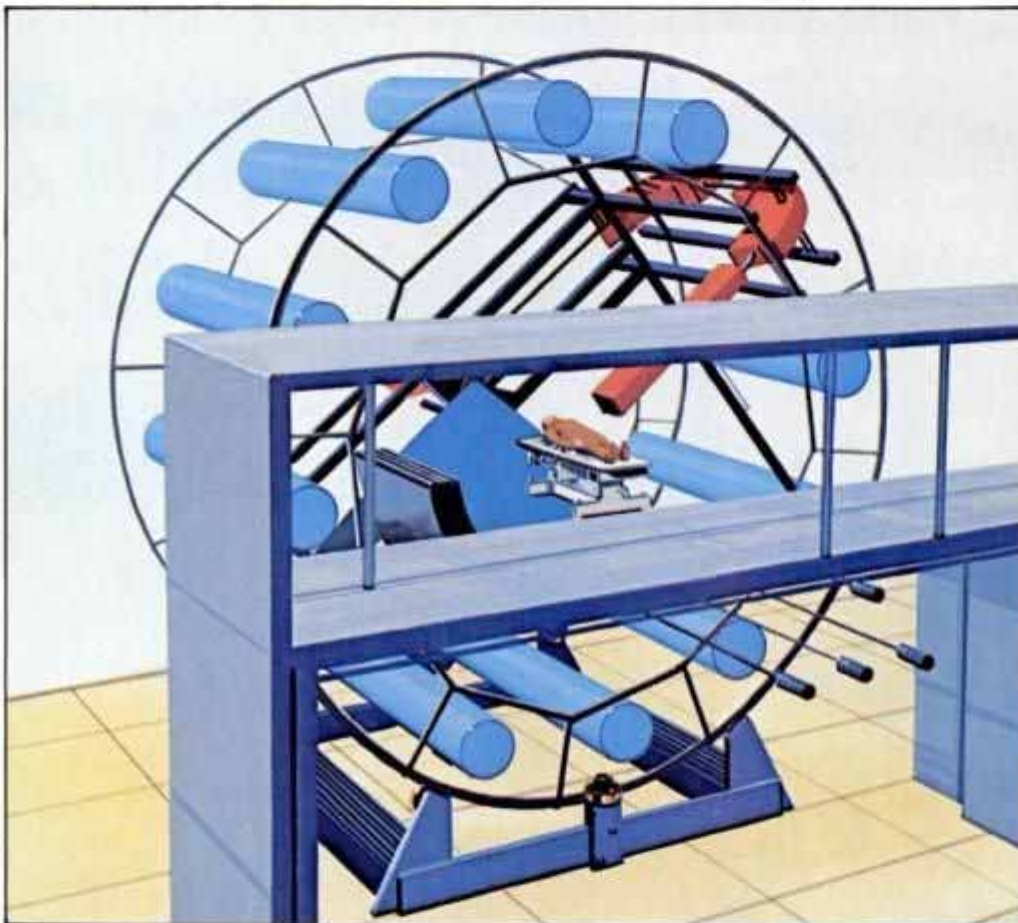
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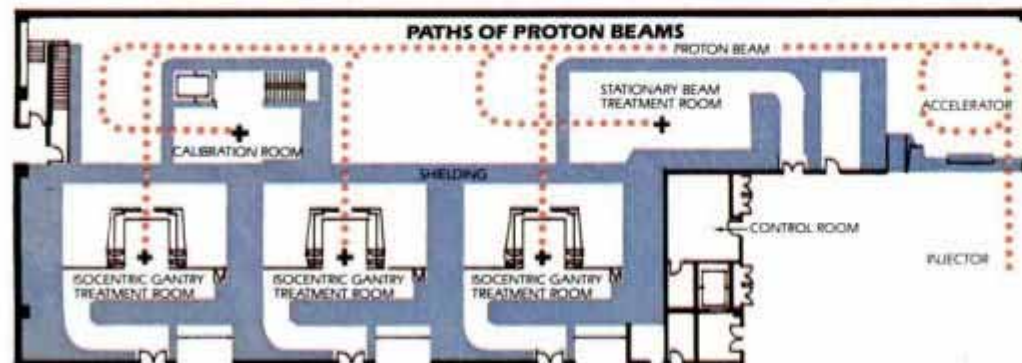
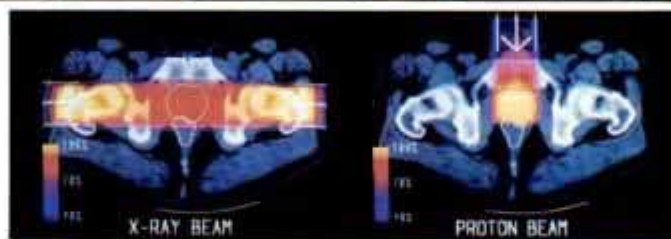
# PM TECH UPDATE

FEBRUARY 1988

## First Medical Accelerator To Zap Tumors With Protons



Rotating isocentric gantry system (above) enables beam to irradiate any part of the body. Magnetic imaging (right) shows minimized radiation dose to surrounding tissue from proton beam compared to X-rays. Vacuum pipes transport protons to treatment rooms (below).



LOMA LINDA, CA—

**B**Y 1990 a beam of protons will deliver tumor-killing energy to patients at Loma Linda University Medical Center.

To date, more than 5000 cancer patients have benefited from proton-beam therapy at accelerators built originally for particle physics experiments. The Loma Linda facility will have two key advantages: the ability to customize the protons' energy for therapeutic use and a design enabling irradiation of any part of the body.

Proton beams seem tailor-made for cancer therapy. Conventional radiation therapy uses X-rays, which deposit energy as they move through the body toward and beyond the tumor, wasting energy and damaging healthy tissues. In contrast, protons—positively charged subatomic particles—only deliver their energy when they are slowed down enough by collisions with atoms in the body. So by controlling the initial velocity of the beam, a radiologist can pinpoint the spot where the protons unleash their cell-killing energy.

In the Loma Linda setup, a synchrotron will accelerate and store the protons. The outgoing stream of protons will split into five beams—one for calibration and four for treatment.

Combined with advanced imaging techniques, proton-beam therapy has the potential to revolutionize radiation therapy.

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История, унаследованная от предков



# THE BEST-BUILT TRUCKS IN THE WORLD.

## GM SETS STANDARD FOR FULL-SIZE PICKUPS

The old measure of quality was the number of customer complaints. GM truck builders have a new, tougher, more reliable standard, one that has a genuine payoff to our customers: How the truck is built.

GM's 1988 Chevrolet and GMC Sierra pickup trucks are the first completely new, re-designed and re-engineered full-size pickups from any company in this decade.

There is a new, personal involvement of GM people working together to meet our customers' needs with world-class quality as their objective. GM teamwork and technology are producing trucks at a level of manufacturing excellence nobody has seen before.

Engineers from our Truck and Bus Group, working with GM's Hughes Aircraft subsidiary, have developed systems which helped make the plants where these trucks are built models for the world. They're the all-new Fort Wayne, Indiana, plant and the completely rebuilt plants at Pontiac, Michigan, and Oshawa, Ontario.

In these plants one of the most sophisticated electronic tools in the world—called MAP (Manufacturing Automation Protocol) and developed with the help of EDS, another GM subsidiary—integrates the processes that permit consistent and precise manufacturing.

How can we say these are the best-built trucks in the world? By comparing how they are built: Assembly tolerances are consistently held at plus or minus half a millimeter assuring a near-perfect body on every truck. Most structural steel and all exterior sheet metal, except the roof, is two-sided galvanized. Anti-corrosion phosphate is applied to each truck by immersion, guaranteeing complete coverage. The base coat/clear coat paint application is totally automated for consistent quality control.

The Chevrolet and GMC Sierra full-size pickups are another triumph of teamwork and technology. At GM, teamwork and technology are multiplying the power of people to serve GM customers.



**THE VISION  
IS PAYING OFF.**



## Robot Welding With Vision

**ABINDGON, ENGLAND**—Robotic vision-guidance systems for welding are usually restricted to light industrial environments. Now a British company called Meta Machines Ltd. has introduced a vision-guided system that it claims can withstand the heat and airborne dirt of high-current welding.

An integral cooling unit prevents overheating of the camera and associated electronics that make up the sensor. Shielding also contrib-



A 600-amp torch guided by robot vision system.

utes to cooling and keeps the optical window clear. The sensor is small enough to operate in tight corners.

The sensor guides the robot welder to the correct position and continuously monitors the weld, modifying the

welding parameters to suit the joint. The Meta Torch's software allows the system to adapt to complex joint shapes and multipass welding. The system can be tailored for work such as shipbuilding and construction.

## Liquid Coal

**MORGANTOWN, WV**—The coal-fired locomotive could return to America's railroads. However, the coal would come in a fine slurry, burned directly by a specially designed gas turbine engine. A coal gasification plant wouldn't be needed to convert the coal to the gaseous fuel normally used by a gas turbine. General Electric hopes to have the first turbine engine ready for testing by 1991, if it can develop com-



Powdered coal is suspended.

bustion chambers and fuel injectors that can handle the reconstituted material.

## Surveillance Under The Sea

**LONDON, ENGLAND**—Underwater security is the aim of this sonar unit, developed by Plessey Naval Systems.

Sending sonar pings over a 150° detection arc, the sensor can use pattern-recognition software to distinguish a swimmer at 600 yards and a small vehicle—such as a bottom-crawling submersible or a midget submarine—at 1000 yards. A network of such units could defend harbors, offshore oil platforms, naval bases or coastal nuclear plants against potential saboteurs.



Underwater watcher.

## B-1B Simulator With State-Of-The-Art Graphics



Trainees practice aerial refueling in B-1B simulator.

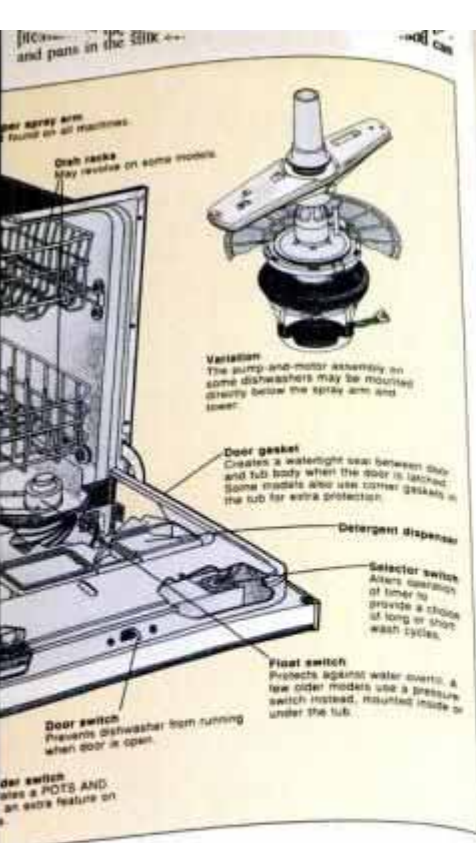
**HUNTSVILLE, AL**—Boeing Aerospace Co. is developing a full-mission simulator for the B-1B. The trainer features super-realistic computer images generated by several tons of computer hardware. To a pilot trainee in the simulator cockpit, the world shown in his "window" changes 30 times a second. The "window" is a huge projection screen containing 1.5 million pixels. Real-world information provided by the Defense Mapping Agency includes terrain elevation grid maps and features such as rivers, towns and roads. Boeing's computer repro-

duction of real-world details reduces objects to constructions of many small triangles rather than fewer multisided polygons.

Although the system can simulate worldwide flight, trainees are restricted to a 360,000-sq.-mile region of the United States. It also simulates aerial refueling of the B-1B—a ticklish procedure that takes many man-hours of inflight training.

In the future, Boeing wants to be able to shrink the hardware down to fit into an on-board aircraft system, to give pilots an advance look at their target zones.





condition—(you may need to use more detergent. If you have soft water, or use a water softener, you may need to use less detergent. For portable models, the house's main service panel or, for portable models, the machine.

TROUBLESHOOTING GUIDE		continued >	
SYMPTOM	POSSIBLE CAUSE	PROCEDURE	
Dishes dirty or spotted after washing	Dishes loaded incorrectly	Rearrange dishes following manufacturer's loading instructions	
	Water not hot enough	Test water temperature (p. 81) <input type="checkbox"/> ; if lower than 140°F, raise temperature at water heater	
	Water pressure too low	Check water pressure (p. 82) <input type="checkbox"/> ; if low, avoid using house water supply while dishwasher is running	
	Detergent ineffective	Make sure detergent is made for dishwashers; try different brands to find one effective for local water conditions	
	Detergent dispenser faulty	Check for binding or broken parts (p. 78) <input type="checkbox"/>	
	Rinse agent dispenser empty	Refill dispenser	
	Rinse agent leaking	Tighten loose fill cap; check rinse agent dispenser washers or gaskets; replace cracked tank (p. 78) <input type="checkbox"/>	
	Rinse agent dispenser faulty	Test terminal terminals on rinse agent dispenser (p. 78) <input type="checkbox"/>	
	Spray arm stuck or clogged	Look for obstructions, such as measuring spoons, which fall under racks and back sprayer; check and clean spray arm (p. 80) <input type="checkbox"/>	
	Heating element faulty	Test heating element (p. 81) <input type="checkbox"/>	
Dishwasher doesn't fill with water	Selector switch or timer faulty	Test selector switch (p. 75) <input type="checkbox"/> and timer (p. 76) <input type="checkbox"/>	
	Pump clogged; impeller corroded, worn or chipped	Call for service	
	Water supply line turned off or blocked	Ensure whether water is coming to faucet sharing same water line as dishwasher; if not, turn on water supply, clear sink drain clog, or call plumber	
	Water inlet valve faulty or valve screen clogged	Test water inlet valve solenoid <input type="checkbox"/> and inspect filter screen (p. 83) <input type="checkbox"/>	
	Float or float switch jammed or faulty	Inspect float and float switch (p. 82) <input type="checkbox"/>	
	Door switch faulty	Adjust door test door switch (p. 77) <input type="checkbox"/>	
	With a low buzzing sound; Filter under spray arm clogged (models with filter)	Clean filter using an old toothbrush <input type="checkbox"/>	
	Faucet coupler clogged (portable models)	If faucet coupler is clogged, remove and clean or replace <input type="checkbox"/>	
	Dishwasher drains during fill	Drain valve stuck open	Inspect and repair drain valve <input type="checkbox"/>
		Drain valve solenoid open	Test timer <input type="checkbox"/>
Timer doesn't advance	Timer faulty	Test timer <input type="checkbox"/>	

DEGREE OF DIFFICULTY:  Easy  Moderate  Complex  
 ESTIMATED TIME:  Less than 1 hour  1 to 3 hours  Over 3 hours

**▲ Multimeter required**

# We've done the troubleshooting to make your repair jobs easier.

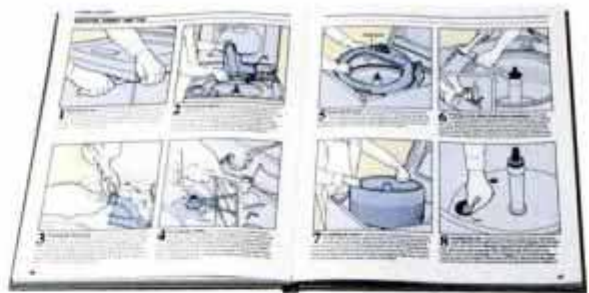
The new **FIX IT YOURSELF** series from **TIME-LIFE BOOKS**, the experts who've sold over 60 million how-to books, makes it easier to fix things around the house from start to finish. First, problems are easier to diagnose, because unique Troubleshooting Guides in each volume list symptoms and possible causes and lead you to the right solutions.

Then, detailed exploded diagrams point out where each part belongs and how they all work together. And clear, step-by-step instructions and illustrations show you how to make your repairs.

You're told which tools you'll need. Even how to handle an emergency. This depth of detail sets the **FIX IT YOURSELF** series apart from other do-it-yourself books. You'll save time, energy and money because you'll know what to expect every step of the way. And be able to solve new and difficult repair problems as confidently as a pro. With **FIX IT YOURSELF** you can repair a washing machine. Rewire a lamp. Shore up a sagging ceiling. Repair a drywall panel. Rehang a door. And much, much more. Inside and outside the house.

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## New from Time-Life Books! **FIX IT YOURSELF**



## Energy Water

KEAHOLE POINT, HI—Inside the model Argonne Lab plant, warm sea-surface water enters a low-pressure chamber where it flashes to steam. The steam drives a turbine generating electricity, then condenses into fresh water after cooling with cold water pumped from a half-mile undersea.



ARGONNE NATIONAL LABORATORY PHOTO

Ocean thermal-energy plant.



POLYSUN PHOTO

Streetlamp powered by the sun.

## Sun Light

VIENNA, AUSTRIA

—During the day, solar cells convert sunlight to electricity that is stored in a battery. Built-in electronics control the power supply to the fluorescent streetlamp and regulate the charging and discharging of the battery.

Developed by Polyair Product Design, Polysun street lighting negates the need for circuit lines and transformers as it runs independently of public electricity. The lamps can also be turned on by a remote-control radio signal. The battery has a 4-night capacity in case of solar-cell breakdown.

## Laser To Test SDI Materials

WRIGHT-PATTERSON AFB, OH—It will be the most powerful laser ever built for testing Department of Defense materials. It's expected to be up and running by summer of 1988.

Researchers at the Laser Hardened Materials Evaluation Laboratory (LHMELE) will fire the laser at vehicle skins and structural components that could be used on space launch vehicles that figure into the Strategic Defense Initiative. A mixture of carbon dioxide, helium and nitrogen will give off the photons that mirrors will focus

into a laser beam. LHMELE personnel have used a less powerful laser for over 10 years to test Air Force materials. The new equipment, however, will provide a look at how intense laser power affects electronic components and overall engineering of a space vehicle. The new facility will feature equipment to test parts under both ambient air and vacuum conditions. Acurex Corp., contracted to build the new laser, has been able to cannibalize parts from the old laser, saving the Air Force over \$7.5 million.



AIR FORCE PHOTO

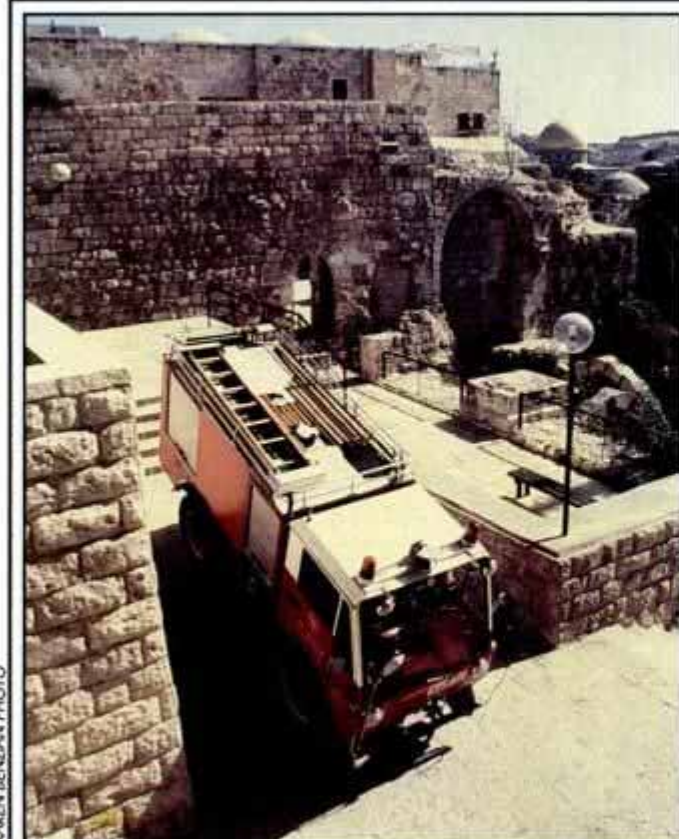
Huge vacuum chamber will clear air out of LHMELE laser cavity.

## High-Stepping Fire Engine

JERUSALEM, ISRAEL—Until recently, firefighters here were nearly helpless when fires started in the labyrinthic, densely populated Old City. Conventional firefighting equipment could not turn the narrow corners or maneuver up or down multilevel stone streets, which were designed for chariots and mule-carts 2000 years ago.

A unique fire engine that can climb slippery steps and turn circles sideways like a circus pony has changed all that. The Trenkle, named for its West German manufacturer, is a bright red engine only 5 ft. wide, 13 ft. long and 7 ft. high. Despite its small size, the engine is no toy—it carries 290 gallons of water, 295 ft. of hoses, air tanks, ropes, gloves, hats and break-in equipment. Sophisticated hydraulic equipment can be operated from the Trenkle while it moves with alacrity over rough, hard or soft terrain, moving backward, forward or sideways at a fixed rate with or without a driver. Its turning radius is only 8½ ft. and when necessary, the top part of the engine lifts off to be picked up by a firefighting helicopter. Sliding blinds that can be opened in the narrowest mews replace conventional doors.

The Trenkle was created after a nearly tragic blaze in the Jewish Quarter. A young woman had to rescue her three small children and octogenarian grandmother because the firefighters were stuck in an alleyway. A team dreamed up the ideal fire engine for Jerusalem and asked Trenkle to engineer and manufacture it. Only after receiving the fire engine did they realize that, in addition to its role in the Old City, the small versatile engine was effective in fighting forest fires amid rows of young saplings and in repelling terrorist attacks.



KAREN BENZIAN PHOTO

Trenkle maneuvers down stairs in Jerusalem's Old City.



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Hand-assembled, hand-polished and  
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Duesenberg was *the* American  
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And now Franklin Mint Precision  
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easily snaps on and off. And the  
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Priced at \$120 and not available  
in any store.



Shown smaller than actual size of 9 1/4" in length. Scale 1:24

Please mail by February 29, 1988.

Franklin Mint Precision Models  
Franklin Center, Pennsylvania 19091

Send me the 1930 Duesenberg J Derham Tourster, crafted of die-cast  
metal components, fully assembled and ready for display. I need send no  
money now. Prior to shipment of my imported die-cast model, I will be  
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City, State, Zip \_\_\_\_\_

85869-22

## THE 1930 DUESENBERG J DERHAM TOURSTER



## Fitness In Space

MOFFETT FIELD, CA  
—In a study at NASA's Ames Research Center, 11 volunteer subjects were kept for 30 days in beds slightly tilted to simulate weightlessness. Researchers sent 10 to 12 milliamps of electricity



Sparking muscles into shape.

surging into the subjects' various leg muscles.

The experiment showed that electromyostimulation keeps legs strong in weightless conditions and prevents calcium and fluid loss. The outcome could be a leotard-type spacesuit designed with an electrical connection.

## Atomic Timer



Portable superprecise clock.

DENVER, CO—Developed by Ball Aerospace, this 150-pound suitcase-sized timekeeper is accurate to one billionth of a second per day.

New microwave technology makes unnecessary the huge chambers of excited hydrogen atoms in conventional atomic clocks.

That means the Ball clock is light enough to go wherever precision timekeeping is needed—such as orbiting navigation satellites or radio telescopes.

## Heavy Launcher: Unmanned But Reusable



Shuttle-C could put payloads up to 150,000 pounds in orbit.

WASHINGTON, DC—NASA is considering a heavy-lift launch vehicle (HLLV) that will complement, not replace, the Space Shuttle. The focus is whether such a vehicle could be cost-effective for assembling the Space Station. Why the need for such a vehicle? NASA believes the reusable HLLV (tentatively called the Shuttle-C for cargo) will enable increased payloads, prove highly reliable, and save money.

An HLLV would also free the Space Shuttle from launching satellites and allow it to perform increased work in science areas.

One way NASA believes the HLLV could save money is by using some of the existing Shuttle systems such as solid rocket boosters, engines, external fuel tank and existing

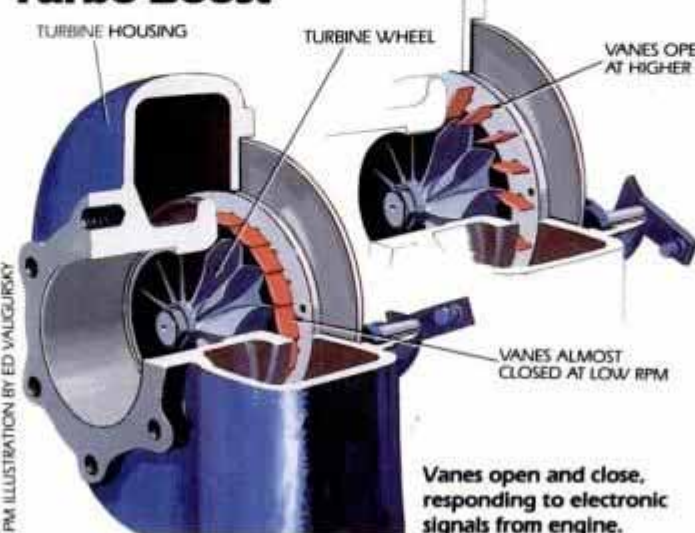
launch facilities. Being unmanned, there would be less thermal protection, also saving money and weight. Also, without life-support systems it could deliver a bigger payload.

Rockwell International's idea of a HLLV has a cargo bay 15 ft. longer than the Shuttle cargo bay. Rockwell believes the HLLV "glider" would weigh 80,000 to 90,000 pounds as opposed to the Shuttle "orbiter" with a landing weight of about 200,000 pounds.

The results of the study will be added to the other study already underway for an HLLV known as the Advanced Launch System (ALS). Led by the Air Force with NASA participation, the ALS study is concentrating on systems incorporating advanced technologies instead of the Shuttle-C.

## Lag-Free Turbo Boost

TORRANCE, CA—A new generation of turbochargers



developed by Garrett Automotive features a series of vanes around the exhaust-driven turbine wheel.

Initially, the vanes are wide open for a split second to fill the turbo chamber with hot exhaust gases. At low rpm, the vanes close almost completely, taking the small volume of exhaust available and greatly increasing its velocity as it hits the turbine. As rpm increases, rather than using a pop-off valve to prevent engine overload, the vanes open wider to let exhaust gas into the turbo chamber more freely. The result is a significant drop in initial turbo lag at low rpm.



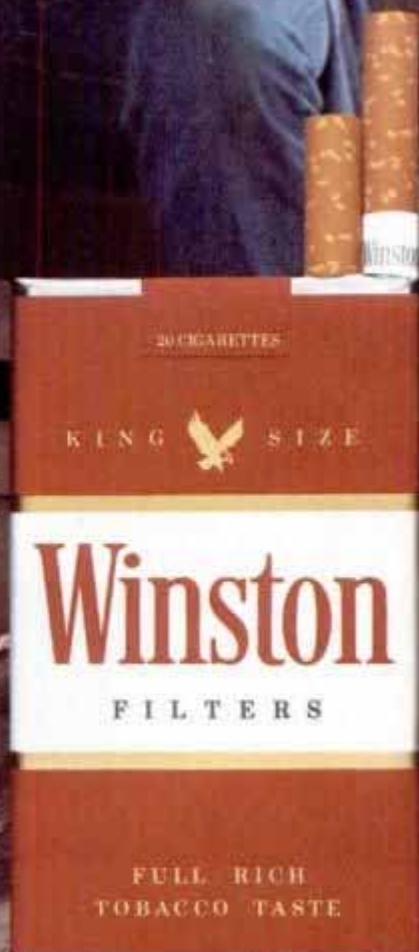
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**Real people  
want real taste.  
Winston.**

16 mg. "tar", 1.2 mg. nicotine av.  
per cigarette by FTC method.

**SURGEON GENERAL'S WARNING: Quitting Smoking  
Now Greatly Reduces Serious Risks to Your Health.**





**TOYOTA 4x4 V6**

**NOW THE MOST ADVANCED  
V6 ENGINE IN ANY  
COMPACT 4x4.**



**TOYOTA QUALITY**  
WHO COULD ASK FOR ANYTHING MORE!



## NO OTHER COMPACT 4x4 CAN OUT-MUSCLE THE TOYOTA V6.

Now you can have V6 horsepower, V6 torque, and Toyota quality all in one spectacular machine: the 1988 Toyota 4x4.

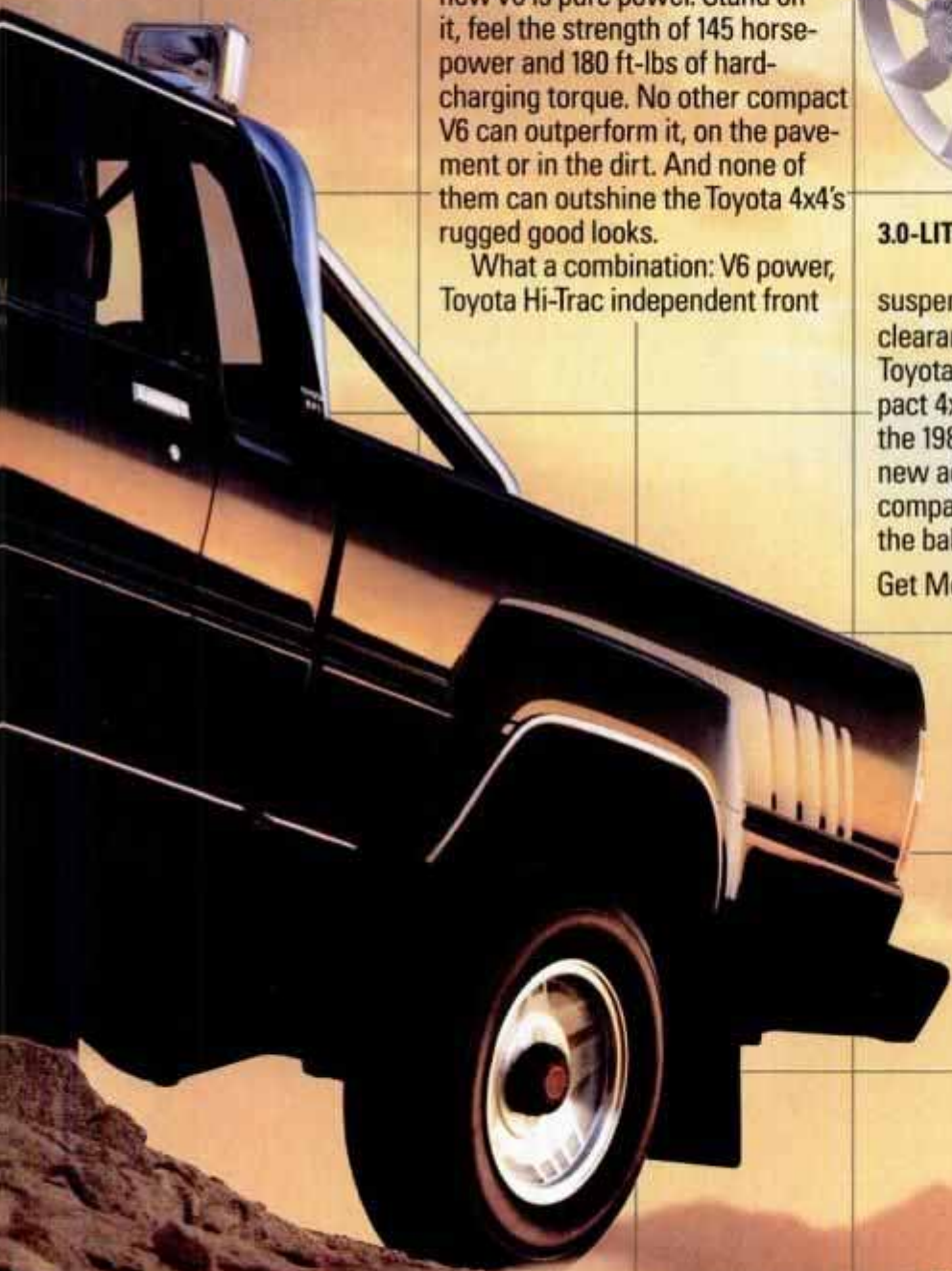
Available in every Toyota 4x4 Truck, from Standard Bed to Xtracab SR5 to 4Runner, the all-new V6 is pure power. Stand on it, feel the strength of 145 horsepower and 180 ft-lbs of hard-charging torque. No other compact V6 can outperform it, on the pavement or in the dirt. And none of them can outshine the Toyota 4x4's rugged good looks.

What a combination: V6 power, Toyota Hi-Trac independent front



### 3.0-LITER, 145-HP

suspension, high running ground clearance, and the quality that made Toyota Trucks the most reliable compact 4x4 trucks sold in the U.S.\* Drive the 1988 Toyota 4x4 V6, a powerful new addition to the #1 selling line of compact 4x4's in America.\*\* Now the balance of power shifts to you. Get More From Life... Buckle Up!



\*J.D. Power & Associates 1987 Compact Truck CSI—Customer Satisfaction with Product Quality and Dealer Service.  
\*\*R.L. Polk Registrations, 4x4 compact pickups, 1980-1988.  
Light bar not supplied by Toyota nor intended for occupant safety.  
© 1987 Toyota Motor Sales, U.S.A., Inc.



## Megamagnets For Fusion

OAK RIDGE, TN—Researchers at Oak Ridge National Laboratory have set a new world record for field strength in large superconducting magnets. The 40-ton magnetic coils put out a magnetic field equal to 180,000 times the Earth's natural field. The force on each coil reached more than 5000 tons.

Though similar forces have been achieved in smaller magnets, it's a challenge to build a large magnet that can withstand such forces. Com-



20-ft.-tall superconducting coil.

mercial fusion plants will need large powerful magnets to keep the million-degree hydrogen plasma from the reactor vessel walls. Cooling the coils to superconducting temperatures ensures that they consume little electricity—important for efficient power.

## Computer Realism



Cornell computer-graphics.

ITHACA, NY—Depicting the interplay of light, shadow and texture in a simulated scene was the aim of computer graphic researchers at Cornell University.

They first used the ray tracing technique to calculate the paths of light rays bouncing off surfaces and arriving at a viewer's eye. Ray tracing is good for rendering how shiny surfaces are seen from a selected point of view.

The second technique, radiosity, computes the balance of colors on a surface that result from light reflecting off surrounding surfaces. Radiosity cannot handle shiny surfaces because the color of such a



Vermeer-inspired subtleties.

surface changes if the viewer's position shifts.

By combining the two techniques, they've achieved a new level of realism. The dual approach allows architects and stage set designers to look at their works before they are built.

## Microbe Electricity

LONDON, ENGLAND—At King's College, a prototype microbial fuel cell can power a digital clock for a year. The key ingredient is sugar. Inside the fuel cell, microbes are breaking down the sugar molecules for energy. Sugar metabolism involves the transfer of electrons from molecule to molecule. But molecules

known as redox mediators intercept the electrons and shuttle them from the microbes to the fuel cell's anode. As long as they have sugar, the microbes will produce a flow of electrons—and electric current.

Large versions of the microbial fuel cell could generate power while breaking down agricultural waste.



Microbes "burn" sugar to power this prototype fuel cell.

## Cheaper Pet Scans

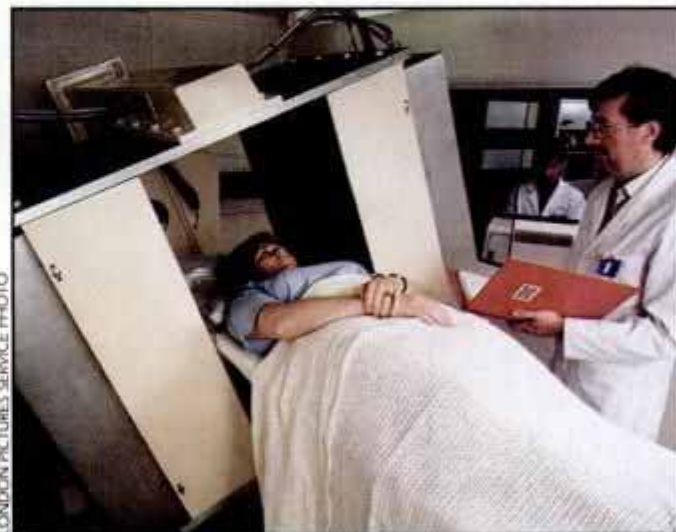
LONDON, ENGLAND—New apparatus developed at the Royal Marsden Hospital may make positron emission tomography (PET) scans more affordable.

PET scanning can detect tumors the size of grape pits anywhere in the body. The patient is given drugs containing radioactive isotopes which emit positrons—positively charged electrons.

When a positron collides with an electron, two gamma rays are emitted.

The cost breakthrough in the MUPPET (for Multiwire Proportional Chamber Pet) is in the equipment that detects outgoing gamma rays.

In addition to spotting tumors, MUPPET scanning can be used to study blood flow and schizophrenia. **TU**



MUPPET equipment rotates around patient.



# CAR CLINIC

BY MORT SCHULTZ

## Double Or Nothing

**I** have two '77 Chryslers—a Cordoba and a Newport. They use the same style computer (part No. 4094022). As luck would have it, both computers went bad within a few days of each other. I found a used replacement in a junkyard for \$40, so one car is back on the road. But I can't find another second-hand computer—nor can I get a new one. Is there a place to get a broken-down computer rebuilt? **JAMES R. STRAW**  
ST. BERNICE, IN

*Maybe there is, but I don't know of it. Besides, who says you can't get a "new" computer? As long as you can get to a Chrysler-Plymouth or Dodge dealer, you can. A dealer will have in stock—or will be able to get you a remanufactured computer directly from Chrysler. I've been informed by those running the Chrysler logistics system that there's an ample stock of these units in the supply chain.*

*However, the remanufactured units are not like the originals that went bad on you and probably not like the used one you bought.*

*All their electronics are mounted on one board, instead of the two used for the originals. Therefore, when you get the computer from a dealer, make sure you also get a plug-in adapter that will let you fit the single-board unit to the 2-board plug.*

*Suggested price of the replacement computer and adapter is \$143.*

## Fly In The Ointment

My 1984 Monte Carlo 229-cu.-in. V6 engine has broken three flywheels in two years. Mechanics don't know why. Please help.

**PETER J. CALDERONE**  
VALLEY STREAM, NY

*A car that's gone through as many flywheels as yours was probably the recipient of a badly machined part that*

*makes contact with the flywheel. The flywheel is the victim—not the culprit—although it's not entirely inconceivable to get three poorly machined flywheels in a row. It is far more likely, though, that the flywheel-mounting flange on the crankshaft is warped, or the bolt holes are out of whack. To determine this, use a dial indicator to measure runout.*

*Now for the bad news. If unevenness is found on either the engine or transmission end, the engine or transmission has to be replaced if you want to keep from busting flywheels.*

*If there's any bright spot to this dismal forecast it's that Chevrolet may stand all or part of the cost. After all, this isn't your fault. Get all your documentation together and contact the Chevrolet Customer Service Department in Warren, Michigan.*

## Wheels Of Misfortune

The aluminum wheels on my 1981 Toyota have some sort of plastic coating over them which has deteriorated. Consequently, the metal under the coating has started to oxidize. Is there a way to restore them?

**TREVOR SMITH**  
BALTIMORE, MD

*You can arrest this process, but curing it is another matter. There are kits available from auto parts and supply stores that include a stripper and refinisher.*

*I haven't used them, so I can only tell you what I've been told by those who have: The stripper works fine. It removes the old coating.*

*The refinishing agent is something else. It does not restore wheels to their original state and has a tendency to break down. Your alternatives are to halt the oxidation and keep the old wheels or buy new ones.*

*In buying new ones, you may want to consider getting*

*steel wheels so you won't be faced with the same situation in the future. If your aluminum wheels were sized in standard measurement rather than metric, you'd be able to buy replacement steel wheels that were the same size. But Toyota aluminum wheels are sized metrically. I doubt if you can find steel wheels of the same size since steel wheels usually come in standard sizes. Thus, you'll probably have to buy steel wheels that are close in size to your metric wheels. The new wheels will throw the speedometer/odometer off kilter by maybe 5 mph, but this can be taken care of by changing the speedometer gear. Also, steel wheels weigh more than alloys, though this probably won't produce any noticeable affect on handling.*

*I can't complete this discussion without advising that the way to avoid this situation is to give aluminum wheels proper care. The alloy used to cast wheels must be protected from road salt and corrosion. The coating is adequate to do this—until it's scratched. The main enemy is the carbon-impregnated tire/wheel brushes used by many automatic car wash facilities. They gouge the coating. Road salt and water getting through gouges do the rest.*

*If you wash the car yourself, don't use any abrasive, including cleanser, on the wheels—only soap and water. When having tire/wheel assemblies balanced, ask the one doing the balancing to put wheel weights, which might damage the coating, on the inside of the wheels.*

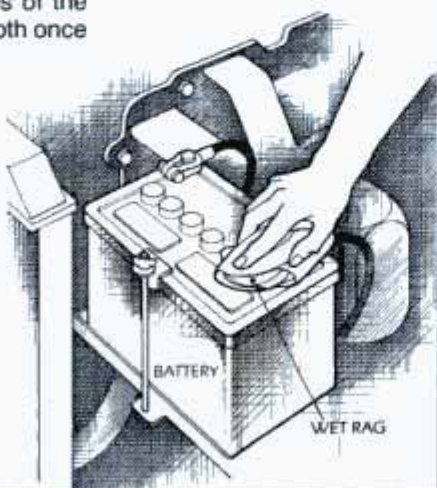
## Needed: Lincoln Wisdom

This one's a beaut, Mort. It concerns my Mercury Marquis bought new in '85. It's fighting the Civil War all over again. As long as I keep the car down here in Florida, it shifts as smoothly as the Miami Dolphins' backfield.

*(Please turn to page 28)*

## Battery Wipeout

One minute a week can save you the nuisance of periodically removing the battery from your vehicle for cleaning. In fact, that 1 minute a week may add to the life of your battery. That little bit of dirt and corrosion along the top and sides of the battery is a constant electrical drain, especially in damp weather. This has been the experience of Dave Fusco of Arlington, Texas. He just wipes off the top and exposed sides of the battery with a damp cloth once a week when he checks the engine oil level. Says Dave: "I've never experienced a buildup of corrosion on any battery in any of the vehicles I've ever owned, and my batteries have lasted as long—in many cases longer—than those of my relatives and acquaintances." **Note: Wear gloves when you do this.**





## CAR CLINIC

(Continued from page 27)

But whenever I drive it up north during cold weather, it fumbles. When I start off in the morning, the transmission stays in Second for about 2 miles before it grudgingly shifts into Drive. The car has been to the dealer who finds nothing

wrong. I've got the extended warranty, so he's willing to fix it if he knows what to fix. Care to take a shot?

WILLIAM SCHATZEL  
CLEARWATER, FL

*Nothing to it. This condition with the Merc C5 transmission was first noticed in Canada by salespeople who stay over-*

*night at motels after driving long distances during the winter. The combination of long drives and overnight cold allow the governor in the transmission, which seems to be somewhat sensitive, to take a set. Next morning it has trouble shaking itself loose and stays in a lower gear for awhile before shifting up.*

*Tell your dealer that there's now a service kit that contains cast-iron sealing rings for the output shaft. This should make the governor more responsive on cold mornings. If not, then the governor should be replaced, but the cast-iron rings should still be installed.*

## Unfair Test

Why doesn't the chest part of the safety belts in my Dodge van fit snugly? Those in my Honda lie next to the body, and I can make them hold or lock by grabbing onto the steering wheel and throwing my body forward. Not so with the Dodge. Am I in danger if I get rear-ended?

GEORGE PLUN—  
INELIGIBLE ADDRESS

*Your seatbelt "test" is not valid. A true test is to throw yourself forward as you hit the brake pedal using medium to heavy force. If the belts lock properly, we'll have to assume that they will hold in an accident.*

## Duct Hunt

How many vehicles lack get up and go? How many thousands of dollars do you suppose owners spend in vain attempts to resolve these problems? How much irritation and money do you suppose could be saved by inspecting carburetor ducts for damage? Plenty.

There are usually two ducts that direct air to the carburetor—for manifold-heated and cool outside air. Interrupting the temperature-controlled air supply to the carburetor can result in a performance problem. There could be tears hidden in the folds, so look closely.



# WARN WINCHES. TURN YOUR TRUCK INTO A ROLLING WORK-STATION.

A self-propelled workshop on wheels. That's what you've got if you own a pickup truck or four-wheel drive equipped with a Warn Winch. Warn makes winches for just about any kind



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The belts in your Dodge are not designed to fit snugly around the chest, but to lie lightly for the sake of comfort. When 1 to 2 Gs of deceleration force is applied, a pendulum part of the belt mechanism is supposed to swing and lock to grab the belt. If you want still further assurance that the locking mechanism is sound, remove the cover from the belt housing. See the pendulum? Flick it back and forth with your finger. As long as it's swinging, all's well.

### Third-Party Mediator

I have a 1986 Buick Grand National with a condition the dealer claims is normal. The problem didn't start until the car reached about 6000 miles. The car has now been driven 14,000 miles. It's fine until the torque converter engages. Then, the engine feels as though it's lugging. To be specific, somewhere between 30 and 55 mph the car starts to jerk. This happens about 80 percent of the time. The dealer says everything is okay, but an independent repair shop tells me the transmission should be overhauled. Whom should I believe?

ALAN C. MURPHY  
PORTSMOUTH, NH

*My guess is it's the engine. When the torque converter clutch (TCC) was introduced about five or six years ago, a sensation GM called "chuggle" occurred as the TCC alternately engaged and disen-*

gaged. Since then, chuggle has been engineered out of the converter. Your car didn't do the chuggle for the first 6000 miles nor does it do it some of the time now.

In 1985 and 1986, there was a situation with the originally installed sparkplugs and plug cables that caused the engine to misfire at a specific speed within the range you mention. Most times the

offending sparkplug or plugs misfired, but occasionally they didn't.

My suggestion is to replace the plugs, and then the cables. If this doesn't work tell the dealer you want a meeting with the Buick technical service representative. The condition is not normal—I can't agree with the dealer there—but neither can I agree with the transmission shop—not without having the transmission tested as outlined in the service manual. But why should you have to pay when your car is still under warranty? That's why you should deal with the Buick rep and not with the dealer who appears to be adamant. Good luck.

FM

### DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

Whoever  
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### SERVICE TIPS

- If the windshield of your 1986-87 Chevy Caprice Classic fogs up when the weather is hot and humid, there are voids and cracks in the upper panel of the defroster duct through which cold air from the a/c is leaking. Use thumb-grade sealer, duct tape, strip calk or body sealer to plug them up—that's what TSB 87-227 says.
- If you have an '87 or '88 Chrysler Corp. product equipped with the Mitsubishi 3-liter V6—New Yorker, Dynasty, Voyager or Caravan—use only the Mopar oil filter (part No. 4105409), also specified for the Chrysler 2.2- and 2.5-liter engines—or the Mitsubishi oil filter (part No. MD108063). Both have American Standard thread (.75 in. diameter). Don't let anyone tell you the Mitsubishi filter designed for the 2.6-liter engine will fit. It will be too loose and can blow off the engine, causing rapid loss of oil and maybe a ruined engine.
- A noise coming from the rear of your '87 Escort or Lynx may be made by the rear shocks. Have shock absorber insulators (part No. E8FZ-18A179-A) installed as per TSB 87-19-5.
- If your '84 to '88 Jeep Cherokee, Wagoneer or Comanche doesn't shift when you throw it into 4-wheel drive, a damaged front-axle fork, inoperative vacuum motor or a screwy transfer-case vacuum switch is probably the reason. IS 44E/MR 244 for the Cherokee and Wagoneer or IS 37E/MR 277 for the Comanche has the "fixin's" your dealer needs.



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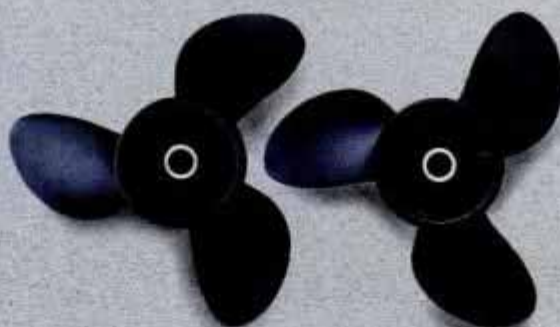
*First Lightweight Aluminum Outboard*



*First Oil Injection for Small HP Outboards*



*First Full Gear Shifting for Outboards*



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*First Sacrificial Anodes as Standard Equipment*





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# INSIDE DETROIT

BY JIM DUNNE

## At The Wheel Of The Buick Reatta

**R**EATTA—the new luxury sports car from Buick, is the fourth 2-seater in GM's lineup. But Reatta is different from the Corvette, Fiero and Allante. If you want roominess, a quiet ride, a slightly softer suspension and a smooth drive-train, Reatta delivers. But if you prefer all-out performance, Reatta falls a bit short. The 165-hp 3.8-liter V6 can pull this 3350-pound car to 60 mph in 9.5 seconds, which is far from slow but still not in a class with other 2-seaters.

