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Get GM Performance Parts wherever you see these signs.



# Popular<sup>®</sup> Mechanics

FEBRUARY 1990  
VOLUME 167  
NO. 2



## 56 COVER STORY

Aircraft size takes a flying leap into high-tech design and increased weight capacity.

—PM illustration by Attila Hejja



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POPULAR MECHANICS (ISSN 0032-4558) is published monthly by The Hearst Corporation, 224 West 57th Street, New York, NY 10019, U.S.A. Subscription prices: United States and possessions, \$15.94 for one year; \$27.94 for two years. Canada and all other countries, add \$16.00 for each year. Second-class postage paid at New York, NY, and additional mailing offices. Authorized second-class mailing-in-Canada privileges by Canada Post, Windsor, Ont. Send returns to Canadian Direct Mailing Sys. Ltd., 920 Mervin St., Windsor, Ontario N9A 7C2. Registered as second-class matter at the Post Office at Mexico D.F., Mexico, June 20, 1960, © 1990 by The Hearst Corporation. All rights reserved. Printed in U.S.A. POSTMASTER: Send address changes to Popular Mechanics, P.O. Box 7170, Red Oak, IA 51591.



# EDITOR'S NOTES

**P**resident Bush has declared war on drug dealers. Drugs are a blight on our society—in my opinion, the most pressing problem facing America today. Now we are at war with the drug dealers, smugglers, importers, kingpins and underworld slugs who feed off the victims of their plague. And make no mistake about it. It is war. Total war.



Sci/Tech Editor Dane at the network's nerve center.

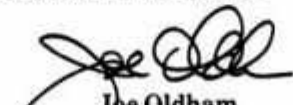
Now, finally, the weapons of war are being brought to bear against the enemy—everything from automatic assault rifles to F-16 jet fighter planes. Everything from the North American Air Defense Command to the U.S. Customs Service and the Coast Guard. Science/Technology Editor Abe Dane recently observed in action the many facets of this high-tech system of interdiction and came back with some good news. It's going to be more and more difficult for the smugglers to get their poison into this country from now on. Read his report starting on page 49. . . . If this is the February issue, can the spring boating season be far behind? No, and we're going to help rush things along here by offering you our annual new boat issue. This is a year of high style and megawatt motors. It all begins on page 93. . . . With the new spate of minivans from General Motors and the Japanese car manufacturers, Chrysler's Dodge Caravan/Plymouth Voyager minivan is feeling the heat. The Caravan/Voyager has been the benchmark

vehicle in this category since its introduction. Can the Pentastar stave off the invading marauders? Find out on page 62. . . . Starting this month, a new column on the financial aspects of home management will appear in POPULAR MECHANICS. Our new columnist is internationally recognized financial adviser David Elias. Elias's Buffalo, New York-based firm manages more than \$200 million for individuals and corporate pension and profit-sharing plans. In each of the past



New contributor David Elias.

three years, Elias was chosen by *Forbes* magazine as one of the nation's top five stock selectors, and by *Money* magazine as one of the best money managers in the United States. You may have seen him on TV on "The Today Show," Cable News Network's "Moneyline" and PBS's "Nightly Business Report." Perhaps he can help me balance my checkbook. Till next time.

  
Joe Oldham

# Popular Mechanics

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# THE OFFICIAL MILITARY ISSUE GENUINE LEATHER A-2 FLYING JACKET

## A Piece of American History.

The A-2 Leather Flying Jacket is one of the most famous pieces of battle gear in history. During World War II, the brave pilots of the U.S. Army Air Forces relied on the A-2 for protection and comfort. Worn by the daring "Flying Tigers" who fought over China in their P-40 Warhawks. And Jimmy Doolittle's B-25 bomber squadron that hit Tokyo in a daring carrier-launched raid. Lightweight and comfortable yet "tough as nails," the A-2 identified its wearer as one of an elite, brave breed of fighting men.

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The Cooper A-2 Leather Flying Jacket can be yours for just \$249\*, payable in six convenient monthly installments of \$42.75 charged to your credit card. Your satisfaction is guaranteed. If you are not completely delighted with your jacket, simply return it in original condition within 30 days for exchange or refund. Order today. Available in even



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# TIME MACHINE

75 YEARS AGO: FEBRUARY 1915

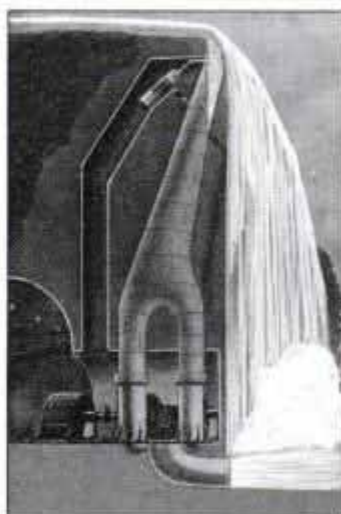


## Midwinter Diversion

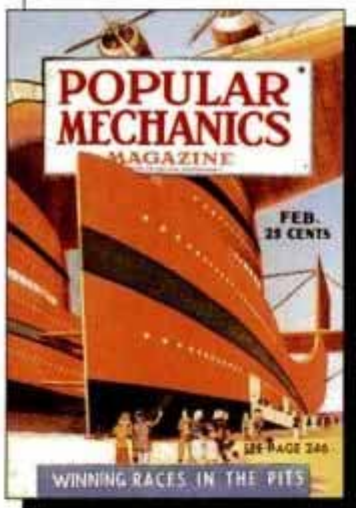
Brightening our deep-winter cover was a fresh-faced snow maiden dashing among the pines astride a coasting novelty. The newly patented single-runner sled was said to have surprising stability and, with less surface area on the snow, it could reach greater speeds than conventional 2-runner designs. Offering maneuverability nearly on par with a motorcycle, the single-runner sled was steered simply by leaning into curves.

## Harnessing Niagara

Before environmental impact statements, the splendor of Niagara Falls brought one thing to the mind of an enterprising inventor: wasted energy. He proposed a scheme by which 75-80 percent of that energy could be recovered, without harming the landmark's appearance. Penstocks would catch a portion of the water below the crest of the Falls. Led down through sluiceways, the water would drive turbines and then be discharged at the base of the Falls.



50 YEARS AGO: FEBRUARY 1940



## Aerial Ocean Liner

At a time when flying boats were among the world's largest aircraft, an American came up with a scheme to top them all. John Molinet exhibited a model of a 500-passenger superliner with transatlantic range. Propelled by six electric motors, powered by dynamos burning 50 gallons of fuel oil per hour, it would fly at 200 mph. Passengers could stroll along a glassed-in promenade along the wing's leading edge, or retire to accommodations in the giant pontoons.

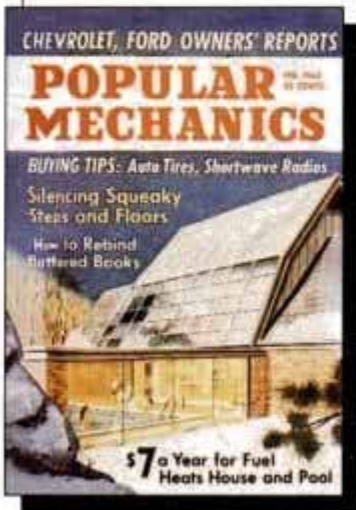
## Radio Goes To War

America strained to hear as the greatest radio drama in history unfolded across the Atlantic. For the first time, live broadcasts brought into people's homes the sound of gunfire, artillery and warplanes—the pulse of the raging European conflict. To make it all possible, NBC and CBS marshalled armies of technicians and foreign

language specialists (listening to shortwave below) and built special-purpose facilities to get word to hundreds of stations in seconds.



25 YEARS AGO: FEBRUARY 1965



## Solar Pioneer

While most were content with cheap oil, Harry E. Thomason was looking for a better way. PM recounted his independent-minded experiments in solar homebuilding. Practically all was done from scratch. Neighbors gawked as he put a 1600-gallon water tank in his basement, then surrounded it with 50 tons of rock. Just as baffling were the solar collectors on the roof. In the end, though, he had a house that consumed only \$7 worth of fuel oil in an entire winter.

## Scouting The Moon

Although the Apollo program was already well advanced, there were still a lot of frightening unknowns about the nature of our astronauts' destination. Would dust swallow them like quicksand? Would it clog their gear? *Surveyor*, the probe that would soon be sent to fill in the blanks, was featured in our February issue. Launched a little more than a year later, the first of seven *Surveyors* beamed back 11,150 pictures of the Moon. **PM**





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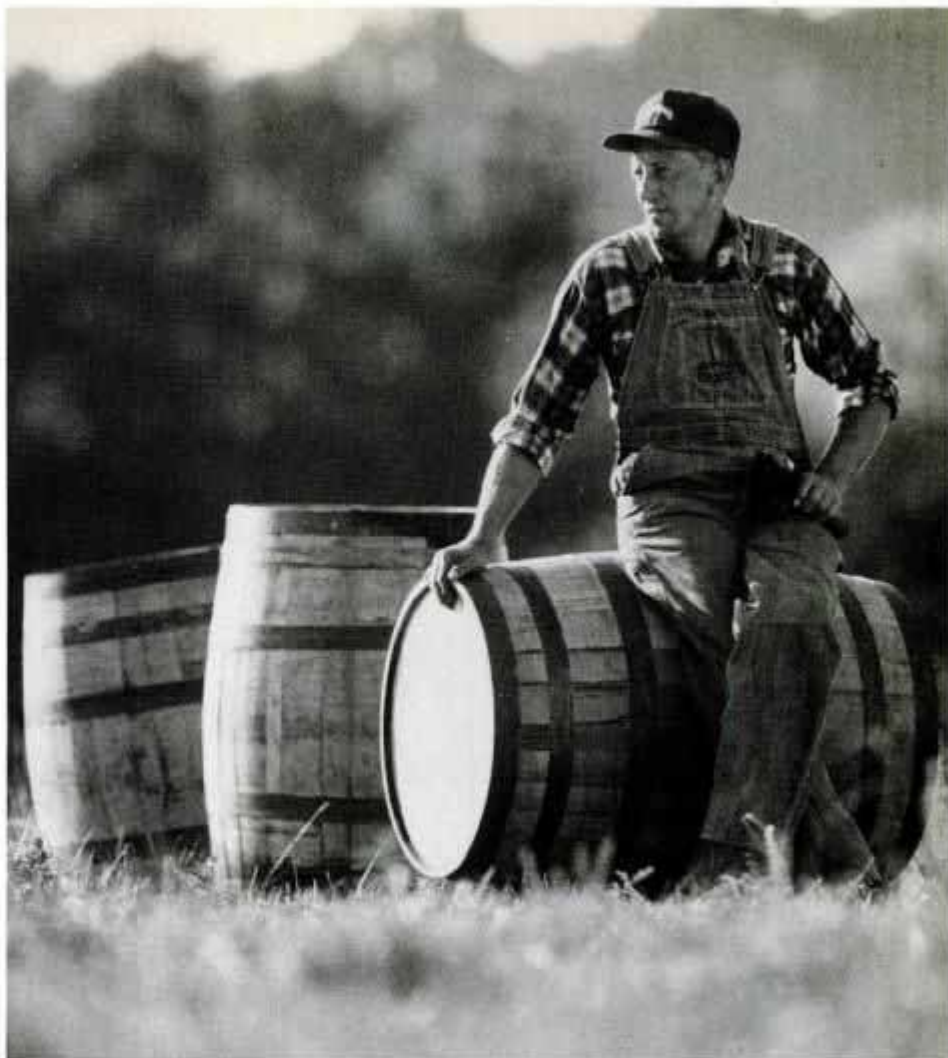
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POPULAR MECHANICS is published monthly by the Hearst Corporation, 959 Eighth Avenue, New York, NY 10019, U.S.A. Frank A. Bennack Jr., President; Randolph A. Hearst, Chairman; Harvey L. Lipton, Vice-President and Secretary; Edwin A. Lewis, Vice-President and Treasurer. Hearst Magazines Division: Gilbert C. Maurer, President; D. Claeys Bahrenburg, Executive Vice-President; K. Robert Brink, Executive Vice-President; George J. Green, Executive Vice-President; Mark F. Miller, Executive Vice-President, General Manager; Raymond J. Petersen, Executive Vice-President; Thomas J. Hughes, Vice-President & Resident Controller.

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If you like our charcoal mellowed whiskey we hope you'll write us and say so. We promise to write back.

AT JACK DANIEL'S DISTILLERY, men take pride in a whiskey-making tradition that calls for moving slowly.

Every drop of Jack Daniel's is seeped through room-high mellowing vats prior to aging. It's an old Tennessee process that simply can't be hurried. Then, we wait while our whiskey gains more smoothness in charred oak barrels. Admittedly, there are times when it looks like we're hardly working. But after your first sip, we think you'll appreciate our laid back ways.

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# LETTERS



Drag racing, jet-style: Craig Arfons (in Camaro, foreground) and Roger Gustin in a race in Memphis, May '89.

ish. Cost was \$128.78 for red oak, chains, hardware and finish (another \$120 if you include my night classes). A project like this deserves to be personalized, so I'm having a brass inscription plate made that will be mounted on the back upper rail of the swing. Thanks for the detailed plans and construction steps that were part of the story.

DAVID S. GABRIELLE  
WYCKOFF, NJ

*Plans for both the porch swing and lattice fence are part of the stories mentioned. A photocopy of the swing story is \$4.50 and the fence \$1.50. Available from POPULAR MECHANICS, P.O. Box 1014, Radio City Station, New York, NY 10101.*

## Hotlines Are Hot

I think your reader Hotline is a great idea. It's a real service and no other magazine has anything like it. However, here's my gripe. I've been trying for a month to get through to Mike Allen to ask a question. His Hotline is busy from 3 to 5 pm every Wednesday. I know, I've been trying to get through constantly. No luck. What gives?

LEO VECCHIONE  
CLIFFWOOD BEACH, NJ



Old-fashioned porch swing built by PM reader David Gabrielle is from July '83 issue (page 94).

## The Need For Speed

I WANT TO thank Joe Skorupa for the story and tribute to Craig Arfons ("Outdoors: Final Run For A Speed Legend," page 26, Nov. '89). My first jet-powered race car was built by Craig's dad, Walt, in 1972. When Craig was racing his own jets, we were fierce competitors, but always close friends. Since 1985, Craig built all the engines for my team cars. Last year he joined our team as a driver, and in June of '89, he defeated me in a race in Michigan in our Black & Decker Univolt jet car to break my 3-year win streak. Craig was like a brother to me and my two brothers, Phil and Bill, who manage our race-car operation. In the 32 years I have spent in drag racing, I have never met a more talented person than Craig Arfons. Our team has suffered a great loss professionally, but each of us has lost a true friend.

ROGER GUSTIN  
ETNA, OHIO

## Fence Me In

A few minutes with your June '89 issue and I knew I had just the fence to run the length of my property line. The sectional design topped with lattice in "Private Domain," ("Outdoor Structures," page 83) is ideal. My

fence is 102 ft. long, 92½ in. high and constructed completely of redwood lumber. My investment was \$527 for materials and I completed the job in about 3½ weeks. I've received many compliments on the project and thank you for the plans.

RON E. WALKER  
LITTLETON, CO

## A Real Swinging Time

My wife and I bought our first home in Feb. '86 and looked long and hard for the right seating arrangement for the front porch. Once we decided on a porch swing, we combed catalogs and outdoor stores for the right one, but found nothing to our liking. So, I went through past issues of PM and, Bingo!, found exactly what we were looking for: "Build PM's Old-Fashioned Porch Swing" (page 94, June '83). I enrolled in a local adult education wood-working course, since I haven't done much work with wood since high school. Well, the swing turned out just beautifully. It's finished with Minwax indoor/outdoor polyurethane satin fin-

*Simple: Mike spends two solid hours once a week speaking to readers, first come, first serve. It's a dialogue he loves, but you can understand that with 8 million readers two hours don't go very far, especially with a magazine to publish.*

*So, hang in there, or write to Car Clinic if you have a specific car problem.*

## We Hear You!

When I was a kid, my grandfather gave me a gift subscription to PM every year. I devoured each issue as only a kid can do, and the things I learned helped me fix and create things as I've moved around the world.

Somehow, though, after my granddad died, I neglected to renew the subscription myself. That was in 1960, and possibly my head was turned by college, or girls, or other endeavors less straightforward than PM's topics.

I recently renewed my subscription: What a delight! It's like reliving those joys of boyhood I experienced. I still devour each issue (even the classified ads, which I used to use to fill the house with the oddest assortment of gadgets). The recent issue that featured Ro Capotosto's handmade wooden secretary ("Woodworking Guide," page 71, Nov. '89) was truly magnificent. I'll save it forever.

The writing is as clear and precise as ever. The diagrams are the same, easy-to-follow ones I remember as a boy. The photos are even better! Hats off to all of you at POPULAR MECHANICS—one of America's great traditions.

BRUCE KINSEY  
ARLINGTON, VA

*Mr. Kinsey, you sure made the PM staff's day!*

PM



# Richland, USA

Taste the richness of America



SATURDAY, 1:30 PM



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

Kings 16 mg. "tar", 1.1 mg. nicotine av. per cigarette by FTC method.





## There's never been a car like Thunderbird. And there's never been a Thunderbird like this.

### **Quality by design.**

The idea is simple: commitment to the excellence of each vehicle component can result in improved vehicle quality overall. An example: over 400 of Thunderbird's mechanical, operational, and comfort features were compared to features on cars like Mercedes 190E, Toyota Supra L, and BMW 633CSi. By employing this kind of detailed analysis, Ford strives to make each new vehicle superior to what we've offered before. It's all part of insuring that Quality is Job 1.

### **Structural integrity.**

Thunderbird was designed with increased structural adhesives at joints and two-part expanding foam throughout.

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

This not only results in reduced noise and vibration in the passenger compartment, but allows for a longer, wider wheelbase that gives the vehicle a more substantial feel over the road.

### **Ride and handling.**

Thunderbird features a four wheel independent suspension with rear control arms and a front tension strut that are "double isolated." All of which helps to insure less harshness in ride and in handling.

"Speed sensitive" rack and pinion steering also adds to the Thunderbird's "feel." It adjusts the amount of power assist from light effort steering at lower speeds to a firmer feel at faster speeds.





### **Power.**

Thunderbird's 3.8 liter V-6 features "low friction" roller tappets and sequential electronic fuel injection. Also, lightweight components like magnesium rocker covers assist in providing a better power-to-weight ratio.

### **Aerodynamics and ergonomics.**

This is the most aerodynamic Thunderbird ever designed. Which translates into less wind resistance, improved handling, and reduced interior noise. Ergonomically, there's more head, shoulder, hip, and leg room than the Thunderbird of just a couple of years past.

### **Fully equipped.**

Thunderbird LX features air condition-

ing, power windows, electronic AM/FM stereo with cassette player, speed control, fuel/distance computer, and full electronic instrumentation. All standard.

### **Best-built American cars.**

The best-built American cars are built by Ford. This is based on an average of consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1."

## **Ford Thunderbird**

Have you driven a Ford...lately?





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# TECH UPDATE

News Of Tomorrow's Technology Today



Based on preliminary plans by the Soviet Sukhoi design bureau, our artist's concept shows likely look of 19-passenger supersonic business jet to be flown in 1993.

PM ILLUSTRATION BY ED VALIGURSKY

## Plan For 1500-mph Business Jet Takes Wing

SAVANNAH, GA—An unprecedented American/Soviet partnership has issued final design specifications for a plane that would jet executives to work at more than twice the speed of sound. By merging their expertise, Gulfstream Aerospace and the Soviet Sukhoi Design Bureau hope to have a prototype flying by 1993.

Intended to speed business travel between the United States and Pacific Rim countries, the jet will have a cabin about the size of the current top-of-the-line Gulfstream IV's, and have a range of about 5000 miles.

Sukhoi, with its experience in building high-performance combat planes such as the Su-27, will do most of the basic airframe work. The Soviets have already pledged

\$1 billion to cover research and development. One critical challenge will be reducing sonic booms, so the plane can fly over populated areas.

Gulfstream's contributions will include avionics, interior outfitting, product support and Western certification. "We will be providing the stuff to make it as Westernized as possible," said Al Balaban, director of corporate communications at Gulfstream.

Engines will be developed by a partnership between Rolls-Royce, which has built the engines for all previous Gulfstream jets, and the Soviet Lyulka Design Bureau. If the supersonic business-jet project succeeds, Gulf-

stream and Sukhoi believe it may serve as the basis for a small passenger liner that

would be a more profitable successor to the 100-passenger Concorde.

### Highlights This Month

- **Earthquake Engineering**—Giant hydraulics and vibration generators simulate the Big One.
- **World's Fastest Train**—France's second-generation TGV *Atlantique* breaks records for speed and comfort.
- **Aircraft Deicing Breakthrough**—Electro-Explosive film shatters ice buildups.
- **TV Of The Future**—Thin-film deposited on glass may bring TV you hang on your wall.
- **Combustion Engineering**—See-through sapphire cylinder lets researchers see inside working engine.
- **Midget Fighter Plane**—All-composite ultralight could be flown from the front lines.

Editor: Abe Dane  
Contributors: Mike Fillon,  
Michael Lamm, Greg Pope



## Machinery Re-enacts Quake

OAKLAND, CA—Engineers are using hydraulic rams, capable of delivering 3.6 million pounds of force, and large eccentric-mass vibrators to learn why California's I-880 collapsed in last October's earthquake.

Two of the vibrators, known as forced vibration generators, have been placed on an intact section of the condemned freeway's upper deck. Each consists of two 100-pound weights spun in opposite directions on a common shaft, rapidly pulling the roadway from side to side with 5000 pounds of force. By running both machines at the structure's natural frequency—about 2½ hertz—resonance is produced that multiplies the force to as much as 100,000 pounds.

After studying the vibration's effects, the engineers



Newer columns (inset left) do without hinge joints (inset right) that failed in collapse of I-880.

will damage the roadway by activating hydraulic jacks attached to the upper deck and to specially built loading frames. Then they'll vibrate the structure again and note any changes. The process will continue until the road-

way is severely damaged.

The collapse of I-880 is now attributed to the failure of column hinge joints that used too little vertical reinforcing steel. Although solid, hingeless columns made this type of construction obsolete in

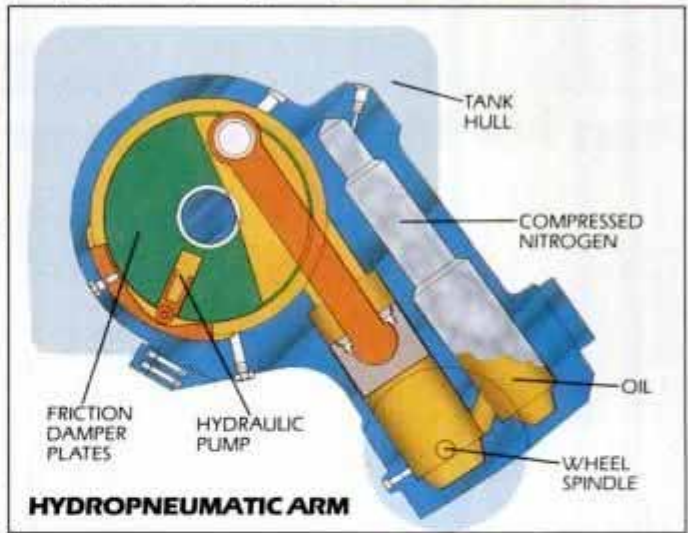
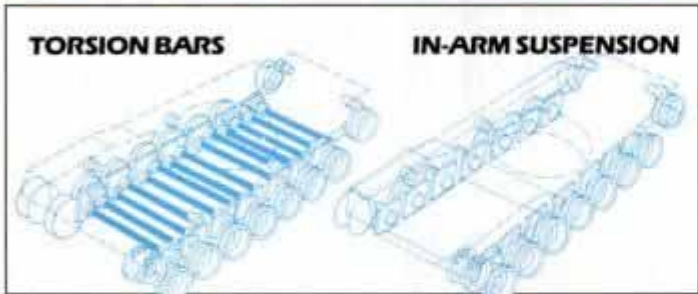
the early 1970s, it remains in many structures built before that. The experiments now being carried out will provide real-world data for computer simulations that will show how to reinforce these structures.

PM ILLUSTRATION BY DEAN ELLIS



CADILLAC GAGE PHOTO

In-arm suspension in trials on M1 tank (left) replaces torsion bars that waste hull space and add weight (below left). Friction damper and gas spring (below right) are kept far apart.



PM ILLUSTRATIONS BY HANK IREN

## Simplified Tank Suspension

WARREN, MI—An ingenious self-contained suspension arm that bolts to a tank's hull may replace complex systems of torsion bars and interconnections that weigh down current fighting vehicles. Called an in-arm hydro-pneumatic suspension, it combines a compressed-nitrogen springing mechanism

with a friction damper in one unit that fits between the tank and its road wheels. As each wheel moves to follow terrain, the arm it's attached to rotates, forcing a piston fixed to a stationary pivot into a cylinder. Oil from the cylinder compresses nitrogen that acts as a spring.

Damping is provided by a

stack of interleaved rotating and stationary plates that are squeezed together by a hydraulic pressure plate. A cam-operated pump varies the pressure, and thus the damping, in response to the arm's position and velocity.

One advantage of this arrangement is that springing and damping functions are kept separate. This prevents the tremendous heat built up

in damping the motions of a large tank from being transmitted to the gas used for springing. In other systems, such heat transfer causes the gas to expand, altering the tank's height and causing track-tensioning problems.

The army is now testing the system aboard an M1 tank. Manufacturer Cadillac Gage hopes to bring it into production this year.



# Special Report: New TGV Breaks Speed Record

PARIS, FRANCE—With a record run of 299.5 mph, the new TGV *Atlantique* blazes past the standard set by the first-generation TGV, and confirms France's mastery of the technology of high-speed rail.

Running between Paris and Le Mans, the new TGV (*train à grand vitesse*, or high-speed train) retains the same basic configuration as the original Paris-Lyon TGV, but a decade's worth of new technology results in a slicker, more comfortable train with a cruising speed of 186 mph—18 mph faster than the old TGV.

In both variants, trailer cars are sandwiched between a pair of power cars. Wheel assemblies rest beneath the adjoining ends of the trailers, keeping vibrations as far from passengers as possible. And axle load is only 17 tons, compared to 22 for comparable German and American trains.

But there are also plenty of changes. Key to the 186-mph cruising speed is a brushless synchronous motor that gen-



SNCF PHOTOS

erates twice the horsepower, yet weighs 10 percent less than its predecessor. Not only does the *Atlantique* get by with only eight rather than 12 motors, but it can haul 10 trailer cars, where the old TGV manages only eight. This cuts power costs per passenger by more than 15 percent, and at 12,000 hp, the train can now handle a 5-percent gradient without losing speed.

What's more, the new TGV *Atlantique* sacrifices nothing in comfort, running even smoother than the first-generation TGV. New pneumatic shock absorbers replace the springs that suspended the body over the bogies. Car-to-car dampers add further to the isolation. The pas-

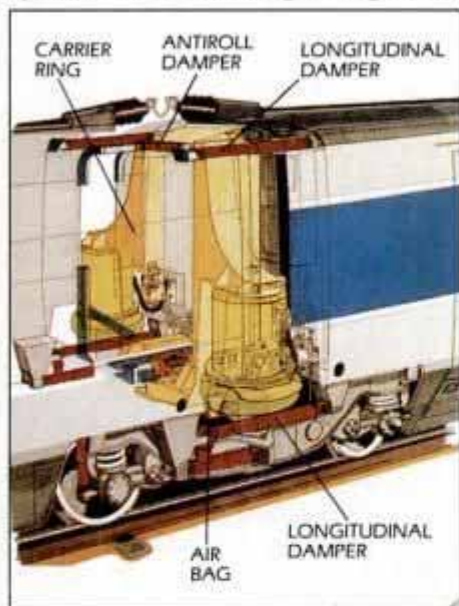


Looking like the Citroën of trains, the ergonomics of the TGV's cab (left) are peculiar but effective. Panel features keyboard and display tied to self-diagnostic system, and to digital public-address system that gives info on LCDs in passenger cars.

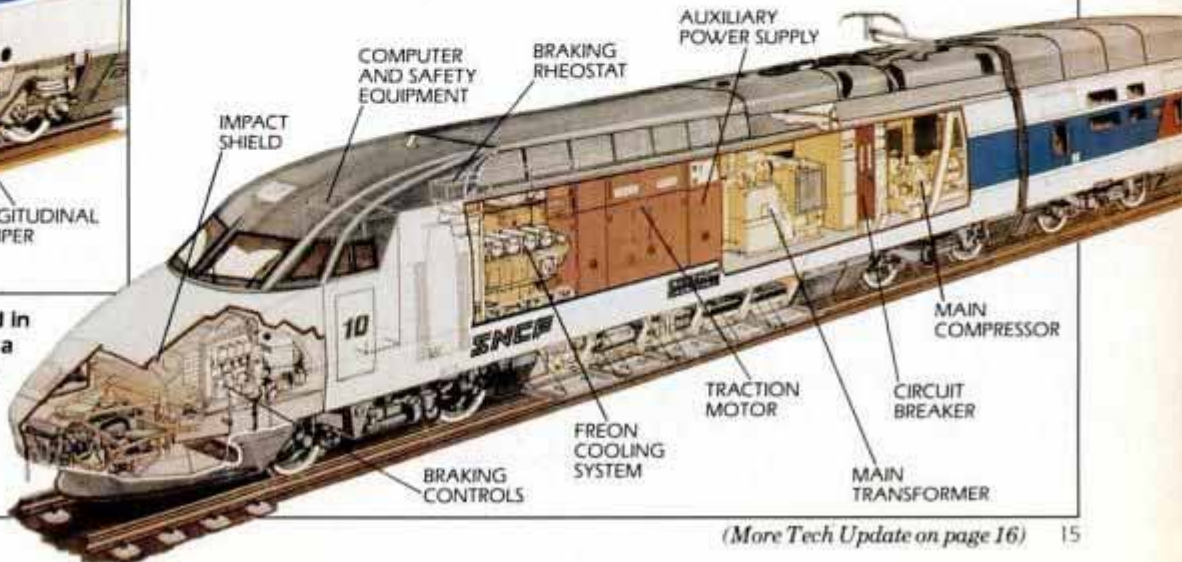
senger areas are unusually quiet, the locomotive rumble is drowned out by a jetlike hiss from air rushing by.

Other changes include microprocessor-controlled disc brakes, improved subcar aerodynamics, and high-voltage power electronics sealed in freon-filled canisters. And unlike the original TGV, which carries no computers, the *Atlantique* train set features an extensive data-processing network.

Although maglev trains now being developed in Japan and Germany have higher theoretical speed potential, France's TGV has the advantage of running on standard European gauge track. Thus, as economic unification proceeds in Europe, chances are good that the TGV will eventually be the mainstay of an integrated high-speed rail network uniting the European continent and Great Britain.



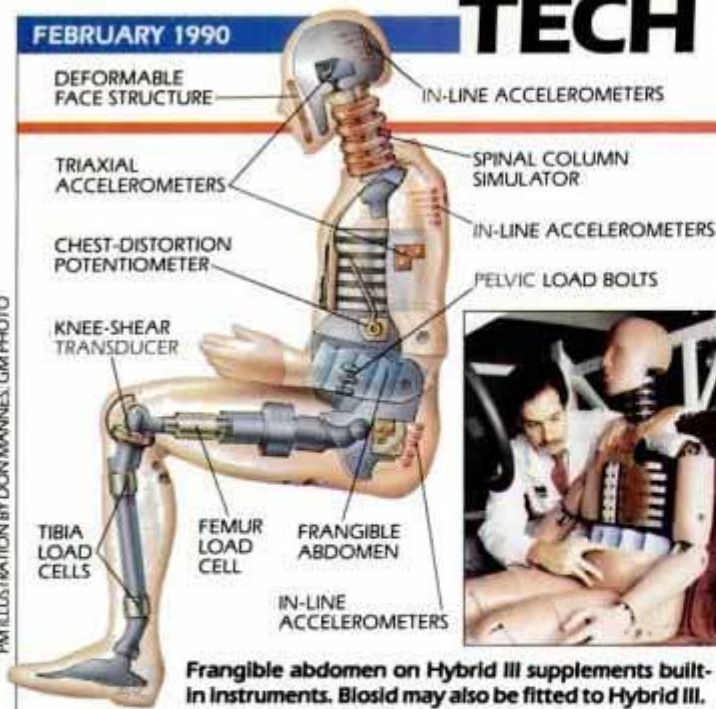
Key improvements incorporated in the TGV *Atlantique* include a pneumatic suspension system between trailer-bodies and wheel trucks, brushless synchronous motors and new electronics in the locomotive.



(More Tech Update on page 16) 15



PM ILLUSTRATION BY DON MANNING, GM PHOTO



Frangible abdomen on Hybrid III supplements built-in instruments. Biosid may also be fitted to Hybrid III.

## More Realistic Crash Dummies

WARREN, MI—Merging the disciplines of engineering, biomechanics, mathematics and physiology, researchers are seeking crash dummies that will report more precisely on what happens to the human body in a car accident.

One challenge has been to develop devices that detect high concentrations of force occurring in small areas of the body. GM has addressed one example of this by adding a so-called frangible abdomen to its Hybrid III anthropomorphic dummy. Essentially

a crown-shaped block of Styrofoam, the new abdomen crushes to record forces that would damage internal organs as a person submarines under his lap belt.

Another concern is what is known as the third impact, which occurs when internal organs are thrown against the skeletal structure. A GM dummy called Biosid uses five damped, spring-steel ribs that replicate the stresses applied to soft internal tissues in side impacts more effectively than earlier designs were able to.

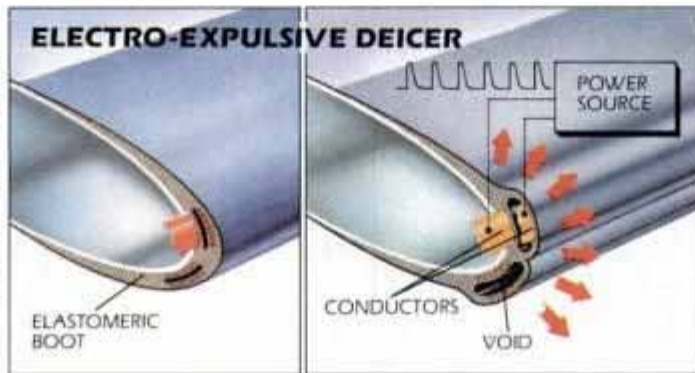


## Electro-Expulsion Breaks Aircraft Ice

AMES RESEARCH CENTER, CA—A NASA researcher has found what may be the best way yet devised to cope with aircraft icing, which has been blamed for 124 fatal accidents between 1977 and 1987.

Known as an electro-expulsive deicer, it consists of two layers of polyurethane sheet, with a conductive copper ribbon sandwiched in each. Direct-current pulses from capacitors surge through conductors creating opposed magnetic fields. These cause the layers to separate a fraction of an inch, pulverizing accumulated ice.

Because the device is only 20 thousandths of an inch thick and operates for just a



Boot on leading edge expands when current is applied. Wind-tunnel photos show effects on ice.

few microseconds at a time, it causes virtually no change in aerodynamics. Leonard A. Haslim, a program manager at Ames and inventor of the system, claims that power consumption is 500 times lower than conventional elec-

tro-thermal deicers, and it's easy to retrofit to existing aircraft.

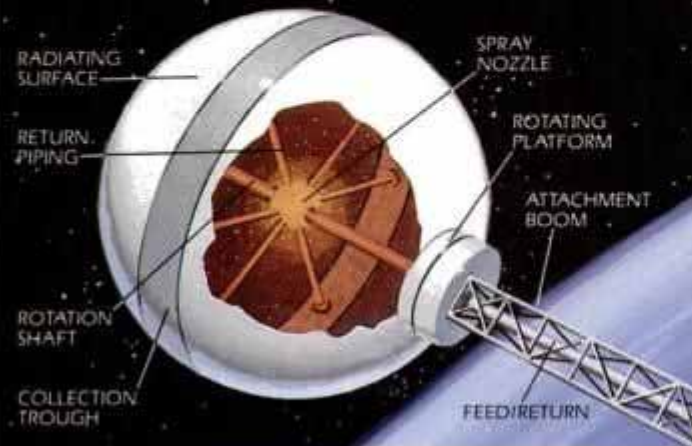
Electro-expulsive deicing has already been tested on NASA's Twin Otter and on Navy F/A-18 aircraft. Results were good enough that



a commercial firm has now been licensed to produce the system for use on military aircraft.

Future uses include deicing ships and transmission towers, and popping parts out of molds.

## ROTATING BUBBLE RADIATOR



Bubble of ceramic fabric permits heat transfer between evaporated coolant from spacecraft systems and the vacuum of space.

## Lightweight Space Radiator

RICHLAND, WA—Battelle's Pacific Northwest Laboratories have patented a radiator that could solve many of the problems associated with keeping spacecraft systems cool.

Called a Rotating Bubble Membrane Radiator (RBMR), the device would be made of flexible plastics and advanced ceramic fabrics, making it 50 percent lighter than conventional radiators. For transport in the Shuttle, it could be folded into a shoebox-size container.

Designed to keep liquid

and gas phases of a cooling medium separate in a weightless environment, the device rotates to simulate gravity. A central spray nozzle emits evaporated coolant, which falls toward an outer membrane bubble as it condenses. Gathered in a trough, or gravity well, at the bubble's equator, the cooled liquid is then piped back to the radiator's center, and back down to the spacecraft. The heat given off in condensation is radiated into space through the membrane.

PM ILLUSTRATION BY ED VAUGHAN

PM ILLUSTRATION BY ADOLPHE BROTHMAN, NASA PHOTOS



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The quality you need, the price you want.

**Spring  
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Starts  
January 28**

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12 pages of the newest  
and best name brand  
fishing equipment...  
specially priced  
for two weeks only.

**SPECIAL PURCHASE!**

Abu Garcia Spinning Reels  
4 graphite body styles...values to \$39.87.  
Choose from Strike Set, Dragmaster, GTI,  
or GTX models, all rear drag.

**YOUR CHOICE 18.88 EA.**





# K mart Spring Preview Sale

## A. Abu Garcia Ambassadeur 4800C Baitcast Reel

Compact pro design casts 15-20% farther, two s.s. ball bearings. Fast cast thumbbar.

**SALE 59.97**

## B. Abu Garcia Ambassadeur Power 4 Baitcast Reel

3.8:1 power retrieve, compact pro design reel, power handle, s.s. ball bearings.

**SALE 49.97**

## C. Abu Garcia Ambassadeur Pro Plus Baitcast Reel

Ultracast with magtrax magnetic control. Graphite construction. 5.1:1 ratio. LH/RH. K mart exclusive.

**EVERYDAY LOW PRICE 29.97**

## D. Abu Garcia Ambassadeur XLT I 2-Speed Baitcast Reel

Best value 2-speed reel on the market. 8.1:1 high speed, 3.8:1 power speed, automog, thumbbar, flippin' switch.

**SALE 79.97**

## E. Abu Garcia "Pro Power" Graphite Rod

Choice of lengths and actions. Fluorescent orange "power" tip design. Spinning or casting models. New lighter weight.

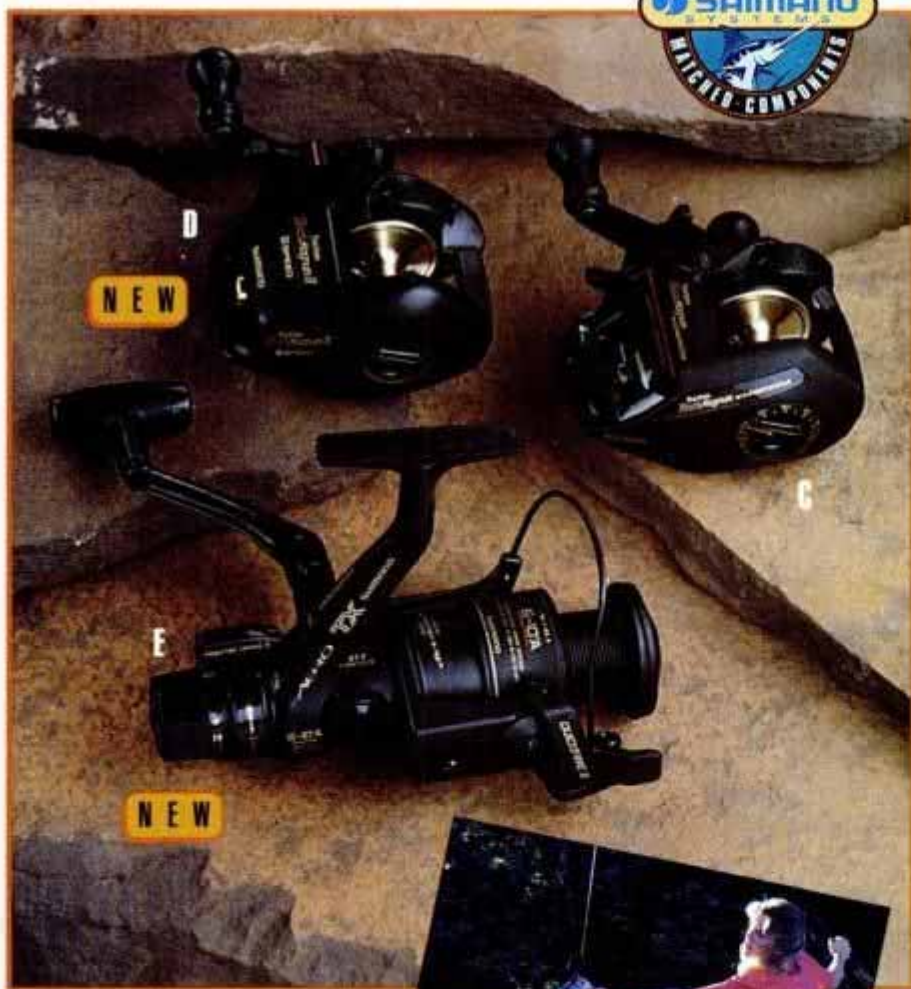
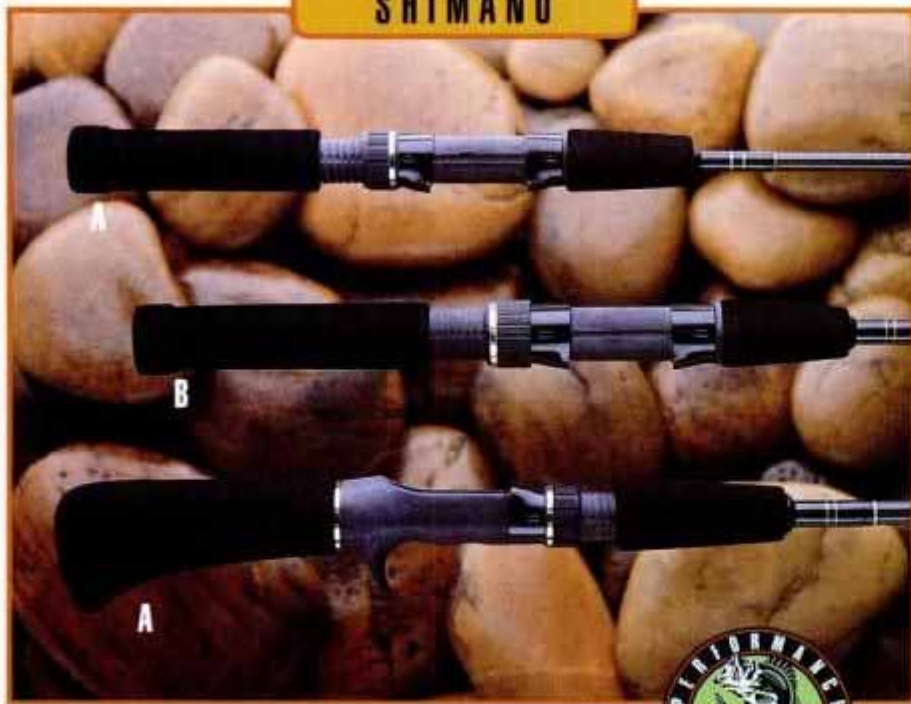
**SALE 24.88**



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SHIMANO



## Gone Fishin'

If you knew how to think like a fish, maybe you'd bring home more from your fishing trips. Learn more about fish behavior, along with other marine gamefishing topics, at the Salt Water Sportsman National Seminar Series 1990, sponsored by K mart. This series is the most complete one day seminar ever held, tackling everything from inshore to offshore fishing. To find out where you can catch the Salt Water Sportsman National Seminar, pick up a brochure in your K mart sporting goods department.

**A. Shimano BTX Rod**  
Magnumlite TX graphite rod. Thru handle blank design. 5'8" cast or 6'8" trigger.

**B. Shimano STX Spinning Rod**  
Magnumlite graphite. Thru handle blank construction. 5'8" or 6'8".

**YOUR CHOICE 34.88 EA.**

**C. Shimano BKM200 Black Magnum Baitcast Reel**

New Fighting Star Drag system with calibrated magnetic spool control. Quickfire casting system. Flippin' switch. Graphite construction. LH/RH. S.S. ball bearings.

**SALE 74.97**

**D. Shimano BKM2000 Baitcast Reel**  
2-speed reel with "on demand" 8:1 or 4:1 lever. Free spool button for casting, flipping. Magnetic spool control. 50% more drag on demand (only in low power gear). Two s.s. ball bearings.

**SALE 89.97**

**E. Shimano TX Aero Reel 6-10A**  
Aero wrap feature for further casting. Fightin' Drag. Quick fire trigger. Two s.s. ball bearings.

**SALE 49.97**



# K mart Spring Preview Sale

**A. Daiwa Samurai Rod**  
Powermesh graphite blank. Dynaflo guides. Sensor grip handle. Blank thru handle construction. Assorted lengths and actions.

**SALE 22.97**

**B. Daiwa #MA1000 Black Baitcast Reel**  
Low-profile design. Magnetic anti-backlash control. 4.7:1 gear ratio. Graphite bearing.