Reatta is restricted to one transmission, the same 4-speed overdrive automatic



1988½ Buick Reatta: good handling, lots of room, limited zoom.

that GM uses in its luxury sedans, which helps to make this one of the smoothest, most responsive drivetrains you can find.

Interior volume is perhaps the best of any 2-seater on the road today. Passengers sit in large bucket seats that offer good side support without undue restriction. The console is set low between

the seats, leaving lots of space for elbow room.

And behind the seats is where Reatta's roominess shows up most. A large storage compartment, with three, lockable, small-object bins, is big enough to carry a wide variety of cargo, and there's also a 10-cu.-ft. trunk.

On the road, Reatta has a feel of balance, security and

outstanding control. The car is faithfully obedient to the slightest touch of the steering wheel, body roll is nearly nonexistent and ride quality has no harshness.

Inside, the instrument panel appears as though it was lifted intact from the Riviera, including the video screen with touch-screen controls for radio, heater and a number of other information readouts. Overall, give the Reatta a B+ rating. It lacks true sports-car performance. But its distinctive looks, roominess, quiet interior, smooth drivetrain and excellent handling are among the best in its class.

## Four Doors For The Big Bronco

Ford's next response to the continuing boom in the sport-utility market will be an extra set of doors for its full-size Bronco.

Adding a 4-door to this perennially popular line of 4x4s will give Ford a chance to expand into a portion of the market that has belonged to the Jeep Grand Wagoneer and the GMC Suburban.

The 4-door version of the big Bronco will probably debut in 1991, one year after the Bronco II 4-door.

As with the Bronco II project, look for the big Bronco 4-door to arrive with a wheelbase stretched from the 2-door's current 104.7 in.,

probably by 10 in. Overall length, currently 180.5 in., will be in the vicinity of 190 in., a bit longer than the Grand Wagoneer and shorter than the Suburban.

Look for the engine offerings to be the same as the current Bronco lineup: 4.9-liter inline Six, 5.0-liter V8 or 5.8-liter V8.

## Goodbye To The K-Car

When Chrysler rolls out its Dodge Aries and Plymouth Reliant replacements for 1989, code-named the A-bodies, it will mark the end of an era. For the first time since the dark days of 1980, Chrysler's bread-and-butter entries will roll on an all-new

chassis. Although the new cars will still be front drive, the underpinnings have been brought up to date, both in terms of componentry and overall design.

Besides the original Chrysler 2.2-liter Four, powertrains should include the 2.5-liter Four, complete with balance shaft, and the new Mitsubishi 3.0-liter V6.



All-new Dodge Aries will replace aging K-car for 1989.

This has significance that goes beyond the two new car lines, since an important key to Chrysler's dramatic return to profitability has been manufacturing efficiencies achieved by building a number of different cars on variations of the same basic platform. The introduction of the K-car replacements, as a result, will likely usher in a new era for a number of other Chrysler nameplates as well.

Though conservatively styled, the new sedans will be more aerodynamically efficient than their predecessors.

They'll also offer more in the way of engine options.

## Imperial Air Ride

Chrysler will follow Lincoln's lead in using an air-spring suspension in the 1989 Imperial luxury sedan. The air springs are rubber cylinders filled with pressurized air that take the place of coil or torsion-bar steel springs.

Any driver should be able to feel the slight difference in an air-spring ride. It is smoother, in that some road vibrations are damped out by pneumatic suspension that would be felt by the driver of a car using conventional springs.

The improvement is enough to add a touch of luxury to the car's ride.



Future Ford: paneling disguises 4-door Bronco II.



Lincoln Continental and Mark VII were the first cars to offer air springs since the mid '50s, when an industry-wide experiment with the systems turned into a complete flop. Now, Chrysler's Imperial will become the third car in this revival of an old idea in suspensions.

### Costly Cimarron

Cadillac will fix its problem with the Cimarron by replacing the car with a completely new model in 1990, a cure that's likely to include a \$10,000 price increase.

Cimarron sales are an embarrassment to Cadillac, slumping almost 50 percent from 1986 to 1987. The year's total of less than 15,000 represents only a fraction of the 50,000 or so Cadillac hoped to sell when Cimarron was introduced five years ago.

What Cadillac is planning is a much more expensive sports sedan that is unlike any other car in GM's lineup. The new model will still be subcompact in size, but will be built on an exclusive, new space-frame chassis.

Cimarron's sales troubles remind me of what a Cadillac engineer came up with when asked what was the difference between the Cimarron and its sister car, the Chevrolet Cavalier, "Oh, about \$6000."

### Stretched Aerostar

Ford will introduce a stretched version of its Aerostar compact van next fall as part of the 1989 model lineup. The body of the van will be lengthened about 18 in. behind the rear wheels, leaving the chassis and drivetrain mostly unchanged.

The new van will compete, Ford hopes, with the stretch Chrysler van in carrying capacity. Look for added passenger capacity, with an extra seat in the station wagon version.

### GM Powertrain Plans

Horsepower is increasing across the board at GM, with the latest plan concentrating on the company's 3.8-liter V6 engine.

"We will have double overhead cams next," one GM insider reports. "All our engines will be upgraded."

GM got caught in a massive swing to smaller engines when it switched most of its car lines to front-wheel drive. Now, GM no longer regards front drive as the answer to all its needs. So, more powerful Fours and Sixes, bigger V8s—even a V12—are under development in GM dynamometer test cells.

### No Confidence

Renault's supersport Alpine coupe will not be imported by Chrysler because Chrysler executives have "no confidence" in Renault's ability to build that

model as a quality car. The Alpine was to be introduced in the U.S. last year, but AMC dropped the plan shortly before Chrysler took over. When asked if Chrysler planned to revive the Alpine idea, a Chrysler executive made the no-confidence comment.

Instead, Chrysler will stick to its Italian connections for sports cars—Maserati and Lamborghini.

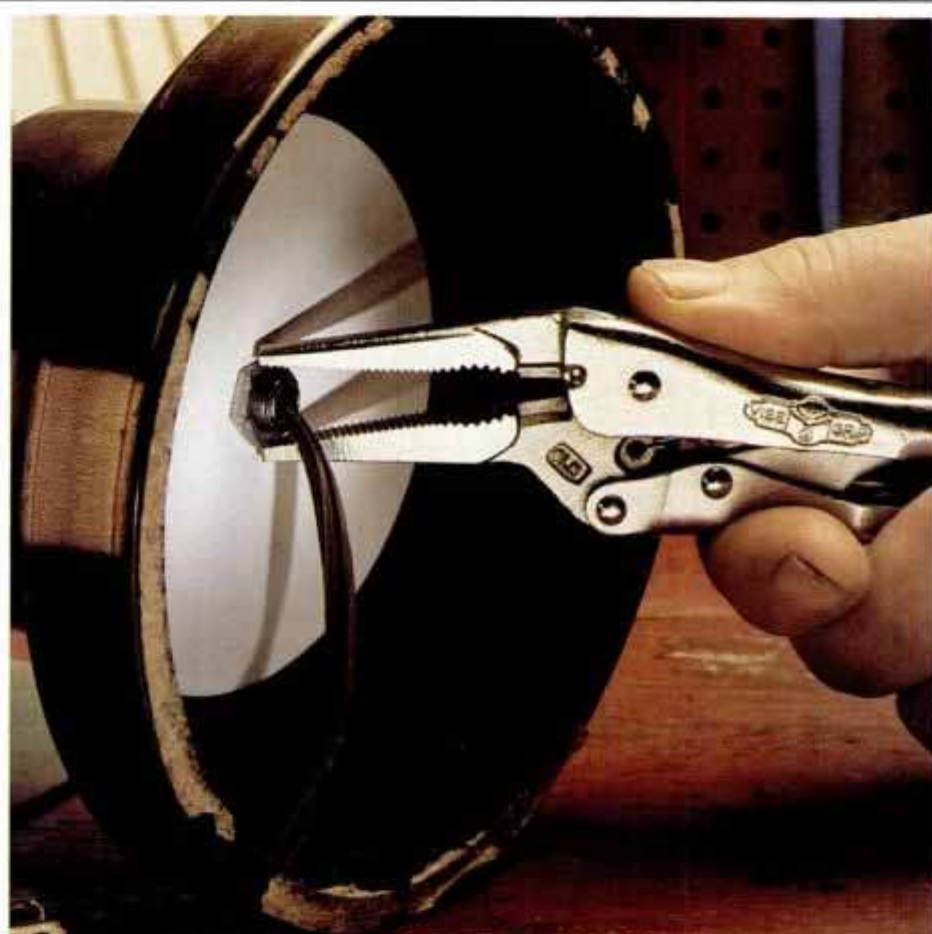
### Big-Ticket Hyundai

Hyundais are among the lowest-priced cars sold in the U.S., but their buyers like comforts like air conditioning and high-cost automatic transmissions. The

lowest-priced Hyundai sedan is listed at \$5295.

However, Hyundai reports that the average out-the-door price of the Korean-built sedans is \$7300. Reason: More than 85 percent of the buyers want either automatic or 5-speed manual transmissions. In addition, about 75 percent of Hyundais are equipped with air conditioning.

Still, even at \$7300, Hyundai is one of the least expensive subcompacts on the market. Why? Labor costs in Korea average \$3 per hour versus \$24 per hour in the U.S. and \$15 per hour in Japan, according to Hyundai estimates. **PM**



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# CYCLES

BY NORMAN MAYERSOHN

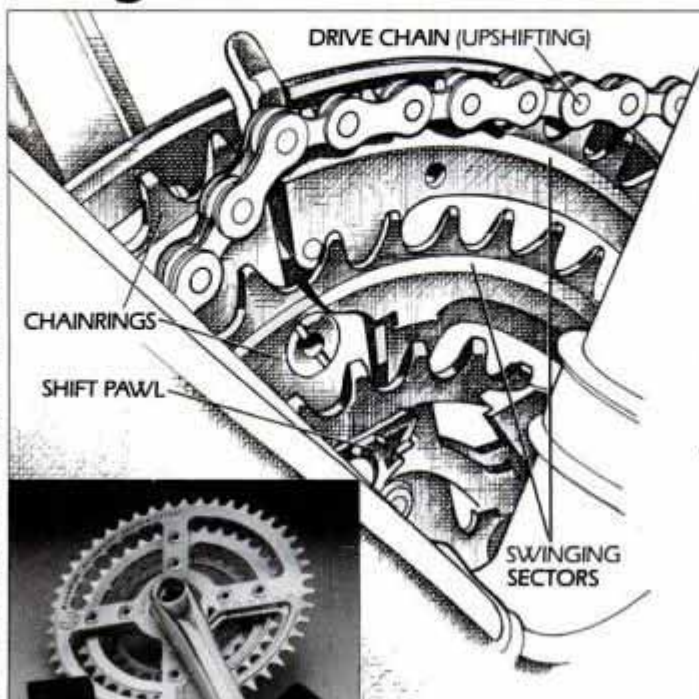
## Shifting When The Power Is On

**I**T'S THE classic no-win situation: Pedaling along on rising terrain, you're taken by surprise as the approaching hill turns deceptively into a steep, out-of-the-saddle grind. Sit down to let off the power for a downshift and you'll lose momentum—if you don't gear down, you'll slow to a near stop just the same. What's needed to get you out of this jam is a transmission that changes ratios without the need to relax pedaling force.

Shifting up or down under full load will be a reality when the Browning Automatic Transmission finds its way on to a few selected '88 model bicycles and later hits the bike shops as a retrofit kit. By using a front chainring set with hinged swinging sectors to move the chain, the Browning design keeps the chain fully engaged at all times, even while the shift is underway. The swinging sectors and their selector mechanism replace the conventional front derailleur entirely, eliminating the need for precision control at the shift lever. That, in turn, makes missed shifts an inconvenience of the past.

If the company name strikes you as familiar, you should associate it with the fine products of Browning Arms Co., long known for its smooth-working and utterly dependable guns. The transmission inventor Bruce W. Browning is in fact a grandson of the firearms magnate and originally drew up his design for a line of bicycles the company was marketing. At this point he's spent over 10 years developing and refining the device, assuring that it will hit the market fully debugged.

First designed as a 2-speed for BMX applications, Browning then moved his idea up to an All-Terrain Bike and touring 3-speed.



Both transmissions shift the same way, using a pivoting pawl to control a movable section of the chainring. Moving the pawl up or down levers the chainring's swinging sector left or right, transferring the chain to the next ring. The swinging sector comprises one quarter of the chainring's total diameter.

Switching gears takes no more than a touch of the thumb on the upshift or downshift button. The unit is powered by a replaceable 9-volt battery which Browning claims will last a couple of riding seasons.

The actual shift is delayed until the chain mates with the swinging sector of the chainring—it only happens once per revolution—but in riding there's not much noticeable lag. When the Browning Automatic Transmission hits the shops late this spring the price will top \$200. Browning is at 105 W. 2950 South, Salt Lake City, UT 84115.

Shifting is by a hinged swinging sector. Complete transmission includes chainrings, selector, shift button and battery.

### Pedal-Powered Sportscar

Recumbent bicycle designs seem to come and go with regularity, but they've never caught on in a big way. Perhaps it's the riding position that looks so ungainly, or maybe all that chain and sprocket hardware hanging off the front repulses buyers. The Corsa, from H.P.E. Corp. (2030 First Ave., Seattle, WA 98121) addresses both hangups with a stylish new design.

At just 21 in. high, the Corsa is not well-suited for busy city streets but it is a

terrific way to navigate parks, bike paths or maybe even a parking lot gymkhana. The two front wheels are steered by dual side-stick controls which also carry the brake and gearshift actuators. The transmission offers a choice of 25 speeds, allowing a peak velocity of more than 40 mph. With an aluminum alloy frame, the Corsa tips the scales at 41 pounds.

### Classic Hangup

With the Motorcycle Classics 1988 calendar you'll hardly want to turn the months, not having the heart to cover up a magnificent 1950 Vincent Touring Rapide until you see that the next page reveals a stately 1913 Pope. So it goes through the year, each

Motorcycle Classics 1988



A year's worth of fine vintages.

month illuminated by a high-quality 11x17 photograph.

Also available in the collection (\$12.95 each from the Oxman catalog, 17165 Newhope St., Fountain Valley, CA 92708) is the America's Classic calendar, a pictorial sampler of Harley-Davidson's finest machinery from years past. When 1988 runs out, though, there'll still be a fine collection of cycles suitable for framing.

*(Please turn to page 38)*

Corsa recumbent is a sleek 3-wheeler with 40-mph potential.





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## CYCLES

(Continued from page 34)

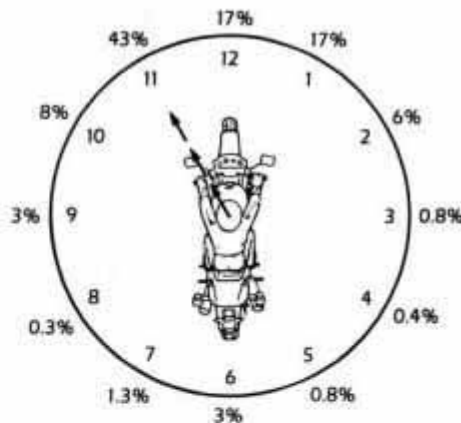


Rokon's 2-wheel drive is unstoppable.

## Rokon's 2x2 ATV

Rokon gained its reputation on TV as the unstoppable companion of explorers on the Mutual of Omaha "Wild Kingdom" series. Across the plains of Africa it proved itself time and time again, reliably hauling cameras and supplies in search of each week's footage. In the past decade, though, the Rokon fell out of sight, forgotten to all but the most dedicated fans.

Now built in New England (Rokon International, P.O. Box 189, Jaffrey, NH 03452) this ATV's all-terrain tires are inflated to just 3.5 psi, assuring good flotation over mucky surfaces. The



Most bike accidents come from left front.

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wheels are liquid- and air-tight, so you can fill each with 4.5 gallons of fuel for extra range in the back country. A 10-horsepower, air-cooled, 2-stroke engine is linked to the 3-range transmission via an automatic torque converter clutch. Disc brakes are used on both wheels, which are chain driven.

With 15 in. of ground clearance, a stream fording depth of 24 in. and the capability to climb 60° grades, the Rokon is an awesome backwood's mount. Front and rear cargo racks are available, depending on whether you opt for the Ranger or Trailbreaker model. With a sidecar attachment in place or when using a towing hitch on the chassis, up to 600 pounds of rider and cargo can be transported to the Earth's most remote corners.

The rugged 2x2 weighs in at a beefy 185 pounds dry, has a top speed of 40 mph, and fires up with a recoil rope, so you're unlikely to see one parked at the country club anytime soon.

## Defensive Anticipation

Heads-up riding is the best safety measure there is for pilots of 2-wheel vehicles. And knowing where your greatest danger is likely to come from will go a long way toward preventing the accidents that can result when inattentive drivers don't see you.

From the diagram above, you can see that the greatest threat to a cyclist comes from vehicles approaching from the 11-o'clock position—43 percent of the accidents researched in a Department of Transportation study showed that this was where the colliding vehicle approached from.

An organization known as Project: Safety Bike (P.O. Box 6664, Woodland Hills, CA 91365) has gathered more than 60 companies that build safety-related products and initiated a public information program.

For \$1.50 to cover postage and printing costs, Project: Safety Bike will send you a comprehensive list of products, techniques, features, sources sponsors and safety tips (please provide a self-addressed envelope).

PM



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3  HARD ROCK 4  POP/SOFT ROCK 5  CLASSICAL

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[ ] [ ] [ ] [ ] [ ] [ ]

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D1 [ ]  
D1 [ ]  
D1 [ ]  
XBT55 [ ] [BH]

CHECK ONE: 1  Classical 2  Pop/Soft Rock

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# OLD HOUSE RESTORATION

BY BOB VILA

## Repairing Old Brickwork

**M**OST FOLKS would probably agree that, as far as wall materials go, brick is one of the most durable. But don't let this sense of permanence fool you—periodic maintenance is required to keep a brick wall in good shape.

If you know what to look for, a simple visual inspection of your home's exterior brick walls, old or new, should turn up most signs of failed masonry. Repointing and replacement of damaged brick are usually the solution to any problems you may find. Of course, no discussion of this type of restoration work would be complete without mentioning cleaning and paint removal techniques, too. But first things first. Let's see what shape those brick walls are in.

### Working from the inside out

Water is the major culprit in brick damage and deterioration. Any weaknesses in a brick wall—areas where mortar is cracked, soft or missing and where bricks are chipped and spalled—allow in this natural enemy. If you live in a Northern climate, the effects of the freeze/thaw cycle on this trapped moisture are repeated expansion

*Contributing Editor Bob Vila is host of public television's "This Old House."*



**This brick wall shows the effects of moisture damage. As the water freezes and thaws with the change of seasons, it expands and contracts which ends up cracking the mortar and the bricks.**

and contraction which causes even more cracking and chipping. This, in turn, allows more moisture in, and the cycle repeats itself.

If corrective measures aren't taken, a serious wall problem will result.

Actually, this inspection to detect damaged or deteriorated masonry should start inside your home.

Do you have a moisture or mildew problem on walls or ceilings that face the exterior? If so, this may be an indication that moisture is seeping through the brick wall.

Therefore, I'd check the outside wall surfaces opposite these areas first for signs of weakness.

Any openings in either the bonding mortar or the bricks themselves can act as a passageway for water. In gener-

al, you should look for signs of moisture penetration, like damp spots on the brick, as well as spots where either the mortar or the brick itself has failed. The mortar joints that bond bricks together are usually the first to feel moisture's negative effects.

Is the mortar soft, cracked or missing? If you can break it with an old screwdriver or cold chisel, the joint should come out and be repointed. Also note any badly chipped, cracked or spalled bricks. These, too, should be replaced.

Brick damage isn't limited to walls. Don't forget to inspect masonry chimneys for signs of damage. Like anything else, repointing has its limitations. It won't stabilize a leaning chimney, for example. Usually when a chimney

leans, it's a pretty good indication that mortar has deteriorated at some point, allowing a shift in the chimney's weight. The tilt causes pressure on the chimney and liner, and should be corrected. In most cases, if a chimney is leaning enough for it to be noticeable with the naked eye, it has to come down and be rebuilt.

Every situation is different. I've seen people remove only the bricks down as far as the lean, while other times the whole chimney is taken down to the roofline or below. A chimney professional or masonry contractor can advise you further. As far as price goes, expect to pay an average of around \$5 to \$6 a brick, depending on locality, to rebuild a brick stack.

### Pointing basics

Once your visual inspection is complete, it's time to repair any failed masonry you might have found.

The size of the area that needs repair should be a factor in deciding whether or not you take on this job yourself. Most "sophisticated" do-it-yourselfers can usually do the job if the damaged areas aren't too extensive. By this I mean if you're considering repairing less than 10 percent of 1000 linear ft. of mortar. Anything more than this may be a bigger job than you can comfortably handle. If



**To repoint brickwork, begin by removing the old mortar. Use a 1/2-in. cold chisel and mason's or ballpeen hammer.**



**Dampen the joints, then apply new mortar using a mason's trowel and a narrow joint filling tool as shown above.**



you have any doubts, it's probably worth getting an estimate from a professional. Depending on where you live, expect to pay a mason somewhere between \$2.50 to \$3 a sq. ft. to repoint a brick wall.

Mortar joints are generally 1/2 in. to 3/4 in. thick, although you may find joints as small as 1/4 in. in some very old houses. I find that a good ballpeen or mason's hammer and a 1/2-in. cold chisel are usually all that's needed to remove the old mortar from the wider joints.

If your house has very fine 1/4-in. to 1/2-in. joints, you'll have to cut the mortar out with a power masonry saw, something that is better left to a chimney professional or masonry contractor. Many of the bricks used in homes built more than 35 years ago are softer than those used in today's newer building construction. So, be careful that you don't inadvertently gouge or chip off pieces of the brick while you're chiseling or sawing.

Clean the joint out to a depth of at least 1/2 in. Make sure you dig down far enough to remove all of the old, crumbled mortar. New cement won't adhere well if the base surface isn't sound. Use the water stream from a garden hose to remove the dirt and dust. This will also dampen the joint before applying the new mortar.

Usually, the trickiest part of all this is trying to match the color of the new mortar to the old.

Don't be afraid to do some experimenting with coloring agents if necessary until you feel comfortable with the match. It's best to try a small patch first and let it dry to be sure you'll be happy with the results.

Fill the joint so it's nearly flush with the surrounding brick surfaces. "Tooling" the joint with a professional jointing tool so it's concave, to both seal the joint and make it repel water, is the finishing touch.

Replacing cracked, spalled bricks can be a good bit more difficult than repointing masonry. Each damaged unit must be carefully cut out and replaced with one that's similar in size and color. This can be quite a task for the old house owner. You may find an okay match from a brick that's made today. Or you always have the option to check out what's available at a salvage yard or local demolition site.

### Cleaning brick

I didn't want to write this column without giving some advice on cleaning brick. When most people ask me about this, their primary concern is usually how to remove paint from exterior brick walls. I can answer this question in two words: DON'T SANDBLAST!

Many times, this process removes the hard outer brick coating along with the

paint. Obviously, this allows water to penetrate the now exposed softer, porous inner surface. And, of course, when this happens, you're setting yourself up for some trouble!

I've found that the best way to remove paint from brick is chemically. There are folks out there who specialize in masonry surface cleaning and paint removal. Every situation is different, and removal techniques depend on factors like the type of brick, how much paint there is and how long it has been on there. You can usually find someone capable of removing paint this way through a masonry or restoration con-

tractor. Make sure before you agree to the job that you like the results of a sample test patch, and that the technique they used on this approved test area will be the same one used on the entire building. Unfortunately, I've seen situations where the paint can't be removed with results that are acceptable to the old house owner. In this situation, there's nothing else to do but repaint.

If you live in an urban area, your brick walls may need an occasional cleaning to remove dirt and soot. Soap, water and a good stiff brush—don't forget the elbow grease—are usually all that's needed to remove any objectionable streaks. **PM**



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# How they stand up to each other

## ADVANCED NEW CHEVY.

All of these items are standard equipment on Chevy's advanced new pickup:

Chevy tops Ford in power. With a modern, fuel-injected Vortec V6 that gives you 15 more standard horsepower in the half-ton than Ford's old in-line 6 gives you even with fuel injection.

Chevy has a Getrag-licensed 5-speed manual transmission with overdrive.

Chevy has a new double A-arm independent front suspension. Ford doesn't.

Chevy has more glass area than Ford—933 more square inches of glass.

Chevy's big new cab gives you more leg room, more shoulder room and more total room than Ford.

Chevy has two-sided galvanized steel front, sides and rear—more of it than Ford.

Chevy protects the paint with a new clear-coat finish you can't get from Ford.

Chevy half-ton gives you a strong, massive new frame that's bigger and heavier than Ford's.

Chevy has a new all-welded cargo box with no exposed bolt heads to trap water and cause rust.

Chevy has special indentations in the cargo box that let you build a platform of 2x6s across the top of the wheelhousings for two-tier loading. Ford doesn't.

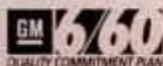
When it comes to 4x4 models, Chevy gives you shift-on-the-fly Insta-Trac as standard equipment. Ford still makes you stop, get out and change hubs.

**Drive the first all-new full-size pickup introduced in this decade.\* At your Chevy dealer's.**

\*Excludes other GM products.

Comparisons based on data available at time of publishing.

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TODAY'S CHEVY TRUCK







## **OLD NEW FORD.**

Ford says they're new. But you'll find their 1988 pickup doesn't have much new to talk about: taillight lens, revised fuel-tank capacities, alternator/regulator, 5-speed manual transmission and 5 new colors.



# OUTDOORS

BY JOE SKORUPA

## Rally Round The Amazon

**S**TOP signs in South America mean we look both ways . . . if we remember," said a veteran driver I met in Ecuador. Despite his advice, I came across few stop signs on a recent 1800-mile drive through Peru, Ecuador and Colombia. In fact, there weren't many signs at all, especially the kind that told you where you were.

There were other unexpected differences, too. Children played a foot off the road, drivers went too fast for conditions, and convoys of poorly maintained and overloaded trucks hogged the highways and blasted their high beams into your eyes. "It's war out here," explained my battle-tested Ec-



The sun sets over Andes Mountains near the route of TransAmazon Adventure Rallye-Raid.

uadoran driver friend.

Sound like fun? You bet. I'd go back in a second. South American jungles, deserts, mountains, rivers and waterfalls are among the most spectacular in the world. It's an adventure driver's dream—which is why I'm excited about covering the upcoming TransAmazon Adventure Trophy Rallye-Raid, sponsored by the 1-year-old Exploration Society of America.

The rally promises to be one of the most exciting long-distance road adventures of 1988 and, if successful, will become an annual event.

Interestingly, the rally is open to a wide range of competitors. Anyone with an entry fee of \$3800 to \$8000, depending on vehicle used, can expect to compete, though there are certain quota categories. Other expenses include round-trip shipping of

vehicle, airfare, hotels and a fee of \$1000 per rally participant.

There's just enough time to get your application in. Contact the Exploration Society of America at 1912 St. Charles Ave., New Orleans, LA 70130 or telephone (504) 523-1111. Rally dates are April 10-

May 5, though vehicle must be in New Orleans March 8-13 for inspection.

The 8500-mile route passes through Venezuela, Brazil, Bolivia, Peru, Chile, Argentina and Paraguay. Although money awards will be offered, more than \$300,000, the real prize will be the incredible experience of a once-in-a-lifetime driving adventure through the world's most spectacular terrain.

### Is It a Bird?

Although I've recently come across computerized fishing reels, wristwatch-size depthfinders and outboard motors that talk, Robo-Duck seems to be in a class by itself. This remote-controlled, retrieving decoy is more than a technological marvel, it's an improvement on nature.

According to Outdoorsmen's Herter's, the exclusive marketer for Robo-Duck, hunters now have an alternative to Labrador Retrievers. The "serious water-fowl hunter," according to the company from Beaver Dam, Wisconsin,

can buy a \$1250 propeller-driven, battery-powered decoy to do everything his loyal dog once did.

Robo-Duck retrieves two mallards or one large goose in its 20-in.-long steel talons. Fingertip controls are handled from behind a blind. And after hunting season, unlike man's former best friend who had a habit of hanging around playfully, Robo-Duck can be efficiently stored with the rest of your gear.

For duck hunters ready to cope with future shock, you can call Outdoorsmen's Herter's at (800) 654-3825.

### Ultimate Test For A Tough Bike



Fisher's Montare, shown in Central Park, conquers streets of NYC.

I know mountain bikes were designed for, well, mountains. These incredibly durable fat-tire cruisers with easy-shifting racing gears can climb rocks, cross creeks, descend gravel piles and jump logs, all with great speed and agility.

I even spoke with Gary Fisher, who invented the mountain or all-terrain bike, in California about 15 years ago. Fisher confirms that he and his friends used the early models to ride backcountry trails in Marin County, north of San Francisco, especially the challenging 2600-ft. Mount Tamalpais, where they did kamikaze descents. This provided the inspiration for installing a multispeed derailleur onto a fat-tire frame and launching a new sport and booming industry.

But if you're really looking to test an all-terrain bike, such as

*(Please turn to page 47)*



Robo-Duck wraps its talons around a less sophisticated decoy.

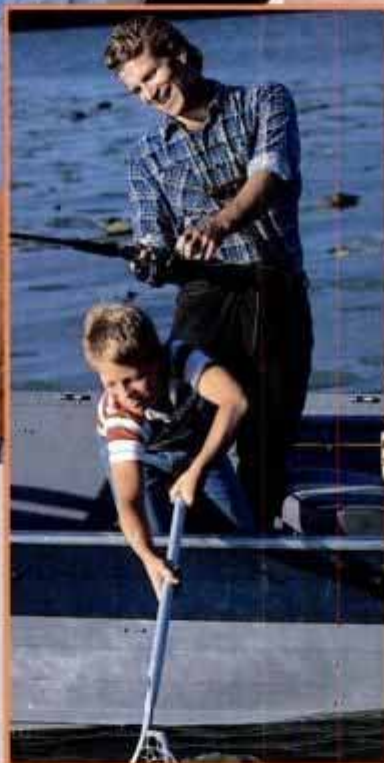


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ON THE NEXT PAGE.



*"These helpful  
tips made buying  
a boat easier..."*



\*Monthly cost of ownership figures based on 20% downpayments and average finance rates and terms from nationwide sample of lending institutions polled Fall 1987.

\*\*Retail price ranges based on nationwide manufacturer sample and include price of outboard or sterndrive engines where applicable.





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## OUTDOORS

(Continued from page 44)

Fisher's 1988 Montare, I believe I've discovered something tougher than mountain trails. I got my hands on a shiny, new red Montare and I rode it into the jungle—the asphalt jungle of the streets of New York.

A few years ago, Manhattan's hard-driving messengers got wise to all-terrain bikes and switched, practically to a man, from racing bikes. I started following their routes and discovered why.

First of all, taxis, buses and trucks take no prisoners. Get out of their way or else. And this means maintaining speed and trying to stay in a 1-ft.-wide lane despite washboard roads, slabs of excavation steel and crater-size potholes. You don't have the luxury of going around anything in New York. You keep pedaling, hang on and hope your bike was built to take the ungodly pounding.

The Montare, I can safely report, took everything Manhattan dished out. Its outstanding balance and responsive handling are the result of a superb combination of innovative features and designs. The frame, made of light but strong chrome-moly tubing, features a complex geometric shape that distributes the rider's weight for ideal balance and power.

Hard-core bike buffs know that the 18-gear Montare has handbuilt stainless-steel wheels, Shimano New Deore XT brakes, aluminum-alloy Bulge Bars with a 12° bend, Fisher Rhino chrome-moly stem, slightly oval Shimano Biopace II chainrings and Shimano New Deore XT ergonomic pedals. And these riders probably know a lot more about tube lengths and frame angles.

But the two features that most impressed me, other than overall tight, responsive handling and incredible absorption of punishment, were the Shimano XT SIS index-shifting system and the Avocet GelFlex saddle seat.

The index system, new to mountain bikes, makes a shifting expert out of everyone. Unlike previous systems, SIS clicks solidly into gear every time. The SIS thumb-shifter is located conveniently on the handlebars and eliminates any search for exact cog centering.

The Avocet GelFlex saddle seat, also a new feature, is ergonomically designed to remain under your body and not creep up where it doesn't belong. It does this by providing strategically located pads that support the two lower pressure points of the rider's pelvis. Take my word, it sounds incredibly simple, but you can really feel the difference.

Yes, I took the \$615 Montare over some rocky trails, jumped some logs and pushed it hard through some rugged back-country terrain. But I knew it would easily handle this stuff. It had already proven to me it could conquer the

streets of New York, and if it can make it there, it can make it anywhere.

## New Drop Handlebars

Aerodynamics are more important in racing than in all-terrain touring, which is why racing bikes have drop handlebars and mountain bike bars are straight across. But there are times—running downhill or in a stiff headwind—when you wish your upright body wasn't acting as a drag chute.

Now fat-tire bikers can have the best of both worlds with Grizzly Bars, a drop-bar system that attaches to straight-across handlebars.

Made by a Canadian company, DIDn of Biggar, Saskatchewan, the adjustable-drop bars attach to existing handlebars. Locking pins allow the bars to flip down, for getting into a racing-tuck position, or up and out of the way when not in use, where they form a convenient carrying rack.

Mounted correctly, the bars should not interfere with brakes and shifters. They cost \$35. Brackets mount onto handlebars using Allen wrenches. The bars then slide into brackets and are secured by a position knob. Brakes can be fastened as an option. Grizzly Bars cost \$35. Phone (306) 948-3626 for more information. **FM**



## It can do so much, it's almost unfair to call it a sander.

The new Delta 1" Belt Sander is so handy that there's almost no end to what you can do with it. And at only \$69.95, just think what a great addition it'd make to your shop.

You can use it to sand, grind, deburr, contour, sharpen, buff, or polish just about any material. It uses standard 1" x 30" abrasive belts. And there's a power take-off for mounting an accessory flexible shaft with attachments that can do dozens of extra jobs.

In fact, our new 1" Belt Sander does so many things so well, you may wonder how you ever got along without it. Call toll-free for the name of your Delta Dealer. Delta International Machinery Corp., 800/438-2486 (in PA, 800/438-2487).



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# HOME VIDEO

BY FRANK VIZARD

## Super Visions

**A**MERICANS have bought more than 50-million videocassette recorders since 1975, when the product made its debut. In effect, says the Electronics Industries Assn., there's a VCR in every other home. Makes you wonder what the rest of those homes are waiting for. If they're holding out for an improvement in picture quality, then their time has come.

"Super" VHS, which was detailed in last month's issue ("Super Home Video," page 58) offers a greatly enhanced image compared to conventional VHS. Super VHS is capable of a picture resolution of 400-plus lines while the old VHS standard can manage only 240. That's a big and truly visible improvement!

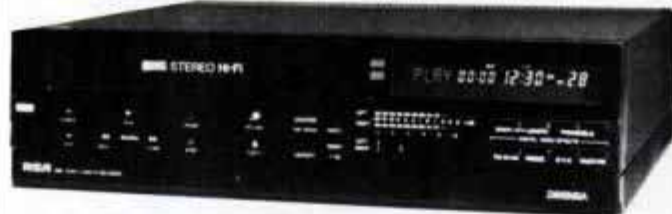
Although JVC invented the SVHS format and introduced the first SVHS machine some months ago, SVHS got a real boost of support when RCA announced it would bring two SVHS camcorders and two SVHS videocassette recorders to market. It was RCA's entry into VCRs—just think how much sales clout the company has—that helped precipitate the VCR explosion.

Of RCA's two SVHS VCRs, the VPT695 deluxe model (\$1300) is something special. The SVHS picture, of course, is largely responsible for the steep price, but a better picture isn't all you get. The "multipix" feature, for instance, splits the screen into still frames of television broadcasts from 12 consecutive active channels. This feature allows you to quickly scan the programs being broadcast before selecting one for viewing.

Other features include picture-in-picture, hi-fi sound, stereo (MTS) reception, 8-event/1-year programming



The next generation of video gear is here. The many features in Panasonic's Super VHS camcorder make it a portable movie studio. RCA's Super VHS VCR (below) offers multiple special effects.



via an on-screen display, "mosaic" and "posterization" special effects and a 167-channel tuner. RCA's other SVHS VCR, the VPT640 (\$1000) dispenses with some of the special features offered on the VPT695. The SVHS camcorders cost \$1500 and \$1700.

Speaking of camcorders, sooner or later home movie-makers are going to have as much gear available to them as Steven Spielberg would have on a film set. Of particular excitement of late are Panasonic's SVHS camcorder and Toshiba's new "3D-Cam" camcorder.

Let's face it: We all remember 3-D as a joke from the 1950s, but in reality 3-D still has the power to stir our imaginations. Until now, filmmakers have used 3-D to entertain. Because video's easier to work with than film,

3-D will be used not only to entertain but for education and health care too.

You'll have to wait awhile yet for a 3-D camcorder. Toshiba says it will be at least summer before the 3-D camcorder appears in the U.S., and its price will be more than \$2000.

As reported earlier ("Electronics," page 44, Dec. '87), the 4-pound camcorder achieves its stereoptic effects with two CCD image pickups fed by two lenses spaced apart like human eyes. You'll view the images with LCD glasses, but flicker is eliminated by doubling the TV scanning rate from 60 to 120 frames per second. The 3D-Cam uses a VHS-C cassette for **Make 3-D videos with Toshiba's camcorder.**

20 minutes of standard play or 60 minutes of extended play recording time. Toshiba says you'll be able to use a conventional VCR for playback, although you will need an extra component that contains an analog-to-digital converter (the flickering is eliminated digitally) and a frame memory and scanning-speed converter. The camcorder will have a manual zoom capability, and light sensitivity that is rated at 8 lux.

Lux is a somewhat subjective measurement, but this specification is one of the things that makes you sit up and take notice of Panasonic's new PV-S350 SVHS camcorder (\$2400).

One lux is defined as the illumination of a one meter surface by a standard candle—a sensitivity rating that Panasonic claims the PV-S350 "approaches." Why this qualification? Panasonic says the improved lux rating is due to a special digital circuit that enhances the colors and the brightness levels of the scene being recorded. Chip manufacturing, however, appears to be an uneven art: Depending on production, the lux rating is sometimes actually under 1 lux or a little over 1 lux.

Creativity rather than sensitivity might be the real mark of the PV-S350, due to the host of other features it





offers. With a touch of a button, you can create a still picture frame which can then be phased into a live shot by using the wipe, box wipe or overlap special-effects feature.

Less obvious but just as important from a creativity standpoint is a high-speed shutter with three different settings—a real plus if you intend to shoot a slow-motion video of a golf swing, for example. The 8:1 power zoom specification is greater than the usual 6:1 found in many camcorders, and the flying erase heads make sure that your edits are neat and not filled with "snow."

## Better Beta

There will be a picture improvement story akin to SVHS in the rival Beta video format soon. Meanwhile, Sony is introducing Beta VCRs on par with the competition as far as special effects are concerned.

One of the most useful is called "flash motion" and it's available on Sony's SC-HF860D VCR (\$1100). Accessing the flash motion feature results in a picture that is viewed as a series of successive stop-motion frames. The speed at which you view these stop motion frames can be adjusted in six intervals, from 1/8 seconds to 4 seconds. This would be an intriguing way in which to analyze Ivan Lendl's tennis serve, for example.

While flash motion presents images sequentially, the "multistrobe" feature puts as many as nine or 16 separate images on the screen at once, either manually or automatically, at selected time periods. To stay with our example, you could view Lendl's serve from the toss to follow-through.

You also don't have to wait for television directors to show you a closeup. At the press of a button, the "digital zoom" feature enlarges a designated area of the picture to four times normal size. This effect can also be used in the multistrobe mode, thus bringing one of the nine or 16 images to full-screen size. The SL-HF860D also has many other features you'd associate with a top VCR. These include MTS stereo, hi-fi sound, picture in picture, among others.

## Video Games

I'll probably never get the chance to luge, but I can still win a gold medal in this and eight other Olympic events thanks to a new interactive video game developed by Mindscape, a company known for computer software.

The game is called "ABC Sports Winter Olympics" (\$50) and though it's not the first VCR game ever to hit the store shelves, it is the best I've played. It manages to avoid the predictability of other games with a new technique that insures the randomness of outcomes without sacrificing strategy.

After each sequence in the videotape,

you are instructed to put your VCR in PAUSE. At this point in the tape, each picture frame has a different point value. The number of spaces a player moves on the board constantly changes as well. Predicting at what point the tape will pause is virtually impossible because of the time lag between pressing the PAUSE button on your remote control and the point at which the tape actually stops.

Game cards that might help or hinder a player introduce further uncertainty into the game. The game ends once a gold medal has been awarded in each of nine events—a Winter Decathlon—al-

most. A combination of points scored and medals awarded determines the winner.

The footage for this game has been culled from the 1984 Winter Olympics and it is consistently exciting. Mindscape also offers "MISL Soccer Shoot-out" (\$40). Sports seems to lend itself well to VCR games. In fact, the only exception to the sports theme is a mystery-solving game from VCR Enterprises called "VCR 221B Baker Street"—an address recognizable to all fans of Sherlock Holmes. This \$40 video is derived from the popular 1970s board game version. **PM**



## Radar detectors: Which are really best?

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Cobra	Whistler	BEL
Uniden	Maxon	Snooper
Radio Shack	Radio Shack	Uniden
BEL	Uniden	Whistler
Whistler	Fox	Cobra
Sparkomatic	Cobra	GUL
Fox	BEL Vector	Radio Shack
GUL	Snooper	Sparkomatic
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# ELECTRONICS

BY STEPHEN A. BOOTH

## Telephony With Pictures

**S**OME concepts have staying power. No matter how fantastic and far-off they seem at first, there is something about them that captivates the imagination and holds it hostage 'til the real thing comes along. This lasting appeal is what separates fad from future.

Like 3-D imaging and the flat-panel television, which are virtually at our doorsteps, the concept of a telephone with pictures is long-lived and persistent. AT&T offered a glimpse of the future nearly a quarter-century ago, when its Picturephone shared the limelight with Miss Rheingold at the New York World's Fair. Now the videophone is here, ready and waiting to take its place beside the VCR, microwave and other household appliances.

The first practical videophone for the home hails from Mitsubishi, carries a \$399 price tag and the name VisiTel. In reality, it's the little brother of Mitsubishi's \$1500 Luma 1000 videophone, the first such device that could send and receive black-and-white still images over ordinary voice lines (See "Electronics," page 36, July '86).

Until then, video teleconferencing was limited to entities wealthy enough to afford the hardware and the special 56-kilobyte Accunet phone lines necessary to transmit images and sound.

As reported here in 1986, the Luma 1000 was designed for commercial and institutional use—by police departments, for instance. In fact, the Mitsubishi videophone made a cameo appearance on TV's "Miami Vice" that season. Part of the Luma 1000's \$1500 sticker was a pretty sophisticated, spare-no-expense *telephone*. That's the part Mitsubishi has stripped away to make its VisiTel

affordable for home use.

The new product assumes you already own a phone, to which VisiTel connects via the standard, modular jack. Despite its lower price, VisiTel actually projects a larger picture than its commercial predecessor.

Before describing VisiTel any further, it's only fair to mention that Mitsubishi's system isn't the only videophone in the world.

In Japan, Sony and Nippon Telephone & Telegraph (NTT) have developed a similar system, which sells there for about \$350.

Unfortunately, the Mitsubishi and Sony/NTT systems can't "talk" to each other, at least where pictures are concerned. This incompatibility might prove troublesome in the future. For the time being, Sony has yet to decide whether it will sell its videophone in the U.S. Meanwhile, electronics giants such as Panasonic, NEC, Sanyo, Toshiba and Hitachi have

agreed to adopt the Mitsubishi "protocol" (which was developed by the company's Santa Clara, California, subsidiary, and is manufactured in the U.S. for export).

The Mitsubishi and Sony/NTT videophones do much of the same thing, but do it differently.

Each device is about the size of a 6-pack and houses a fixed-focus, black-and-white videocamera and a TV display tube (4½ in. for Mitsubishi, 4 in. for Sony). Each plugs into a modular telephone wall-jack.

Your phone, in turn, connects to a modular jack in the camera/display unit, which takes power from an AC wall outlet.

With each system, you can pose up to 2 ft. away from the camera, and see your self-portrait on the screen before you press a SEND button to transmit it. Brightness controls help you compose the image to your satisfaction. Once either party hits the

SEND button, neither can converse for the duration of the transmission. This is because the picture information occupies all the available bandwidth in the voice line.

The Mitsubishi system needs 5½ seconds to transmit an image. The Sony/NTT protocol takes about 9 seconds. Herein lies the rub: Each uses a different transmission system to achieve different degrees of image resolution.

Mitsubishi employs conventional AM (amplitude modulation) to yield an image that has 96 x 96 pixels per inch (ppi) of display, with 32 levels of gray scale. Sony/NTT uses amplitude *pulse* modulation to realize finer detail—100 x 160 ppi—with 16 levels of gray.

Other differences between the systems involve image storage and reproduction. VisiTel can store up to three images on its internal memory chip, and retain them for as long as power is supplied to the machine. The stored images can be retransmitted during another phone call. Unfortunately, there is no output jack for peripheral devices, such as a video printer. The Sony/NTT device offers no internal storage, but there is an output jack for a peripheral storage device—one as simple as an audio cassette deck or telephone answering device. Why? Because the visual information is transmitted as *audio* over a voice line, and the bandwidth is easily accommodated by an analog cassette or microcassette.

What neither system is capable of doing at present is communicating via cellular radio-telephones. And in case you're wondering, the answer is yes: You can still make a conventional, gab-only call, even if the phone's attached to the video.



Mitsubishi's VisiTel: The first home videophone.



## The Rating Game

If the darkest hour comes before the dawn, then February—not April—qualifies as the cruelest month. During the next couple of weeks baseball players will be migrating south to their training camps. Fine-tuning for Opening Day begins with exhibition games in March—and some of these are even televised. This early whiff of spring reminds me that our November '87 issue was already on the stands before I began to regret having written about the World Series "sweeping" the TV ratings ("Electronics," page 12, Nov. '87).

In fact, the opening game of the fall classic didn't sweep anything in the prime-time slot, nor did Game 2—even after a Sunday full of make-believe football. According to the A.C. Nielsen Co., Game 1 scored a 19.2 rating, the lowest ever since the Series went to prime-time in 1971. This caused me to wonder how these ratings are compiled, and to what purpose.

Television audience ratings are compiled on a national and local level, and by several measuring services. In national ratings, Nielsen has supplied the morning line since Milton Berle wore diapers. Broadcasters and "sponsors" subscribe to the ratings for a hefty price, and use them to negotiate advertising schedules and fees. Because the product that the

broadcaster sells is a program, poor ratings relative to competing programs can reduce the product's sales value. The broadcaster might have to adjust its charges to the advertiser, or perhaps switch the program to another time slot where it competes more favorably, or even drop the program from its "product" line.

As with so many other things, the technology used to measure TV viewing habits has become increasingly sophisticated. Let's use the World Series for an example.

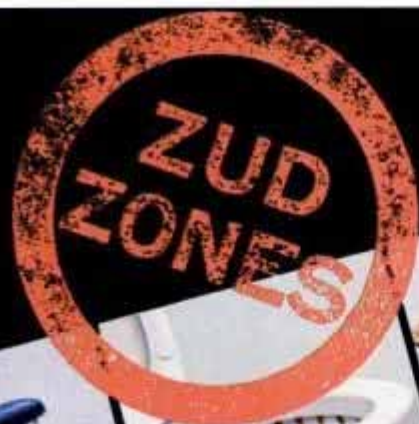
Nielsen's 19.2 rating describes the percentage of the nation's 88.6 million TV households tuned in (about 17 million). The program's "share" denotes the percentage of the total audience watching TV at that time (Game 1 had a 35 "share"). In the past, this information was derived from two samples. Devices attached to the TV sets of one panel of viewers would record the channel that the set was tuned to, and the time. Meanwhile, members of a separate viewer panel would submit a diary that detailed what each person in the household watched. This diary also provided age, sex and other demographic information about the viewers. When the information from the two panels was combined, Nielsen could determine, for example, the number of single, 25-year-

old he-men watching lady-rassling versus celebrity bowling on a Friday night.

Now Nielsen and its new competitor, AGB Television Research, are using "people-meters" in place of the older measurement tools. Each company has impaneled 2000 households and supplied them with a device that looks like a remote control but serves as an electronic diary. In addition to logging what's on at what time, the new meter is designed to record who's watching and when. Demographic information is collected on each household member, who is then assigned a number on the meter. Viewers are asked to punch in whenever they're viewing and to punch out whenever they take a break. The information is fed via phone to the research companies' computers.