**SALE 29.97**

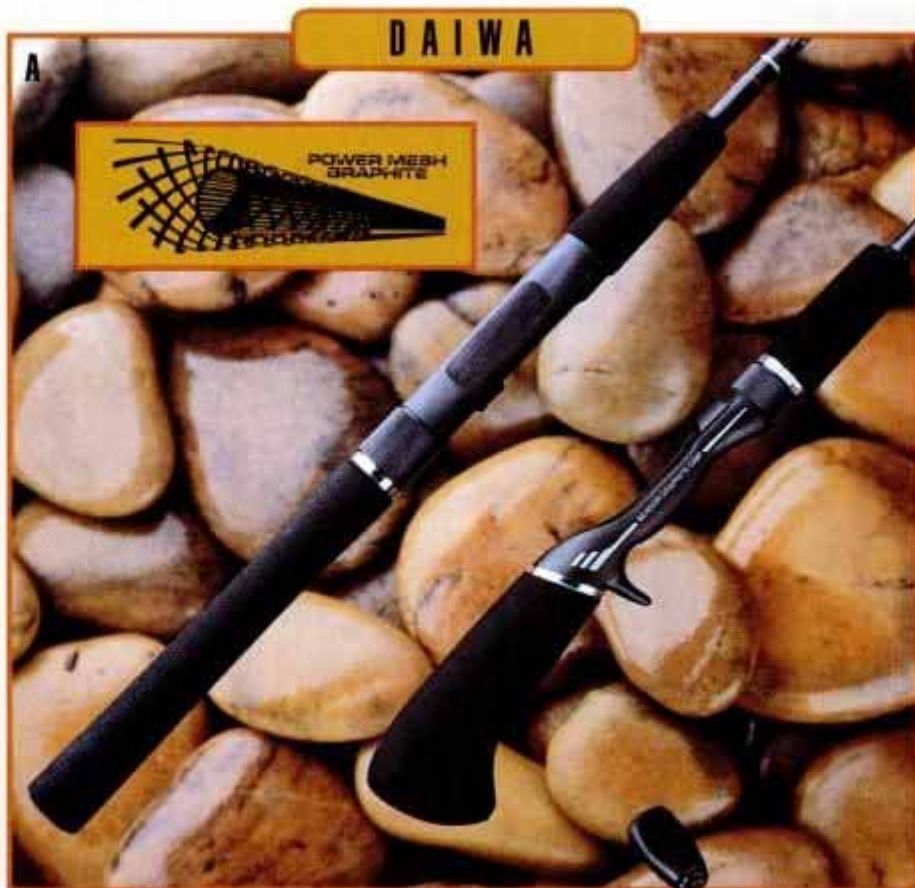
**C. Daiwa #1305 Samurai Spinning Reel**  
Long cast graphite spool puts less friction on line for 10% longer casting. RH/LH retrieve. Autocast<sup>®</sup> ball bearing drive.

**SALE 38.88**

**D. Daiwa PS2-2B Baitcast Reel**  
Two ball bearings. 5.2:1 gear ratio. Magforce anti-backlash control. Flipping selector. Power mesh control.

**SALE 49.97**

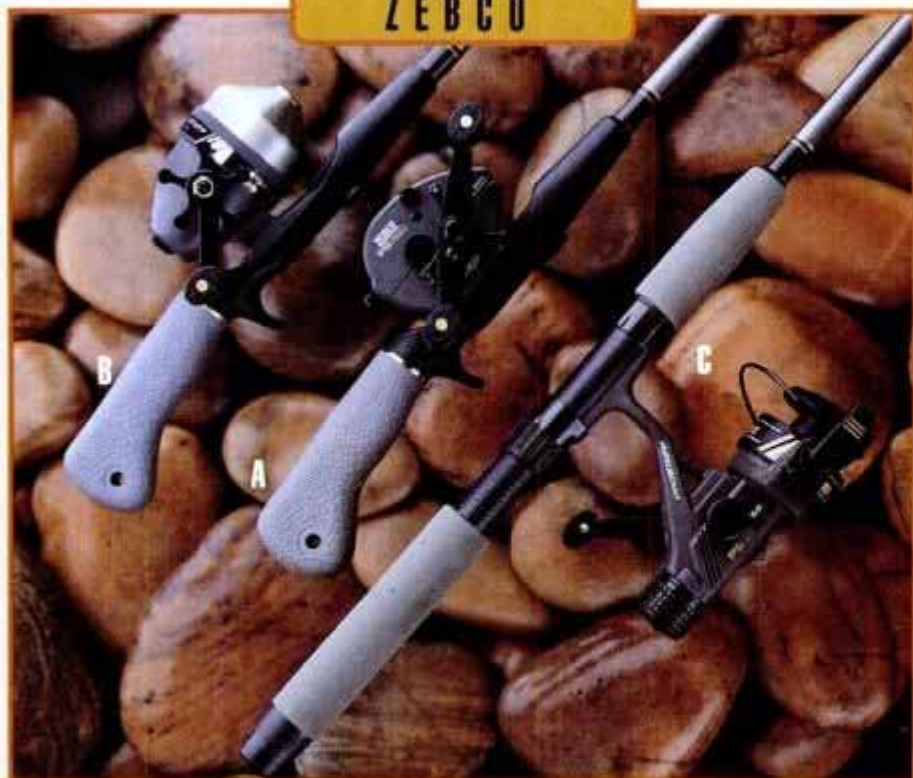
When you're packing for your next fishing excursion, remember your rod, remember your lures, and above all, remember to get your fishing license! K mart has fishing licenses available at most stores, so you can pick one up along with anything else you might need. Just ask your sporting goods department clerk for assistance. Happy fishing!



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Z E B C O



## Gone Fishin'

For 80 days, fishermen at 42 lakes across America are challenged to catch tagged crappie with names like "K mart Kid" in the 1990 Crappieathon U.S.A., sponsored by Johnson Reels and K mart. Rewards range from \$25 to \$85,000 for winners of the Crappieathon, known as the country's largest fishing participation contest for men and women.

You could win a \$5,000 K mart gift certificate plus a bonus \$5,000 K mart gift certificate. Get details in the sporting goods department at participating K mart stores.

### A. Zebco PS1210 Pro Staff Baitcast Combo

PS220 baitcast reel, with magnetic cast control and graphite frame. 5'8" graphite 2-piece composite rod.

**SALE 39.97**

### B. Zebco Pro Staff Spincast Combo

20/20 spincast reel, 2-pc. graphite composite spincast rod.

**SALE 24.97 EA.**

### C. Zebco #6521 Pro Staff Spinning Combo

PS-20 reel with 2-piece graphite composite spinning rod. RH/LH retrieve.

**YOUR CHOICE 24.97 EA.**

### D. Zebco Rhino Rod

Black graphite blank, gold glass tip for extra power. Choice of styles, lengths, and actions.

**SALE 19.97**

### E. Zebco Quantum SS20 Snapshot Reel

Med/light action, 220 yards 6# capacity. 5.1:1 gear ratio. RH/LH retrieve. Graphite components. Self-centering firing pin line pickup system.

**EVERYDAY LOW PRICE 24.97**

### F. Zebco #33C Classic Spincast Reel

New leather touch feature. 3:1 gear ratio. 100 Yds. 10# test prespooled. Magnum drag. Helical gears, s.s. exterior components.

**SALE 19.97**



# K mart Spring Preview Sale

## A. Mitchell GT Plus Rod

Choice of styles, lengths, and actions. Graphite composite. Blank thru handle construction.

**SALE 16.88**

## B. 8530K Mitchell Spincast Combo

8530 spincast reel with top dial drag. Filled with 100 yds. 8# line. 5 1/2 ft. 2 pc. fiberglass rod.

**SALE 16.88**

## C. 1040K Mitchell Spinning Combo

1040 front drag spinning reel, RH/LH retrieve, 6 ft. 2-pc. fiberglass rod.

**SALE 16.88**

## D. Mitchell 310UL Ultralite Spinning Reel

Twin s.s. ball bearings, leather/teflon front drag, RH/LH retrieve. 5:1 gear ratio.

**SALE 23.97**

## E. Johnson #CM6 Country Mile Spincast Reel

New spool design permits free line flow to cast farther. Hi-speed retrieve. Spooled with Stren 8# line.

**SALE 14.88**

## F. Johnson #CM10 Country Mile Spincast Reel

New spool design permits free line flow to cast farther. Hi-speed retrieve. Spooled with Stren 10# line.

**SALE 15.88**



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BERKLEY

NEW

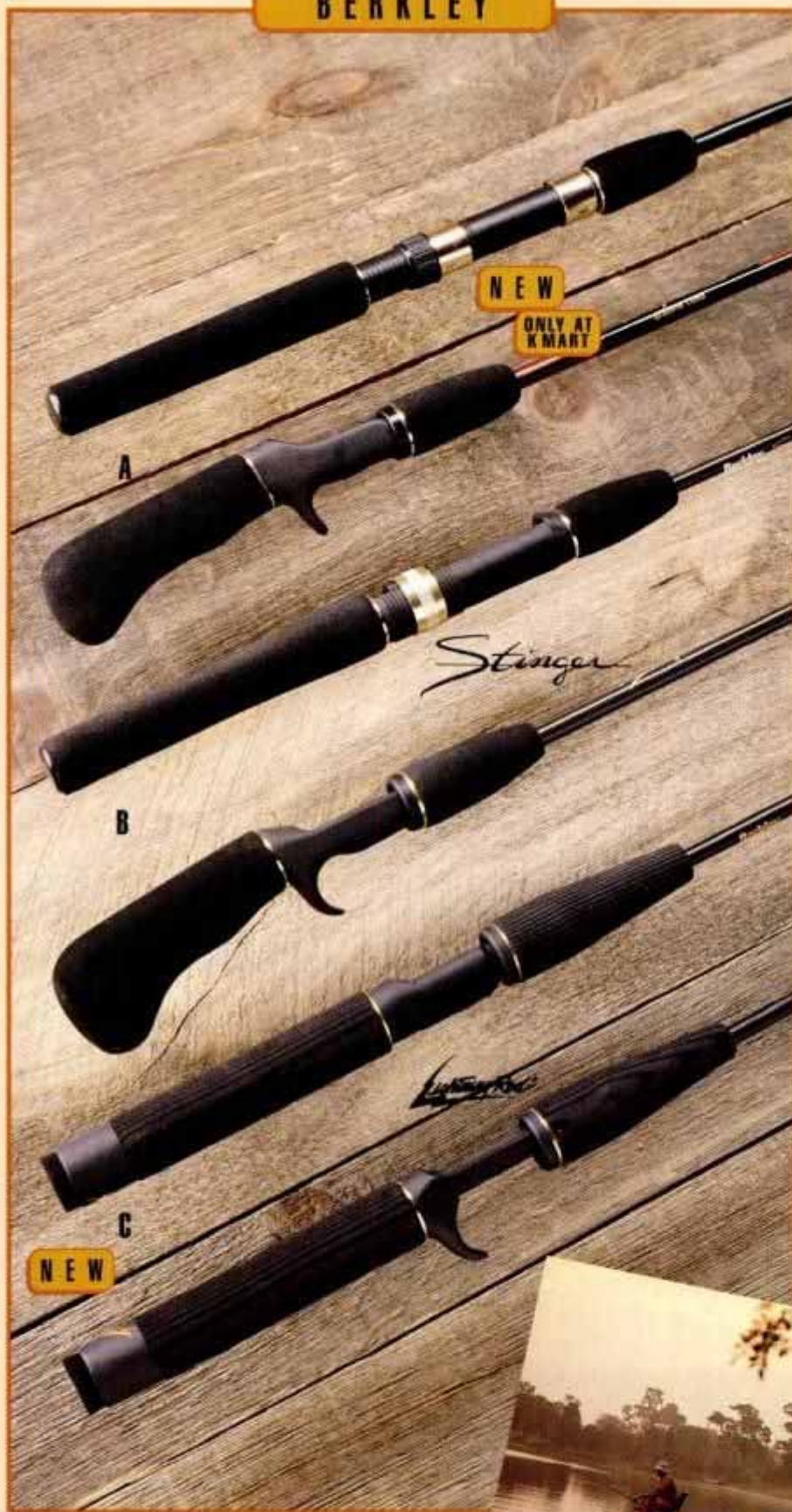
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C

NEW



## Gone Fishin'

To enjoy fishing tomorrow, we have to protect the environment today. Fish America Foundation was formed in 1983 to preserve and enhance the quality of North American waters through the funding of special projects and programs. As a Charter Member of Fish America Foundation, Kmart is helping to fight the problems of diminishing water quality and declining fish populations. If you'd like to team up with Kmart and Fish America Foundation, get your membership application in the Kmart sporting goods department.

**A. Berkley "Shadow" Casting Rod**  
1-pc. blank thru E.V.A. handle. 5'8" graphite composite casting rod. Assorted graphics.

**Berkley "Shadow" Spinning Rod**  
1-pc. blank thru E.V.A. handle. 6' graphite composite casting rod. Assorted graphics.

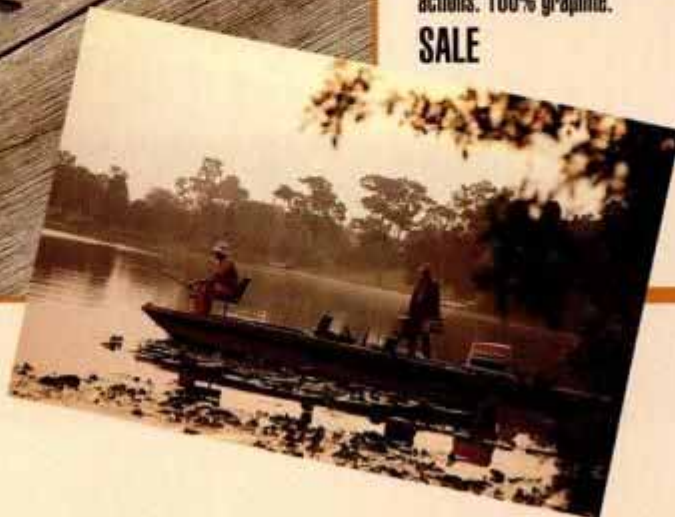
**YOUR CHOICE 14.97 EA.**

**B. Berkley Stinger Graphite Rod**  
Fuji stellite guides. Fuji type handle. Choice of styles, lengths, and actions.

**SALE 19.97**

**C. Berkley Lightning Pro Rod**  
New redesigned EVA straight pro handle. Polymer injected tip, aluminum oxide guides. Choice of styles, lengths, and actions. 100% graphite.

**SALE 32.88**





# K mart Spring Preview Sale

**A. Eagle Claw Mach III Spinning Combo**  
6' 2-pc. graphite rod, graphite composite reel. RH/LH retrieve. Rear drag. Auto trip bail.

**SALE 29.97**

**B. Eagle Claw Mach ULS Combo**  
New Ultralight combo. 4'6" 2-pc. graphite rod, front drag graphite composite reel. RH/LH retrieve.

**SALE 29.97**

**C. Eagle Claw Mach VI Combo**  
7 1/2' 2-pc. graphite rod, graphite composite big water reel. Auto trip bail.

**SALE 37.97**

**D. Abu Garcia Crossfire Rod**  
100% graphite. Blank thru-handle. Better balance and feel for casting. Spinning and casting styles.

**SALE 26.88**

**E. Sharp 4" or 6" Fillet Knife**  
Stainless steel blade with wood handle. Leather sheath included.

**YOUR CHOICE 7.97 EA.**

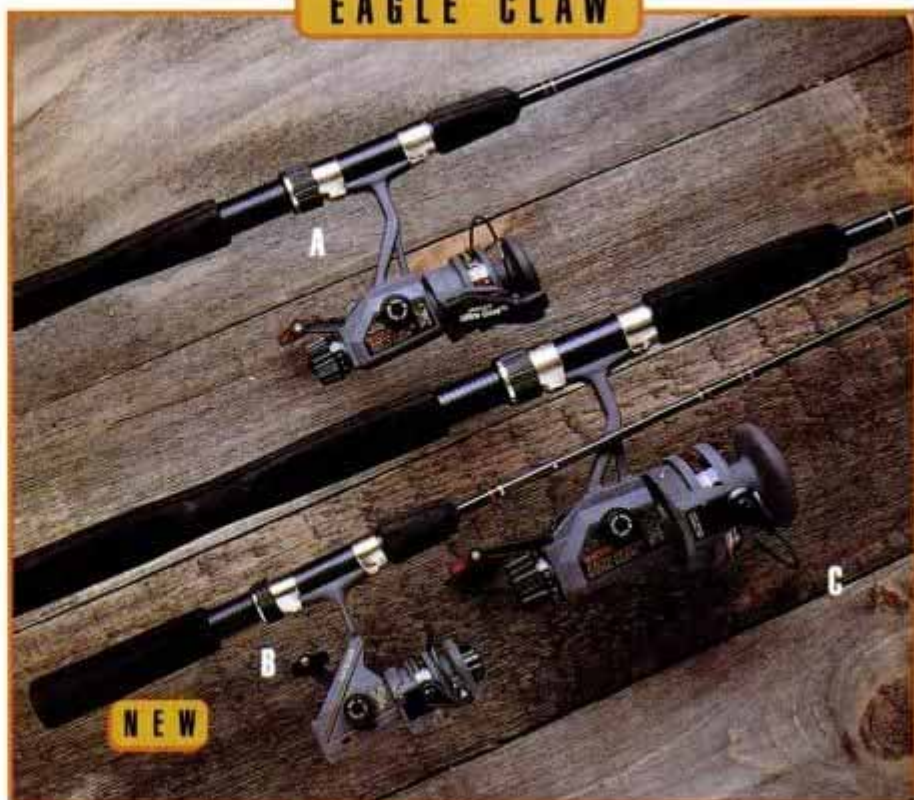
**F. Trilene XL High Visibility 8 lb. Monofilament Filler Spool**

**SALE 4.47**

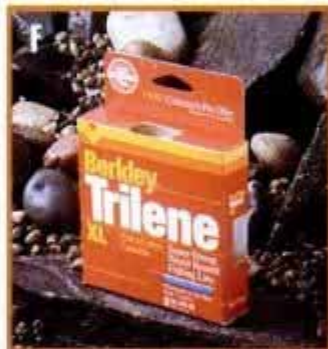
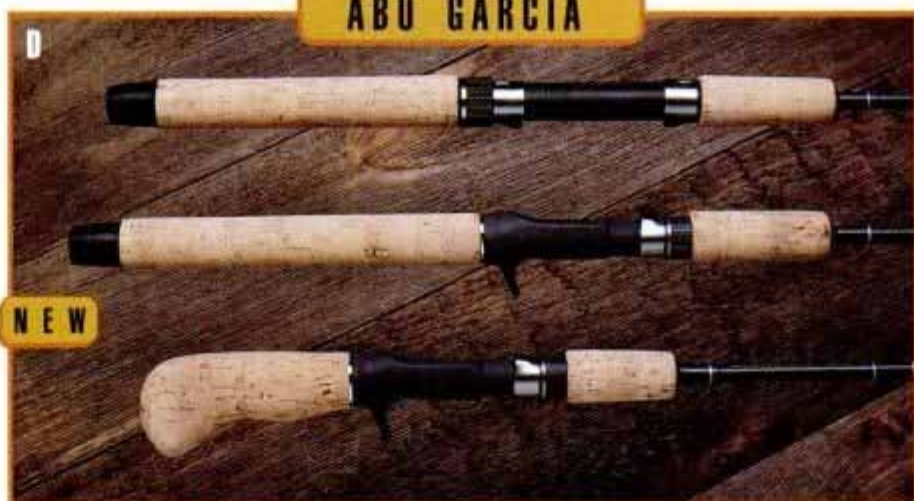
10-14 lb. spool

4.97

## EAGLE CLAW



## ABU GARCIA





# Gone Fishin'

Whether you use your boat for fishing, or just for general enjoyment, K mart can help you accessorize it for whatever your need. From ski vests to depth finders, K mart has the quality that will stand up from season to season, at affordable prices. So before you head for the water, head to K mart for the best selection of marine equipment and accessories.



## A. First Mate Deluxe Fitted Boat Cover

Heavy duty marine-grade water repellent cotton canvas. Includes tie-down rope and bungee cord.

**SALE 69.94-89.94**

## B. Action Deluxe Padded Fold-Down Boat Seat

Assorted colors. Model #5481.

**SALE 19.44**



## C. Eagle Ultra Liquid Crystal Fish Locator

"Ultravision" super twist display. Advanced fish I.D. system. Backlighted. High resolution. Nine zoom ranges. 400' depth.

**SALE 269.88**

## D. Humminbird LCR400

Liquid Crystal recorder with multiple depth ranges, digital depth readout.

**Everyday Low Price 129.00**

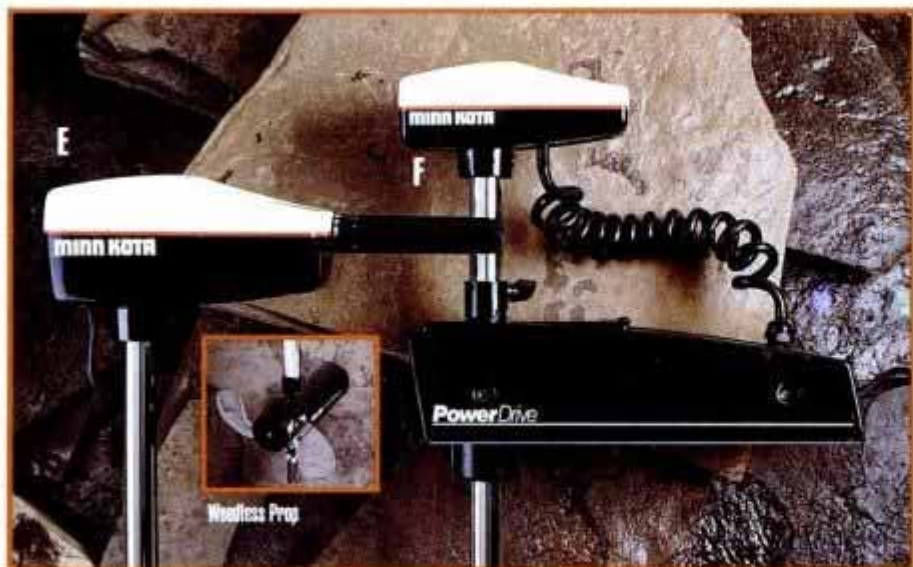
**E. Minn Kota #65MX Trolling Motor**  
Transom mount with maximizer control built in. Weedless prop.

**SALE 219.00**

## F. Minn Kota #785MX Powerdrive Trolling Motor

Bow mount, new foot controlled remote with 18 ft. cord. Built-in maximizer.

**SALE 319.00**



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# K mart Spring Preview Sale

**Normark Rattl'n Rap Lure**  
Choice of colors. #5 or #7 size.

**SALE 3.47**

**Bill Lewis Rat-L-Trap Lure**  
Assorted colors, 1/2 oz.

**Bill Lewis Mini Trap Lure**  
#1 bass lure. Asst'd. colors, 1/4 oz.

**YOUR CHOICE 2.77 EA.**

**Bassbuster Whaletale Lure**  
Choice of size and colors.

**SALE 1.17**

**Snagproof Moss Master Buzz Bait**  
Assorted colors.

**SALE 2.27 EA.**

**Renosky Super Fish-It Spin**  
1/16 or 1/8 oz. size. Choice of colors.

**SALE 1.07**

**Heddon Zara Pooch**  
Choice of colors. Ultra-lite lure.

**SALE 3.74**

**Heddon Teeny Torpedo**  
Ultra-lite, 1/8 oz.

**SALE 3.74**

**Yakima Rooster Tail Spinner**  
Hot trout lure. 1/24, 1/16 or 1/8 oz. sizes. Choice of colors.

**SALE 1.37**

**Classic Sticky Worms**  
#1 Worm, 7 1/2". Asst'd. colors. 7/ bag.

**SALE 3.17**

**Berkley Power Trout Bait**  
Hot trout bait! Color choice.

**SALE 2.57 EA.**

Lure styles may vary by store location.



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## Gone Fishin'

When you're shopping for fishing gear, you want a great selection of quality name brands to choose from. And of course, you want the best price. Smart fishermen know they can count on K mart for the quality they need at the prices they want. It's what's made K mart the #1 fishing tackle and sporting goods retailer in the world. Put our experience to the test on your next fishing trip!

**A. Plano 6-Tray #8606**  
with 38 worm-proof compartments.

**B. Plano Tackle Box**  
Magnum Over and Under #1257

**YOUR CHOICE 21.97 EA.**

**C. Sportfisher 2-Tray Tackle Box**  
Comes complete with 215 pieces terminal tackle.

**SALE 14.97**

**D. Plano Phantom Pro #797**  
4-drawer Tackle Box  
Folds down for increased space.

**SALE 42.94**

**E. Fenwick 3-Tray Tackle Box #1063**  
23 adjustable compartments in top tray.  
Lockable.

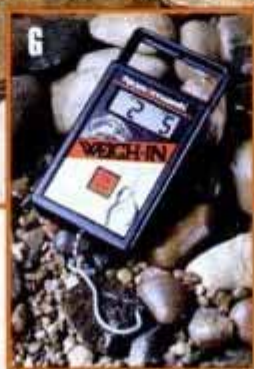
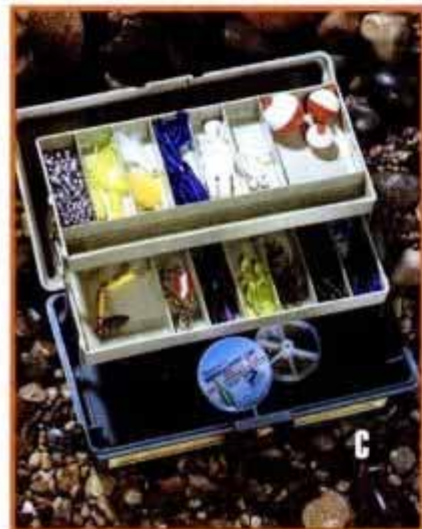
**SALE 9.84**

**F. Fenwick 2-Tray Tackle Box #1052**  
15 compartments. Worm-proof.

**SALE 6.84**

**G. Normark Weigh-In Scale**  
Accurate, easy-to-read digital scale. Uses  
1 9-volt battery (not included).

**SALE 24.97**



Tackle not included with box (except Sportfisher).



# K mart Spring Preview Sale

**A. Voyager Starting/Trolling Battery**  
Dual purpose starting, trolling and RV battery. 620 MCAs, 125 minute reserve capacity. KM24 ME

**EVERYDAY LOW PRICE 64.93**

**B. Voyager Starting/Trolling Battery**  
720 marine cranking with extra reserve capacity. Capable of over 300 cycles under normal trolling usage. Totally sealed "maintenance free" construction. KM27ME

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**C. Voyager KC24 MF**  
Marine Cranking Battery

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**D. Schumacher 10A Deep Cycle Charger**  
Made especially for trolling motor and RV batteries. Auto shutoff.

**SALE 39.97**

**DELCO VOYAGER**

**Lunker Power. To Go.**

Batteries are \$5.00 additional without exchange. Sold in automotive department.

## Improve your fishing skills with pro Hank Parker and Mann's "The Classic" Spinnerbait

12,000 enthusiastic fishing fans showed up to see Hank Parker win the 19th annual BassMasters Classic.® Parker won the Classic using Mann's "The Classic" spinnerbait, making him only the third repeat winner of the Classic since it was inaugurated nearly two decades ago — chances are he'll be using "The Classic" Spinnerbait again next year!

Send for Hank Parker's video, "How I Got Started," just \$9.95 with K mart coupon. Great for all levels of fishermen. Coupons and details are available in the K mart sporting goods department. With every video purchase, K mart will donate \$2 to the Fish America Foundation.



Mann's "The Classic" Spinnerbait. Choice of 1/4, 3/8, 3/4 oz. sizes, colors.

**SALE 2.94**

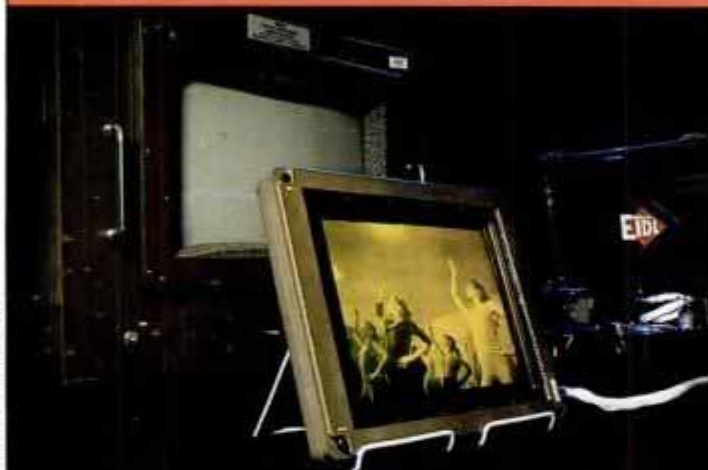


The quality you need, the price you want.

**K mart ADVERTISED MERCHANDISE POLICY**  
Our first intention is to have every advertised item in stock on our shelves. If an advertised price is not available for purchase due to any unforeseen reason, K mart will issue a Rain Check on request for the merchandise (one item or discontinue family quantity) to be purchased at the same price whenever available or will call you a comparable quality item at a comparable reduction in price.

Spring Preview Sale begins January 28 and ends February 10, 1990 at most K mart stores across the U.S.A.





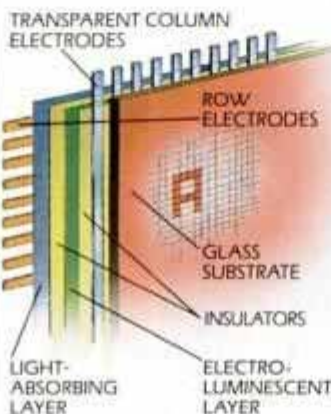
PM PHOTO BY BILL ASH-E

## Army Tech May Bring Flat TV

FORT MONMOUTH, NJ—The Army's Electronics Technology and Devices Laboratory (ETDL) is developing flat-panel displays that may one day lead to a color TV no thicker than a pane of glass. Arising out of military requirements for use in tanks and aircraft, the technologies produce lighter and more durable flat-panel displays than are commercially available.

One especially promising technology produces a picture on a 10,000-angstrom-thick multilayer film applied to a glass substrate. The first layer is a sheet of indium tin

### FLAT-PANEL CONSTRUCTION



oxide, a transparent conductor, which is etched into a series of columns. Next, a silicon nitride insulating layer is deposited, followed by a layer of electroluminescent material, and another of insulator. Lastly, aluminum is applied, and etched into rows that crisscross the first set of column electrodes. Individual pixels light when AC voltage pulses are applied so that a negative electrode on one side crosses over a positively charged electrode on the other.

Although the panels are already on the market as monochrome computer displays, color will not be along until a usable blue phosphor is developed. If current trends hold, that may happen as early as 1991. Manufactured like microchips, the displays could be produced cheaply, if economies of scale are achieved.

Deposited on a single glass substrate, electroluminescent thin film is more durable than other flat-panel designs.



GM PHOTO

Phosphorescent particles aid viewing through cylinder.

## See-Through Engine

WARREN, MI—GM engineers have made a working internal-combustion engine cylinder from a single transparent sapphire crystal. Part of a 1-cylinder, 4-stroke research engine, the 6-in. cylinder gives researchers a 360° view of the combustion process through its 5-mm-thick walls. Observations are enhanced with a 30-frame-per-second stereo video imaging system, and by seeding the charge with phosphorescent particles that glow under laser light.

## Portable Fighter

ALBUQUERQUE, NM—An 890-pound airplane designed to carry 2000 pounds of external weaponry for use in counterinsurgency operations is now in the final stages of construction. Builders claim the advanced composite Falcon Avenger can be carried aboard a trailer, then unloaded and assembled near a battlefield in less than 20 minutes.

Powered by two 110-hp Orion Super-Fan engines attached to NASA-designed 7-bladed fans, the plane should be able to take off from unimproved runways of as little as 250 ft. Its top speed is expected to be in the area of 235 mph, and a failsafe twin-spar design along with three rudders enable it to perform aerobatics up to 9 Gs.

Eight hardpoints can carry miniguns, air-to-air missiles, air-to-ship missiles, bombs or up to 62 2.75-in. air-to-

ground rockets.

Costing \$246,300, the plane is intended for sale to small Third-World coun-

tries, but is also being considered for a variety of special operations uses. **Tu**



PM ILLUSTRATION BY ED VALIGURSKY

Field-assembled Avenger carries a variety of stores adapting it to air-to-air combat, or ground attack.



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BRINGS PEOPLE  
BACK LIKE THIS  
ONE.**



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Which is why we say we have

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#### ENGINES:

145-hp 4.9L EFI Six; 185-hp 5.0L EFI V-8;  
210-hp 5.8L EFI V-8; 230-hp 7.5L EFI V-8;  
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#### PAYLOADS:

F-Series 4x2 pickups — 1610 to 5245 lbs.;  
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#### CABS:

Regular Cab; SuperCab; 4-Door Crew Cab.

#### MAJOR STANDARD EQUIPMENT:

Power brakes; Power steering; Electronic fuel-injected gas engines; Anti-lock rear brakes; Electronic radio and clock; Gas-pressurized shocks; 5-Speed manual over-drive transmission; Full instrumentation.

### BEST-BUILT AMERICAN TRUCKS.

The best-built American trucks are built by Ford. This is based on an average of consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1."

\*Based on 1989 New Truck Buyer Study.



## FORD PICKUPS

BUILT FORD TOUGH





# FREEWHEELING

BY MIKE ALLEN, Assistant Automotive Editor



Unmarked Mazda MX-6 sports coupes, equipped with VASCAR or radar, supplement Connecticut's full-sized patrol cars.

some taller troopers. Also, the door is 4 in. longer, and when you're opening and closing that door next to traffic all day, 4 in. represents a lot more potential for being sideswiped."

CSP's Mazdas are equipped with automatic transmissions and an antilock braking system (ABS). The 5-speed manual transmission isn't practical, in spite of better performance, because troopers sometimes need to use the radio while driving. Juggling the microphone and the shifter would be difficult at best.

The MX-6's top speed is around 120—certainly less than the 5.0 Mustang or the Buick GN. "We don't often need to go more than a hundred or so—true high-speed chases are rare. Connecticut is small and congested, there's always another trooper a few miles ahead, and all we really need to do is to stay visually in contact with the fleeing vehicle. What's more important is acceleration, because we need to merge rapidly into traffic from the median or shoulder many times every shift, and the Mazda has that," says Rizzuti.

ers from seeing it.

Lt. Rich Rizzuti is deputy commander of Police Support Services for the state of Connecticut. He's in charge of the Connecticut State Police's specialty vehicle evaluation program. "We wanted a vehicle that would be comfortable to drive all day, had adequate performance, front-wheel drive, and didn't cost an arm and a leg." CSP eventually settled on the Mazda MX-6.

"We considered the mechanically identical Ford Probe as well, but it's shorter, and wouldn't fit



Troopers train for three days before moving into fwd coupes.

## Big Brother-San Is Watching

**C**OP CAR. We all know what a cop car looks like, right? The paradigm has always been defined by a full-sized Plymouth sedan, a Broderick Crawford clone at the wheel, filling your rear-view mirrors with flashing lights and your heart with terror.

Even an unmarked full-size cruiser broadcasts its presence with the subtlety of the Thanksgiving Day Parade coming down Broadway in New York City.

Well, okay, the California and the Georgia Highway Patrols and some other agencies have been putting black-and-white Mustangs to good purpose for a while. But the clown suit makes them pretty easy to spot from six lanes away. But for the most part, a cop car looks like, well, a cop car. There's no mistaking the genre.

Connecticut takes its enforcement of the 55-mph speed limit very seriously, and uses full-sized sedans,

Ford LTD Crown Victorias, for regular patrol cruisers. Cars that look like cop cars. For several years, they've also used Mustang GTs and Buick Regal Grand Nationals for speed enforcement—completely unmarked cars equipped with radar or VASCAR.

Those cars had the disadvantage of being difficult to drive when the weather was poor. Anyone who's driven a Mustang GT in snow or rain will know (and after two full seasons of racing the PM Mustang I can testify) that rear-wheel drive can be a real eye-opener halfway around a sloppy entrance ramp.

All of this led to a search for a new patrol vehicle. They needed a high-performance car with enough trunk space to carry gear, one that delivered decent gas mileage, and didn't cost much more than the Crown Vics. Plus, it had to have a low-enough profile to keep speed-



## Pursuit Training

I spent a day with several troopers who were training to transition into the first six MX-6s. Fwd might be *better* than rwd in the snow, but the specifics of driving technique are certainly different. The day I spent with them was graced with a constant, frog-choking rain which made hanging around the training area pretty squishy. But it was perfect for learning to drive on the ragged edge of control. Qualified, pursuit-school-trained drivers spend an additional three days transitioning into the Mazdas, practicing lane changes, decreasing radius corners and slaloming back and forth between pylons.

Hurrying through traffic with the lights and siren on has a lot in common with the parking-lot gymkhana used in training sessions. For instance, a police officer trying to rapidly and safely pick his way through expressway traffic. The difference is that the pylons are rubber and aren't damaged if you clobber them. The pylons also don't change their minds and pull in front of you at inopportune moments—a stunt civilian drivers pull all the time when a trooper is hurrying to the scene with lights and siren going. Lastly, rubber pylons don't have attorneys who will sue.

What's it like to drive the MX-6 around the pylons? Like most fwd cars with a healthy amount of power, low speeds combined with plenty of right foot leads to wheelspin and massive understeer. But there's plenty of warning, and backing off hooks things up immediately with no drama. There's no propensity for the tail to come around even if you want it to. If you're used to using the left-foot-braking techniques favored by rally drivers to swing around corners, forget it. The ABS just makes it impossible, keeping the back end neatly tucked in. It's not the ultimate in speed, but it's fast enough, predictable and confidence-inspiring.

## Broderick Crawford— Move Over

I fully expected the Crown Vic to be just about helpless through the training course. The civilian examples of LTDs I've driven in recent years have been marshmellowy, undersprung and underdamped, wallowing through turns in a state of terminal understeer. They're relatively underpowered as well.

What a difference the police package makes. Police packages generally include not only the big motor (in the case of the Ford, a 351 with a 4-bbl. carb), but also suspension upgrades, more cooling capacity and a larger alternator and battery. Idling by the side of the road for hours with the radio, flashing lights, radar and a/c on isn't the kind of abuse that most passenger cars are subjected to.



## COLD REMEDY

Now there's a prescription for helping your car or truck start significantly faster and easier in cold weather: Just add a bottle of Winter Start\* to your motor oil.

Last season, thousands of drivers, nationwide, tried this new multi-viscosity oil conditioner and got welcome cold-temperature relief: 27% easier engine turnover, plus 36% better oil flow to engine parts to minimize friction and wear during warm-ups.

(Compared to oil without Winter Start.)\*

This season, don't get left out in the cold. Try Winter Start... for a cold remedy that'll really get you going.

For more information, send for your FREE copy of the booklet, "The Cold Facts About Winter Start." The Shaler Co., Box 471, Dept. P020 Waupun, WI 53963, 1-800-777-9870. (Ext. 7000)

If you can't locate Winter Start in your area, write Shaler for your nearest dealer. Or, call 1-800-777-9870 for direct ordering information.

\*Results of independent laboratory tests, available on request.



The big 351 4-bbl. V8 delivers enough horsepower and torque to handle any situation a trooper might encounter.

But the most incredible difference is in the handling. Stiff shocks, stiffer springs, fatter front swaybars, a rear swaybar and a different spool valve in the power steering transform the LTD into a really taut, nimble sedan. The limits aren't as high as the out-and-out performance cars. The stock LTD Crown Victoria understeers enormously when pushed hard, while the cop car retains just enough understeer to be predictable.

By the way, the Mazda MX-6s receive

no other upgrades other than replacing the stock 70-amp alternator with an 80-amp version. Mazda also made changes to the suspension ride-height controller, to eliminate interference with the FM police radios.

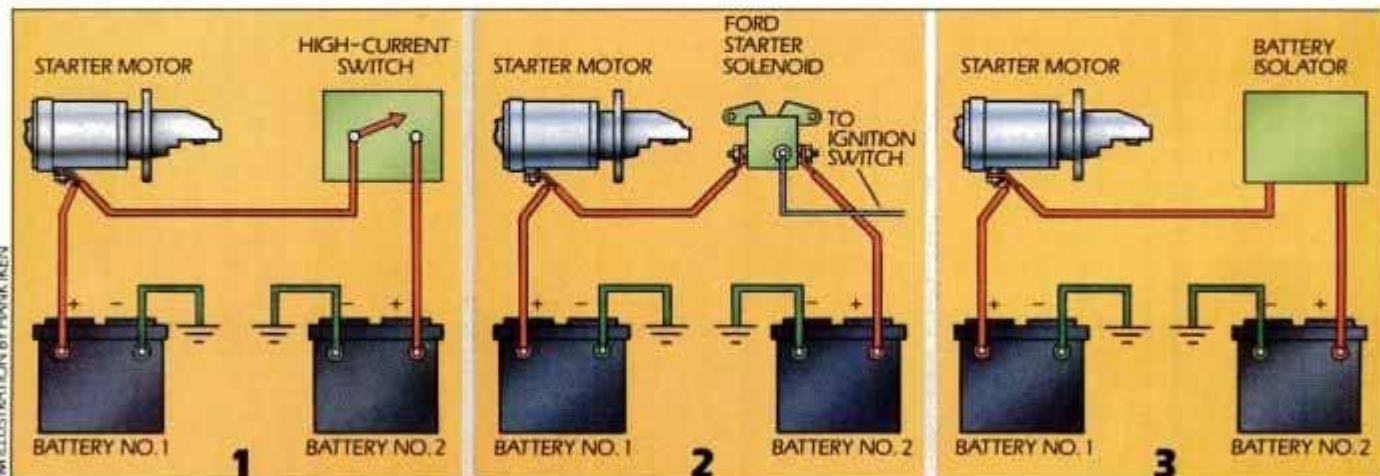
Initial purchase of MX-6 patrol cars was six units. But a few months of experience satisfied the troopers concerning the value of fwd. So CSP is about to order an additional 24 cars in 1990, replacing their Mustangs and Buick GNs as those get old and are retired. By the way, they've been ordered in several different colors. So don't speed—especially in Connecticut.

PM



# CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



## Juice Junkie Needs More

I WOULD LIKE to put dual batteries in my truck. Do I need to go to the expense of using an isolator, or can I just hook them in parallel?

JOHN SCHRAFF  
EASTON, PA

Why do you need more than one battery? If you feel you need the extra capacity because your car won't start, then you should fix whatever's wrong. Short of that, you could simply attach another battery cable to the starter and the second battery. It would charge properly, add considerable cold-cranking amps and reserve capacity to your starting system. Just be sure to use real battery cables, and to ground the second battery to the engine block. Follow Fig. 1 (above), but without the switch. Although I've shown the battery wires leading directly to the starter, if you have a Ford or Chrysler, or other vehicle that uses an external starter solenoid, the battery wires should run to the solenoid, not to the starter directly.

Or, if you need an extra deep-cycle battery to run accessories while the truck is parked, and you really remember to use it every time,

then a simple high-current switch to isolate the deep-cycle battery will be fine (Fig. 1).

You can also use a Ford starter solenoid, switched on by the ignition switch, to accomplish the same purpose (Fig. 2). Connect the high-current leads with  $5/16$ -in. studs to the battery and starter. (Again, if you have a Ford, or any other vehicle that uses a separate solenoid, connect the switched lead to the battery post side of the stock solenoid.) Connect the small lead labeled IGN to the accessory post on your ignition switch. This will connect the batteries in parallel anytime the ignition is on or in the ACCESSORY position. A Ford solenoid will set you back about five bucks.

If you just want to charge a trolling motor battery, all you need is the switch. But, when the battery is in the boat, there's the danger of shorting the positive clamp to something in the truck's engine compartment. I'd use wingnuts and remove the positive lead along with the battery to be sure.

Frankly, isolators aren't that expensive. A good isolator (Fig. 3) will let you use the auxiliary battery as a booster, as well as keeping it

charged and preventing inadvertent discharge of the main battery. The 20 or 30 bucks this will cost is cheap insurance against a flat battery stranding you out in the boondocks.

## Prince Valiant

My 1972 Valiant has 104,000 miles on the original 225 slant Six. Although I have changed the oil and filter every 3000 miles for the 80,000 miles I've owned it, I've noticed something lately: The oil gets very dirty and black-looking within 800 to 1000 miles of changing it. It runs like a top and doesn't use more than 1 quart of oil between changes.

JOHN ELIO  
BRONX, NY

At 100,000-plus miles, your Valiant is deservedly getting a little tired of slaying dragons in New York City traffic. And the rings and valve guides are a little looser than they were when new. The black sludge is carbon leaking into the oil from the combustion chambers.

Part of the phenomenon is related to the very good detergents and dispersants in modern-day SG-rated oils. They are supposed to pick up and hold junk, like carbon and dirt, until the next oil change, instead of letting

them turn to tar in the bottom of the oil pan and rocker box. SG-rated oils replaced SF grades 18 months ago, and the major difference was in their antisludging capability, intended to cope with the extended oil-change intervals in today's cars.

Keep changing your oil at least every 3000 miles. You might try oil analysis to try to get some indication of the interior health of your engine, but I'd start saving money for a ring-and-bearing job, including the valves. It may be, though, that it will run well for a long time—especially if it's not burning any oil yet.

## Squeaky Cat

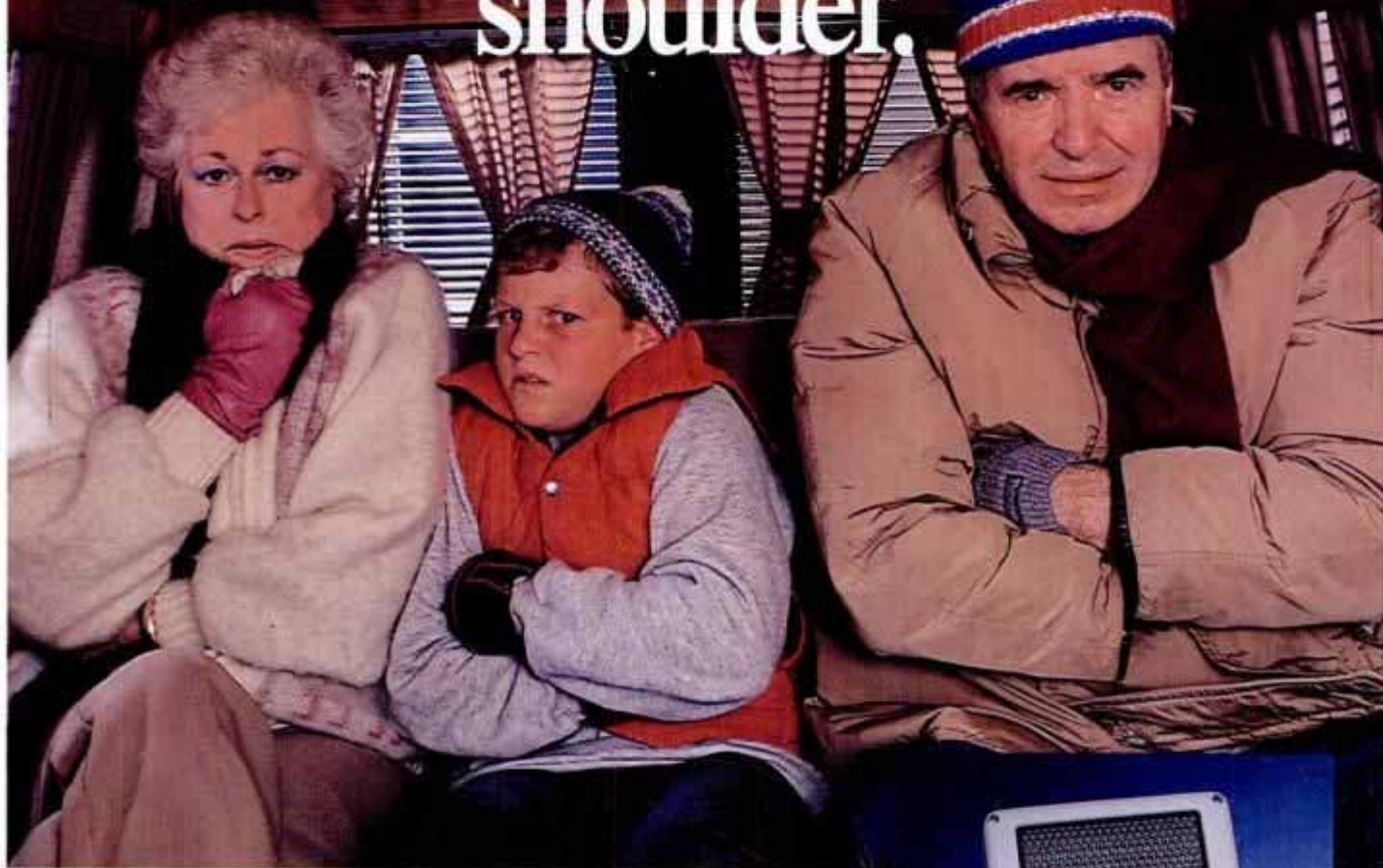
My '89 Cougar XR7 has a squeaking, clanking noise that comes from the rear brakes. A passing motorist called it to my attention, and if you roll down the window, it's pretty loud. The noise can only be heard when the brakes aren't being depressed. The salesman said this is a common problem with Cougars, but I wanted your opinion as to the cause of the problem before I take it back to the dealer.

MANUEL REYES  
HONOLULU, HI

(Please turn to page 24)



# Back Seat Heat™ eliminates icy stares, chilly looks and the cold shoulder.



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The innovative high tech compact 12 volt heater from Therm Technology Corp., designed to heat cold areas in RV's, vans, boats, trailers, cabs and more.

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It may or may not be a common problem on XR7s (or T-Birds, which are mechanically identical). What's important is that it certainly isn't normal. Our own long-term test T-Bird is devoid of brake noises. Disc brakes are guilty of occasional squealing noises that can be difficult to cure. But these kinds of noises would be heard only when the brakes are actually being used, and certainly nothing you might describe as a clanking noise.

Your problem might be anything from a loose pebble inside the hubcap to a bad wheel bearing to a parking-brake problem.

### Film Critic, Part II

I have to clean the windshield and interior windows of my Topaz every two weeks, to remove a glare-producing film that leaves a black smudge on the paper toweling. I don't smoke. I have this film during the summer whether or not I use the a/c, and in the winter with or without the heater.

My real concern is health. What are we breathing inside the car?

LYNN ZOLL  
SMITHTOWN, NY

*What's collecting on the windows is a residue from plastics and adhesives*

### Getting A Handle On Halogen

Lots of new cars are using quartz-halogen lamps instead of ordinary tungsten-filamented bulbs.

Quartz lamps are smaller and deliver more light for less current, and are in headlamps, dashboards and overhead fixtures. Replacing these special bulbs isn't tough—there's only one caution. Don't touch the bulb. Ever. The new bulb will come in a cardboard box, and probably will be in a paper or sponge rubber sleeve. Use the sleeve to hold the bulb until it is seated in the socket. Why? Unlike the old, tungsten-filamented bulbs, the quartz-glass bulbs run at very high temperatures—high enough to carbonize

the oils in your fingerprints. And the thermal stresses radiating from the fingerprints will crack the glass. If you must touch a quartz lamp, degrease it with alcohol and a clean cloth after installing it.



PM ILLUSTRATION BY ADOLPH E. BROTHMAN

## “IT’S YOUR BOSS ON THE PHONE. ARE YOU STILL HERE?”



GNB Incorporated is a Pacific Dunlop Company.

\* CHAMPION IS A REGISTERED TRADEMARK OF CHAMPION SPARE PLUG COMPANY.



that are used in the interior of your car. The vinyl fabrics will continue to out-gas plasticizers for years, but the adhesives should be finished drying in a few months of summer weather. These compounds are generally colorless, so I suspect the black is airborne dirt that sticks to the gummy vinyls.

Yes, these compounds are mildly toxic. But, before you panic, realize that they only build up to any measurable concentration when the car is parked for long periods with the windows rolled up. Also, the specific compounds are much less toxic than they were even a few years ago, before the federal government started regulating exposure to toxic chemicals in the factories where cars and car components are manufactured and assembled.

While your car is running, the ventilation system will assure a steady flow of fresh air. You might try leaving two windows on opposite sides of the car cracked a millimeter or two to provide cross-ventilation.

### Wide Ride

I can't get the front tires on my S-10 Blazer to wear evenly—the outside edges wear rapidly and cup. The alignment is right on the money, according to two alignment shops.

The dealer installed aftermarket wheels before I bought it. One of the alignment shops told me these wheels have an offset to them, and there are only two companies that make the correct offset wheel.

Is this true?

STEVE SHEPPARD  
JANESVILLE, WI

If the offset of the aftermarket wheel is greater than the stock GM wheel, then your tire-wear problems can be blamed on the excess offset. Too much offset can also lead to premature wear of steering components, as well as wheel bearings and suspension parts.

Blazers use the very common GM 4 $\frac{3}{4}$ -in. bolt pattern, and there are a hundred aftermarket wheel manufacturers that make appropriate wheels with every conceivable offset. I'd be back at that dealership looking for a good explanation as to why they sold you aftermarket wheels without proper regard to General Motors' offset recommendations. **PM**

### DO YOU HAVE A CAR PROBLEM?

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

### SERVICE TIPS

■ Some '86-'89 Cadillac Broughams may not reach wide-open throttle until the accelerator cable is replaced with one that is slightly shorter, PN25504323.

Cadillac cautions that vehicle performance is highly subjective, and other causes should be evaluated if performance is still considered substandard. T-89-84

■ Ford TSB 88-15-4 discusses proper care of anti-theft decals required by federal law to be used to identify many components of high-theft vehicles like T-Birds, XR4Ti, Mark VII, Town Car and others. The fragile stickers must be covered, not simply masked with tape, when repair, painting or undercoating operations are performed.

■ If the sun visor on your '88 or '89 Prelude or Accord keeps dropping open, Honda TSB 89-005 says to replace the stopper plate with PN83213-SF1-000.

■ Audi TSB 87-01 shows how to bend the wiper arms to ensure that the blade is in proper 90° contact to the glass. This will minimize streaking and chatter.

## ...OR NOT?"



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GRADE THEIR TRUCKS FOR INITIAL QUALITY AND TROUBLE-FREE PERFORMANCE. AND IN THE LATEST SURVEY, MAZDA OWNERS GAVE THEIR TRUCKS THE HIGHEST GRADES OF ALL. AND HELPED MAZDA EARN ITS PLACE AS THE MOST TROUBLE-FREE COMPACT TRUCK IN AMERICA.\*



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BUT THIS ISN'T THE ONLY REASON MAZDA OWNERS ARE SO ENTHUSIASTIC. THERE'S ALSO A 36-MONTH/50,000-MILE BUMPER-TO-BUMPER WARRANTY\*\* WITH NO DEDUCTIBLE. THE BEST BASIC WARRANTY IN THE ENTIRE INDUSTRY. SO IF YOU WANT TO KNOW WHAT MAKES A TOUGH MAZDA TRUCK SO EXCEPTIONAL,

TALK TO A MAZDA TRUCK OWNER. BETTER YET, SEE YOUR MAZDA DEALER AND PUT A MAZDA TRUCK TO A LITTLE TEST OF YOUR OWN.

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\*J.D. Power and Associates 1989 Compact Truck Initial Quality Survey. \*\*Based on owner-reported problems during the first 90 days of ownership. \*\*\*See your Mazda Dealer for limited warranty details.



# BOATING

BY JOE SKORUPA, Boating/Outdoors Editor



## Born-Again Chris-Craft

**T**HEY DON'T build them like they used to and for good reason. Today, they build them better. This applies as equally to powerboats as it does to many things built over the past few decades.

But, in modern usage, better doesn't necessarily mean more graceful, elegant, painstakingly crafted, inspired. Today, better often means bigger, faster, hotter, flashier. In many cases, deeply satisfying, emotional values give way to incremental gains in efficiency and concessions to popular style.

The question on the minds of a growing number of people today is: Why can't we have the best of both—modern efficiency *and* timeless appeal. For people who think this way, Christopher J. Smith, grandson of legendary Christopher Columbus Smith, founder of 106-year-old Chris-Craft, has a boat for you.

### Déjà vu

"Boating has been my life from day one, you might say," Chris Smith tells me as we walk along a marina dock in Mamaroneck, New York. Smith means it literally. "I

started working with the company officially in 1947, but I hung around the plant (the original Chris-Craft plant in Algonac, Michigan) as a kid and I've always worked there."

In 1987, after 40 years at a labor of love, Smith retired. But building boats is in his blood, and the opportunity to work on an exciting new project brought him back. The project is the Chris-Craft Mahogany Runabout Company, and its first boat (an emblem on the dash reads "Hull Number 1") is a sleek wooden powerboat tied to the dock at our feet.

The boat is a limited-edition, 24-ft., 1930-model runabout that's true to the original in design and materials. Some concessions were

made to modern times, but these are few and each is an improvement that takes nothing away from the boat's genuine evocation of the classic era of wooden boats.

"Classic boats appeal to the same kind of people who love antique cars," explains Smith. "They take them to shows, dress them up, polish them, make them a hobby. And, most importantly, they appeal to those who love the look and feel of fine wood and fine woodwork."

The warmth, character and beauty of the 1930 Chris-Craft reissue is undeniable. It's handcrafted in Holland, Michigan, with marvelously cut and fitted planking that has sculptural lines of varied, but matched, patterns of grain, color and density.

Veteran boatmen, however, know that classic wooden

beauty exacts a price—varnishing, plank replacement, constant upkeep. To many in the fiberglass age, this kind of boating is less like recreation than like strapping on a ball and chain.

### West System

The most important upgrade on the runabout, according to Smith, is the decision to use the epoxy-resin technology developed by Gougeon Brothers, of Bay City, Michigan. This technology, called the West System, permits a combination of wooden-hull beauty and gel-coat-like sealing and durability.

West System epoxy resins are formulated to bond with wood fiber. Hull bottom (three layers of cross-laid 1/4-in. mahogany) and sides (two layers) are temporarily sta-

*(Please turn to page 30)*



Banjo steering wheel and dash are authentic.



New is the 351-cu.-in. OMC/Ford inboard.



# HOT TUB.



Had a tough week?

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Call 1-800-661-RIDE for the Kawasaki dealer nearest you. Kawasaki believes safety begins with us and ends with you. Drive responsibly. Jet Mate boats are "Class A" inboard boats and their use is subject to all applicable state and local boating laws. All on board should always wear a USCG approved personal flotation device, eyewear and other appropriate safety apparel. Respect the rights of shoreline residents and other marine recreationists. Specifications and price subject to change without notice.

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# TOTEMS. THE NEW WAY TO CHEW!

It's like nothing else!  
Golden Blend Totems.

Fresh, moist  
and packaged  
to travel.



WARNING:

THIS PRODUCT  
MAY CAUSE  
MOUTH CANCER.

**RED MAN**  
**GOLDEN BLEND**  
**TOTEMS**  
CHewing TOBACCO

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## BOATING (Continued from page 28)

pled in place and then, using a roller, a thin film of resin is applied. When the resin cures, it's so clear that a natural wood finish is achieved by applying a coat of varnish.

In addition to creating a surface with a barrier coating as water resistant as fiberglass, the reissued Chris-Craft is stronger than the original. So much so that a number of stringer ribs were eliminated from the 1930 design and the hull still easily handles the increased weight and power of the big OMC/Ford 351 inboard.

According to Smith, who has owned a reissued wooden runabout for several years, boats constructed with this technology are as easy to varnish as waxing and buffing fiberglass boats.

"If you leave this boat out in the weather," says Smith, "all you have to do is lightly sand it to make the next coat stick, and then brush on varnish. You can do it in the morning and use it in the afternoon.

"The trick is to do it when the finish gets dull. Don't wait until water seeps into the wood. Then you have to sand more and take off the hardware. I keep my boat in a boat house raised on an electric hoist. I buff it, but I haven't had to varnish it in four years."

### Out in the sound

A few minutes into my first classic boat ride, as Smith and I idle our way through a busy estuary that leads to Long Island Sound, I begin to discover the special pleasures of driving a 1930 Chris-Craft.

My first discovery is that the boat has no hump angle upon acceleration. When the throttle is pushed forward on a modern runabout, a rear-mounted engine digs a hole in the water and the bow rises skyward until it drops down on plane. The long (24-ft.) and narrow (6-ft. 4-in.) Chris-Craft, on the other hand, with its center-mounted engine, simply shoots forward with a level attitude.

Also impressive is the boat's flat stern, which produces an excellent wake for waterskiing, and its hard chine at the waterline, which forces the bow curl away from the hull. Equally of note is the boat's solid tracking and responsiveness in hard turns. Top speed is a brisk 43 mph.

Still, I couldn't help noticing that the 1930-era boat's flat bottom bangs the chop a bit harder than V-shaped hulls and that the noise is amplified by its wooden construction. Also, it's somewhat noisy at full throttle in a 2-ft. chop, at least by modern standards. The engine comes without a muffler (although it has long copper exhaust tubes exiting at the transom), and the engine compartment is without insulation.

But mufflers and insulation can be

added, and the boat looks and feels wonderful. It's also an incredible head-turner. On our short ride out to the Sound, it drew dozens of admiring stares, and, back at the dock, Smith had to keep a cloth ready to wipe off fingerprints from passersby who couldn't resist the temptation to run their hands over the warmly textured deck and gleaming hardware.

### Rebuilding a legend

Because the engine is mounted in the middle, it has two large, separated cockpits. The roomy main cockpit, which seats five adults comfortably, is configured with two seats forward and a wide bench seat aft. The stern cockpit has a bench seat that accommodates two adults comfortably or three cozily.

Nearly as impressive as the fine woodwork, is the 24's period hardware. Many pieces are cast from the original molds. The stylish cut water (on the bow), stern quarter rails and fender rails are stainless steel. The bow light, lifting rings, fore and aft cleats, step-pad frames, gas cap and ventilation ducts are all chrome-plated brass. The flag poles are solid mahogany.

Sitting at the helm, in a rich, wine-colored leather seat, the driver feels at once transported back to the glory days of radio shows, Packards, Duesenbergs, talking pictures and raccoon coats. The art-nouveau dash panel, alive with detailed swirls of vines and grape clusters, surrounds five analog gauges that give readings for oil, fuel, voltage, engine temperature and rpm. Above the panel, an emblem reads: "Custom Built by Chris-Craft."

Throttle and shift are integrated into a single lever on the driver's left. The large steering wheel, called a banjo steering wheel, has three, 5-string arms and is centered with a polished mahogany cap. Stowage is found in a roll-top glovebox at the driver's feet and under the bench seats.

Craftsmen who build these works of art (working at the yard that produces Grand Craft reissued wooden boats) use production techniques that have varied little in 60 years. As a tribute to the uniqueness of the 1930 design, they will produce only 24 of these models. Price for this collectible is \$75,000 and includes a custom trailer.

Chris-Craft, once a generic term for recreational boats, is now emerging from a briefly turbulent period. OMC purchased the company last year and breathed new life into it. The reissued 1930 runabout is an example of the company's rejuvenation. So is its exciting line of new fiberglass designs for 1990. A great deal of goodwill exists among boatmen toward reborn Chris-Craft and many are glad to see it back. **PM**



EXCITING NEW LAB TESTS CONFIRM SLICK 50'S BENEFITS!

# Save Gas, Save Engine with "POLY"

The following introduces one of the most fully tested and credentialed gas saving, friction reducing engine treatments ever to reach the market!

## The Secret is POLY

"Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man. The 1989 Guinness Book of World Records (pg. 184) says: "The lowest coefficient of static and dynamic friction of any solid is 0.02, in the case of Polytetrafluoroethylene—equivalent to wet ice on ice."

A one quart treatment of Slick 50 will bond slippery "poly" to your engine for a minimum of 50,000 miles. Unlike some temporary products on the market, Slick 50 does not need to be added every time you change your oil. By reducing engine friction, Slick 50 increases gas mileage and horsepower and it reduces wear, defraying costly overhauls.

## Slick 50's Credentials are Impressive

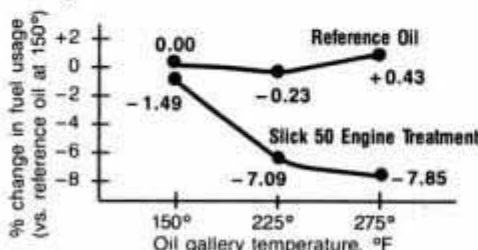
"Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicated that it will improve gas mileage by about two or three miles per gallon . . . Slick 50 does exactly what Petrolon claims it does." *Consumer Digest* (Mar/Apr 1982, p. 35)

In 1989, the premiere engine and lubricant testing lab in the U.S. tested Slick 50. This EPA recognized lab conducted a strictly controlled experiment using industry standard ASTM procedures. Results showed Slick 50, compared to a standard reference oil, reduces engine wear by more than 50%. Be cautious of those Poly treatments that cannot back up their claims with such solid evidence.

In a fuel usage test conducted by this same prestigious lab, results showed that Slick 50 (compared to a standard reference oil at 150°) reduced fuel consumption in the test engine by 7.09% at an oil temperature of 225° and 7.85% at 275°. Once warmed up, most cars operate within the range of 225° to 275°.

Especially interesting is the fact that fuel usage with just the reference oil increased (see graph) as the oil got hotter than 225°. This is due to the well known fact that oil gets thinner at higher temperatures, causing increased friction (and wear) in your engine. However with Slick 50, fuel usage actually decreased, showing that Slick 50 produces its greatest friction reducing benefits at higher temperatures, which is exactly when your engine needs it the most.

As with any lab test, these results may not translate exactly the same percentagewise for every engine under every type of driving condition in the "real world." However, the conclusion for these test cases is clearly that Slick 50 does reduce engine wear and does increase gas mileage.



The Federal Aviation Administration has fully accepted a similar product—Slick 50 Aircraft Treatment (F.A.R. #33.49).



TUV, a prestigious German testing laboratory, tested Slick 50 and found substantial increases in both gas mileage and horsepower. 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.

The Cranfield Institute, known worldwide for its work in tribology (the study of friction), concluded a five-year study on Slick 50 in 1989. Results showed Slick 50 does indeed coat metal surfaces, dramatically reducing friction and extending the life of metal.

Perhaps the most dramatic of all is the torture test seen by thousands of viewers on NBC TV station KPRC. A Lincoln Town Car was treated with Slick 50. During the broadcast, the oil was drained and the car was driven without the oil plug for about 30 minutes. The water temperature never rose and the engine sustained no apparent damage.

## It's Easy to Treat Your Engine

Change oil and filter and substitute one quart of Slick 50 for the last quart of oil. (Add two quarts for engines with oil capacities of seven quarts or more.) Slick 50 is excellent for turbo-charged engines, aluminum block engines and rotary engines.

Slick 50 will work with all petroleum based oils and synthetics compatible with petroleum based oils.

## What are the Benefits of Slick 50?

By reducing friction, Slick 50 does all of the following:

1. Increase gas mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
4. Minimize or eliminate costly overhauls by drastically reducing engine wear
5. Easier starting (important in cold weather)
6. Since lubricating lead is being removed from gas, and unleaded gas is poor in lubricating qualities, this extra lubrication of Slick 50 on valve systems and guides is a real bonus.
7. Slick 50 eliminates the "lubrication starvation" that all cars experience when you first

start them, before the oil has a chance to circulate. Up to 90% of engine wear can be caused by this starvation. You receive all these benefits for less than the cost of two tanks of gas (\$39.95).

## Will Slick 50 Harm my Engine or Affect my Warranty?

No! The base oil for Slick 50 meets, or exceeds, every manufacturer's engine warranty requirements and carries an API service classification SG-CD.

More Slick 50 products are available. A FREE catalog sent on request.

**DOUBLE GUARANTEE!**

Guaranteed lowest price and guaranteed satisfaction. If at the time of purchase you have seen Slick 50 advertised in a current magazine at a lower price, we will beat that price by \$2.00 a quart and you will still get your free DURALT FC. If you are not satisfied with our Slick 50, within 4 months, send us a note and proof of purchase for a full refund of purchase price. This makes trying Slick 50 RISK FREE to you. We have been in business for 10 years and intend to keep our customers happy.

Free DURALT FC sent with each order. Free shipping with orders of 2 or more.

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Yes, I want to improve my car's performance and save my engine—rush me risk free:

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# IMPORTS

BY BILL HARTFORD, Managing Editor



## Tons Of Fun For '91

**N**OW THAT you're out from behind the eight-ball and writing '90 on your checks, along comes '91. A number of next year's models are well down the pike and about to nose into your new-car dreams. The real driver's cars with little or no back seat are leading the pack. Dealers are already taking properly dated checks as deposits from first-on-the-block buyers who have seen these cars only as images on a page in a magazine.

### Toyota MR2

The two views above show Toyota's redo on the Mister Two. The designers took a spatula to the shape and left the folds and wrinkles of the first-generation mid-engine midget for posterity. The slippery bodywork now stretches 164.2 in. overall, almost 9 in. longer than the '89 version (there was no '90 model-year MR2). Width is also up, an inch-plus to 66.7 in. A 3-in.-longer wheelbase puts the '91 MR2's stance at 94.5 in. The layout is still the same, with the en-

gine breathing down your neck. But the power to the rear wheels now comes from Toyota's 2-liter, 16-valve Four (as used in the Celica All-Trac). With twin-entry, intercooled turbo, the wild, dual-exhaust 225-hp MR2 is a 140-mph roadburner. The mild version—no turbo and no rear spoiler—is 165 hp. We'll have a complete drive report soon, after we've experienced the new MR2 firsthand.

### Mitsubishi 3000GT

Based on advance word from Mitsubishi about its Starion replacement, we figure that



a track test drive of about a mile will be all the convincing we need that the 3000GT has left a lot of competition behind. The first 5 seconds in this supercar will see 60 mph coming up, with all four tires—245/45VR-17 ultra-high-performance radials—taking bites on the road. The 2+2 is powered by a quad-cam, 24-valve, twin intercooled turbo, 3-liter V6 that will bring up a 160-mph top speed if you don't back off at the quarter-mile mark. To increase hp when you want

it, there's a variable-backpressure exhaust system. But the 280-hp GT won't be all brute: 4-wheel steering, 4-wheel vented discs with ABS, limited-slip differential, electronically controlled variable-damped suspension and interior appointments and power controls worthy of a luxury car will make it a very refined sport coupe indeed. The 3000GT rides on a 97.2-in. wheelbase, with a length overall of 180 in.

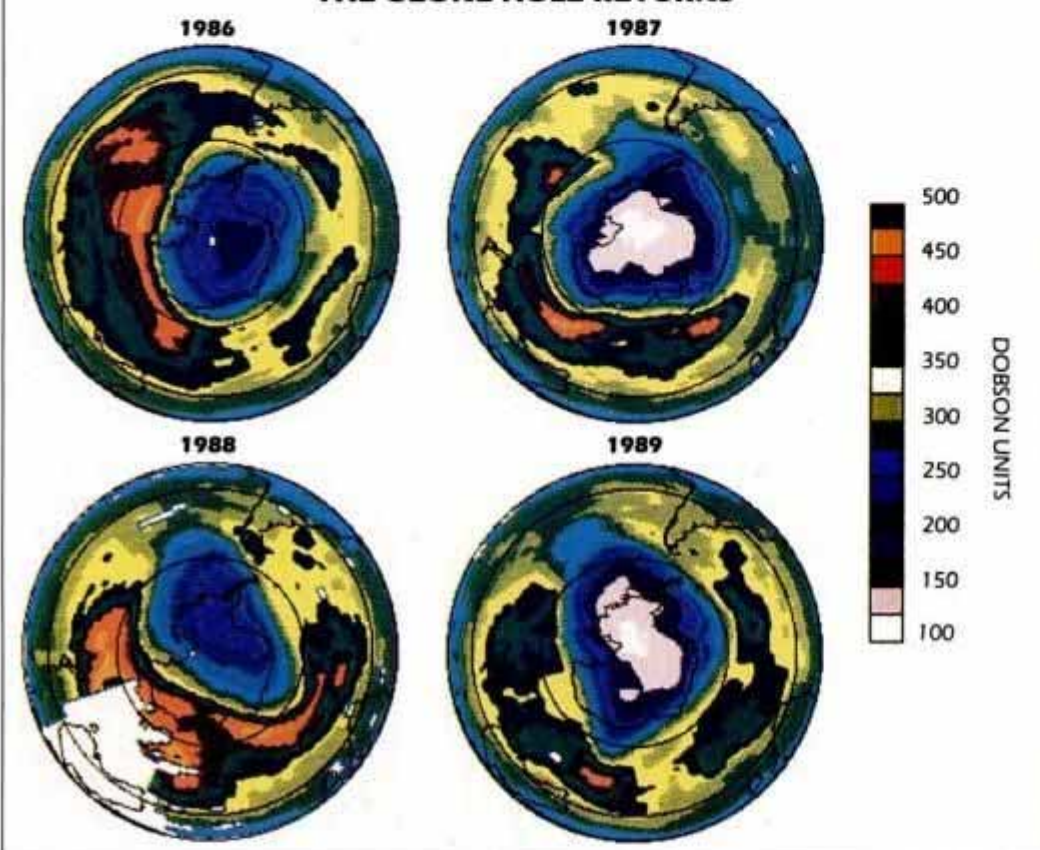
Until you see the 3000GT in showrooms this fall and the MR2 this spring, hang onto this page. **PM**



Mitsubishi 3000GT, a fast, high-tech, 2+2, 4x4 grand tourer, rides on 8.5 x 17-in. alloy wheels.



## THE OZONE HOLE RETURNS



NASA graphics show this year's ozone hole covers about 5 percent of the atmosphere. One thousand Dobson units equal a centimeter thickness of ozone at sea-level pressure. (Missing data account for large white area in 1988.)

potential to clobber the ozone layer all by themselves.

### The greenhouse connection

The problem in containing CFCs goes beyond increased rates of skin cancer from UV radiation, however. I spoke to Nick Sundt, an analyst at Congress's Office of Technology Assessment who has been following ozone depletion since the mid-'70s. He emphasizes a connection seldom discussed in the press between the thinning ozone layer and our other big atmospheric worry—global warming. Although the primary greenhouse gas blamed for the warming is CO<sub>2</sub>, CFCs are highly efficient greenhouse gases themselves, and may account for as much as 25 percent of global warming.

Ozone depletion and the greenhouse effect interact in other ways as well. For example, the increased amounts of UV radiation passing through an ozone-poor atmosphere damage vegetation. Plants constitute a huge reservoir of carbon, which if released, could raise atmospheric CO<sub>2</sub> levels and accelerate the greenhouse effect.

Although global warming is now an area of more wide-open scientific debate than ozone depletion, Sundt sees them as two interconnected symptoms rooted in the same disease. That may sound ominous, but it also means that whatever we do to cure one problem will also help with the other. **PM**

## Ozone Hole: What It Means

**T**HE VERDICT is in on the Antarctic ozone hole. It's back, it's bad, and it's our fault. Data beamed from the Total Ozone Mapping Spectrometer aboard NASA's Nimbus 7 satellite late last year shows that after vanishing in 1988, the giant atmospheric bald spot at the bottom of the world has reappeared. The finding clinches the argument that the hole, and ozone depletion generally, are caused by man's release of chlorofluorocarbons (CFCs).

The atom that actually does most of the dirty work is chlorine. Broken off from CFCs by ultraviolet light in the stratosphere, it drifts down and grabs oxygen atoms away from the ozone (O<sub>3</sub>) molecules below. The result

is 2-atom oxygen molecules and chlorine monoxide molecules.

Containing both chlorine from CFC and oxygen from dismembered ozone molecules, chlorine monoxide is the smoking gun that incriminates CFC. The link had long been suspected. But the ozone hole has given scientists a chance to tie the absence of ozone and the presence of chlorine monoxide together into a damning case against CFC.

### Now what?

With the basic scientific questions about as settled as they're going to get, we move to the murkier realm of politics. The Montreal Protocols have been signed by the developed nations responsi-

ble for the great bulk of CFC production. That means we'll all have to cut our production of most CFCs by 50 percent by 1998. It's an impressive example of international cooperation.

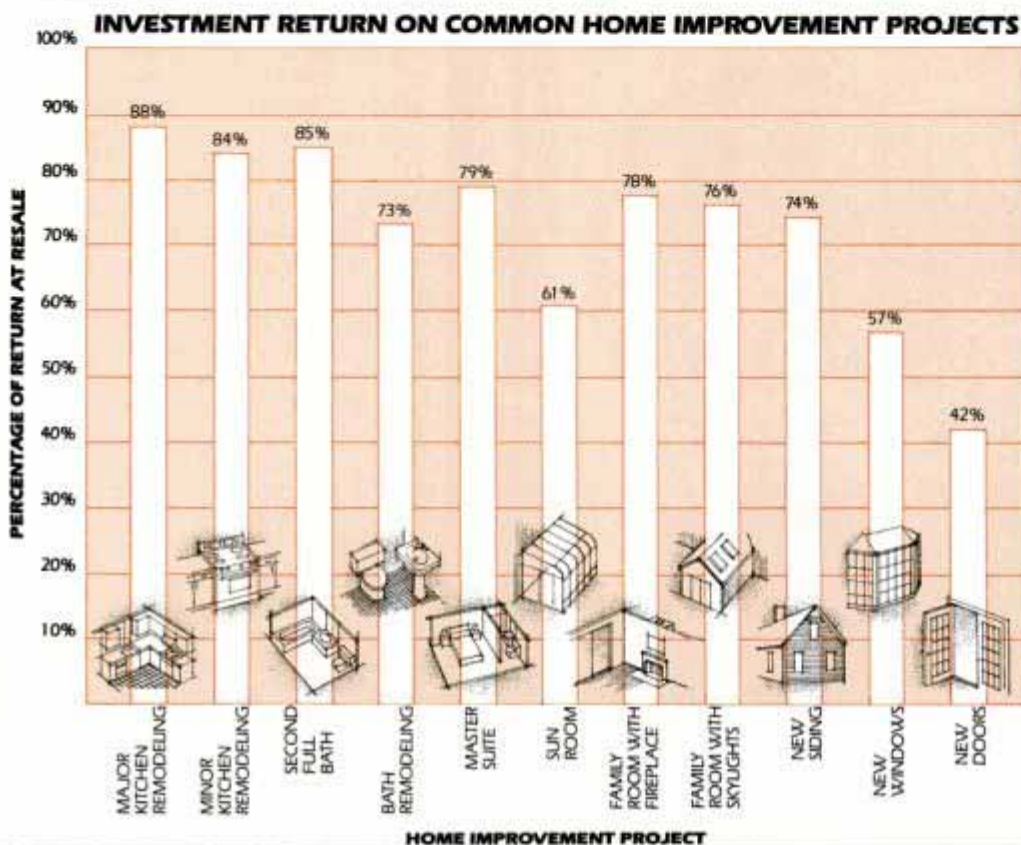
But China, India and less-developed nations accounting for most of the world's population haven't signed. And they're not likely to either. The reason is simply that while we're talking about taking steps like recycling the freon in our car air conditioners, they're still worried about getting refrigerators to prevent food spoilage, and so are unlikely to volunteer any cuts. Unless some sort of economic aid program can be devised, or a technology developed that substitutes cheaply for CFCs, nations outside the Montreal Protocol have the



# HOME FINANCE

BY DAVID ELIAS

PM ILLUSTRATION BY ADOLPH E. BROTMAN



## Remodeling Returns

**H**OME improvement is defined as anything that adds value to your home or appreciably prolongs its life. Lumped together under this heading are things like interior or exterior refurbishing, the addition of a new heating plant, remodeling a kitchen or bathroom or even adding a swimming pool. All of these things will add value to your home.

Value, however, does not automatically translate into marketability. In other words, what you put in might not necessarily come out should you decide to sell your home. If you're not intending to sell in the near future, then the choice of which improvement to do is simple. Do the one you most want to do, the one that will be the most useful and enjoyable for your

family. However, if you are intending to sell, or if for some other reason you want to see your home improvement investment directly translate into what you can get for your property, then the choice you make can help, or, in some cases, even seriously hurt the bottom line of what you get out of your house.

### Remodeling binge

According to a survey conducted for *Professional Builder* magazine, homeowners are about to go on a home-remodeling binge in the 1990s, with home improvement expenditures expected to top \$114.4 billion in 1990. The survey also predicts that "at some point in the 1990s, people will spend more money annually to re-

model homes than to build new ones." It is estimated that homeowners who are 30 to 49 years old will spend an average of about \$13,500 on remodeling in 1990. Younger homeowners will spend about \$7000 and older homeowners, \$9700.

An important factor in your remodeling decisions is how long you plan to stay in your present house. As a rule of thumb, the longer you stay, the greater your profit will be.

If you plan to move in the next three or four years, a minor renovation may prove to be more cost effective than a major one. So instead of spending \$20,000 to totally redo a kitchen, spend \$5000 to upgrade. Refinish rather than replace.

If you have no plans to move in the immediate future, a new kitchen will prob-

ably be worth the expense.

Deciding on the right home improvement is not the only decision involved in the ultimate profitability of a project. You've also got to figure out the best way to pay for it (68 percent of those surveyed by *Professional Builder* expected to pay cash), and decide whether you'll do the work yourself or contract it out (75 percent of all home improvement work involves a professional), and then, find the right contractor.

### Tax deductibility

Another benefit to making capital improvements is that the cost is deductible on your income tax in the year you sell the house.

A capital improvement is defined as one that adds to the value of the house, appreciably prolongs its life or adapts it to a new use. Added to your purchase price, these expenses will help determine the profit you will be taxed on when you sell.

Your property tax can also be affected by the improvements you make. According to Steve Carlson, author of "Your Low-Tax Dream House: A New Approach To Slashing The Cost Of Home Ownership," exterior features tend to increase the assessment more than do interior features.

Built-in appliances are taxed, but freestanding appliances are not. Carpets are taxed, but rugs are not, among many other items of interest to the homeowner.

### Maintenance

Be careful not to confuse improvements with basic maintenance, which includes interior and exterior painting, patching leaks, cleaning gutters and replastering. While these things do not add value to your house, a clean,



well-kept house is easier to sell. Realtors estimate that 95 percent of prospective home buyers don't bother to go inside of a house that doesn't have curb appeal—a generally attractive, well-maintained exterior, which includes the yard.

In general, the higher the quality of the materials and workmanship, the higher your return will be. Although exact figures differ somewhat from house to house, neighborhood to neighborhood and region to region, there are definite cost-to-value relationships.

### Good returns

According to *Remodeling*, a respected trade journal, the most profitable improvement you can make is kitchen remodeling. On a national average, major kitchen remodeling will return 88 percent of your dollars invested within the first year. Minor kitchen remodeling will return 84 percent.

The strength of both these projects is based on the commonly held belief that the kitchen is the room that sells a house. These days, a kitchen is more than a place just to prepare food. It's often the family gathering place for meals and conversation, as well as the focal point for casual entertaining.

(You'll want to see our April 1990 issue and its complete "Kitchen Remodeling Guide" if you're contemplating doing any kitchen renovating in the near future.)

The addition of a second, full bath is also an excellent investment, returning 85 percent of your money. Anyone living with at least one other person can see why! Remodeling an existing bathroom will yield an average of 73 percent within a year.

A newer trend in home improvements is the combining of two bedrooms and a bathroom to create a master suite. This project will return an average of 79 percent, but, the *Remodeling* report cautions, don't leave yourself with less than three bedrooms.

Some other cost-to-value ratio estimates that you should keep in mind include adding a sun room (61 percent return), insulated siding (74 percent), new windows (57 percent), replacing doors (42 percent), adding a deck (67 percent), the addition of a family room with a zero-clearance metal fireplace (78 percent) and the addition of a family room with two ventilating, insulated, glass skylights (76 percent).

### Bad returns

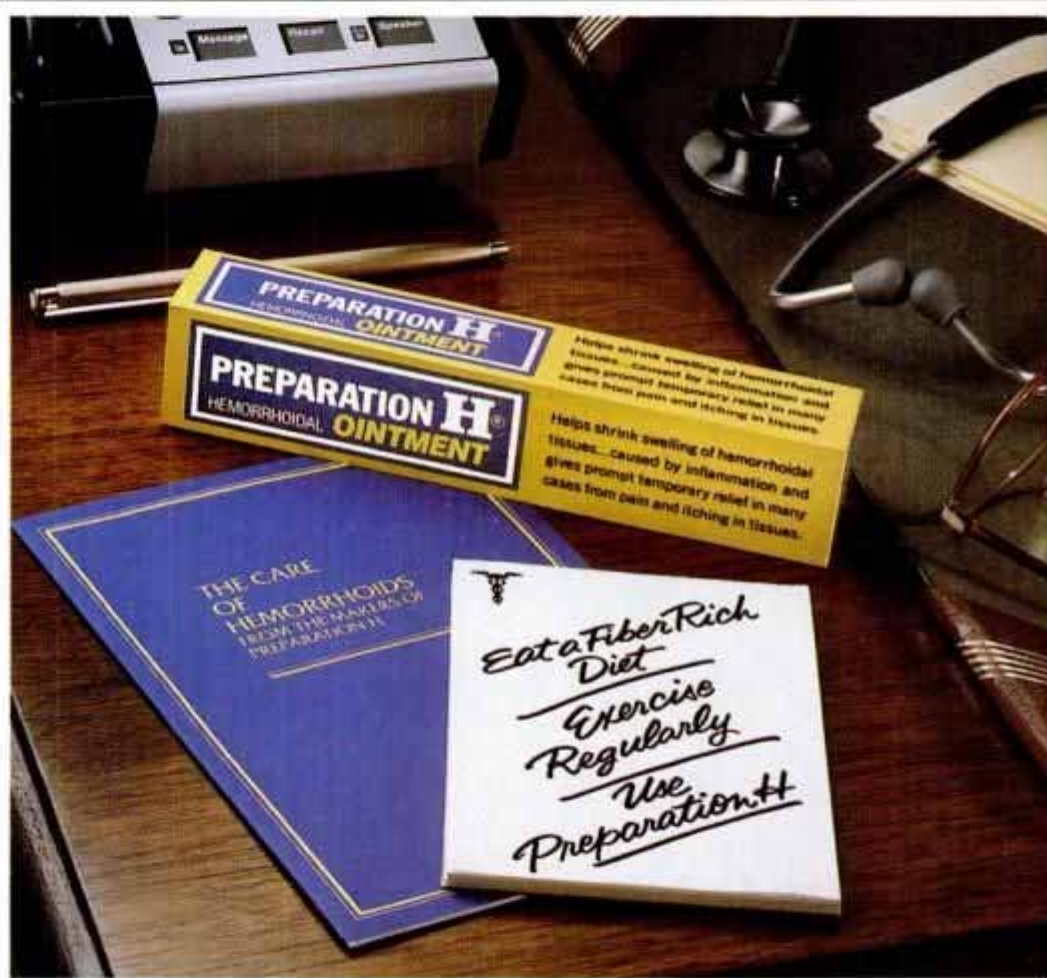
Swimming pools, tennis courts, fitness rooms and other luxury projects are not generally recommended as investments, unless your house is in Bel Air. This is known as overimproving, spending more on a home improvement than you can ever hope to see returned. Im-

provements should not only fit your house, but the houses around it, as people shopping for \$150,000 houses don't shop in \$100,000 neighborhoods. Make sure the current market value of your house, plus any planned renovations, doesn't exceed the value of the better homes in your area by more than 20 percent.

Get in touch with a local real estate agent, and ask to see, or be sent, a market analysis report. This will tell you exactly what's selling, and for how much, in your local real estate market. This service is free, nonbinding and of benefit to both you and the agent.

Once set on a project, you must decide whether you are going to do it yourself or hire a professional. Naturally, the more work you can do yourself, the more you'll save on labor costs and the better the return will be on your financial investment.

If you don't have the tools or the know-how, then you'll have to hire someone to do the work for you. Of course, we at POPULAR MECHANICS hope you'll be doing as much of the work as possible, not only to get a good return on your investment, in the form of sweat equity in your home, but in personal satisfaction as well. **PM**



## Preparation H. When your doctor says you don't need surgery.

If the agonizing pain and burning itch of hemorrhoids makes you feel you might need surgery, the very first thing you should do is see a doctor. Most likely, your doctor will tell you that your problem is not that serious and a simple regimen of care can alleviate the problem.

Thousands of doctors distribute this hemorrhoidal care guide from the makers of Preparation H. It advises a fiber-rich diet, regular exercise, and, for flare-ups, Preparation H to help shrink the swelling of hemorrhoidal tissues and often provide temporary relief of pain and itch.

Don't suffer the pain of hemorrhoids or the anxiety of surgery. Consult your doctor today.



Doctor recommended  
**PREPARATION H**  
Ointment and  
Suppositories  
Use only as directed.



# OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



PORTLAND STOVE CO. PHOTO

## Antique Kitchen Stoves

**M**ANY OLD-house restorers stop their restoration efforts when they reach the kitchen. They just don't want to sacrifice the conveniences of today for the sake of authenticity.

As far as modern appliances go, like refrigerators and dishwashers, there's not much you can do to get a period look short of disguising them with wood panels. The stove, however, is a different story.

Restored antique kitchen stoves are sturdy appliances that work remarkably well. One of these old beauties is

*Contributing Editor Bob Vila hosted public television's "This Old House" for 10 years.*

sure to become the focal point of your room and, together with the right combination of period features, will give your kitchen the unmistakable feel of years past.

### Wood and coal ranges

Some of you may remember the glowing cast-iron range that warmed your grandmother's kitchen. Many of these old stoves had six top burners over a wood- or coal-powered oven, with an open high shelf or warming oven overhead. Often, a hot-water reservoir sat on the righthand side, keeping warm water handy for dish washing and other tasks.

The dual functions these stoves served in years past—both to cook food and help heat the home—were again realized by conscientious restorers in the energy crunching '70s. Reproductions of these relics, made from the same molds and patterns used 80 years ago, became popular.

Although you can still find some restoration shops willing to make a new reproduction wood or coal range from old patterns they own, it's usually cheaper to buy a restored original. The reproduction models require that each piece be individually cast by a foundry and then ground precisely so everything fits together tightly. Of course, in a restored stove all this work was done when the stove was

All sorts of reproduction wood-and/or coal-burning stoves are available these days. This Queen Atlantic model was based on stoves built in the early 1900s.

built and, generally, all that's required is less expensive, superficial work.

Since the firebox setup varies from stove to stove, the first thing you need to know before buying one is what your primary source of fuel will be. This is largely dependent on your location and what is abundant there.

A wood-burning firebox is usually longer than one that is used for coal. There may be an extension on the back of the stove allowing pieces as long as 22 in. to be burned. The lining of the firebox is generally a thin, 1/4-in. cast iron.

Since coal burns hotter than wood, a thick lining of fireclay (usually at least 1 to 1 1/2 in. thick) is necessary in the firebox. Because of this, the firebox is smaller, generally around 14 to 15 in. Since coal needs more air to accommodate its needs, the grates on a stove using this fuel are set wider apart than those on a wood-burning stove.

If you think you'll be burning a blend of both fuels, it's best to choose a coal-burning setup. Use small pieces of wood that easily fit in the firebox and be aware that, because of the wide spacing of the grates, the wood will burn fast. Adding a summer wood grate or wood plate—a heavy cast-iron perforated plate that lies on top of the coal grates—will help reduce air infiltration and allow the wood to burn longer. Don't attempt to burn coal in a firebox set up for wood. The 1/4-in. cast-iron liner will burn out quickly.

Although the warmth these stoves generate is a welcome addition in the cold winter



months, no one wants to heat the kitchen unnecessarily in the summertime. Thus, the 2-season stove or *gas side car* was born. Often replacing the water reservoir or shelf on the side of the stove, a gas side attachment usually consists of three or four burners, an oven and a broiler. Considered a retrofit item years ago, a gas side car makes cooking on a coal- or wood-burning cookstove a more comfortable chore in the warm months.

A proper restoration of a cookstove should involve breaking down the entire appliance and rebuilding it again. All black iron parts are sandblasted, and enamel parts are washed. Any cracked pieces are welded, and those that are missing or badly broken are replaced. After everything is inspected and cleaned, it's put back together again. The only maintenance that's usually required—aside from the periodic cleaning of soot from the oven and flues—is replacement of the firebox liner and grates when they start to crack and bulge.

### Gas stoves

Early gas stoves were low-legged, square, boxy-type ranges. But the mid-teens saw the advent of the cabinet range, the vintage gas stoves in demand today. Commonly constructed of rust-resistant or aluminum-coated sheet metal and cast iron, the finish was often baked enamel. Generally, these stoves sported four or five burners with a stacked oven and broiler to the side. A curved warming oven was sometimes overhead.

Perhaps the most sought-after restored range today is the combination gas and coal- or wood-burning stove. Not as wide as a wood or coal range with a gas side car, these combination stoves often had an elevated gas oven and broiler above the standard wood, coal or gas burners and oven.

A good restoration shop will completely dismantle the stove and reinsulate it. The plumbing is resealed and the gas valves are rebuilt with automatic pilots. Thermocouples are added to the oven, and all gas manifolds are dismantled. The pipes are cleaned and threads resealed

with joint compound. In addition, each gas cock must be taken apart and meticulously cleaned, reassembled and greased.

Prices on restored gas ranges vary. The low for a small, apartment-type appliance with three burners on top and a little oven underneath is about \$1000. An ornate top-of-the-line, 6-burner, double-oven stove, the kind commonly found in a large Victorian home, can run as much as \$3500. You can usually buy a restored long-legged, 4-burner Glenwood with an oven, broiler and a curved overhead warming oven for between \$1500 and \$2500. Combination stoves are usually the most expensive and generally aver-

age between \$3500 and \$4500 restored.

Like the wood- and coal-burning stoves, not much is likely to go wrong with a properly restored antique gas stove. After years and years of use, the most common maintenance needed is a regreasing of the gas cocks.