Some broadcasters dislike the people-meter. They believe it will yield lower ratings than the older system because it requires panel members, especially kids, to do too much. Accordingly, Nielsen is experimenting with a passive people-meter that will scan the room with infrared light to determine who's in the audience, and for how long.

Meanwhile, VCRs still pose a measurement problem. Today's devices don't reveal when a taped program is viewed (if ever) or whether the commercials are zapped via remote-control infrared. **FM**



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BY TIM COLE

## In The Footsteps Of Fuller

**T**HE AMERICAN genius R. Buckminster Fuller, who gave us the geodesic dome and other architectural structures, taught us how to see patterns, shapes and order in a world of entropy and chaos. In his lifelong exploration of geometric solutions to architectural problems, Fuller created lasting, simple shapes based on a "less is more" quest for efficiency and economy. Fuller's "energetic geometry" is the result, consisting of basic building blocks that rely on the fundamental principles of attraction and repulsion at the heart of nature.

Fuller called this concomitant compression and release "tensegrity," a combination of the words "tension" and "integrity." Tension occurs when something is stretched or pulled. Integrity means completeness. When both forces act in concert they are, according to Fuller, in a state of tensegrity. The push and pull of tensegrity exists in every molecule, indeed in the cosmic swirl around us.

It wasn't until sculptor Kenneth Snelson managed to visually model Fuller's concept of tensegrity that his well known structures emerged. At the same time, Fuller's domes and other shapes became rather precise analogies for the way structures are assembled in nature.

Tensegrity is also at the core of an intriguing new science puzzle created by Stuart Quimby and Cary Kittner of Tensegrity Systems Corp. A "new-age tinker toy," Tensegritoy consists of numerous wooden dowels that represent the outward thrust of nature—the spinning electrons and centrifugal energies that tend to pull matter apart. Elastic cord used to connect the dowels represent the forces that draw matter together—molecular attrac-



Cary Kittner and Stuart Quimby with their "tensegrity" creations.

tion, magnetism and gravity that keeps the universe integral and whole. The unifying elastic is stretched and attached to slots on the ends of the dowel. End caps keep the elastic in place. By tensioning the elastic from dowel to dowel, intricate structures begin to materialize.

When combined in a single piece, these simple wooden dowels and pieces of elastic dramatize the fundamental cohesiveness of the universe. Without the outward force of the dowel, the elastic would collapse inward. Without the inward force of the elastic, the outward force of the dowel would disintegrate.

The same holds for Fuller's complex shapes, with elements relying on one another for rigidity and support. Beginning with simple spheroids, Fuller was able to expand his concepts into durable structures. His concepts inspired the central sphere at Disney World's Epcot Center and the dome at the South Pole.

Similar models can be achieved with Tensegritoy. Budding Bucky Fullers are instructed to build from the basic starter kit of 30 wooden

dowels and 32 elastic bands (\$25.00). Add-on kits can result in complex structures limited only by the imagination. Would you believe you can actually create a rhombicuboctahedron? For more information, contact Tensegrity Systems, Station Hill Rd., Barrytown, NY 12507, (800) 227-2316.

### Evolution In A Clamshell

More than 100 years have passed since Charles Darwin advanced his widely accepted theory of evolution. And yet, an intellectual struggle persists between evolutionists—those who believe that all species including man evolved from lower life forms—and creationists, who adhere to the Genesis principle. Creationists have long pointed to the "missing link" in the fossil record to argue against the gradual adaptation and evolution of Earthbound creatures. There has never appeared a clear progression from apes to man, they say, which proves beyond a reasonable doubt that the species evolved.

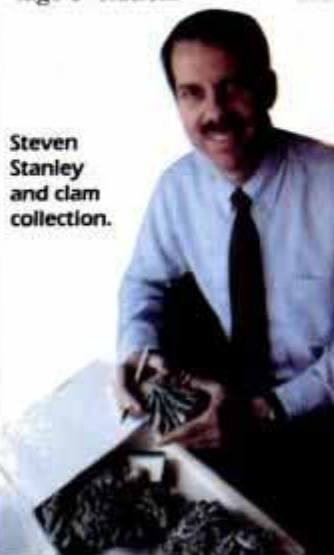
But now, paleobiologist

Steven Stanley of Johns Hopkins University has proved there is no such thing as a "missing link"—only fluctuations in the process of evolution that cause species to develop at varying rates.

Stanley's exhaustive 2-year study of clam shells—some more than 17 million years old—included more than 43,000 measurements. Stanley says his data proves the "punctuational model" of evolution that challenges the traditional view that evolution is a gradual, orderly process. His research shows that major change occurs when a segment of a species is isolated and subjected to intense environmental pressure—from factors like changes in climate, an increase in predators and changes in the food chain. The rapid adaptation that results speeds the process of evolution relative to geologic time, which might produce gaps in the fossil record.

Although Stanley is not the first to propose the punctuational model of evolution, his study is considered one of the most thorough, based on data collected from fossils in eastern North America, Italy and Britain.

The debate will continue. But for now, the ball is in the creationists' court—advantage evolution. **FM**



Steven Stanley and clam collection.



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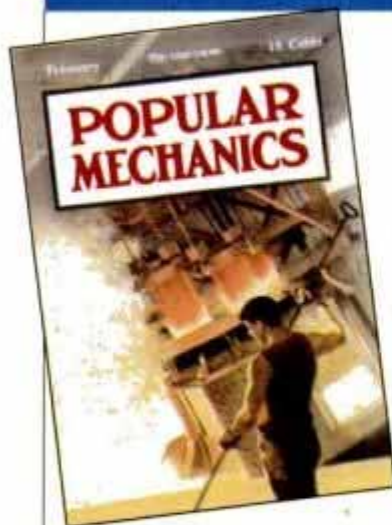
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# TIME MACHINE

75 YEARS AGO: February 1913



Melting iron electrically.

## Steel Flash

A fireworks show put on by an electric steel-making furnace lit up PM's cover 75 years ago. In an electric furnace, huge carbon electrodes spark up the heat to liquefy pig iron. Unlike conventional open-hearth furnaces, electric furnaces don't introduce impurities into the molten steel. In 1913 the introduction of this clean heat made possible the large-scale manufacture of high-grade alloy steel—a strategic material for a world on the eve of war.



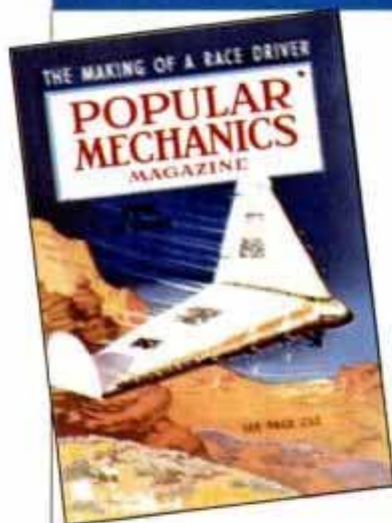
Exploring the sea by tugboat-towed sleigh.

## Deep-Sea Sleigh

Divers of this era could ride in a car with runners instead of wheels, drawn along the ocean bottom by a towboat. Connections to the surface included a phone line to the towboat captain and an electricity line that powered a spotlight, for operation in murky depths. A metal hood protected the operator from currents as the craft moved through water.

One application was the location and recovery of sunken shipwrecks, roles played today by submersibles and midget subs.

50 YEARS AGO: February 1938



Taking wing.

## Flying Wings

The flying-wing concept intrigued aircraft engineers in the years before World War II. The no-fuselage "plane of the future" on PM's cover would have been made of stainless steel with a 300-ft. tip-to-tip wing span.

Northrop borrowed the design in building 14 172-ft.-wide flying-wing strategic bombers for the Air Force between 1946 and 1949.

But as aircraft designers became enamored of the very efficient swept wing, the flying-wing idea never really took off.

## Super-Car

A spare-no-expense dream machine of the late '30s was touted as "one of the most striking and revolutionary cars ever built." A lightweight engine powered the car to speeds of 122 mph. Features considered noteworthy then included front-wheel drive and an electric

gear shift. Other luxuries included four forward speeds, an independent suspension system, and an innovative rubber-lined interior.

Driving a dream in the '30s.



25 YEARS AGO: February 1963



Folding a flyer.

## Folding Wings

PM's cover story a quarter century ago featured six homemade fold-wing airplanes built in response to an Experimental Aircraft Assn. contest. The idea was to use ordinary workshop tools and readily available construction materials to build a plane that you could tow on the highway with its wings folded. Your plane had to be so easy to construct that any amateur could duplicate your effort on his first try. *Fly Baby*, a peppy open-cockpit single-seater built by a Boeing engineer, took top

honors and was praised for its structural simplicity.

## Tiny Wheels

Austrian trick cyclist Rih-Aruso rode this miniature bicycle, complete with tires,

chain, saddle and racing-style handlebars. His act featured the obligatory hula-hoop routine. He also performed tricks on ice. **PM**

Spinning midget wheels.







# LAPPING IN LUXURY

We test a fabulous 4-door foursome—Jaguar XJ6, BMW 735i, Maserati 425i and Mercedes-Benz 560SEL.

You're sitting at a traffic light next to a guy in a hot-rod Mustang. He jumps the green in a squeal of tire smoke, but bobbles his one-two shift when he looks over to see you accelerating past him—as you adjust the climate control at the same time. Your friends in the back seat don't even realize you're racing.

Steppin' out like this can only be done in a Super Sedan—a 4-door with the tire-shredding performance of a Corvette, the stature of a Rolls-Royce and the passenger-pampering ride of



## LAPPING IN LUXURY

a Cadillac, all rolled up into one wonderful car. Of course, the price would buy you a dozen Hyundais, but the best doesn't come cheap.

There are only four models in this entire market segment, and annual sales of all of them put together are less than one week's production at a single Chevrolet plant. Now *that's* exclusivity.

Maserati's twin-turbo 425i is a hot performer and the easiest to afford at \$34,975. Jaguar has a completely new XJ6, the first new Jaguar sedan in nearly 20 years. BMW likewise has an all-new big sedan, the 735i. Both are aimed at Mercedes-Benz's flagship, the 560SEL, though they cost significantly less than the M-B with its \$66,260 sticker price.

To see which Super Sedan has the edge, we assembled all the contenders for a few days of driving around Princeton, New Jersey, to gauge their status appeal and everyday usefulness, and another day at English-town's Raceway Park to measure their on-track performance.

### Maserati 425i

Maserati will sell only 300 sedans in America in 1988, which makes the 425i the most exclusive production car in the country. By comparison, the 8000 560SELs, 9000 735i BMWs and 21,000 XJ6 Jags look like run-of-the-mill, mass-production sedans. For that matter, even Bentley will sell 400 to 450 cars in the U.S. this year.

The 425i is the 4-door version of the Biturbo, made by adding 10 in. of wheelbase and two doors to the coupe. It's still a small car, about the same size as a Toyota Camry or Honda Accord.

Like the coupe, the 425i has boxy Italian styling with a squared-off grille, slab sides and an abbreviated trunk. It looks rather like an Alfa-Romeo Milano. But looks are deceiving. Under that modest hood lives a lovely 2.5-liter V6 with a single-overhead camshaft on each bank of cylinders. And nestled on each side is a turbocharger—hence Biturbo—each with its own intercooler.

The result is a fiendishly full engine compartment—but also a 4-door sedan that is faster and more fun to drive than many expensive 2-seaters. Like a traditional Italian sportscar, the 425i demands to be kept constantly on the boil. Drive it *con brio*, and it will zip to 60 mph in 7.6 seconds and top out around 140. That's *very* quick.

Thankfully, the 425i has 4-wheel disc brakes to match its performance. All the other cars in this class—and many cheaper cars—now offer ABS,

### BMW 735i



### JAGUAR XJ6



### MASERATI 425i



### MERCEDES-BENZ 560SEL



and at the track, the 425i's stopping performance didn't measure up to its ABS-equipped competitors.

However, ABS doesn't ensure shorter stopping distances on dry pavement, and in everyday driving the brakes were terrific.

Driving the Maserati is like driving a Ferrari racing car. You sit way back from the steering wheel in the classic Italian driving position. The steering is light and easy, the 5-speed gearbox is a joy, and the handling is simply wonderful, albeit with plentiful understeer. You can fling the car around with gusto, and it never puts a wheel

wrong. This is a real driver's car, a car for an expert, that simply demands to be driven flat-out all the time. Every mechanical feature—handling, steering, acceleration, shifter and brakes—is beyond reproach.

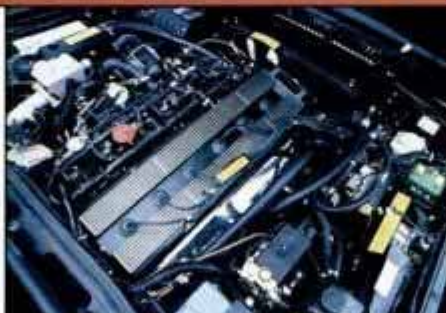
Unfortunately, there aren't many places where you can drive at the limit all the time. Or even any of the time. And at less than the limit, the 425i is less than fun.

This is a small car, so the interior is cramped. It's also a hand-built car, so a lot of the detailing isn't as good as on your typical mass-produced Japanese econobox. Italian designers have





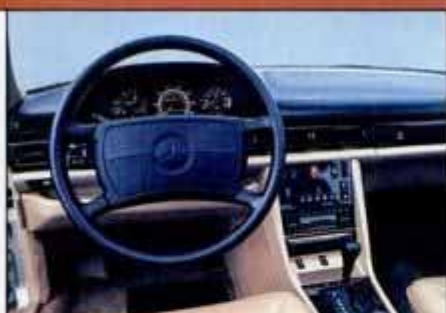
Bimmer's interior shows evidence of Teutonic industrial designer's touch throughout. Stereo might need engineer to explain anything besides on/off. Steering was light and progressive, although handling was more comfortable than sporty. The 735i's 3.5-liter Six was adequate, but we're waiting for BMW to graft on another bank of cylinders for V12 power, due later in the year. Fusebox, which fortunately is easy to find, packs in 33 separate fuses.



Sybaritic luxury of Jag interior includes acres of real burl walnut and Connolly leather, goofy digital/analog instruments, seat controls on transmission tunnel. Tall gearing was wonderful on parkway, agonizing in the city. Later production cars now get more power, shorter gears and substantially improved acceleration. True to British tradition, electrical system was odd, with fuses hidden all over car in bizarre corners. Reaction to new, contemporary styling has been mixed.



Maserati was relentlessly Italian, from bus-driver steering wheel/seating position to race-car-like handling. Comfort is accordingly limited, but performance is nothing short of vivid. Twin turbos and intercoolers, 5-speed transmission, limited availability, make this car fast and attention-getting. Serviceability is ludicrous even for very small Neopolitan mechanics, but you'll open the hood a lot just to show off the engine compartment. La Dolce Vita! La Dolce Zoom!



There's still no substitute for a big V8, and here's the proof. Flagship Benz felt as solid as the Bismark at any speed, has enough acceleration to outrun a police car (not recommended) and an outrageous price tag. Controls were classically straightforward and easy to find. This also applies to instrumentation. Complex systems like climate and cruise control have simple switches, are unobtrusive and incredibly effective. Seats, steering and ride are firm, very comfortable.

been slower than some in getting the word on ergonomics, so switches work the opposite way from what you'd expect, the seats are uncomfortable, and not all the controls are where you might expect. On the other hand, the six white-on-black Jaeger instruments are terrific.

Owning a 425i will no doubt be an adventure. Even routine maintenance will be an ingenuity test, and replacing an accessory drive belt might take days. The quality of the upholstery material and carpets seems very cheap, and our test car was already starting to deteriorate

with only a few miles on it. Depreciation no doubt will be fierce, and even at the relative bargain price of \$34,975 the 425i seems a bit steep.

On the other hand, this is an Italian car, through and through. There can't be a 4-door sedan with more pure charm, more personality, more eagerness to please. By upgrading the quality of the seating, materials and construction, adding ABS and cleaning up the engine compartment, Maserati could build some sort of ultimate Italian sports sedan from this car. The basics are all there.

The Maserati 425i is obviously not

for everybody. It's very different from any other car on the road, and more fun than most. But realistically, it's not in the same league with the Jaguar, BMW and Mercedes—which is why it finished fourth in our test.

## Jaguar XJ6

Sir William Lyons, the founder of Jaguar, was an artistic genius with a fabulous eye for proportion. He styled the XJ6, which came out nearly 20 years ago and has been acclaimed as a classic ever since. For 1988, that car has finally been replaced with an all-new car of the same name, the first



## LAPPING IN LUXURY

Jaguar sedan *not* designed by Lyons since the company was founded.

Unfortunately, trying to replace Lyons' XJ6 is like trying to redesign Christopher Wren's St. Paul's Cathedral—no matter what you do, it's not likely to be perceived as an improvement. The new XJ6 is more contemporary, roomier and more aerodynamic, but nevertheless doesn't quite manage to upstage the original. On the other hand, it *is* being hailed in some circles as the best Jaguar ever.

Under the hood, there's a new double-overhead-cam 3.6-liter, 24-valve alloy Six that's lighter and more compact than the classic XK engine used to power every Jaguar since 1948. In European tune, the new engine produces some 220 horsepower. Unfortunately, the first batch of U.S. models, including our test car, were rated at only 181 hp, the sacrifices largely attributable to compliance with U.S. emissions regs.

Jaguar has a running fix in for this glaring disparity, an increase in compression ratio from 8.2:1 to 9.6:1 that's worth 14 additional hp. As our test results indicate, this is badly needed. Even on Raceway Park's high-traction surface, the XJ6 couldn't get under 19 seconds for the quarter-mile, at only 77 mph, and 0 to 60 was a mediocre 13 seconds. A \$6000, 58-hp Ford Festiva is quicker.

The extra 14 hp should make these performance numbers better, but what this hefty sedan really needs is the 262-hp V12 that powers Jaguar's XJ-S coupe. This is an option that's coming, but not for at least another 24 months.

Like a Rolls-Royce, Jaguar compromises a bit in handling in order to get a soft, luxury car ride. The XJ6 is noticeably slower to respond to steering inputs than its competition, and scored rather average marks in most of our track tests. On the road, however, it's a pleasant car, and once you get it up into the 80- and 100-mph range, it will sit there all day without working up a sweat. On-center steer-

ing feel is a bit numb, but high-speed stability is superb.

Jaguar introduced disc brakes to LeMans 35 years ago, and ever since has had the reputation of building cars with excellent stopability. The XJ6 is no exception. Thanks to four huge discs with ABS, gliding to a stop is a cinch from any speed.

The British do Tory Traditional like nobody else. The Jaguar's leather-lined interior, spiced with real wood trim, is the nearest you can come, this side of a Rolls-Royce, to a traditional English men's club on wheels. The driving position is very good, and the occupants are appropriately pampered with excellent appointments and a rich aroma of Connolly leather that lends just the right aura of sophisticated self-indulgence.

Surprisingly, the design of the front seats limits rear toe room, and the long Jaguar trunk has little more luggage room than that of the much smaller Maserati. Two couples traveling away for the weekend could very well have a hard time fitting all their luggage in this trunk, at least if they were dressing up to the level that the car demands.

The XJ6's controls are disconcerting. The electronic turn signals—operated by a switch, rather than a mechanical lever—take some getting used to. So does the peculiar U-shaped pattern for the shifter.

Overall, the new XJ6 seems to be very much in the Jaguar tradition of world-class luxury sedans. There are likely to be those who will prefer the styling of its predecessor, but the new exterior still preserves the grace and proportions that have made this car a perennial favorite while bringing its aerodynamics and detailing up to date with its contemporaries. However, the new Jag's power shortage leaves it a few yards behind its competitors in terms of performance, which is where it seems likely to remain until the V12 edition comes along.

### BMW 735i

Like the XJ6, the 735i is all-new from the ground up, and it's a stunner, dra-

matically prettier than the previous 7-series sedan. The 735i is conservative but nevertheless exhibits a contemporary flare. A drag coefficient of just 0.32 is excellent for a full-size production sedan, too.

The 735i is almost Japanese in its level of sophistication and electronic gadgetry. In addition to the expected antilock brakes, the car has ASC—antispin traction control—to eliminate wheelspin under acceleration. The suspension is electronically adjustable for Normal or Sport handling and is automatically self-leveling. The steering is progressive and the 4-speed automatic transmission can have its shift points switched from Economy to Power, or locked in gear until manually shifted.

This is not to mention the computer-controlled climate control and state-of-the-art sound system. Altogether, there are some 33 separate fused circuits in the fuse box, so tightly packed that BMW supplies tweezers in order to change fuses.

Happily, it all works. The 2-ton 735i is too heavy for its 3.5-liter Six to make really spirited headway under acceleration, and its Pirelli P600 tires limit adhesion, but the car is otherwise an excellent performer at the track and infinitely pleasing to drive on the road. Put the suspension and transmission in the Sport settings, and this car can be thrown around like a Maserati, yet has the high-speed stability of a Mercedes—not surprising, considering the *Autobahn* heritage of both. It's totally predictable and vice-free.

Like the exterior, the interior of the 7-Series has been totally redesigned. And "designed" is the operative word. Germany is the world leader in ergonomic office furniture, and the 7-Series has the same functional, comfortable and upscale feeling as the best products you'll see at the Frankfurt Orgatechnik furniture exposition. Obviously, an industrial designer has been at work here, with commendable thoroughness. Everything is logical and in the right spot—a great driving environment.

## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEEL-BASE (in.)	LENGTH (in.)	WEIGHT (lb.)
Maserati 425i	\$34,975	\$34,975	187-hp SOHC 2.5-liter V6, Twin Turbo	5-speed manual	102.4	174.6	2800
Jaguar XJ6	47,500	47,900	181-hp DOHC 3.6-liter In-line-6	4-speed automatic	113.0	196.4	3903
BMW 735i	49,500	51,580	208-hp SOHC 3.5-liter In-line-6	4-speed automatic	111.5	193.3	3880
Mercedes-Benz 560SEL	66,260	67,760	238-hp SOHC 5.6-liter V8	4-speed automatic	121.1	208.1	4080

1. Best speed while weaving through seven cones placed 100 ft. apart; the higher the speed, the better the transient handling.
2. G-forces generated during steady-state cornering around a 200-ft.-dia. circle; cw=clockwise, ccw=counterclockwise.
3. The number of standard-size grocery bags that will stand upright (1-in. crush space permitted) in trunk with rear seats up.



# 1989 Bentley Turbo: The Heavyweight Contender



Performing behemoth: 2½ tons, 155 mph.

**A**LTHOUGH it won't make its debut on American highways until next year, the Bentley Turbo seems to have the right stuff—performance, prestige and a prodigious price tag—to take a prominent place among the leading luxury lappers when it does.

Sampled during a recent preview in England, the Bentley's turbocharged, 300-hp, 6.7-liter V8 is capable of hurling some 5000 pounds of meticulously painted steel, hand-stitched leather and hand-finished walnut to 60 mph in about 8 seconds, with a quarter-mile coming up in about 8 more and top

speed governed to a mere 155 mph by the car's computerized rev limiter.

The marketing aim is to capture the younger, affluent executive type who wants to move up from Mercedes but isn't quite ready for the stuffy Rolls-Royce image. When it finally reaches these shores, look for the Bentley Turbo to have a price tag consistent with its curb weight and position in the prestige market. Rolls-Royce Chairman Peter Ward is estimating between \$130,000 and \$140,000, depending on prevailing exchange rates.—T.S.

In Germany, you can already buy a 750i. This is the same car, but with a 300-hp, 5.0-liter V12 made by putting two of BMW's 2.5-liter Sixes on a common crankcase. Another 100 hp and the 7-series sedan will post a formidable challenge to the Mercedes 560SEL for absolute supremacy. No doubt, when the V12 (in the long wheelbase 750iL edition for the U.S. market) arrives later this year, it will raise the price of BMW's flagship to somewhere near \$70,000.

## Mercedes-Benz 560SEL

Although it's surrounded by increasingly tempting alternatives, the 560SEL is still King of the Road—the Best Sedan in the World. It's easy to see why. This is a big car, with room for five adult passengers, a huge trunk and a 121-in. wheelbase, the same as a Cadillac Fleetwood Brougham. The styling is an aerodynamic update of the solid, Teutonic look Mercedes has been selling successfully for decades. It looks and feels like a big, expensive car, just as it should.

An endearing policy at Daimler-Benz AG is to help preserve the resale value of used Mercedes by making sure that every new Mercedes bears a family resemblance to every old Mercedes, while becoming increasingly rounded and aerodynamic with each model change-over. This car's basic body shell came out in 1981, and is reaching the tail end of its model run, and a new S-class sedan is in the

works. Still, this Mercedes looks like every other Mercedes and doesn't look dated. The 560SEL you buy now will still look good in the '90s.

You can buy this same car for less money with either a 3.0-liter Six or 4.2-liter V8, but the engine of choice is the 238-hp, single-overhead-cam 5.6-liter V8. Supposedly, Mercedes is working on a 300-hp V12 made by putting two 3.0-liter Sixes on a common crankcase, but it will be years before this engine appears, if at all.

No matter. The 560SEL may be big and heavy, but it goes like stink—0 to 60 under 8 seconds, the quarter-mile under 16 seconds at nearly 90 mph and a top speed around 150 mph. This makes the big Mercedes the best-performing 4-door sedan in America, and one of the fastest cars in the country.

Of course the 560SEL comes with 4-wheel disc ABS brakes, and its all-around braking performance is fabulous. It also sticks surprisingly well, and was nearly a match for the little Maserati 425i in our slalom and skid-pad tests. Any time you can get a 2-ton sedan to pull over .80 G, you're doing good.

This is largely due to Mercedes finally fitting decent Michelin MXV radials on the 560SEL, after years of using lesser tires. The Michelins are much narrower than an American manufacturer would specify on a car of this weight and performance capability, but who can argue with success? It would be fun to see what one of these cars could do at the track with

a set of ultrawide Goodyear Gatorbacks or something similar.

Driving the 560SEL is simplicity itself. The car is predictable, straightforward and relaxing. Truly high-speed travel is effortless, and no matter what kind of situation you get yourself into, the car always gives you the confidence that you can get yourself out again. You'd have to be really ham-fisted—or singularly unlucky—to hurt yourself in one of these cars.

Where the 560SEL really shines is in ergonomics, an area of design that Mercedes perfected long ago. Every control is in the most logical place, the analog gauges are easy to read, the big wheel is comfortable to hold, the steering has just the right amount of feel, the automatic shifter is logical to shift manually or automatically, and the bucket seats will take you through an all-day drive without fatigue. Thoughtful touches abound, from the standard airbags and 10-speaker sound system to adjustable rear passenger footrests.

No question, \$68,000 is a lot of money for a car. But all things considered, including performance, comfort, status, resale value and warranty coverage, the 560 SEL is a better buy than any of its competitors. It's a wonderful machine, an automotive icon and the feeling of superiority it provides is rare at any price.

Though the competition is steadily closing in, the 560SEL is still the best sedan in the world. In fact, it just might be the best car. Period. **PM**

## TEST RESULTS

GAS MILEAGE (EPA city/ PM test)	¼-MILE (sec. @ mph)	ACCELERATION 0-60 mph (sec.)	BRAKING (ft.) (60-0 mph)	SLALOM <sup>1</sup> (mph)	SKIDPAD <sup>2</sup> (cw/ccw)	CARGO VOLUME <sup>3</sup> (cu. ft.)	INTERIOR SPACE INDEX <sup>4</sup>	TEST TRACK RANKING <sup>5</sup>	ROAD TRACK RANKING <sup>6</sup>	OVERALL RATING <sup>7</sup>
13/13.85	16.332 @ 84.98	7.61	156	59.29	.80/.84	14	136.23	3	4	4
18/14.79	19.057 @ 77.31	13.10	124	54.96	.74/.74	15	143.94	4	3	3
14/16.18	17.150 @ 84.66	9.85	138	55.86	.77/.81	23	157.90	2	2	2
13/13.48	<b>15.885 @ 88.32</b>	7.79	141	57.98	.78/.81	22	<b>158.66</b>	1	1	1

4. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom ÷ 1000.

5. Points are awarded from best (1) to worst (6) in each category. Fewest total points ranks first, and so on.

6. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.

7. Average of Test Track and Road Test ratings. Road Test score breaks ties. Bold numbers show best performance.







A complete teardown analysis  
of America's first all-new  
production multivalve engine.

# QUAD 4

## THE INSIDE STORY

**W**HAT'S the No. 1 competitive deficiency of American cars versus import nameplates—particularly Japanese nameplates—today? Opinions vary, but the answer that comes up most often is powertrains.

While Japanese manufacturers have been rushing a veritable tidal wave of new, high-tech powerplants to market, American manufacturers have been struggling to keep pace with engines that belong largely to a bygone era. Good old pushrods and 2-valve combustion chambers may still be fully capable of getting the job done in most applications, but they lack the marketing technoflash of the twin-cam, multivalve layouts of so many competing makes.

Against this background, the new General Motors Quad 4 acquires special importance. Though its design doesn't really blaze any new trails, it is nevertheless the first domestically produced, mainstream multivalve engine to come down the pike.

And this, in turn, makes it worth a close internal inspection. Designed by the Buick-Olds-Cadillac powertrain division, the Quad 4 began with a clean sheet of paper, unhampered by requirements to use existing tooling or components. Design goals for an engine meant to be a bread-and-butter corporate powerplant until the turn of the century included not only specific horsepower, torque, fuel consumption and emissions numbers, but also high reliability. And just as important, it had to be an engine that could be cost competitive.

The idea of four valves per cylinder is far from new. The essence of developing power is to move fuel/air mixture into and exhaust gases out of the cylinder as efficiently as possible, a process that's largely a function of valve area. There's a limit to valve area with only two valves, and that's the diameter of the cylinder, minus a little room for a valve seat. And even as the design approaches this size, there's a point of diminishing returns: Valve ports too close to the cylinder wall don't flow well because the wall is in the way. A 4-valve design improves port area and provides the inherent advantage of a central plug location.

The "bang" inside your combustion chamber is really a relatively slow-moving flame front, spreading in all directions like a grass fire from the sparkplug electrodes. The Quad 4's combustion chamber is not the traditional hemispherical or pent-roof design usually used in 4-valve motors. Note the ridges between the intake valves, and also between the exhaust valves. They're there as aerodynamic aids, to smooth gas flow in and out of the ports. Also notice that the combustion chamber squish band snuggles up in between the intakes, and right up to the exhaust seats. The idea was to achieve, with the dish in the piston top, a 9.5:1 compression ratio. The dished piston makes the combustion chamber more nearly spherical, so even low-octane gas burns without detonation. The sparkplug sits on a little hill between the valves, raised 4 mm above the rest of the head. This places the plug gap, where the flame front starts, closer to the theoretical center of the idealized spherical combustion chamber.

The result is a flame front that progresses evenly throughout the combustion chamber, providing more complete combustion.

Putting the exhaust ports at the rear of the cylinder head, closer to the catalytic converter, allows the converter to heat up rapidly from a cold start. Combine this with complete combustion, and emissions meet standards without an air injection pump.

The EPA emissions test cycle favors part-throttle operation, where most engines spend most of their time, so one major design priority was reduced friction. Cylinder bores, for example, are polished to a 10-micro-in. surface. One side benefit of this technique is very low blowby, permitting a simple metering orifice for crankcase ventilation instead of a conventional PCV valve.

To further reduce friction, rod journal diameter was reduced, while journal width was increased to handle the loads. Rods are machined so accurately that no balancing pad is used for final weight matching—the rods are virtually identical.

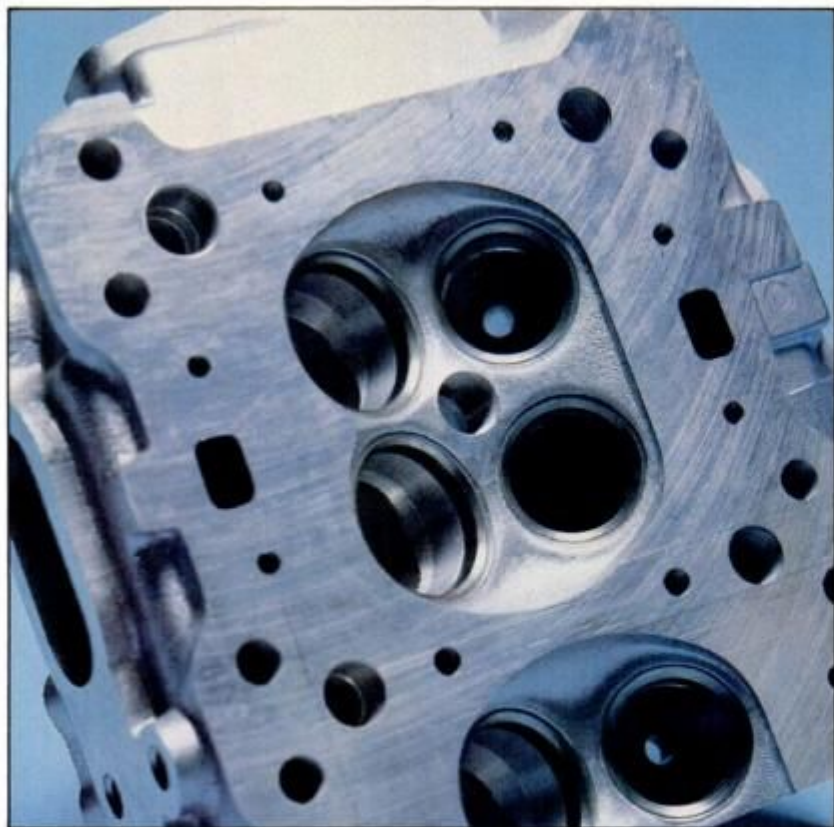
Normal practice for overhead-cam engines calls for boring a hole directly in the aluminum to hold the steel lifters. Differ-

MIKE ALLEN  
Asst. Auto Editor

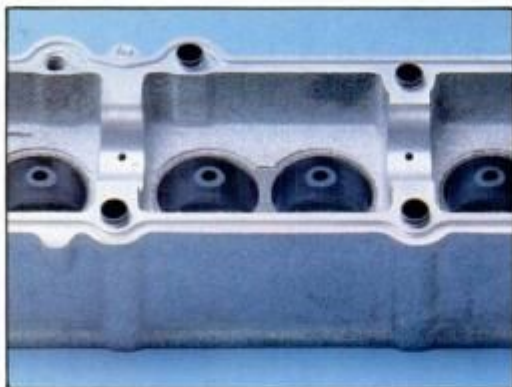


Cutaway into Quad 4 cylinder head (above) shows 4 valves per cylinder. Parts laid out (opposite) make up Inline Four. Top row: ignition coil assembly, ignition module, heatsink. Second row: timing chain, sprockets, timing cover, water pump, cam carriers and lifters. Third row: pistons with rods, stainless exhaust manifold, head with valves, fuel rail, oil pickup and intake manifold. Bottom row: crankshaft, cast-iron block, windage tray, oil pump and oil pan.





The aluminum-alloy head (above) has subtle aerodynamic shaping in combustion chambers, room for water passage between exhaust seats. Tidy hydraulic lifter (right, top) is only 35 mm in diameter, has close-tolerance fit to bores in cam carrier. Iron insert in alloy cam carrier (right, middle) prevents clearance change with temperature variations. The 1-into-4 equal-length intake manifold (right, bottom) is fabricated from thin-wall alloy tubing which is welded to cast flanges.



## QUAD 4

ences in thermal expansion dictate large enough clearances to require a large, deep bore to keep lifters from cocking sideways.

The Quad 4 employs a different approach. In order to reduce contact area between the lifters and their bores, an iron insert is cast into the cam carrier. Clearances between the lifter and bore are so close that a robot is used to install them because it's too difficult for a human operator to get them in straight consistently.

Camshaft and water pump are both driven by a double-row timing chain, which should last as long as the engine. The gerotor oil pump is geared directly to the crank. This tiny 35-mm pump turns at a substantial overdrive to the crank, rather than at half speed like a camshaft-driven pump. High capacity is necessary to provide oil flow to the piston cooling orifices drilled into the connecting rods. These orifices index with the oil gallery in the rod journal once per revolution, squirting oil onto the bottom of the piston crown.

Computer-aided design and manufacturing (CAD/CAM) techniques figure heavily throughout the Quad 4's development history. Computer modeling makes it possible to calculate the strength of a component without having to make it and break it.

"That means we can simply try something like increasing the dimensions of a gusset or fillet, rather than simply making the entire component thicker. This saves considerable time, and allows us to try more solutions to any design problem before we reach the prototype stages," says Don Miles, chief engineer on the Quad 4 team. That computer network also tracks every engine as it passes down the line, recording all the vital dimensions. If there's a problem, corrections can (and are) made immediately, either by management or more likely by the operator of the machine. There is no separate quality control staff.

It takes over 18 years of seniority to even apply to work in the Quad 4 plant. There are no time clocks. "We know who's here. We know what's getting done," says Miles.

Rather than hot-test selected engines at random, B-O-C goes to elaborate lengths to ensure that every engine coming down the line is right on. Problem engines should be detected by automated equipment and returned to the station where the fault was committed.

For example, rather than simply squirting the engine full of oil, a fitting pumps in the requisite amount under pressure at the oil filter adapter. At the same time, an electric motor spins the engine while a computer monitors the oil pressure "signature" at the gauge sender. The computer can even tell the difference between a missing bearing shell and a leaky fitting. A side advantage is that the engine is completely oiled at the first twist of the key in the vehicle.

Traditional casting methods for iron





blocks have limitations as to how thin the cylinder walls can be. Sand molds are poured full of molten cast iron, and after cooling the sand is washed out.

Handling and assembly tolerances that go with traditional methods often result in core misalignment. The result is holes for cylinders that aren't always centered around their design dimensions. Also cast into the block are machining pads, places for the block to be gripped by the fixture while the cylinders and crankshaft tunnel are being machined.

In the traditional block casting, every critical dimension is pegged to the machining pads. However, the pads are not formed by the same cores as the cylinders, but by the cores that form the relatively unimportant water jacket on the exterior of the engine. Tolerances creep in, and the cylinder bores can vary considerably in their placement. Quad 4 blocks, by contrast, are cast with carefully interlocking cores, eliminating many of the tolerances that commonly result in fitting the cores together.

The crankshaft center counterweight has several notches machined into its perimeter. Bolted into the block is a sender for the computer, and the ignition coils live in the valley between the cams. Each of the two coils fires on both the compression and exhaust strokes, and they are both mounted to a large plastic housing that has the high-voltage ignition conductors cast inside. So, there are no points or moving parts.

In fact, there is no provision for setting the timing at all—it's fixed when the notches are machined onto the crank.

In 1988 trim, the Quad 4 produces 150 hp at 5200 rpm and 160 lbs.-ft. of torque at 4000. That's 1.08 hp per cu. in., more than any current production small-block V8, and at a "dressed" weight of just over 300 pounds. Perhaps even more important, 80 percent of the Quad 4's torque is available all the way down to idling speed. And waiting in the wings is a 180-hp normally aspirated version, probably available in 1989, as well as a 230-hp turbo.

**PM**



Cast-steel crankshaft (above) has small-diameter journals for low friction. Ignition timing grooves are machined into center counterweight flange. Connecting rods (left, top) are forged, then machined carefully so balancing is unnecessary. Drilled hole in base of rod beam squirts cooling oil onto piston crown once per crank revolution. Gerotor oil pump (left, middle) is tiny, spins at nearly twice crank speed. Cast-iron block (left, bottom) is computer optimized for low cylinder-wall distortion, lowest practical weight.





## CAR OF THE FUTURE

PART 2 OF A SERIES

# AFTER SHOCKS

Computer-activated hydraulics will give tomorrow's suspensions a mind of their own.

BY PAUL VAN VALKENBURGH  
PM Illustration by Jeff Mangiat

It's an exciting time to be an automotive engineer—in electronics, engines, aerodynamics and especially suspensions and vehicle dynamics. This also means that soon it's going to be even more exciting to be a customer. Today a handful of new owners are proudly showing off their new 4-wheel-steering Hondas and Mazdas, and a few auto journalists are being wowed by test drives in "fully-active" suspension prototypes. But in terms of what lies just down the road, these innovations are only the beginning.

Lotus started it all, with a system designed to keep its Formula One cars from bottoming on the track under the tons of aerodynamic downforce generated at top speed. From the rarefied air of F1, Lotus went on to demonstrate the system's real-world advantages in an Esprit Turbo, which was soon followed by a project car for Volvo. Then, of course, GM bought a major interest in Lotus, and now there are a couple of Corvettes running around with hydraulic active suspension.

There are some hints that the novelty of 4ws may wear off and it could go away—or be seen as the answer

DRIVE-AXLE FRONT SUSPENSION

STEERING WHEEL-POSITION SENDER

HYDRAULIC PUMP





HYDRAULIC LINES

HYDRAULIC RESERVOIR

PIVOT PEDESTAL

SLIDER

SPINDLE SUPPORT CAGE

SPINDLE

BRAKE DISC

TIRE HEAD

ULTRALOW ASPECT RATIO TIRES

20-IN. COMPOSITE RIM WITH HIGH CENTER

STEERING RAM

WIDE-BASE CONNECTION TO CHASSIS

CAMBER/SIDEFORCE RAMS

RAM

### Active Suspension Of The Future

PM concept shows suspension design using components bearing little resemblance to those used today. Hydraulic slider and ram, which replace springs and shocks, control ride height, pitch and roll. Smaller rams set steering, camber, caster and toe-in, and reduce side-loads on vertical ram while cornering (arrows show up and down, and pivoting movement). High-center rims provide plenty of room for suspension components inside the wheel. Steer-by-wire system uses no mechanical linkages.





to a question nobody asked. Or it may remain as a small contribution to more exotic systems.

In fact, there are easier ways to make a car more maneuverable, and, in the electronically sophisticated car of the future, other ways to make it more responsive and stable. But when the true fully-active "intelligent" suspension (or at least pretty-smart suspension) arrives, within a decade of its introduction we may all be wondering how we ever did without it.

The sensationally obvious advantages of active suspensions have already been well-noted, especially the concept of a "stable platform." This means that the onboard computer controls hydraulic suspension rams to keep the car from pitching or rolling during the most violent maneuvers. Although this may look strange, and feel strange to the new driver, Corvette project engineer Ken Hanchett says there doesn't seem to be a need for any pitch or roll. "Even novice drivers do quite well with the car held dead flat," he observes.

The feel is almost as if the car is disconnected from the ground, and is being "levitated" around by some unseen force—which, in fact, it is. Hanchett does admit that it might be necessary to develop other driver feedbacks to replace the roll sensation, to provide better clues when the car is getting close to the limit of adhesion.

Also, computer logic and external power (the defining characteristic of "active" suspensions) can do a better job than any kind of "passive" spring, providing almost complete absorption of the most severe road impacts. At the

same time, vehicle response and handling are not only improved, but they can be modified instantaneously, to suit the driver or the conditions.

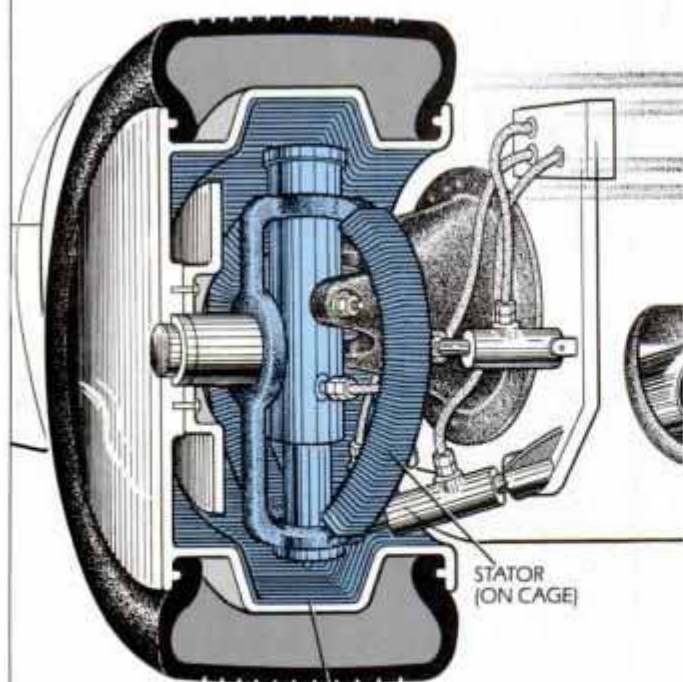
And finally, it becomes a trivial add-on to lower or raise the entire car at whim, whether for better aerodynamics at speed, or for easier tire changing or for payload leveling—although these features are already available with some pneumatic systems. Which brings up a controversy as to "Who's on first?"

### Name games

Lotus was already threatening lawsuits against the Williams Formula One team for using the term "active suspension" for the Williams race car, when it merely had a comparatively simple aerodynamic load-leveling system. The 1988 Lincoln Continental and the Mitsubishi Galant are available with the first production active suspensions—somewhere inbetween simple load leveling and complex pitch/roll correcting. These use pneumatic "helper" springs co-axial with the existing coil springs and shocks—an evolutionary step up from load leveling—and control each spring booster independently for roll and pitch.

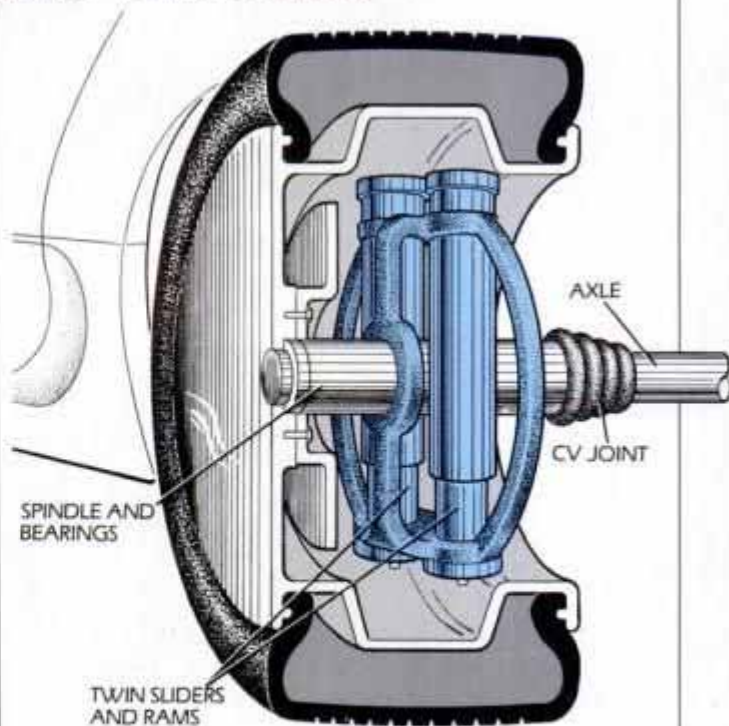
But to Lotus, it's not fully *active* unless you throw out the entire spring, shock and antiroll bar, and replace everything with hydraulics. Lotus argues that there are a number of limitations to a pneumatic helper system, such as response time, though these systems—particularly the one employed on the new Continental—have drawn positive reviews.

## ACTIVE SUSPENSION OF THE FUTURE



### ELECTRICAL DRIVE

Transmission can be replaced with direct electrical drive. Motor windings could be cast directly into plastic wheels.



### WITH DRIVE AXLE

Conventional drive axle could snake between two smaller sliders. Front wheel would need some way to pivot for turns.



## Tomorrow

But that's today, or at least the near future. Speculating on suspension specifics beyond the year 2000 is a bit more difficult. One limitation is that the corporate engineers developing tomorrow's suspension technology aren't in a position to discuss their work openly, even if they wanted to. As a result, our forecast is woven of hints, cross-references and years' worth of shop talk with guys whose favorite topics are yaw, roll gain and polar moment.

Computer-controlled power-driven suspensions will be the centerpiece, of course, but they won't stand alone. To accurately prognosticate, one has to consider the implications in combination with other developing innovations in tires, wheels, electronic controls and sensors, and chassis.

The most dramatic implication is that continual increases in wheel size (diameter and rim width) should make it possible to design the entire suspension *inside* the wheel. In fact, it is almost predestined, to make efficient use of what would otherwise be four large volumes of wasted space. Tires become wider for obvious traction reasons, but tire section height also drops (larger diameter rims for the same tire diameter) to get stiffer sidewalls for quicker response. Also, in the case of the radical new Continental design, the inside rim clearance is increased to provide run-flat capability. Put the two together, and it should be possible to get 20 in. of vertical travel space inside a tire and rim with conventional overall diameters.