Although there are only a handful of antique stove restoration specialists (see supplier list), most of them will ship their stock nationwide. These places are also a good source for parts. Gas valves, porcelain handles and burners are commonly sought for gas stoves, while new grates, linings and ash pans are in demand for the wood- and coal-burning ranges. **PM**

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### Source List

Following is a list of some of the leading restorers/dealers of antique stoves:

- Barnstable Stove Shop, Route 149, P.O. Box 472, West Barnstable, MA 02668 (Brochure: \$1)
- Bryant Stove Works, Inc., P.O. Box 2048, Rich Rd., Thorndike, ME 04986
- Erickson's Antique Stoves, Inc., 2 Taylor St., P.O. Box 2275, Littleton, MA 01460
- Good Time Stove Co., Route 112, P.O. Box 306, Goshen, MA 01032-0306
- Harrington's Appliance, 2926 Upas St., San Diego, CA 92104
- Macy's Texas Stove Works, 5515 Alameda Rd., Houston, TX 77004
- Portland Stove Co., P.O. Box 37, Fickett Rd., N. Pownal, ME 04069 (Literature: \$2)
- Stanley Iron Works, Inc., 64 Taylor St., Nashua, NH 03060
- Wendall's Wood Stoves, 19964 Inks Dr., Tuolumne, CA 95379



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# ELECTRONICS

BY STEPHEN A. BOOTH, Electronics Editor



Projection television by JVC uses three LCD panels to create a 35- to 120-in. diagonal image.

of about 85,000 pixels each. Its blue-white metal halide lamp is close to the color temperature of a TV tube, and can be replaced only by factory-authorized service personnel. The JVC/Epson unit has a user-replaceable halogen lamp whose color temperature is closer to that of a movie-theater projector.)

The resolution of the JVC/Epson projector is an amazingly good 350 lines horizontally, 440 vertically, and the machines can display a Vistavision-type widescreen picture when outfitted with an optional anamorphic lens (the movie, prerecorded or camcorder-made, would have to be shot with the same lens). Three 12-watt audio amps are built-in for the supplied Dolby ProLogic surround-sound system.

Also in LCD projection, Panasonic showed a 31-in. rear-projection model for ClearVision reception. By using dichroic mirrors and red-green-blue LCD panels, cabinet depth is kept to 18 in.

Elsewhere, there was increased attention to color LCD portable TVs. Sharp showed a remarkably crisp 6-in. prototype. Epson fielded a good-looking lineup of 2.5- to 5-in. models, some cleverly mounted in viewing racks with outboard minispeakers. Toshiba's 4-in. Clamshell (\$407) made its debut, while Hitachi's 5-in. C5-LC2 (\$641) boasts a feature that lets you zoom in on a 4x enlargement of the center of the screen.

## Personal Video

Sony's Video Walkman, the color LCD/8mm VCR combo, (Please turn to page 42)

## New And Novel For The '90s

**I**N LAST month's column, the SharpVision LCD projection television took center stage. Despite its high price, it probably was a fitting way to kick off our electronics coverage for the 1990s: This breadbox-size electronics component that casts a 100-in. TV picture is a harbinger of things to come in the last decade of the 20th century.

Since writing that column, I've been to the Japan Electronics Show, to get an eyeful of the new technology that will be appearing in consumer products in the near-and-not-so-distant future. Among those products was yet another LCD projection TV, from JVC and Seiko-Epson, that ups the ante in that category only a month after we reported on Sharp's breakthrough. Let that be a lesson for the '90s: Improvement will follow fast on the heels of innovation.

We'll describe the JVC/Epson TV in detail later during this report on the Japan Electronics Show. First, some general observations.

Experimental high-definition TV broadcasts have commenced in Japan, and the so-called HiVision widescreen

programs are transmitted by satellite for an hour each day. EDTV (Enhanced Definition Television), called ClearVision in Japan, is already up and running. This offers sharper horizontal and vertical resolution, and better color than current NTSC broadcasts. Much of the magic is in the studio production equipment and especially, the broadcast cameras. Because the latter are in short supply, EDTV broadcasting is limited to about 5 hours a day—mostly live programming such as sports, where the improved image quality is most evident.

Nonetheless, EDTV receivers are available for sale, along with so-called ghostbuster tuners that are almost as hot as the movie series whence they derive their name. Part of the ClearVision broadcast includes a synchronization signal that permits the TV's tuner to filter out those annoying multipath ghosts. In the demonstrations I saw, the difference was like night and day. Still, as exciting as ghostbusters were, if you had to describe the Japan Electronics Show in a word, it would be LCD.

Color liquid-crystal displays were everywhere—in portable TV, personal video, front- and rear-projection TV, even laptop computers. On the computer front, CD-ROM made a welcome move to the home PC from the industrial arena, and Sharp's Wizard portable electronic notebook attracted new competition in the pocket-smarts category, from NEC and Casio. As for Digital Audio Tape, things were quiet—too quiet.

What follows is a category by category report of new products and future prototypes displayed at the Osaka show. Currency conversion is done at the then-prevailing rate of 140 yen to the dollar.

## LCD Television

Sorry, folks. The flat, wall-hanging, big-screen TV remains in the future. But LCD in Osaka came big and small.

In the big department, JVC and Seiko-Epson introduced their jointly developed LCD front-projection TV. The projectors, priced at \$7000 under the JVC and Epson brands, use three LCD panels of 210,000 pixels each to display a 35- to 120-in. picture. (Sharp's XV-100, reported last month, uses three panels



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lightweight, metal-impregnated polycarbonate, and powered by a tiny rechargeable battery. The company also is fielding a Super VHS-C camcorder with 16x zoom lens and color LCD viewfinder.

Fuji and Toshiba have decided to offer their jointly developed digital IC card still-video camera to professionals. A full system goes for about \$28,000. Panasonic, meanwhile, introduced a VCR geared to movie renters. The NV-F500 (\$643) has a "rental" circuit to remove noise from deteriorated tapes and enhance the presentation overall. This includes sound quality, through the use of a bass-boost circuit to simulate theater sound systems.

## Hands-On

One of the annoying things about cordless telephones has always been the necessary antenna. If it's not poking into something and getting bent, it's certainly threatening as a potential safety-hazard.

Cobra Electronics has eliminated both shortcomings with its Intenna line of cordless phones—which eliminate the usual mast aerial. Instead, these phones use a metal plate antenna implanted at the earpiece-end of the handset.

After using a Cobra Intenna phone under all sorts of conditions, I'm convinced that its performance isn't comprised by the lack of a mast. Reception is strong and the signal clear, with one proviso. You have to resist the impulse to cradle the phone between your shoulder and ear, cup your hand over the top of the handset, or cover the upper portion of the walkie-talkie in any way.

With a little practice, you'll get used to it, and the effort is worthwhile considering the elimination of the nuisance.

## Late News

Philips, codeveloper of the compact disc, says it has improved the CD-I (Interactive) format by adding the capability for 70 minutes of full-motion video on the 4.75-in. disc. Interactive CDs, for education and entertainment, may debut later this year. **PM**



Cobra's Intenna cordless phones use an internal antenna instead of usual mast type.

## ELECTRONICS (Continued from page 41)

now has strolling companions from Sanyo and Funai.

Sanyo calls its entry to personal video the A/V Burger (\$986), which is due to its clamshell-folding design. The 2-pounder incorporates a 3.3-in. LCD color display and an 8mm VCR, including VHF/UHF tuner. Funai's Video Note 8, an unpriced prototype that could appear in the U.S. Under other brand names, ups the video display to 4 in.

In the VHS format, JVC has put a Spring 1990 launch date (but no pricing) on its Concept C modular system. Under this scheme, a miniaturized Super VHS-C deck hooks up to a 3.3-in. LCD screen, a mini-videocamera and other components. Meanwhile, Panasonic is bringing personal video to the boardroom with its Laptop—a briefcase-styled transportable that combines a 5-in. LCD and full-size VHS HiFi deck with tuner (\$1271).

Panasonic also showed a prototype line called Sports A/V Gear, that includes a tiny marine housing outfitted with video camera, miniature VHS-C recorder, 3.3-in. color LCD viewfinder and underwater lights. Speaking of VHS-C, both JVC and Hitachi showed working models of tray-loading VCRs that accept the standard-size and the smaller VHS-C videocassette. Tentative introduction: Spring of 1990.

## Computers

Where would laptop computers be without LCD? Soon, they'll be coming with color displays.

Mitsubishi showed one color model and Epson showed two. In monochrome LCD, Casio demonstrated an extremely fine-pitched display, called Fine LCD, for graphics on laptops and writing-phones.

Laptops continue to shrink. Epson's Note Executive weighs in at 4.5 pounds and is just 1 in. thick. NEC, whose Ultralight started the slim-and-trim trend, now is pushing CD-ROM for PCs. The company's IBM PC-compatible PC-8801MC Model 2 (\$1421) packages a CD-ROM disk drive in the same chassis with two 1-MB 5.25-in. floppy drives. (In the U.S., Vendex/Headstart has announced two personal computers with CD-ROM drives and a library of free disks.)

## Neat And New

At the Japan Electronics Show, Sony demonstrated a personal word processor that uses 2-in. floppies—the same type used in the company's Mavica still-video camera. Not surprisingly, the word processor can upload Mavica still-video images for conversion to graphic printouts.

Sharp is using the name Pin (\$149) for a jewelry-like line of personal cassette players no larger than a cassette box. They're made from a superstrong, super



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# DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



## Heating Up The ZR-1

**A**LTHOUGH THE Corvette ZR-1 is the hottest production car built in America, it's not hot enough to suit Chevy, and more muscle may be on the way for the 1991 model year.

The development mule shown here is distinguished from the current ZR-1 by two small NACA ducts in the hood. Besides helping to distinguish the ZR-1 from regular Corvettes, the ducts are intended to help reduce underhood temperatures and improve engine breathing. If nothing else, the ducts will give the ZR-1 a distinctive front face. Chevrolet has been criticized by some Corvette enthusiasts for not making the front of the super Vette recognizably different from the regular, cast-iron-engined car.

Chevy engineers expect the ducting to help the ZR-1's 5.7-liter 32-valve dohc aluminum V8 achieve the original design goal of 400 hp. The LT-5 V8 is currently rated at 380 hp.

Whether the increased horsepower goal is achieved or not, you'll probably see ducted ZR-1s on the road as early as midsummer.

### Swinging Doors

No major styling changes are

scheduled for the overall Corvette lineup before the 1996 model year. But by 1992 the designers are likely to introduce a dramatic change in the way you get in and out of the car.

The plan is to replace the Corvette's conventional door design with a door that is



Park Avenue brings aero shape and 0.31  $C_d$  to Buick lineup for '91.

hinged to swing upward, like the Lamborghini Countach.

With this design, when the door is completely open, its bottom edge would then be vertical.

Chevy favors the scissor-type door over a true gull-wing design due to the high cost and complexity of the latter.

### 1991 Buick

One of the production car stars of the 1990 Detroit Auto Show is the new Buick Park Avenue, which will appear in Buick showrooms this year as a '91 model.

Developed from Buick's Essence concept car, the

Park Avenue's smoother, aero lines have a  $C_d$  rating of 0.31, and Buick marketing executives expect exceptional operating quiet.

The new car is also bigger than the current Park Avenue—8 in. longer, with an interior volume increase of 4.8 cu. ft.

Powertrain improvements include a new electronically

controlled 4-speed automatic transaxle that coordinates shift control with the car's engine management computer to make shifts all but imperceptible.

Buick plans to offer the car in two trim levels, the basic Park Avenue and the Park



Mazda 323-based Ford Escort will be assembled in Michigan.

Chevy Corvette spotters will know the 1991 ZR-1 by the twin NACA air scoops in the hood.

Avenue Ultra, which replaces the current Electra nameplate.

## It's Thickening

After a decade of thinner and thinner window glass, some manufacturers, particularly those building luxury cars, are getting ready to increase thickness again.

Reducing window glass thickness was an important part of the ongoing effort to reduce the overall vehicle weight, which translated into more improved fuel economy.

However, the thinner glass didn't do nearly as good a job of insulating vehicle occupants from wind and general road noise.

Mercedes leads the return to thicker glass for 1990 with its 300-class cars. The window thickness of the 1990 300-class range is 4 mm, compared to 3 mm last year, an increase of 33 percent.

## Escort Update

The photo at the bottom of the page is the last spy shot you'll see of the new Ford Escort. That's because the all-new replacement for Ford's high-volume subcompact was only a few weeks from its media preview as we went to press.

Unlike the current Escort, which is largely a domestical-



ly produced car, the new Escort will be a Mazda-Ford hybrid.

The floorpan and substructure of the new car will be essentially Mazda 323, with some 323 running gear as well. However, Ford will supply the new Escort's powertrain. The body also represents a combined Ford-Mazda effort, although the shape is consistent with the Ford-family aero look.

### Chrysler Minivan Plans

Winners since their introduction back in 1984, Chrysler's minivan family will finally get a complete restyling, due to debut this fall when the 1991 models are introduced.

All three models—Dodge Caravan, Plymouth Voyager and Chrysler Town & Country—will get a more rounded, aerodynamic look, a faster windshield angle and more dramatic grillwork.

Chrysler has no plans to alter the vans' basic front-wheel-drive design. Product planners expect the new corporate 3.3-liter V6 engine to dominate powertrain choice among buyers.

Antilock braking will also be available in all three divisional offerings, though Chrysler plans to keep basic equipment simple in an effort to hold the line on pricing.

### Active Seating

Under development: An in-vehicle seating system that will employ the basic principles of active suspension.

Designed for use in big-rig trucks, the seat uses a computer-actuated system of electronic sensors, hydraulic rams and a small hydraulic pump to compensate for bumps and dips in the roadway.

Although testing has produced an enthusiastic response on the part of truck drivers, the system is still some way from production-readiness.

One important decision still to be made is whether it might be more effective to apply the active-suspension principle to the entire truck cab, isolating it from jolts to the chassis. That will hinge on whether the drivers will accept the system, which, at the current state of development, moves the seat but not the pedals, wheel or shifter. Big rigs currently use air-suspended seats, but the active system will involve more movement, and under some circumstances might make it tough to hang on.

### The Viper Lives

Although Chrysler is being cagey about dates, the company still insists its Viper show car will find its way onto an assembly line. The brawny 2-seater, essentially an update on the old Ford Cobra sports car, has been redesigned to accommodate production, according to Chrysler design chief Tom Gale.

"You won't be able to recognize any difference from the show car," says

Gale, adding that this includes the exposed side exhaust pipes.

### Viper Power

While plans for the car move forward, the fate of the Viper's V10 powerplant is uncertain.

Chrysler continues to scrutinize the possibility of producing two versions of the engine—an automotive 450-cu.-in. edition that would certainly put the Viper on a competitive footing with Chevy's Corvette ZR-1, and a 490-cu.-in. truck engine.

The uncertainty has to do with the enormous cost of tooling up for a low-

volume engine such as this. Chrysler can effect some economies, since the V10 is essentially a current Chrysler 360-cu.-in. V8 with two more cylinders. This would theoretically allow the V10 to be assembled at the same facility, and perhaps even use some of the same tooling as the V8.

But with an annual volume of 50,000 units or less, cost is still going to be a forbidding issue.

On the other hand, the V10 is attractive to Chrysler because it would give the company a powerplant capable of competing in the lucrative motorhome business. **PM**

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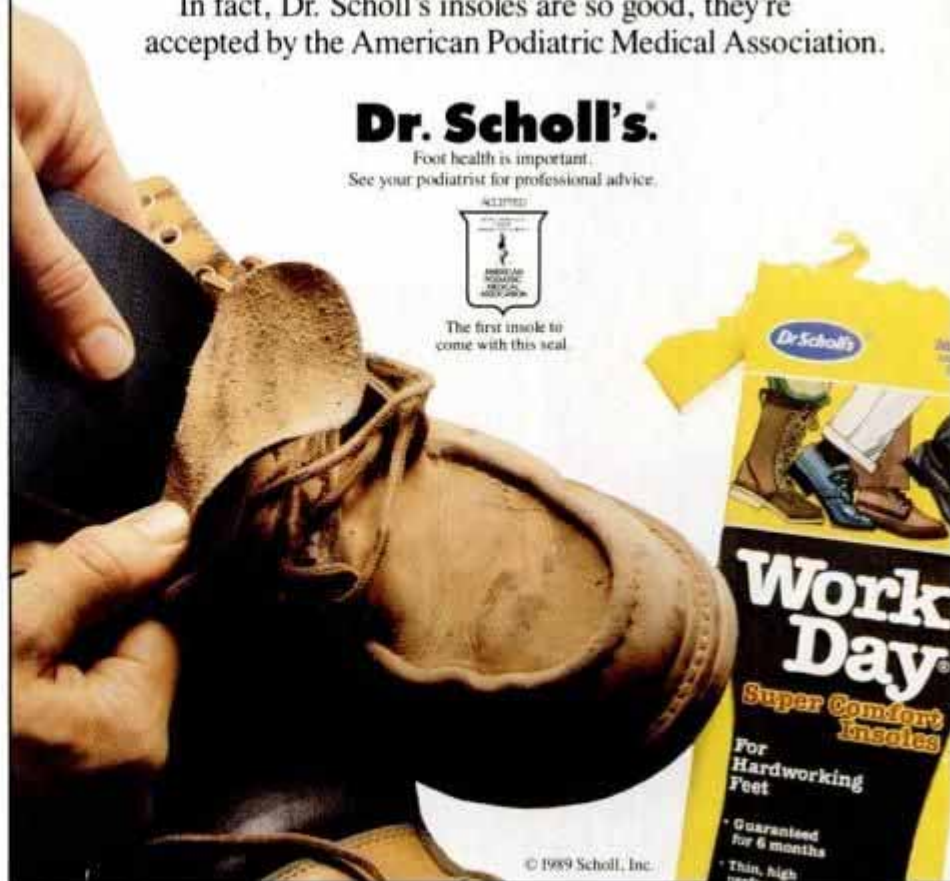
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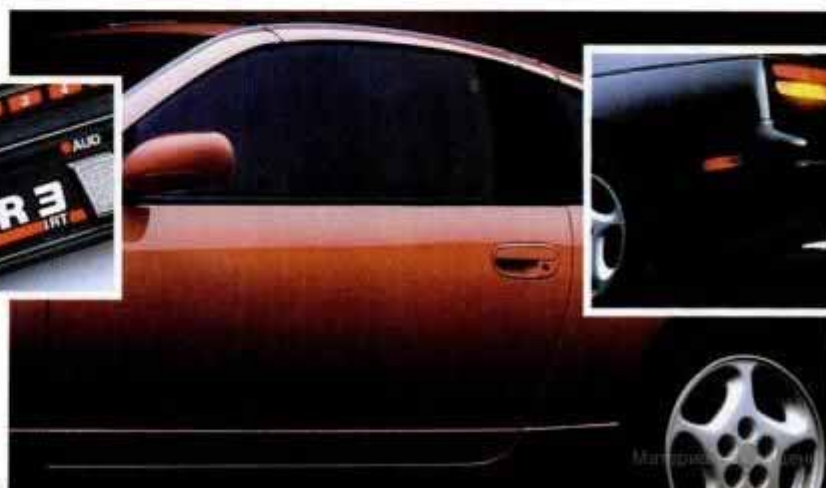
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Maxco PH222	101.5	94.8
Mason RD 25	106.3	106.8
Radio Shack Motorola		
Road Patrol KK	107.6	106.0
Linder RD90	113.1	109.9
Whisper Spectrum 2	115.6	110.4
Average unit	110.1	106.3

Source: Road & Track, Nov 1988  
BEL VECTOR 3 is the only unit in this test that also detects Ka band radar.

## The Technology Leader In 3 Band Radar Detection.



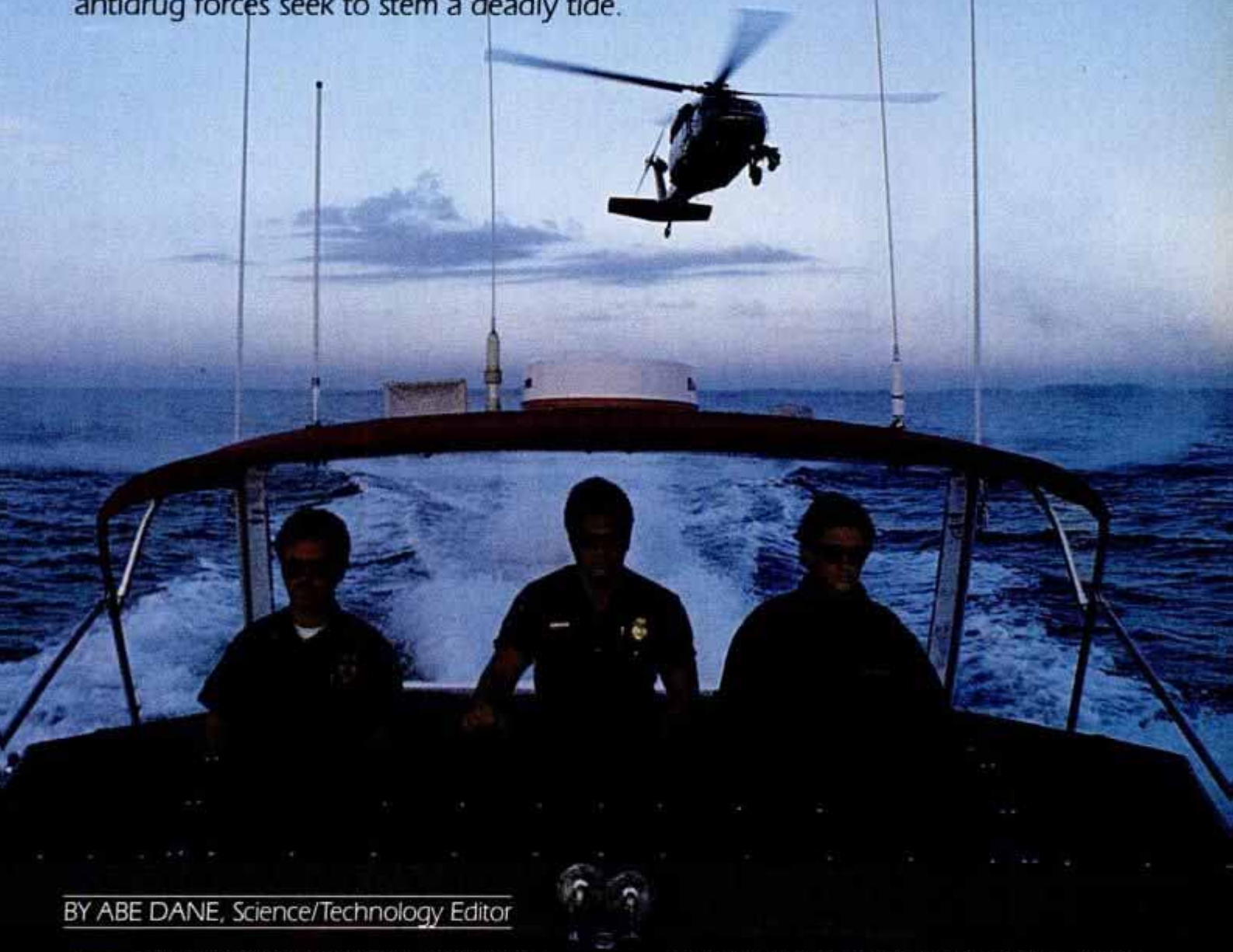
**BEL-TRONICS LIMITED**  
The Intelligent Choice





# HIGH-TECH DRUGBUSTERS

With an increasingly sophisticated arsenal of aircraft, ships and sensors, our antidrug forces seek to stem a deadly tide.



BY ABE DANE, Science/Technology Editor

**T**HE INTENSE GREENS and blues of Florida's wetlands sweep beneath us. Ahead through the cockpit glass of the Coast Guard HU-25C Falcon, the sky is vast and empty. Somewhere out there, beyond visual range, our target drones northward at a lazy 90 knots.

We get our vector from the ground controller, call sign Slingshot, and bank to intercept. From here, we'll be guided by our radar operator jammed in sideways facing his console in the rear of the sleek, Dassault-Breguet jet. Green phosphor on a 4-in.-sq. monitor records the output of a Westinghouse AN/APG-66 pulse-Doppler radar (standard equipment on the F-16)

scanning a 120° cone of sky ahead of us. A blip appears, drifting down from the top of the screen.

Working a thumb control on his joystick, the operator slides the cursor over it and clicks a trigger. We're locked on. The target's bearing, speed and range flash onto the screen and, as we close in, the belly-mounted forward-looking infrared turret swivels to search the radar-designated patch of sky.

If this sounds like war, it is. But it's not MiGs we're chasing. We're after the aircraft of a different evil empire, one driven not by communist zeal, but by free enterprise gone wrong, by avarice in its purest and most savage form. We're after drugrunners.



# AN INTERDICTION NETWORK



**AEROSTAT RADAR BALLOON**  
Carries lookdown radar that sweeps a 120-mile circle for boats and low-flying aircraft.



**GRUMMAN E-2C HAWKEYE**  
Provides surveillance data to interceptors or C<sup>3</sup>I.

**SIKORSKY UH-60 BLACK HAWK**  
Ferries in the bust crew.



**JOINT SURVEILLANCE SYSTEM RADAR**  
A network of FAA and military radar antennas used by C<sup>3</sup>I to follow air traffic.

**MOBILE AEROSTAT PLATFORM VESSEL**  
Carries tether-handling and support equipment for radar balloon, along with communications gear, to dispatch data to interceptors and C<sup>3</sup>I.



**DASSAULT-BREGUET HU-25C FALCON**  
Intercepts, identifies and monitors suspect aircraft.

**ISLAND-CLASS PATROL BOAT**  
Combines 30-knot speed with twin M-60 machine guns and 20mm cannon to intercept and stop suspect boats.



**C<sup>3</sup>I CENTER**  
Pulls together data from land-based, airborne and seaborne radar, along with intelligence and other information, to coordinate interdiction operations.

**BLUE THUNDER CATAMARAN**  
Runs at up to 70 mph to pursue smugglers in coastal waters.



Their cunning is as limitless as the profits to be had in the drug trade, and they need only slip across some unwatched mile out of the thousands making up our border to accomplish their mission. Technology is the only way to even the odds.

With the results of the recent drug-interdiction buildup now in the field, we set out to see how the new tools are being applied.

**Nature of the threat**  
The tactics of the drug smuggler and the technology for

catching him are constantly evolving in response to each other. From the smuggler's point of view, the simplest way to do business would be to fly from the producing area—usually Colombia—to the nearest part of the consuming nation—Florida

—land at some out of the way airstrip, leave the goods with a load crew and return. Fortunately, the counter to this is relatively simple, too. A tracker aircraft such as the Falcon, or a similarly equipped Customs Service Cessna Citation, is dis-



Radar symbology aids sorting at C<sup>3</sup>I West. An X indicates primary track only. Slash is civilian transponder. Box with slash is transponder and primary. Pound sign is coast track, meaning contact has been lost. And green triangle is military transponder.

PHOTO BY RON HUSSEY

U.S. CUSTOMS PHOTO





**GENERAL DYNAMICS F-16**  
Held in reserve as a backup to be scrambled in case Coast Guard or Customs aircraft cannot intercept a target.



**DC-3**  
Smuggler's favorite. Big load capacity. Will fly through anything.

**SMUGGLER'S BOAT**  
Picks up bales and makes the run into shore.

patched to identify and shadow suspicious planes picked up by ground or airborne surveillance radar. When a landing seems imminent, a Customs Service Black Hawk helicopter carrying a bust crew of specially trained air officers joins the chase.

The tracker plane lands behind the smuggler, blocking one escape route, and the helicopter lands in front blocking the other. Then the bust crew charges out of the helicopter, assault rifles in hand, and makes the arrest.

At one time, this scenario



Aerostat ship rests at Miami station between 27-day voyages.



PHOTO BY SKIP GANDY

Customs Sikorsky Black Hawk with tail stabilator down for low speed.

was played out regularly in Florida. But as the Customs Service and Coast Guard perfected it, the smugglers got wise, and since then life has been more complicated for both sides. Now drugs are often offloaded or airdropped in the Bahamas, then ferried into the United States by small, high-speed boats. Much of the action has also shifted westward, where radar coverage has been spotty, and wide-open spaces invite clandestine landings. Lately, some drug-runners have even been tracked going all the way up either coast to Canada looking for a safe way in.

The logistics of responding to tactics such as these are formidably complex. At the heart of the approach adopted by the Federal Government is a \$63-million pair of Command, Control, Communications and Intelligence (C<sup>3</sup>I) Centers located at either end of the country. From here the aim is to coordinate the activities of agencies ranging from the Coast Guard to local police, forming an organized antidrug blockade. If necessary, Air Force F-16 fighters may even be scrambled to chase down suspects beyond the reach of Customs and Coast Guard flyers.

### Antidrug command post

The C<sup>3</sup>I facility we visited at California's March Air Force Base was in a low concrete building surrounded by barbed wire. In its control room, half a dozen men were quietly going about the business of watching 2000 miles of border.

Key to the center's effectiveness is massive computing power that fuses data from numerous radar and in-

telligence inputs into a coherent picture. Each operator sits at a 2-screen console, with a computer-generated composite radar image on one side and a variety of digitized maps and database information available on the other.

Most of the operator's job consists of sorting through radar tracks in a certain area and picking out suspicious blips—usually planes without transponders or flight plans filed with the FAA. The operator then goes to the database screen and makes queries for information on the aircraft. Next, he begins assessing the options for interception by bringing up the Status of Forces database, showing detailed information on the range, speed and equipment of all the aircraft available to be diverted or scrambled to the target. Throughout the process, a variety of maps are called up to show possible landing sights, terrain contours and roads along the suspect's route. At the end of an operation, a complete radar log can be printed out for use in court.

Supervisor Jeff Houlihan ran the system through its paces for us, and the speed and sureness of its response was impressive. It seemed as if any information you could possibly want was there at the roll of a trackball and the touch of a button. You want to search the radar screen for a plane with a particular tail number? It's done. Check the FBI National Crime Information Center database to see if it's stolen? Done. Superimpose the radar track on a road map? Done. Get the local sheriff's home phone number? It's autodialed. The level of detail is truly amazing when you consider this



# HIGH-TECH DRUGBUSTERS



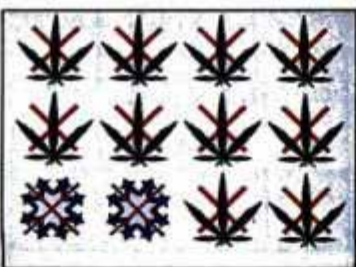
PVA PHOTOS BY SKIP GANDY

COAST GUARD PHOTO

center's coverage extends all the way east to the Mississippi River.

## Feeding the nerve center

Information comes to the C<sup>3</sup>I centers from a variety of sources, most of it through the Joint Surveillance System (JSS) network, which blends together FAA air traffic control and Air Force defense radar data from all over the country. Gaps in this network are filled by land-based aerostat radar balloons, now being installed in a picket line along the southwestern border. Even these have blind spots, however, and that's where air- and sea-based mobile radars come in.



Falcon (top) practices maneuver for reading tail number. Its sensor panel (above) has radar and FLIR displays for intercepts. Customs air officers (above left) practice helicopter deployments. Markings on Coast Guard cutter (left) show the score—leaves for marijuana busts, snowflakes for cocaine.

The Coast Guard uses E-2C Hawkeye surveillance planes on loan from the Navy. Designed to protect carrier battle groups, the plane's 24-ft. above-wing radar has a 200-mile range and can track up to 300 targets at once. One E-2C flying over the congested New York-to-Washington corridor could follow all air and sea traffic within the radar's footprint. Staying up as long as 6 hours,

the Hawkeyes fly long sorties, primarily over southern Florida and southward. "It's like flypaper that you drag through the Bahamas or the Yucatan to snag bad guys," says Coast Guard Cmdr. Bradford Niesen of the E-2C. In addition to surveillance, the E-2C often works as an airborne control center, communicating directly with interceptors to coordinate the details of a bust. The Cus-

toms Service flies Lockheed P-3 Orions fitted out with more recent surveillance radar on similar missions.

While the E-2C's 250-knot cruising speed helps it surprise smugglers, the cost of keeping one in the air is considerable. For tracking sea-going targets, the ship-borne aerostat balloons run by the Coast Guard are more efficient and move fast enough to keep drugrunners guessing. The 110-ft. balloon is usually run up to about 2500 ft. on a Kevlar tether, which contains a fiberoptic data link, copper power conductors and a tube to supply extra helium. A backup VHF link keeps the balloon in contact with the surface in case the fiberoptics fail, or the tether snaps. The cable's winch and an elaborate tensioning system designed to prevent tether breakage are housed in a rotating turret where the aerostat docks when out of operation. A container bolted to the deck

*(Please turn to page 114)*



Maneuverable, stable and swift Blue Thunder catamarans patrol waters off southern Florida.

U.S. CUSTOMS SERVICE PHOTO



# DODGE DYNASTY

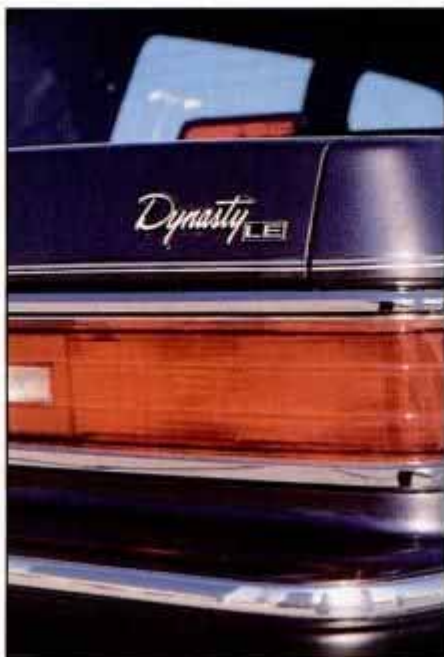
Right the first time.



BY MICHAEL LAMM,  
Contributing Editor

**Q**UICK, describe the Dodge Dynasty in one sentence. How about "a practical 4-door family sedan with a touch of class." That sums up this contemporary front-wheel-drive sedan that debuted in 1988. Since then, it has made quite a dent in the upper midsize market segment, competing against the likes of the Pontiac 6000, Chevrolet Celebrity and the segment champ, the Ford Taurus.

The Dodge Dynasty is a thoroughly modern automobile with all the engineering buzzwords as part of its component vocabulary—front-wheel drive, electronically controlled automatic transaxle, fuel-injected, balance-shaft Four or fuel-injected V6 engine (depending on the model).



What's more, since its inception, the Dynasty has had a high level of standard equipment, with the option of even more.

As we begin the car's third model year, one thing is plainly clear. The Dodge Dynasty is a home run—in the marketplace and with owners who like the car just the way it is. In fact, nearly half the respondents in our recent PM Owners Report survey (44.3 percent) told us they like their car exactly as is.

This is a very high percentage. By way of contrast, only 17 percent of Acura Legend owners, a generally satisfied group, reflected a leave-it-be attitude.

Part of the reason for this is a savvy owner body. Dynasty owners are mostly mature buyers who've been around the track and know exactly what they want. And in this case,





they figure they got a really good deal. Most recognized that they paid an average of \$5000 less for the same sedan that Chrysler dealers sell as the New Yorker. The standard Dynasty stickers out at approximately \$13,000 versus \$18,000 for the least expensive New Yorker.

While it's true that New Yorkers come with a bit more in the way of standard equipment, there's not that much difference between the two cars. So the Dynasty does turn out to be a relative bargain, a fact that wasn't lost on 25.6 percent of our respondents, who said the price was definitely right.



Interior features old-new blend of traditional instrument panel with steering wheel-mounted airbag. New 3.3-liter V6 delivers good midrange torque, improved performance.

We don't mean to suggest that Dynasty buyers went for the bare-bones edition. A full 70 percent opted for the upmarket LE series, and another 26.3

percent chose the V6 engine over the base Four. (The standard Dynasty comes with a 2.5-liter Four and 3-speed automatic transaxle, while the

### SUMMARY OF 1989-90 DODGE DYNASTY OWNERS REPORTS\*

<b>Total miles driven</b>	980,108	<b>Comfort</b>	46.0	<b>Workmanship opinion:</b>		<b>Yes</b>	68.6%
<b>Average miles per gallon:</b>		<b>Handling</b>	31.3	<b>Excellent</b>	57.1%	<b>No</b>	31.4
With 2.5-liter Four		<b>Riding qualities</b>	25.3	<b>Good</b>	41.1	<b>Dealer service opinion:</b>	
In town	23.8	<b>Performance</b>	16.7	<b>Average</b>	1.4	<b>Excellent</b>	47.9%
On the highway	29.5	<b>Power</b>	16.2	<b>Poor</b>	0.5	<b>Good</b>	41.7
With 3.0-liter V6		<b>Specific dislikes:</b>		<b>Comfort opinion:</b>		<b>Average</b>	6.2
In town	21.9	<b>No complaints</b>	13.8%	<b>Front seats:</b>		<b>Poor</b>	4.2
On the highway	27.9	<b>Noises and rattles</b>	12.2	<b>Excellent</b>	67.6%	<b>Number of vehicles owned:</b>	
<b>Why did you choose the Dynasty?</b>		<b>Instrument panel layout</b>	7.3	<b>Good</b>	28.8	<b>This car only</b>	34.2%
Styling	59.5%	<b>Tilt of driver's seatback</b>	7.3	<b>Average</b>	1.8	<b>Two cars</b>	34.7
Price/value	25.6	<b>Glovebox too small</b>	5.7	<b>Poor</b>	1.8	<b>Three cars</b>	20.7
Comfort	12.6	<b>Paint/finish quality</b>	5.7	<b>Rear seats:</b>		<b>Four or more cars</b>	10.5
Past experience	12.6	<b>Rough-shifting</b>		<b>Excellent</b>	57.8%	<b>Would you buy a Dynasty again?</b>	
Good handling	10.2	<b>4-speed automatic</b>	5.7	<b>Good</b>	40.3	<b>Yes</b>	70.9%
<b>Series chosen:</b>		<b>What changes would you like to see made?</b>		<b>Average</b>	1.5	<b>Maybe</b>	24.7
Dynasty LE	70.1%	<b>No changes</b>	44.3%	<b>Poor</b>	0.5	<b>No</b>	4.5
Standard Dynasty	29.9	<b>Greater silence</b>	5.4	<b>Had any mechanical trouble?</b>		<b>Maybe</b>	63.8%
<b>Engine selection:</b>		<b>More upright seatback; better view of instruments</b>	4.9	<b>No</b>	81.8%	<b>No</b>	18.4
3.0-liter V6	96.3%	<b>Smoother transmission</b>	3.2	<b>Yes</b>	18.2	<b>Yes</b>	17.9
2.5-liter Four	3.7	<b>Large glovebox</b>	2.7	<b>What type of trouble?</b>		<b>Principal driver:</b>	
3.3-liter V6	0.0	<b>More legroom</b>	2.7	<b>Rough-shifting</b>		<b>Male</b>	50.7%
<b>Major options chosen:</b>		<b>Trunk shape and lower-liftover sill</b>	2.7	<b>4-speed automatic</b>	22.5%	<b>Female</b>	44.7
Antilock braking system	39.4%	<b>How much did you pay?</b>		<b>Electrical</b>	15.0	<b>Equal</b>	4.6
Road handling suspension	36.7	<b>Average</b>	\$15,244	<b>Air conditioning</b>	15.0	<b>Age distribution of owners:</b>	
Automatic load leveling	22.9	<b>Range</b>	\$11,500-\$20,000	<b>Did you repair it yourself?</b>		<b>Under 29 years</b>	0.5%
Power sunroof	3.8			<b>No</b>	97.6%	<b>30-49</b>	26.3
<b>Specific overall likes:</b>				<b>Yes</b>	2.4	<b>50-plus</b>	73.3
Exterior styling	48.5%			<b>Dealer repairs satisfactory?</b>			

\*Percentages might not equal 100 percent due to rounding or an insufficient amount of data.



LE is equipped with a V6 and 4-speed automatic.)

In tallying our questionnaires, we found that nearly 60 percent of all buyers cited the Dynasty's styling as the one big feature that won them over. Once won, nearly half said that styling was still what they liked best about the car.

The only consistent gripe had to do with rough 1-2 and 2-1 shifting in early editions of the then-new 4-speed automatic transaxle. Although 81.8 percent of the respondents said they'd had no problems at all, a quarter of the remaining 18.2 percent did mention the rough shifting.

Chrysler Corp. acknowledges this as an early problem that's since been corrected. However, not all dealers were able to cure the rough shifting on the first try, which led to a slightly below-average satisfaction rate with dealer repairs, even though all cars in our survey were covered under Chrysler's 7/70 warranty.

Front- and rear-seat comfort got top marks, except for 7.3 percent who felt the seatback of bench-seat models was tilted too far rearward. There's no recliner with the standard bench seat, so the rear tilt—intended to compensate for limited seat travel—caused a few aching sacroiliacs and also obscured the view of the instrument panel for shorter drivers.

In addition, a tiny minority pointed out that the Dynasty's trunk floor isn't flat. There's a big, round depression designed to hold a full-sized spare tire, even though the standard spare is a compact. Other owners suggested a lower liftover height for the trunk.

As the quality gap between American, European and Japanese cars narrows, there's less to criticize in terms of workmanship—something that's reflected in the Dynasty's quality rating. Fit, finish and overall quality pleased the overwhelming majority—98.2 percent. A few, very few, complained of dashboard rattles, engine roar at higher speeds and miscellaneous body squeaks.

Predictably, the standard Four outperformed the V6 in fuel economy—by 2 mpg. But both engines averaged almost 30 mpg on long trips.

Many owners praised the Mitsubishi-supplied 3.0-liter V6, which delivers 141 hp, versus 100 for the 2.5-liter Four. For 1990, a new 147-hp 3.3-liter Chrysler-built V6 is available.

But with or without extras, these owners appear to be exceptionally well pleased with their purchases. They perceive value in a car that looks good, performs well, gets decent fuel economy and delivers the comfort and space they want. **PM**



Severely formal roofline gives Dynasty a conservative look that scores well with buyers. Some owners complained that trunk liftover height should be lower.

#### EDITORS REPORT

## Right Doesn't Mean Perfect

**I**T'S FAIR TO SAY that the Dodge Dynasty didn't exactly cause anyone to swoon or rend their garments when it rolled onto the world automotive stage three years ago. Our own response was a sort of polite nod, while we looked around to see what Carroll Shelby might be cooking up.

But car buyers have an uncanny ability to sniff out the sleepers, a trait that has helped the Dynasty emerge as one of the best buys in autodom. It became clear that there might be virtues here we'd missed. Accordingly, while our Dynasty owners filled out questionnaires, we spent some time with a new Dynasty.

There's certainly no question here that this midsize sedan is priced right. With an average retail in the mid-teens, there's quite a lot of car here for the money. The same price would take you down about one size class in a Japanese sedan.

We can't comment on the long-term durability of our Dynasty, obviously, but our owners are well satisfied on that count as well. Chrysler is clearly doing something right.

Still, we aren't as convinced as the owners that this design couldn't be improved. A good place to start on this score is the Dynasty's handling. While we agree that ride quality, the second most lauded trait by the Dynasty owners, is good, we have a different opinion about the car's conduct on curves and switchbacks. Straight-line stability is quite acceptable, but when the Dy-

nasty is hurried through a turn it displays excessive body roll and mulish understeer.

To be fair, Chrysler doesn't label the Dynasty as a sport sedan. But by contemporary handling standards, its performance is below average.

Workmanship was another section of the Dynasty's scorecard that drew praise from the owners, and once again we agree in general—with a specific exception. The paint showed serious orange-peel, particularly on vertical panels.

We'll refrain from comment on the Dynasty's styling—its strongest appeal among our owners—other than to note that the formal roofline allows for generous rear seat headroom. In fact, we're surprised that roominess didn't show up on the list of specific likes.

Power did show up on the like list, cited by 16.2 percent, but we'd be willing to bet it would have commanded a higher place in the ratings if Chrysler's new 3.3-liter V6 had been available during the first couple years of production. Although this new engine didn't get much attention when Chrysler Corp. introduced it last summer—with all the multicam, multivalve powerplants available today, it's hard to get excited about a pushrod 2-valve V6—our opinion has gone sharply upward now that we've had a chance to live with it for a while. It's smooth, quiet and commendably torquey—just the thing to make this good buy even better.





The million-pound An-225 caps off a quarter century in which the mightiest airlifters have more than tripled in size.

# HEAVY

BY JOHN FRICKER

**I**T APPEARS FROM the soggy Paris sky like a gigantic whale dropping out of the clouds. It drifts slowly, deceptively slowly, along the base of the leaden gray haze, its great arrowed wings swathed in snatches of vapor, its six underslung turbofans rumbling like distant thunder. Slowly, another aircraft materializes, seemingly in tight formation above. But as the pair descend, you can see that the strange

delta-wing shape is, in fact, riding piggyback on the aerial leviathan beneath it.

Downwind for landing, the great fuselage suddenly grows twin rows of 28 wheels from its lower sponsons, and the sleek wings sprout leading- and trailing-edge flaps. The abundant thrust of the Lotarev turbofans power the giant plane's 1,036,171-pound bulk onto Le Bourget's runway as delicately as a Piper Cub. The landing rollout is remarkably short, but the biggest surprise comes when the huge, hulking aircraft taxis in, loom-

ing like a multistory apartment house laid on its side. The aircraft taxis closer, then suddenly veers off the perimeter track across the rain-sodden grass to demonstrate the high-flotation qualities of its millipede gear.

For those of us at the 1989 Paris Air Show, this first appearance of the Soviet Union's Antonov An-225 *Mriya* aerial freighter, carrying the *Buran* space shuttle on its broad back, was an unforgettable sight. What we saw sweeping into the circuit, banking with surprising agility at angles up to 45°, was an aircraft on a scale that's a





An-225, carrying *Buran*, descends for its western debut at the 1989 Paris Air Show.

# LIFTERS

quantum leap greater than anything ever seen before in the West.

Awesome.

## Genesis of the giants

Although the An-225 seemed to emerge out of nowhere, her origins are actually not so mysterious. As in most areas of aeronautical innovation, except helicopters, the Soviets have followed the West's lead in designs for large transports. In the early 1960s, the 343,000-pound Lockheed C-141 Starlifter pioneered the 4-engine, high-wing, rear-loading layout

that set the standards for the modern heavy lifter. It was not until more than seven years after the C-141 flew that the Soviets introduced the similar 374,785-pound Ilyushin Il-76.

Meanwhile, Lockheed used its experience in building 285 Starlifters to produce the vastly scaled-up C-5 Galaxy. In addition to its 728,000-pound takeoff weight, the C-5 was remarkable for a top-hinged nose section and kneeling landing gear which eases loading. Vast trailing-edge slotted flaps interconnect with full-span leading-edge slats to reduce approach

speeds for short-field operation, and spoilers improve braking. Fin-mounting of the horizontal stabilizer keeps it clear from the ferocious downwash of the flaps, and provides clearance for ground vehicles using the rear-loading ramp.

With four 43,000-pound-thrust turbofans, and an improved wing, the C-5B's maximum takeoff weight has been progressively boosted to 840,000 pounds. Once in the air, it can take on extra fuel from aerial tankers to increase its flying weight to 920,000 pounds.



# HEAVY LIFTERS

## The Soviets come back

The Soviets were even slower in responding to the C-5 than they had been to the Starlifter. But as usual, they responded in a big way. The Antonov An-124—later named *Ruslan* after Pushkin's fabled giant—first flew Dec. 26, 1982. Except for its low-mounted horizontal stabilizer, the An-124 has been called a C-5 clone and is certainly remarkably similar in concept, size and configuration, although its maximum attainable payload is 53 percent larger by some measures.

The 14-year gap from the C-5's debut allowed the Antonov design and engineering team under Pyotr Balabuyev to incorporate new technology. Carbon-fiber composites and lightweight materials comprise some 12,125 pounds, or 5 percent, of the An-124's empty weight, and save around 4410 pounds in structure. While duplicating the C-5's flap, slat and spoiler layout on similarly anhedral wings, the surfaces are controlled by fly-by-wire technology.

Many details differ in interesting ways as well. For example, the An-124 lacks the fully pressurized cargo bay and in-flight refueling capacity of the C-5. On the other hand, the An-124 does have an all-titanium cargo floor, something only the U.S.S.R. with its unrivaled reserves of this valuable, lightweight metal would be able to afford.

Like the C-5, the An-124 spreads its weight through sponson-stowed multiple landing-gear bogies that kneel for loading. It also supplements its rear-loading ramp with a swing-up nose. Floor space in the cargo bays is almost exactly the same—2515 sq. ft., versus 2300 for the C-5.

## The dream is born

Proud as they are of their aircraft records, the Soviets are motivated by serious design purposes. Very large aircraft are required to lift outside in-



An-225's faired external attach points are arranged for a variety of loads. Cockpit (right) is similar to An-124's, except for extra throttles in the center to control the fifth and sixth engines.



dustrial loads into primitive airstrips in undeveloped areas of the U.S.S.R., not to mention military airlift missions. Thus, when even the mighty An-124 left certain needs unmet, work began on a still more massive air freighter. One key concern was the need to carry the cylindrical 150 x 26-ft. segments of the Soviet space program's *Energia* heavy-lift booster, which had to be carried externally. Such a load would subject the An-124's single vertical stabilizer to unacceptable levels of turbulence.

In 1984, Balabuyev was assigned to produce a transport aircraft able to lift a 551,116-pound maximum external or internal payload and operate from any 11,500-ft. runway. This meant a 220,462-pound increase in maximum payload over the An-124. And the design staff had to produce the aircraft in record time.

For a quick solution, the Antonov team decided on a 3-way stretch of its successful giant jet-freighter, the An-124. By inserting fore and aft fuselage plugs, which increased the overall

length of the An-124 from 226.7 ft. to an astonishing 275.6 ft., the dream (*Mriya*, in the local Ukrainian dialect) gained substance. A new 49.2-ft. wing center section was designed to carry an extra pair of Lotarev D-18T turbofans. New spoiler and flap sections were designed as well. This stretched the original wingspan from 240.49 ft. to 290 ft. To provide external-load wake clearance, a completely new tail was designed with twin vertical fins at either end of a horizontal stabilizer longer than the wing of a Boeing 737.

Cargo space in the An-225 stretches some 23 ft. to a length of 141 ft., which is actually just 20 ft. more than the C-5's. With the same internal height and width as the An-124, the An-225 offers 2959 sq. ft. of floor area, and usable volume of at least 42,706 cu. ft.

The landing gear retains the An-124's kneeling capabilities and has two extra twin-wheel bogies on each side. This increases the number of main wheels to a total of 28, to handle the maximum design takeoff weight

## How The Giants Stack Up



PIPER CUB



C-130 HERCULES



C-5 GALAXY



AN-225 MRIYA





of an unbelievable 1,322,770 pounds.

Faired attachment points are provided along the An-225's fuselage top for its external loads. These may include oil rig towers or similar freight up to 32 ft. dia. and 230 ft. in length. The attachment points might also be used to turn the An-225 into an airborne launch platform for the Soviet space shuttle. Launches would be possible up to altitudes of 33,000 ft.

### A look around

Climbing the ladder to the An-225's upper deck brings you to a maze of compartments, including two sideways crew stations behind the captain's and copilot's seats. The stations accommodate two flight engineers, a navigator and a communications specialist, with off-duty rest bunks in the rear. In this respect, as in most others, the An-225 is similar to the An-124. About the only change in the control layout is the addition of two more engine and thrust reverse levers, required by the extra powerplants.

Climbing into the beast through the small crew door on the left of the forward fuselage dumps you into the immense tunnel of the cargo hold. Its soundproof cladding stretches far away into the distance, producing a sense more like the Moscow subway than the interior of an aircraft. Immense loads like 80 automobiles, 16 standard ISO freight containers or general cargo up to 551,160 pounds can be handled with the help of four 11,000-pound-capacity overhead cranes running the entire length of the hold.

First flown on Dec. 21, 1988, the An-225 set its first 106 records on its 44th flight just three months later. Specifically aiming to top payload-to-altitude figures recently achieved by the new 870,000-pound Boeing 747-400 (see "Big Bird," page 74, March '89), it took off with a 344,485-pound payload, which it managed to lift to 39,400 ft. and over a distance of 1242 miles at an average 440 knots.

A second An-225 is ex-

pected to join the development program in late 1990, but wide-scale production of this behemoth beyond three to five units is not currently planned. Will there be still bigger Antonov transports?

"I think maybe we should stop there," said Deputy Chief Designer Anatoli Bulanenko, "if only because of airfield handling problems. But when An-225 certification is completed, we'll be able to offer commercial rates for lifting any cargo, inside or out, anywhere in the world."

Antonov has already received an official go-ahead to commission heavy-load contracts. If you need to carry around a few 20-story buildings and need a price quote, just call Kiev 442-61-24, or contact Aeroflot. If you'd prefer to buy your own An-225, it will cost you around \$200 million—almost twice the number for Lockheed's C-5. All you would have to do then is come up with \$35,000 per flying hour in direct operating costs, and anticipate the highest landing fees in aviation history. **PM**



Largely digital instrumentation in C-5B Galaxy is less austere than Antonov's. Yawning C-5 can carry 16 three-quarter-ton trucks, six Apache attack helicopters, or a pair of M1 Abrams main battle tanks.





O N L Y O N

Mobil 1



*The one-of-a-kind Aston Martin Group C racer.  
Exclusive tires: Goodyear Eagle racing radials.*



*The \$275,000 limited edition Aston Martin Volante Zagato.  
Exclusive tires: Goodyear Eagle V speed-rated "Gatorback" street radials.*



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## **GOODYEAR**

BECAUSE THERE REALLY IS A DIFFERENCE.



# THE LIGHT VAN

Eleven minivans battle for the all-family championship.

BY RICH TAYLOR,  
Contributing Editor

**V**ANTASTIC! Some of the most innovative, useful and downright clever cars made today are in this gang of 11. That's right, cars. Despite their truck shapes, these are really tall automobiles designed for hauling Cub Scouts, as distinct from greasy auto parts or sacks of cement.

Most of these lightweight vans will comfortably carry seven adults, which makes them perfect as car-pool transportation. They'll also handle dozens of grocery bags or a stack of 2x6 timbers, thanks to readily removable seats that open up the cargo area. The toughest can also tow your bass boat or small travel trailer with ease.

Best of all, these vans will fit in your garage, they're compact enough for convenient city parking and as easy to drive as any sedan. Since the birth of this new species back in 1984, when Chrysler introduced the Plymouth Voyager and Dodge Caravan, minivans have steadily replaced the station wagon as standard family transport. And as this group indicates, the offerings are more diverse and sophisticated than ever before.

As always, our rankings and comments represent the consensus of the group.

## Mazda MPV

Mazda's very car-like Multi-Purpose Vehicle emerges as our all-around favorite—provided cargo volume isn't the primary consideration. We think the MPV looks like a big Honda Civic, smooth and rounded as a streambed pebble. It could have been styled by organic sculptor Henry Moore.

Beneath this pretty body, the chassis is mostly Mazda truck. This means a separate frame—good for durability—and rear-wheel drive, with a tow rating of 4500 pounds.

The MPV's 150-hp V6 delivers smooth, flowing power that makes nearly all driving effortless. It's per-

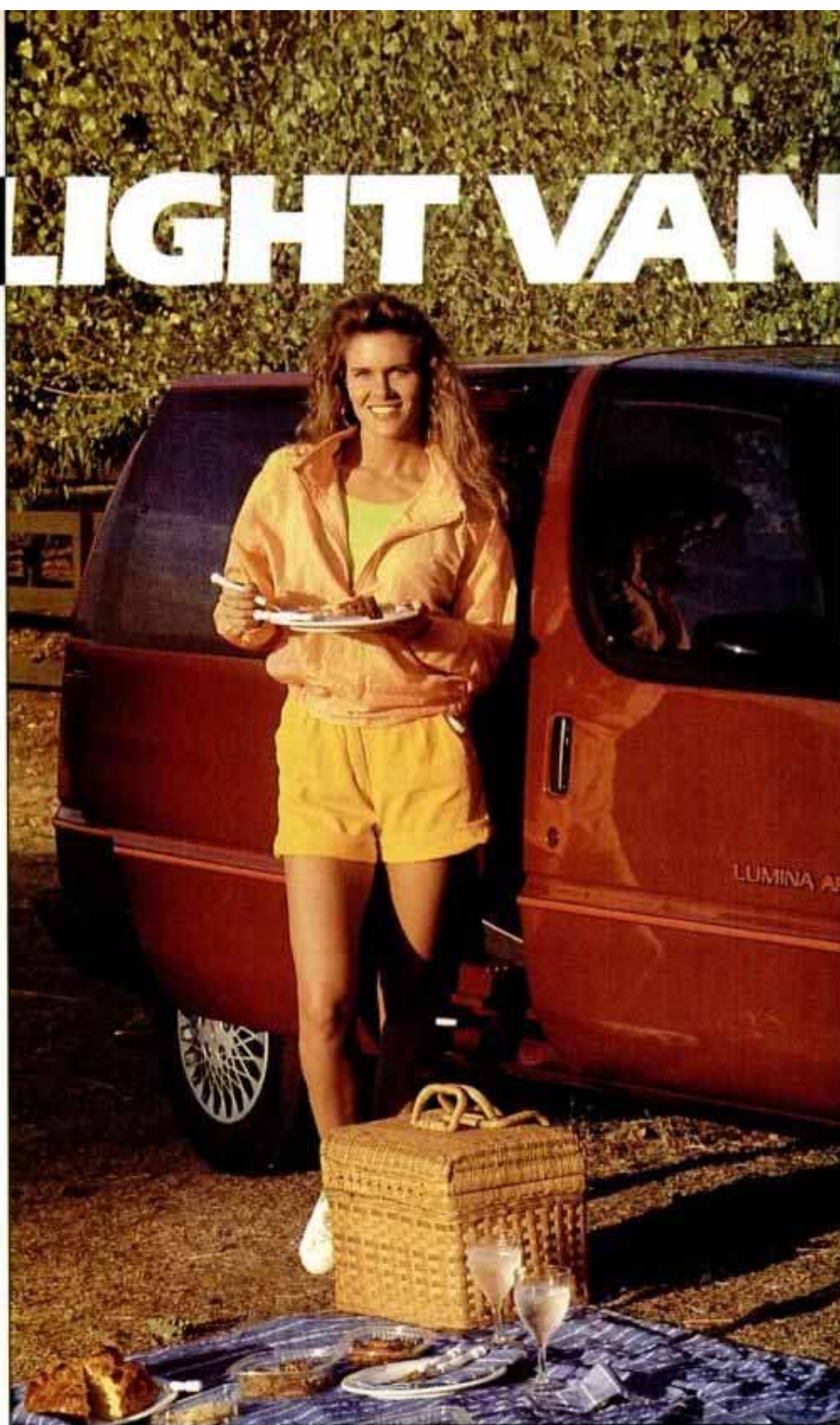
fectly matched to the 4-speed automatic transmission. The MPV also handles very well. It feels neutral right to the very limits of adhesion, and can be cornered almost like a sports car.

We like the interior, too. It's stylish without being overdone. Ergonomics are terrific. There are four white-on-black gauges, including a tachometer. The fat-rimmed steering wheel is especially comfortable, and the chair-height seats are fine. We especially like the hinged side door.

We have only a couple of complaints. Our larger testers observed that the Mazda's bucket seats are too narrow, and all hands found the column shifter a bit awkward to use.

Mazda's pickup truck scores highest in Customer Satisfaction year after year. We predict MPV owners will be similarly satisfied. The MPV leads this group in styling, performance and handling, and is also among the best in interior design.

For the way most families use a minivan, this is a brilliant design.





# TASTICS



## **Dodge Caravan/ Plymouth Voyager/ Chrysler Town & Country**

Slick as the MPV is, though, it's probably not the best choice for the family that needs a lot of interior volume. The MPV is the first of a new subclass of minivans—small ones—while the minivans we've come to know and love are now available in stretch versions offering even more space.

In this class, the benchmark contin-

ues to be the Dodge Caravan/Plymouth Voyager, both of which are now available in lengthened "Grand" versions. We tested a Grand Caravan, and scored it tops among the bigger minivans in the test, provided towing isn't important. The Caravan's front-wheel-drive chassis enhances this vehicle's basic car-like feeling and provides superior traction in many driving situations, but rear-drive continues to be best for towing.

The Caravan's square-cut styling is so familiar it's hard to step back and

realize just how perfectly drawn and timeless it really is. A decade from now, it will still look good.

Though the styling has remained the same, Chrysler has made hundreds of improvements, including the stretched version tested here. It's just as convenient to drive as the standard Caravan, but considerably roomier. The longer wheelbase also improves ride quality.

New this year is a 3.3-liter pushrod V6 rated at 150 hp. Chrysler's powertrain engineers obviously went for



## THE LIGHT VANTASTICS

ease of maintenance and low production costs for this lightly stressed engine. It has lots of midrange torque and is also the quietest in this group.

After years of old-fashioned interiors, Chrysler stylists are finally doing some nice work. The Grand Caravan is no fashion leader, but the six analog gauges, 3-spoke steering wheel and logically located controls are a vast improvement. The bucket seats also improved over previous editions.

Every front-wheel-drive Chrysler we've ever tested has been competent in handling, and the Grand Caravan is no exception. It's devoid of nasty surprises and completely predictable.

Commercial users have been racking up 200,000 miles on these vans without trouble. There's no reason

Inside, the seats are typical Ford buckets, fat, plush and comfortable. A floor shifter for the automatic means a long lever, but it works a good deal better than Mazda's column shifter. Visibility is good in all quarters, and ride quality is comparable with the Chrysler clones.

Overall, the Aerostar is as comfortable for passengers as Mazda or Dodge. On the other hand, it's not as car-like. For towing, it would be our first choice, but we'd rather have Mazda or Dodge for commuting.

### Chevrolet Astro/ GMC Safari

Of the vehicles in our test fleet, the snub-nosed Astro—sold by GMC

tow. On the other hand, the Astro is the only minivan with 4-wheel ABS braking, an important safety plus.

### Pontiac Trans Sport/ Oldsmobile Silhouette/ Chevrolet Lumina APV

Since these were the newest minivans on the market at the time of this test, we made sure we had one of each. But they're so similar that we can easily discuss them as one.

Obviously, you have to start with the terrific styling. Taken as a group, these GM200s are literally one whole styling cycle ahead—they're dramatic, innovative and thoroughly visible. There isn't a more exciting-looking vehicle on the road today.

There's creativity under the skin, too. A space frame, welded up from separate pressed-steel pieces, supports plastic body panels bonded in place with adhesives—a technique pioneered on the Pontiac Fiero.

The GM200 body panels are mostly reinforced polyester composite. The flexible front fenders are the first production use of polyurea-reinforced reaction injection molded material (RRIM) in a mass-produced vehicle. The resilient RRIM is pedestrian friendly, lightweight, easily replaced and virtually damage-proof in most minor fender-bending encounters.

Running gear is straightforward GM10, with a 120-hp version of GM's corporate 3.1-liter V6 driving the front wheels. The V6 is mated to a 3-speed automatic for decent, if somewhat anemic, driveability.

Handling is competent, characterized by modest understeer. The Olds and Pontiac had an edge at the track, thanks to their Eagle GT+4 tires.

All three vans can be ordered in a variety of seating configurations. Ours all had six individual bucket seats that quickly unlatch for removal. GM designers obviously saw these as commuter vehicles, because there are over a dozen separate drink holders molded into the interior.

Pontiac seems to have a distinct ad-



Mazda's 3.0-liter V6 made it the second quickest of the minivan test fleet.

why the understressed new 3.3 V6 shouldn't be equally long-lived. Detail, quality of paint, trim and assembly seem much better than on previous Chrysler minivans.

As for the \$25,000-plus Town & Country, which also rides a stretched wheelbase, we have to say we don't get it. The leather upholstery, synthetic wood siding, lower body cladding and alloy wheels aren't worth the extra money, in our opinion.

### Ford Aerostar LX

If you plan to do much towing or heavy hauling, the rear-drive Aerostar rates as an excellent choice. Built on the Ranger pickup chassis, the truck-tough Aerostar enters 1990 with a smooth new 4.0-liter V6 that delivers impressive power and midrange torque. An excellent 4-speed automatic provides responsive part-throttle downshifts.

But there's more to the Aerostar than that. The aerodynamic styling has been upstaged a bit by the MPV and the new GM200s, but it still looks contemporary, and overall fit and finish are first rate. Ford is making a determined effort to improve quality, and the Aerostar seems as well built as any van you can buy. About the only real flaw is serviceability—it's almost impossible to get at the engine.

dealers as the Safari—is the most like a traditional van. The engine intrudes into the footwell, while driver and passenger sit far forward. There's very little front-seat legroom.

On the plus side, the front bucket seats are comfortable and visibility is generally good, save for the center post dividing the rear windows.

Like other GM small trucks, the Astro uses the excellent 4.3-liter V6, which is three-fourths of the 5.7-liter Chevy small-block V8. The 4.3 has plenty of low and midrange torque, but is also obtrusively noisy.

The Astro's 10,000-pound Gross Tow Rating is tops in the minivan class. Unfortunately, the exceptionally stiff suspension tends to make the Astro a bit too lively on bumpy surfaces, with or without something in



Dodge Caravan proved competent in all areas of performance.



PREVIEW

# TOYOTA PREVIA



PHOTOS BY RON HUSSEY

**W**E WEREN'T ABLE to corral Toyota's soon-to-be-introduced Previa minivan in time for our comparison test, but one look at this nifty new shape convinced us we couldn't leave it out entirely.

Accordingly, Toyota gave us an afternoon with a preproduction prototype, the first time anyone outside of Toyota had actually driven this vehicle.

We left thoroughly impressed. Not only is this new van, penned by Toyota's California design facility (Calyt), pleasant to look at, it's loaded with neat features and interesting technical touches.

Foremost under this last heading is the new engine, a 2.4-liter dohc 16-valve Four. Besides being more potent than its pushrod predecessor (37 more hp, 21 more lb.-ft. of torque), it's also more efficiently packaged. The engine still sits amidships, a plus in the handling department, but it's canted over 75° and no longer intrudes into the cabin.

The Previa is a good deal bigger than the old van—11.2 in. longer, with a 24.8-in. stretch in wheelbase. It's roomier inside, with seating for five and optional 2-2-3 seating that expands capacity to seven. The rear seats fold up and fasten to the wall to expand cargo space.

And speaking of availability, you can look for Previas to show up in Toyota stores sometime in March. —Tony Swan



Dashboard design (above) lends George Jetson look to Previa. Optional rear seats (left) fold up to expand cargo space.

## SPECIFICATIONS

BASE PRICE	\$12,500 (est.)
ENGINE/DRIVE LAYOUT	Mid/Rear (4wd optional)
WHEELBASE (in./mm)	112.8/2865
LENGTH (in./mm)	187.0/4749
WIDTH (in./mm)	70.9/1800
TRACK, FRONT/REAR (in., mm)	61.7/61.2, 1567/1554
HEIGHT (in./mm)	68.5/1739
CURB WEIGHT (lbs.)	3418
ENGINE	L4 DOHC 16V
DISPLACEMENT (cu. in./cc)	148.7/2438
HP (net @ rpm)	138 @ 5000
TORQUE (lb.-ft. @ rpm)	154 @ 4000
TRANSMISSION	5M, 4A
BRAKES, F/R	Disc/drum (disc/disc, ABS optional)
STEERING	Power rack & pinion
FUEL ECONOMY, EPA City/Highway (mpg)	18/23 (est.)



# THE LIGHT VANTASTICS



Clockwise from lower left: Dodge Caravan, Chrysler Town & Country, Oldsmobile Silhouette, Ford Aerostar LX, Chevrolet Lumina APV.

## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE: LIST/ AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE/ HP, NET/ TORQUE (lb.-ft.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in./mm)	LENGTH OVERALL (in./mm)	WIDTH OVERALL (in./mm)	TRACK FRONT/REAR (in./mm)
<b>Chevrolet Astro</b>	\$16,325/ \$21,727	OHV V6 262/4301	150 @ 4000 rpm/ 230 @ 2400 rpm	front/ rear	4-speed auto	110.0/ 2793	177.0/ 4494	77.0/ 1955	F: 65.1/1653 R: 65.1/1653
<b>Chevrolet Lumina APV</b>	\$13,999/ \$17,726	OHV V6 191/3097	135 @ 4400 rpm/ 180 @ 3600 rpm	front/ front	4-speed auto	109.9/ 2792	194.2/ 4931	73.9/ 1876	F: 58.7/1490 R: 60.0/1546
<b>Chrysler Town &amp; Country</b>	\$25,515/ \$25,515	OHV V6 201/3303	150 @ 4800 rpm/ 185 @ 3600 rpm	front/ front	4-speed auto	119.1/ 3024	190.5/ 4837	72.0/ 1828	F: 59.9/1521 R: 62.1/1577
<b>Dodge Caravan</b>	\$18,325/ \$22,553	OHV V6 201/3303	150 @ 4800 rpm/ 185 @ 3600 rpm	front/ front	4-speed auto	112.0/ 2844	175.9/ 4466	72.0/ 1828	F: 59.9/1521 R: 62.1/1577
<b>Ford Aerostar LX</b>	\$14,948/ \$16,943	OHV V6 245/4015	155 @ 4200 rpm/ 215 @ 2400 rpm	front/ rear	4-speed auto	118.9/ 3019	174.9/ 4440	71.7/ 1820	F: 61.5/1561 R: 60.0/1523
<b>Mazda MPV</b>	\$14,944/ \$19,466	SOHC V6 180/2954	150 @ 5000 rpm/ 165 @ 4000 rpm	front/ rear	4-speed auto	110.4/ 2805	175.8/ 4465	71.9/ 1826	F: 60.0/1525 R: 60.6/1545
<b>Mitsubishi Van</b>	\$16,579/ \$19,323	SOHC I4 143/2350	107 @ 5000 rpm/ 132 @ 3500 rpm	mid/ rear	4-speed auto	88.0/ 2235	175.2/ 4450	66.5/ 1690	F: 56.9/1445 R: 54.3/1380
<b>Nissan Axxess</b>	\$16,499/ \$18,144	SOHC I4 146/2389	138 @ 5600 rpm/ 148 @ 4400 rpm	front/ 4wd	4-speed auto	102.8/ 2610	171.9/ 4365	66.5/ 1690	F: 57.5/1460 R: 56.3/1429
<b>Oldsmobile Silhouette</b>	\$17,195/ \$19,587	OHV V6 191/3097	135 @ 4400 rpm/ 180 @ 3600 rpm	front/ front	4-speed auto	109.9/ 2792	193.9/ 4923	74.2/ 1884	F: 59.1/1500 R: 60.8/1544
<b>Pontiac Trans Sport</b>	\$18,125/ \$19,550	OHV V6 191/3097	135 @ 4400 rpm/ 180 @ 3600 rpm	front/ front	4-speed auto	109.9/ 2792	193.9/ 4923	74.2/ 1884	F: 59.1/1500 R: 60.8/1544
<b>Volkswagen Vanagon</b>	\$14,080/ \$15,890	OHV F4 129/2109	90 @ 4800 rpm/ 117 @ 3200 rpm	rear/ rear	4-speed manual	96.9/ 2460	179.9/ 4570	72.6/ 1845	F: 62.4/1585 R: 61.8/1570

1. Best speed while weaving through seven cones placed 100 ft. apart; the higher the speed, the better the transient handling.

vantage in the area of ergonomic design versus the other GM divisions. The shaped steering wheel and supportive bucket seats are tops. Olds uses the same basic interior, with similar seats but a more conventional wheel. Chevy's Lumina APV is more straightforward, with flatter seats and less side and lumbar support.

Our high expectations for these new vans magnified a number of detail disappointments. Wind noise, for example, is higher than you'd expect of a shape like this, and paint quality was flawed by orange peel.

The fat B-pillar creates a substantial blind spot, the heating, ventilation and air-conditioning controls require you to look away from the road and the steering wheel, which is offset to the right, becomes annoying

after only a few miles. Clambering into the rear seats is a chore, and the long shelf extending in front of the driver takes a lot of getting used to.

It's reasonable to expect improvements in this line of vehicles—more powertrain options, including 4-wheel drive, for example—as time goes by. That's the GM way. Appealing as these shapes are right now, we'd be inclined to wait for the line to mature a bit before taking one home.

### Volkswagen Vanagon

Spiritual progenitor of this entire class, the veteran Vanagon still rates as an excellent people-mover. The finish is traditionally German, which is to say nearly flawless, and the interior is nicely done up in a very European style—clean and contemporary.

The front bucket seats are the same ones that have been used in VW sedans and sports cars for years, with great lateral and lumbar support. In the Vanagon, these seats have individually adjustable armrests on either side, a wonderful feature that no other van offers. All the controls and gauges are classic VW, and while there's nothing flashy, everything does the job it's supposed to do.

The interior is marvelously efficient. You can carry seven passengers, five of them grouped around a fold-down table if you want. There's a big cargo area at the rear, right over the flat-Four engine, and it's equipped with its own upholstered mattress.

Driving the Vanagon requires some orientation. Plentiful body roll makes the driver initially apprehen-





Clockwise from lower right: Mazda MPV, Nissan Axxess, Pontiac Trans Sport, Volkswagen Vanagon, Mitsubishi Van, Chevrolet Astro.

## TEST RESULTS

CURB WEIGHT (lbs.)	STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG-EPA city/PM test)	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	BRAKING 60-0 MPH (ft.)	700-FT. <sup>1</sup> SLALOM (mph)	SKIDPAD <sup>2</sup> 200-FT. CIRCLE (G)	EPA CARGO VOLUME (cu. ft.)
3500	Power recirculating ball/ 2.8	ABS 11.9-in. vented disc/ ABS 9.5-in. drum	17/ 17.3	11.88 18.51 @ 72.54	160	56.58	.67	151.8
3505	Power R&P/ 2.7	10.2-in. vented disc/ 8.9-in. drum	18/ 17.9	12.95 19.06 @ 70.77	153	57.40	.67	104.6
3817	Power R&P/ 2.9	11.0-in. vented disc/ 8.9-in. drum	18/ 19.1	10.80 17.91 @ 75.60	164	56.98	.67	150.0
3584	Power R&P/ 2.9	10.1-in. vented disc/ 8.9-in. drum	18/ 18.8	11.10 18.12 @ 75.09	166	56.58	.68	150.0
3500	Power R&P/ 4.0	10.3-in. vented disc/ ABS 10.0-in. drum	16/ 14.2	9.80 17.31 @ 77.65	169	59.75	.72	140.4
3558	Power R&P/ 3.9	10.1-in. vented disc/ ABS 10.2-in. drum	17/ 19.1	10.80 18.00 @ 75.06	152	56.42	.70	110.0
3307	Power R&P/ 3.5	10.1-in. vented disc/ 10.0-in. drum	18/ 18.6	14.05 19.62 @ 68.32	128	55.83	.63	161.6
2934	Power R&P/ 3.3	10.0-in. vented disc/ 9.0-in. drum	17/ 17.5	12.05 18.71 @ 71.24	144	56.95	.70	83.7
3457	Power R&P/ 2.7	10.2-in. vented disc/ 8.9-in. drum	18/ 17.5	13.00 18.99 @ 70.54	130	57.92	.73	111.0
3500	Power R&P/ 2.7	10.2-in. vented disc/ 8.9-in. drum	18/ 17.4	13.50 19.22 @ 70.20	132	57.63	.73	104.6
3460	Power R&P/ 3.8	10.9-in. vented disc/ 9.9-in. drum	18/ 19.6	15.70 19.83 @ 65.80	136	56.45	.71	99.7

2. G-forces generated during steady-state cornering around a 200-ft.-dia. circle; average of best cw and ccw laps.

sive, but a little time behind the bus-like wheel creates an impression of predictability and stolidity. Powered by VW's old 2.1-liter water-cooled boxer Four, it's not what you'd call exciting, but if you're not in a hurry, there are still plenty of other virtues.

### Mitsubishi Van

For more than a generation, this was what all Japanese minivans were like, with the engine between the front seats and the driver cantilevered out front. Today, only Mitsubishi continues to offer this design, and it suffers in contrast to the rest of this fleet.

The problem lies with the basic cab-over design. It makes the driving position awkward, engine maintenance difficult and limits the usability of the substantial interior space.

Like all Mitsubishi products, the van is superbly built and detailed, with nary a thread gone wrong. The 2.4-liter Four has adequate power, and the rear-drive chassis can actually be driven with surprising verve.

Compared to more modern minivans, though, this one feels dated.

### Nissan Axxess

Shorter and lower than all its competitors, the Axxess almost seems to be in a different vehicle class. It's by far the most car-like of all these minivans—small, handy and even fun on a winding country road.

The little Axxess has some clever touches, including rear-hinged rear doors. There's no central door pillar, so opening both front and rear doors exposes the whole side of the van.

Unlike its competitors, the Axxess also has rear doors on both sides. Who says that vans can only have a curbside door for rear-seat access? The Axxess design makes sense, although getting into the rearmost seat requires climbing and determination.

The weak point of the Axxess is under the hood. Our test van was equipped with 4-wheel drive—we'd requested 2wd—which didn't help much in the 0-60 mph department. But even without the added weight and mechanical drag of 4wd, the 2.4-liter Four that powers the Axxess doesn't get the job done with much zeal. Moreover, it was noisy.

Perhaps there's a way to squeeze Nissan's excellent 3.0-liter V6 under the hood. That would make the Axxess very interesting indeed. **PM**



# VIDEOGAMES IN THE FAST LANE

With 16-bit microprocessors under the hood, the latest videogames deliver warp-speed action, 3D-like graphics, a rainbow of color and digital sound. Soon, you'll play by phone.

BY FRANK VIZARD, Contributing Editor

**T**HE DIFFERENCE between playing videogames at home and at the amusement arcade is narrowing, thanks to the arrival of more powerful machines that plug directly into your television. Although they are more expensive than videogame systems that are already in many homes, the new game systems offer greater complexity, more realistic and colorful graphics, better sound and a lot more action.

The hottest new contenders are the Genesis system, from Sega, and TurboGrafx-16, from NEC. Of the two, Genesis is the more advanced.

## Computer power

The new Genesis system boasts the same 16-bit technology found in ar-

cade games, and it also uses the same Motorola 68000 microprocessor as an Apple Macintosh computer. By comparison, conventional videogames like Nintendo's and even Sega's previous system use 8-bit digital processing. The extra computer brainpower gives Genesis a list price of \$189, roughly \$100 more than what 8-bit systems sell for in stores. Individual game prices range from \$30 to \$50,

comparable to the cost of present videogames.

To fully appreciate the technical ability of Genesis, it's helpful to study it against the immensely popular Nintendo system.

The Nintendo system has 52 colors available, four per sprite. Sprite is videogame jargon for any on-screen movable object—a baseball, for example, or even the arm of a player throwing the ball. Genesis upgrades



PHOTO BY BRIAN KOSOFF





the amount of color considerably. It offers 512 colors, with 16 available per sprite. Genesis also offers more sprites, 80 versus 64 for an 8-bit system. This means that more on-screen objects can be created, with more lifelike detail and greater mobility. A ballplayer's throwing motion, for example, can show greater articulation of the body joints—including movement of the eyes.

### 3D-like images

The added brainpower of the Genesis system is evident in other ways. Most games present an on-screen character moving against a stationary back-

ground. Genesis independently scrolls both the foreground and the background to achieve perspectives that are almost 3-dimensional in appearance. All of the action is seen in greater detail because of the Genesis system's finer resolution. Genesis offers a resolution of  $320 \times 224$  lines, while Nintendo offers  $256 \times 240$  lines.

The Genesis control pad includes a third ACTION button—one more than usual—to control on-screen action

more precisely. Only one control pad is supplied with the game although there are ports for two. The second control pad must be purchased separately.

Although the visual upgrade is most immediately evident, the sound quality of the Genesis system also is an improvement over the tinny char-



Finer resolution is one attribute of 16-bit video graphics, giving depth and texture to scenes in Sega's "Last Battle."



Lifelike color and stereo sound effects are another bonus of 16 bits (notice the muzzle flash). Both excel in Sega's "Thunder Force."



A 16-bit system screens more objects, with more realistic motion. Sega fields a chopper task force in "Super Thunder Blade."



## VIDEOGAMES IN THE FAST LANE

acter of older systems. Stereo sound is available through headphone inputs. Audio has been generally improved by the addition of true-to-life sound effects.

All the advantages of the Genesis system are apparent in a game such as "Tommy Lasorda's Baseball." It's as realistic as the Nintendo system's "RBI Baseball," and has better action and graphics.

The 16-bit technology employed means that a variety of information screens provide contestants with data as the game progresses. Updates include speed of the last pitch, the count of balls and strikes, the number of outs, and statistics on both the pitcher and batter. There's also a small white outline in the lower right corner that shows all the players and their locations. Lineups and pitchers are chosen according to stats on file for each team member. Once the game begins, look for all the stealing, bunting and fielding you'd see in a real baseball game. At times you'll even see the stitching on the ball.

### Play by phone

Soon, baseball fans will be able to play "Tommy Lasorda's Baseball" and popular arcade titles, such as "Altered Beast," against cross-town or cross-country rivals—by telephone. Players will use a specially designed TeleGenesis modem that connects to your home phone line. The modem is scheduled for delivery later this year. Based on an evaluation of the system during a recent trade show, the data exchange between two callers is virtually instantaneous. Besides the telephone modem option, Genesis is equipped with an expansion port that could be used for a keyboard or other extras to be developed later.

Genesis also is backward compatible in that all the older Sega games can be played on the new system. An optional "power base converter" allows the existing group of more than 80 games to be played, although the 8-bit games do not benefit from the more powerful 16-bit microprocessor.



NEC's TurboGrafx-16 system brings compact disc technology to videogames. The CD option enhances game complexity.

### TurboGrafx-16

Also using 16-bit technology is NEC, a new name in the videogame business. The company's TurboGrafx-16 system (\$199) uses 16-bit technology only in its handling of a game's graphics. Like the Genesis system, therefore, the TurboGrafx-16 has 512 colors available, 16 for each sprite. But it fields only 64 sprites, and resolution is limited to 256 x 212 lines. Other than its excellent graphics, the NEC TurboGrafx-16 system operates like any older 8-bit system in its gaming capabilities, though NEC does add stereo sound for much improved audio.

From an operating standpoint, the NEC TurboGrafx-16 system will look familiar to anyone who's ever seen a Nintendo system. There are some differences, however, not immediately apparent to the eye.

One difference is that the game console comes with only one port, for a single control pad. If more than one person wants to play a game simultaneously, the competitors must use an

optional TurboTap controller (\$20) and control pads. The TurboTap controller allows up to five players to compete at once. Each additional control pad costs \$20.

Every TurboGrafx-16 control pad has a 3-position switch over each of its two ACTION buttons. These switches control the rapidity of fire in shooting games. The switches are also important in games such as "Victory Run," a simulation of the Paris-to-Dakar automobile rally. The switches and buttons determine your ability to shift gears and control your rate of speed.

### The CD option

Also different is the appearance of the TurboGrafx-16 game cartridge. It is about the size of a credit card, and slips into a small slot on the game console. It is as if you were using an automatic bank teller machine. Game playing can be expanded with a novel compact disc player that attaches to the front of the game console. A compact disc can store up to 550 megabytes of information, roughly the equivalent of 300,000 typed pages. CD-based videogames promise levels of complexity not otherwise available. The digital audio capability also promises some good special sound effects. The \$399 CD player is specially designed to interface with the TurboGrafx-16 system. It can also be used to play standard 3- and 5-in. music CDs, as well as CD+G (graphics) discs.

Other options for the TurboGrafx-16 system include a joystick with slow-motion capability (\$45) and an adapter (\$35) that provides direct video and stereo audio to a home entertainment system.

Despite the merits of NEC's TurboGrafx-16, the Genesis system from Sega clearly points the way toward the future of videogame playing. The 16-bit system is the closest homebound players can get to the arcade experience and soon, the telephone will let them compete across town or across time zones. **PM**



"Victory Run" for TurboGrafx-16 celebrates the Paris-to-Dakar auto rally. Advanced controls facilitate shifting and steering.



TurboGrafx-16's optional CD player can be used for musical entertainment, too. Your CD player controls are displayed on screen.



Another 16-bit benefit is more on-screen information. Notice the first and third base windows in NEC's "World Class Baseball."



# HOME AND SHOP JOURNAL



## HAND TOOLS

### FILES

A tool of a thousand faces—there's one for every purpose.

BY THOMAS KLENCK, Associate Home And Shop Editor  
PM Photos by Brian Kosoff

**M**OST HOMEOWNERS have at least one file lying in the bottom of the toolbox or in the back of a drawer. And, when the time comes to sharpen the lawnmower blade or clean up the rough edges after cutting a bolt to length, it's this simple hand

tool that comes to the rescue.

While the basic idea of a file may be simple—a bar of hardened steel with rows of finely spaced cutting teeth, the variations on this theme are practically endless. For every smoothing, trimming and sharpening job that you can imagine, there's a specially designed file for the job.

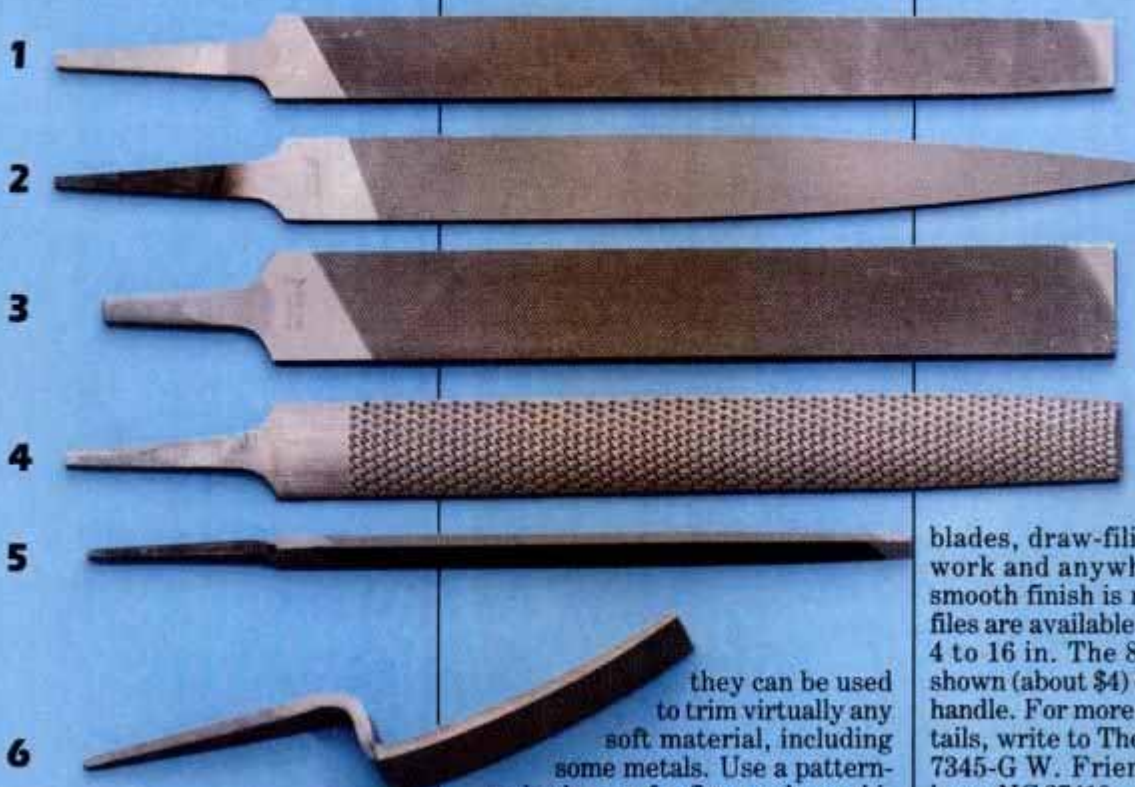
However, because there are so many different types, knowing which file is right for your needs isn't always easy. And the problem is compounded because the nomenclature that describes these tools isn't quite as informative as you might like. Knowing that you need a small file for smoothing steel, for instance, doesn't help when the dealer asks if you'd prefer a 6-in. mill bastard or an 8-in. second-cut hand file.

Fortunately, many files are designated by the job that they perform, such as a chain saw file or a warding file. However, the best way to know what you're looking for is to understand the standard way that files are classified.

Files are classified in terms of their shape, cut and length. The cross-sectional shape of a file can be circular, rectangular, triangular, diamond-shaped or a combination of flats and rounds. Many types are available with either straight or tapered sides. Choosing a particular shape simply involves finding a file to fit the work. Mill files and flat files are suitable for flat edges or surfaces, but a triangular saw file is best suited for fitting between the teeth of your handsaw.

The cut of a file refers to both the





tooth configuration and to the space between the teeth or coarseness. A single-cut file, such as a mill file, has a series of parallel, diagonal teeth and is the choice for sharpening and smoothing surfaces, and when only a small amount of material must be removed. For faster cutting and when a rougher finish is acceptable, a double-cut file is used. Here, a second opposing row of diagonal teeth are cut over the first. The first row of teeth is called the overcut, and the second, opposing row is called the upcut.

While the faces of a typical rectangular-section file do most of the work, the edges are often cut for working in slots or cleaning out corners. However, some files have *safe* or uncut edges for filing in corners without marring the adjoining surface.

Both single- and double-cut files are commonly available in three grades of coarseness: smooth cut, second cut and bastard cut. However, the actual space between the teeth is also related to the length of the file body—as the length increases, the file gets coarser. In general, a 6-in. bastard-cut file (short, but coarse) will produce results similar to a 10-in. second-cut file, or a 14-in. smooth-cut file.

Rasps differ from single- and double-cut files in that the teeth are individual points rather than lines. This reduces clogging and makes for a fast, but rough, finished surface. Although rasps are generally used on wood,

they can be used to trim virtually any soft material, including some metals. Use a patternmaker's rasp for fine work, a cabinetmaker's rasp for quicker cutting and, finally, a wood rasp for fastest stock removal.

In addition to single, double and rasp cuts, you'll find files with curved teeth and specialty files designed for more efficient cutting in specific materials. Keep in mind that files are not abrasives. They cut the wood in one direction only. Rubbing a file back and forth over a surface won't get the job done any faster, and you're likely to wear out the file sooner. Always have a file card on hand for cleaning out clogged material and store the files so they won't become dulled by striking other metal tools.

The following is just a small sampling of the many files available. Note that for safe use, a file with a tang must be fitted with a handle. Unless indicated in the description of a particular model, the prices given are for the file only.

**1. Mill file**—The most common single-cut file is the mill file. It's used for sharpening circular saw

blades, draw-filing, lathe work and anywhere else a smooth finish is required. Mill files are available in lengths from 4 to 16 in. The 8-in. mill bastard shown (about \$4) comes with a plastic handle. For more information and details, write to The Disston Company, 7345-G W. Friendly Ave., Greensboro, NC 27410.

**2. Warding file**—This file is designed for shaping and trimming the notches in locks and keys. It's double cut on the faces and single cut on the edges. The tapered profile is useful in situations where an ordinary file won't fit. Produced in bastard, second and smooth cut, warding files are available from 4 to 10 in. This 8-in. model costs about \$5.25. Contact Cooper Tools, Box 728, Apex, NC 27502.

**3. Hand file**—Double-cut files of various shapes are generally classified as machinist files. And, although they're all used by hand, the term *hand file* refers to a flat file with straight, uncut (safe) edges. This particular 8-in.

model is actually half hand file, half mill file. The other side is single cut for smooth work. It costs about \$6 with handle. For details, write to The Disston Company, 7345-G W. Friendly Ave., Greensboro, NC 27410.

**4. Cabinet rasp**—While coarse files designed for use on metal *can* be useful in woodworking, the quickest way to remove stock is with a





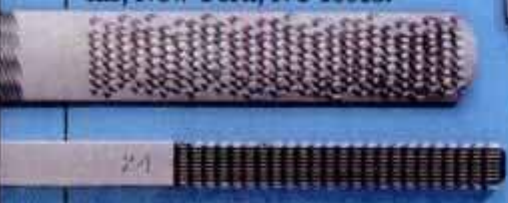
rasp. This typical model is 8 in. long and has a round and flat face. It costs about \$15 with plastic handle. For more information and details, contact The Disston Company, 7345-G W. Friendly Ave., Greensboro, NC 27410.

**5. Handsaw file**—Single-cut triangular saw files are available in a range of sizes to suit the size of the saw teeth being filed. This 6-in. slim



taper file is best for 7- or 8-pt. saws. Other sizes include heavy, regular, extra slim and double extra slim. Double-cut triangular files are called three-square files and are used for trimming internal angles in metalwork. The file shown costs about \$4.60 and comes with a plastic handle. Contact Sandvik, Box 1220, Scranton, PA 18501.

**6. Cranked-neck rasp**—Curved rasps come in a wide variety of shapes and sizes, and each makes a particular shaping operation easier. This small rasp ( $\frac{3}{4} \times 2\frac{1}{2}$  in.) is ideal for carefully shaping flat or slightly concave surfaces and is especially useful in woodcarving. This handmade tool (\$24.50) is available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.