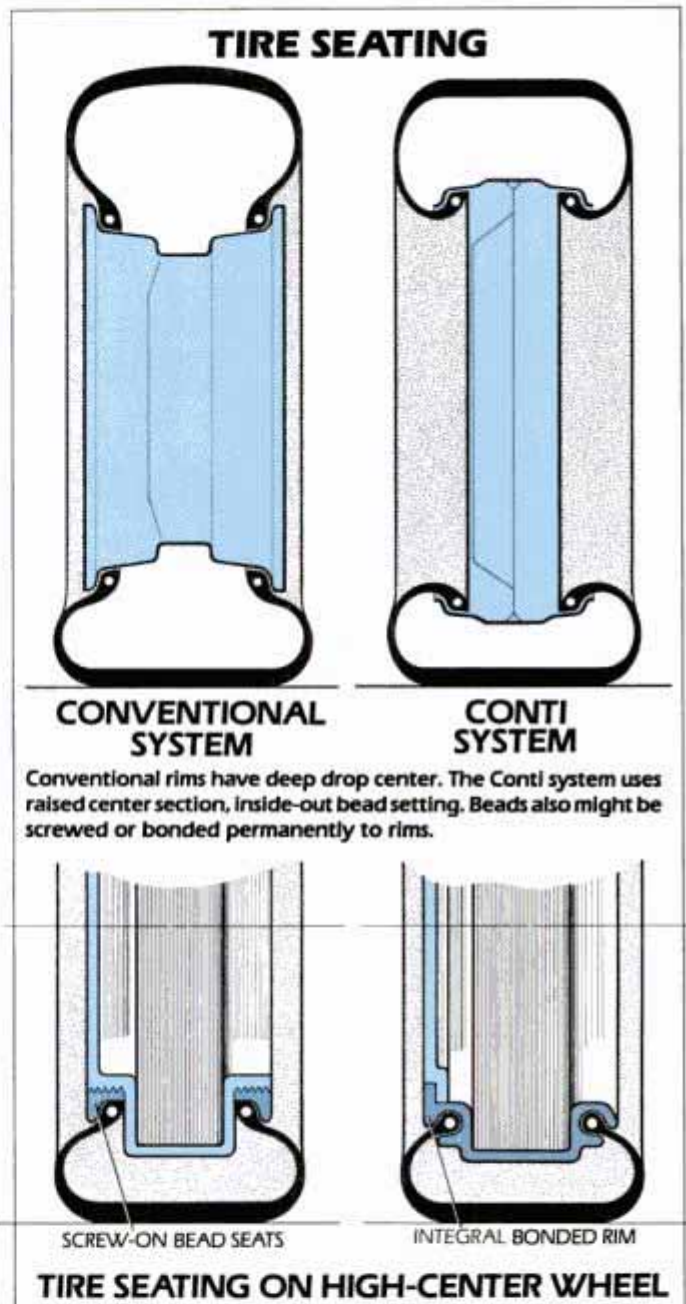
One possible answer to the problem of how to mount the tires is truck-type split rims, or screw-on bead seats. The assembly could be economically based on trade-ins, allowing the old worn-out tire to be vaporized off and the life-time composite rim cycled back into production.

The wheel face of the next century will surely be flat and nearly flush with the tire sidewall for aerodynamic reasons, as rotational aerodynamics becomes the last drag-reduction trick. It has been found that just a free-spinning wheel has considerable aero drag, which can be reduced significantly with smooth tires and wheels, and a smooth, snug enclosure. Incidentally, variable-pressure tires may also be possible, to go one step further in the trade-off between ride and handling, tire life and fuel economy. Already we have tire pressure monitors, which could bleed the tires down, but it will take some clever plumbing to *add* pressure to a spinning tire.

## Starting over

If it's exciting to be involved in spectacular innovations, it's also frustrating, as decades of accumulated knowledge—in existing designs—gets tossed out the window. To appreciate the space advantage potential of an active suspension, it's necessary to understand the current technical problems and solutions. To minimize geometry changes with wheel travel, and yet have a soft ride, it has been necessary to make suspension control arms longer and longer, or with very complex intentional flexures.

Porsche's Weissach axle minimizes trailing throttle oversteer by putting a rubber bushing into the control arm attachment point that squishes with cornering loads, and changes the rear toe-in. Now, with computer-controlled travel, there is less (or no) concern with trade-offs such as



antidive, antisquat, antiroll, camber change, bump steer, camber compliance and so on. The wheel is told where to go and it goes there.

So if there's room for all the suspension hardware inside the wheel, how might it be designed? Current prototypes, of course, utilize existing geometry designs (very poorly) and simply replace the conventional spring/shock with a hydraulic ram. But if exotic geometries are no longer necessary, the wheel bearings can be attached directly to the ram, and the ram cylinder anchored relatively simply to the chassis (perhaps with some vibration isolation).

The large pivot-pedestal shown in the cutaway would distribute suspension loads over a wide area on a mono-coque-composite chassis. With the highly stressed bottom of the gimbal-knuckle attached to the freely pivoting ram, the top MacPherson-like slider would bear light lateral

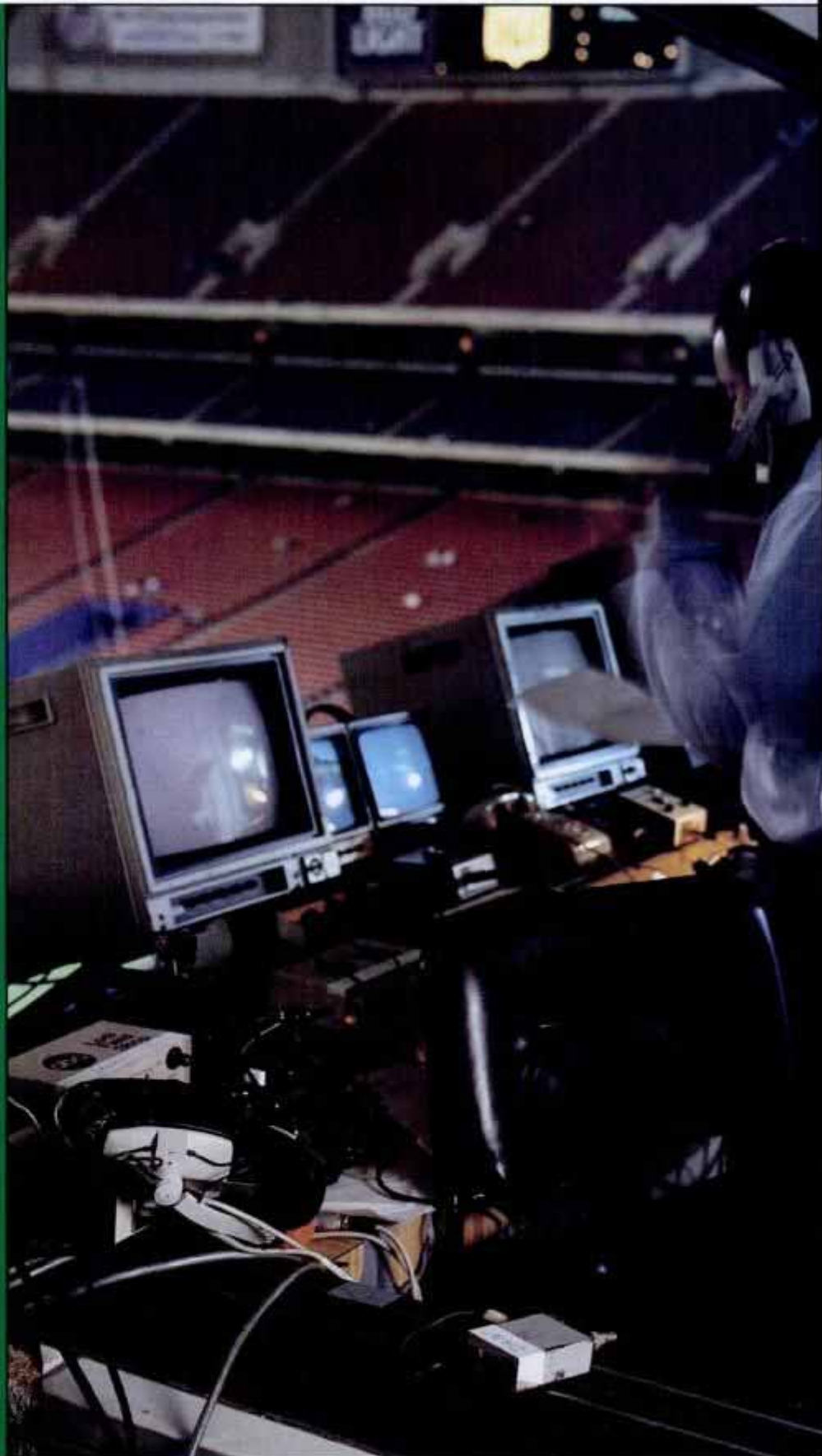
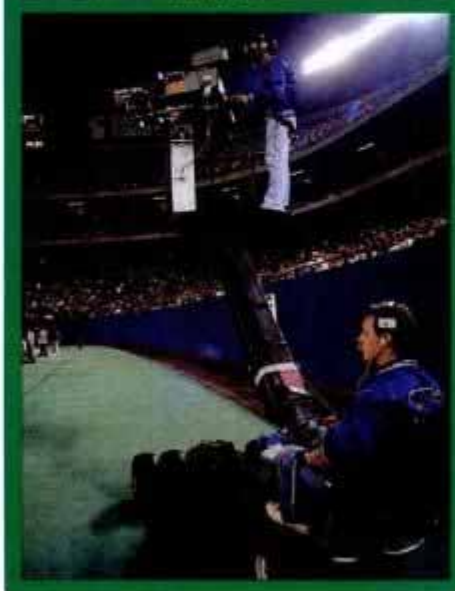
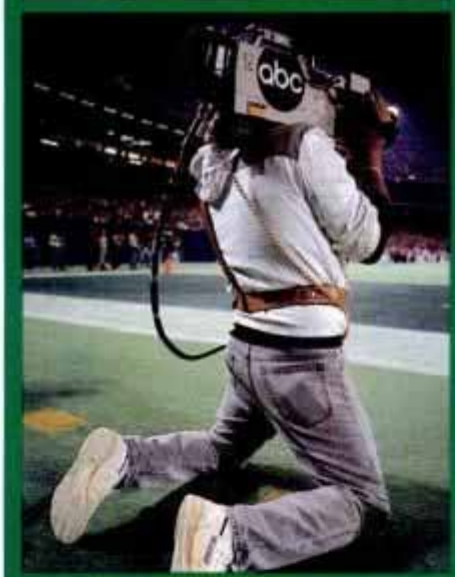
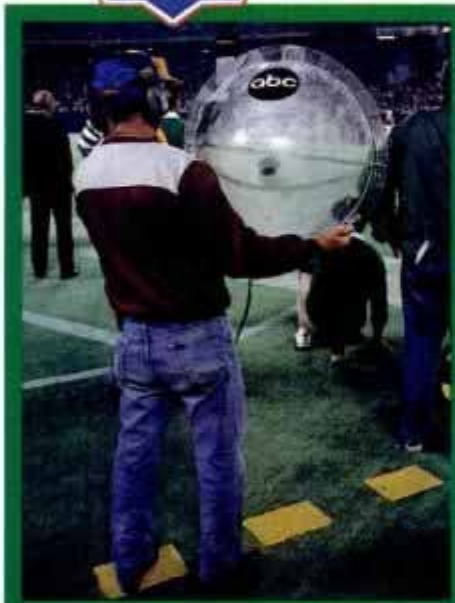
*(Please turn to page 134)*





COVER STORY

# HIGH-TECH





# TOUCHDOWNS



How TV will cover Super Bowl XXII for 120 million viewers.

BY FRANK GIFFORD  
PM Photos by George Lange/Outline Press

I was set to open the telecast of Super Bowl XIX at Stanford University in January 1985. Boone Arledge, our producer for that telecast, was in the production truck outside the stadium counting down, "Ten, nine, eight . . ." When he got to "five" he suddenly said, "Be great, there are 120 million people watching . . . three, two, one . . ."

This was Boone's way of saying, "Relax, take it easy, everything is fine," but it reminded me at the last moment that this was the greatest show in television sports. I just managed to get my opening sentence out all right.

We like to kid ourselves by saying that Super Bowl XXII will be just another game. Our crew at ABC Sports—including my colleagues in the announcers' booth, Al Michaels and Dan Dierdorf, our producer Ken Wolfe, our director Larry Kamm, our engineers, cameramen, replay technicians, soundmen and statisticians—has already broadcast a full season of Monday Night Football games throughout the autumn.

Why should this one be any different? The Super Bowl audience, although much larger, is quite a bit like the Monday Night Football audience—made up of the world's football fanatics, to be sure, but also a sizable percentage of casual viewers, many of whom know very little about football.

Because of this, it will be a mistake to dip too deeply into our bag of technical tricks. We could confuse this audience with a jumble of instant replays, split screens and isolations. We will seek to walk a delicate line, because at the same time, this is the Super Bowl, and we want to be able to bring extra nuances to our coverage.

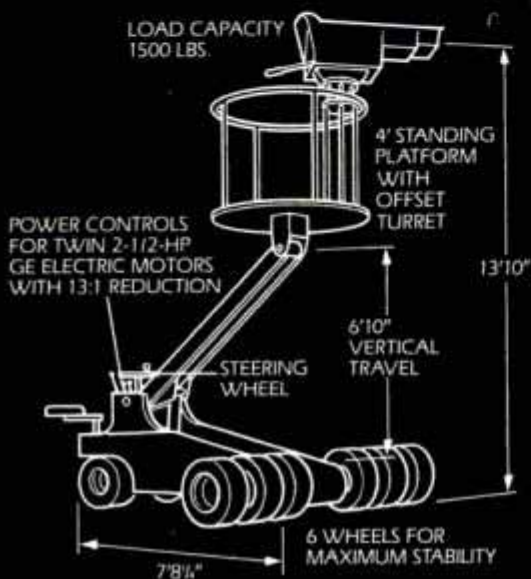
To do this, our engineers and technicians will have loaded up Jack Murphy Stadium with more cameras, more microphones, more miles of wire

While ABC's Frank Gifford (left) tells the story from the broadcast booth, sideline technology captures the play-by-play (far left). Parabolic microphone targets only sounds from the gridiron, not the roar of the crowd (top). Handheld camera allows flexible coverage and quick escape from explosive field action (middle). Mobile camera crane combines stability with silky-smooth camera movement (bottom).

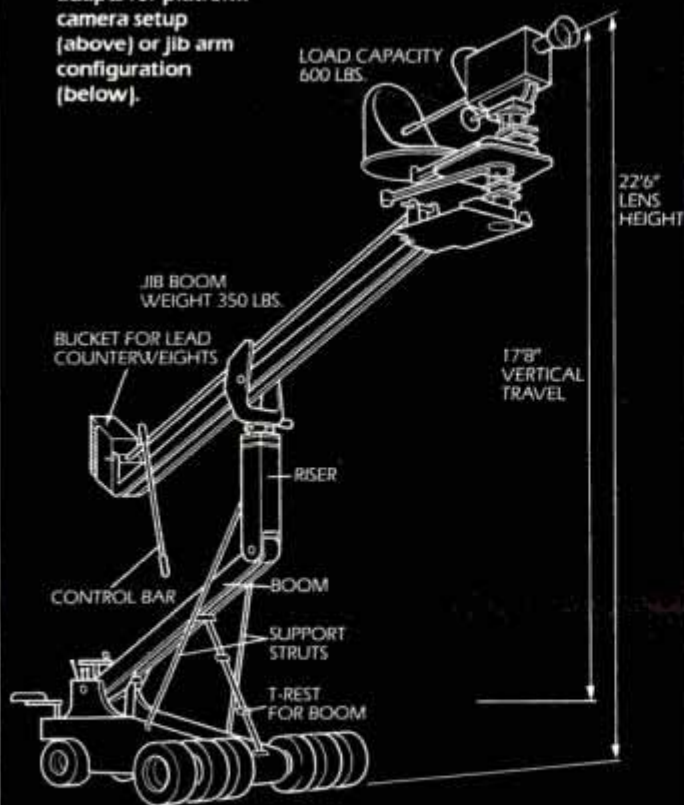




## Getting Above It All



Olympian Crane adapts for platform camera setup (above) or jib arm configuration (below).



and assorted electronic gizmos than ever before.

Officials in San Diego decided to add 20,000 seats to Jack Murphy Stadium prior to the Super Bowl, and that meant that camera locations we had used in the past might not work for us this time around. And because we use more cameras in the Super Bowl, we have to plan more carefully.

At a normal game we use three cameras in the press box, one to cover the 50-yard line and the other two to focus on about the 20-yard lines at either end of the field—a configuration basic to football coverage. But a camera takes up about 8 sq. ft. of space—and that space is in great demand for the Super Bowl. So for this event our technicians supervised construction of camera platforms that extend outward from the press box.

Normally, we have eight other cameras on the sidelines, but the Super Bowl allows us the luxury of adding extra cameras, perhaps 20 in all. For example, on this day we will have four end-zone cameras, one high and one low on each side of the field.

**B**UT, AS the plans progressed for the additions to Jack Murphy Stadium, we encountered problems with our end-zone camera positions. Ken and Larry worried that the camera platforms might not be very stable, especially as 70,000 fans worked themselves into a frenzy. In addition, the platforms would have impeded the views of a few spectators, and this is something that we work hard to avoid. We were concerned also that the cameras might be vulnerable. As every football fan knows, the action often carries past the perimeter of the gridiron. Escape is an option for a still photographer or the operator of a handheld TV camera, but not for a camera on a fixed platform.

Larry came up with the solution. By using a motion picture crane set back from the safety line, he could position the camera on a stable, yet movable platform. Known as the Olympian Crane and manufactured by Leonard Studio Equipment of North Hollywood, California, the 1800-pound electrically propelled platform can carry a 1500-pound payload. Its jib boom, extending as high as 20 ft., can tote an additional 600 pounds. The hydraulic variable-speed lift provides smooth transition in vertical position, critical for our camera work. On Super Sunday the base will be set back 12 ft. from the safety line while the camera sits forward on the arm of the crane, above danger. If a spectator's view is blocked, it will be only briefly as the camera moves up and down.

**I**N THE Super Bowl we will have the luxury of 10 tape machines to provide replays, and here is one area where we really have to exercise caution. The idea is not to overload the viewer with replays (as, in my opinion, some Super Bowl telecasts have done), but to show selected shots of key plays.

Last year, we added Super Slo-Mo to our coverage. It is a higher quality replay system than was available in the past, recording more frames to produce a picture of incredible clarity. For the Super Bowl, we will tie it in to more handheld cameras than ever before, so we anticipate some spectacular replay coverage.

Larry would like to do something in this Super Bowl that is already feasible, but NFL executives will not yet allow it. That is to install a tiny microphone in the helmet of an interior lineman to bring you the actual sounds of the tough life in the trenches. ABC used such a micro-





Production truck is nerve center of broadcast, as ABC personnel guide coverage and compile Super Bowl information.

phone in its USFL coverage a few years back, but it is no secret that football players utilize colorful language, and so the NFL remains hesitant. We could solve that problem by using a 2-second delay, or using the sound only on replays when we have had a chance to monitor it first but, alas, that will have to wait for another year.

**W**HAT we will do is use additional parabolic microphones on the sidelines to provide more complete audio coverage. Normally, we use only a single parabolic. In the Super Bowl, we will have two on each sideline.

Our engineers construct our parabolics for us. They first have a plastic dish, measuring either 18 in. or 24 in. across, fabricated to our specifications. Then they attach an Electrovoice 635 microphone at the center. The microphone itself is a fairly standard piece of broadcasting equipment, but when mounted *backward*, facing into the dish, it picks up only focused soundwaves.

On Super Sunday, Al, Dan and I will begin by reviewing our broadcasting strategy. Just as the two opposing teams have a game plan, so do we. We have reviewed the game films tenaciously.

As the game gets underway, we will be aided greatly by two men who are whacko over numbers. George Hill, our statistician, will be with us in the booth, taking copious notes, although he will be able to spout most of the key stats from memory. Researcher Steve Hirdt will be at his computer console, studying patterns and tendencies.

**T**HE MAIN production truck will be a hub of activity. Larry and Ken sit in front of 30 television monitors, flanked by a technical director and an audio director. As Larry calls for the shot he wants, these men push the appropriate buttons, providing the picture you see and the sound you hear. Ken will also help Dan set up his Telestrator diagrams (see sidebar).

When it's over, there will be a winner and a loser on the field. But for us in the booth, the final gun will signal a beginning as well as an end. For even as the crowd makes its way out of Jack Murphy Stadium, our technicians will begin breaking down the equipment and packing it safely. They will work through the night, until after sunrise, when they begin the long haul to Calgary where, in less than a month, we will begin our coverage of the Winter Olympics.

**PM**

## Dan Dierdorf's Telestrator

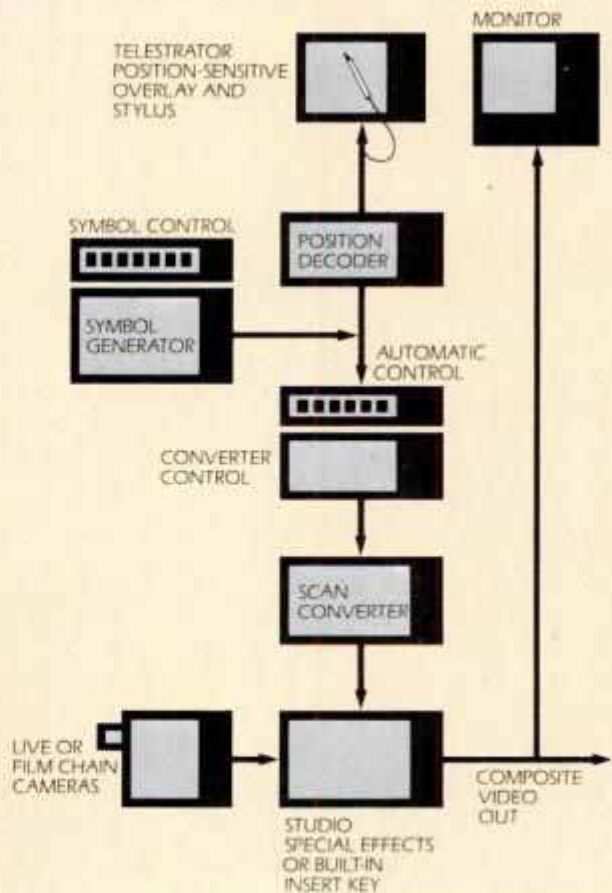
**T**HE VERSATILE Telestrator 440 Video Graphics System is the perfect tool to add a measure of pizzazz to football coverage, and ABC has placed it in the large, capable hands of Dan Dierdorf, who will use it to simplify some of the complexities of play in Super Bowl XXII.



"Hot" sheet of conductive plastic coats Telestrator monitor.

The Telestrator is a product of the Chicago-based Interand Corp. The package is comprised of a 13-in. video monitor, digital slow-scan unit, electronic, stylus-controlled graphics system and a modem.

When Dan diagrams the action of a replay, he watches the very same image you see at home. What he draws on is a "hot" sheet of transparent conductive film attached to the monitor. As his stylus moves, the film sends high-frequency radio signals to a microprocessor that instructs the screen to illuminate the points the stylus touches. Options allow Dan to work with thick, thin or dotted lines and even add arrows or circles.



Electronics convert diagrams to lines on viewers' video screens.







# THE LAST GO-ROUND

After 100 years, the record turntable is at the height of its development. Just in time to become obsolete.

BY  
FRANK VIZARD  
Contributing Editor

Among the nearly 200 turntables available today is this bevy of belt-drive, pivoted-tonearm models. From top: Onkyo CP-1116F (\$110), Bang & Olufsen RX-2 (\$229), Acoustic Research ES-1 (\$500) and Dual CS-5000 (\$450).

RUN SILENT. That's the common goal of submarine engineering and turntable design. But while the sub cruises into the 21st century, the analog record player will be joining the mothball fleet of museum artifacts, made obsolete after 100 years of service by the sonic superiority of the digital audio compact disc.

Ironically, the very innovation responsible for its demise has prompted a spate of recent improvements in the turntable. Today's record players are at the apex of their abilities as designers strive to narrow the sonic gap between the mechanical, analog system and its optical, digital cousin. The primary focus of this sonic improvement is to minimize the turntable's inherent noise and distortion, which detract from the musical content of a recording. This includes designing tonearms that track records more accurately—even warped ones. Fact is, today's most modestly priced turntable outperforms its more expensive ancestor of just a decade ago.

All this is for the good, because a variety of considerations will permit the turntable to coexist with CDs for years to come, much the way manual typewriters still find employment in an age of word-processing computers.

Like the manual typewriter, turntables have die-hard adherents—fans motivated by nostalgia or by distaste for the sound of digitally recorded CDs. More important, though, is the practical and economic value the turntable offers.

Namely, analog turntables guarantee continued access to a musical world not always available on CD. It is unlikely that all of the vast musical repertoire preserved in vinyl will make the transition to optical discs—any more than the full catalog of 78s was reincarnated as LPs. Meanwhile, analog records are a bargain to buy, compared to CDs. They're also cheaper to produce, which means vinyl will remain the medium for new artists and small, independent labels producing musical genres that range from blues to zydeco.

If you want to protect your investment in LPs or ensure your access to uncharted musical waters, now is the time to buy your last turntable. They'll only become rarer—and more expensive—as they're swamped by

the CD and approach their berth in the technological drydock. At this writing, there is still a wide assortment of turntable styles and operating systems to choose from.

Functionally, the turntable can be divided into two parts: the platter upon which the record spins, and the tonearm that supports the phonocartidge with its stylus or "needle." Not so obvious, but critical for good performance, is the turntable's suspension system and the materials that make up its chassis.

The platter portion of a turntable uses either a belt-drive or a direct-drive motor system for rotation. In the belt-drive system, a motor mounted to the outer chassis spins at 300 rpm and transfers its energy to the platter via a pulley and a thin rubber belt that grips a rim on the underside of the platter. The circumference of the rubber belt is generally nine times that of the pulley. This ratio yields the platter speed of 33 $\frac{1}{3}$  rpm used for most 12-in. LP records. Most turntables adjust to 45 rpm for playing 7-in. "singles" (and 12-in. audiophile discs) by increasing the motor's speed, or by switching the rubber belt to a second pulley (which alters the ratio to 6.6:1). Turntables with a 78-rpm speed are a rarity of the species. In fact, Dual's Model CS-5000 (\$450) is the only broadly distributed turntable today with provision for playing old 78s.

The belt-drive system was popularized by Acoustic Research nearly a quarter-century ago in a now-classic turntable that currently manifests itself as the company's ES-1 model (\$500). The belt-drive's simple design makes it easy to manufacture, while still yielding high performance. Besides transmitting motion, the rubber belt wrapped around the platter functions as a filter to prevent motor vibration from reaching the platter. Mounting the platter separately from the motor, and suspending the platter/tonearm assembly independently from the turntable's base, effectively isolates it from outside vibration. The platter/tonearm assembly is literally hung or "floated" from the top of the chassis with well-damped springs. By suspending the business end of the turntable in this fashion, the record and pickup (phonocartidge) are isolated from acoustic feedback (caused by loudspeakers, footsteps and so on) which



## THE LAST GO-ROUND



Dual's CS-5000 (top), seen in detail on the opening page, is the only widely distributed turntable with the ability to play 78-rpm discs in addition to 33s and 45s. Kenwood's KD-76F model (above, \$240) and Technics' SL-J33 (right, \$250) are among the new breed of programmable, direct-drive turntables, made possible by the use of a motorized tonearm that travels in a linear track behind the record platter.



interferes with tracking the record.

Some turntables borrow from CD player design by having platters—and even a whole chassis—made from nonresonant materials such as ceramic, resin compounds or granite. This also dampens vibrations. The chassis of Ariston's Q-Deck model (\$300) sandwiches a viscous "goo" between layers of fiberboard. Meanwhile, every good turntable (belt-drive or direct-drive) is isolated from vibration by viscous-damped rubber feet on its base.

If belt-drive systems have any disadvantages at all, it's in their relatively slow startup time and in their occasional susceptibility to speed inaccuracies.

While little can be done about the former, numerous improvements have been made to regulate platter speed. Fluctuations result in a wavering sound or audible roughness called wow-and-flutter. To reduce wow-and-flutter to a minimum, companies such as Technics, for example, couple an electronic monitoring system to their turntable motors. These "servo-controlled" models automatically detect any fluctuation between the motor speed and a reference signal for platter speed, and perform an instantaneous correction if necessary. Tech-

nic's model SL-BD22 (\$105) includes a pitch control and an illuminated stroboscope on the control panel so that users, particularly musicians wishing to play along, can raise or lower speed by as much as 6 percent.

Direct-drive turntables operate quite differently from belt-drives—with different consequences. Specifically, the platter rests directly atop the motor. The record spindle is, in fact, the motor's main shaft. The advantage here is that the motor—and by extension the platter—are perfectly synchronized regarding rotational speed. Elaborate electronic circuitry makes sure the speed remains constant. Direct-drive turntables get up to speed immediately, making them a favorite of radio stations.

Another advantage of direct-drive turntables is the freedom of design they afford manufacturers. The space-saving, low-profile record player is one result. Another is the programmable turntable—an attempt to match the convenience of CD players.

Like belt-drive systems, direct-drive turntables have their share of negatives. The absence of a rubber belt to isolate the platter from motor vibration means these motors require more precise engineering to sidestep a motor-noise problem called "cogging." Audibly, cogging manifests itself as a rumbling sound picked up by the phonocartilage during playback of a record. Additionally, because the platter/tonearm assembly is not as well isolated from the chassis as it is on belt-drive models, a direct-drive turntable can be more susceptible to acoustic feedback. Recently, though, some manufacturers of direct-drive turntables have managed to incorporate all of the isolation and suspension features of belt-drives. Generally, these models reside at the higher price-points. If you're interested in the the programmability afforded by direct-drives, be sure to check out their "road-handling" ability too.

### Auto or manual

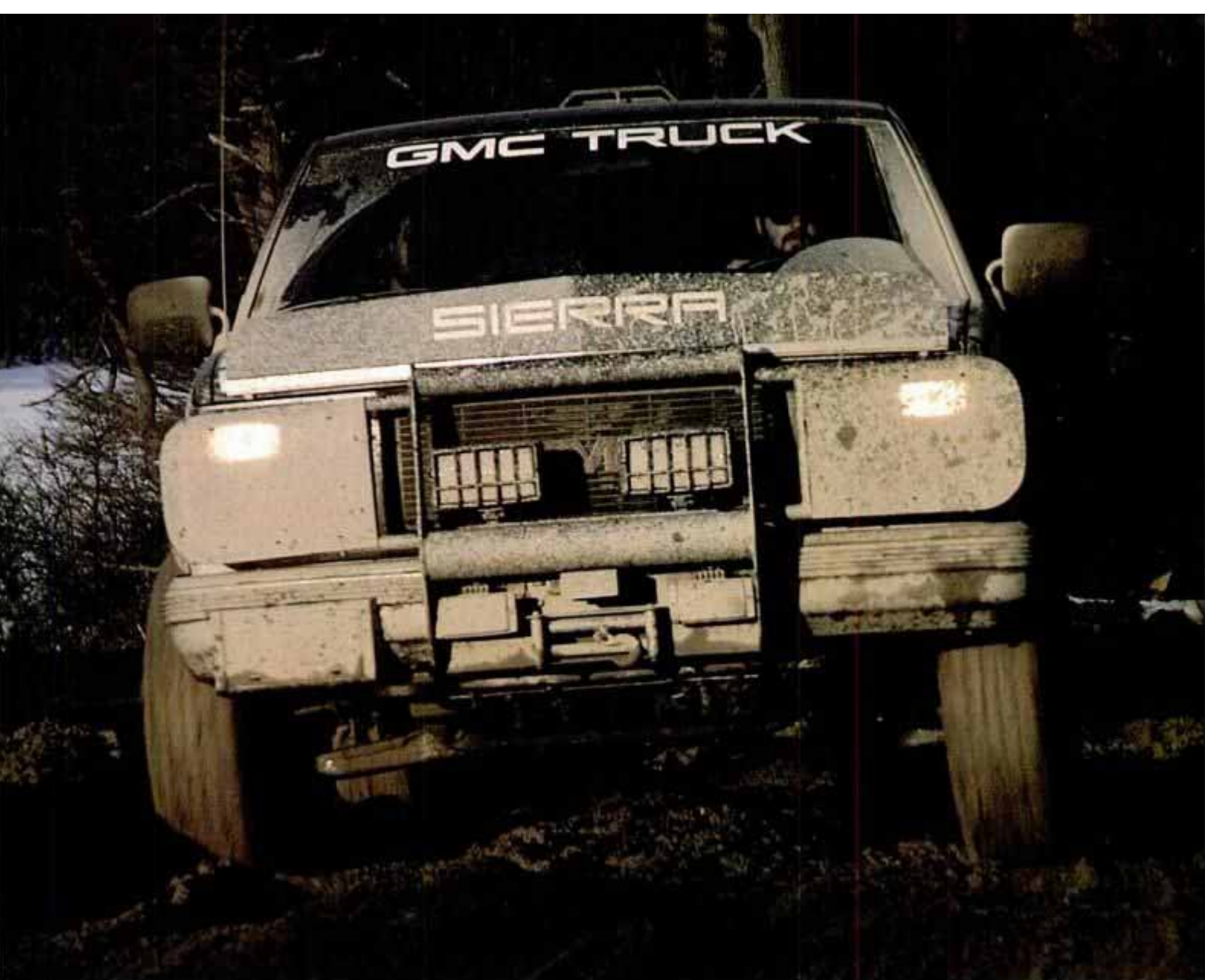
Tonearms lie in the middle ground between the platter and the cartridge, and their function is of sufficient importance that many audiophiles purchase their tonearms separately. The degree of automation afforded by a tonearm is usually used to describe the type of turntable. In automatic turntables, the tonearm automatically moves to the beginning of a record and returns at the finish. Semi-automatic turntables require you to move the tonearm manually at the start, but the arm returns automatically at the finish. Manual turntables require you to set the arm on the record at the beginning and remove it at the end.

Tonearms are characterized by their tracking method. The more traditional tonearm is called a pivoted or radial-tracking arm. These tonearms travel in an arc across the record from a fixed pivot point.

Besides the pivoted, radial-tracking tonearm there is the linear-, tangential- or straight-tracking tonearm. Linear-track-

*(Please turn to page 137)*





# PAN AMERICAN EXPRESS

BY JOE SKORUPA,  
Outdoors Editor



Muddy roads in Tierra del Fuego camouflage the 4x4, (top) and clog the engine, too (above).

PM goes for the ride as hard-driving adventurers conquer the world's longest road and set a new record.

**T**IME is the enemy. A clock's been ticking inside the heads of marathon drivers Garry Sowerby and Tim Cahill since they left Argentina 23 days ago at 4:30 a.m. It ticks loudest during delays—document checks by heavily armed police, border crossings, rock slides and accidents. It quiets down when they stomp the pedal and let their GMC Sierra pickup fly.

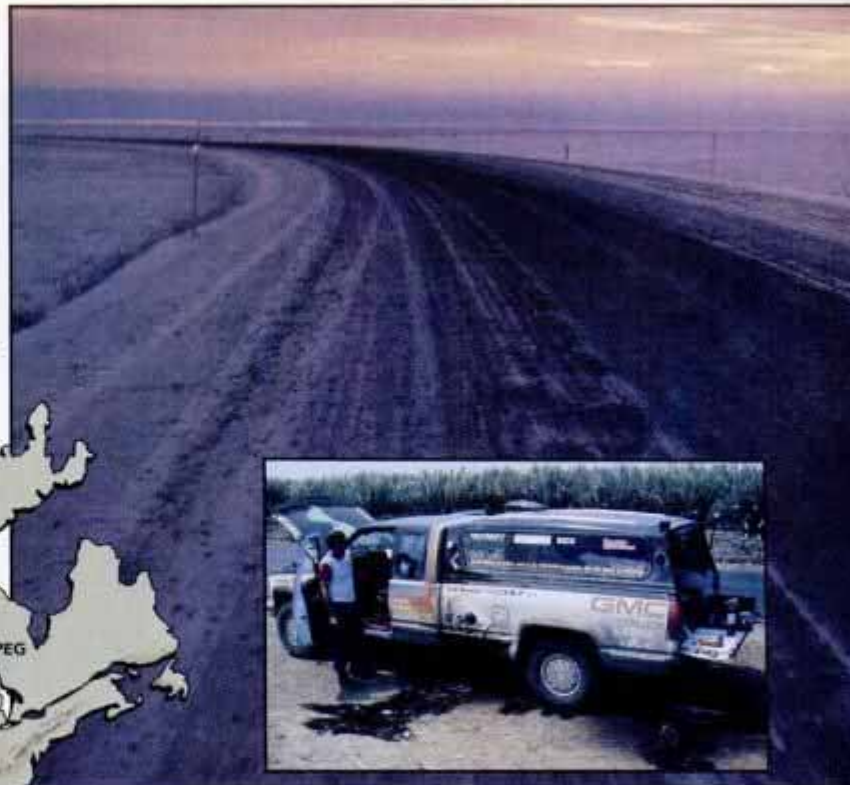
But the ticking never goes away—not even during sleep.

The clock's been ticking for more than 14,600 miles, and now, at 10:13 p.m. on October 22, 1987, it finally ceases. Garry and Tim roll the Sierra to a halt in Prudhoe Bay, Alaska, step into the frigid Arctic air and shake hands 23 days, 22 hours and 43 minutes after leaving Tierra del Fuego on the tip of South America.





Garry Sowerby (above left) and Tim Cahill make a final equipment check, the last time they'd see the Sierra's original colors.



For the record run (route, right), the Sierra was fitted with a fiberglass cap (below) enclosing water coolers, fire extinguisher, bunk, storage drawers, generator and, in the back, a 100-gallon fuel cell. In the cab (bottom right) a technician installs a control panel for auxiliary lights, air horn, rear fuel pump, and alarms, plus CB radio and mobile phone. As miles piled up, much of this equipment began to fail, such as 100-gallon fuel cell in Peru (inset right).



"End of the line, buddy," says Garry to Tim. "No one can take it away from us now."

No one can take away the *Guinness Book Of World Records* mark they just set for the fastest time on the world's longest road, the Pan American Highway. Future adventurers will have to think long and hard before they attempt to beat it. The previous mark was 56 days.

I first met Garry in Detroit last April, six months before the start of the Pan American Challenge. The tall, bearded athletic figure strode into the hotel and I immediately recognized him from a book I was reading about his driving adventures.

Though trained as an engineer, the 37-year-old, restless Canadian from Moncton, New Brunswick, is one of the world's few long-distance driving professionals. He already held two world records—around the world in

74 days and Africa to the Arctic in 28—and was preparing for a third.

I listened to Garry talk about the logistics of the proposed trip and came to realize the amount of preparation was mindboggling. He'd begun a year and a half ago and still needed every bit of the remaining time for establishing a network of contacts and assembling a mountain of paperwork.

His choice of vehicle was a 1988 GMC Sierra pickup with 4-wheel drive and a 6.2-liter diesel. Since the Sierra was GM's first totally re-engineered pickup since 1972, GMC was anxious to give it a good road test.

Garry's plan was to make the truck as self-contained as possible. Everything had to be stowed in the pickup

bed under a fiberglass cap. An auxiliary 100-gallon fuel cell, equipped with its own pump, would give the truck a 2000-mile range. Other modifications, outfitted by Cars & Concepts, near Detroit, were: custom bucket seats, winch, auxiliary lighting, heavy shocks, tachometer, fuel pressure gauge, brush guard, CB radio, mobile phone and sleeping bunk.

The fully-loaded truck, depending on fuel, weighed 8000 to 9000 pounds. It was ready by mid-July. Garry invited me to Moncton for a shakedown run and to take advantage of the only time I would be allowed to touch the wheel. Although I later joined Garry and Tim for an 1800-mile leg in South America, I couldn't drive en route. Guinness specified a 2-man driving team, no exceptions.

Tim Cahill, Garry's co-driver, was also in Moncton for the test drive. Like Garry, Tim is no stranger to ad-





The world-record run began in the snowmelt of Tierra del Fuego (left), continued through jungle mountains of Colombia (top right), and finished in Alaska's tundra (top center). Cahill and Sowerby flank PM's Joe Skorupa at Arctic Ocean.

venture. The tall, burly, well-traveled outdoorsman is just as likely to be found hiking in South American jungles or climbing Alaskan mountains, as typing at his home in Livingston, Montana. Last year, the 42-year-old author published two well-received books, *Buried Dreams* and a collection of outdoor adventure stories, *Jaguars Ripped My Flesh*.

We took the Sierra to the rugged Bay of Fundy and pushed it hard. The gutsy, advanced machine took everything we dished out—loose sand, rocky beaches, power slides and spin outs. The real test, however, began a month later, when Garry and Tim airfreighted the truck to Buenos Aires, Argentina, and drove 1700 miles to Ushuaia, Tierra del Fuego—located at 54°, 46 minutes south—the southernmost continental town in the world.

On October 3, I met Garry and Tim

in Lima, Peru. They'd made good time and had only taken four days to go 3500 miles, but the trip was taking its toll. The Sierra, a dazzling marvel when I'd last seen it, was splattered with a thick layer of mud and grime. The space under the cap looked as if a twister had hit it.

And this was the good news. The production-line vehicle was performing like a dream, but the outfitting was failing bit by bit. Burglar alarm, tachometer and pump for the auxiliary fuel tank all shorted out. Rewiring of the windshield wipers caused them to short, too. And the fiberglass cap was cracked and threatening to take a permanent South American vacation.

Since leaving Tierra del Fuego, four days ago, Garry and Tim only stopped once for 5 hours of sleep. And they looked it—greasy hair, sweaty bodies and eyes that looked like deeply bruised wounds.

At one point, they'd driven continuously for 60 hours and Garry's arms and chest were still sore from the muscling it took to get through a 400-mile, mud road from Tierra del Fuego to Rio Gallegos, Argentina.

Worst of all was the nightmare of southern Peru, where the badly broken road repeated a brutal series for nearly 500 miles—10 miles of tight, downhill switchbacks, followed by a 50-ft. bridge over a dry river bed, followed by 10 miles of uphill switchbacks. And at the top of each mountain, a thick, creamy fog hit them right in the face.

Garry and Tim overnighted in Lima, refueled and were on the road by 6 a.m. The roads were good and we quickly ate up a lot of foggy, desert moonscape.

Just past the town of Trujillo, Garry noticed a fuel leak. We pulled

*(Please turn to page 116)*





### **BOOK STAND**

Our solid oak book stand keeps an often-used book on hand for quick reference or holds a cherished volume for display. Equally at home in the kitchen, den or study, it adjusts to three display positions and folds flat for easy storage.

### **STEPSTOOL/ CHAIR**

And, here's just the thing for reaching that book on the top shelf—and more. By simply pivoting the top section down, this sturdy stepstool transforms into an attractive oak chair.



## STEPSTOOL/CHAIR

BY CLARK CASWELL

**T**HE COMMON chair is such a simple structure that it's often called on to help with a variety of household chores. It's not unusual to see a chair used for a plant stand or as a handy saw horse when cutting a shelf to length. And, how many times have you pulled over a kitchen chair so you could climb up and reach the top cabinet shelf? Ideally, you'd have a stepstool on hand just for this purpose but would you really get it from the hall closet every time you needed to use it?

This design combines the requirements of both chair and stepstool in a neat package that's not much more complicated to build than either separate piece. A simple pivot converts the chair to a 36-in. stepstool.

Although this is a traditional design, we've updated and simplified the joinery by using easily available drywall screws, strong epoxy adhesive and butt joints for convenient fitting and aligning of components.

### Starting out

Begin construction by making patterns for the front and rear legs using 1/4-in. plywood. Draw a 1-in.-sq. grid for each leg on the plywood. Then, transfer each point of intersection that the leg outline makes on the grid in the drawing to its corresponding position on your full-size grid. To connect the points in a smooth curve, rip a 48-in.-long piece of scrap stock to 1/8 in. thick x 1/2 in. wide. Then, drive small brads at the intersection points on your grid, hold the flexible strip against the brads and trace the curve. Cut out both leg patterns leaving 1/4 in. extra on the bottom of the rear leg. Then, using these patterns, lay out a complete full-size side view of the chair as it is shown in the drawing. This layout will enable you to accurately dimension and position the remaining components.

Keep in mind that the rear section

pivots forward at the hinge position. The distance from the top of the rear leg to the seat should be equal to the height of the seat above the floor. This ensures that the rear leg tops will contact the floor when the unit is in its stepstool orientation.

Next, rip the 3/8-in.-thick rear leg stock to 6 in. wide and the front leg stock to 5 in. Crosscut these pieces slightly longer than their leg patterns. Transfer the pattern profiles to the stock and use a band saw or sabre saw to cut to the line.

Smooth the sawn edges with a

drum sander or by hand with a spokeshave and sandpaper.

Rip the stock for the middle support pieces (C and F on the drawing) to 1 1/4 in. wide. Using your full-size layout as a guide for the support lengths, crosscut each piece slightly oversize. Use a sliding bevel gauge to copy the trimming angle. Then lay out and transfer this angle to the miter gauge on your table saw.

Trim the rear support 1/4 in. oversize in length at the appropriate angle and cut the front support to the exact length shown in your layout. The legs

and supports of the rear side sections are connected by a rail (H) at the top and wedge (D) at the bottom. We used a tapering jig (photo 5) to cut the wedges. If you don't have a tapering jig, you can cut a piece of scrap 3/4-in. plywood to the required angle and guide this along the saw fence for cutting the wedges. Or, you can transfer the wedge shape from the layout and cut on the band saw.

Don't trim the points off the wedge bottoms as the entire rear section bottom will be trimmed after assembly.

Cut the forward end of the upper side rails to the correct angle and transfer the line where they join the rear legs using your layout as a guide. Band saw to the line. Lay the four parts that comprise each rear side assembly on the layout and check for proper fit and alignment. Repeat this alignment check for the front side components.

### Side assemblies

When you're sure all side components match your full-size layout you're ready for assembly. Clamp the pieces for one front side section in position on a corner of your worktable (photo 7) and mark the screw positions as shown in the drawing. When boring for the screws, keep in mind that you'll need to bore three holes for each screw. First bore the 3/8-in.-dia. hole for the oak plug. Then, bore the shank hole followed by the actual pilot hole. The shank hole must be just larger than the outside diameter of the screw thread. You can buy special drill bits designed for boring all three holes at once to speed the operation. After boring, screw fasten the two front side pieces together without ep-

# OAK DUET

A stepstool/chair and folding book stand for your study or kitchen.



Mild-mannered and traditional, this solid oak chair hides its double-duty utility.

Color photo: J.R. Rost  
Black-and-white photos: Peggy Caswell  
Technical art: Eugene Thompson



## STEPSTOOL/CHAIR

oxy. Repeat this procedure for the remaining front section and two rear sections. When all four sections are screwed together position each on the layout to make sure the parts are properly aligned. If you're satisfied, remove the screws, apply epoxy to all joints and reassemble. Then, mark the bottom cut off lines for the rear assemblies, set your miter gauge to the required angle as taken from the layout and saw to the line (photo 8).

### The steps and back

The steps (L and M on the drawing) are housed in dadoes cut in the side assemblies. Place each side section on the layout and transfer the step positions. Then, lay a front and rear section—inside face up—on your worktable so the marks for the steps align. Clamp a straightedge guide over the

sides to guide your router and  $\frac{1}{8}$ -in.-dia. straight bit (photo 9). After the dadoes are cut, plane the stock for the steps to  $\frac{3}{8}$  in. thick, joint one edge on each and crosscut to the specified length. Obtain the exact width and bevel angle of each step from the full-size layout and trim the stock to width. Crosscut the back slat pieces and front rail to exact length and rip to width.

Before assembling the front and rear halves, construct a jig to hold the back slats in place. Temporarily tack two pieces of  $\frac{1}{4}$ -in. plywood together and trace the rear leg pattern on them. Mark notches at the slat positions as shown on the layout and saw out the notches with a sabre saw. Separate the templates and clamp each to a rear section inside face.