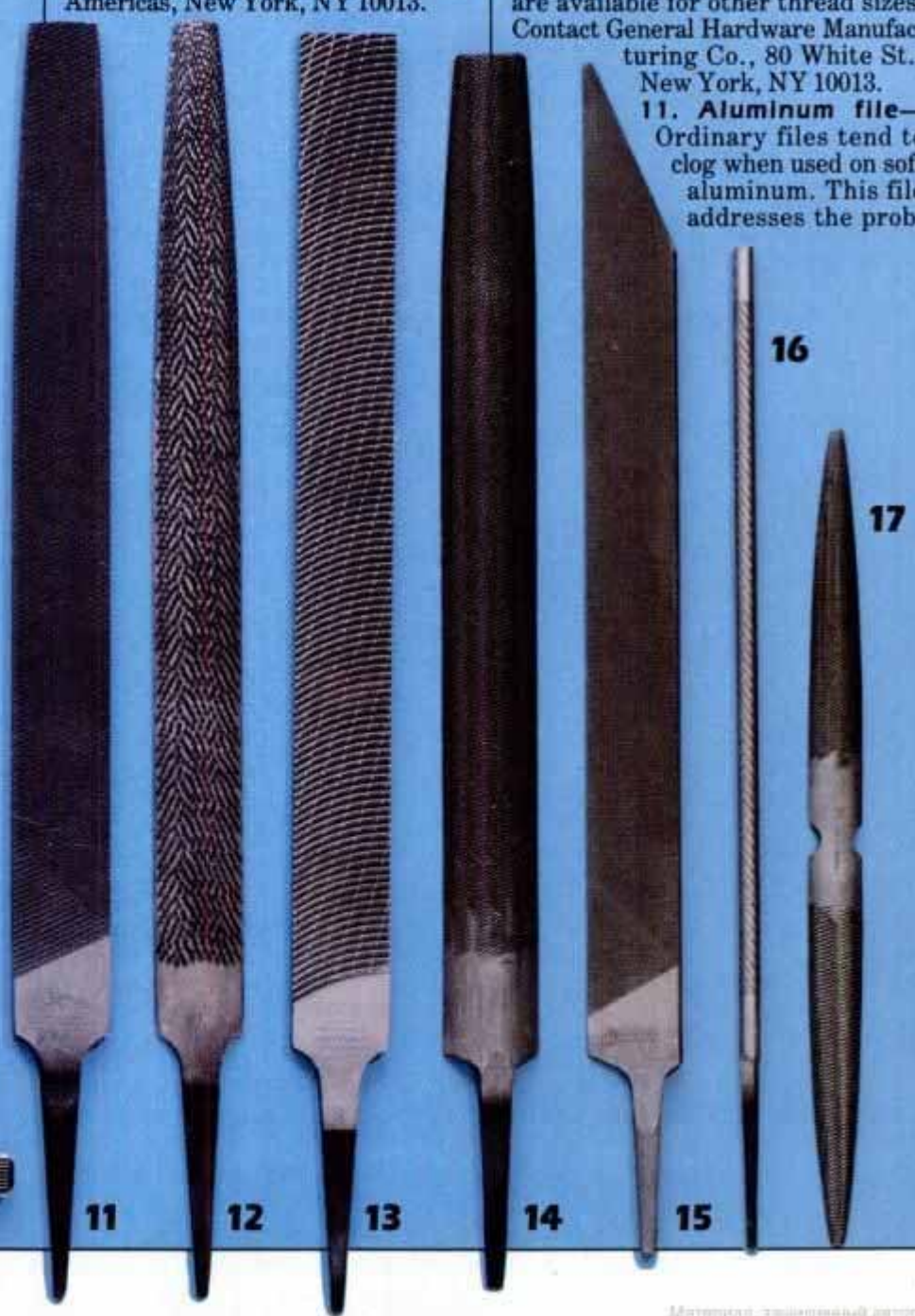
**7. Rifflers**—These tools enable you to shape and smooth details that no other file can handle. One end of each uniquely shaped, rasp cut riffler is fine and the other end is coarse. For an extra fine finish, these rifflers are also available in a file cut. A set of eight costs about \$95. Contact Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

**8. Needle rasps**—These tiny rasps ( $5\frac{1}{2}$  in. long overall) are ideal for modeling or detailed carving and fitting. They feature a smooth rasp cut and come in the following shapes: rectangular, tapered, triangular, round, half round and square. For metalwork, needle files are available. This set of six rasps costs \$21.25 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

**9. 4-in-hand file**—If you're only going to own one file, then this combination tool might be what you need. The 8-in.-long file has both round and flat surfaces, and each side of the file has a double-cut and rasp-cut end. The 4-Way file shown costs about \$4.30. For more information and details, write to Stanley Tools, Div. of Stanley Works, 600 Myrtle St., New Britain, CT 06050.

**10. Rethreading file**—This tool is designed to clean out and restore damaged threads on studs, bolts, screws and threaded pipe. Each cutting face of the tool is shaped to fit a different pitch thread. The model shown (No. 177-1, about \$5) will fit screw threads of 11, 12, 13, 14, 16, 18, 20 and 24 threads per inch. Three other models are available for other thread sizes. Contact General Hardware Manufacturing Co., 80 White St., New York, NY 10013.

**11. Aluminum file**—Ordinary files tend to clog when used on soft aluminum. This file addresses the prob-





lem with a unique double-cut pattern that resists clogging. The initial deep overcut is followed by a light upcut on the opposite diagonal. This produces a scalloped-tooth pattern that cuts cleanly and leaves a fine finish. The Type-A aluminum file (about \$7.50) is made by Cooper Tools, Box 728, Apex, NC 27502.

**12. Patternmaker's rasp**—Like regular rasps, these tools have individual teeth for fast cutting. Here, however, the teeth are staggered and smaller for a finer finished surface in wood. Available in second and smooth cut, patternmaker's rasps also have cut edges for working in corners. This model costs about \$20 from Cooper Tools, Box 728, Apex, NC 27502.

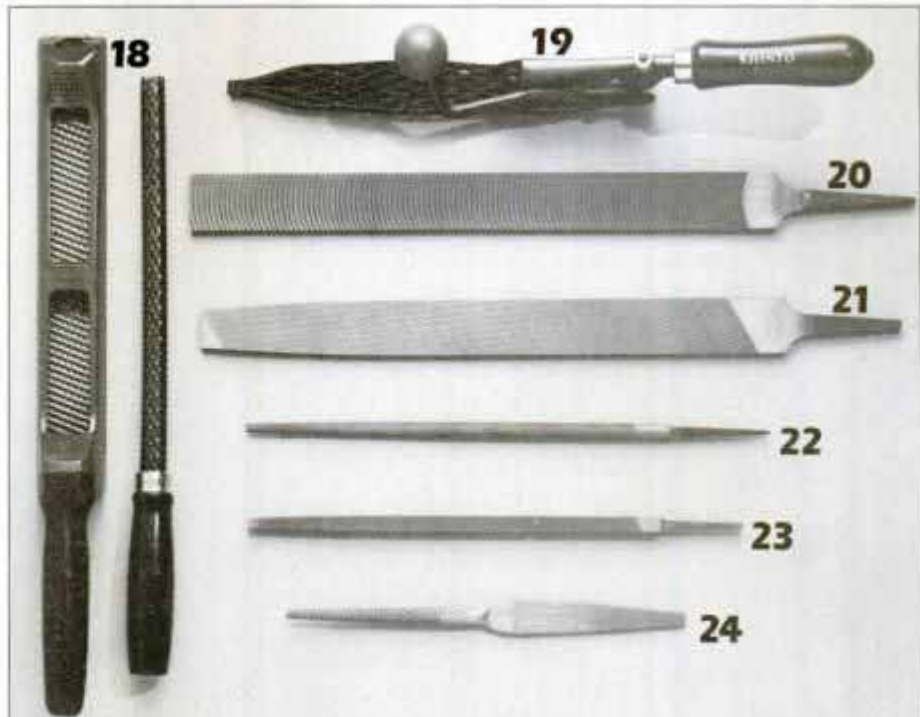
**13. Super shear file**—This file has an offset circular tooth that cuts both fast and smooth. A light upcut, almost parallel to the plane, breaks each circular cutting edge for clog-free filing. Designed for work on softer metals, iron, annealed steel, plastic and hardwood, this Nicholson file costs about \$16.50. Contact Cooper Tools, Box 728, Apex, NC 27502.

**14. Half-round file**—This bastard-cut file is double cut for fast stock removal and one face is round for working concave shapes. Although it's classified as a machinist file, it's useful for fine trimming in wood. Half-round files are available in smooth and second cut, and some of the finer varieties are single cut on the round side. The 10-in. half-round bastard shown costs \$9.50 from Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102.

**15. Knife file**—The single-cut edge of this file is about  $\frac{1}{16}$  in. thick, and the double-cut faces are at about a  $10^\circ$  angle to each other. The wide top edge is uncut. Used by tool and die makers, this file is excellent for working in tight, acute angles. This knife file is 10 in. long and costs about \$6.60. For more information, contact Sandvik, Box 1220, Scranton, PA 18501.

**16. Spiral-cut chain saw file**—Featuring a special spiral-cut pattern, this file cuts faster than standard round chain saw files. It's offered in diameters of  $\frac{5}{32}$ ,  $\frac{3}{16}$  and  $\frac{7}{32}$  in. Regular smooth chain saw files are available in sizes ranging from  $\frac{1}{8}$  to  $\frac{3}{8}$  in. dia. The file shown costs about \$1. Contact Cooper Tools, Box 728, Apex, NC 27502.

**17. Detailing file**—Basically a half-round combination file, this tool is handy for working small flats, rounds and hollows. The ends are tapered for working in confined spaces and one



end is bastard cut while the other is second cut. The detailing file (\$19.75) is available from Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102.

**18. Surform tools**—Versatility and speed make these tools the choice for shaping wood, body filler, fiberglass, aluminum and other soft materials. The Surform file (left, about \$11.50) accepts three different hardened-steel replacement blades and two grades of abrasive cutters. The round Surform (about \$10.80) is ideal for roughing out tight curves and shaping holes. For more information and details, contact Stanley Tools, Div. of Stanley Works, 600 Myrtle St., New Britain, CT 06050.

**19. Japanese rasp**—Here's an oddity that's guaranteed not to clog. It's basically a grid of hardened-steel saw blades. One side is fine and the other coarse. The  $1\frac{1}{2}$ -in.-wide  $\times$  10-in.-long replaceable blade cuts wood, plastic and soft metals. The Japanese rasp costs about \$20 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

**20. Curved-tooth file**—This 14-in. file features deeply cut curved teeth for fast cutting and reducing clogging in soft material. Widely used in auto-body work and on aluminum and sheet steel, it's also available in 8-, 10- and 12-in. lengths. And, there's a flexible type that fits in a special holder with handles similar to a plane. The holder can be adjusted to bend the blade for working convex and concave surfaces. The file shown costs about \$24.

Contact Cooper Tools, Box 728, Apex, NC 27502.

**21. Magicut file**—A close cousin of the standard, double-cut machinist file, the Magicut file is designed for fast, yet smooth cutting. Angled serrations across the teeth create a chip-breaker-type tooth that resists clogging. Available in four sizes from 8 in. to 14 in., the 14-in. tool shown costs about \$11. Write to Cooper Tools, Box 728, Apex, NC 27502.

**22. Round file**—This is the standard file for cleaning up or enlarging holes and shaping tight internal curves. It works on metal or wood. It's available in single- or double-cut and smooth-, second-cut or bastard grades. The 10-in. bastard shown costs \$6.50 from Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102.

**23. Square file**—When you need to make a round hole square, this is the file to reach for. Its long, tapered profile also makes it useful for cleaning up right-angle shapes such as slots and keyways. Available in widths from  $\frac{5}{32}$  to  $\frac{5}{8}$  in. and lengths from 4 to 14 in., the 10-in. double-cut bastard shown costs about \$4. For more information, write to Sandvik, Box 1220, Scranton, PA 18501.

**24. Keyway rasp**—A combination rasp for shaping wood. One end is flat and tapered with cut edges. The other end is a tapered round rasp. This 10-in. tool costs \$12.95. For more information, write Woodcraft, 210 Wood County Industrial Park, Box 1686, Parkersburg, WV 26102.





## WOODWORKING PROJECT

# KITCHEN TABLE

A sturdy table for the well-furnished kitchen.

BY NEAL BARRETT

**I**T OFTEN SEEMS that things aren't what they used to be, and this feeling holds true for furniture as it does for other aspects of our lives. Some contemporary designs force us

to think of furniture as art—or, at the very least, as decorative embellishment—and in the process, seem willing to leave the comfort and function of furniture behind. This is why we thought it might be refreshing to harken back to the days when a table was a table, simple and functional, yet beautiful.

Our kitchen table's straightforward construction and clean lines are reminiscent of Shaker furniture. And, in the Shaker tradition, the table was also designed to serve both as a utilitarian workstation, for preparing a meal, and as a dining table. It's dimensioned to seat four diners or, in a pinch, accommodates up to six.

A kitchen table is often the most

Clear away the cooking utensils and the table comfortably seats four for dining.

used table in the house, and we designed our table with durability and ease of maintenance in mind. It's built of solid maple and its rugged mortise-and-tenon joints are further bolstered with hefty corner blocks screwed to the aprons.

For a finish, we chose a simple penetrating mixture of tung oil and varnish. It's easily applied with a rag or brush and is built up in several coats. It's also easy to reapply the finish if it starts to wear.

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



## Making The Top

**T**HE TOP is made from  $\frac{5}{4}$ -in.-thick stock (about  $1\frac{1}{8}$  in. thick). Aim for consistency of grain and color when selecting the stock. Crosscut the boards about 1 in. longer than the finished dimension. Using a hand plane or jointer, make one edge of each board straight and square. Rip 13 strips  $2\frac{9}{16}$  in. wide. Joint the sawn edge of each strip straight and square. Lay out the strips, alternating the growth rings to minimize cupping in the top, and number consecutively.

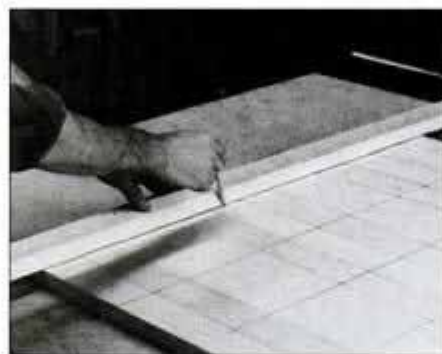
It greatly facilitates assembly to use some means of keeping board faces flush during glue up. We could have used dowels or splines, but chose No. 20 joining plates (also called biscuits) because they are easy to use and they greatly strengthen the joint.

Mark the plate locations starting about 3 in. in from each end of the top and space the plates 6-8 in. on center along each joint's length (Photo 1). Then, place each strip on a clean, flat surface, such as a table saw top, and push the strip against a fixed block or fence. Holding the strip firmly, align the center mark on the plate joiner with the line on the strip and cut the plate slot (Photo 2). Be sure to keep the plate joiner and the workpiece flat against the table and keep your fingers clear of the cutter area.

Glue and clamp together groups of

three or four strips. When the glue has dried, glue and clamp the groups together (Photo 3). Clamp the top to the bench and use a sharp plane to

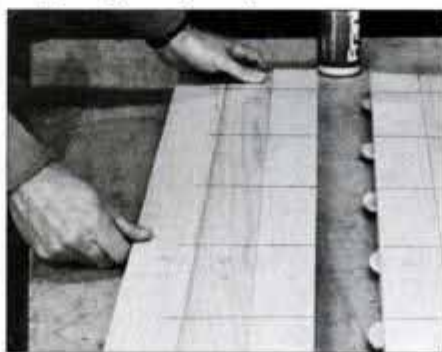
smooth off surface irregularities (Photo 4). Trim the top to length with a circular saw and a straightedge clamped across the top.



**1** Place the top strips on bench, alternating growth rings. Use a straightedge to mark the joining plate (biscuit) locations.



**2** The saw table provides an excellent surface to cut slots for joining plates. The saw's fence supports the workpiece from behind.



**3** Apply glue to the board edges and the plate slots. Then, install the plates and clamp together the strips into small groups.



**4** Clamp the top to the workbench and use a sharp plane to smooth and flatten the surface. Plane diagonally and with the grain.

## Making Tapered Legs

**T**HE LEGS are made from  $1\frac{1}{4}$  stock (actually about  $2\frac{3}{4}$  to  $2\frac{7}{8}$  in. thick), but you can also glue them up from thinner stock. Crosscut leg blanks to a few inches longer than their finished length and rip them to  $2\frac{1}{2}$  in. sq. The legs will be crosscut to finished size on the table saw or the radial-arm saw.

With either saw, you should use a stopblock to ensure that the legs are cut to the same length. With a radial-arm saw, simply clamp a stopblock to

the fence so that the distance from it to the blade equals the length of the finished leg. Butt one end up to the stopblock and crosscut the leg to size.

To set up a stopblock on a table saw, clamp a block to the saw's fence. Then, slide the fence over until the distance from the block to the blade equals the leg's length.

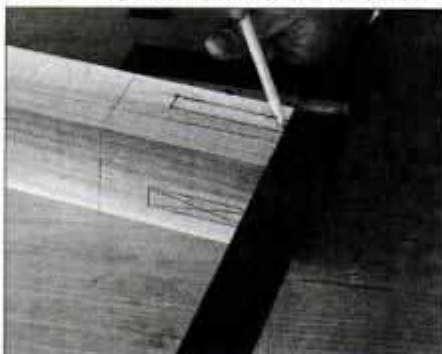
Butt one end of the leg against the stopblock and push the leg forward using the miter gauge. The leg should be clear of the stopblock once it contacts the blade. Make sure you have

the clearance, otherwise the leg could pinch between the blade and the stopblock and bind dangerously in the cut. Also, hold the leg firmly against the miter gauge to ensure that it doesn't move while it's being cut (Photo 5).

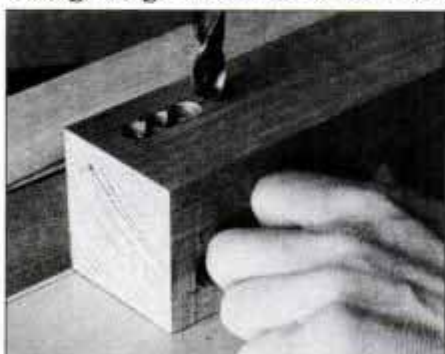
Next, lay out the lines for the mortises. You can use a mortise marking gauge for this, or just a sharp pencil and a square (Photo 6). Also, mark the lines below the mortises that determine the start of the leg's taper. Use a straightedge to extend a line from



**5** Crosscut  $2\frac{1}{2}$ -in.-sq. leg blanks. A stopblock clamped to the fence ensures the legs will be cut to the same length.



**6** Mark the lines for the apron mortises near the top of the legs. Use a sharp pencil and a square or a mortise marking gauge.

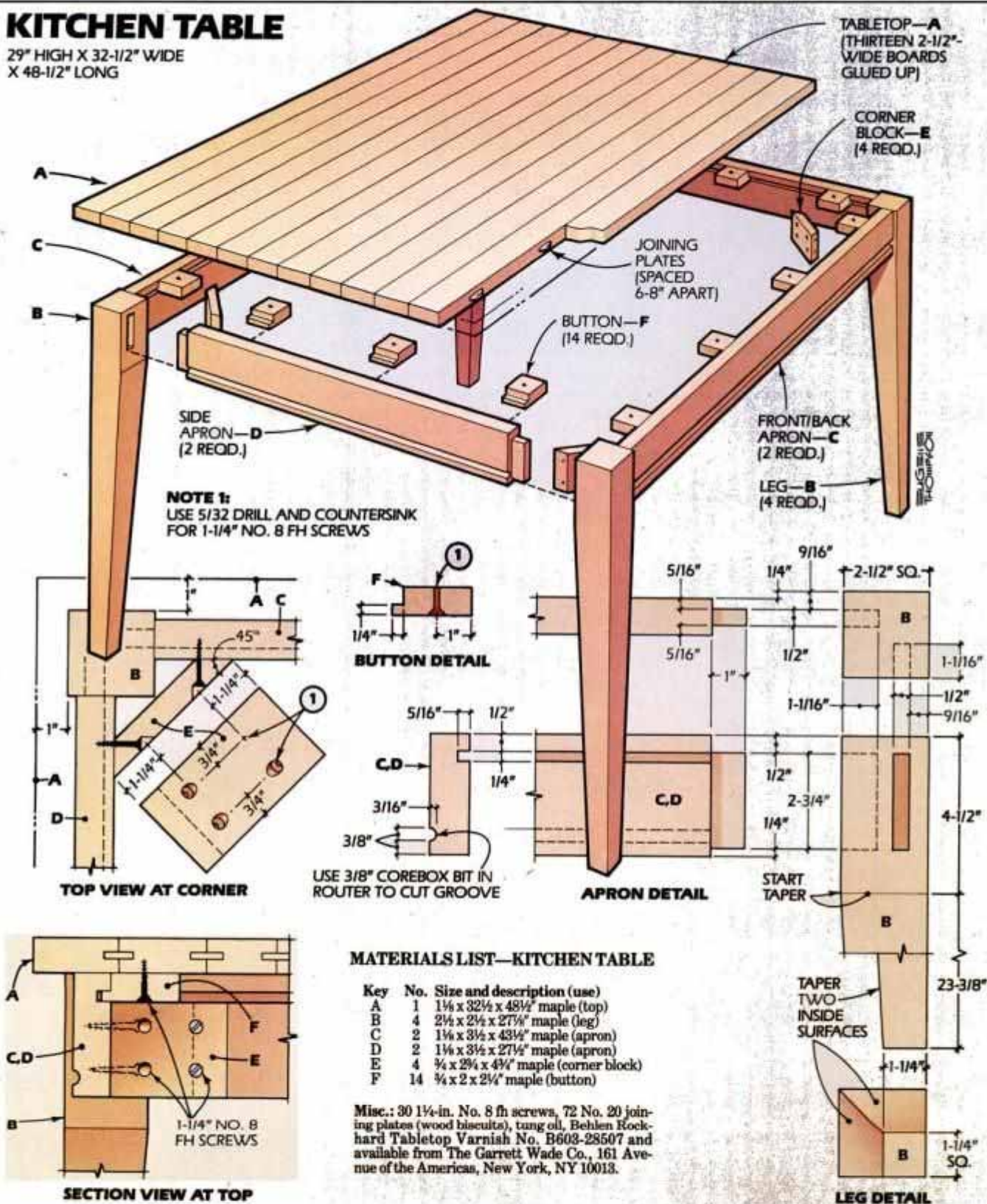


**7** Remove the mortise waste by boring overlapping  $\frac{1}{2}$ -in.-dia. holes. A fence clamped to drill table stabilizes workpiece.



## KITCHEN TABLE

29" HIGH X 32-1/2" WIDE X 48-1/2" LONG



### MATERIALS LIST—KITCHEN TABLE

Key	No.	Size and description (use)
A	1	1 1/4 x 32 1/2 x 48 1/2" maple (top)
B	4	2 1/2 x 2 1/4 x 27 1/2" maple (leg)
C	2	1 1/4 x 3 1/2 x 43 1/2" maple (apron)
D	2	1 1/4 x 3 1/2 x 27 1/2" maple (apron)
E	4	3/4 x 2 3/4 x 4 3/4" maple (corner block)
F	14	3/4 x 2 x 2 1/4" maple (button)

Misc.: 30 1 1/4-in. No. 8 fh screws, 72 No. 20 joining plates (wood biscuits), tung oil, Behlen Rockhard Tabletop Varnish No. B603-28507 and available from The Garrett Wade Co., 161 Avenue of the Americas, New York, NY 10013.

that point to the leg's bottom. The bottom should be 1 1/4 in. x 1 1/4 in. sq. Note that the legs taper only on the two inside surfaces. The 2-sided taper gives the table a refined profile and makes the legs look as if they are splayed slightly.

Remove the waste inside the mor-

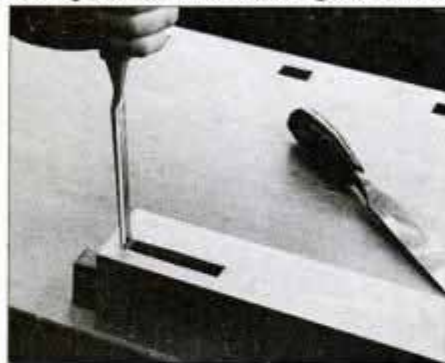
tise lines using a 1/2-in.-dia. bit in the drill press (Photo 7) or with a portable drill and a doweling guide. If you use a drill press, clamp a fence to the table to position the workpiece. If you use a portable drill, mark the mortise depth on the drill bit with a stop collar or wrap a piece of masking tape around

the bit. With either method, bore a series of overlapping holes inside the mortise layout lines.

Next, clamp each leg to the workbench, and use a sharp chisel to finish cutting the mortises to size. Pare by hand to smooth the walls of the mortise and use a mallet to chisel the ends



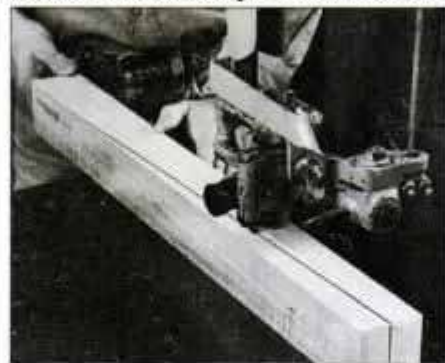
of the mortise square (Photo 8). Note that the mortises are cut  $\frac{1}{16}$  in. deeper than the apron tenons' length to allow space for the excess glue at the



**8** Clamp the leg to the workbench. Square up the ends of the mortise with a sharp, narrow chisel driven with a mallet.

bottom of the mortise.

Use a band saw to cut the leg tapers. Be sure to cut just to the waste side of the taper line (Photo 9).



**9** Lay out the taper on the two inner surfaces of the legs. Feed the leg smoothly into blade and cut slightly outside of layout line.

Clamp each leg to the workbench and use a sharp hand plane or belt sander to smooth away saw marks and refine the leg profile (Photo 10).



**10** With the leg clamped to the workbench, use a belt sander or a hand plane to smooth away saw marks and refine profile.

## Aprons

**R**IP THE aprons to width from  $\frac{5}{4}$  stock. Use a hand plane or jointer to make their edges square and straight. Use a stopblock, as discussed on page 76, when crosscutting the aprons to ensure they are the same. Equal lengths for both aprons in a pair is important. If they are not the same, then it will be impossible to square up the leg/apron assembly.

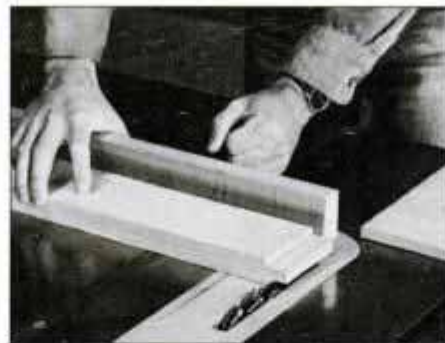
Use a dado blade in the table saw to cut the apron tenons. Again, a stopblock clamped to the saw table will ensure the tenons are a consistent length. It will also eliminate having to lay out each tenon (Photo 11). Readjust the blade height and cut a shoulder at the tenon's base. Raise or lower the blade and cut the other shoulder. Which shoulder is cut first is not important.

Since the dado blades tend to leave small ridges on the surface of the cut, it's good practice to cut the tenons slightly oversize and trim them to finished thickness by removing these ridges. To trim the tenons, hold the aprons in a bench hook—or clamp them to a table—and carefully pare away the ridges with a razor-sharp chisel. (For information on how to make a bench hook, see PM's November '89 "Woodworking Guide," page 71.) It's important to keep the chisel's back flat against the tenon's cheek to prevent gouging. A  $\frac{3}{4}$ -in.- or 1-in.-wide chisel works better for this operation than does a narrow chisel (Photo 12).

Test fit each joint and, if necessary, lightly pare down the tenon for a proper fit. It's best to concentrate on adjusting the tenon to fit the mortise rather than the other way around, because a mortise is more difficult to

trim than a tenon. The tenons should be snug in their mortises, but should not require great force to bring the joints tight.

Replace the wide dado blade setup with one to plough a narrow groove. Cut the  $\frac{1}{4}$ -in.-wide  $\times$   $\frac{5}{16}$ -in.-deep groove on the inside of each apron for the wood buttons that attach the top to the leg/apron assembly (Photo 13). Each button's tongue fits snugly into this groove, but since the buttons are not glued in place, the top is free to expand and contract with humidity and



**11** Cut apron tenons on the table saw using dado blades. For uniform tenon length, butt apron to a block clamped to table.



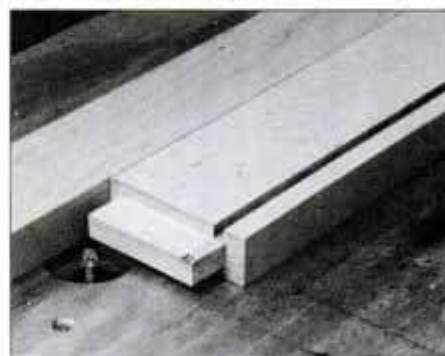
**13** Using the dado blades in the table saw, cut groove in apron's back. Groove receives wood buttons that attach top to base.

still remain firmly attached to the base assembly.

Use a  $\frac{3}{8}$ -in.-dia. corebox bit in the router table to cut the decorative groove on the bottom edge of each apron. (We used a Bosch No. 85445M bit.) Apply steady pressure on the apron to keep it against the fence as you feed it over the bit (Photo 14). It's easy to mistakenly cut the decorative groove on the wrong edge, so use the button groove as a reference point. The groove should be facing up and on the edge closest to you.



**12** Hold the apron to a bench hook, or clamp it to bench. Carefully pare tenon cheeks smooth with a sharp, wide chisel.



**14** Cut the decorative groove on the apron's face using corebox bit in router table. Hold apron firmly against the fence.

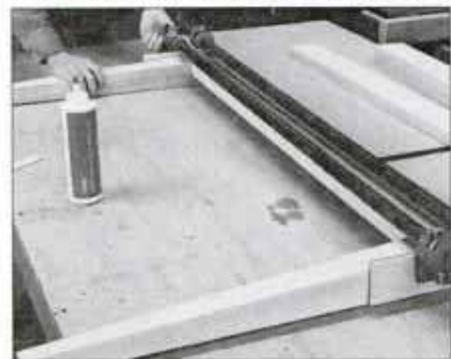


## Base Assembly

**B**EFORE assembling the base, sand all legs and aprons with 120- and 220-grit sandpaper, then dust them off. Gently knock off any sharp corners with a block plane or a sanding block and 120-grit paper. Test fit the entire base assembly before gluing the pieces together. Make any adjustments necessary so that the joints fit together well.

Apply glue to the tenon cheeks of a long apron and the corresponding mortise walls on two legs. Push the pieces together by hand and bring the joint tight with a pair of clamps (Photo 15), and check for square. Also, use a thin scrap block under the clamp jaws to prevent marring the work. Repeat this procedure on the second leg/apron assembly.

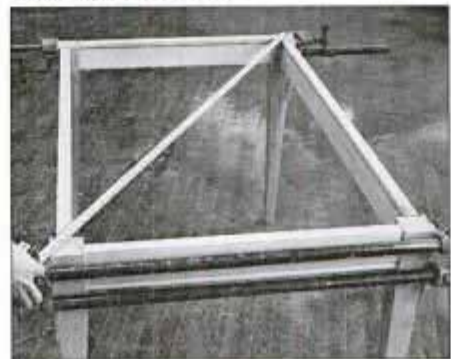
Once the glue has dried, join the front and back assemblies to the side



**15** Glue and clamp together a pair of legs and a long apron. Use scrap blocks under clamp heads to prevent marring the legs.

aprons. Be sure to assemble the base on a flat surface to avoid imparting a twist to the frame during glue up. If you have any doubts about whether the surface is flat, place a pair of sticks—on edge—across the assembly. The sticks should be the same size and should span the width of the table. Place one stick at each end. Sight down the assembly, over the sticks, and if you see one stick sloping above the other, then the assembly has a wind. You will have to move the assembly to a flat surface.

Use a pair of clamps at each end of the table, and use thin blocks under the clamp jaws. Measure diagonally across the top of the assembly to check for square (Photo 16). Adjust the clamps, if necessary, until the diagonal measurements are the same. Let the glue dry overnight before removing the clamps.

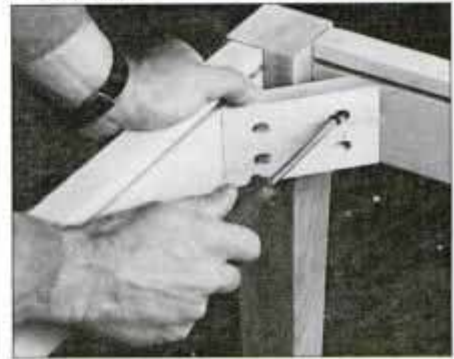


**16** Join two long assemblies with short aprons. Clamp across the table's width and measure diagonally to check for square.

Rip the corner blocks to width from  $\frac{3}{4}$ -in.-thick stock. Use a miterbox to cut the  $45^\circ$  angles on the block ends. With the drill press and a  $\frac{5}{32}$ -in.-dia. bit, bore and countersink pilot holes in each block. If you don't have a drill press, use a portable drill to bore the hole, aligning the bit with a sliding bevel gauge.

Press the blocks against the apron and poke a bradawl through the holes you just bored to mark the location of the pilot holes in the aprons. Bore the angled pilot holes into the aprons, being careful not to break out the other side. Mark the drill bit with a piece of masking tape or use a stop collar to mark the hole depth.

Install blocks at each apron corner with  $1\frac{1}{4}$ -in.-long No. 8 fh screws, holding the block flush to the bottom apron edges and below the groove (Photo 17).



**17** Screw the corner block flush to the bottom edge of aprons. Top of corner block should be below apron's bottom groove.

## Base Assembly/Finish

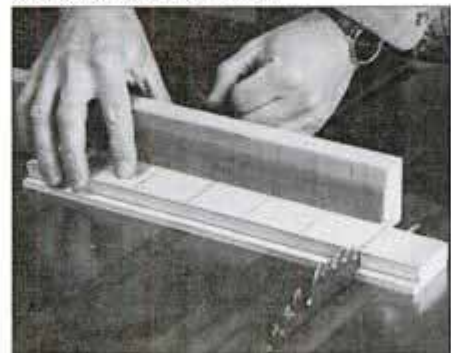
**R**IP A piece of  $\frac{3}{4}$ -in.-thick stock to  $2\frac{1}{4}$  in. wide. Use dado blades in the table saw to cut a  $\frac{1}{4}$ -in.-wide  $\times$   $\frac{1}{2}$ -in.-deep rabbet in the strip's edge. Crosscut the strip to make buttons using the table saw and miter gauge (Photo 18). Bore and countersink a pilot hole in each button.

Sand the tabletop thoroughly with 120- and 220-grit sandpaper and touch-up sand the table base as required. Dust off parts and wipe them with a tack cloth before finishing.

The oil-varnish mixture we chose for a finish imparts a good amount of moisture and abrasion resistance, while allowing a natural, close-to-the-wood feel. It consists of equal parts of pure tung oil and Behlen's Rockhard Tabletop Varnish. (See the materials list on page 77 for a supplier's address.) Using a lint-free rag, or a brush, apply a liberal coat of the mixture, and let it soak in for 5 minutes. Wipe off the excess with a clean rag, leaving only a damp surface. Remem-

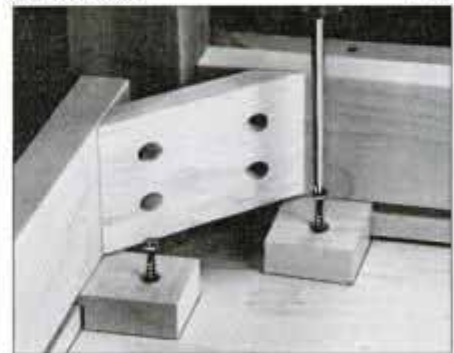
ber to apply the finish on both sides of the aprons and the top.

Let the finish dry overnight and repeat the process for at least three or four coats. You can apply more coats, if you like, to achieve greater luster and a rich satin glow. When the final coat has dried at least 24 hours, buff it out with  $4/0$  steel wool or an extrafine Scotchbrite pad to remove dust nibs and even out the finish.



**18** Cut the rabbet in a strip and mark the lines across it for buttons. Crosscut the strip into buttons with miter gauge on table saw.

Place the top upside down on a padded surface and invert the base over it so there is equal overhang on all sides. Place the wood buttons around the aprons and bore the pilot holes in the top. Mark the bit with masking tape or use a stop collar to prevent it from breaking through the top. Attach the top with a  $1\frac{1}{4}$ -in.-long No. 8 fh screw driven through each wood button (Photo 19).



**19** Invert the base assembly on the top and measure for equal overhang. Then, slide buttons into grooves and screw into the top.



## TOOL TEST NEW SCROLL SAW

TEXT AND PHOTOS BY  
ROSARIO CAPOTOSTO,  
Contributing Editor

**F**OR MANY YEARS, Dremel has been synonymous with quality in compact tools. So I anticipated the fine results I received from using its new 16-in. scroll saw.

The Dremel handled hardwoods and softwoods, up to 2 in. thick, with ease. A direct-drive 1/10-hp, ball-bearing motor powers the saw arm through a 3/4-in. blade stroke. At high speed, with a fine-tooth blade, it produced remarkably smooth cuts.

The saw's cutting speed is adjusted from 890 to 1790 strokes per minute by flipping the HIGH/LOW switch. Low speed proved ideal for cutting 1/8-in.-thick aluminum and brass.

The saw's dust blower is powered by the blade's reciprocating action. It keeps the cutting line clear, and the blade guard contains flying particles.

Nicely built, the saw features a cast-aluminum table and frame supported on a cast-iron base. It weighs



Dremel's 16-in. scroll saw handles intricate cuts in wood, soft metal and plastic.

42 pounds and runs with minimal vibration. It bolts to the benchtop or an accessory stand (about \$40).

The table tilts 45° left to permit bevel cuts, and it accepts stock up to 1 in. thick at that angle. Its depth of cut, with the table perpendicular to the blade, is 2 in. The saw's throat capacity is 16 in., but it accepts longer workpieces with the blade installed sideways. The Dremel uses 5-in.-long

pin-end and plain-end blades, and it comes with a pair of adapters for the latter. A built-in gauge on the saw's top helps you to attach adapters on the blade.

The saw comes with 13 blades for woodworking or metalworking, two adapters, two hex wrenches and costs about \$200 at hardware stores and home centers. Write Dremel, 4915 21st St., Racine, WI 53406-9989. **PM**



**1** Blade tension is adjusted by turning the knob on the top frame. The blade guard pivots to give you access to the blade.



**2** Built-in gauge on top of saw helps to accurately attach the adapters on the plain-end blades. Hex wrench tightens the adapters.



**3** The 12-in.-dia. table tilts 45° left for bevel cutting. The ON/OFF and the HIGH/LOW speed switches are next to each other.



**4** At high speed, a fine-tooth blade leaves smooth edges. The blade cuts plywood without splintering along the kerf's edge.



**5** The Dremel saw cuts up to 2-in.-thick stock. Built-in blower, powered by saw's reciprocating motion, clears away sawdust.



**6** The blade is mounted sideways to saw long workpieces. Sturdy construction helps the saw handle large workpieces.





## THE BETTER HOME INSTALLING A CLOSET LIGHT

BY MERLE HENKENIUS  
PM Illustrations  
by George Retseck

**I**F YOUR HOME is one of the millions with a shortage of closet lighting, don't despair. Installing a closet light is a simple task, requiring only the most basic electrical and household tools. Expect to invest between \$10 and \$25 and a couple of hours of time. The easiest approach is to install a simple pull-chain-operated porcelain fixture. But the installation we've illustrated here offers a more convenient switching option: a door-operat-

ed plunger switch. The plunger turns on the light automatically each time you open the door.

### Lighting options

Before launching headlong into the project, be sure to check your local electrical codes. It's a good bet that they will approximate National Electrical Code (NEC) standards which prohibit incandescent fixtures closer than 18 in. to clothing or other combustible items that are hanging or shelved. Also, an incandescent fixture must be placed at least 6 in. away from any wall. If installed on a wall, the fixture must be located directly above the closet door.

### Locating a power source

Finding a convenient source of power is always the first step in approaching any electrical retrofit job. Because general lighting circuits are not usually filled to capacity, a nearby hall light or an overhead room light—that's ac-

cessible from your attic—will often be your best source.

Start by turning off the power to the circuit that serves the nearest overhead light. Then unscrew the fixture, pull it down and inspect the wiring inside the box. If there's only one cable coming into the box—each cable should have a white wire, a black wire and a bare ground wire—this box cannot be used as a power source for your new closet light.

If you have two or more cables in the box, you can assume that power is available. (The only normal exception to this rule is if the light in question is the middle light in a sequence of three or more lights, all of which are operated by a single switch.)

### Cutting in the closet fixture box

Once you've found convenient access to power at the ceiling level, lay out an area within a joist cavity, then hold your new box against the ceiling



—within this area—and trace around it (Fig. 1). Then, using a drywall or keyhole saw, cut about 1/4 in. inside the line to accommodate the new box flange (Fig. 2).

We used what is commonly called a cut-in box for this job. It consists of a box with a U-shaped bracket connect-

ed to it. The sides of this bracket splay out, and by squeezing these against the box, you can slide them through your ceiling opening (Fig. 3). Then the sides will snap out, above the drywall, and support the box. To secure the box, simply tighten the screws that hold the bracket.

## Wiring the new fixture

Start by running a 14-gauge, 2-wire-with-ground-wire (14/2 W/G) cable between the existing box and the new box. Staple the cable to the joists every 4 ft. and within 8 in. of each box. Then, bring a second cable into the new box to serve as a switch leg.

This wiring configuration requires that the black (hot) side of the incoming cable will be diverted through the switch. Start by stripping the sheathing from the cables. Then remove 1/2 in. of insulation from each wire. Mount the fixture bracket to the box and join all ground wires to the bracket via an insulated pigtail lead. Follow by joining the white fixture lead to the white neutral wire from the incoming power cable.

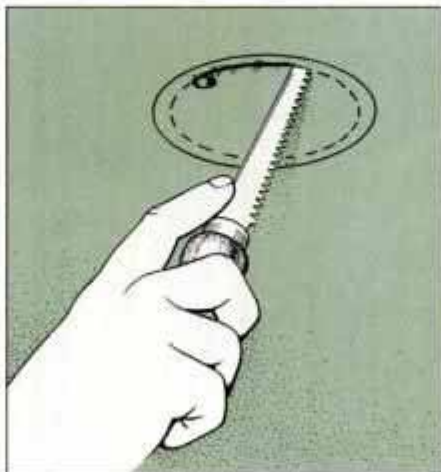
This will leave the black and white switch wires, the incoming hot wire and the black wire on the fixture to be connected. Join the black wire from the switch to the black fixture lead. Then, join the black from the incoming power to the white switch wire (Fig. 4). As both switch leg wires are now considered hot, code the white wire black by wrapping it with a piece of black electrical tape.

## Accessing the hall fixture

Return to your existing fixture and once again make sure that the circuit power and the wall switch have been shut off. Unscrew any Wire-Nuts, making sure to note which wires were joined together. With the wires spread apart so they can't touch each other, turn on the power to the circuit and check for power at each cable (Fig. 5). Do this by touching the black wire in the cable with one probe of a voltage tester and the white wire in the same cable with the other tester probe. If the tester lights, power is present in the cable. This is the cable



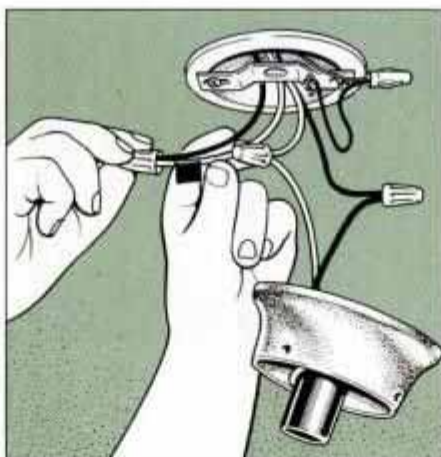
**1** Locate a cavity between ceiling joists and hold a cut-in box against the ceiling in this area. Trace around the box perimeter.



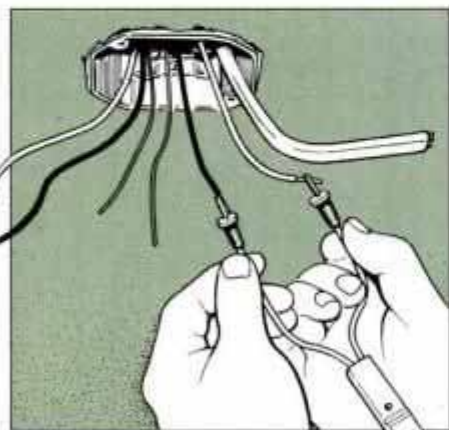
**2** Using a drywall or keyhole saw, cut a hole in the ceiling material. Stay at least 1/4 in. inside the box flange outline.



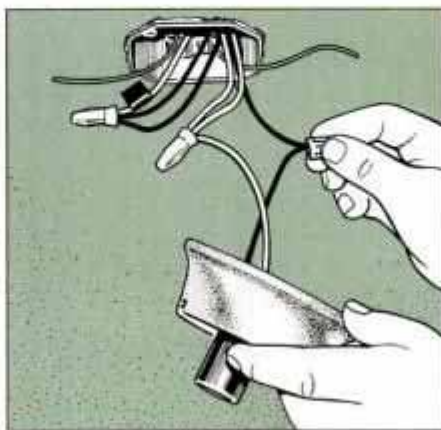
**3** Compress bracket and push box into opening until bracket snaps past edge of drywall. Then tighten bracket screws.



**4** To install, join grounds, join white leads from power and fixture, and divert black through switch to black fixture wire.



**5** Turn off power, remove fixture from box and separate wires. Use voltage tester to find incoming power cable.



**6** Join new cable to power cable with whites together and blacks together. Attach switch and fixture wires as before.



**7** Place plunger-switch box against hinge side door jamb and door stop. Trace around perimeter of box using sharp pencil.



that you will use to service your closet light.

Turn off the power again. Then strip the sheathing and insulation from the closet light power cable. Attach the ground to the other grounds and the white and black wires to the power wires in the box and to the other wires that the power cable wires were joined to originally. Reinstall the fixture (Fig. 6).

## Installing the switch leg and switch box

To bring a length of cable to the switch location, bore through the top plate of the wall so that the drill bit enters the stud space next to the hinge side of the door jamb. Then, remove the door and set it aside. Outline the switch box—and covering plate for the switch itself—on the jamb (Fig. 7). Bore through the jamb—and the studs behind—only in the outlined area for the box (Fig. 8).

Next, use a saw to square up the opening in the jamb to accept the switch box (Fig. 9). Then, press the switch box into the opening and check for proper fit. When satisfied, chisel out the trim plate area to a depth of  $\frac{3}{16}$  in. so that the plate will fit flush with the jamb (Fig. 10).

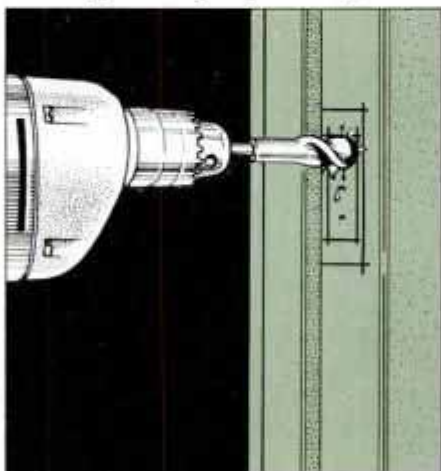
With the box opening made and the trim plate area recessed, drop a short length of chain through the hole bored in the top plate of the wall (Fig. 11). Clamp locking pliers onto the chain to keep it from falling completely into the wall. Then, feed a short piece of hooked wire into the jamb opening and pull out the chain through the jamb (Fig. 12). Return to the attic and fasten the switch-leg cable (already wired into the fixture) to the chain and return to the door jamb and pull the chain and wire out through the jamb opening.