Using bar clamps, dry assemble the rear sides sections with the step, place the slats in the template notches

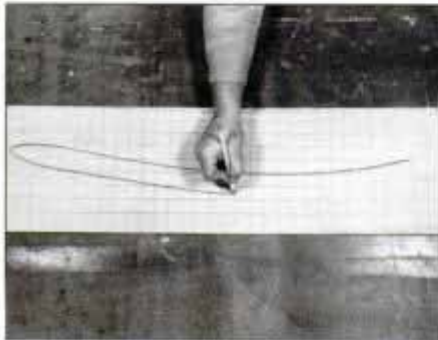
and temporarily clamp. Then, mark the screw positions and bore the plug, shank and pilot holes for connecting the halves. Install the screws and check for proper alignment. Remove the screws from one side and apply epoxy to the mating surfaces. Refasten and repeat the procedure on the other side. After the rear section is completed, assemble the front halves, step and rail in the same manner.

### Seat and top step

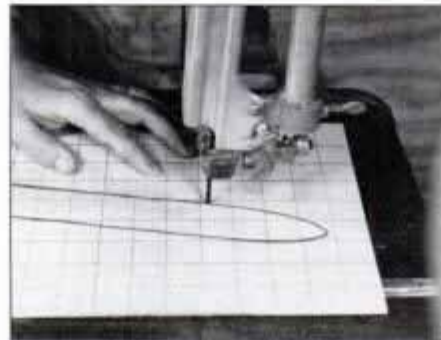
Prepare the seat pieces by trimming two boards slightly wider than necessary and planing to  $\frac{1}{4}$  in. thick. Crosscut to exact length and cut to width following the dimensions and bevel angle shown in your layout. Notch the rear seat board to fit between the rear legs. Transfer the front edge shape of the forward seat piece from the draw-

(STEPSTOOL/CHAIR *continued on page 138*)

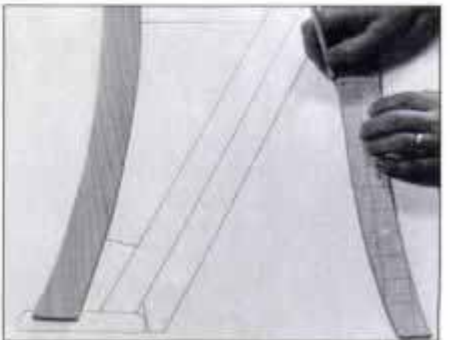
(BOOK STAND *begins on page 84*)



**1** Begin leg templates by laying out 1-in.-sq. grid on  $\frac{1}{4}$ -in. plywood. Transfer front and rear leg profiles as shown in drawing.



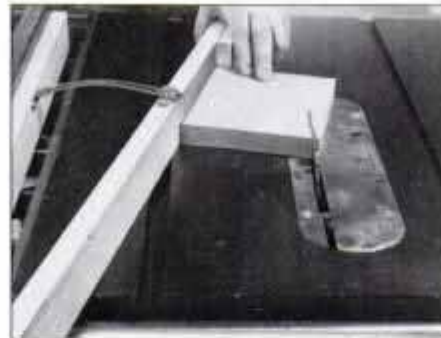
**2** Carefully following the pattern outline, cut out the front and rear leg patterns with a band saw or a sabre saw.



**3** Draw a full-size layout of chair using the leg patterns. Specifications for the remaining pieces are taken from this drawing.



**4** The trim angle for the middle support pieces is copied from the layout and transferred to the miter gauge for cutting.



**5** Use a tapering jig to cut bottom wedges at the required angle. Stop block behind stock keeps work in place during cut.



**6** When all the side pieces are cut, place them on the full-size layout and check for fit. Trim components where necessary.



**7** Clamp each side assembly to a corner of the worktable and mark and bore the plug, shank and pilot holes for the screws.



**8** The rear side bottom is trimmed after assembly. Use the table saw with miter gauge set to the angle taken from the layout.

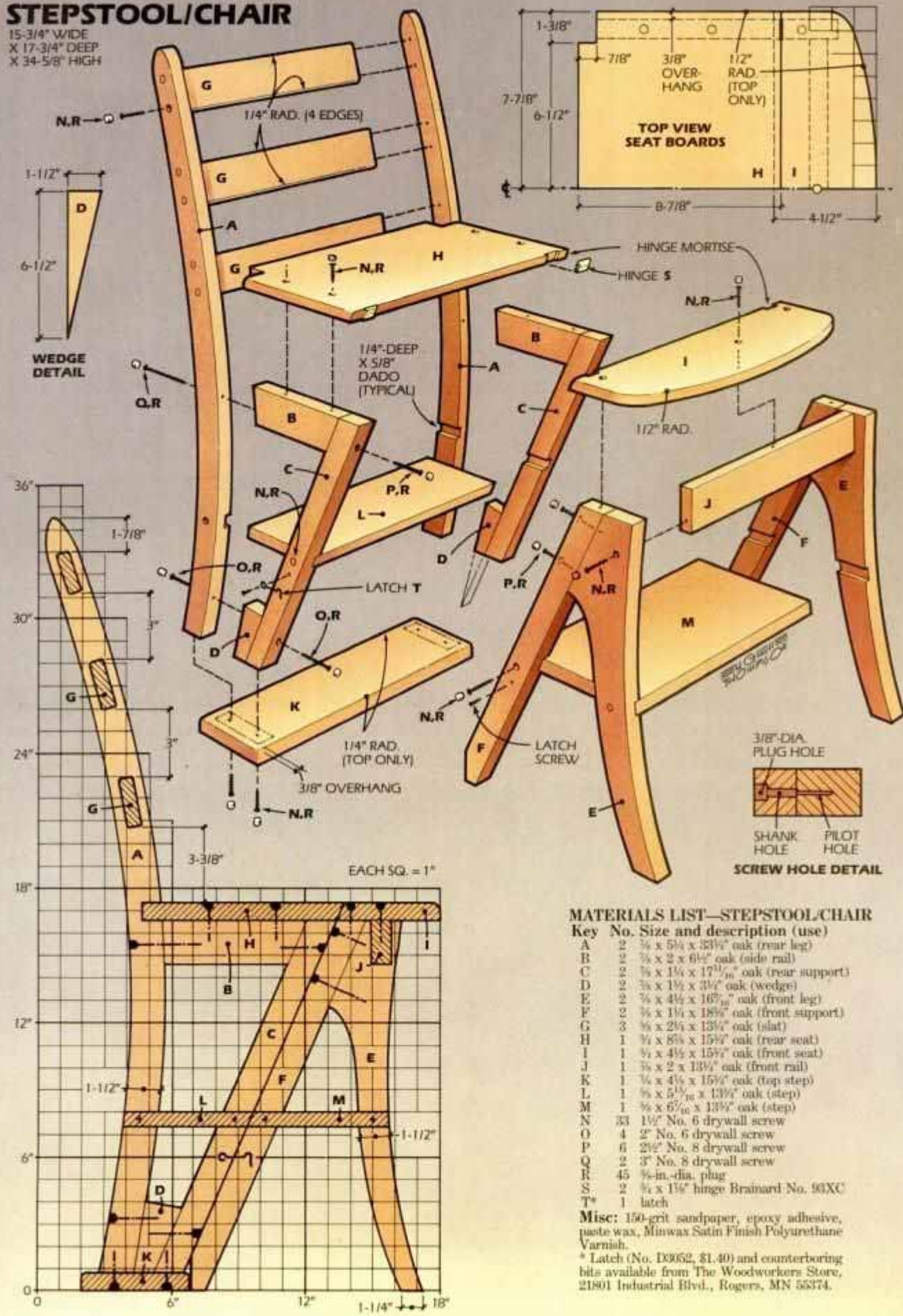


**9** Mark the lines for the dadoes that house the steps. Using a straightedge guide, rout the  $\frac{1}{8}$ -in.-deep  $\times$   $\frac{3}{8}$ -in.-wide dadoes.



# STEPSTOOL/CHAIR

15-3/4" WIDE  
X 17-3/4" DEEP  
X 34-5/8" HIGH



## MATERIALS LIST—STEPSTOOL/CHAIR

Key	No.	Size and description (use)
A	2	3/4 x 5 1/2 x 33 1/2" oak (rear leg)
B	2	3/4 x 2 x 6 1/2" oak (side rail)
C	2	1/2 x 1 1/2 x 17 1/2" oak (rear support)
D	2	3/8 x 1 1/2 x 3 1/2" oak (wedge)
E	2	3/4 x 4 1/2 x 16 1/2" oak (front leg)
F	2	3/4 x 1 1/2 x 18 3/4" oak (front support)
G	3	3/8 x 2 1/4 x 13 1/2" oak (slat)
H	1	1/2 x 8 3/8 x 15 1/2" oak (rear seat)
I	1	1/2 x 4 1/2 x 15 1/2" oak (front seat)
J	1	3/8 x 2 x 18 3/4" oak (front rail)
K	1	3/4 x 4 1/2 x 15 1/2" oak (top step)
L	1	1/2 x 5 1/2 x 13 1/2" oak (step)
M	1	3/8 x 6 1/2 x 13 1/2" oak (step)
N	33	1 1/2" No. 6 drywall screw
O	4	2" No. 6 drywall screw
P	6	2 1/2" No. 8 drywall screw
Q	2	3" No. 8 drywall screw
R	45	3/8-in.-dia. plug
S	2	3/4 x 1 1/2" hinge Brainard No. 90XC
T*	1	latch

**Misc:** 150-grit sandpaper, epoxy adhesive, paste wax, Minwax Satin Finish Polyurethane Varnish.  
\* Latch (No. D9062, \$1.40) and counterboring bits available from The Woodworkers Store, 21801 Industrial Blvd., Rogers, MN 55374.

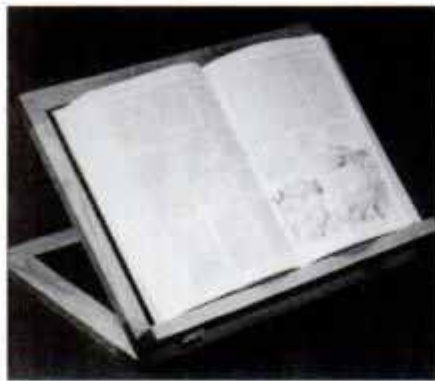


# BOOK STAND

BY ROSARIO CAPOTOSTO

Complimenting our stepstool/chair is this solid red oak book stand. Designed to support any size volume, from recipe book to unabridged dictionary, this piece can hold the book while your hands are busy or keep an "often used reference" at your fingertips. It features a 3-position pivoting frame that ranges from 15° to 60° and folds flat for easy storage.

Our design calls for 5/8-in.-thick stock. If you don't own a thickness planer, you may be able to get your supplier to plane down the more commonly available 13/16-in.-thick stock. Otherwise, buy the thicker oak and resaw it to a thickness slightly greater than 5/8 in. on your table saw or band saw. Before attempting to re-



Keep the book open and your hands free with our easy-to-build solid oak book stand.

saw the oak, however, rip it to 1 1/2 in. wide, dress the sawn edges and cross-cut each piece slightly longer than necessary. After resawing, sharpen your hand plane and smooth the sawn surface. Plane the full length of each piece in one continuous stroke and progress across the width evenly.

Next, cut each piece to exact

length. Temporarily assemble the frames with clamps and mark the dowel hole positions as shown in the drawing. Then, remove the clamps and use a doweling jig to aid in boring the 1/4-in.-dia. x 9/16-in.-deep holes.

If you own an extra-long 1/4-in. drill bit, you can bore the pivot pin holes through the two center short members and pivoting arm in one operation. If not, lay these parts together, mark the hole centerline and use your doweling jig. Rebore the hole in the arm with a 17/64-in.-dia. bit to allow it to pivot easily.

Next, mark the notch positions on the lower frame center member. You can cut these with a dado blade, or use a regular blade and make several passes shifting the stock after each cut. Note that the rear notch is slightly beveled to accept the arm in the 15° position. Use a sharp chisel to make this cut.

(Please turn to page 143)

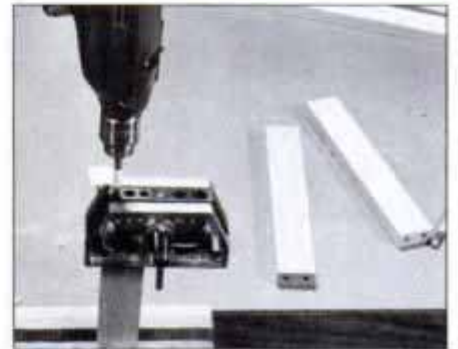
Black-and-white photos: Rosario Capotosto



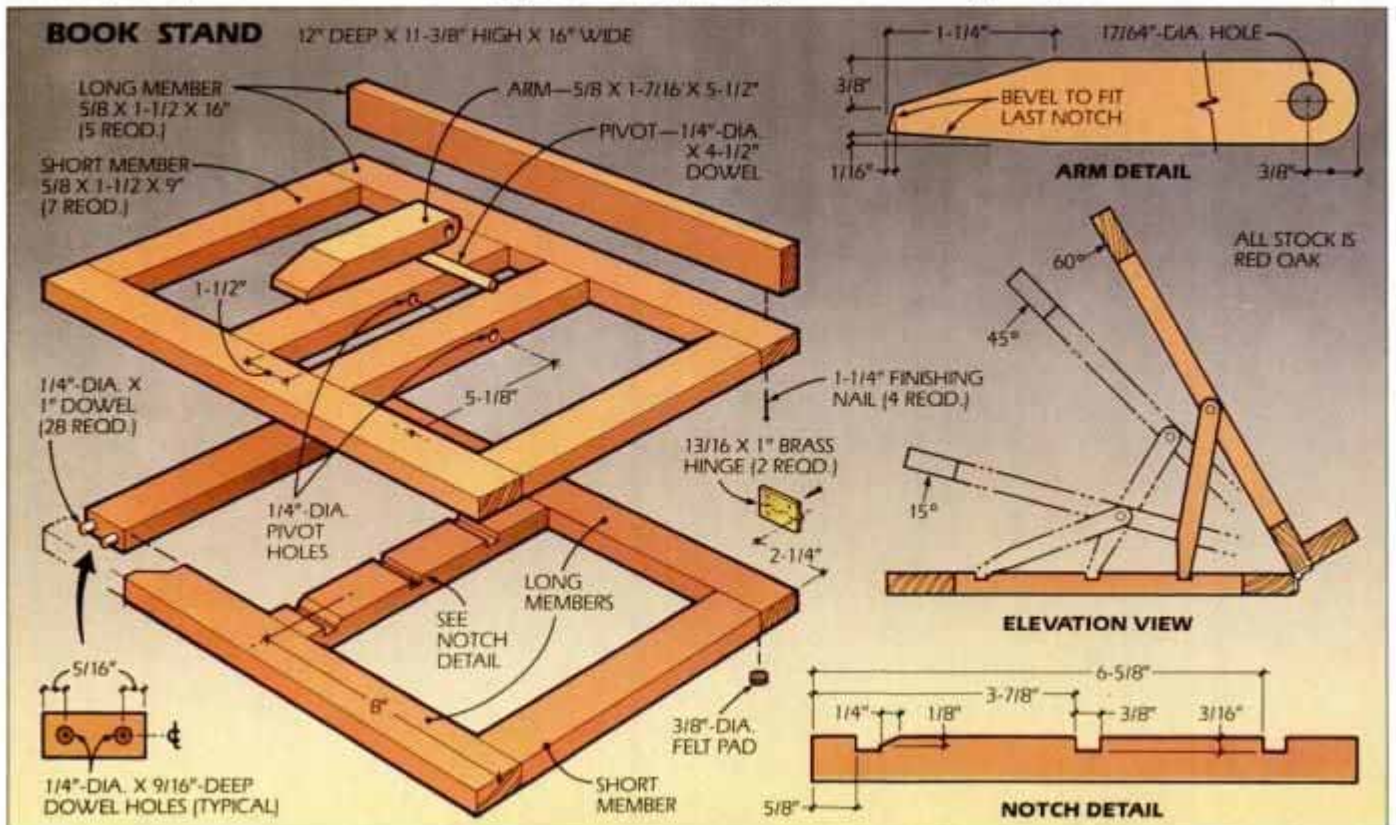
1 After trimming to width, resaw the stock to slightly greater than 5/8 in. To safely rip thin stock, use a splitter and featherboard.



2 A sharp, finely set hand plane makes quick work of dressing the rough-sawn edges. Be sure to follow the grain direction.



3 The joints are doweled with 1/4-in.-dia. x 1-in. dowels. A jig ensures accurate positioning and tape on bit indicates hole depth.







# SUPERSAW

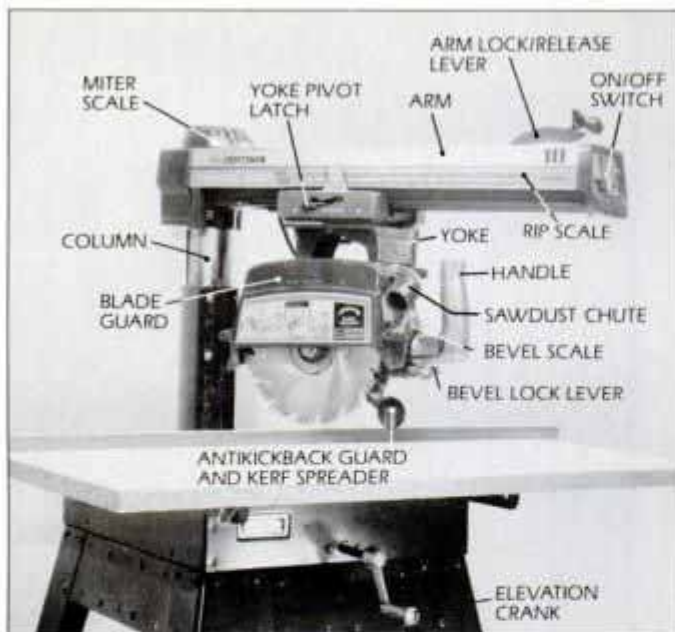
A woodworker's guide  
to the radial-arm saw.  
It's not just for crosscuts.

TEXT AND PHOTOS  
BY ROSARIO CAPOTOSTO  
Contributing Editor

**A**FTER years of promising yourself a wood-working shop, you've finally gotten the time and space that's required. The question is, which stationary power tool should you buy first? For most woodworkers, it comes down to a choice between a table saw or a radial-arm saw. While both tools are undeniably valuable, if a choice must be made, I'd recommend the radial-arm saw for several reasons.

First, for making crosscuts, perhaps the most common woodworking cut, the radial-arm saw is the ideal tool. This is especially true when crosscutting a long board. Just imagine trying to crosscut a 2x12 that's





Here's a typical home workshop radial-arm saw—a Sears 10-in. model—with its major components identified and guards in place.

## SUPERSAWS

16 ft. long on a table saw. Yet, on a radial-arm saw, this would be a simple task. Also, since the blade is above the work, aligning the line-of-cut accurately with the saw blade is easy because it's clearly in view.

A radial-arm saw is arguably the most versatile wood-working tool you can buy. It will accept various saw blades, dado blades and a molding cutterhead to handle virtually any woodworking cut. And, on most saws, both ends of the motor's shaft are designed to accept a wide range of useful accessories. For example, with the proper accessory, you can use a radial-arm saw for horizontal boring, surface planing, drum sanding, buffing, grinding and wire brushing. **Caution:** Only use accessories designed for use on a radial-arm saw.

### Saw specifics

Radial-arm saws are sized according to the diameter saw blade they use. Home workshop models range from 8 in. to 12 in. The 10-in. radial-arm saw, however, is by far the most popular. Common 10-in. saws cost between \$250 and \$750, depending on their construction and features.

A typical 10-in. radial-arm saw has depth-of-cut capacities of 3 in. at 90° and 2½ in. when set to 45° (bevel). The length of the saw's arm determines the maximum crosscut and rip capacities. Most 10-in. saws can rip to at least 24 in. which allows you to cut to the center of a 48-in.-wide panel. Most radial-arm saws come equipped with a combination saw blade that can be used to crosscut, rip and miter. For best results, however, use a blade designed specifically for the type of cut you're making. Use a rip blade for ripping and a crosscut blade for crosscutting and mitering. High-speed steel blades are inexpensive and readily available, but for better performance, use carbide-tipped saw blades. Also, some blade manufacturers offer blades designed specifically for use on a radial-arm saw. These carbide-tipped blades reduce overfeeding—the tendency of the blade to feed faster than it can cut.

### Safety tips

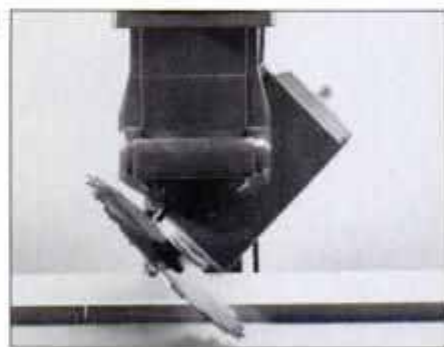
A radial-arm saw is a relatively easy-to-use tool. It's also a potentially dangerous tool. Here are a few precautions that will help ensure safe, accident-free sawing.

First, read your owner's manual before using the saw. If you don't have a manual, contact the saw's manufacturer

Beside straight cross-cuts, radial-arm saw can be positioned for left and right miter cuts, as shown. Blade guard is removed for photo clarity.



With the saw's arm in the crosscut position, the blade and motor tilt for making bevel cuts. Most radial-arm saws have a positive lock at 45°.



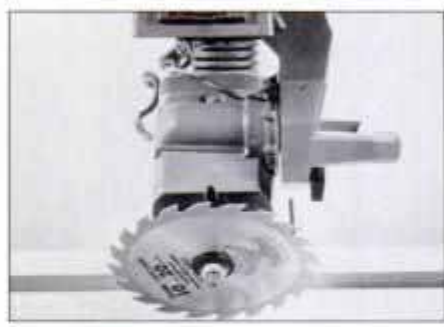
Most rip cuts are made with the saw blade positioned between the fence and the motor, as shown. This is commonly known as the in-rip position.



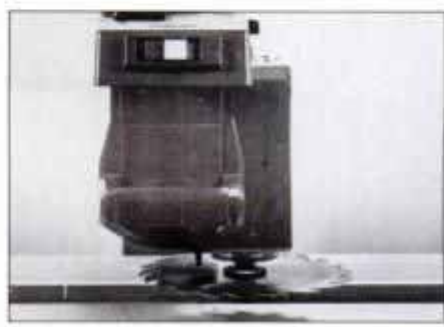
For wider rip cuts, use out-rip mode. Note blade rotation and, therefore, feed direction change between in-rip and out-rip modes.



A radial-arm saw can also handle beveled rip cuts. Position the saw in the rip mode and pivot the motor and blade to the desired bevel angle.



Horizontal cutting is possible by rotating motor 90° so that the blade is parallel to the table. Again, blade guard is removed for photo clarity.







A single, clean kerf cut in fence acts as a quick-and-easy guide for aligning the proposed line-of-cut with blade. Keep hands clear of blade path.



Try gang cutting—sawing more than one piece at a time—for identical-length parts. A stop block, clamped to the worktable, ensures accuracy.



Raise the saw blade, using the elevation crank, to cut notches. Stop block clamped to the saw fence establishes the left shoulder of the notch.



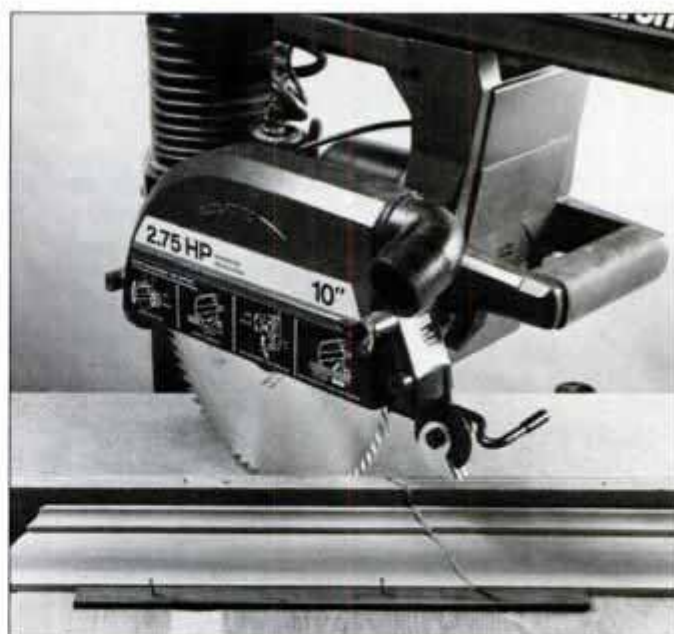
Make two passes to cut through stock that's thicker than the saw's depth-of-cut capacity. A stop block ensures that the two cuts align.



Radial-arm saw cuts right and left miters. Right-hand miter position (shown) is preferred because it offers a clear view of the blade and work.



The radial-arm saw excels in cutting accurate compound miters. Set saw's arm in the miter position and the blade in the bevel mode.



Cut crown molding with saw set for mitering. Nail a wood strip to table to hold molding at the same angle that it will be installed.

and request one. The saw blade is protected by a guard. Never operate the saw without the blade guard in position. Note that in some of our photos the blade guard is not in place. This was done for photo clarity only.

To help prevent kickback, use the antikickback device. This device, which is attached to the front of the blade guard, consists of a steel rod that has several steel fingers, known as pawls. When the guard is adjusted properly, the pawls drag across the top of the workpiece. If the blade kicks back the work, the steel pawls dig in and prevent the work from moving. Some antikickback devices are also equipped with a narrow steel wheel, called a kerf spreader or splitter, that rides in the kerf and keeps it open.

When crosscutting, always keep a firm grip on the handle and advance the blade slowly. Try to keep the blade from advancing faster than it can cut. When ripping, it's very important to feed the work *against* the rotation of the blade. Always use the antikickback device and rotate the blade guard back so that its rear end is positioned just slightly above the workpiece. This will keep the saw blade from lifting the workpiece off the table.

Safety precautions that apply for other power tools, apply for the radial-arm saw, too. Always wear safety goggles and keep the work area around the tool clear of debris. Keep all guards in place and disconnect the saw from the electrical outlet when changing blades.

### Basic adjustments

The radial-arm saw's versatility is due in large part to its wide range of adjustments. A few basic adjustments allow the saw to change from crosscutting to ripping, mitering, beveling and compound mitering. The adjustments shown are rather typical, but be sure to check your saw's operating manual for the recommended procedure.

The saw consists of a yoke-mounted motor that is attached to a carriage. The carriage is mounted to an arm that is fastened to a sturdy column. The carriage rides back and forth on the arm and it can be locked anywhere on the arm for operations such as ripping. An elevating crank is used to raise and lower column to control depth-of-cut.

The arm pivots on the column to the right and left for miter cuts. Be sure to raise the blade slightly above the worktable before swinging the arm to the desired angle. The motor rotates on the yoke 360° on the vertical axis and it pivots 90° left and right on the horizontal axis. After making an adjustment, it's very important to lock in place



## SUPERSAWS

the adjusted saw components before making the cut.

Another important part of the radial-arm saw is its worktable which is usually made of  $\frac{3}{4}$ -in. or 1-in.-thick particleboard. Most saws use a 3-board table that consists of a large front worktable and two rear boards—one narrow (about 2 in. wide) and one slightly wider (about 6 in.). The front table is fastened to the saw's base. The rear boards are usually positioned behind the fence and held securely by tightening the saw's table clamps. Make the fence of hardwood or hardwood-veneer plywood. The 3-board table is useful because it provides three different locations for the fence. The fence can be placed between the front table and the first rear board, between the two rear boards, or, for maximum cutting capacity, behind both rear boards. The farther back toward the column you position the fence, the greater the saw's cutting capacity.

### Basic procedures

Now let's briefly discuss the most common radial-arm saw

For narrow rip cuts, it's best to use in-rip position. Feed work against the blade's rotation. Note blade guard is tilted back to keep work from lifting.



This shows cutting a rip bevel. Note antikickback pawls resting on stock in front of blade. Again, always feed work against blade's rotation.



Use the out-rip mode when ripping wide panels. Here, the saw has been moved nearest to the column to obtain maximum ripping capacity.



Make two passes when resawing wide boards. Install a high fence for additional support and place a small wedge in the first cut to keep the kerf open.



procedures. These include crosscutting, mitering, ripping and using a dado blade and molding cutterhead. Then, go into the shop and practice what we have preached.

■ **Crosscutting**—Straight, square crosscuts are made with the saw's arm locked in the 0° position. Hold the board against the fence with your hand away from the line-of-cut. For accurate repetitive cuttings of identical size, clamp a stop block to the fence at the desired distance from the blade. Then, simply place each board against the stop block and make the cut. To cut bevels and chamfers, pivot the blade to the desired angle and lock it. Now make a crosscut as you would normally.

Some crosscuts, like the mortise and tenon cuts shown, are made with the blade in a horizontal position. In such cases, use a shopmade support table to hold the work off the table. Make the support table at least 3 in. high.

■ **Mitering**—Mitters are simply crosscuts that are made with the saw's arm swung to the right or left. When cutting miters on both ends of a board, it isn't always necessary to readjust the arm after making the first cut. Often, the

(Please turn to page 132)



Turn blade horizontally to cut mortises. Make a plywood support table to hold up the workpieces. Table should be at least 3 in. high.



Matching tenons can also be cut using the plywood support table. Be sure to clamp the workpiece securely to the table and keep your free hand clear.



Radial-arm saw is ideal for kerfing plywood so that it will bend. Space the deep kerfs about every  $\frac{1}{2}$  in. Test kerfs on a scrap board first.



To form a concave cove, pass work under blade that's rotated slightly on yoke. Cut cove gradually. Lower blade about  $\frac{1}{16}$  in. per pass.



SPECIAL REPORT

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Hot for 1988 are Suzuki's Exante outboard (right) and Bayliner's vanishing-point instrumentation (far right). Suzuki's 200-hp V6 Exante is equipped with Comlink, an operation and warning system that actually talks to you. Bayliner's digital-style instrumentation, available on its cruisers, brings a futuristic aerospace look to a marine command station.



BY JOE SKORUPA, Boating/Outdoors Editor

**F**ORM follows function. If you drive your boat like a Grand Prix racer, you want it as sleek as a bullet and powered by high-performance marine muscle. If hooking billfish is your idea of fun, then ability to tame rough water, speed at sea and maximum room for fighting is what you need.

Water skiers, bass fishermen and weekend cruisers have their own requirements and each wants his own specialized boat. The days of production-line, multi-purpose boats are gone. Boaters no longer want to adapt to generic hulls and layouts, and in today's sophisticated market they don't have to.

While the best pleasure boats in the world are made here in the U.S., the most advanced yachts are pro-

duced in the Mediterranean, and this year's fleet of new boats reflects the best of both worlds—American engineering combined with European flair.

"Italian styling is the most advanced in the world," concedes Art Carlson, noted designer for StarCraft and his own line of racing boats. "Some of those boats are so radical—inspired by the contoured lines of a Formula One racer—that most Americans, right now, probably wouldn't accept them. But they're going to see more ideas borrowed from Eurostyling, because these are the boats of the future."

And the future is now. Euroflair is seen everywhere in this year's fleet, from muscleboats to runabouts, bowriders to deck boats. Wraparound consoles and



BOATING<sup>'88</sup>

# RIDE THE WAVE



Slashing through the Gulf of Mexico like a stiletto is Chris-Craft's Stinger 415, a high-performance water scorcher with Eurostyle profile and an interior of deep-pleated and contoured luxury (below).

tinted windshields enclose aerospace-style command stations. Thermoformed contours and deep-pleated upholstery are inside and out.

Powerplants and marine gear are also breaking new ground. Big-motor features are moving down the line into smaller drive systems. Fuel injection, oil injection, loop-charging, counter rotation and power steering are now widely available. And marine electronics, for communication and navigation, is making incredible advances in satellite-inspired interference dampening and miniaturization.

A surge of high-tech advances and sophistication is cresting in the world of pleasure boating, and 1988 is the year to ride the wave.

PM



PM PHOTOS BY SKIP GANDY



BOATING<sup>88</sup>

# EUROFLAIR IS



BAYLINER 2150 CIERA  
SUNBRIDGE

STARCRAFT STARTRON I



BY FRANK SARGEANT

**W**EEKEND WARRIORS don't always drive their pleasure boats like Formula One racers. They go fishing, skiing and take the family out for leisurely cruises. But now they can look like they're tearing up the water even when they're crawling without a wake.

Boat designers this year have taken a page out of European sportscar styling and transformed runabouts, bowriders, small cuddy, ski boats and deckboats into sleek, lean, sporty machines. You can see Euroflair in Sea Ray's Sorrento line, Regal's Valanti, Cobalt's Condurre, Four Winn's Candia, Rinker's Fiesta, Renken's Italia, throughout Chris-Craft's fleet, and in boats from many other state-of-the-art builders.

Needle-nose bows and raked sterns with integrated swim platforms give a sharp, forward knife-edge to new boat profiles. Wrap-around windshields flow into molded freeboards. Everything is thermoformed and contoured, without a straight line or sharp crease anywhere.

One of the leaders in this trend is

the Starcraft Startron I, designed by Art Carlson. The Startron I has a wraparound command console that looks like it was lifted out of a Lamborghini. The runabout's plush bucket seats and wrap-around bench, both with deep-pleated upholstery, provide a secure ride at 60 mph, which the 20-footer can easily maintain with its



AVON SR4M



Big-boat features and Eurostyling move down the line into specialized craft for every budget and special interest.

# EVERYWHERE



WELLCRAFT SCARAB EXCEL



HARRIS FLOTE DECK 180

standard 260-horse sterndrive. Price for this Ferrari-red water scorcher is \$19,000.

With model names like Monte Carlo, St. Tropez, Portofino and San Remo, it's not surprising that Wellcraft has an impressive Euro-style muscleboat to offer. Like its bigger brothers, the Scarab Excel is a screamer powered by a 7.4-liter

MerCruiser that buries the needle at 60-plus mph.

This year's 28-ft. Scarab Excel has been completely redesigned with a stiletto nose, body-hugging bucket seats, sculpted engine vents, tinted wraparound windshield and black bottom-painted hull—Euroflair to the max. It retails for \$36,000.

Donzi is another company noted for high-performance boats that's also moving forcefully into Eurostyling. The new Ragazza line, ranging from 19- to 25-footers, not only offers integrated swim platforms, brilliant gelcoats of bright yellow and hot red, and a sporty racing profile, but it does so at affordable prices.

The Donzi R-19 bowrider, powered by a 2.8-liter, 128-horse Cobra sterndrive, brings Euroflair and other big-boat features into the \$15,000 price range. While the goal of the Ragazza line is to offer an alternative to Donzi's upscale Classic and Z lines, the modifications are subtle and the result is a rich offering competitively priced.

Another company bringing big-boat features into smaller offerings is Bayliner, especially with its 2150 Ciera Sunbridge. This stylish



DONZI RAGAZZA R-19



**YOU CAN CAST,  
STEER, CRANK,  
STEER, CAST,  
STEER, CRANK,  
STEER, CAST,  
STEER, STEER,  
STEER.**



# Or you can catch fish.

Now you can fish with both hands while you steer with a touch of your toe. The Minn Kota PowerDrive™ Motor gives you hands-free control from anywhere in the boat.

The secret is its MicroTouch™ electronic remote control. The inch-high pedal puts steering and speed control where you want it—on the fishing platform of a bass boat, at the center console, or all the way in the back.

Three PowerDrive™ models give you a choice of 28, 36 or 41 pounds of thrust, plenty of power for any size fishing boat.

Keep both hands on your reel and put boat control under your toe with a Minn Kota PowerDrive™ Motor. It's not only hands-free power. It's the quiet power that catches fish.

## **MINN KOTA** QUIET POWER CATCHES FISH.

1531 Madison Avenue, Mankato, MN 56001 Phone 507-345-4623





sterndrive pocket cruiser comes complete with CB radio, AM/FM cassette stereo, digital depth sounder, convertible top and many other standard features. Fully outfitted with a 130-horse Cobra powerplant and trailer, it's \$16,300.

A number of this year's most interesting boats show hints of Euroflair without adopting a completely new design vocabulary. These transitional boats give a nod to hot-boat styling and features without abandoning their own special strengths.

One such boat is the Harris Flote Deck 180, an aerodynamically contoured deck boat with enough seating to handle a large family and enough power to double as a ski boat. The racy looking 18-footer seats eight adults and cruises at 45 mph with a 128-horse sterndrive. At \$13,300, the Flote Deck is affordable and stylish.

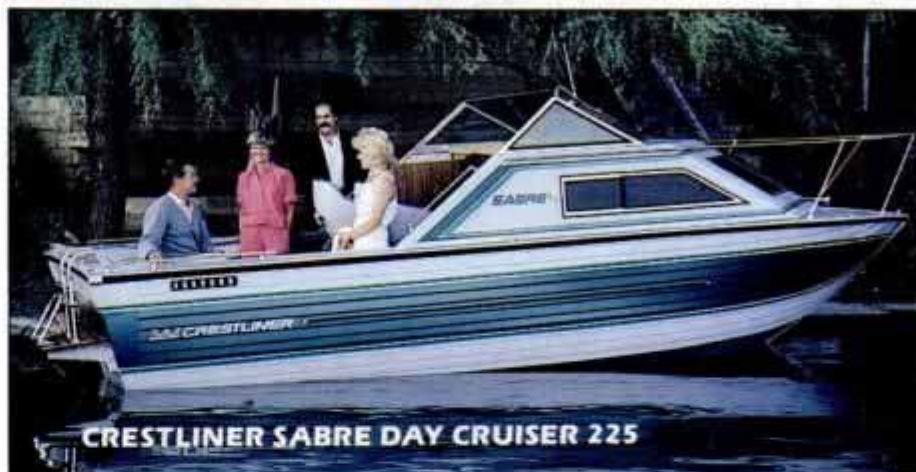
Since it's made in Wales, Avon's SR4M inflatable was born with Eurostyling. What's different about the new SR4M is the boosting of its load-carrying ability and durability through the addition of a rigid hull. A fiberglass deck design adds some style and built-in davit lifting points. A molded interior provides upholstered seats that can be configured either for two or four passengers—an unheard of luxury in an inflatable under 13 ft. in length. It's \$5800.

Aluminum has also come of age recently, making tremendous improvements in eye-appeal and functional style. Grumman's GBW 223 is a remarkable example of something most people thought was impossible a few years ago—an aluminum cabin cruiser with a radar arch and wraparound windshield. Fisher's Gray Thunder bass boat is equally remarkable.

Perhaps the best example of recent advances made in aluminum is found in Crestliner's Sabre Day Cruiser 225, a cabin boat with a rivet-free hull and baked enamel paint inside and out. With a smooth-riding deep-V hull, walkaround cabin, cockpit depth of 3 ft., padded gunnels and a 120-horse sterndrive, it's \$18,300.

When a fishing boat is modified, the intent is to improve substance rather than style. Skeeter, from Kilgore, Texas, invested \$600,000 to develop its latest bass boat, the SK-2000, and it's no accident that it's a finely focused fishing machine.

In a design breakthrough, the \$11,000 SK-2000 is a streamlined beauty with a center console for total walkaround freedom. Its helm seat is raised in comparison to conventional bass rigs to provide better visibility, and its seating arrangement is near



CRESTLINER SABRE DAY CRUISER 225



SKEETER SK-2000



GRADY-WHITE OFFSHORE 24

the centerline for a flat, balanced ride. Interestingly, the circular front casting deck, the result of a unique and efficient use of space, is gigantic.

Walkaround fishability is also a primary strength of the new Grady-White Offshore 24, which has a snug cabin for overnighting. With its huge cockpit, 110 sq. ft. and extra casting space at the bow, this 24-ft. hull has nearly as much fishing room as most center consoles of similar length. Fishermen will like the recirculating livewell with rounded corners to keep delicate baitfish alive, 5-ft.-long fish-box and washdown system. Price for

this offshore fisherman is \$19,800.

Eurostyling aside, perhaps the biggest trend in boating this season—and probably for the coming decade—is the abrupt turn taken by manufacturers toward producing package boats. The goal is to make buying a boat as easy as buying a car, complete with motor, trailer and a host of items formerly considered options. Major players in current boat packaging are Outboard Marine Corp., the Brunswick Corp., Grumman, Tracker Marine and others. The result is competitively priced boats with big-boat features. **PM**





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# BIG MUSCLE FOR SMALL BOATS



MERCURY 220 LASER XRI



MARINER 100



EVINRUDE XP300





## High-performance features break through to smaller powerplants for extra speed and efficiency.

BY JOHN WOOLDRIDGE

**T**HERE used to be an old rule of thumb for marine powerplant buyers which advised them to tell a dealer how fast they wanted to go, and then wait for the dealer to tell them how much they had to pay. Life was simpler then, but not better.

Today's drive systems offer more than raw speed. Efficiency is of equal

importance. This year's outboards and sterndrives are noteworthy for a number of advanced, high-performance features. Chief among them are counter rotation, power steering, fuel injection, oil injection, loop charging and Comlink—an outboard operation monitoring and warning system that actually talks to you.

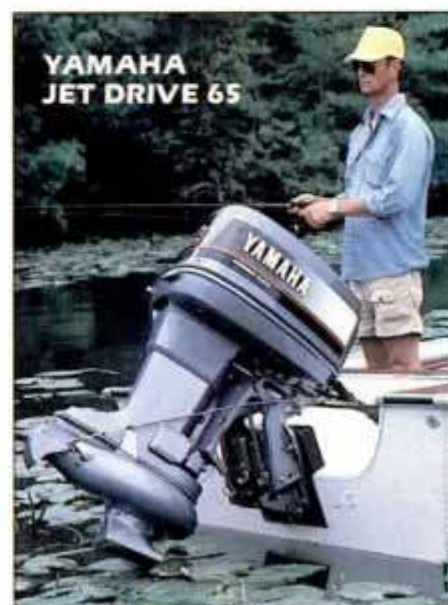
The hot, new OMC King Cobra 350

is the latest word in a V8 sterndrive intended for midsize sportboats and cruisers from Waukegan, Illinois. The 5.7-liter, 270-horse King Cobra engine is based on the identical block Chevrolet uses in the current Corvette and IROC Camaro.

Designed to fit in the same engine compartment space—350 cu. in.—as the less powerful 5.7-liter, 260-horse



**OMC KING COBRA 350**  
Using the identical block that Chevrolet uses in its current Corvette and IROC Camaro, OMC's new King Cobra 350 offers big-boat power to midsize sportboats. The 5.7-liter V8 sterndrive kicks out 270 horses.



**YAMAHA  
JET DRIVE 65**

Propless unit allows running through weeds and 6 in. of water.



**JOHNSON 140**



# IF MOVING FAST GOT YOU WHERE YOU ARE, ISN'T THIS WHERE YOU'D RATHER BE?



Those who know the virtues of staying out front can surely appreciate the 220 Laser XRi. It's so technologically advanced, the competition may never catch up.

#### THE FIRST AND ONLY FUEL-INJECTED OUTBOARD.

What microprocessors have done for the computer industry and turbo-charging for automobiles, the advent of electronic fuel injection has done for the high performance outboard.

And only Mercury offers it.

The system consists of six separate injectors, one for each cylinder, and electronic sensors to regulate the air/fuel mixture for varying atmospheric and engine conditions.

The result is easy starts. Unbelievably crisp throttle response. And plenty of power on tap throughout the throttle range.

#### THE BRAINS BEHIND THE BRAWN.

While cold starting, idling and

wide open throttle typically require a richer mixture, midrange operation is generally leaner. The Electronic Control Unit (ECU) on the 220 Laser EFI responds to all these conditions instantly. It digests five types of data to deliver just the right amount of fuel to each cylinder based on engine speed, load, manifold pressure, air temperature and engine temperature.

What's more, the ECU also commands an Onboard Vapor



# LASER

by Mercury

2020

Separator to eliminate air bubbles from the fuel, reducing vapor lock and providing instant, no-choke starting. And if anything requires attention, the Laser will let you know. An alarm will alert you to either water in the fuel or an oil injection problem, and a signal light distinguishes between the two.

**THE BOLDEST ANTI-CORROSION WARRANTY EVER.**  
Only Mercury offers a 3-year limited warranty protecting you



Mercury 200 hp & Mercury 135 hp.

in the event of major component failure resulting from corrosion. Because no other engines are built to last as long in saltwater.

So if your fast lane begins where the pavement ends, get the one that comes with action, excitement and dependability standard.

**MERCURY**  
**OUTBOARDS**



engine, the new King Cobra 350 sports a 4-barrel carburetor, high-rise intake and exhaust manifolds, through-transom exhaust, finned-aluminum valve covers and braided stainless-steel hydraulic hoses.

As a further extension of OMC's user-friendly approach, the King Cobra 350 has power steering and an audible alarm system to announce drastic changes in oil pressure and water temperature. Counter rotation, highly desirable for neutralizing torque-roll tendencies in dual engine installations, is optional.

Farther north, in Fond du Lac, Wisconsin, the engineering wizards at MerCruiser recently launched the innovative Bravo One, a state-of-the-art outdrive, equipped with extra-stout gears, shafts and bearings to handle the high torque of big-block V8s, such as Merc's 7.4-liter and 5.7-liter engines.

The use of oversized components in the upper drive allowed development of a smaller-diameter, drag-reducing torpedo in the lower gearcase. Other innovations include a weight- and power-saving, high-torque clutch, which doesn't require a separate hydraulic transmission, extra-wide anti-ventilation and acceleration plates, a forward-mounted, high-volume water pump, power steering, high-rise flame arrestor and one of the more interesting accessories, a vacuum-operated system that allows the operator to switch between transom or prop exhaust routes.

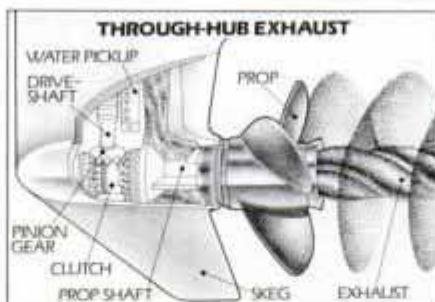
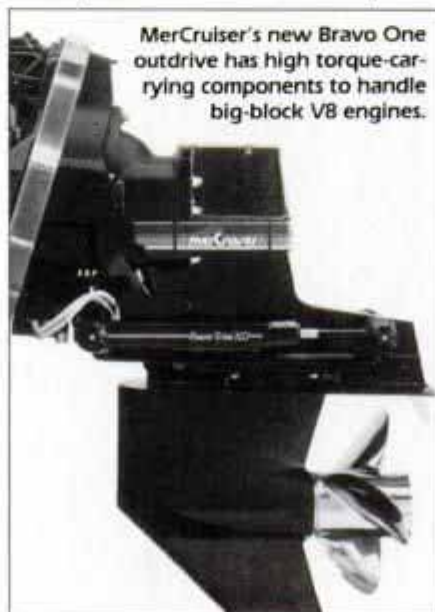
Suzuki, with five new models, leads the marine field in outboard introductions this year. The two most interesting units are Suzuki's 3-cylinder, 30-hp model and the V6 Exante. The new 30 is remarkable because it has all the features found on much bigger motors, including an integrated circuit-controlled ignition, pre-atomized oil injection and a complete engine warning system.

But it's the new V6 Exante that's making the most noise in the industry. The Exante outboard motor talks. That's right—it has a voice-synthesis module, called "Comlink," which verbally directs the boater's attention to all manner of engine conditions. The easily understandable feminine voice announces status updates and operator alerts at a volume that's always understandable, no matter what speed the 164.3-cu.-in., 200-horse motor is running. And it won't permit any backtalk, either.

The biggest news from Mercury and Mariner is the introduction of the long-awaited 100-horse unit that

squeezes power out of every drop of gasoline by using multiple carbs, special reed valves and blocks for maximum atomization and intake manifolds to promote loop charging of precombustion mixtures. Gear-driven oil injection varies the fuel-to-oil ratio depending on the throttle setting—ranging from 100:1 at idle to 50:1 at flat out.

Perhaps the most interesting feature of the new 100 is the "cracked cap" connecting rods, which are cast as a single piece and then mechanically cracked horizontally across the crankshaft opening. This produces mating surfaces considered superior



**Silent-running through-hub exhaust, pioneered in smaller motors, is now available on big outboards and sterndrives.**

to machined faces. Bearing durability and important contact with the crankshaft are also enhanced.

Race-proven electronic fuel injection is now a reality in Mercury's production model 220-horse Laser XRi (Extra Response Injection). At the heart of the 142-cu.-in. V6 outboard is an electronic control unit that precisely delivers fuel to the engine based on input from monitoring sensors. It also has a vapor separator that recycles fuel vapors into the induction manifold, so only liquid fuel is provided to

the fuel pump. The result is improved fuel delivery for hotter burning, better performance and extra speed.

An interesting development in the Johnson and Evinrude lines of outboards for 1988 is the availability of torque-suppressing counter rotation in outboards as small as the 140-hp. As mentioned earlier, this feature is important in dual-motor installations and is a welcome breakthrough in 140s, which are ideal for center console offshore fishermen.