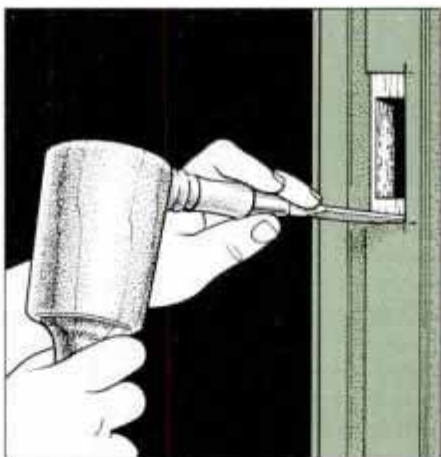
**12** Fashion a hook on the end of a hanger wire, then use the wire to retrieve the chain from stud cavity behind the jamb.

## Wiring the switch

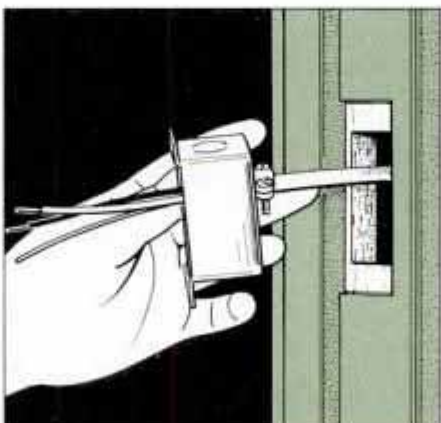
With the switch-leg cable stripped and ready, fasten it to the switch box with a standard cable connector (Fig. 13) and mount the box in the jamb opening. Then, connect the ground wire from the cable to the switch box with a grounding clip. Next, join the



**8** Trace outline of switch cover plate on jamb. Bore holes through jamb to remove waste within box—not plate—outline.



**10** Using a sharp chisel, cut along switch cover plate outline then remove the waste. Cut to a depth of about  $\frac{3}{16}$  in.



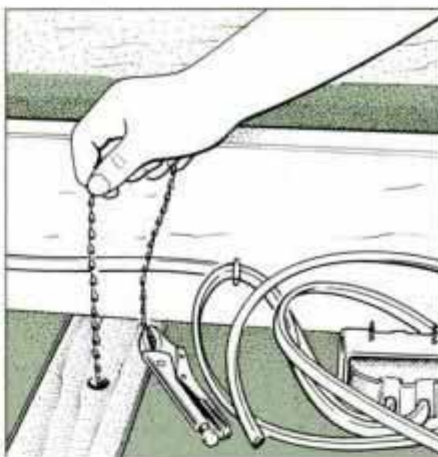
**13** Pull switch cable through stud cavity using chain. Then attach cable to switch box using standard cable connector.

two switch leads to the switch-leg wires with Wire-Nuts (Fig. 14). Finally, fold the wires into the box and screw the trim plate into its recess. When you restore power to the hall light, replace the door and open it, your door-operated closet light should work as well.

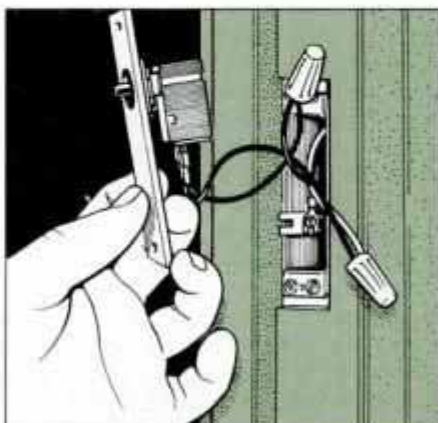
FM



**9** Using a drywall or keyhole saw, square the cut edges of the box recess. Test fit box to make sure it fits properly.



**11** To install switch cable, bore hole in wall top plates and feed chain into cavity. Locking pliers keep chain from falling.



**14** Attach switch box to jamb, then connect leads from switch to cable wires using Wire-Nuts. Attach plate to switch box.



## THE BETTER HOME HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

### Contemporary Roof Vent

I just moved into a contemporary one-family house that has a sawtooth (half-gable) roof. Apparently my attic is inadequately ventilated because there is a mildew buildup on the underside of the roof deck. I want to increase the vent openings to my attic. Is there a vent that I can use which is similar to a ridge vent for a gable roof?

SANDRA LIBESON  
POMONA, NY

*Yes, there is. As you know, a ridge vent is a low-profile vent installed at the ridge of a gable roof. It provides continuous ventilation for the area below the roof. A ridge vent combined with soffit vents is a very effective way to ventilate an attic or the area under the roof deck in houses with cathedral ceilings.*

*Two manufacturers who make vents for sawtooth-peaked roofs are: Air Vent, Inc., 4801 N. Prospect Rd., Peoria Heights, IL 61614 and Browning Metal Products Co., P.O. Box 2405, Norcross, GA 30091.*

*As shown in the drawing, the vent allows warm moist air from inside to pass outside but stops it from reentering with a baffle. A fiberglass weather filter prevents rain and snow infiltration. You can write to the companies for product literature and to locate a distributor near you.*

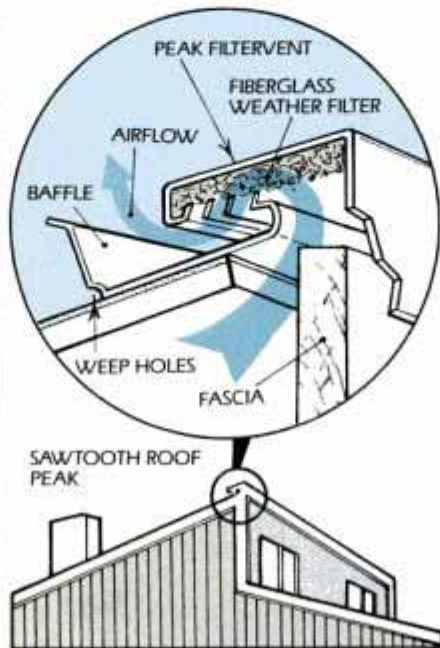
### Airbound-Waterlogged

Our ranch house has an expanded second floor and is heated with a forced hot-water system. The system is controlled by a single heating zone with four piping circuits. For the most part, it works very efficiently, except for the second floor. I have been advised that to improve the system, I need to periodically close the other three circuits and drain the air-entrained water out of the pipes.

Also, at least twice, the expansion tanks have filled with water and caused the relief valve on the boiler to go off. I have drained the tank, which appears to solve the problem, but why does the expansion tank fill up?

Any suggestions will be appreciated.

JOHN GILMARTIN  
MOUNTAINSIDE, NJ



Ridge vent on a contemporary roof peak ensures air movement below the roof deck.

*I assume that your expansion tank is the conventional air-cushion type and not the diaphragm type. If so, the two problems you describe are inter-related and can probably be eliminated by installing an air-separator dip tube. The air you are purging from the second-floor heating pipe should be directed into the expansion tank to prevent waterlog.*

*When boiler water is heated, dissolved air is driven out and rises to the boiler's top. Some air passes into the connection to the expansion tank. However, most of it makes its way into the distribution supply piping. The air rises to the highest point, in your case the second-floor piping, eventually making it airbound.*

*The boiler and distribution piping in a forced hot-water system are completely filled with water. The boiler water expands when heated, and the increased volume of water flows into the expansion tank, where it dissolves a small amount of air. The on-off cycling of the boiler can eventually deplete the air in the expansion tank causing it to become waterlogged. This will occur if not enough air is directed to the expansion tank from the boiler. A waterlogged expansion tank causes high pressure in the boiler. When water pressure climbs over*

*30 psi, its relief valve discharges.*

*The dip tube is a piping arrangement connected to the boiler end of the distribution supply piping. It extends into the boiler so that it is below the air bubbles that accumulate at the boiler's top. Heated water enters the lower end of the dip tube, minimizing air accumulation in the distribution piping. With a dip tube, the air that separates out from the heated water will remain at the boiler's top and also pass into the expansion tank, minimizing the possibility of waterlog. Plumbing and heating supply stores sell dip tubes.* **PM**

### Safety Tip

It's very important to periodically inspect the exhaust stack of an oil- or gas-fired water heater, furnace or boiler to check that exhaust gases are passing harmlessly up the chimney. Condensing flue gases produce corrosive acids which deteriorate metal flue pipes (exhaust stacks). Deteriorated sections must be replaced because they allow poisonous exhaust gases to seep into the house.

Also, exhaust gases can spill into the house from the bottom of the draft hood skirt. To check for this, hold a lit match at the bottom of the draft hood skirt when the heater or furnace is firing. If the match flame is drawn toward the underside of the hood, the exhaust gases are discharging properly. However, if the flame is blown out, the exhaust gases are spilling into the house. If so, shut off the water heater or furnace. There is either an obstruction in the chimney or an improper slope in the exhaust stack.

### Hot-Wired

*Here's a useful tip sent in from Victor Lingis of Reno, Nevada.*

To strip the insulation off twin-line TV antenna cable, heat the cable over a flame for 15 to 20 seconds. Slowly rotate the cable as you heat it, then wipe off the softened insulation with a folded piece of paper towel. The copper wire will be left cleanly exposed.

### DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.



TOOL TEST

NEW  
PLANER/  
MOLDER

TEXT AND PHOTOS BY  
ROSARIO CAPOTOSTO,  
Contributing Editor

**T**O USE Sears' new planer/molder is to be impressed with the performance and features in this compact and moderately priced machine.

Its dual-knife cutterhead is supported from the side, allowing the 6-in.-long knives to surface 12-in.-wide boards with a double pass. This also allows you to cut moldings or rabbets around the stock's perimeter. The machine is powered by a 110-volt, 12-amp, 2-hp motor. It can thickness or edge plane stock from  $\frac{3}{16}$  in. to  $\frac{1}{2}$  in., taking up to  $\frac{1}{16}$ -in. cuts per pass.

The disposable planer knives have a cutting edge on both sides. When one edge dulls, flip them over. When both edges dull, replace the pair with a new set (about \$10). Just screw in the self-aligning knives or molding cutters. No adjustment is necessary.

Adjust for stock thickness by turn-



Planer/molder surfaces stock up to 12 in. wide, planes edges and cuts moldings.

ing the hand crank on the machine's top. One revolution moves the cutting head  $\frac{1}{16}$  in. A chain-and-sprocket drive system powers the infeed and outfeed rollers which push the board past the cutters at a rate of 20 ft. per minute. With a cutterhead speed of about 6500 rpm, this results in 58 cuts to the inch and thus produces a very smooth surface.

The Sears Craftsman Planer/Molder comes with stand, edge-planing and edge-molding guides, and planer knives. Eighteen accessory molding cutters are available. It's sold at larger Sears outlets and through the catalog for about \$350. For more information, write Sears, Dept. 703 PM, BSC 40-16, Sears Tower, Chicago, IL 60684. **PM**



**1** The crank, for positioning the cutterhead, and the ON/OFF switch are easily accessible from the machine's feed side.



**2** The 6-in.-wide cutters can surface boards up to 12 in. wide, in two passes, thanks to the unusual open-throat design.



**3** Guides bolted to the bedboard support stock for edge planing. The machine can edge plane stock up to  $\frac{1}{4}$  in. wide.



**4** Molding cutters are substituted for the planer knives to shape a board's edge. Moldings can also be cut on the stock's face.



**5** In two separate operations, the planer/molder cuts the rabbet and shapes the face of stock to make a picture frame molding.



**6** Among the available cutters are (top to bottom, left to right): picture frame, rabbet, clover, glue joint, three bead and planer.



# THE BETTER HOME APPLIANCE CLINIC

BY STEVE TOTH,  
Contributing Editor

## Belt Tightening

I have a portable Maytag Electric Dryer model No. KDE50, serial No. 994018 DU. The belt on the drum broke. I got a new belt but could not get it on in its place. I tried every trick I could think of but nothing worked. This unit worked well until the belt broke. Any help you can give on how to solve this problem will be greatly appreciated.

WILLIAM KAVANAGH  
WHEATON, IL

Disconnect the dryer from the power supply. Remove the exhaust duct work from the dryer's back. Place an old blanket or drop cloth on the floor behind the dryer. Then, lay the dryer carefully on its back on the cloth. This protects the dryer's finish and your floor.

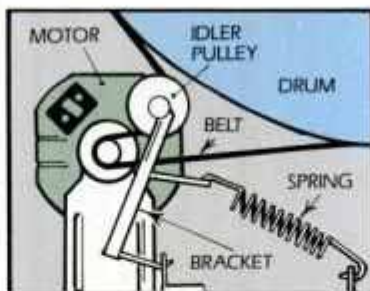
First, you need to remove the lower access panel, located near the bottom of the dryer front. Remove the two screws at the bottom of the panel, then lift up the panel and pull it away from the cabinet.

Next, remove the two screws holding the front trim strip to the cabinet. There is also double-faced tape on the strip's back, so be careful when removing the strip since it bends easily. Now, remove the screws under the lip at each lower corner of the front panel. You need to reach under the lip on the panel to locate the screws that go from the back into the front panel.

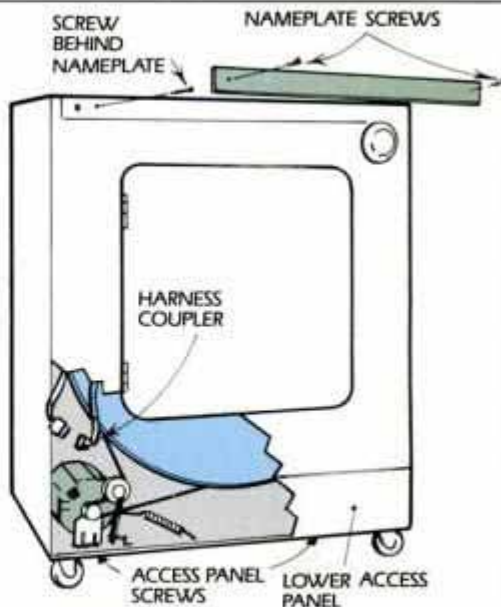
Disconnect the wire harness coupler on the motor side of the dryer. Release the coupler by squeezing the plug then pulling the coupler apart. Now, remove the three screws at the top of the front panel.

The next step is to carefully lift the front panel up and off the cabinet. You will see the drive motor on the left toward the back. In front of the motor, and to the right, is the idler pulley with bracket. A spring hooks into the bracket and attaches to an L-shaped bracket on the base.

Remove the spring from the idler pulley bracket. Place the new belt around the drum, smooth side down. Then, slip the belt under the idler



To install a new drive belt on a portable dryer, remove lower access panel, disconnect harness coupler and remove front panel. Remove spring to release tension on idler pulley. Install new belt and turn drum to locate belt on drum.



pulley, through the pulley bracket and over the motor pulley. Once the belt is in place on the motor pulley, reconnect the idler pulley spring to provide tension on the belt. Then, turn the drum clockwise several times to properly locate the new belt on the drum. Reassemble the dryer and perform a test run on it.

For additional information on your dryer, I suggest you purchase a service manual from the Maytag Co. The publication is Maytag part No. 56148. It costs \$4 (including shipping and handling). Write to Maycor, 240 Edwards St. SE, Cleveland, TN 37311, Attn: Publication Dept.

## Don't Get Zapped

I need to find a repair center for my Litton Solid State Microwave, model No. 420, rev. 500, serial No., 7795. The oven is 8 years old, and I haven't used it in the past three years. Now that I want to use it, it won't turn on. Any help in solving this problem will be appreciated.

DOROTHY BIASE  
WEST CHESTER, PA

Litton sold the microwave cooking division about a year ago to Microwave Products of America, Memphis, Tennessee. Contact them at P.O. Box 1976, Memphis, TN 38101. To find out the name and address of your local authorized Litton servicer, write to the customer service division at the above address.

Microwave oven manufacturers advise against do-it-yourself repairs. These appliances contain high-voltage components, and there is a danger of electric shock if they are disassembled or reassembled incor-

rectly. Microwave ovens should be serviced by a qualified technician.

## Broken Cook Surface

I broke the lefthand ceramic cooking surface on my Thermador electric stove top, model No. TGT45, serial No. 649168. I would appreciate any help finding a new one.

WALTER CALLEN  
LANCASTER, CA

Unfortunately, the chances of finding a replacement cooking surface are very slim. Thermador discontinued making the ceramic cooking surfaces in 1982. They were custom made by Corning Glass, and neither Corning nor Thermador have any left in stock. The company is prepared, however, to put you in touch with a list of dealers. It's a longshot, but maybe a dealer somewhere has a ceramic cooktop in stock. Call the company's sales department at (213) 563-1133.

## Service Tip

To help consumers make wise decisions when buying appliances, Maytag publishes a set of six booklets covering refrigerators, washers, dryers and gas and electric ranges. Each book costs 25 cents and the set, \$1.25. Write to Consumer Information, How-To-Buy Booklets, Dept. PM, Maytag Co., Newton, IA 50208.

**DO YOU HAVE AN APPLIANCE PROBLEM?** Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.



## THE BETTER HOME

# CLEARING CLOGGED DRAINS

BY MERLE HENKENIUS  
PM Illustrations  
by George Retseck

**A** CLOGGED or sluggish drain is not a major catastrophe, but it can be a real nuisance. Luckily, correcting a troublesome drain is a simple matter, requiring only the most basic of household tools.

As always, gaining access is half the battle. Because trap clogs are easier to clear than line clogs, and generally do not require trap or drain disassembly, you'll want to start with a plunger. To avoid losing the force of the plunger through secondary passageways, always plug the sink's other compartment opening.

Also, try for a good seal around the plunger cup on both the up and down strokes. A little petroleum jelly or liquid soap on the rim of the cup will improve the seal.

Secondly, try plunging with a little water in the basin. The water will help force the trap and will indicate when you've broken through. And finally, follow any drain-cleaning procedure by running very hot water down the drain for about 5 minutes.

If plunging does not clear the blockage, you'll need to free the line with an inexpensive hand snake. While some sources suggest snaking through the fixture drain, this is rarely a workable solution. Instead, take the time to disconnect the sink trap and snake through the open line at wall or floor



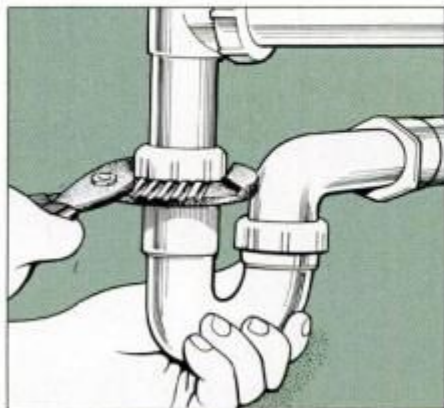
First step in clearing any clogged drain is to try plunging. For best results, be sure to plug any secondary passageways—like this tub overflow opening—with a damp rag.

level. To remove a trap, use adjustable pliers or a pipe wrench to loosen the slip nuts on the trap. Remember that the trap will contain water, and additional water may be backed up in the line, so keep a bucket underneath the trap. Then loosen the nut that secures the trap arm to the drainage-line fitting (Fig. 1).

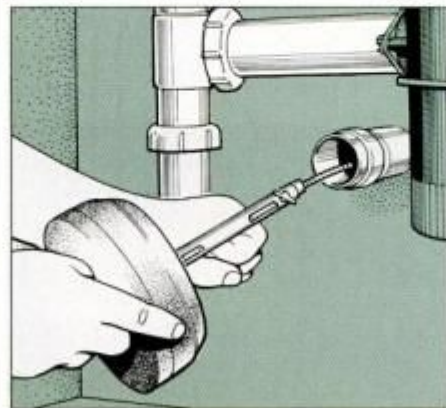
With the trap off, feed the cable into the line and crank clockwise (Fig. 2). If you find brief stubborn resistance, the cable will have encountered a local clog, usually near a bend in the

pipe. Crank back and forth through the clog several times before retrieving the cable. If you find steady resistance throughout the length of the line, move the cable back and forth—a foot or two at a time—until you've reached the stack connection.

With the cable retrieved, reassemble the trap and flush the line with plenty of hot water. Often a snaked line will clog again when loosened debris collects at a bend in the line. If the water drains briefly, then backs up again, use a plunger to force the de-



**1** To free sink drain, first remove trap in waste line with pliers. Be sure to place bucket under trap to catch waste water.



**2** Once trap is removed, push snake cable into waste line and turn handle in clockwise direction until line is clear.



**3** To remove hair, or plunge a tub with pop-up tripwaste mechanism, gain access to drain line by lifting out pop-up arm.



bris. Keep plunging until the water flows freely.

### Clearing bathtub drains

Before assuming a clogged drain line on a tub, look to the tripwaste mechanism. Quite often, the mechanism will attract a hair clog or simply need adjustment. Hair clogs are almost a given on pop-up-style drains. Begin by turning the control lever to the open position and grasping the plug. Slow-

ly pull the plug and its trip lever out of the drain shoe (Fig. 3). If hair accumulation on the pop-up lever is the problem, you'll see it immediately. Simply remove the hair. Then turn the control to the closed position and feed the pop-up lever and plug back into the drain.

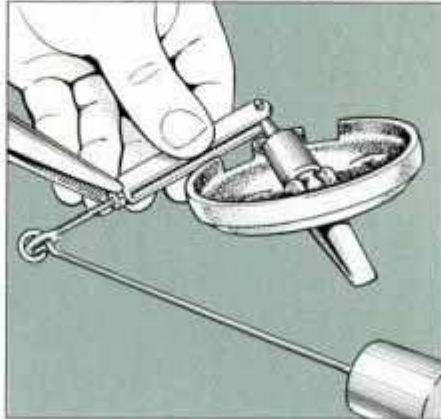
Plunger-style tripwastes seldom collect hair but if yours is plugged, simply remove the covering plate screw (Fig. 4), lift off the plate, clean

off the hair and sludge, then reinstall the plate.

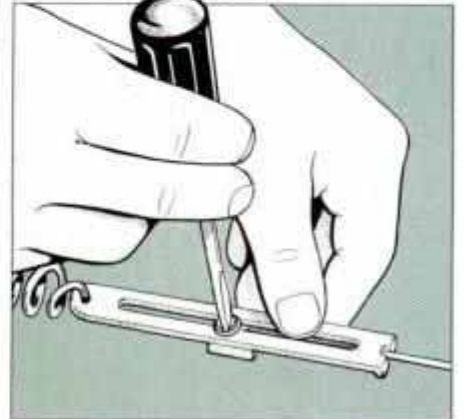
A more likely problem is that the tripwaste mechanisms—on both plunger and pop-up styles—may need adjustment. In a plunger-style tripwaste, the rod will need to be shortened to increase flow. With a pop-up-style mechanism, the opposite is true. In any case, you'll usually find one of two rod configurations: a locknut and threaded rod setup (Fig. 5), or a slot-



4 To remove hair, or plunge a tub with a plunger-type tripwaste, gain access to drain line by removing cover screen.



5 To adjust plunger-type tripwaste, first remove it from overflow opening, then tighten or loosen lock nut to move lift rod.



6 To adjust pop-up tripwaste, first remove it from overflow opening, then loosen set screw to free up lift rod. Move rod as needed.

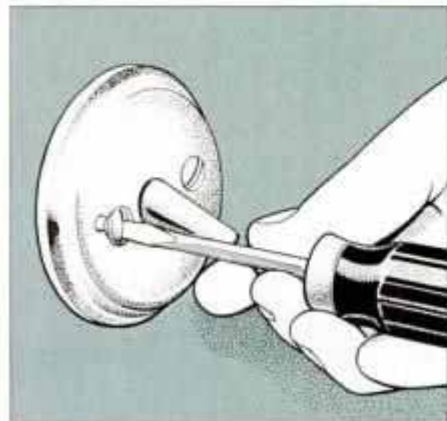
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ted strap and setscrew arrangement (Fig. 6). You'll simply loosen the locking device and adjust the rod up or down, as needed. As a little adjustment goes a long way, make your changes in 1/8-in. increments.

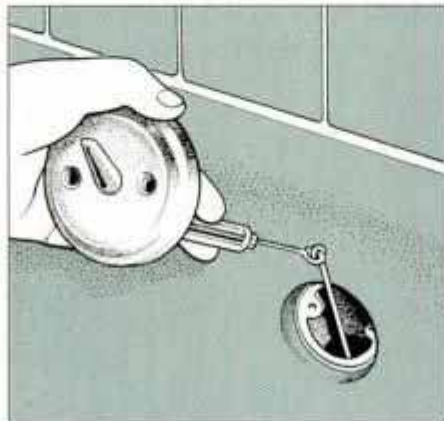
If the problem is not in the tripwaste, expect it either in the trap connected to the drain or in the waste line connected to that trap. As a trap clog is likely, plunging the drain is the simplest approach. Again, you'll have to



**7** If drain requires plunging or snaking, first remove cover plate on overflow opening. Plate is usually attached with two screws.

keep the pressure from escaping through the overflow. With luck, you may be able to plug the overflow slots in the cover plate. If not, remove the cover plate (Fig. 7) and pull out the tripwaste mechanism (Fig. 8). Then, stuff a wet rag into the opening.

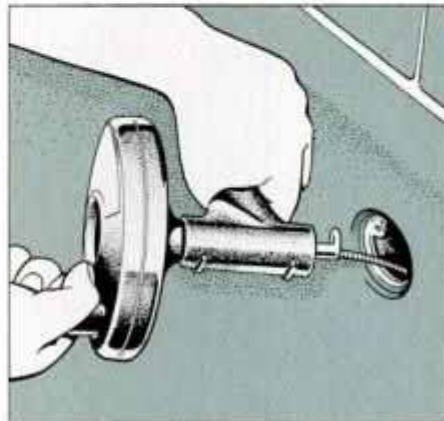
If plunging the drain offers no solution, you'll need to use a snake. Unlike sink traps, most tub traps are inaccessible and cannot be taken apart, so you'll have to work the cable from in-



**8** With cover plate free, lift out tripwaste mechanism. If plunging, cover overflow opening with damp rag, then work plunger.

side the tub. But don't try working through the drain. The snake won't make it past the drain-shoe tee. Instead, remove the cover plate and tripwaste and insert the cable through the overflow tube (Fig. 9).

Within 2 ft. of the overflow opening, you'll feel resistance at the trap. Slowly work the cable through the trap and crank into the drain line. From that point on, you'll work it just as you would in a sink line. **PM**



**9** If snaking is required, slide cable into overflow opening and turn handle clockwise. Advance cable as necessary.

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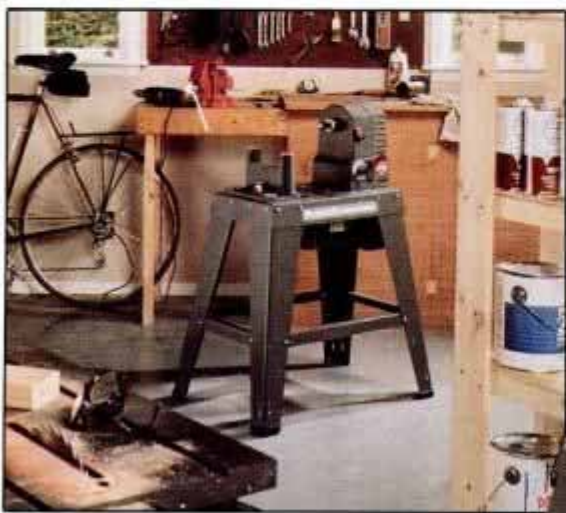


## NEW TOOLS

### MULTIPLE CHOICE

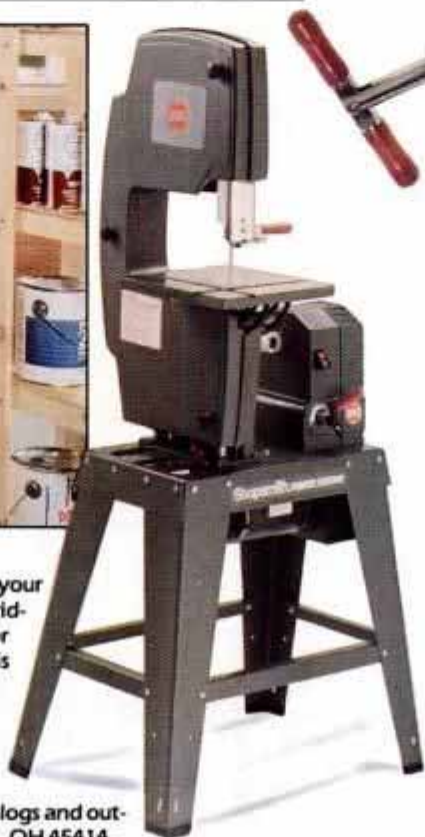
Eleven tools for working wood, metal and even stone.

BY ROY BERENDSOHN, Assistant Home and Shop Editor



#### Power Hungry

The Power Station shop system lets you expand your woodworking capability without buying individually powered machines. Its heart is a 1/4-hp motor on a 55-pound steel stand (\$200). Motor speed is dial-adjusted from 850 to 3850 rpm. Accessories that mount on the stand include a 4-in.-wide jointer (\$369), an 11-in. band saw (shown, \$400), a 20-in. scroll saw (\$450), a strip sander (\$190), a belt sander (\$320) and flex-shaft cable and chuck (\$62). It's sold through Shopsmith catalogs and outlets. Write to Shopsmith, 3931 Image Dr., Dayton, OH 45414.



#### Mark And Measure

Designed with portability in mind, this kit includes a tungsten-carbide scribe with magnetic tip, a 0-1-in. dial micrometer with an adjustment hex wrench, a 6-in. stainless-steel rule in 1/64-in. increments, and a reinforced-fiberglass 0-6-in. dial-gauge caliper. The kit costs about \$68 at hardware stores and home centers. Write to General Hardware Manufacturing Co., Inc., 80 White St., New York, NY 10013.

#### Dado Discs

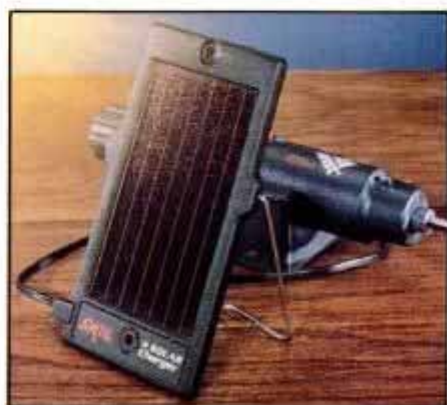
A standard table saw or radial-arm saw can cut 1/2-in.-wide dados or rabbets in one pass with this accessory. The two tapered die-cast metal washers and collar slip on to a saw's 5/8-in. arbor and cause the blade to wobble as it cuts. To adjust kerf width, you twist the washers to line up their tapers differently. The set fits up to 10-in.-dia. blades and costs \$14.95 postpaid from Woodcraft Supply, 210 Wood County Industrial Park, P.O. Box 1686, Parkersburg, WV 26102-1686.



#### Tight-Spot Wrench

The Sidewinder wrench works in areas too tight for other socket wrenches. According to its manufacturer, a twist of its T-handle equals eight regular ratchet motions. It's designed to

be durable with a ductile cast-iron head, a seamless steel tubing handle, heat-treated steel gears and bronze bushings. The Sidewinder wrench comes in 1/4-in., 3/8-in. and 1/2-in. drive sizes that cost about \$30 at auto parts and hardware stores. For more information, write to Sidewinder Products Corp., 2066 Old Rocky Ridge Rd., Birmingham, AL 35216.



#### Sunny Side Up

To top off its power charge, just hook a Skil cordless screwdriver or wrench to the photovoltaic panel. Left in a sunny spot, it recharges a completely drained tool in 10 to 13 hours. It stands upright or can stick to a window with its two suction cups. A 5-ft.-long cord allows for flexible placement of the charging tool. Cost is about \$20 at hardware stores and home centers. Write to Skil Corp., 4300 W. Peterson Ave., Chicago, IL 60646.



#### Swirl Free

This random-orbit disc sander is designed for quick swirl-free finish sanding on wood, metal or manmade composites. Its 3.7-amp motor drives a 5-in.-dia. pad at 6000 opm (orbits per minute). Its other features include ball-bearing construction, a 10-ft.-long power cord, and a handle that mounts on the left or right side. It uses adhesive-backed abrasive discs and costs about \$205 at industrial suppliers. Contact Porter Cable Corp., Youngs Crossing at Highway 45, P.O. Box 2468, Jackson, TN 38302-2468.



# Lock Up Electronically



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## Shorty

Stanley says its new saw, designed to fit in a compact toolbox, cuts wood 30 percent faster than conventional handsaws, thanks to teeth with cutting faces on the front, back and top. The saw cuts on the push and pull strokes. Its 9-point, 15-in.-long blade is secured to a hardwood handle. And, the handle has 45° and 90° angled edges to act as marking guides. Cost is about \$15 at hardware stores and home centers. For more information, write to Stanley Works, New Britain, CT 06050.



## Ornamental Iron

Hobbyists can make wrought-iron projects with this kit. It enables you to work 1/2-in.-wide x 3/32-in.-thick mild steel strips without heating or welding. In it is a punch/shear (lower left), a rivet/bend/roll tool (upper right), a scroll former (right of center), steel strips, project patterns, instructions and related hardware. The kit costs \$165, plus shipping. It's available direct from Wrought Iron Handicrafts, 1620 38th St. N.W., Rochester, MN 55901.



## Benchtop Plate Joiner

Delta's biscuit joiner bolts to a benchtop for maximum stability. Blade movement is foot-pedal controlled. Powered by a 10-amp motor, its 6-tooth carbide-tip blade cuts up to 1/2 in. deep and three depth stops match standard biscuit sizes. Stock rests on an 8-in. x 12-

in. cast-aluminum table—that has 5 in. of vertical adjustment—or on the tilting sheet-metal table. It comes with a miter gauge and costs about \$645 at hardware stores. Write Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15238.



## Curve Bore

You can bore curved and straight-line holes in wood to snake wiring with this new drill bit. According to the manufacturer, its cutter head allows it to curve up to 45° from a straight line. The 6-in.-long bit has a hex shank to prevent chuck slippage. And, it's sold in 7/8-in.-dia. and 1 1/8-in.-dia. sizes, for about \$8 and \$9, at hardware stores and home centers. For more information, write to Vermont American Tool Co., P.O. Box 340, Lincolnton, NC 28093-0340.

## Safety Hammer Drill

This 3/4-in. rotary hammer drill stops if its bit jams. Top speed is 1400 rpm, and it delivers up to 6200 blows per minute. The hammer function can be disengaged for use as a regular drill. It weighs 5.5 pounds and is powered by a 5-amp, variable speed, reversing motor. It comes with a steel case, side handle, depth gauge, dust shield and costs \$300 at industrial suppliers. Write AEG Power Tool Corp., P.O. Box 6003, New London, CT 06320. **PM**





SPECIAL SECTION

# BOATING'90



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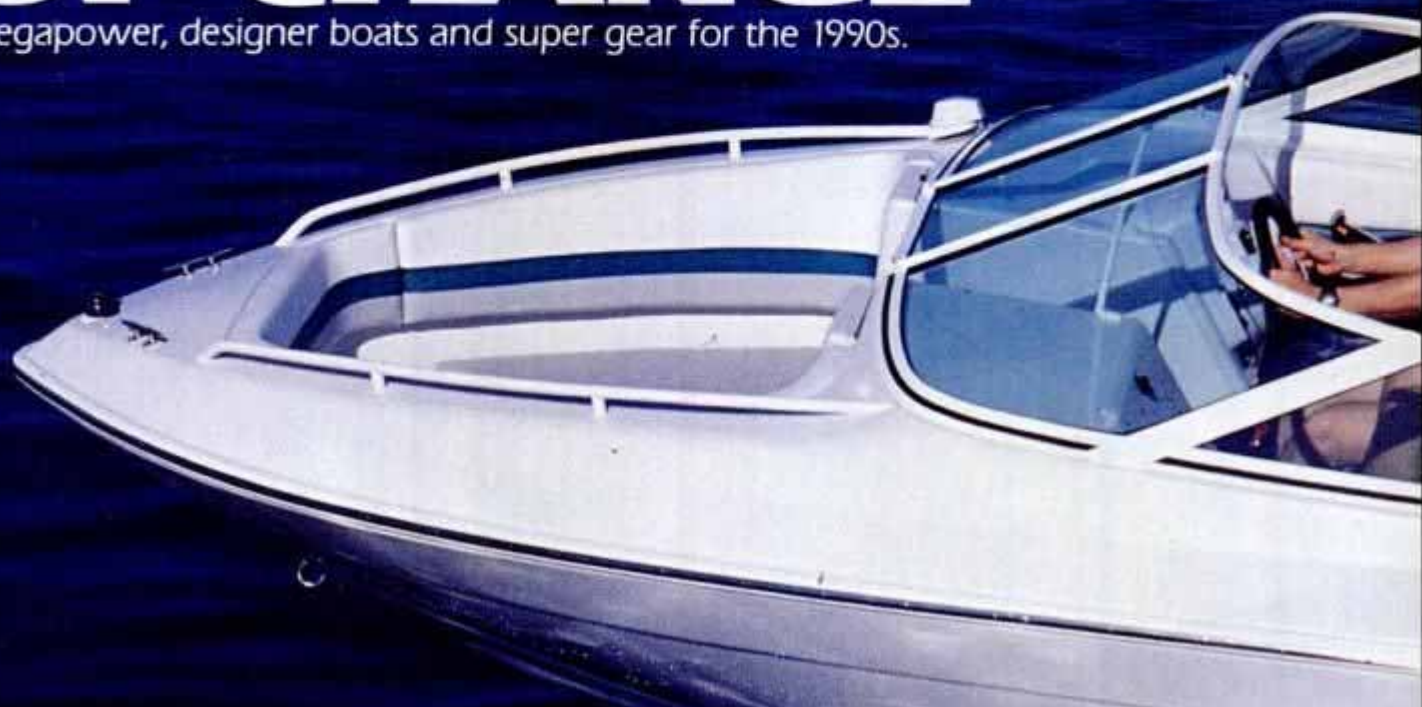
PM PHOTO BY SKIP GANDY



BOATING'90

# A NEW DECADE OF CHANGE

Megapower, designer boats and super gear for the 1990s.



BY JOE SKORUPA, Boating/Outdoors Editor

**B**OAT DESIGNERS ARE taking a cue from the newly regenerated Rolling Stones: *If you start me up, I'll never stop.*\* Like the celebrated rock-and-roll group, designers have recently broken free of restraints. High-concept boats this year are everywhere, from new-wave speedsters with twin canopies and molded arches to radical fishing machines with 360° casting decks and sunken seating pods.

The new Chris-Craft 177 bowrider, shown on this page, is a good example of breakthrough design. Its eye-catching exterior, which includes white-anodized windscreen supports and bowrails, is only the beginning. Equally innovative is the self-contained bow seating pod and engine compartment that sets a new standard for insulation, noise damping and ventilation.

Putting an unmistakable stamp on the Condurre line from Cobalt is designer Peter Granata. A reverse transom with rare molded character lines and indents highlights the new Condurre 223. And the helm station, with its leather padding and well-conceived instrument display, would look at home in a Mercedes.

But the name most synonymous with high-concept boats is West Coast designer Art Carlson. His new 33-footer from Glastron, with its softened contours, low stern wing and high-tech interior, vividly demonstrates Carlson's highly individualistic approach to boating. Glastron makes it a true designer boat by labeling the

model the 33 Carlson Signature Series (CSS).

Engines this year also exhibit imaginative design. No-knock electronic management was the first priority for OMC's new King Cobra 454, but engineers also added a helm/engine wiring harness, diagnostic plug-in receptacle and shift center for adjusting counterrotation.

The big engine news, however, is big engines. In outboards, the hot action is in 200-hp-plus motors and in sterndrives a bigger big block—Chevy's 502—debuts.

Some boaters, noting the flood of recent high-tech advancements—from super sonar to handheld electronics—and high-concept designs, might be tempted to say the times are a changin'. But this is a sentiment from another era. The new decade has begun with a more adventurous, more Rolling Stones kind of spirit. One that pursues what it wants and swiftly embraces changes, that in many areas, are already here. **PM**





Concept by Chris-Craft (above) emphasizes purity of shape in the graphics-free 177 model. The Glastron 33 Carlson Signature Series (top right and far right) bears the designer's highly individual stamp and name. Engineers considered the OMC King Cobra 454 (right) to be a blank sheet of paper when they developed a big-block engine for the '90s. Numerous user-friendly improvements were added. Note auto influence on Cobalt Condure 223's well-conceived helm (far right).





# LOOKS ARE EVERYTHING

High-concept boats, for every budget and special interest, challenge old conventions and create functional, new designs.

BY JIM YOUNGS

**N**EW decade, new image. So, what about the '90s? It's difficult to put a label on something yet to come, but a glimpse of this year's new boats reveals builders aren't easing into things. They're boldly reaching for new benchmarks in design, performance and versatility—really *stylin'*, as bad dudes say.

High-tech composites and resin-injection molding are swiftly moving into boat construction, and other breakthrough techniques are poised to follow. But, if we had to pick one trend that stands out among the rest, high-concept styling would top the list.

## Boat stylin'

Taking plenty of cues from auto stylists, there seem to be more designer boats introduced for 1990 than at any time in recent memory. And the new-wave designs aren't limited to trendy, upscale sportboats. Concept by Chris-Craft, for instance, concentrates on a new line of flashy entry-level family runabouts, and Glaston's Carlson Signature Series, designed by Art Carlson, begins with an affordable 19-footer.

Even traditional fishing boats aren't immune to radical design, and since this is historically a slow-to-change segment of the market, let's look at it first.

Striper fishermen, who battle behemoths up to 60 pounds, can get real busy at times. They require a sport-specific layout, which is what they get with Crestliner's new V200 Striper.

To maximize cockpit room, the 20-ft. 4-in.-long, 8-ft.-wide boat is equipped with an outboard bracket that moves the twin engines away from valuable interior space. To

maximize fighting room, the deck is configured with a center console and leaning post. There's also a raised bow platform with casting chair.

To make it a freshwater/

saltwater machine (stripers are found in both), the boat has a welded-aluminum, deep-V hull. Other features include filtration system for baitwells, cockpit wash-



**BAYLINER  
2070 CAPRI**





**WELLCRAFT  
20 EXCALIBUR**

down, bimini top, foul-weather curtain and spray dodger. Price is \$15,523.

Skeeter took a giant leap of faith when it chose to pursue the walleye fishing scene. Skeeter's background is in bass boats, but some carry-over can be applied to the deeper-V, higher freeboard walleye rigs. A forward casting platform is a case in point. Other features on the 17-ft. 2-in. fiberglass System Walleye 135 include a side console, livewell, baitwell, lots of stowage and the ability to



**CRESTLINER  
V200 STRIPER**

handle both a kicker engine and electric trolling motor on the transom, plus an electric positioning motor on the bow. Retail price is \$6589.

Two boats that take oppo-

site approaches to offshore angling this year are from Donzi and Sea Ray. The clean and simple Donzi F-18 center console is equipped with a 115-hp outboard. It

sports a very affordable \$14,995 price tag and comes with fold-down splash board, Igloo cooler seat, bait cutting board, insulated fish box, forward casting platform,



# BOATING'90

rod racks under coamings, and a big console that provides plenty of stowage and room for installing the latest electronic gear.

The second noteworthy offshore boat is a fully loaded Laguna 23 cuddy from Sea Ray. This 24-ft.-long, 8-ft. 6-in.-wide boat is loaded with all the fishing goodies: two removable fish boxes, large baitwell, rod holders, cutting board, tackle storage, wash-down and transom doors. Belowdecks, there's rod storage, a comfy V-berth and space for a portable head. Laguna has a handsome profile and the look of a serious angling machine. Equipped with twin 115-hp outboards, the boat is \$28,000. Buyers better be serious.

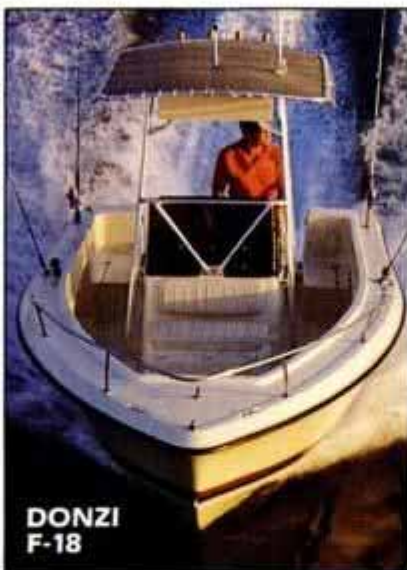
## Eye on design

Long recognized as the quality leader in upscale family boats, Cobalt adds to its Condurre series with a sleek new cuddy, the 223. Typically deluxe Cobalt touches on the 22-ft. 3-in.-long, 8-ft. 5-in.-wide boat include aluminum dash fascia, VDO instruments, Nautolex vinyl upholstery and, perhaps, the best fit and finish in the business. The base engine is a 5.7-liter MerCruiser, and suggested retail is \$32,000.

Wellcraft maintains its lead among high-performance boats with the introduction of its stunning 20 Excalibur. Reminiscent of the musclecars of the 1960s, this boat exudes speed even when tied to the dock. Its stiletto lines feature twin-cowl windscreens that sweep back to a pair of bucket seats in a sculpted cockpit with deeply cut jump seats around an upholstered engine box.

The Excalibur's novel command center is tucked under a fighterplane-style canopy. Stylish recessed vents and an integrated swim platform round out the exterior lines. This racy Wellcraft is about \$25,000, depending on engine.

The new Larson Senza 210LX features an equally unusual design. A set of molded steps pulls out from



**DONZI  
F-18**



**COBALT  
CONDURRE 223**



**LARSON SENZA 210LX**



**SEA RAY  
LAGUNA 23**



**SKEETER  
SYSTEM  
WALLEYE  
135**

the dash to provide access to a self-contained open bow, but unlike most bowriders, this one has a small cuddy belowdecks. The instrument panel is a handsome integrated arrangement, and the hull is a well-behaved Delta Conic design. The Senza measures 20 ft. 10 in. overall with an 8-ft. beam. Equipped with a 5.0-liter MerCruiser, the

Senza 210LX is \$24,525.

Rounding out our high-concept boat showcase is the Bayliner 2070 Capri, an entry-level craft powered by US Marine's innovative L-Drive. Thanks to the space-saving L-Drive, which is basically a 2-cycle outboard mated to a sterndrive-like unit, the Capri (\$10,495) gains additional room where

it counts—in the cockpit. There is a full bench seat across the stern and plenty of legroom overall.

The slippery-looking 2070—all rounded contours and fluid lines—represents a complete redesign of Bayliner's extensive Capri line. But this is the year of redesign. Who said looks aren't everything? **PM**





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# YEAR OF THE MEGAMOTOR

Outboard and sterndrive engines follow the big-bang theory for 1990—bigger cubes, bigger horsepower, bigger punch.