In-the-crankcase counter rotation is also making an appearance in Johnson and Evinrude big V-block outboards, but that's not the only story here. The Evinrude XP-300 and Johnson GT-300 are now considered the most powerful production outboards on the market due to a new boring out of their 90° V-blocks. Power steering, loop charging and a new electronic management system, called Quik-Start, are standard equipment.

Yamaha has waterskiers, fishermen and runabout cruisers in mind with its new V4 130-horse outboard, which is a boosted-up version of its well-received 115-horse V4. Increased compression, bigger gear ratio in the lower unit and internal changes promoting better breathing produce real acceleration gains for this versatile drive system. A standard feature on this outboard is Yamaha's innovative digital LCD Marine Meter, a monitoring unit combining tach, trim and oil status in one easy-to-view display.

Yamaha is also becoming a driving force in jet drives. Jet power has been around for years, but it has suffered from an inefficient power loss, compared to conventional motors, and most previous users have been in highly specialized markets. Yamaha is broadening jet-drive applications by lowering fuel consumption and raising power output in an affordable line that runs from 28 hp to 140 hp.

A crankshaft-driven impeller draws water through the jet-drive intake grill, pressurizes it and forces it out the rear nozzle. Consequently, Yamaha's propless powerplant can sit high on a transom and blast through as little as 6 in. of water. Yamaha backs jet drives with a 1-year warranty, the same as its outboards.

If one of 1988's breakthrough outboard or sterndrive features interests you, but you can't find it on the model you want, wait a season or two. Leading-edge drive systems, like the ones highlighted here, are good indicators of what will soon be available in the powerplant you want.

PM



*"I'm proud he did it on his own..."*

# MAKING MONEY

Last summer, my son Robert turned 18, and he was looking for a way to make money.

We've had the worst drought here in Oklahoma since the 1930's. A lot of folks are running out of water, and I told Robert he could make good money if he learned how to drill water wells.

I've been in this business for about 12 years. I operate a big truck-mounted drill which I finally got paid off last year. I thought if I could find a good deal on a used drill, I'd get it and teach Robert to run it.

But he had a different idea. He saw an advertisement that got him excited. It claims you can drill water wells with a little \$600 machine.

He asked my opinion. I told him I just didn't believe any little \$600 machine could drill a water well - not around here. It went against everything in my experience. I advised him to forget it. But Robert kept studying it and finally he made up his mind to get one.

When it was delivered by United Parcel Service, you can pretty well imagine what I was thinking.

## FIRST DAY ON THE JOB

The day he went out to drill his first well, Robert got a buddy to help him. They were so enthusiastic, I went along to watch even though I figured they were in for a big disappointment. It was July and hot - about 98 degrees. I found a shade tree and settled down to wait.

It was 2 hours later when they came over, both of them grinning. I asked if they were ready to call it quits. They said they sure were because they had finished the well.

I couldn't help being impressed. It was a good well - clean water and plenty of it. What impressed me even more was this: they had drilled that well in about the time it takes me just to set up my big drill.

## MAKING MONEY

The next morning, Robert started another well. He said he wanted to do it all by himself. He drilled about 115 feet,



mostly through rock, and hit water that afternoon. I couldn't have set up and drilled the well any faster than that.

In the past, I've lost out on some jobs because people were afraid my truck would tear up their yard. Robert says he can drill anywhere without tearing up anything, and that gets him customers

other well drillers can't get.

He's one happy young man. And why not? The first week he made more money than he paid for his drill. Now every dollar he takes in is nearly all profit. That's really amazing, isn't it?

## WHAT I BELIEVE

I admit I was skeptical when Robert bought a HYDRA-DRILL. I didn't believe that someone without any experience could go out and drill water wells, and surely not with that little machine. Also, I thought he'd be calling for help. But he didn't. He just went by the instructions that came with the drill, and it worked!

The best part is that he didn't have to go in debt and struggle to pay it off the way I did. I'm thankful for that, and I don't mind saying I'm proud of how he did it all on his own.

I believe the man who invented the HYDRA-DRILL really knew what he was doing. To invent a machine that does the job, and to keep it simple and inexpensive - that's a wonderful thing, isn't it?

*"Easy to Use!"*

## WATER WELLS FOR EVERYONE!

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# GEAR YOU CAN'T DO WITHOUT

The hottest, new, high-tech accessories are miniature electronics and summer-fun water toys. But boating basics have a new look, too.



A new lower unit for silent running powers Motorguide's 600 series Brute hand-operated, bow-mounted thruster with a 50-in. shaft for V-bottom boats. Price of the powerplant is from \$325 to \$550.



Molded-in grooves that allow new Ocean Fenders to clip directly to stanchions and rails are a clever feature. They interlock easily to form bumper boards and come in many sizes and colors. Prices for the fenders range from \$23 to \$95.



Navigation takes a big step forward with the Datamarine 7000 Chartlink, which translates loran and SatNav information onto visual charts. For \$2595, you can measure distance and bearing between points, plus plot your course on an overview of the waters you're navigating.

**G**EARING up was never like this. The big story this year is miniaturization. The new ICOM IC-M8 handheld transceiver is slightly larger than a pack of cigarettes. The Furuno LE-4000, an LCD recorder, is about the size of a paperback book. And Ski-Free, a skier-operated personal watercraft, is smaller than a 1-man bobsled.

There are bright new ideas in marine accessories, too, especially boating basics. Comprop is a graphite-reinforced plastic propeller that's supertough and floats. And Ocean Fenders, which feature a new-age design with built-in grooves for attachment to rails, eliminate the need for wire baskets or storage space.

Today's developments show that 1988 is shaping up to be a year of great gear.—John Wooldridge



Shades of Dick Tracy. The Si-Tex RT-101 LCD Sounder is a fixed-base transmitter that broadcasts bottom conditions, fish activity, boat speed and other data to remote displays that you wear on your wrist. Prices will be fixed later in the year.



Here's the perfect solution for die-hard waterskiers who can't find a driver, copilot or even a boat to pursue their favorite sport. Ski-Free is a skier-controlled, jet-powered personal watercraft that can pull you all day on 3 gallons of gas. Controls are located in a yoke with a throttle trigger on the left and steering response on the right. This 210-pound, personal ski machine, which costs about \$4500, has a deadman switch that shuts down the 40-horsepower engine if you drop the controls. Available by late spring.



# BOATING '88



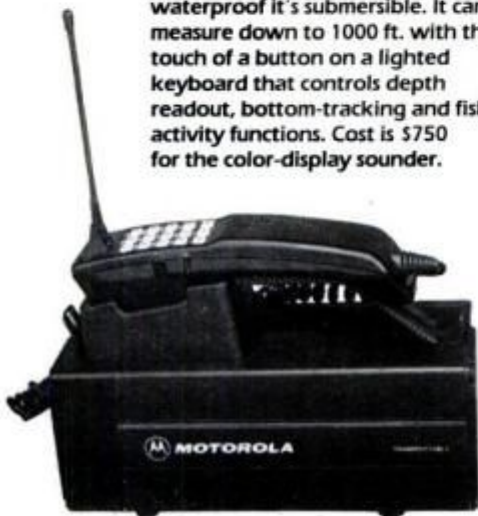
Built to withstand the punishment of open water, Humminbird's CVR 1000 Color Depth Sounder is so waterproof it's submersible. It can measure down to 1000 ft. with the touch of a button on a lighted keyboard that controls depth readout, bottom-tracking and fish activity functions. Cost is \$750 for the color-display sounder.



Omega combines running-shoe comfort and support with marine-tough durability, for \$79, while its bottom sole pattern gives a solid grip on wet and nonlevel surfaces.



An entertainment center is a welcome relief to the chatter of a VHF radio. Cybernet's CMS-4000 Stereo AM/FM Cassette has a case and controls sealed with O-rings for corrosion proofing. It also has 20 watts of power per channel and numerous features for \$699.



Getting away from it all is more fun when you can call your office with a "wish you were here!" Motorola's Triton 180 Cellular Transportable phone does the job. This second-generation unit, which costs \$1595, weighs just 9½ pounds and has a tough polycarbonate and extruded aluminum housing so it can be operated in rugged environments.



Truth is you want your prop to break before damage is done to your lower unit. Comprop, made of a graphite-reinforced composite plastic, is as tough as metal and an ideal spare prop for \$60-\$70. And, when necessary, it breaks.



Personal watercraft become more social with the introduction of Bombardier's new Sea-Doo, a high-performance water toy powerful enough to seat two riders and tow two skiers. Its muscle comes from a 580-cc, twin cylinder Rotax jet-drive system that can reach a maximum speed of 40 mph. Price for Sea-Doo, which will start coming off the production line for the first time this spring, will be about \$4500.

# GOOD BETTER BEST



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### Here's the evidence...

A major university laboratory concluded NordicTrack users burned more calories and obtained significantly more cardiovascular exercise than from any other machine tested.\*

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The efficient arm exerciser on the NordicTrack provides upper body exercise missing when sitting on a stationary bike.

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Because no other exercise machine burns more calories than NordicTrack, you can lose weight faster without dieting.

### Duplicates the world's best exercise—cross country skiing

Even if you've never skied, in a few minutes you'll be "tracking."

\*Scientific test results included with NordicTrack Brochure

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# NordicTrack

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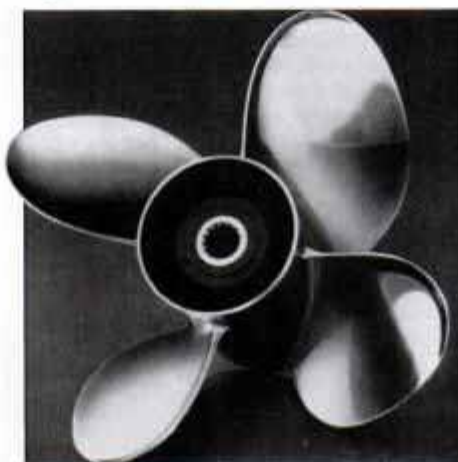
Based on automotive-racing technology, the K&N Flame Arrestor channels incoming air through a screen mesh and oiled cotton gauze to provide a bigger gulp of useable air for each intake stroke. Price ranges from \$94 to \$159, depending on size.



A third dimension's been added to sonar. The Eagle 3D-100 Positional Sonar allows you to examine distinct zones under your boat in addition to normal depth and distance scanning. The \$500 unit has a high-definition vertical screen.



Radar for small boats? Apelco's broken the barrier with the full-featured LDR 9910. For \$1595 you get a compact unit that reads from 1/4 to 8 nautical miles and interfaces with your Ioran. A 12-pound, 18-in. radome is included.



Hole-shot power for big engines is provided by the new OMC Shooter, a 4-blade stainless-steel prop. It offers maximum acceleration with an over-and-through hub exhaust design. About \$400.



It takes a tough binocular to survive sea duty—military tough. Such is the case with Steiner Optik's 7x50 Military Marine binocular, a commercial version of an antifogging model recently ordered by the U.S. Army. Price is \$450.



Power and silence are the advantages of Mariner's new Stalker series of bow-mounted thrusters, which run from \$350 to \$559. The weedless Machete prop and direct-drive motor give 28 pounds of thrust with 24- or 12-volt operation.



Think visual. That's what Lowrance did with its new X-50 LCG (liquid-crystal graph), which features a screen with 192 vertical pixels for improved resolution. The \$640 instrument is a multifunction depth-finder with a range of 1000 ft.



Ever wish two electronic instruments were conveniently combined into one unit? Impulse did, and created the 2830 Fish Finder/Loran. For about \$1500 you get pinpoint navigational accuracy combined with a full-featured fish finder.



Go with a friend or go solo, but either way the WetJet 432 skims over the water like a pocket rocket. The propless 40-horse, twin-cylinder jet drive pulls a waterskier with ease yet weighs only 273 pounds. Solo, it tops out around 37 mph. Simple steering and throttle controls make it easy to operate, so you'll be seeing these high-action toys all over the water this season. Price is \$3695 plus freight and setup.



Micro-sized is the best way to describe ICOM's IC-M8 VHF handheld transceiver. It measures only 2.4 in. wide x 5.3 in. high x 1.2 in. deep. It receives all U.S. and international channels, has selectable memory, scrolling and costs \$500. **FM**



# Canadian Club Classic<sup>®</sup>

Out of the wood  
comes the  
perfect smoothness  
of the world's first  
barrel-blended  
12 year-old  
Canadian whisky.



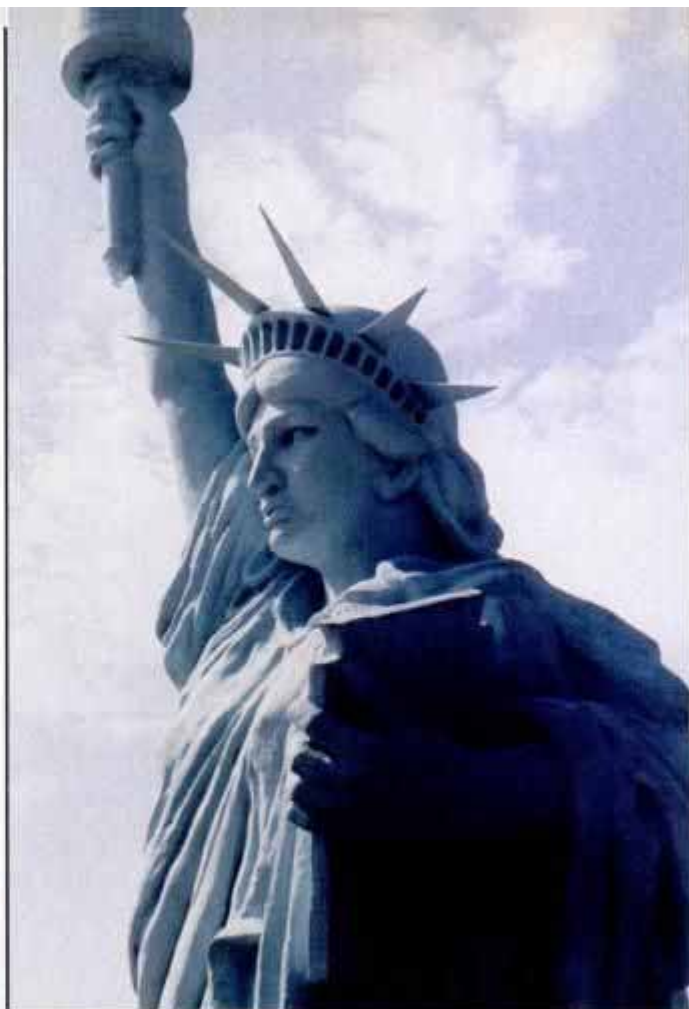
Barrel-Blending is the final process of blending selected whiskeys as they are poured into oak barrels to marry prior to bottling.  
Imported in bottle by Hiram Walker Importers Inc., Detroit, MI © 1985



# PHOTO CONTEST WINNERS

With keen eyes and quick trigger fingers, readers score shots-on-goal.

**WE'VE SAID IT BEFORE:** We learn a lot, and we learn a lot about readers, every time POPULAR MECHANICS holds a contest. For our "Canon Camera Photo Contest" (page 98, Jan. '87) we asked you to submit photographs that would show us what you'd learned from reading our Special Report in that issue. In this contest, we awarded three cameras. Top prize was Canon's T90, perhaps the most sophisticated computer-program SLR available. Our second prize was Canon's T70, another program SLR. The company's com-



We judged the contest entries for their originality, imagination, visual impact and compositional skill. The first-prize winner (above) had it all. Reader Stephen Lewis of Midwest City, Oklahoma, used a zoom-equipped Canon T70 and some clever positioning to create the illusion of a shot taken from the base of the Statue of Liberty. He did—sort of—but this Lady is a 6-ft.-tall replica that beckons from an Oklahoma City parking lot!

Herb Wenger of Wakarusa, Indiana, took second prize for his photo of the moon and stars (left). He used a Canon F1 and three lenses to make four exposures on a single frame over a 6-hour period. The solitary figure seen below seems to cast a magical aura: That's what Ronald Ayotte of Saginaw, Michigan, imagined when he saw the gent silhouetted by the sun's reflection off the water. He alertly fired his Ricoh Singlex, and bagged a third-prize award.



pact, autofocus Sure Shot Supreme was awarded as third prize. The winning photos grace this page—and seven others we liked enough to publish appear on the succeeding page.

Most of the 3200 images submitted were taken with manually focused, single-lens-reflex cameras. About half the entries were from print film, and frankly, we were surprised and pleased to see how many people still shoot black and white. Most of the slides submitted were dupes, and therefore, a tad on the dark and contrasty side—as were prints made from slides. We took this into account in judging—but you should keep it in mind for future contests. Also, since size doesn't count, be wary of enlargements: What looks sharp as a snapshot print often becomes grainy as a blow-up. **PM**



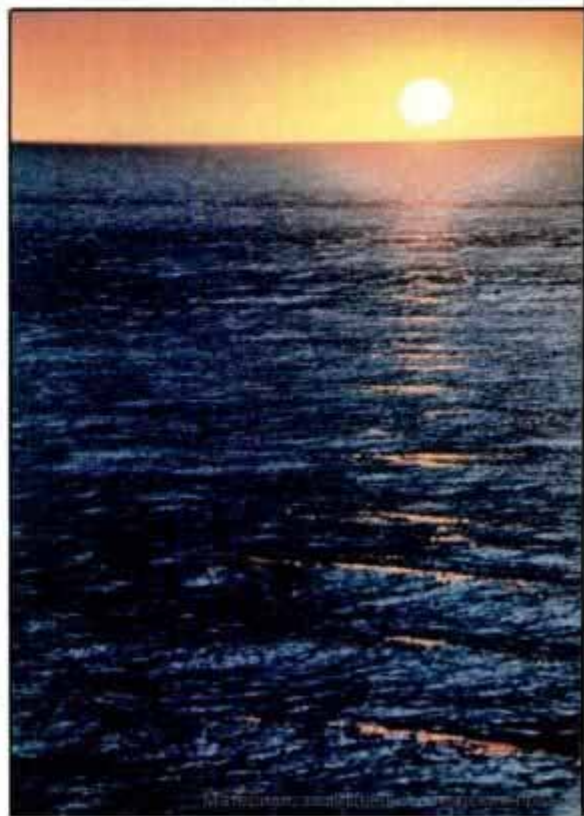
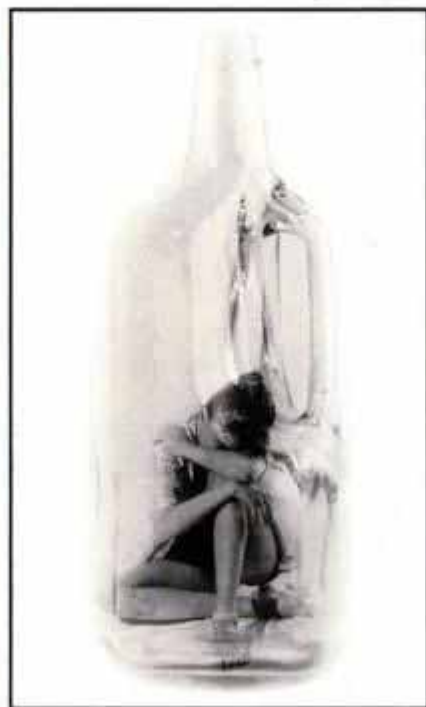


Our contest prizes, shown clockwise from top. Canon's T90, the first prize, is valued at \$865 with its 50mm f/1.8 lens. Pocketable, autofocus Sure Shot Supreme (\$301) is third prize. The second-prize T70 program SLR and lens has a \$470 value.



These seven photos made it to the final stage of our judging. The photographers and their equipment are listed here in corresponding order with their photographs, arrayed clockwise from above.

- H. Randall Schlake, Spring Valley, CA. Olympus OM-1.
- Richard D. Nagel, Carleton, MI. Nikon F3.
- Danielle Smith, Highland, IN. Pentax 1000.
- Debbie Mignard, Champaign, IL. Canon AT-1.
- Betty J. Butler, Desert Hot Springs, CA. Canon AT-1.
- R.L. Stuart, Madison Heights, MI. Canon EF.
- Amy Oliver, Valley Center, KS. Nikkormat EL.

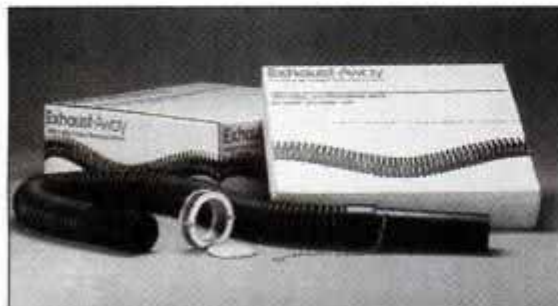




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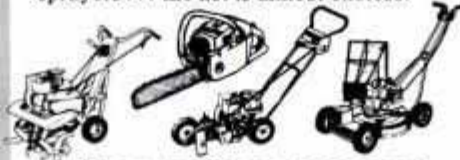
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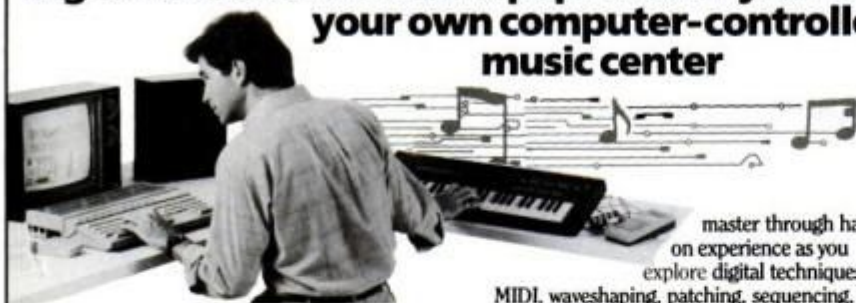


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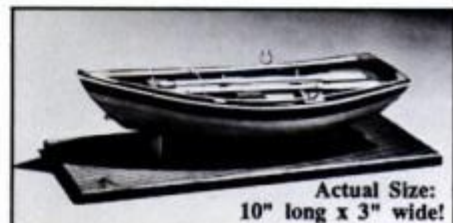
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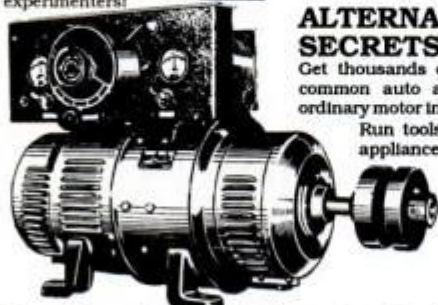
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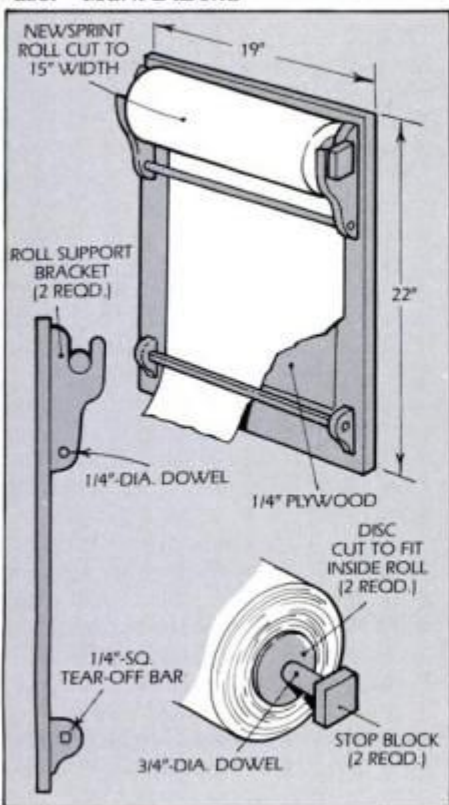
## Art On A Roll

We learned that the local newspaper sold the remains of 30-in.-wide rolls of newsprint paper too small to be loaded into the press. The rolls were the ideal solution for our children who love to draw. The only problem was their large size which made them difficult to handle and cut.

To solve this, I built a wall-mounted holder that accepts a roll cut in half with a hand saw. It's made with 3/4-in.-thick stock and a 1/4-in.-thick plywood panel. Miter the frame corners and rout a rabbet on the inside back edge to accept the panel. Cut two discs to fit inside the roll and bore a 3/4-in. hole in each for the 19-in.-long support dowel. Glue these to the dowel 2 in. in from the ends.

Then glue two square blocks—each with a blind 3/4-in. hole—on the ends of the dowel. The roll mounting brackets also hold a 1/4-in.-dia. dowel positioned close to the back panel to hold the paper down. At the frame bottom, two smaller brackets hold a 1/4-in.-sq. hardwood tear-off strip.

When mounting the unit, be sure it's at a height the kids can reach. You may find you need a second one for your own use.—*Mark DiBona*



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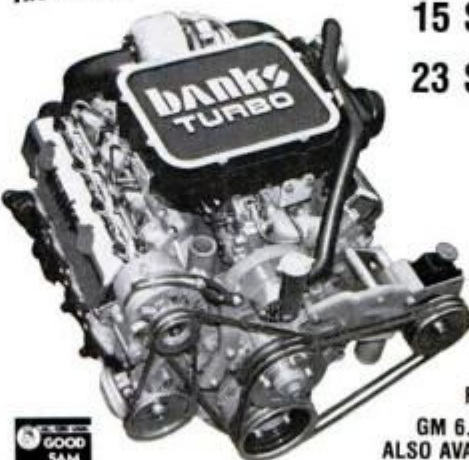
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## PAN AMERICAN EXPRESS

(Continued from page 79)

over and discovered diesel streaming through the chassis. The 100-gallon auxiliary tank suffered a stress fracture and, as we looked on, it opened wide. Nothing to do but let it drain. A 90-gallon spill expanded on the dusty Peruvian ground, black evidence of another failure of outfitted equipment. Now we carried only 35 gallons of fuel, tremendously reducing our driving range.

We pushed on toward the Ecuadorian border. Up to Lima, Garry and Tim encountered 16 document checks, in addition to border crossings, but not one today. Until now.

We were in Peru's northern frontier, where a terrorist group called the Shining Path explodes bombs and pulls robberies with alarming frequency. Bridges were washed out, and every few miles, we left the road to drive through dry washes.

About 10 p.m., a half-dozen grim policemen pointed machine guns at us, signaling us to pull into a ramshackle courtyard. They checked our passports and vehicle papers, and began poking around the truck. Garry stayed near the vehicle to make sure no contraband was planted.

As determined as the inspection was, the policemen only reached about 6 in. into the back of the truck. Its filthy appearance proved to be a clever strategy. "If you go in with a nice, clean, brand-new vehicle, it'll take forever to get through these checkpoints," Garry explained. "We want it to look like a dirty mess on top, but underneath, everything is in its proper place."

After an anxious half hour, Garry and Tim began to play the role of dream merchants, handing out maps of the journey, fliers printed in Spanish, and buttons stamped in the image of the truck. They dazzled them with paperwork, souvenirs and goodwill, until the police just gave up.

In Ecuador, the low country was lush and the roads good. Then our route took us over a 10,000-ft. mountain pass and into Quito. From here, nearly to the northern Colombian border, the road was a twisting, high mountain trail. Chapels and shrines were everywhere, marking spots where drivers plunged over cliffs.

We averaged only 30 mph through Colombia, yet we were driving like maniacs through rock slides, truck convoys, blind passing zones and heavily armed checkpoints. Our only mechanical problem was a flat tire, yet the potential for disaster was always near. The closest call of the trip, an unexpected testing of the antilock

brakes on a hairpin turn, occurred in this beautiful but dangerous country.

Finally, we came down from the Andes and pushed through lowland jungles to Cartegena. Exactly nine days, 7 hours and 40 minutes after the team left Ushaia, they'd logged 6300 miles and arrived at the top of the South American continent.

From Cartegena, it was a 24-hour boat ride to Balboa, Panama, through the Panama Canal. A roadless, inhospitable region, known as the Darien Gap, makes the water route necessary. I left Garry and Tim here, promising to meet them at the finish line with bottles of champagne.

The boat layover turned out to be a major setback, dragging on for five days. But when they finally got the truck off the boat and through customs, it was a speedy ride through Panama to the Costa Rican border.

In Costa Rica, Garry and Tim encountered the highest point on the Pan American Highway, at more than 10,000 ft. It was ominously named Cerro de Muerte, the Mountain of Death, in reference to the many who died on its roads.

The next challenge was Nicaragua. After crossing the border, Garry and Tim were met by a camera crew making a tourism promotional film and requested to answer a few questions about the Nicaraguan political situation. Tim was compelled to think fast and find a diplomatic way of saying theirs was not a political trip.

After the interview, it only took 4 hours to get to the Honduran border. Though Garry and Tim were never stopped or hassled in any way, they saw evidence of Nicaragua's turmoil. Northern frontier border buildings were so shot up that an armored, mobile office was used to check travel documents. It was moved in and out of position every day.

After overnighing in Tagusagulpa, the capital of Honduras, they took the mountain road to the Guatemalan border, avoiding a shorter but riskier route through El Salvador. Guatemala's lush, volcanic landscape passed by without incident, although the team's greatest fear, an accident with a careless pedestrian, felt most intense here.

Within 45 minutes of crossing into Mexico, Garry and Tim were stopped three times by the police. Still, they were excited by the good quality of the roads and could almost feel the U.S. border approaching. After 32 hours in Mexico, which included 6 hours of sleep in Vera Cruz and a blazingly hot drive through the Sonoran Desert, they arrived at the busy border town of Matamoros. Then, with-



out document check or passport stamp or vehicle search, they paid a bridge toll and crossed into the U.S.

According to Garry and Tim, this was the biggest emotional milestone of the trip. Time for another handshake. It was only later that it dawned on them they weren't quite two-thirds of the way to the finish.

Dallas was the first of a series of quick press conferences in the U.S. and Canada. It was also the last stop of the trip. Since Garry and Tim slept for a few hours south of San Antonio and again in Dallas, where the 100-gallon fuel cell was replaced, they decided to make a final push all the way to Prudhoe Bay.

Dallas to Winnipeg took 22 hours. Winnipeg to Edmonton, which included an intense snowstorm, took 16. And Edmonton to Fairbanks, through the most gorgeous mountain country of the trip, took 34.

The final run, capping a 5000-mile, 85-hour push from Dallas, almost didn't happen. The Dalton Highway, which runs along the Alaskan Pipeline to Prudhoe Bay, is a restricted-access road, and permits weren't secured until an hour before Garry and Tim arrived in Fairbanks.

I met the dog-tired driving team outside the town of Deadhorse and drove with them to the official finishing point in Prudhoe Bay. It's not easy to celebrate in zero-degree temperatures, but I brought champagne and we did our best.

Garry and Tim had driven 14,642 miles in 574 hours, for an average of 610 miles per day, counting all down times. Actual driving time was 314.5 hours. Average speed was 46.6 mph.

By mid trip, Garry and Tim were much more concerned with the human machine than with the smooth-riding Sierra. The Sierra had used 1032.7 gallons of fuel and averaged 14.2 mpg. Oil, oil filter, fuel filter and air filter were changed four times, and in Dallas, tires, shocks and front-brake pads were replaced. Its road performance was essentially flawless.

In the end, along with the world record, Garry and Tim experienced three weeks in the life of a hemisphere, a snapshot of the Americas. They came into contact with hundreds of people who provided invaluable help along the way.

And not least importantly, they'd resurrected a nearly forgotten dream. It's actually possible to drive from the bottom of the world to the top, if you have imagination and daring. The Americas, Garry Sowerby and Tim Cahill proved, really are linked by a long, difficult road, an incredible ribbon of pavement, known as the Pan American Highway. **PM**



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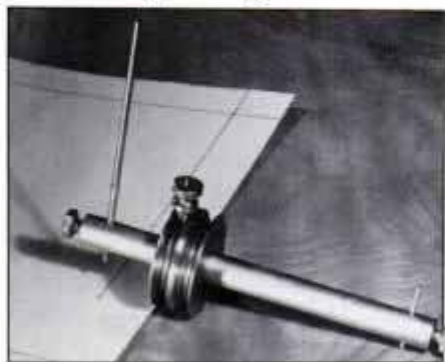
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## HINTS FROM READERS

### Marking Gauge



You can make your own marking gauge with a spare pulley and a length of 1/2-in.-dia. metal rod. It features a steel point at one end for scratching lines and ballpoint pen tip at the other end for drawing. First, drill centered holes 3/8 in. deep in the ends of the rod and tap for 1/4-20 hexhead bolts. Then, drill two parallel 1/8-in.-dia. holes 3/8 in. in from each end to accept the marking points. The pulley setscrew is replaced by a longer bolt of the same diameter and thread size for easy locking. Insert a ballpoint pen refill in one 1/8-in. hole and use an old 1/8-in. drill bit reground for this purpose for the scratching point. You can also mark a scale on the rod for quick setup.

—Walter Burton

### Brass Cleaner

I found some solid brass numerals in my basement that were so tarnished that none of the polishes I tried had any effect. I sprayed them with ordinary oven cleaner and let them sit for 8 hours. After rinsing with water, a light polishing was all that was necessary to make them look like new.

—Ernest Turner

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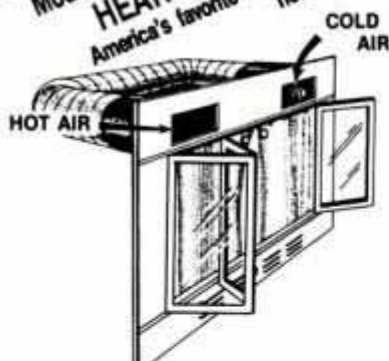
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### Safety Latch

If you have to keep the basement door open for ventilation or heat circulation from a wood stove, but have a toddler in the house, you've got a problem. We came up with a simple solution. Install an ordinary hook-and-eye near the top of the door well out of the reach of little hands. However, instead of positioning the eye to keep the door shut, place it close to the edge of the door. When hooked, the door is held slightly open for ventilation, but latched for safety.

—Clark T. Irwin



# PLATINUM FOUND TO ENHANCE COMBUSTION IN GASOLINE ENGINES

The Platinum GaSaver installs in a matter of minutes and works effectively on all gasoline engines. Cars, trucks, motorhomes, boats and van implementations using gasoline engines all can achieve a dramatic increase in fuel efficiency with the use of this device. The manufacturer guarantees a substantial increase in gas mileage and engine life and offers a 100% money back guarantee.

Even with a properly tuned engine, nearly a third of the gasoline it consumes is not burned. That unburned gas creates carbon deposits that shorten engine life, interfere with proper combustion and cause pings and knocks. And then the auto manufacturers attempt to solve the problem by using a catalytic converter to consume the unburned gasoline in the exhaust system before it returns to the atmosphere.

On February 28, 1984, four years of administrative procedures were completed by the Consumer Protection Department of the U.S. Government reviewing this process.

The government's conclusions? That National FuelSaver Corporation invented and markets a product called (Platinum) GaSaver which brings about more complete combustion and better gas mileage in automobile engines by means of platinum catalysis. That the (Platinum) GaSaver offers substantial fuel savings when applied properly to a gasoline engine. And that independent testing parties make stronger claims for (Platinum) GaSaver than does National FuelSaver Corporation.

The device takes only minutes to install on an automotive engine and allows for a more complete combustion. Normally, over one-third of the gasoline is wasted out of the exhaust system, unburnt. With the Platinum GaSaver you have near-perfect combustion. That means more power is developed by a given amount of gasoline. The device works on both leaded and unleaded gasolines, and meets or exceeds Environmental Protection Agency and California emission standards.

The federal judge in charge concluded a five-year administrative procedure studying the device by stating, "Independent testing shows greater fuel savings with the GaSaver than . . . claimed by the developer."

The gas-saving system was tested by the Concord-Carlisle Regional School District in Massachusetts, which installed the devices on a fleet of 26 school buses and cars equipped with V-8 engines.

"We've been pleased with the results." Francis D. Curran, transportation manager for the school dis-

## Reprinted with permission from **The Albuquerque Tribune** Device increases gas mileage dramatically in gasoline engines . . .

On July 11th, the government awarded National FuelSaver Corp. \$22,000 for developing a simple automotive accessory that increases gas mileage by means of Platinum Catalysis.

Called the Platinum GaSaver, it injects microscopic quantities of platinum into the airstream entering the engine.

The Injector itself takes only minutes to install, while the platinum entering the engine increases the percentage of each gallon burning in the engine and allows for the combustion of gasoline that is normally lost out of the exhaust system.

Normally, that lost gasoline would only burn when it came in contact with the platinum-coated surfaces of the catalytic converter. But with the GaSaver introducing the platinum into the engine, platinum catalysis can now burn that fuel in the engine where the release of that heat and energy is harnessed to drive that vehicle.

With more of each gallon burning in the engine, fewer gallons are required and the cylinder remains clean and free from carbon deposits.

trict, concluded. The fleet has achieved a major improvement in gas mileage as well as an improvement in cold weather engine starts.

In addition to the \$44,000 savings in fuel costs for the school district, the transportation manager notes that the real savings comes from reduced major engine repair on the buses as a result of cleaner burning engines that produce more power for the same amount of fuel.

In a press interview, the developer states that the only problem the company has encountered is keeping up with the demand. "With the heavy demand in the transportation industry (i.e., school districts, trucking and cab companies, police departments and government vehicles) and now the news has spread to the farming community and we are working around the clock to keep up with the growing demand. At this time we are able to guarantee delivery within three weeks. But at the present growth rate, we can see considerably longer delivery times in the near future."

The process works on both leaded and unleaded gasoline, and meets EPA and California standards.

The federal judge in charge concluded the five-year administrative procedure studying the GaSaver by stating, "Independent testing shows greater fuel savings with the GaSaver than . . . claimed by its developer, National FuelSaver Corporation."

In another study concluded recently, the government confirmed that the Platinum GaSaver raises the octane of gasoline, eliminating the need for premium gasoline.

Joel Robinson, the developer, commented, "We've already sold over 70,000 GaSavers. Ironically, we find more people buying the GaSaver for its third benefit of extending engine life, than buy it for fuel savings or octane boosting. Ever since our economy became battered by OPEC in 1973, we were convinced it would be a small company like ourselves that would reverse the trend of higher fuel costs.

The Platinum GaSaver has passed a 4-year administrative study by the U.S. Government. And has a full money back guarantee.

Taken from a Report presented to  
The American Chemical Society  
April 11th, 1984  
St. Louis, MO

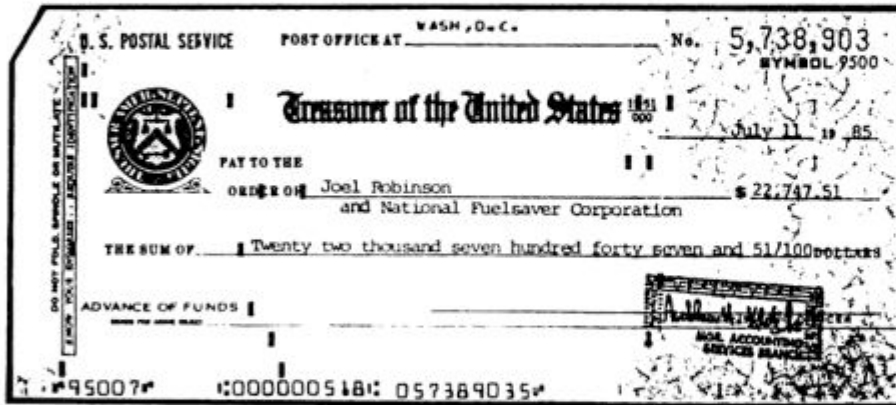
"In a report delivered to the Society of Automotive Engineers, The Engine Technical Center of the Komatsu Engine Company showed conclusive research that if carbon deposits are eliminated from the combustion chamber that there is no significant wear of the cylinder walls or rings, thus prolonging engine life dramatically." The Platinum GaSaver has been found to be one of the most effective devices for the elimination of carbon deposits in gasoline engines. Since carbon is simply another form of unburnt fuel, by burning the gasoline more completely in the cylinder by means of platinum catalysis, the cylinder remains clean and free from carbon deposits thus reducing friction and prolonging engine life dramatically.

### How the Platinum GaSaver System Works

The device needs only to be connected to one vacuum hose. Hose and T adapter are supplied.



## Government awards \$22,000 for development of a simple device that increases fuel efficiency dramatically in gasoline engines.



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### Guarantee


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**7/70**

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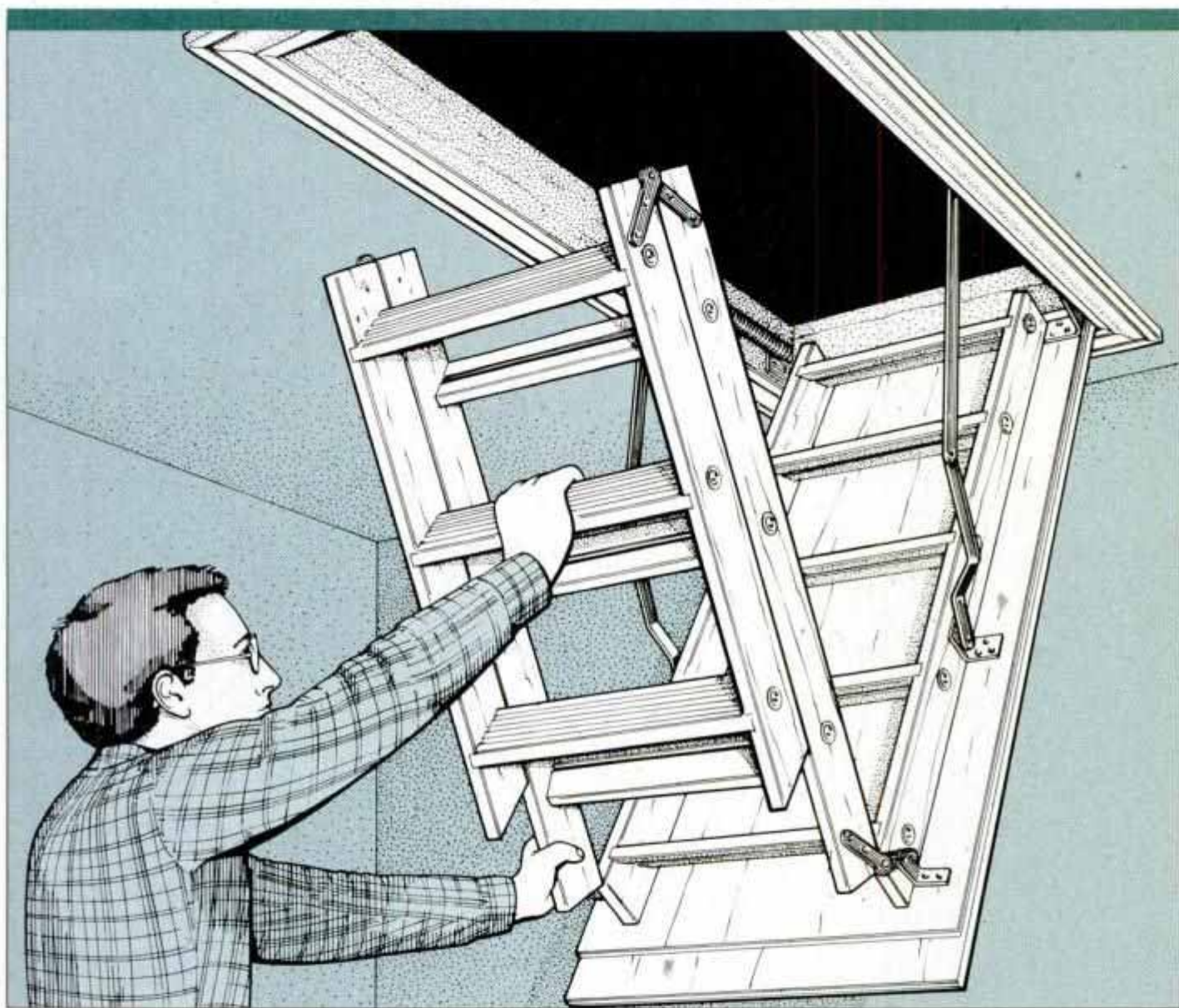


\*See 7/70 powertrain & 7/100 outer body rust-through limited warranty of dealer. Restrictions apply.

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# THE BETTER HOME



## How To Install A FOLDING STAIRWAY

BY PAUL BARRETT; Illustrations by George Retseck

**P**ERHAPS you're fortunate enough to live in an older home that's complete with a full staircase to the attic. If so, you've proba-

bly found that the attic is a great place to store seasonal items and memorabilia. Homeowners without easy access to the attic either don't use the

space, or are forced to haul out the stepladder when necessary. However, there is an alternative. A folding attic stairway allows you convenient access to this otherwise unused space without compromising the floor plan below. All that's needed are a few basic tools, some framing lumber and a friend to help out downstairs when you're in the attic.

Keep in mind that the ceiling framework in most homes without attic access was primarily designed to support the ceiling only. If you plan to use this space for heavy storage, make sure you locate the items above a partition or load-bearing wall.

For our project we installed a folding stairway made by Memphis Fold-



ing Stairs, Inc. This unit accommodates ceilings up to 105 in. high and fits a rough opening of 22 × 54 in. While our choice was a stairway with wooden treads and stringers, this company also makes a similar unit with aluminum stringers. All-aluminum models are available from other manufacturers, too.

## Laying out the opening

The first step in a folding stairway installation project is to inspect the spacing, direction and size of the ceiling joists. Our ceiling was framed with 2x6 joists on 16-in. centers and the stairway unit was to lie parallel with the joists. We only needed to cut away one joist to achieve the required 22-in.-wide rough opening. Installing a folding stairway at right angles to the joists involves a similar operation, but more joists will have to be cut and the framing will be more involved.

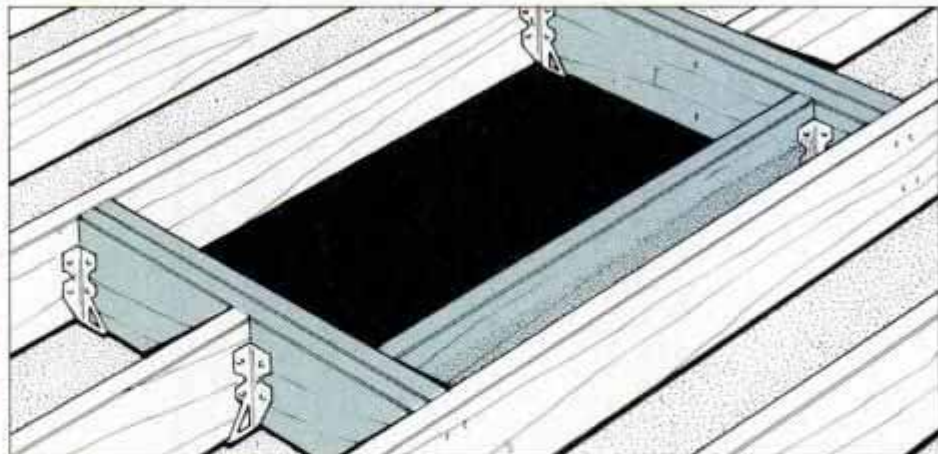
When considering the placement of your stairway, keep in mind that besides providing space on the floor below for unfolding the stairs and moving around the unit, you'll need headroom at the top of the stairs.

Once you've determined where the stairway is to be placed, climb into the attic and remove any insulation over and around the intended opening. Remember that the ceiling itself will not support your weight. Step only on the joists. After removing the insulation, tack-nail wide boards or 3/4-in. plywood on the joists around the area where you'll be working.

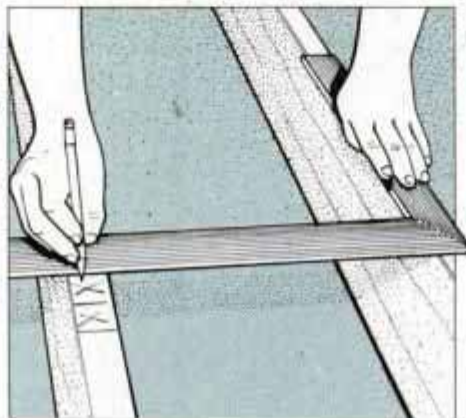
If possible, plan to use an existing joist as one side of the rough opening framework. You'll need to find the position of this joist and mark it on the ceiling of the floor below. Install a 3/16-in.-dia. bit in a drill and bore test holes through the ceiling in the rough opening area to locate the joist. Use a straightedge to clearly mark the joist line on the ceiling. Then, lay out the rough opening with a framing square and straightedge.

The term "rough opening" refers to a size 1/2 in. wider and longer than the unit to be fit. This allows for small errors in laying out and squaring the framework and requires that shims be fit between the unit and the framework before fastening is begun. It's a good idea to double check the actual size of the folding stairway case to make sure it will fit the specified opening.

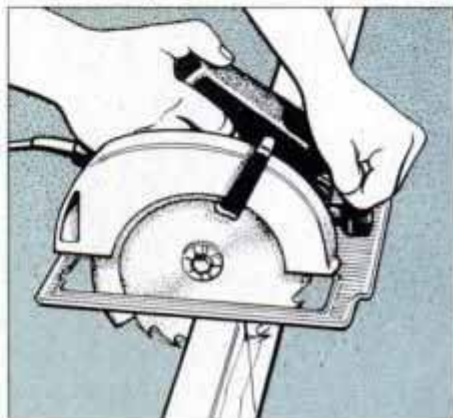
With the rough opening marked, bore 3/16-in.-dia. holes at each corner



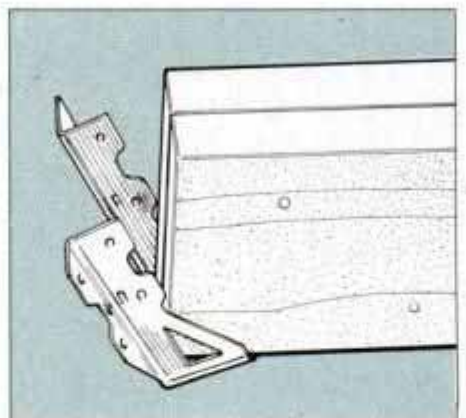
1 Completed framing includes headers for supporting cut joist and a trimming joist placed at width of rough opening. Components are joined with metal hangers and nails.



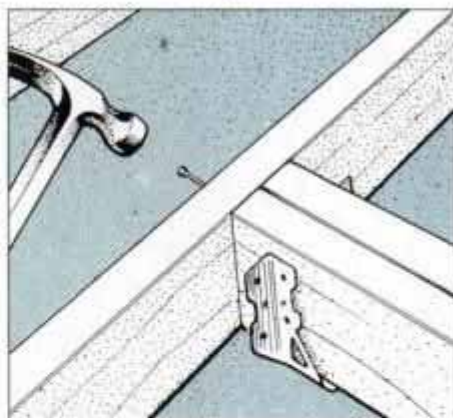
4 Use framing square to lay out for cutting joist. Actual cut line is 3 in. outside rough opening to allow for doubled header.



5 Set blade on your circular saw to maximum depth and cut the joist on inside of the line at each end of the opening.



8 Before setting the headers in place, slip double joist hangers on the header ends for fastening to the ceiling joists.



9 Replace headers between joists and nail through to header ends. Install nails in hangers and toenail with 10d nails.

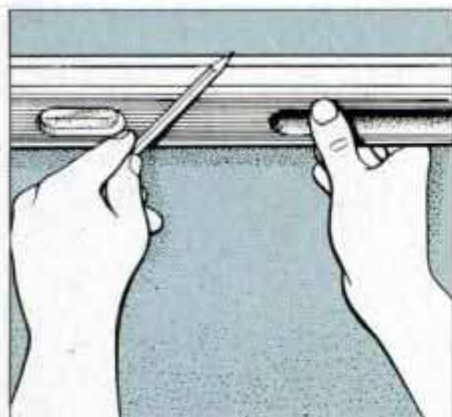
so you'll be able to find the defined area in the attic.

## Framing the ceiling

In any situation where you find that you have to cut through ceiling joists, you'll need to prepare temporary support partitions to carry their load before they're cut. Starting at one end cut two pieces of 2x4 to a length that

spans the two joists on either side of the opening. These serve as a top and bottom plate for the temporary support partition. Then, cut three studs so the combined height of the plates and studs equals the ceiling height. Nail the top plate to the stud ends with 16d common nails. Lift up the top plate and studs so the plate is positioned about 3 in. to 4 in. away from

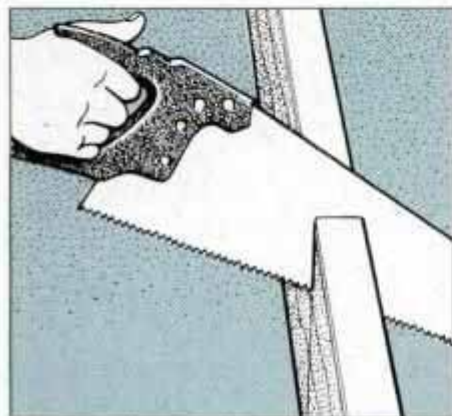




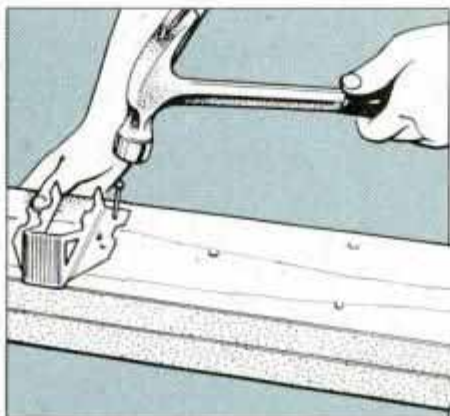
**2** Use a 4-ft. level or long straightedge to mark the side of the rough opening that is aligned with the ceiling joist in the attic.



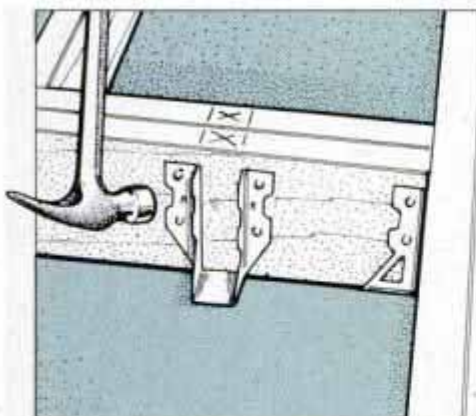
**3** Prior to cutting the center joist, erect temporary 2x4 support partitions about 3 in. away from each rough opening end.



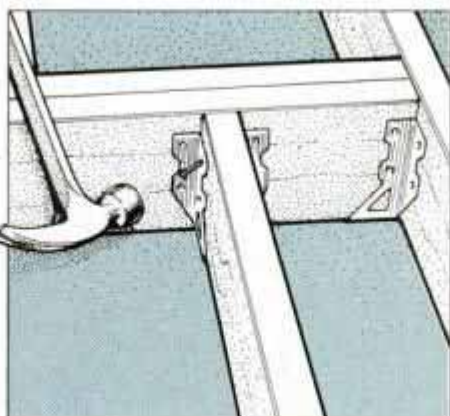
**4** A sharp handsaw finishes cut. Because the cut line is outside the rough opening, make sure you don't cut through ceiling.



**5** Construct both doubled headers to fit between the joists and install metal hangers to support the ends of the cut joist.



**6** Mark position of trimming joist so its inside face is on the rough opening line. Then, install support hangers on headers.



**7** After cutting the trimmer to length, slip it in the hangers and nail. Complete by toenailing with 10d common nails.

the opening. Wedge the bottom plate under the studs and tap the assembly in place so that it's plumb. Then, toenail the studs to the bottom plate. After the first partition is in place, install another at the other end of the opening in the same way.

With the temporary supports in place, climb back in the attic and use the holes bored at the layout corners

to mark the rough opening. Carry the marks squarely up the side of the joist faces and across their top edges. Double check to be sure your marks are square and properly dimensioned. The section of the joist that runs through the rough opening must be removed and the cut ends supported with headers made of doubled joist stock. To find the correct cutting

lines, add 3 in. to the layout marks at each rough opening end on the joist to be removed. This allows for the thickness of the doubled 2x6. Mark a square line down the face of the joist at these points.

To cut the joist, first set your circular saw blade to maximum depth and carefully cut on the inside edge of each cutoff line. Then, complete each cut with a small handsaw. Try to keep the handsaw from cutting through the ceiling.

This is a difficult operation especially if the joists are closely spaced. If you do go through the ceiling, simply patch the hole after the stairway is installed. A carefully handled reciprocating saw can also be used for this job.

After the cuts are made, remove the joist section and measure the distance between the outer joists at each end of the opening. Cut new joist stock exactly to length for the doubled headers at each end and nail together with 12d common nails. Make sure their ends and edges are flush.

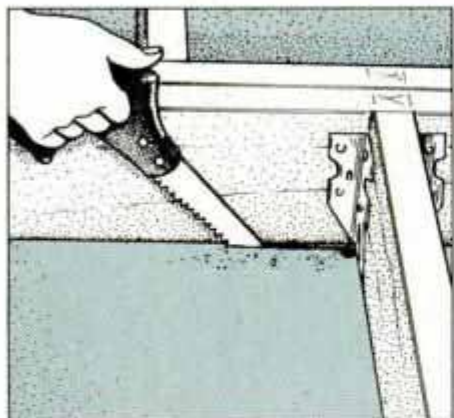
Mark the positions of the cutoff joist ends on the headers and lay out a square line at the mark to indicate the metal hanger placement. Then, install the hangers that support the joist ends. Slip double joist hangers on each end of the headers, but don't nail them in yet. Slide the headers in place and align them squarely with the layout marks and flush with the existing joists. Then, secure them with 16d nails driven through the joists into the header ends. Install hanger nails or 1½-in. roofing nails in the hangers and toenail with 10d common nails.

Because the rough opening is narrower than the width left between the remaining joists, the completed framing will include a section called a trimming joist that spans the headers and serves as a long edge of the rough opening frame.

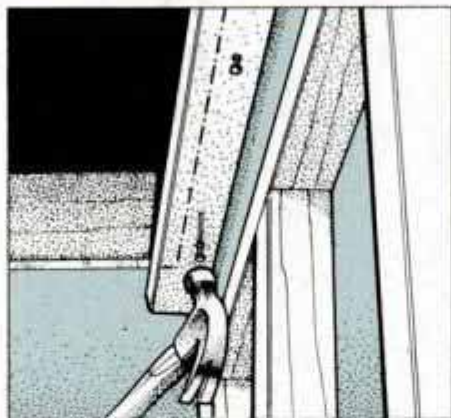
The opening layout indicates the position of the trimming joist. Carry the mark squarely up on the header faces and install hangers to carry the trimming joist. Then, nail the trimming joist in place.

After the framing is completed, you're ready to remove the ceiling. With a helper below to catch the cut-out section, cut around the opening with a compass or keyhole saw. Then, move downstairs and nail the ceiling around the rough opening to the new framework.

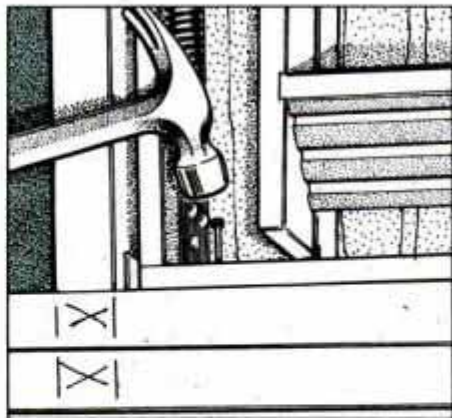




**12** Have a helper on hand in room below when cutting opening with a saw. Then, nail the ceiling to the new frame.



**13** Install temporary ledgers to support folding stairway while it's being attached. Double-headed nails permit easy removal.



**14** Position stairway unit on ledger and use 8d nails to temporarily secure fixed end. Use shims to square unit, if necessary.

## Installing the stairway

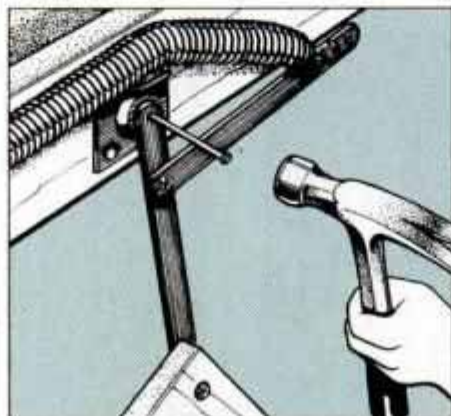
First, tip the stairway on its side, lift it through the opening into the attic and set it aside. Next, install temporary ledgers on both ends of the opening to support the stairway case while it's being positioned and fastened. The unit we installed required the hinge-end ledger to extend  $\frac{1}{2}$  in. into the opening and the ledger on the opposite end to extend in  $\frac{3}{8}$  in. Use 2x4 stock for the ledgers and secure with 16d common nails.

Set the stairway into the opening and let it rest on the ledgers. With the unit still folded, place shims between the stairway case and the headers to straighten and square the unit. Check that it's level and temporarily nail the case ends to the headers with 8d common nails. Leave the heads exposed for easy removal.

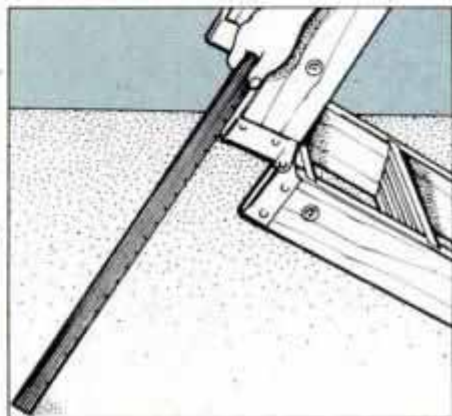
Have your helper fold the mid-section of the stairway down but keep the bottom section folded back. Then, bore pilot holes to prevent splitting and nail through the stairway case to the headers with 16d common nails. Nail through the holes provided in the hinges and complete the fastening by spacing nails 16 in. apart around the entire case. Be sure there's a shim to fill the space between the case and framework where you nail.

## Cutting to length

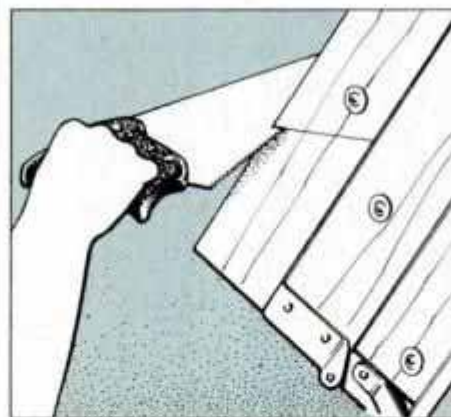
With the unit still partially unfolded place some weight on the stairs so you're sure the hardware is fully extended. Lay a straightedge along the top of one stringer and slide it down until it touches the floor. Mark the length on the straightedge. Then, line up the straightedge with the back of the stringer, extend it to the floor and mark that length. Repeat the procedure on the other stringer to ensure



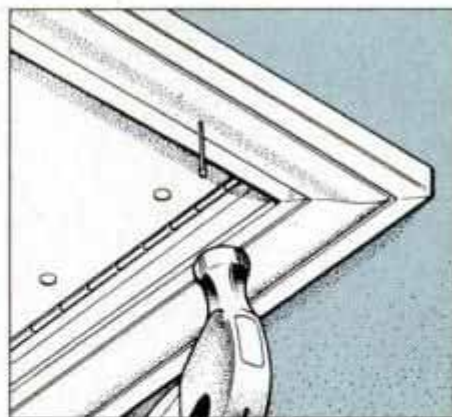
**15** When unit is square and level, drive nails through all appropriate locations. Pre-bore the holes to prevent splitting.



**16** Open stair midsection while keeping lower section folded. Use straightedge to measure cutoff length of lower section.



**17** Transfer length to lower section and mark cutoff line. Saw each stringer to the waste side of the line with a handsaw.



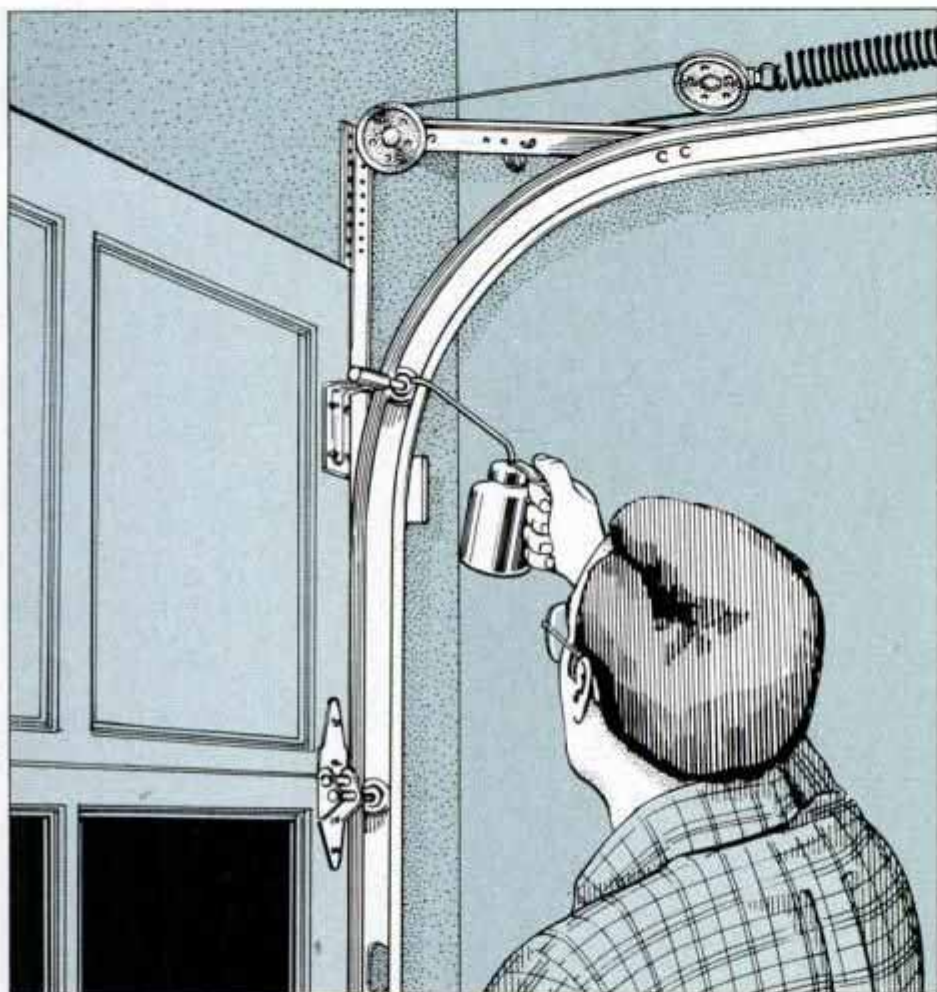
**18** Cut mitered trim for opening and attach to the stair casing with 4d finishing nails and to the headers with 6d nails.

that the legs will seat firmly on the floor even if it's not perfectly flat. Fold the staircase up so you can mark and cut the lengths on the bottom stringers. Unfold the stairway and have your helper stand on the second or third tread. Check that the stairway sections form a straight line and there are no uneven gaps between them. Complete installation by first

removing ledgers and temporary support partitions. Install mitered case molding around the opening, leaving a  $\frac{3}{16}$ -in. reveal between the stairway case and the molding edge. Attach the molding to the case with 4d finishing nails and to the framework with 6d nails. Set the nails, sand with 120-grit sandpaper and prime. Finally, fill the nail holes and paint. **PM**



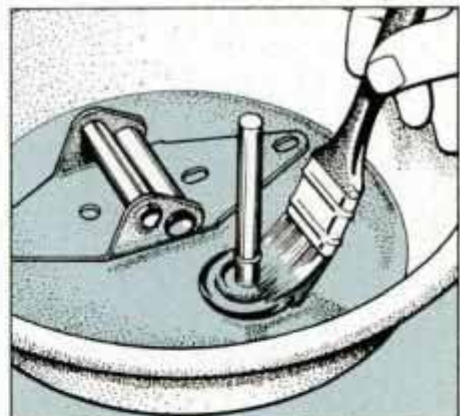
## How To Repair An OVERHEAD GARAGE DOOR



**1** Remove any accumulated grime from the rollers and tracks using an oil-dampened rag. Once they're clean, periodically lubricate the rollers with a touch of lightweight oil.



**2** Severely clogged rollers must be removed from door by backing off retaining nuts. Be sure to remove one roller at a time.



**3** Once roller and hinge are removed, wash both in kerosene until thoroughly cleaned. Use old paint brush or toothbrush.

BY ROSARIO CAPOTOSTO; Illustrations by George Retseck

**L**IFTING and lowering a heavy sectional overhead garage door should normally be an easy task because of built-in mechanical advantages: rollers, pulleys and counterbalance springs. But over time, this job can become very difficult due to neglect of simple maintenance, or because some parts are broken, worn or misaligned. It doesn't take much time and only a few simple tools are needed to get your garage door into tip-top shape once again.

The most common cause for a door to move sluggishly is lack of lubrication—coupled with the accumulation of grime—in the roller bearings. Another possible source of friction can be traced to grime-caked or rusted roller shafts that prevent the roller hinges from pivoting freely as the door moves through its tracks.

Periodic oiling of the rollers and hinges, as well as the pulleys and the insides of the tracks, will help keep the door functioning trouble free. But keep in mind that oiled tracks tend to collect dirt so don't overdo your lubrication. Just apply a thin film of lightweight oil to the rollers and occasion-

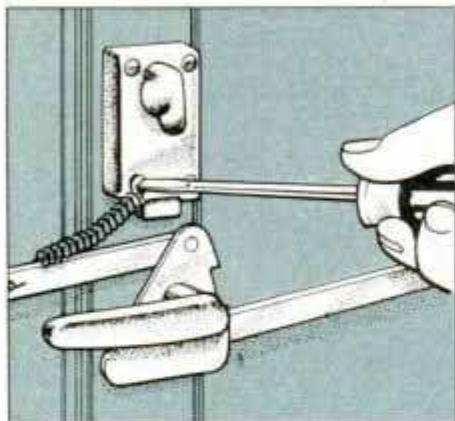
ally wipe the tracks clean with an oil-dampened cloth.

### Removing rollers

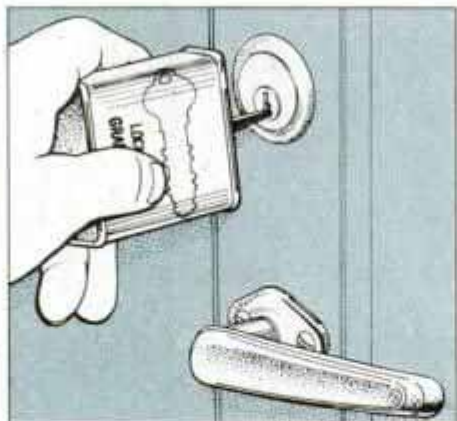
Severely neglected roller assemblies may well call for removal in order to do a thorough job of cleaning and lubrication. If you have to go this route, be sure to remove only one roller assembly at a time and replace it before removing another.

When replacing the hinge, attach the bottom leaf first, then insert a thin cardboard shim between the adjacent door panels before tightening the nuts on the upper leaf. This will prevent the door panels from binding when the door is closed.





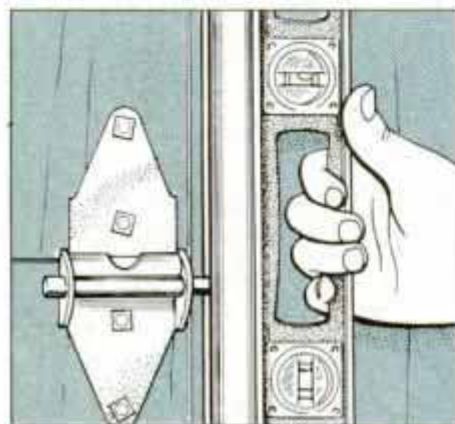
**4** If return spring on lock bars has lost tension, replace it. One end of spring is hooked on bar, other is screwed to lock.



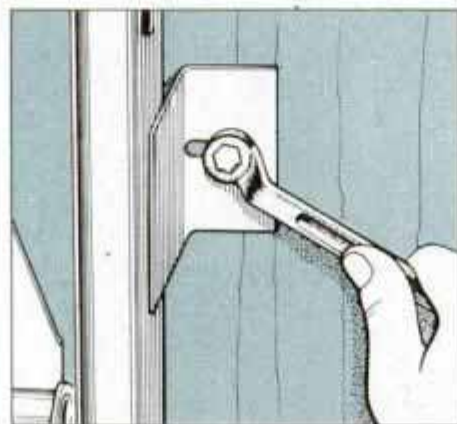
**5** The lockset should be lubricated from outside the door using graphite—in dry or liquid form. Do not use oil on the lock.



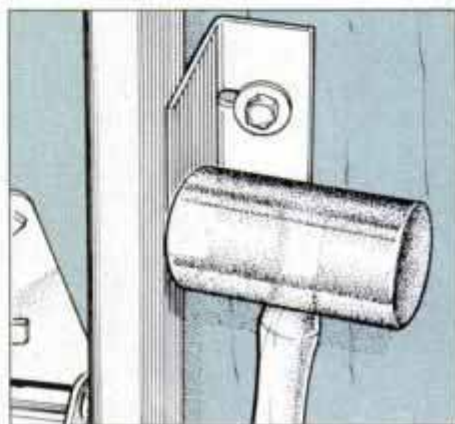
**6** If lock bar doesn't slide into strike opening in the track, then loosen guide bracket screws and adjust bracket up or down.



**7** If severe binding between roller and track occurs, then track is probably out of alignment. Check for plumb using a level.



**8** If track is out of plumb, loosen mounting-bracket lag screws so it moves. Three or four brackets per track are common.



**9** To adjust track, drive it in the appropriate direction using a soft-faced mallet. Once track is plumb, retighten lag screws.

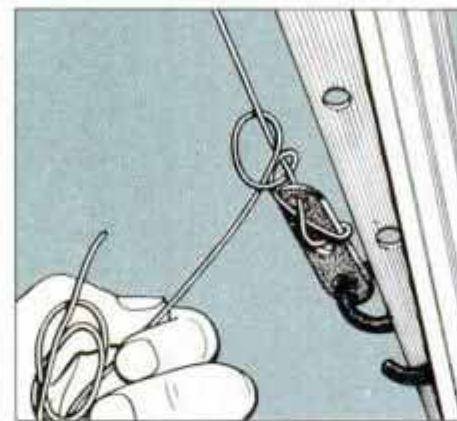
Although the rollers are designed to function in the tracks with a fair amount of play, loose hinges will invariably cause the rollers to move out of alignment and bind. So get into the habit of inspecting the hinges periodically to make sure they are securely tightened in place.

## Track alignment

Another trouble spot to check when the door is balky and functioning poorly is the track alignment. Hard use and abuse in operating the door, as well as normal settling of the garage structure, can cause the tracks to become misaligned. Visual observation of the rollers in the tracks and checking for plumb with a spirit level will indicate whether an adjustment of one or both tracks is required.

Another situation that results from settling is the gradual misalignment of the lock bars. Eventually the bars can start to rub against the strike opening and in the worst cases, miss the hole completely.

The problem can usually be solved by adjusting the slotted bar guides on



**10** To change tension on counterbalance spring, open door completely then tighten or loosen support cable in its bracket.

both ends of the door. In extreme cases it may even be necessary to enlarge the opening with a metal file to allow free movement of the bar.

## Counterbalance springs

The counterbalance springs on the typical door shown have no built-in adjustment mechanism like some of the older doors had. The only way to adjust the springs on these newer

doors is to increase or reduce the tension by tightening or loosening the connecting lift cable. If the spring has lost its tension it should be replaced. This is indicated when the spring, under no tension, does not close tightly and shows spaces between the coils. This determination, as well as the adjustment or removal of the springs, must be done with the door in the fully opened—raised—position.

Some experimentation is required to adjust the counterbalance springs. If your door is sluggish, tighten the spring slightly by pulling more cable through the locking bracket as shown in Fig. 10. If the door lifts too quickly, loosen the cable. In either case be sure to reattach the cable to its locking bracket as shown.

In addition to these simple maintenance chores, also be on the lookout for failing paint on the exterior of a wood door. Keep it well painted to seal out moisture. And occasionally check the weatherstripping seal at the bottom of the door. Replace it if it has lost its flexibility or become misshapen.

FM



# Homeowners' Clinic

BY NORMAN BECKER, P.E.

## Attic Furnace Causes Leaks

My daughter has a problem with her new house. After a snow storm, ice builds up in the gutter and melted snow on the roof leaks through the asphalt shingles. She has a furnace in the attic with conventional duct insulation and a thick layer of insulation on the attic floor. Can anything be done to correct the problem?

THOMAS P. FREEMAN  
CHAPEL HILL, NC

*The ice dam in the gutters is caused by the heat of the roof melting a layer of snow which then refreezes when it reaches the gutter. Further melted snow is contained by the buildup of ice. This water backs up under the shingles and leaks through the roof.*

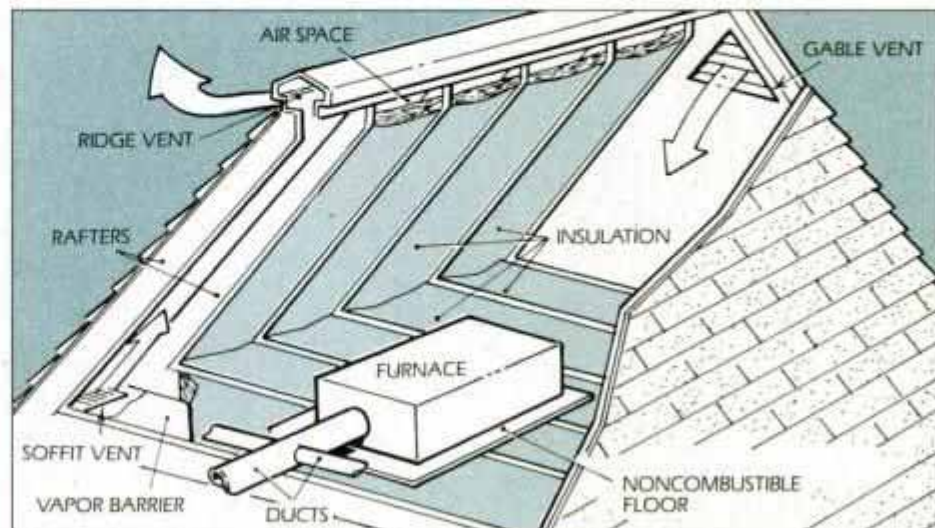
As we discussed in the "Homeowners' Clinic," (page 105, Oct. '87), the best way to prevent or minimize this problem is to keep the roof cold. Normally, insulation in an unfinished attic is located between the floor joists and not between the rafters. This is fine as long as the attic space remains cold. In your case, the attic furnace is contributing to a heat buildup which keeps the roof warm enough to melt the snow.

Insulating between the rafters with an appropriate air space between the roof and the insulation will help produce a colder roof. Ventilating this air space is very important in reducing heat buildup and preventing condensation problems. This can be done with a ridge vent and continuous soffit vents.

To further reduce attic heat, cover the ducts with an insulation blanket. Don't forget that the attic area must be well vented, not only to reduce heat but to provide the necessary air for combustion in the furnace. I'd also recommend that you install at least one smoke detector in the attic as a safety precaution.

## Fan Not Handling Load

I have a problem with my bathroom exhaust fan that I hope you can help me solve. I installed the fan myself in a 5-ft. x 9-ft. bathroom. Although the fan is designed to handle a space bigger than mine, it takes up to 15 min-



Homes with attic furnaces and uninsulated roofs can suffer from ice dams as a result of too warm a roof. Minimize ice dams by insulating and providing the proper ventilation.

utes to clear out the air. I have a flexible tube to vent the unit and the discharge end checks out okay. The bathroom door fits snugly in its frame and against the living room carpet.

EMIL HAUCK  
RAPID CITY, SD

*The answer to your problem is in the last sentence of your letter. An exhaust fan works by creating and holding a slight negative pressure in a confined space. However, to operate properly, the fan requires air to enter the room. Since your door fits tightly all around, there's no way (assuming there's no window) for air to enter the room. The easiest solution is to leave the door slightly open.*

If you want to keep the door closed, then you can cut about 1/2 in. off the bottom of the door. In a typical 30-in.-wide door this is equivalent to a 3-in. x 5-in. opening. If you do have a window, opening it slightly will create the same effect.

Of course, it's always possible that you installed the exhaust fan backward and it's blowing air into the room. Check this by holding a tissue up to the fan. It should be held in place on the grille.

## Flexing Floor

In the home I built I used 2x8 floor joists spaced on 16-in. centers and spanning 12 ft. The subfloor is nailed down with spiral nails and the finish flooring is glued and screwed. Over

the 12-ft. span there is one row of metal bracing.

My problem is that the floor springs when I walk across it. Since I can't use a center support beam, how can I strengthen the joists?

DAVID ZUEHLKE  
COLEMAN, WI

*According to span tables, for a 40-pound-per-sq.-ft. live load (typical design criteria for residential floor joists), your floor should not show excessive deflection or bounce. However, the tables are based on specific grades of wood such as Douglas Fir and Hem-Fir. Since you didn't mention the grade of wood you used, I assume that its bending stress falls within the acceptable limits, however, its stiffness factor may be marginal. You can usually eliminate springiness by nailing "sister" joists of the same size to every other existing joist. When installing these joists, you may need to notch or shave the ends so they fit between the subfloor and sill. Although I'm sure this won't be necessary, you can always add more sister joists to the remaining joists to stiffen the floor further.* **PM**

*Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.*



# Appliance Clinic

BY STEVE TOTH

## Dryer Grinds

As the drum rotates in our 1974 General Electric electric dryer model No. DDE7200NELAV, it seems to slow down periodically and make a loud grinding noise. It doesn't happen all the time. Can you tell me how to repair it myself?

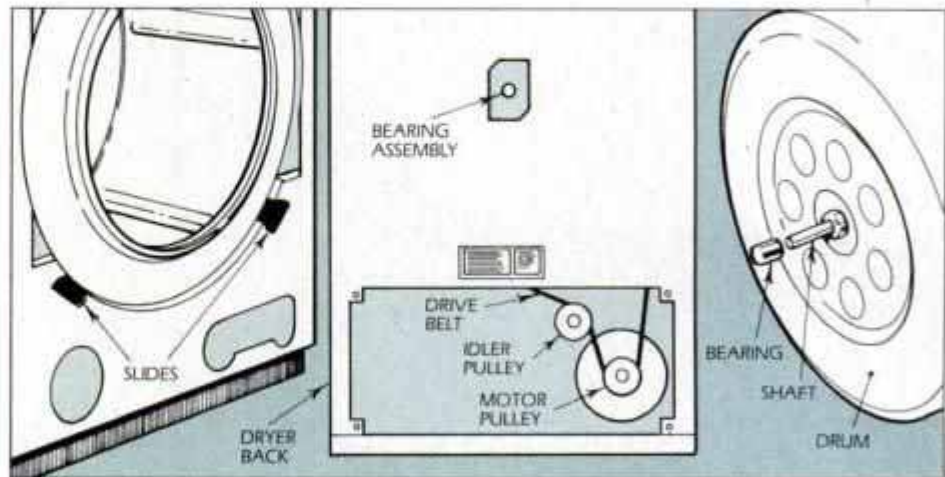
N. GOLDMAN  
COLUMBUS, OH

Begin by checking the drum slides. First, unplug the dryer, open the door and remove the four Phillips-head screws from the upper part of the front panel. Then, lift the top up and lean it against the wall behind the dryer. Be careful that the top doesn't fall off the back of the dryer. You may need to hold it in place with a piece of wire. Next, loosen the two  $\frac{5}{16}$ -in. hex-head screws located near the front legs that secure the front panel. Look inside the top of the panel and remove the retainer clip that holds the wire harness to the cabinet. Finally, remove the two screws from the left and right upper inside corners of the front panel. Lift the panel up and off the cabinet, swing it to the right and place it carefully alongside the dryer.

You'll see the drum slides attached to the cabinet at the bottom of the drum. To check them, lift the drum about  $\frac{1}{2}$  in. and inspect the white plastic material on top of each slide. If the material is worn through, or surface is wrinkled, replace them.

The next component to check is the rear drum bearing. First, lower the cabinet top and remove the center rear access panel. You'll see the drum shaft and bearing assembly. Look for signs of metal-to-metal contact between the drum shaft and the bearing housing. Make sure the Teflon bearing has not slipped out of the housing. A black, powdery substance around the bearing means it's worn and must be replaced.

To inspect the bearing assembly more thoroughly, or replace it, you'll need to remove the drum. First, remove the exhaust vent and take off the lower rear access panel. Swing the idler arm away from the motor, slip the belt off the pulleys, and remove the belt. Go to the center access hole and pry the E-clip from the bearing shaft with a narrow-blade screw-



If your dryer drum slows down and makes noise, first check for worn drum slides. Then, inspect the drum bearing. While the unit is open, check drive belt condition.

driver. Now move to the front of the dryer, lift up the top and secure it. Then, carefully lift out the drum.

While the dryer is disassembled, take the opportunity to vacuum out the cabinet. Also, inspect the drive belt for signs of wear.

The drum shaft and bearing kit is GE part No. WE25X62 and costs about \$27. The kit includes all necessary parts and instructions. The slides (\$24) are sold in sets of two. Ask for GE part No. WE25X60. The drive belt costs about \$14 and is GE part No. WE12X47. After replacing worn or damaged parts, reassemble the dryer in the reverse order. While you're at your local GE parts and service center, you may want to pick up a copy of the GE repair manual for GE and Hotpoint dryers.

## Frosty Frost-Free

We have a 16-year-old Frigidaire Frost-Proof refrigerator, model No. FPCD-166-TN-R, that suffers from frost buildup in the small slits at the bottom of the freezer.

What's the cure? LEO BINDL  
SPRING GREEN, WI

Frost found in the area you describe usually means there's a problem with the defrost system. This system consists of the defrost timer, defrost heating element and defrost limiter switch. If any of these fail, the defrost cycle will not work. Check them by first unplugging the refrigerator and testing each with an ohmmeter.

If the frost is really ice, then you have a different problem. In this case, the defrost drain heater which is part of the divider between the freezer and the refrigerator compartment is probably at fault. The defrost water drain hole becomes iced over which keeps melted frost from draining away. The water simply lays in the bottom of the divider and freezes during the next refrigerator cycle. The slab of ice that forms reduces air circulation and raises the temperature.

The fix for this is to change the divider which contains the drain tube and drain heater. This unit also contains the light socket, and molded top of the food compartment. All functional parts are still available and can be ordered through a Frigidaire parts distributor. **PM**

## Service Tip

Microwave oven users often find that splattered food not immediately cleaned up can be very difficult to remove. If you've ever encountered this problem, here's a solution. Fill a cup with water and heat it in the microwave at full power for about 3 minutes. Let it stand in the oven for another 5 minutes to give the food a chance to soften. Then, wipe the oven clean.

If you have a problem with any appliance, send your question, with the model and serial numbers to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.







## SUPERSAWS

(Continued from page 88)

second miter can be cut by simply flipping over the board end for end. Right-hand miters are preferred because the motor doesn't obstruct your view of the cut.

To cut a tricky compound miter, simply set up the saw for a miter and bevel cut. This cut is used extensively when making picture frames and installing moldings.

■ **Ripping**—Ripping—cutting with the wood's grain—is done with the blade rotated so that it's parallel with the fence. Then, lock the yoke on the arm with the blade at the desired distance from the fence. Note that the photos show two ripping modes—in-rip and out-rip. The in-rip mode, which positions the blade between the motor and the fence, is the most commonly used. Again, it's very important to always feed the work against the rotation of the blade. Also, note that the direction that the blade rotates, changes from the in-rip mode to the out-rip mode. Therefore, the side of the saw that you feed the work from, known as the infeed side, also changes.

Cut quick, clean dadoes, grooves and rabbets with a dado blade. The blade adjusts—usually from 1/4 in. to 13/16 in.—for various width cuts.



To cut long grooves and rabbets with a dado blade, set the saw in the rip position. Be sure to use antikickback pawls and a pushstick.



Special guard (left) is required when using a molding cutterhead horizontally. Note wide fence opening and hole in table for arbor.



With the guard in place, use a molding cutterhead to mill intricate profiles. Feed work against cutterhead rotation—from right to left.



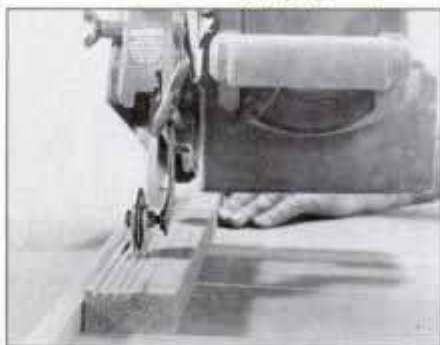
■ **Dado blades**—Dado blades are indispensable for cutting dadoes, grooves and rabbets quickly and accurately. Dado blades can be adjusted, usually between 1/4 in. and 13/16 in. wide, for various width cuts. Most dado-blade cuts are made in several passes. Don't try to remove too much stock in a single pass. For best results, make shallow, slow passes. (For more information about dado blades, see "Using Dado Blades," page 122, June '85.)

■ **Molding cutterhead**—With a molding cutterhead, you can produce various custom and standard moldings, mill an ornate picture frame and shape decorative edges and surfaces. The cutterhead, which replaces the saw blade, holds a set of three blades, or knives. Knives are available in more than 30 different shapes. A molding cutterhead can be used in the rip or crosscut mode and in a vertical or horizontal position. When the cutterhead is in the vertical position, use the standard blade guard.

However, when it's positioned horizontally, you must install a special molding cutterhead guard, as shown. (To learn more about using a molding cutterhead, see "Cutterhead Closeup," page 71, Dec. '86.)

PM

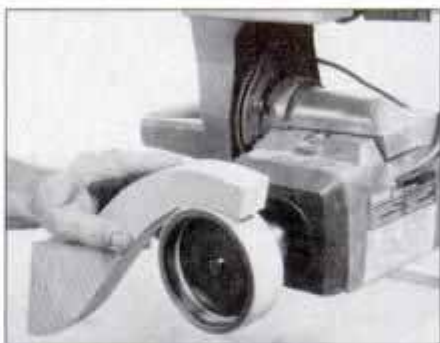
When using a molding cutterhead in the vertical position, install the standard blade guard. Also, use antikickback pawls, as shown.



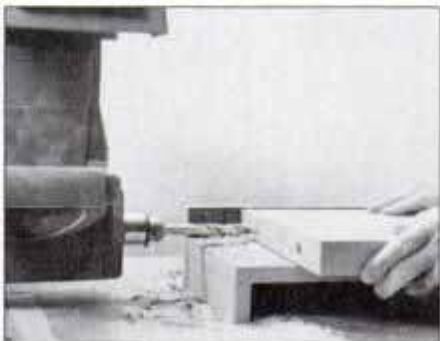
Rotary surface planer, available from Sears, is used to smooth board surfaces. Set planer in horizontal position and make shallow cuts.



Use saw's accessory arbor, located on right side of motor, to attach a sanding drum. Never use accessories with the saw blade installed.



Radial-arm saw can be used for horizontal boring, too. Mount a drill chuck on accessory arbor and use a shopmade work-support table.





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"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

## Years of Testing and Use Have Proved It True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road: The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

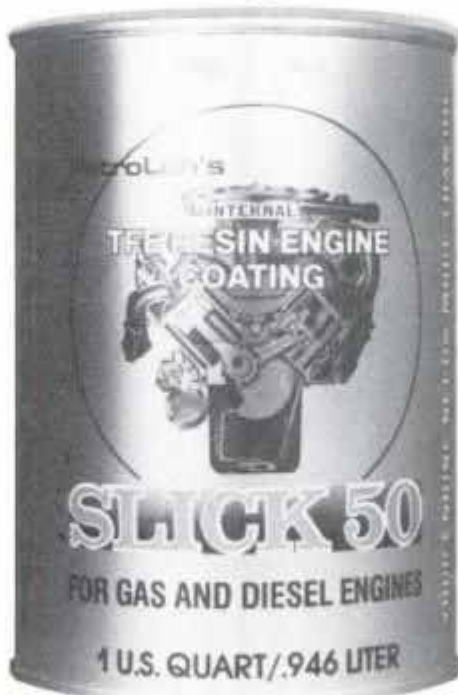
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

## It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

## Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

## Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

## 4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

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3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine

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Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

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## AFTER SHOCKS

(Continued from page 69)

loads, eliminating a major problem with MacPherson struts sticking under high cornering forces.

Given the hydraulic power, and electronic logic and controls, a pair of very short cylinders might make up a variable-length lower A-arm to absorb the greatest cornering loads, and simultaneously provide minor camber and steering axis inclination adjustment. A steer-by-wire arrangement would eliminate the physical connection between the steering wheel position sensor to the computer, and then to the hydraulic steering rams. And another ram could provide minor rear steer corrections, or toe adjustment. Imagine—active alignment by on-board electronics.

The possibility of 20 in. of wheel clearance provides for current levels of wheel travel—maybe 4 in. of bump and 4 in. rebound—which should be more than enough for a fully active suspension to work with.

With all the moving suspension pieces entirely in the wheel, the chassis designers can go hog-wild, especially at the rear of a front-wheel-drive design. There is a tremendous potential for interior volume savings, even assuming the tires to be a couple of inches wider than today's widest. The rear should be free and open, from sidewall clearance to sidewall clearance and from roof to ground clearance.

It would be easy to put a couple more passengers (maybe rear-facing) down low between the rear wheels. At the front, space-saving might not be as important and driveshafts might require offsetting the rams a bit. For geometric reasons, it isn't unusual for the steering axis to be off the centerline anyhow, and with steer-by-wire geometry, it may become irrelevant. Other time-honored systems may also become expendable. Volkswagen, for example, now has a hybrid gas-electric prototype with a large diameter "pancake motor" replacing the fly-wheel/starter/alternator. It's not at all inconceivable that we could someday have a pancake motor in each wheel—and no driveshafts.

The sensing and operation of active suspensions is not shown in the illustrations because it will be unobtrusive, if not downright invisible. It will be necessary to have computers, wheel-speed sensors, wheel-travel sensors, forward-looking terrain monitors, steering/throttle/brake input sensors perhaps even accelerometers and yaw gyros. But instead of tacked-on afterthoughts, they will be integrated into the mechanical com-

ponents themselves. Displacement sensors will be protected inside the ride cylinders, wheel-speed sensors will be designed into hubs and the remainder will be so small that they can be hidden in an armrest.

## The hard part

Although there are a number of active suspension prototypes out already, we won't be seeing the ultimate solution for quite a few years. It will have to evolve through a number of simpler iterations. As Peter Wright of Lotus Engineering has been quoted, "We have hardware that can do anything we want. The hard part is figuring out the logic of *what we want*."

For example, imagine the simple control solution of using accelerometer sensors to keep the car level in cornering and braking. If you drove the car slowly down a steep hill, it would jack the front up to the limit and drag the rear bumper. To deal with this problem, Mitsubishi, for one, uses the slope of the wheel-speed signal to calculate longitudinal G forces. Since there is no lateral velocity signal, they use a combination of lateral Gs and steering wheel movement to distinguish between driving straight on the side of a high road crown and cornering.

Or suppose you try to keep all four wheel oscillations at about the midpoint of their travel, and the car is driven diagonally onto a steep driveway. Then superimpose high-speed transient response on top of that, and things get *really* tricky.

## The payoffs

Finally, what all this means to the designer is a freeing up of many previously iron-clad constraints. The ultimate elimination of all mechanical links from the steering wheel and pedals means they can be placed anywhere. In a wide enough 2-seater, the driver could easily enter a normal seating position, and then adjust his seat and controls laterally to the center of the car when the going gets exciting. Or he could even pass the controls over to his passenger when the going gets boring. The possibilities are numerous.

Looking back, a lot of futuristic ideas have been proposed—or have actually come out—and gone away again when it was discovered that the implementation technology wasn't adequate, or perhaps too costly. But now it seems we are in an era where high technology is more marketable than ever—at any price. All the scientists have to say is, "It's possible," and rest assured, someone will do it.

The fun part is guessing who will do what, and when.



# The standard equipment on a Laser 128 is optional on most computers



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**The Laser 128 is priced to keep money in your pocket.** The Laser is about half the price of an Apple, and is even less than a comparably equipped Commodore unit. You get a lot of computer for a little money.



**Look for the attractive Laser packaging at a store near you.** For more information on the Laser 128 and the name of your nearest dealer, contact Video Technology Computers, Inc., 400 Anthony Trail, Northbrook, IL 60062, or call (312) 272-6760.



## **LASER 128<sup>®</sup>**

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## THE LAST GO-ROUND

(Continued from page 76)

ing tonearms move in a straight line across the diameter of the record, right to left from the circumference to the center. Instead of being attached to a single pivot point, the entire tonearm glides from right to left in a motorized track behind the record, tangentially to the grooves, as it plays.

Proponents of motorized linear-tracking arms say they are more precise than pivoted tonearms which, because of centrifugal force, are pulled in two directions at once during the tracking process and therefore require antiskating compensation. On the other hand, those who defend the pivoted arm point out that motorized arms add noise to the record playback process, which sacrifices musical fidelity for the sake of operating convenience. And operating convenience is one attribute of linear tracking, because these turntables offer a feature more commonly associated with compact disc players—programmability. Linear tracking turntables such as Kenwood's KD-76F (\$240) and Technics' SL-J33 (\$250) can be programmed to play selections in order of preference.

Tonearms are made from light, rigid materials so that they and the cartridge containing the stylus can easily follow the record's grooves. The type of cartridge you place at the end of the tonearm depends largely on your musical taste. Moving-magnet (MM) cartridges are the simplest and the most numerous while most moving-coil (MC) cartridges require an extra, step-up voltage transformer if your amplifier, receiver or preamplifier does not have an MC input switch. The easiest cartridges to install are those which snap onto the P-mount tonearms, thereby eliminating the need for wiring, bolting and precise alignment with gauges.

Turntables vary in price from less than \$100 to as much as \$15,000 for those few models using the rarest of materials, incredibly precise, seismograph-like engineering, and elaborate features. This raises the subject of care and feeding.

Aside from replacing a worn phono-cartridge stylus, turntables require virtually no maintenance, though belt-drives do benefit from an occasional cleaning of the rubber band and its path. A vinyl record, on the other hand, should be cleaned before each play to remove microscopic grit attracted to the grooves by static electricity. There is a wide assortment of record-hygiene products on the market, and since the LP is an endangered species, these cleaners are a prudent investment. **PM**

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## STEPSTOOL/CHAIR

(Continued from page 82)

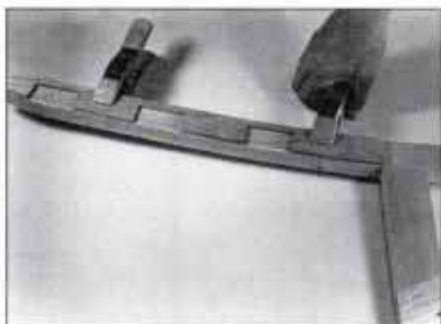
ing to scrap 1/4-in. plywood and cut out. Trace this pattern on the seat stock, cut to the line and smooth the sawn edge with a drum sander or sandpaper and block. Mark the hinge positions and cut the hinge mortises with a dovetail saw and sharp chisel. Place each hinge in position on the rear seat piece and mark for the screw pilot holes. After boring, it's a good idea to pretap the holes with a steel screw of the same size as the brass screws supplied with the hinges. This helps eliminate breaking the soft brass screws as they're driven into the hard oak. Then, lay the front piece on top and install the screws. Align the front and rear assemblies and clamp together. Stand the entire unit up in its chair position using a 7/8-in.-

thick piece of stock in place of the top step (K) to support the rear section. Position the seat and bore the screw holes. If the dry assembly of the seat is correct, remove the seat, apply epoxy and reinstall. Then, cut the top step to size, turn the chair upside down and install.

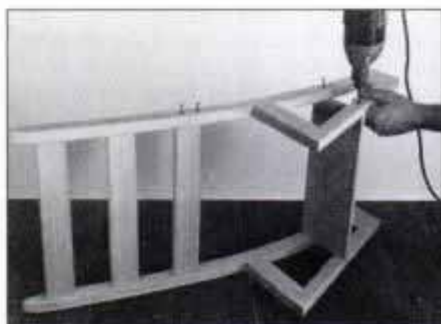
### Completing the piece

Use a plug cutter to make enough plugs for all the screws and glue the plugs in place. Trim the excess with a sharp chisel. Then, remove the hinges and hand sand the entire chair with 150-grit sandpaper. Clean up with a tack cloth and apply two coats of Minwax Satin Finish Polyurethane Varnish following the manufacturer's instructions. Apply a coat of paste wax and reinstall the hinges. Locate the screw positions for the hook and install.

PM



10 A 1/4-in. plywood template of the upper rear leg has notches to help in positioning the slats prior to boring screw holes.



11 Dry assemble the units with drywall screws and check for good fit. Then, remove the screws, apply epoxy and reassemble.



12 Use a plug cutter to make the 1/2-in.-dia. plugs. Glue in place and trim flush with a sharp chisel and fine sandpaper.



13 Use a fine back saw and sharp chisel to cut the hinge mortises. Then, bore pilot holes and screw the hinges in place.



14 After clamping the front and rear units together, lay the seat in position and bore the holes for fastening the seat.



15 Turn the chair upside down and position the 1/2-in.-thick top step. Mark and bore the hole for fastening with drywall screws.



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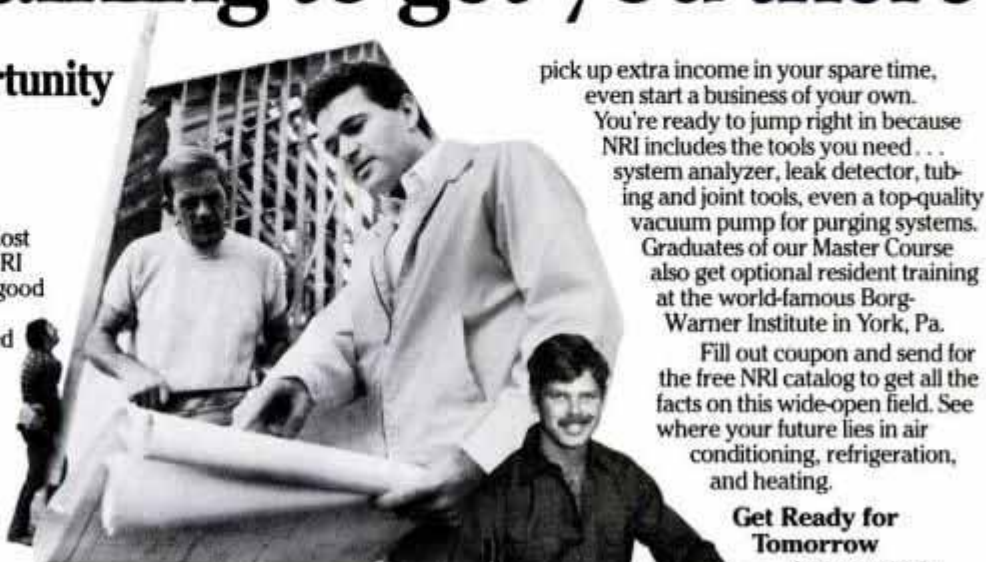
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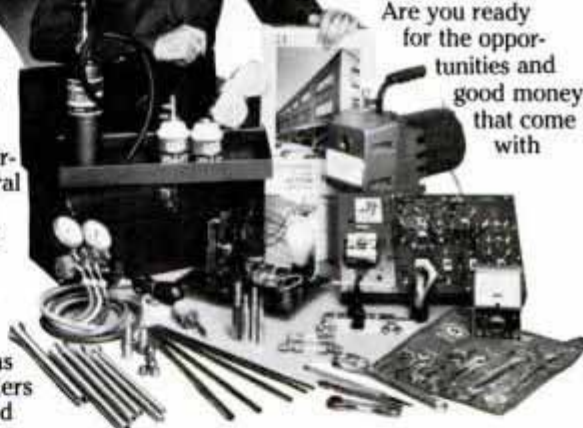
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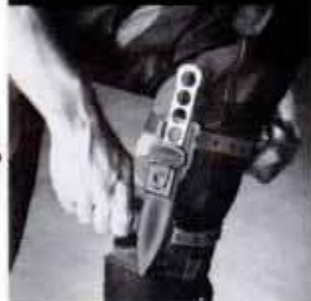
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Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a \$1 million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest legal way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in just 3 years.

You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

## Here's what newspapers and magazines are saying about this incredible secret:

### The Washington Times:

*The Royal Road to Riches* is paved with golden tips.

### Los Angeles Herald Examiner:

We've all got to start somewhere... *The Royal Road to Riches* is the first step in the right direction!

### National Examiner:

John Wright has an excellent guide for achieving wealth in your spare time.

### Income Opportunities:

*The Royal Road to Riches* is an invaluable guide for finding success in your own back yard.

### News Tribune:

Wright's material is a MUST for anyone who contemplates making it as an independent entrepreneur.

### Success!

John Wright believes in success, pure and simple.

### Money Making Opportunities:

John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

### Hollywood Trade Press:

We have never heard of an advertiser offering to pay readers \$20 to try its program. Wright's willingness to do this convinces us that his money secret must really work.

### California Political Week:

... The politics of high finance made easy.

### Hollywood Citizen News:

He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

### The Desert Sun:

Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

## PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

### 'More Money Than I Ever Dreamed'

"All I can say — your plan is great! In just 8 weeks, I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year." A. F., Providence, R.I.

### '\$9,800 In 24 Hours!'

"I didn't believe it when you said the secret could produce money the next morning. Boy, was I wrong, and you were right! I purchased your *Royal Road to Riches*. On the basis of your advice, \$9,800 poured in, in less than 24 hours! John, your secret is incredible!" J. K., Laguna Hills, CA

### 'Made \$15,000 In 2 Months At 22'

"I was able to earn over \$15,000 with your plan — in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money, as fast as I've been able to do. I really do wish to thank you, with all of my heart." Ms. E. L., Los Angeles, CA

### 'Made \$126,000 In 3 Months'

"For years, I passed up all the plans that promised to make me rich. Probably I am lucky I did — but I am even more lucky that I took the time to send for your

material. It changed my whole life. Thanks to you, I made \$126,000 in 3 months." S. W., Plainfield, IN

### 'Made \$203,000 In 8 Months'

"I never believed those success stories... never believed I would be one of them... using your techniques, in just 8 months, I made over \$203,000... made over \$20,000 more in the last 22 days! Not just well prepared, but simple, easy, fast... John, thank you for your *Royal Road to Riches!*" C. M., Los Angeles, CA

### '\$500,000 In Six Months'

"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright." R. S., Mclean, VA

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, *instead postdate your check for a month and a half from today*. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.

## \$20.00 FREE!

There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back *plus \$20.00 in cash FREE!*

Do you realize what this means? You can put my simple secret into use. Be able to solve all your money problems. And if for any reason whatsoever you are not 100% satisfied after using the secret for 30 days, you may return my material. And then I will not only return your original UNCASHED CHECK, but I will also send you an *extra \$20.00 cashiers check* just for giving the secret an honest try according to the simple instructions.

**I GUARANTEE IT! With my unconditional guarantee, there is absolutely NO RISK ON YOUR PART.**

To order, simply write your name and address on a piece of paper. Enclose your postdated check or money order for \$12.95 and send it to:

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Santa Monica, CA 90405

Since the material I'll be sending you is heavy, please add \$1 to cover portion of shipping costs.

But the supply of my material is limited. So send in your order now while the supply lasts.

If you wish to charge it to your Visa or MasterCard — be sure to include your account number and expiration date. That's all there is to it. I'll send you my material right away by return mail, along with our unconditional guarantee.

## SWORN STATEMENT:

"As Mr. John Wright's accountant, I certify that his assets exceed one million dollars."

Mark Davis



# WORTH WRITING FOR

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The National Marine Manufacturers Association's 16-page booklet shows you why boating is more affordable than ever. How and where to select boats, financing and how today's boats give you more value. Free

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**413 DIESEL POWER THAT FEELS GOOD**

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POPULAR MECHANICS' catalog has plans for everyone, from beginner to expert craftsman. Choose from a bookcase wall to a hovercraft. Hundreds of plans, plus complete listings of how-to books, videotapes and handy reprints of past articles. \$1.95

**415 SPRING PLANTING**

Gurney's 66-page color catalog has the most complete selection of seed and nursery products in America! All guaranteed and delivered right to your doorstep. Free

**416 WOODWORKERS DELIGHT**

The Woodworkers' Store 114-page color catalog offers hardwoods, veneers, parts, tools, hardware, books & plans. They guarantee customer satisfaction. \$1.00

**417 EASY WAY TO CHANGE OIL**

The E-Z drain allows you to change oil without removing drain plug from oil pan. Fast and clean because your bolt will never fall into waste oil. Fits most U.S. cars 1962 - 1984, except 4 cylinders. Brochure from Sentex Company. Free

**418 HOW TO CUT GLASS & PLASTICS**

The Fletcher - Terry Company's full-color booklet details how cutting glass and plastics can be easy . . . even fun when you use the right tools and apply the proper methods carefully. Free

**419 HOT STUFF**

New York Bronze's new, easy to use, "small job torch" has a 1,000 uses - in the workshop, garage & in the kitchen. Controllable flame is regulated by an innovative trigger. Full-color brochure. Free

**420 UNDERSTANDING CARPET QUALITY**

Armstrong's informative booklet helps identify long-term performance traits of nylon saxony carpets. How to shop, read and understand carpet warranties. Free

**421 HOME CARE GUIDE**

Your home repairs become easy with our informative guide to plumbing, electrical problems, waterproofing, painting, even fixing squeaky floors. 19 topics in all, printed on large plastic-coated cards. From POPULAR MECHANICS. \$2.45

**422 ALL THE POWER YOU NEED**

Makita's 86-page brochure presents their entire line of industrial quality power tools. Includes cordless tools, saws, planers, sanders, drills, routers, hammers & more. Full specs and accessories. Free

**423 FINE WOODS AND WOODWORKING SUPPLIES**

A woodworker's delight, Constantine's 116-page, color catalog offers 150 kinds of veneers and 250 sizes of fine cabinet woods. Plus, decorative inlays, mouldings, tools, plans, books and hardware. \$1.00

**424 EXTRAORDINARY OFFERINGS**

Johnson Smith's catalog offers 1800 novelties, hobby & sports equipment, jokes, tricks, science and electronic items. A world full of fantastic wonders. Free

**425 GAS ALERT**

Ultralert's color booklet provides in-depth data on the dangers of methane and carbon monoxide in the house and how the Ultralert system detects and protects. Free

**426 RADAR RECOGNITION**

Universal Security Instruments' color brochure illustrates mounting options, details warranty and presents features of their Scout Radar Detector. Free

**427 PELLA'S PRIDE**

56-page color catalog showcases the entire Pella residential product line. Includes windows, doors and sloped glazing systems. Complete specs included. Free

**428 POTPOURRI OF PLANS**

Craftplans' 32-page catalog offers a wide selection of ideas, plans & patterns for woodworkers. Includes bird houses, toys, weather vanes, furniture, computer desks and more. 50¢

**429 PROTECTION MATTING**

Deflecta-Shield's 4-color booklet describes how Tuff Turf™ protection mats provide worry-free footing and easy clean up for pools, showers, boats, trucks, basements & shops. Made of a PVC material, they come in 12" square tiles and will not mildew. Free

**430 LIGHT SNUFF**

Judd, Original Light Snuff offers a 75¢ off coupon toward your next purchase of Judd. Offer not available to minors. Free

**431 WORLD OF ROUTERS**

Choice Precision Tools' 16-page catalog contains 400 router bits, shaper cutters and router accessories. Also, router tables, speed controls, drawer and door sets. \$1.00

**432 VINYL LUXURY**

Solid vinyl tiles combine luxury, beauty & practicality. Azrock Luxury Vinyl Tile's 4-color catalog displays this high-end line that fools the eye and looks like real wood planks, marble slabs and bricks. 25¢

**433 MASTER SHOP GUIDE**

An informative guide to choosing nails, screws, moldings, sandpaper, wallpaper, lumber, floor tiling, wood finishings and more. Do all your home and shop jobs better, quicker and cheaper with this expert workshop reference. \$5.95

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Box 1718, Sandusky, Ohio 44870

This Coupon Expires April 30, 1988

Please see that I receive the items checked below

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|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|----------------------------------|-------------------------------------|
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| <input type="checkbox"/> 413        | <input type="checkbox"/> 417        | <input type="checkbox"/> 421 \$2.45 | <input type="checkbox"/> 425        | <input type="checkbox"/> 429     | <input type="checkbox"/> 433 \$5.59 |
| <input type="checkbox"/> 414 \$1.95 | <input type="checkbox"/> 418        | <input type="checkbox"/> 422        | <input type="checkbox"/> 426        | <input type="checkbox"/> 430     |                                     |

Total money for priced items \$ \_\_\_\_\_  
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**Note: Popular Mechanics processes your requests for the above information and forwards these inquiries to the organization making the offer. Each company mails the material directly. Your order will be on its way to you within 90 days.**



## BOOK STAND

(Continued from page 84)

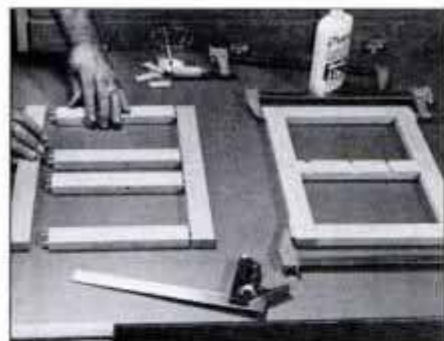
Assemble the two frames with 1/4-in.-dia. x 1-in.-long dowels. If you're making up your own dowel pins from a long length, be sure to cut shallow grooves in them to allow excess glue to escape. Apply glue sparingly to dowels and holes, clamp each frame and check the assemblies for square, by measuring the frame diagonals.

Next, cut the pivot dowel to length and sand it for a slip fit in the frame. Attach the shelf to the upper frame with glue and four 3d finishing nails. To mark for the hinge screw holes, clamp the two frames together with a piece of thin cardboard in between. Then, hold each hinge in place and mark the centers with an awl.

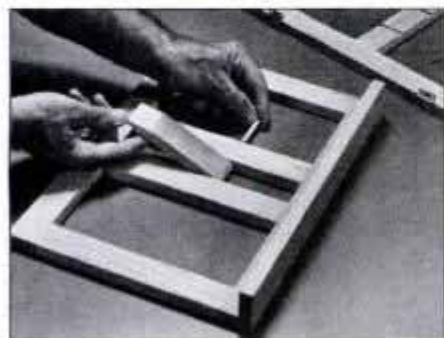
Before installing the hinges and arm, sand the components and apply two coats of urethane varnish. **PM**



4 The three 3/8-in.-wide dadoes in the lower frame center crossmember are cut with a dado blade mounted in the table saw.



5 Apply glue sparingly to all dowels and holes in each frame and clamp until dry. Make sure the assemblies are square.



6 Slide a 1/4-in.-dia. x 3/4-in.-long dowel through the holes in the arm and crossmembers to act as the pivot pin.



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Now, as part of a continuous nationwide publicity campaign, RBM Ltd., a multi-million dollar distributor of sporting equipment offers its nationally advertised GFX DIMENSION-4™ AMBER OPTICS—for only \$5 to every person who writes to the company address (below) before April 30, 1988.

These are the same sports optics currently being nationally advertised by us in leading media throughout America. GFX DIMENSION-4 AMBER OPTICS are as different from ordinary sunglasses as a Concorde Super-Jet is from a World War I Curtiss "Jenny"! Exciting scientific optical technology permits you to see and distinguish objects more clearly, sharply and distinctly than ever before—even through fog, haze and mist. This same startling development also gives your eyes needed protection from potentially harmful sun rays.

We've named these remarkably different sports optics DIMENSION-4 AMBER OPTICS because they seem to extend vision within the accepted three dimensions of height, width and depth—increasing perception and perspective. While ultra-violet rays are long known to be hazardous to eyes, optical scientists today have become increasingly concerned about effects of "blue light" rays. DIMENSION-4 AMBER OPTICS' UV/blue ray filtration blocks out BOTH types of potentially harmful rays. (Incidentally, many conventional "sunglasses" expose the eyes to more of these dangerous rays by forcing the pupils to open wider to overcome reduced light transmission.)

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Blue light has been likened to radio-TV sound interference and has been referred to as visual "noise". Particles of dust and moisture in

the atmosphere diffuse this blue light, interfering with the eye's ability to perceive objects clearly, especially at distances.

In much the same way as an electronic filter blocks out unwanted interference that distorts and blurs voices and music (and shows up as "snow" on TV screens) DIMENSION-4 AMBER OPTICS block out this visual "noise". So, the green and red portions of the light spectrum focus clearer and sharper on the eye's retina. Your visual perception and perspective increase. Distant objects previously unnoticed come into view. *Everything appears more distinctly clear and better defined.*

Drivers see road signs, hazards more clearly in haze, fog and mist. Tennis players see balls in bright sun or night play more sharply defined. Skiers, on cloudy days, can better judge moguls, steepness of downhill runs. Golfers can more accurately determine distance to the pin, "lies" of greens. Boaters can sight other craft, buoys easier in overcast weather.

DIMENSION-4 AMBER OPTICS will *not* be sold at this or any price by the company in any store. There is a limit of two (2) pair per address, but if you order early enough (before April 25) you may request up to five pair. Each pair is covered by the company's full one-year money-back guarantee.

To order: Mail your name and address (on a sheet of paper) and \$5 for each pair of DIMENSION-4 AMBER OPTICS. Add only \$2 shipping regardless of the size of your order. (New York residents add sales tax.) Allow up to 6-8 weeks for shipment. **IMPORTANT:** specify regular style (Item R54260) or "clip-on" style for eyeglass wearers (Item R54262). **One size fits all. Make check payable to RBM Ltd. Mail to: RBM, DIMENSION-4, Dept. 506-128, Box 1784, Hicksville, N.Y. 11855. (R54271)**



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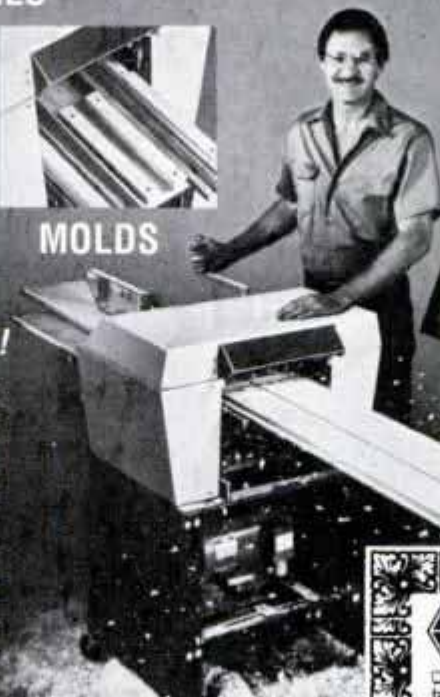
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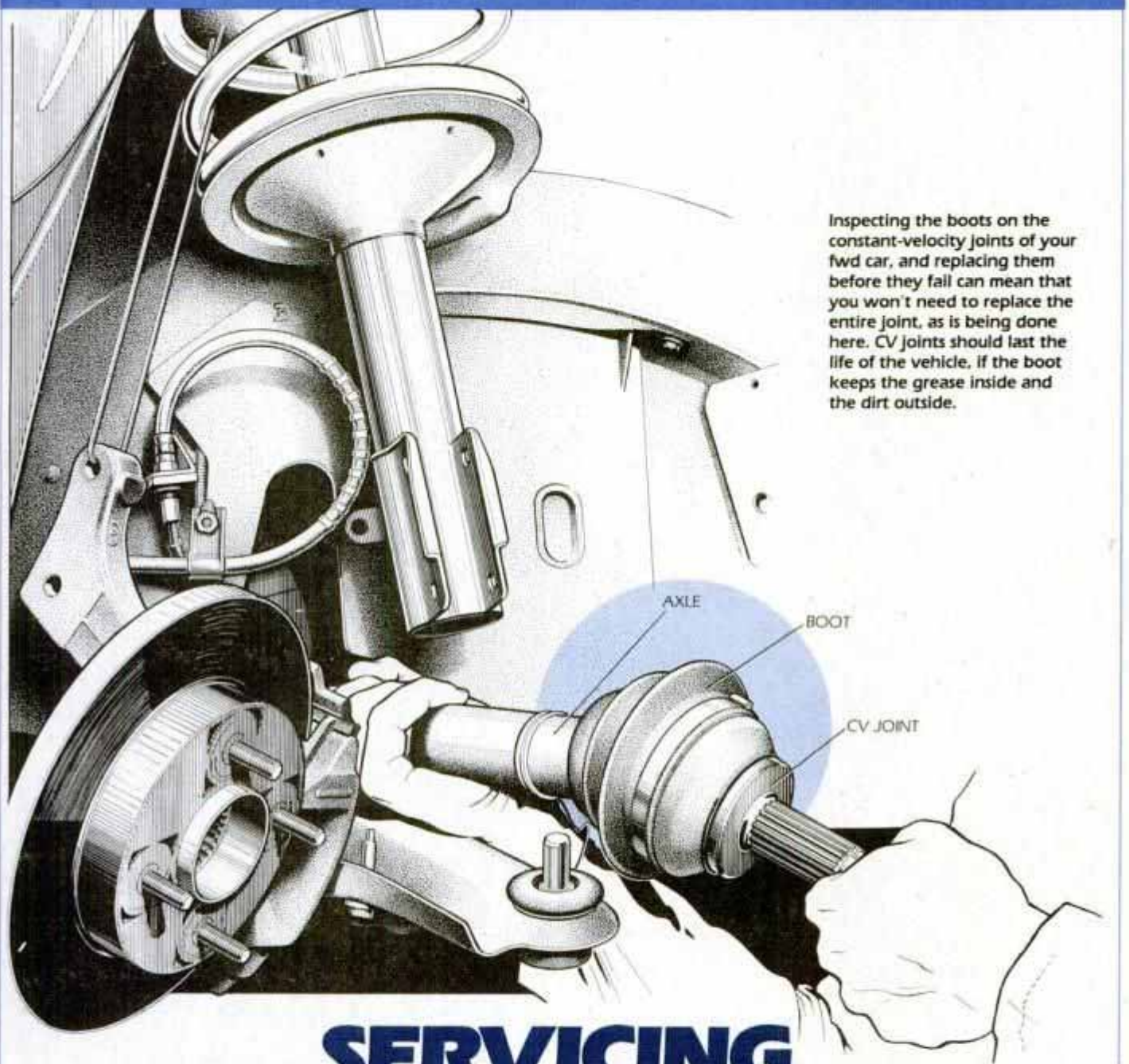
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# SATURDAY MECHANIC



Inspecting the boots on the constant-velocity joints of your fwd car, and replacing them before they fail can mean that you won't need to replace the entire joint, as is being done here. CV joints should last the life of the vehicle. If the boot keeps the grease inside and the dirt outside.

## SERVICING CONSTANT-VELOCITY JOINTS

BY MORT SCHULTZ

**I**N THE 10 years since Chrysler's Omni/Horizon and Ford's Fiesta introduced front-wheel drive and CV joints to modern cars bearing U.S. nameplates, the number of fwd/CV-joint equipped models has increased rapidly. It's now approxi-

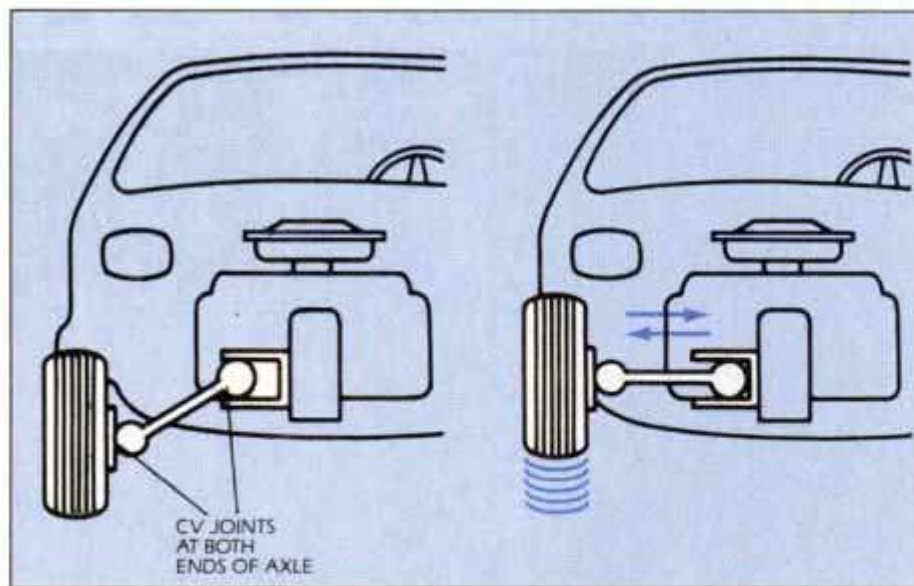
mately 75 percent of the vehicle population. By the mid-1990s it's expected to be more than 90 percent.

Constant velocity joints aren't restricted to cars with front-wheel drive. They are a fixture on 4-wheel-drive models and are seeing increased

use on rear-wheel-drive cars with independent rear suspension. If the mail sent to PM's "Car Clinic" is an indication, there are many wrong impressions about CV joints among car owners.

Front-wheel-drive cars have two





1 CV joints must permit axle to bend, as well as allow length of axle to change.

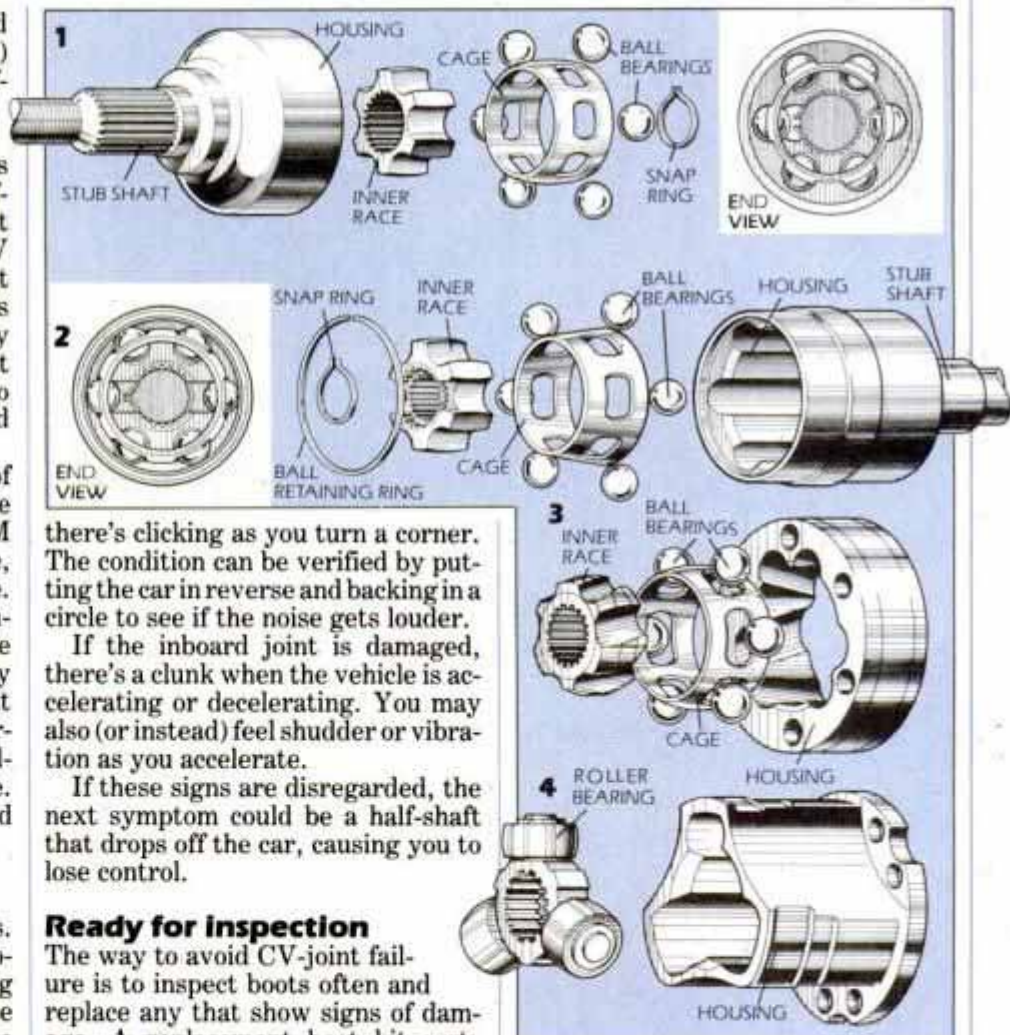
axles or driveshafts, usually called half-shafts. A constant-velocity (CV) joint attaches one end of each half-shaft to the differential part of the transaxle. This joint is called an inboard CV joint. Another CV joint is used on the other end of each half-shaft to transmit power to a front wheel. It's called an outboard CV joint—also a fixed joint, which is not really true because this joint does bend up and down. CV joints not only need to bend, but also must permit the length of the axle assembly to change as the wheel travels up and down. (Fig. 1)

Virtually all outer CV joints are of the Rzeppa fixed type, but there are several types of inners. Ford and GM use the double-offset plunging type, while GM also use the tripod type. Tripod types use roller bearings rather than large balls and grooves. The Rzeppa cross-groove type looks very similar to the Rzeppa fixed type, but its grooves cross rather than run parallel. Like all inner CV joints, it allows the length of the axle to change. They *all* use a boot, and are serviced in a similar fashion.

### The all-important boot

CV joints don't have grease fittings. Instead, they are protected by neoprene or polyurethane boots. As long as the boot stays intact, grease packed inside continues to lubricate the joint. CV joints, therefore, *could* last the life of the car.

When a boot fails and a joint loses grease and is damaged, you'll know it. If an outboard joint is affected,



there's clicking as you turn a corner. The condition can be verified by putting the car in reverse and backing in a circle to see if the noise gets louder.

If the inboard joint is damaged, there's a clunk when the vehicle is accelerating or decelerating. You may also (or instead) feel shudder or vibration as you accelerate.

If these signs are disregarded, the next symptom could be a half-shaft that drops off the car, causing you to lose control.

### Ready for inspection

The way to avoid CV-joint failure is to inspect boots often and replace any that show signs of damage. A replacement boot kit costs about \$10—versus \$100 or more for a new CV joint.

How often should you take a look at boots? Some say every 12,000 miles, but a lot can happen to a boot in 12,000

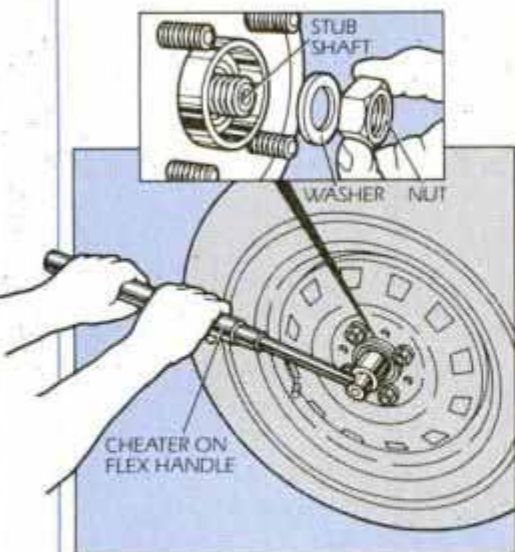
miles. Therefore, examining boots once a month is more like it.

It's easiest to do with the car up on a lift, but a careful inspection can be done in your driveway by looking at the boots from under the front bumper. Turn the steering wheel all the way to the left or right to spread out the folds of the boot. Be sure to move the car a foot or so several times and check all the way around the boots.

Look for grease on the boot—then for cracks, splits, tears and holes. See to it that clamps are still tight. If you can wiggle one by holding a screwdriver to the band and pushing, cut the clamp off with metal shears, being careful not to slice the boot. Slide the boot back so you can scoop out a little grease. If the grease looks milky, it's been contaminated with water. Now, rub the specimen between your fin-

2 Four types of CV joints: 1. Top to bottom: Rzeppa "fixed" outer joint. 2. inner double-offset plunging joint, 3. Rzeppa cross-groove CV joint (note that grooves are crossed, unlike fixed joint), 4. tripod joint.





**3** It might take a cheater handle on your big flex handle to break loose the hub nut. Nut should be replaced, not reused (inset).

gers. If it's gritty, dirt has gotten into the joint.

If grease is contaminated, remove the shaft from the car and remove both CV joints. Whenever you remove a half-shaft, it's wise to examine both joints and install new boots even though only one is suspect. Assuming the joints are okay and don't have to be replaced, clean away old grease, apply fresh grease and install new boots. Be careful to keep from contaminating the inside of the joints with dirt from the outside of the old boot. You don't need to disassemble the CV joint to clean it. You'll find the Rzeppa types in particular almost impossible to reassemble, so be careful. If you do disassemble, be sure to reinstall all the parts in their original relationship to one another, to maintain the proper wear pattern. Replace the clamp with a new one.

### No place for Disney

Some may try to seal a hole in a boot by wrapping it with tape and loosening the clamp to pack in grease to replace what has been lost. This Mickey Mouse "repair" won't last long, because it's practically impossible to get tape to stick to the convoluted surface of a boot. Nothing beats doing the job the right way.

### Getting help

As always, the best source of information on repairing your particular car is the authorized factory service manual. Also, specific instructions are provided with replacement CV-joint boots made by Moog Automotive,

TRW and Perfect Circle. If you still encounter difficulty, Moog has volunteered to help. Call toll-free (800) 325-8886 between 8 a.m. and 6 p.m. Eastern time, Monday through Friday.

Naturally, the people at Moog hope you'll buy their product. The Moog Superboot comes with all parts necessary to install a new boot, including the hub nut (if the car manufacturer recommends that this be replaced), clamps, snap rings and just the right amount of the grease recommended for lubricating the joint. You can buy cheaper boots than those offered by the car manufacturer, Moog, TRW and Perfect Circle, but that's what you'll probably get—a cheap boot without the other stuff that's needed.

### Split down the middle

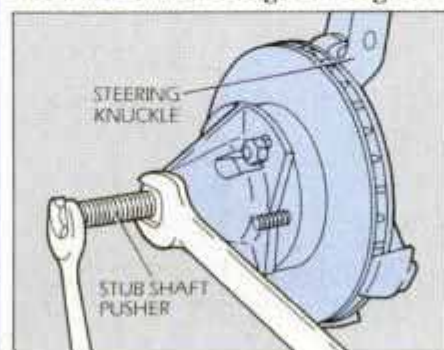
In buying replacement boots, you will probably come across the split boot. It has a slit across the boot to make it possible to replace a boot without removing the half-shaft from the vehicle. The split boot is spread and wrapped around the CV joint. The slit is then sealed with glue and/or bolts.

Theoretically, it sounds great and, if split boots really did a good job, they would save a lot of work. Split boots pose many serious drawbacks:

- It's almost impossible to clean the contaminated or dried-out grease out of an old CV joint without removing it from the car. Replacing the boot and leaving all that junk inside the joint doesn't make any sense.

- Temperature and humidity have to be just right for glue to cure and weld the seam securely enough to prevent the loss of grease. If the split boot is installed at less than the recommended temperature (generally around 60° F), the seam won't seal. The same problem is encountered if the humidity is too high.

- Split boots held by bolts alone permit water and dirt to get through the

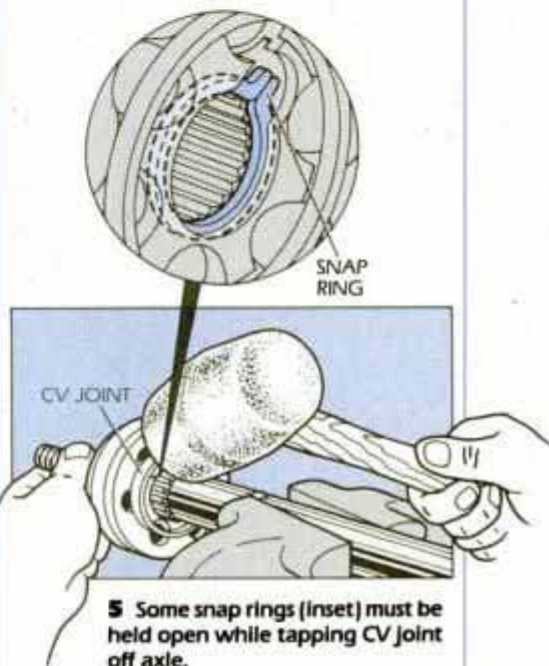


**4** Special tool might be only way to push stub axle out of wheel hub. Try renting.

seam to damage the CV joint.

- With the half-shaft mounted on the car, the angles of the CV joints are such that it's difficult to force the proper amount of grease into the boot. Furthermore, there's a good chance that the lips of the slit seam will be contaminated by grease. Once this happens, you have to throw the boot away, because glue used to seal the seam will not stick to grease.

- After letting the glue cure for 1 hour, you can drive the car, but you



**5** Some snap rings (inset) must be held open while tapping CV joint off axle.

have to try and avoid sharp maneuvers for the next 36 hours.

- A split boot is as much as double the price of a high-quality, 1-piece, sealed boot.

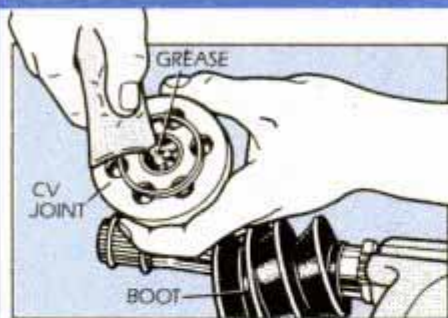
### How to take 'em off

The steps involved in removing a half-shaft from a fwd car are as follows:

1. With all four wheels on the ground, loosen the axle hub nut (Fig. 3). Use a breaker bar or torque wrench—never an impact wrench, since the hammering effect may damage a sound CV joint or the differential gears. Many manufacturers, including Renault, Chrysler, Ford and GM, recommend replacing the axle hub nut. A good way to know if the hub nut of your particular model requires replacement is to look in the hardware bag that comes with the new boot. If there's a new hub nut, use it.

2. Raise the car and examine how the inner-joint stub shaft is attached to the transaxle. If it's pressed into the





6 Fill CV joint with lubricant grease supplied. Put the excess inside of the boot.

transaxle, first disconnect the outer stub shaft from the steering knuckle before separating the inner joint from the differential. If the inner joint stub shaft is bolted to an output flange at the transaxle, first unbolt the inner joint before disconnecting the fixed joint from the steering knuckle.

3. Disconnect the brake hose clip and remove the brake caliper. Support the caliper by hanging it with a length of wire. Before separating the steering knuckle from the MacPherson strut, mark the relative positions of the eccentric bolts with respect to the strut. This should allow you to get the camber setting back where it belongs when you reattach the steering knuckle and strut. These eccentric bolts, with their egg-shaped heads, control camber, and wheel alignment might be necessary if you don't get them back exactly where they belong. Unbolt the steering knuckle from the ball joint.

4. The steering knuckle is now free and can be separated from the half-shaft by pushing it out as you pull back the shaft. If you can't get the two to part company, do not pound on the end of the shaft with a hammer, because chances are you'll ruin a wheel bearing, CV joint, the splines in the hub and/or the differential gears. Instead, try prying the two apart. If this doesn't work, use a pusher like the one illustrated in Fig. 4 to push the fixed CV-joint stub shaft out of the hub. When the fixed joint end of the half-shaft is free, wrap wire around it so you can support the shaft by tying it to the car as you release the other end. If you let the shaft dangle, the inner CV joint may pull apart.

### At the inner end

You have to separate the inner-joint stub shaft from the differential either by unbolting the joint or by pulling it out with enough force to overcome the retention of the snap rings,

or circlips, on the stub shaft. If you have to pull, place one hand on the outer CV-joint housing and the other hand on the inner housing. Try not to pull on the shaft, because the joint may come apart.

If the stub shaft is held in the differential by a snap ring, you may have to slip a large screwdriver, pry bar or slide hammer between the plunging joint and differential housings to get the shaft out.

### New boots

Outer and inner CV-joint service is done much the same way. Outer-joint service is discussed here. If you can handle it, you'll be able to service an inner joint without trouble.

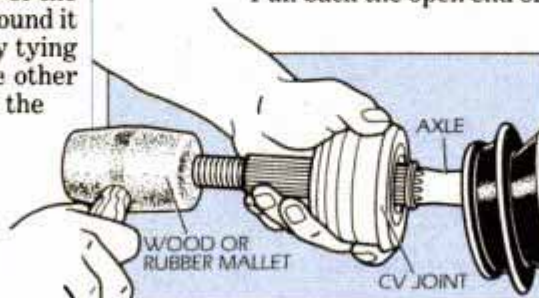
Mount the shaft in a vise that has a soft-jaw adapter. If you don't have an adapter, place rubber or wood strips between the vise jaws and shaft.

Make a mark on the shaft where the outer boot ends, so when you install the new boot you can bring it right to this spot. Then, remove the clamps and cut off the old boot. Wipe away grease and use a mallet to tap the joint from the shaft (Fig. 5). You may need to hold open the snap ring with a pair of snap ring pliers or a screwdriver while you tap. You can now examine the joint which, if damaged, must be replaced.

To reassemble, wipe away any grease that remains on all parts and slide a new clamp and boot on the shaft. Install the stub shaft snap rings, squeeze the proper amount of lubricant from the tube in the replacement kit into the CV joint (Fig. 6), place the joint on the main shaft and give the end of the stub shaft a sharp rap with the rubber mallet until it clicks into place (Fig. 7).

Bring the edge of the boot to the mark you made—then, using a clamp crimping tool (pliers) or for screw clamps a screwdriver, tighten the inner clamp.

Pull back the open end of



7 Reset CV joint on axle by tapping with mallet until snap ring seats.

the boot and empty into the boot whatever grease remains in the tube. Use all the grease. Then, draw the large end of the boot over the CV-joint housing, but don't tighten the clamp yet. You have to "burp" the boot.

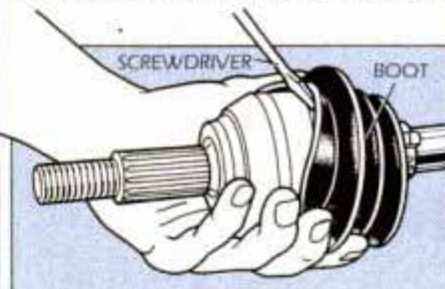
### Pardon me

Burping the boot means equalizing air pressure on each side of the boot. Otherwise the boot can collapse or billow out, depending on whether there's too much or too little air inside. Either way, unequal air pressure can make the boot fail prematurely.

To burp the boot, slide the tip of a small screwdriver under the lip of the boot and lift (Fig. 8). Then, let it fall back into place, bring the large clamp into place and tighten.

*Note:* In some setups, the boot and large clamp come assembled and pre-tightened.

After servicing the joints, carry the assembly back to the car, insert the



8 Use screwdriver to "burp" boot to equalize pressure before tightening clamp.

plunging-joint stub shaft into the differential (press hard until you hear a click if it's held by a snap ring) or bolt it to the differential flange.

After installing the fixed joint side and reassembling the ball joint, steering knuckle and brake caliper, the only other thing you have to take special care with is installing the hub nut. Manufacturers call for torquing to the 200-ft.-lbs. area.

If you don't have a torque wrench that reads as high as 200-ft.-lbs., use this technique: Borrow the bathroom scales from the house. With a breaker bar or cheater handle, mark a spot 2 ft. from the center of the axle.

Tighten the nut most of the way, and index the socket so the handle is level with the ground and set to tighten the nut when you push down. With one foot on the scales and the other on the spot on the handle, step down until the scales read 100 pounds less than your weight.

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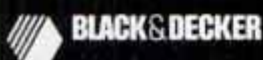
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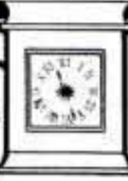
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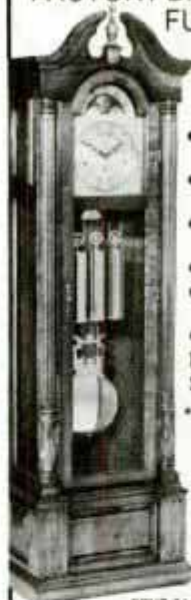
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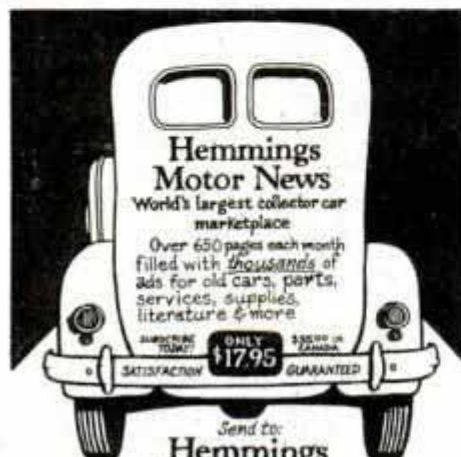
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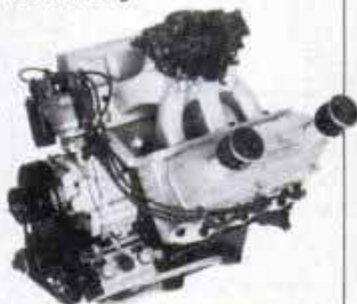


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