BY TIM BANSE

**I**F YOU AGREE with the philosophy that no amount of horsepower is too excessive, then the latest round in the marine power wars will likely get your motor running.

The 200-hp-plus outboard category, once relatively peaceful, has become a hotly contested battlefield. Suzuki, Yamaha and Mercury join a megapower skirmish that was formerly dominated by OMC.

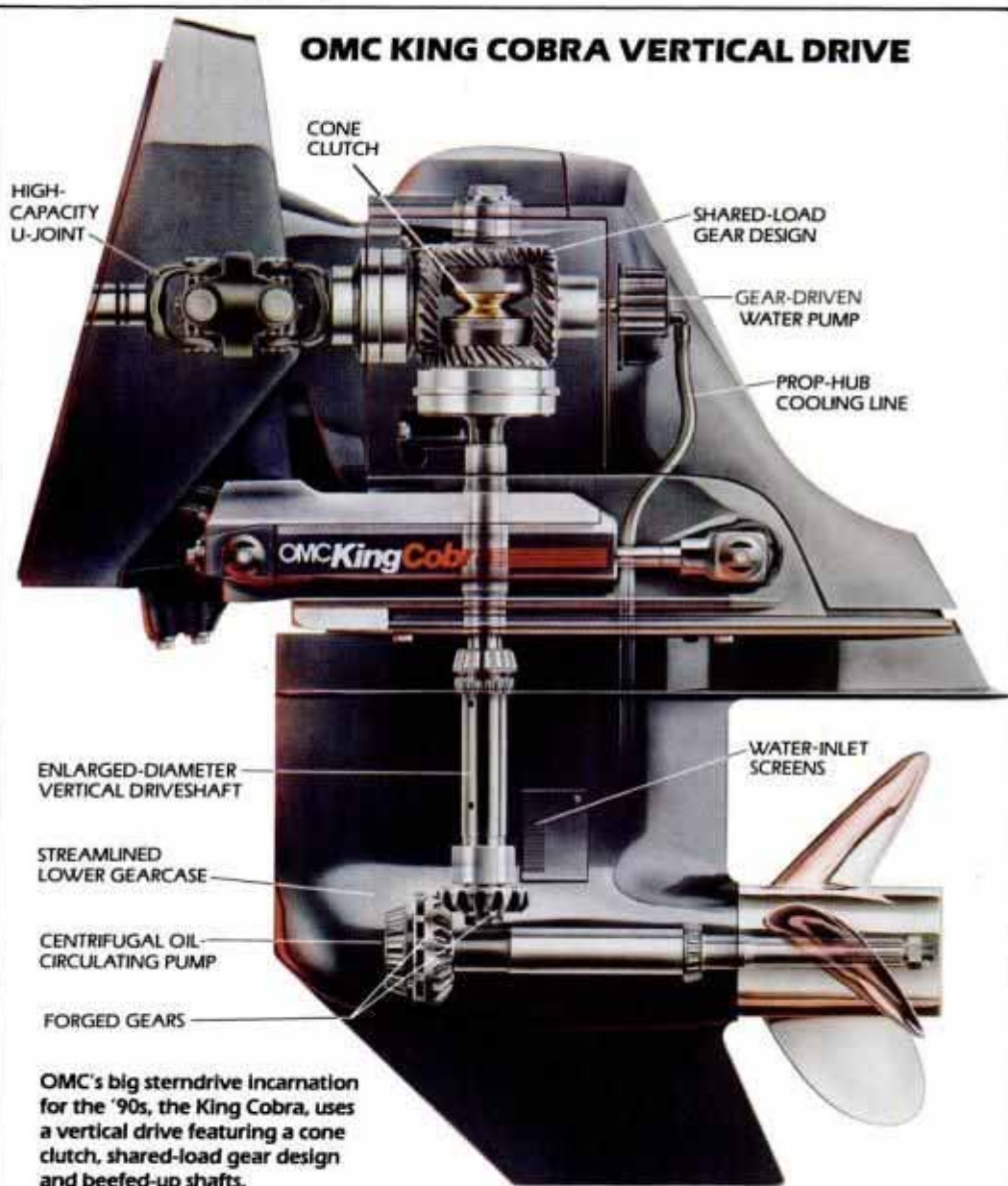
Sterndrives have also increased their firepower this year. OMC Cobra and Volvo Penta introduced new 454-cu.-in. V8s and toughened up lower-unit shafts, bearings and gearsets to withstand the punishment of increased big-block torque.

But the mightiest V-block marinizations this year belong to Crusader and Mercruiser. Both builders are taking advantage of the introduction of a new Chevy block that displaces a whopping 502 cu. in. (see a description in "Big-Block's Big Brother: The Chevy 502" on page 103).

## Big outboards

Back in 1962, when Mercury shattered the 100-horsepower barrier, there was some feeling that power was becoming too excessive. In truth, it was just the start of the megapower trend, and outboards have become steadily more muscular.

Interestingly, this year's news about big motors isn't confined to raw power. Equally important is the fact that the new powerplants are extremely sophisticated creatures. Suzuki's new V6



OMC's big sterndrive incarnation for the '90s, the King Cobra, uses a vertical drive featuring a cone clutch, shared-load gear design and beefed-up shafts.

225 EFI, with a microcomputer management system, is a classic example.

The spec sheet tells us that this motor has electronic fuel injection and cranks out an impressive 225 hp. But the real story is in the engine's exotic composite pistons and cylinder walls.

The 225 EFI is fitted with ceramic and aluminum pistons that retain heat more efficiently than conventional pistons. The more heat available to expand against the piston dome in the combustion chamber and accelerate it down the cylinder bore, the more power generated at the

crankshaft. To counteract potential damage resulting from improved heat retention, the cylinder walls are impregnated with boron to toughen up the bore.

Yamaha also takes the megamotor concept a few notches further with the introduction of its new 250-hp





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And only Merc makes outboards with XK360, the most corrosion-resistant aluminum

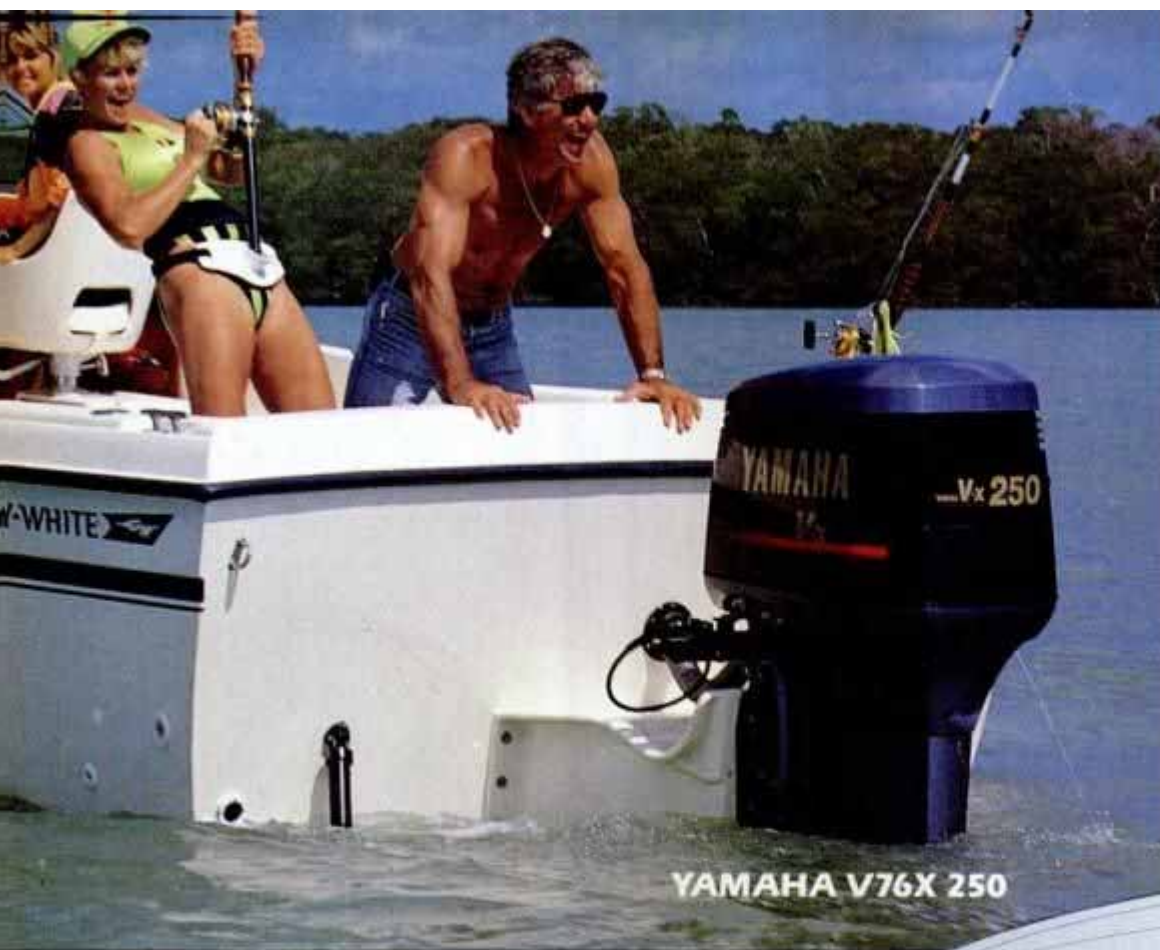
available. That's why Merc offers the only 3-year limited warranty against corrosion failure in fresh or salt water.

From easy starting to safe returns, nobody engineers more fun into your time on the water than Mercury.

So before you take off, see your Mercury dealer. And make sure you're running with black in back.

**MERCURY  
OUTBOARDS**

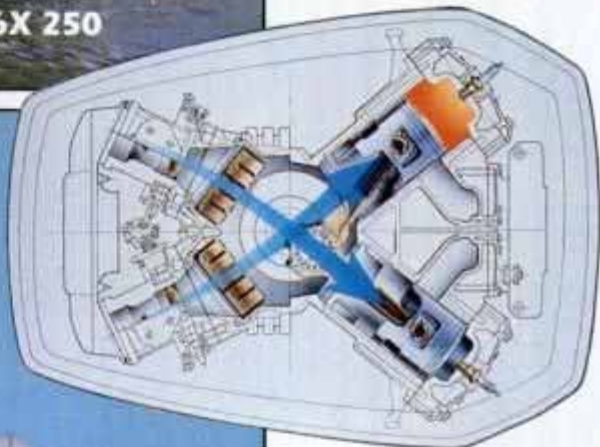




YAMAHA V76X 250



The 250-horse Yamaha V76X (left) features an offset crank (above) to adjust to 76° V and a cross-induction system (below) with six carburetors.



### VOLVO PENTA 740/DP

Volvo Penta enters the big leagues with its first 454-cu.-in. sterndrive. Years of development went into mating engine with unique Duoprop system, which spins counterrotating stainless-steel props for the first time. Note huge muffler that enables quiet and efficient venting through transom.

V76X and, like the top-of-the-line Suzuki, head-snapping power is only the beginning of its allure.

The V in the V76X, for example, measures a slim 76°, enabling it to cut a narrower, more aerodynamically efficient profile than conventional 90° Vs. And the X stands

for a 6-carb cross-induction system that doesn't quite qualify as fuel injection in the purest sense, but is barely a rung down the ladder.

As applied to the V76X, the term cross induction refers to the fuel/air pathway that actually describes a straight line from carb

throat, to intake runner, to combustion chamber. It qualifies as cross induction by virtue of the fact that the left bank of runners crosses over the right bank of runners in an X pattern. But semantics aside, the benefits are chokeless starting and crisp throttle response.

### High-tech block

Ever since Mercury cracked the 100-hp mark, the Black Max family of motors has grown like it's been force-fed anabolic steroids. If OMC's big 300-hp V8, introduced several years ago, is the Andre The Giant of outboards, then Merc's new 3.4-liter 275-horse is the Hulk Hogan.

Although the big V6 is equipped with variable-ratio oil injection and an overrev limiter, given today's level of refinement, Merc's approach is more basic than super-sophisticated.

The heart of the new unit is the block proper, which is cast by Cosworth Ltd., of Formula One racing fame. Merc went to Great Britain-based Cosworth with a very complex aluminum cylinder-block design and asked the company to build a precision-

(Please turn to page 104)



## Big-Block's Big Brother: The Chevy 502

**B**IG-BLOCK ENGINES just got bigger. Chevrolet raises the stakes in the latest round of the horsepower wars with its new 502-cu.-in. gas engine, designed specifically for the marine market.

Since the early 1970s, Chevy's ubiquitous 454 big-block has been the engine of choice for the muscle-boat and miniyacht crowd. In fact, according to GM executives, Chevy blocks, both big and small, currently control about 80 percent of all sterndrive and inboard V-block installations.

But this is the era of the megamotor and boaters are demanding more bang for the buck. Chevy's response? To develop a bigger, stronger, torquier brother to the 454. Introduced at Watkins Glen race track, in western New York, the 502 is based on the heavy-duty Bow Tie block. To increase displacement, the

thick-walled castings have been given a Siamese bore (from 4.25 in. to 4.47 in.), and the result is a fundamentally new piece of iron featuring new tooling and forged parts.

Most internal parts are taken from Chevy's high-performance catalog. These include



forged-aluminum pistons, forged-steel crankshaft, Mark IV high-performance cylinder head, 4-barrel carburetor (which accommodates either a Holley or Quadrajet) and heavy-duty drivetrain.

Chevy rates the engine at 390 horsepower and describes the torque curve as "fat," which means at least 432 lb.-ft. of its maximum 480 lb.-ft. is available over a 3000-rpm-wide band.

The first company to marinize the 502 was Crusader, of Sterling Heights, Michigan. The Crusader 502, which is

The new Godzilla of sterndrives: Merc's 502 Magnum rates 410 horsepower at propshaft.



configured as an inboard, turns out 355 hp at 4600 rpm. Compared to similar powered diesels, size is compact and weight is a trim 1155 pounds.

Mercury Marine was second to develop the Chevy 502 unit for the express cruiser and miniyacht set, the 8.2L Blue Water Inboard. But more interestingly, Merc was first with a sterndrive version of the new block, the 502 Magnum. Mated to a Bravo One outdrive, Merc's huge sterndrive will carry a brawny 410-horsepower rating.

OMC is also working on its version of a 502 sterndrive, which is scheduled to debut later this year. The vertical drive component of the 502 sterndrive is already in place, introduced recently on the beefy King Cobra line.

Look for muscle boats to pack more punch as the 502 becomes the big-block of choice for the 1990s.

—Joe Skorupa



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# BOATING'90



**SUZUKI  
225 EFI**

made, lightweight, thin-wall casting with low porosity. The latter enables Merc to chrome plate the piston bores and results in a Black Max that pumps aluminum—it's tough and durable.

Mariner's top gun, a 250-

horse outboard, is practically a carbon copy of the Merc 275. It has the same block and cubes, but the difference in output is in carburetion and exhaust tuning.

## Beefy sterndrives

OMC has had 7.4-liter units in its sterndrive catalog for years, but the builder decided now was the time to redesign. The result is the walloping King Cobra, OMC's big-block incarnation for the 1990s, which is poised to link up with Chevy's new 502-cu.-in. powerplant.

In order to withstand the crunching torque of the 502, the vertical drive on the King Cobra has been reconfigured with beefed-up shafts and bearings, forged gears, cone clutch, gear-driven water pump and centrifugal oil-circulating pump.

Volvo Penta didn't debut its first gas Duoprop (a patented technology that refers to two props mounted on



**MARINER 250**

counterrotating shafts on a single axis) until 1986 and then only with a 5.7-liter small block. It required a few more years of R&D to adapt Duoprop tech to big-block power. But the 454-cu.-in. 740/DP has finally arrived and Volvo Penta is now a full-line sterndrive player.

To some, this round of

power wars signals a return to the philosophy that bigger is better. But many of the power increases are the result of sophisticated technology—aluminum blocks, high-tech composites, electronic management—rather than increased cubes. Today's engines are both bigger and better.

**PM**

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# GREAT GEAR

Remote-controlled underwater cameras, radical props, handheld electronics and the latest toys of summer make 1990 a great year for gear.

BY JOHN WOOLDRIDGE

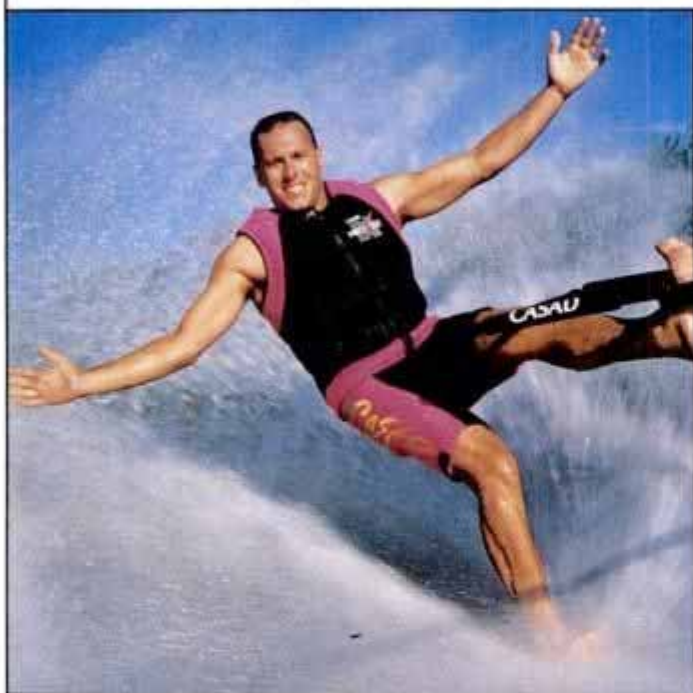
**G**ET IN GEAR for the 1990s with electronics that put power in the palm of your hand or give you hands-off capability. Get wet or keep dry. Go underwater or stay afloat. Here's a look at high-tech equipment on the leading edge.

Wrap your hand around the brainy KVH Datascope, if you want quick location fixes for safe coastal piloting. If you don't want to use your hands, Freedom Troll controls gas motors by foot.

Bombardier makes a splash with a new 3-person Sea-Doo. Pioneer, on the other hand, keeps tunes dry with its first marine audio line.

The next best thing to being a submarine commander is controlling your own subsea robot equipped with a video camera. The remote-controlled Merlin system is ideal for both boat inspection and treasure hunting.

And boating basics aren't neglected either. Five-blade, stainless-steel props by Mercury Marine debut, and tide charts can now be programmed onto your wrist, thanks to Tide Watch. Gearing up never had it so good. **PM**



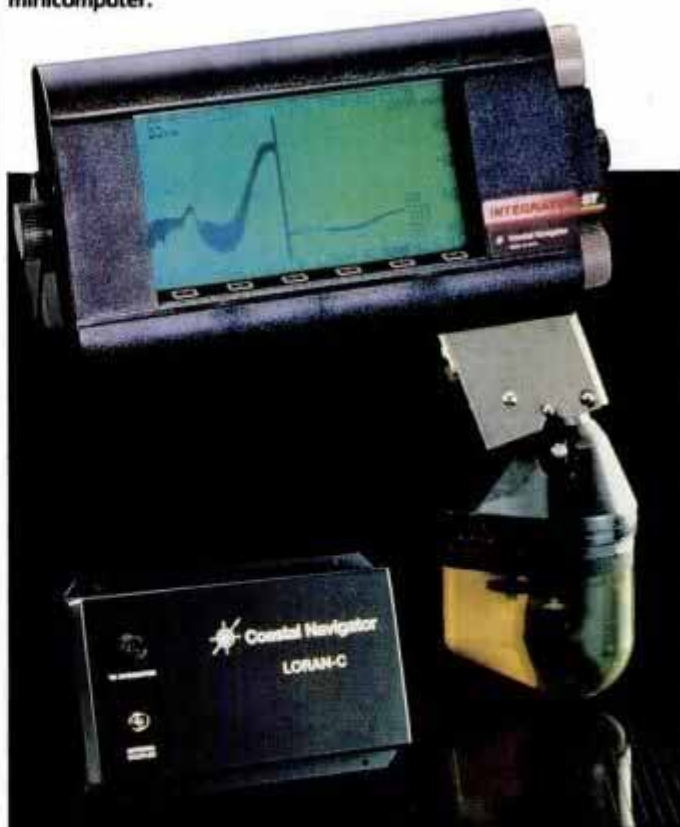
### Afloat In The Wild Vest

Buoyant Ensolite makes Casad's Neovest the first U.S. Coast Guard-approved Type III vest in a wet-suit cut. Made of neoprene, the vest comes in colors and styling hot enough for any waterskier or personal watercraft user. Suggested retail is \$156.



### It's Got Brains, Plus Good Looks

Columbus should have had it this good. Determine course, compute distance and pinpoint position with the KVH Datascope, a 12-ounce 5x30 navigational monocular, electronic rangefinder and fluxgate compass all in one. Price is \$445 for the waterproof minicomputer.



### Fish Can Run, But Can't Hide

When fish can't be found under your boat, Coastal Navigator's Scanning Sonar searches them out. Rotating transponder sweeps 360° and elevation angles to 80°. Price is \$995 for use with Integrator fishfinders. Unit has plug-in capability with Loran-C.





### Water Temp

Tired of taking water temperature with your finger? Eagle's new EDT-30 (\$119 with digital readout and trans-mounted probe) will measure and display temperature changes important for fishing.



### Dry Place For Water Music

Keeping your tunes dry is what Pioneer's Nautica line is all about. The Nautica line includes waterproof bubble cover (about \$50) and choice of Maxxial speaker systems (\$150 to \$200). Moisture-protected circuitry and corrosive-free construction are used.



### HighFive Prop

For head-snapping acceleration, Mercury Marine introduces the HighFive 5-blade, stainless-steel prop. Props (\$495) match Mercury and Mariner outboards and MerCruiser Alpha One stern drives.

### Remote Sub

Make a titanic discovery with Merlin ROV (Remotely Operated Vehicle), which houses a JVC color video camera. It's equipped with power, lighting, buoyancy and maneuvering systems. High tech and high price—\$9900. Made by Platinum Products.

### Three-Doo

Personal watercraft get bigger this year. Bombardier's 3-person craft, the Sea-Doo GT (\$5299), runs 34 mph carrying three adults. Power is supplied by 580-cc Rotax engine.

### Tidal Action

Read time and tide on your wrist with the Tide Watch, which can store up to three years of tide height and direction for any location. Watch (\$69.95) is water resistant to 100 ft. and includes a digital display, alarm, countdown timer and day/date display.







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Second, you don't have to worry about moisture or splashing water

either because even with direct contact, Nautica's specially designed marine cover keeps your cassette deck dry. And with our quick-release AM/FM cassette deck, you can ferry your stereo from your car to your boat, and back again.

But the most amazing thing of all is that now you can have Pioneer sound on the high seas. Which may be distracting when the big one's about to be reeled in. But what do you really want to do—catch a fish or catch a tune?

For more information about the new line of Nautica Pioneer Marine Products, call 1-800-421-1404.

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## Point And Compute

When position is everything, nothing beats a digital compass with bearing memory. With Autohelm's Personal Compass point (\$169), press the button and a digital readout displays heading and bearing.

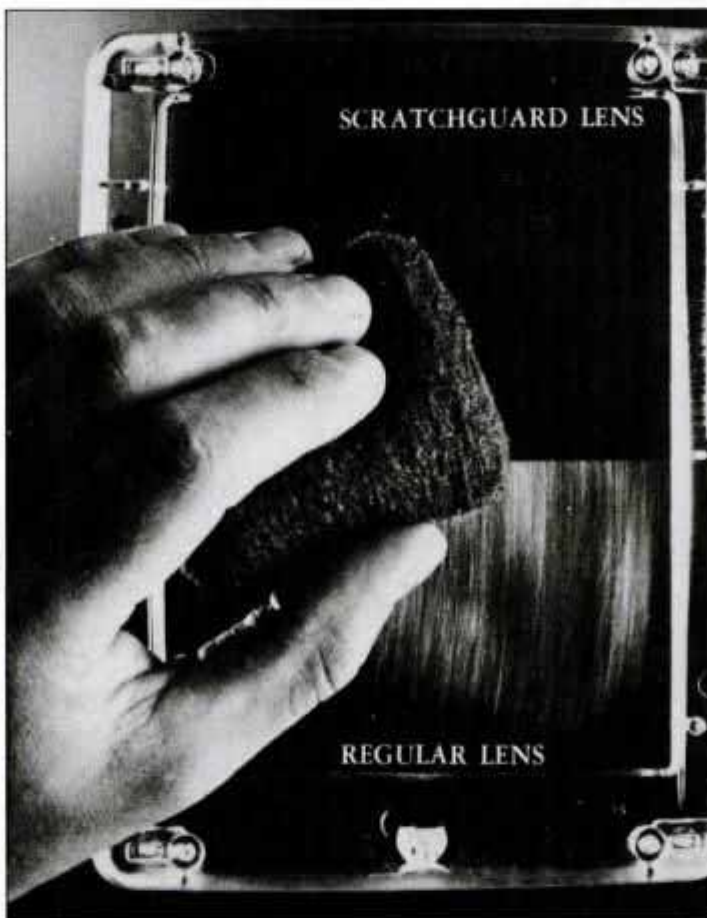


## Spare Prop

When your original prop is badly damaged, Prop Mate, by Hettinga, is an inexpensive backup. The lightweight, polypropylene prop fits motors from 20 hp to 300 hp. Prices range from \$30 to \$35, depending on size.

## Technicolor Sounder

Sonar imaging takes a step forward with the TCR Color-1 (\$499), from Humminbird, of Eufaula, Alabama, which represents signal strengths in eight different colors. The unit is loaded with electronic features and is only 2 1/4 in. thick.



## Touchy Electronics

New depth/fish sonar and Ioran unit, by Impulse Technology, of Pittsburg, California, is controlled by touchscreen technology. The Impulse System 4000 (\$2399), an expandable core unit, has a screen that's essentially a control panel using infrared beams to activate a multitude of functions.



## Antitheft Lock

Sleep easier with Monarch's Stern Guard lock protecting your MerCruiser sterndrive engine. The locking system, made by Monarch Moor Whips, of Normandy Beach, New Jersey (\$59.95 to \$69.95), is made of heavy-duty stainless-steel and locks onto drive-unit mounting stud.



## Tough Lens

An idea whose time has come is the tough new lens by Humminbird. While not a separate product—it's standard on TCR depth sounders—the Scratchguard Lens is so tough that steel wool won't scratch it.

## Engine Blood Test

Diagnose your engine's hidden problems using spectrometer analysis. Draw oil from engine using the Marine Engine Blood Test Kit, send it to a lab and receive a detailed computer analysis of its condition. Price is \$21.95.



# BOATING'90

## GREAT GEAR



### Line Snubbers

Increase line life with Line-Master Integrated snubbers. Guards boat lines against stress caused by water motion. Line-Masters mooring Compensators, by Falcon-Forshead, start at \$25 and have nylon injection-molded locking elements vulcanized onto rubber bodies.

### Handheld Loran

Store up to 100 waypoints in the world's first handheld loran, the Voyager SportNav, by Micrologic, of Chatsworth, California. In addition to position finding, this navigation computer (\$595) displays speed, direction and distance from destination.

### Dry Gear For Wet World

Center-console boats, dive boats and trailerable fishing boats of all kinds get wet and rarely contain true waterproof storage. A new series of marine bags by Bagton contain waterproof pouches that keep clothing, documents and gear dry in all conditions. Bags are made of nylon-reinforced PVC with high-frequency welded seams and double Velcro fasteners. Various sizes run from \$66 to \$200.



### The new ESCORT: Incredible performance

At Cincinnati Microwave, we've continuously advanced the science of radar warning since we introduced the original ESCORT in 1978.

But we've never stopped striving for another quantum leap. And now we've found it: DSP.

#### Incredible technology

DSP is Digital Signal Processing, a technology virtually unheard of in

*The heart of ESCORT's DSP circuitry is this custom 20 MHz 24 bit parallel HCMOS processor, capable of 10.25 million instructions per second.*



## Introducing new ESCORT

personal electronics, but used in many sophisticated electronic devices.

DSP is used by NASA to create detailed space photos from blurry images. It's used by military radar for target recognition. It's used to deliver sharp images from medical scanners. And now we're using DSP to find radar signals too weak to be detected by conventional technology.

#### How it works

The new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This data is then digitized and continuously analyzed by an internal computer. The end result is incredible.

#### Breakthrough performance

New ESCORT provides an incredible increase in sensitivity on both bands. Quite simply, this

means that the new ESCORT picks up radar signals much further away than ever before possible. All this in an incredibly compact package, only 3/8" high and 3 3/4" wide. The science of radar warning will never be the same.

### Bad news for thieves:

A new security system in new ESCORT and SOLO makes them of little use to anyone but the rightful owner. Here's how it works: Included with your new radar detector is a tiny electronic "Digital Key". About every two months, your radar detector's



*Actual size courtesy of Digital Key*

### ESCORT \$295

Ohio residents add \$17.70 sales tax

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**ESCORT**  
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### The right stuff

New ESCORT and SOLO have all of the advanced features we pioneered with ESCORT and PASSPORT. Variable rate audio, with different tones for X and K bands. Alert lamp, ten-segment meter, Dark mode, and a Mute switch with a new Auto-Mute function. A battery-saver even turns SOLO off if you forget to.

### Everything included

Both new ESCORT and SOLO come complete with leather case, visor clip, windshield mount, and comprehensive owner's manual. ESCORT includes power cords (straight, coiled, and direct wire), while SOLO includes both lithium and alkaline 9 volt batteries and a travel case.



## Hands-Off Steering

Gas outboards up to 15 horsepower can now be fitted with foot-controlled steering. Freedom Troll Too (about \$299), by McDougald Enterprises, of Corvallis, Oregon, gives fishermen hands-off steering for existing gas engines. Recommended for boats that are 16 ft. and under.



## Fuel-Flow Gauge

Extend your range, run longer or diagnose an ailing engine with CruiseMaster, by FloScan, of Seattle, Washington. The CruiseMaster tells you how much fuel you're using and how fast you're using it. It costs \$425 for a single gas installation unit.



## Kart Ahoy

You can take it with you with Kart Ahoy, a polypropylene basket and aluminum tote cart. With a capacity of 2 cu. ft. of cargo and 100 pounds, Kart Ahoy (\$50) is the ideal aid for loading the boat and provides ideal ship-to-shore transportation. It features a stable 4-point stance. The basket folds flat for stowage and has an interlocking design for more capacity. The company is based in Clawson, Michigan.



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If you're a business traveler, switching between cars and using rentals in distant cities, you need

circuity will prompt you to insert your Digital Key into a small jack on your detector, and turn your detector on. Your detector will reset its lock and will be ready for two more months of use. That's all there is to it.

However, for someone who doesn't have the right key (and there are thousands of different Digital Keys), the radar detector simply won't work. And there's no reason for a thief to steal a detector if he can't sell it. And if a stolen ESCORT or SOLO is ever returned to us for service, we'll immediately contact you (if you have reported the theft to us).

Our new Digital Key security system will help keep your new ESCORT or SOLO yours.



the most convenient radar detector possible. But radar detectors have always been less than ideal for traveling. Until now.

### Revolutionary convenience

After years of development, we're introducing SOLO, the first self-powered superheterodyne radar detector. Just mount it on your visor or windshield

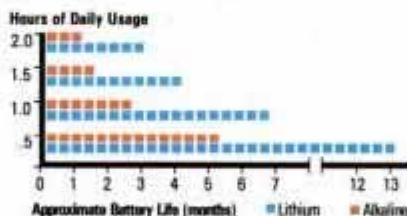
and turn it on. It's that simple.

SOLO doesn't need a power cord, recharger, or add-on battery pack. Its remarkable design uses only 2% of the power of a conventional radar detector. As a result, SOLO operates about 200 hours on a single 9 Volt lithium battery (or 80 hours on a standard alkaline).

### Uncompromised performance

SOLO has the same long-range warning as our test-winning PASSPORT, in an even smaller package (about 3/4"H x 2 1/4"W, weighing only 5 1/2 ounces). And unlike most battery-powered devices, SOLO maintains full performance over its full battery life.

New self-powered SOLO may be the first radar detector that's never too much trouble to use.



### Factory Direct

We only sell direct from our factory to you, and we guarantee your satisfaction. If you're not completely satisfied in 30 days, just return your purchase for a full refund. You can't lose.

The most advanced radar detectors in the world are only a toll-free call away. Call today.

Call Toll Free 1-800-543-1608

(24 hours a day, 7 days a week)



Or mail us your order:  
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**SOLO \$345**

Ohio residents add \$20.70 sales tax  
Prices slightly higher in Canada



## CAR CARE

# Maintenance Minder

A computerized service reminder you can take with you.



Walkman-sized Care Mate installs in your car without wiring (sparkplug shows scale). It provides audible and visible reminders of service operations that should be performed.



**P**ROPER maintenance at the proper intervals is absolutely essential to preserving the function and value of your car or truck. In spite of the lengthening extended service intervals that auto-makers have been specifying in recent model years, there's plenty of good reason to change your oil every 2000 or 3000 miles, as well as keep tabs on your oil and fluids and perform several other simple maintenance checks regularly.

Since self-serve gas stations have become popular, hoods are rarely opened in between oil changes. Even in so-called full-service stations the attendants need prodding before they'll get under the hood. It's altogether too easy for simple things like a loose radiator clamp or low oil level to go entirely unnoticed between services.

The traditional reminder for service intervals had been the sticker on the doorframe, one of the least-noticed main-

tenance communications in the history of the automobile.

A few automobiles—BMW, for example—now include automatic service reminders in their electronic bag of tricks. But if your car doesn't have such a device, it doesn't mean you have to rush out and buy a new BMW. Instead, there's Care Mate, an electronic checklist/reminder, to alert you to check oil, change oil, change sparkplugs, rotate the tires, and so on—a total of 29 routine maintenance operations in all.

Simply program Care Mate with your estimated annual mileage. The bar graph on the panel will count down to the

next recommended service interval. Then Care Mate will start beeping gently but insistently. The display will flash with a graphic reminder of the appropriate type of service needed. Obviously, you probably won't want to pull into the next gas station you see to get this service performed, so pressing the MUTE button will silence the beeping—but the display will continue to flash as a less obtrusive reminder.

Once the service is performed, press the RESET button, and Care Mate will again display its countdown graph, renewing the original program. If you like, you can also re-program the computer for

different service intervals.

Replacing the two AA batteries that power Care Mate can be done without resetting the service interval, as the low-power logic will run for 15 seconds or so without batteries. Battery life should be at least a year, and a battery warning will sound while there's still plenty of time.

Unlike the factory-installed service interval reminder systems, you can take this one with you.

If you sell your vehicle, moving Care Mate is no more complicated than resetting the mileage. Velcro tape is supplied to install the unit in a convenient place inside your vehicle.

It's also much less expensive than the factory built-in units.

The \$49.95 Care Mate can be ordered from Care Mate, Dept. PM, 1 Raynham Rd., Glen Cove, NY 11542, or by calling: (800) 451-2248 and the access code—77822. Please allow \$3 for shipping and handling charges. **PM**



"IT'S  
SLIPPERIER  
THAN  
TEFLON"

# WHY BUY A NEW CAR WHEN YOU DON'T HAVE TO?

## USE **Tufoil**<sup>®</sup> AND YOUR ENGINE WILL LAST... AND LAST...AND LAST!

You've seen the price of new cars...they go up every year! Cars get flimsier ... prices get higher...it never seems to end. There are lots of reasons to keep that nice car of yours on the road as long as possible.

Now it's easy to make your engine run better, last longer. Just add TUF OIL to the crankcase. You don't have to shake the container or add an engine flush. Just pour it in and drive away.

Your throttle will get silky smooth ... acceleration will improve. One customer said his car "takes off like a scared rabbit!"

TUFOIL works wonders for all known engine oils. It's actually slipperier than Teflon<sup>®</sup>. (according to a famous US government laboratory.)

You'll get astonishingly fast starts on cold mornings with both diesels and gas engines. The Canadian government tested TUFOIL at it's cold regions lab. They showed faster cranking and significant fuel savings with TUFOIL.

I keep getting telephone calls from owners of very expensive German diesels wanting to buy stock in our company. They say their diesels are accelerating like nothing they've ever seen before. One said he doesn't have to down shift any more on an annoying hill in his area.

Your car can have more power like that too.

What about additives that claim to be one time treatments that will last the life of an engine? Well, I've been following the scientific literature on lubrication for a very long time. As far as I know, there isn't a shred of scientific evidence for such a claim. So don't believe it!



TRY ONE 8 OZ BOTTLE OF TUFOIL FOR 30 DAYS OR 1000 MILES

If you don't notice quieter-smoother operation, quicker starting, snappy acceleration. Just send us proof of purchase with a note describing the year and make of your car. We'll refund your money immediately.

Send for TUFOIL today and prove to yourself the amazing increase in your car's performance. Fill in the coupon today or call TOLL-FREE any time, 24 hours a day.

**1-800-922-0075.**   
(in New Jersey, call 201-825-8110.)

### Stay in tune with your car!

Engines last longer with TUFOIL. Our 1976- 476 T-Bird is now at 190,000 miles and purring.

A bunch of customers' cars have now passed 250,000 miles.

Several months ago, a nice man I'd never seen before walked into my office, big smile on his face, sat down and said, "Would you believe 340,000 miles on a Tufoil engine?" He went on to rave about how well his engine has been running all these years. I couldn't get a word in edgewise.

It made me very proud. Recently, a truck driver called in with over 1,000,000 miles on a diesel using TUFOIL - Wow!

A customer from Vermont added 10% TUFOIL to his sticky mechanical transmission, called in and said he couldn't believe it... "Shifting is like slicing butter now!", he said.

SAAB owners are writing letters praising TUFOIL in their "NINES" magazine. They report spectacular improvements in their engines and transmissions!

Don't forget! TUFOIL is the result of over 15 years of research and development. The U.S. government has awarded us 6 patents so far...so have Germany, England, France and Canada.

No other lubricant even comes close. One customer put it nicely when he said, "You can hear it...you can feel it!"

PS—Our loyal customers wrote this ad for us. Its full of their comments!

Thanks!

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- TUFOIL Gun-Coat — Super rust inhibited, smooth action
- TUFOIL Compu-Lube — Low viscosity for computer mechanisms
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**FREE** brochures ...  
 30 Questions/Answers about TUFOIL  
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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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**PM HOTLINES**

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**HIGH-TECH DRUGBUSTERS**

(Continued from page 52)

ahead of the turret holds an operations room with radarscope, communications gear, balloon monitoring instruments and a stormscope to help keep the balloon away from lightning. Staying at sea 27 days at a time, the aerostat ships roam choke points between the United States and staging areas in South America, passing off target information to interceptors through a computerized communications system.

The brunt of the interception duty has been borne by 110-ft. cutters of the Island class, a new British-designed vessel that earned high marks from crew members. Built at Louisiana's Bollinger shipyard, the cutters have aluminum superstructures and steel hulls. A pair of 2880-hp Paxman diesels are good for speeds up to 30 knots, and a 9200-gallon fuel supply, along with reverse-osmosis water makers, give 5-day endurance.

Nearer to shore, the helicopters and small high-speed boats of the Customs Service play a more important role. Thirteen 39-ft. catamarans of the Blue Thunder type are in service around southern Florida. Designed by famed race-boat innovator Don Aronow, their specially reinforced twin hulls allow them to handle 4- to 5-ft. chop with greater stability than conventional deep-V types. Twin Mercury Marine racing engines churn out enough power to keep up with the fastest smuggling craft, but are somewhat temperamental for day-in-day-out patrol work (the boat we were aboard blew its transmission, and Customs men spoke of a voracious appetite for expensive parts).

The darling of the Customs Service is the formidable UH-60 Black Hawk helicopter. Its 192-knot top speed and 900-mile range make it a match for most small, fixed-wing craft. And it carries a bust team of up to six men. Capable of flipping a light plane with its downwash, and carrying a million-candlepower night sun and loud hailer, it's an intimidating machine, a fact for which the Customs air officers are grateful. They remember a time when all they had were old Army Cobras carrying a bust crew of one, who had to jump out by himself and convince the smugglers to come along quietly.

The progress since those early days, has obviously been dramatic, but it's interesting to note that not one among the people we met believed that stopping smugglers would solve our drug problem. Those who've tried know better than to think our borders can be sealed. A conviction that was echoed again and again, however, was that until a way is found to defeat the more insidious enemy within, the drug war must continue along our borders.

**PM**



YOU CAN MAKE UP TO

# \$9,800 in 24 Hours!

Dear Friend,

I made \$9,800 in 24 hours. You may do better!

My name is John Wright. Not too long ago I was flat broke. I was \$31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

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 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

## 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.

### 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.

### California Political Week:

... The politics of high finance made easy.

### The Toluca:

You'll love ... *The Royal Road to Riches*. It's filled with valuable information ... only wish I'd known about it years ago!

### 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.

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.

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:

**JOHN WRIGHT**  
Dept. 936  
3340 Ocean Park Blvd.  
Suite 3065  
Santa Monica, CA 90405

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

© 1990 JOHN WRIGHT



# There we go, stretching the rules again.

Okay, maybe you have a right to be upset with us. First, we cheated you out of an easy decision when buying a pickup. It used to be full-size or compact. Simple. Then we had to come along with the Dakota, the first mid-size.

In time, we were forgiven for that moving violation because many of you found the Dakota to be not just a happy medium, but the perfect-size truck.

You'd think we'd leave well enough alone. But, no. Here we are introducing the Dakota Club Cab. Pretty gutsy, huh?

With its new extended cab, not only can this Dakota handle the payload of some full-size pickups, but the gear storage as well.

Sorry to do this to you again. But you know what they say: All's fair in love and Detroit.

*The tough new spirit of Dodge.*



In order to stretch this ad a bit further, we'd like to point out that this Dakota has an available 3.9-liter V-6. And, it's protected by 7/70. See this limited powertrain warranty and its restrictions at your dealer. Buckle up for safety. That's one rule that even we don't mess with.

Dakota 4x2 Club Cab





# RESEALING A LEAKY ENGINE

BY PAUL STENOQUIST; PM Illustrations by Fred Wolff

**D**RIP, DRIP, drip, drip. Day and night, week after week, your car works tirelessly, trying to create a small-scale replica of the La Brea tar pits on your garage floor. Where is the oil coming from?

You've tried tightening engine and transmission oil pan bolts. You've replaced the valve cover gaskets and manifold end seals. You've checked the oil filter's O-ring seal. You've searched for easy-fix solutions, but no luck. The oil, blown by the wind when you drive, drips from just about everywhere in the general vicinity of your engine, as well as coating the

back end of your car—and the front ends of those behind you—with small droplets of oil.

After investing a pocketful of quarters at the local car wash to clean the engine, you're able to localize the leak. The source of all that yuck is a leaking front or rear crankshaft seal.

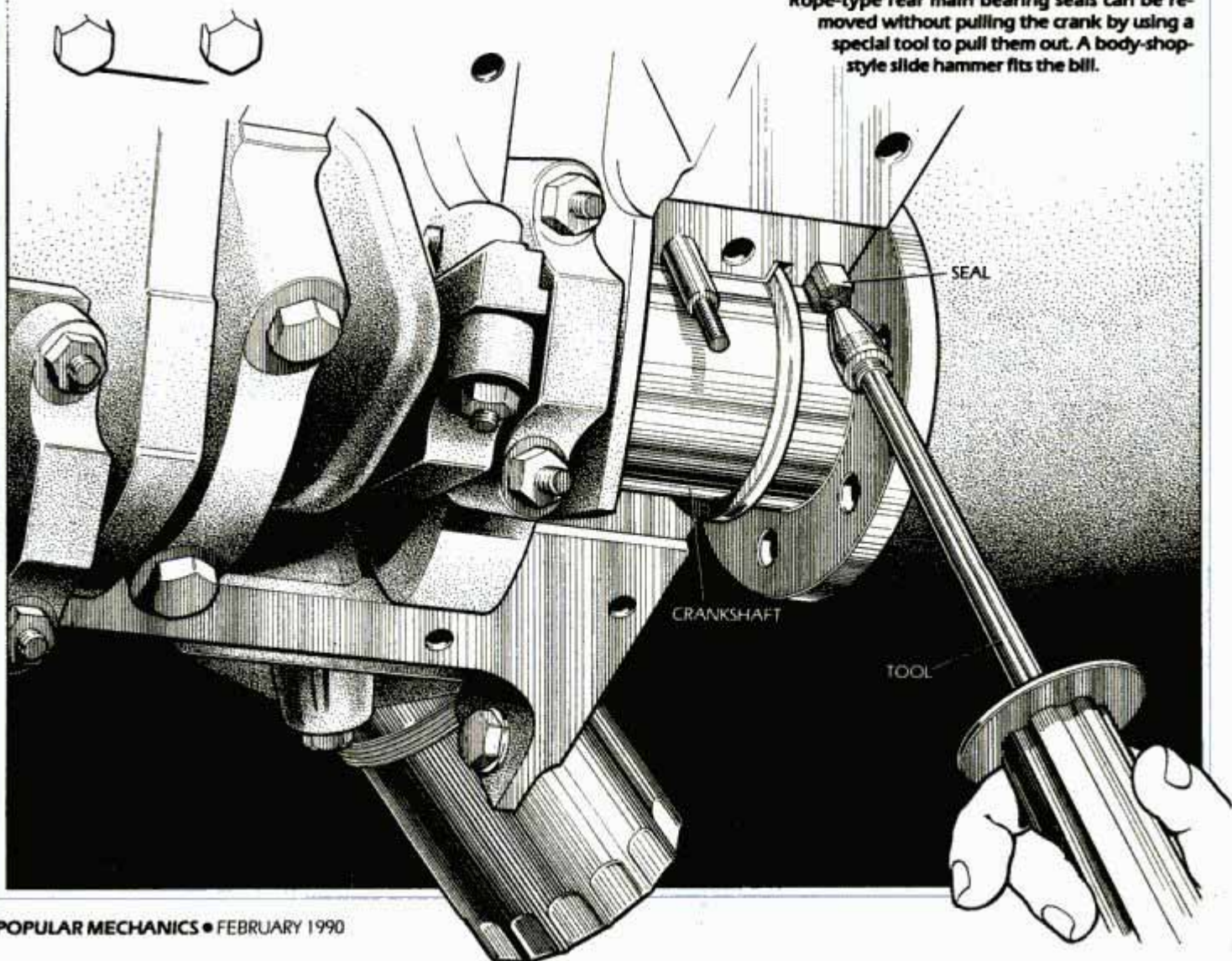
It's time to bite the bullet and dedicate an afternoon or two of messy, but reasonably simple, repair effort to the cause of keeping the oil in the pan. Take heart. While you're under there on your creeper getting oil in your hair, your copy of **POPULAR MECHANICS** will be right beside you, guiding

the way. Replacement of front and rear crankshaft seals does vary somewhat from car to car. So, you may have to consult the manufacturer's factory service manual for specifics.

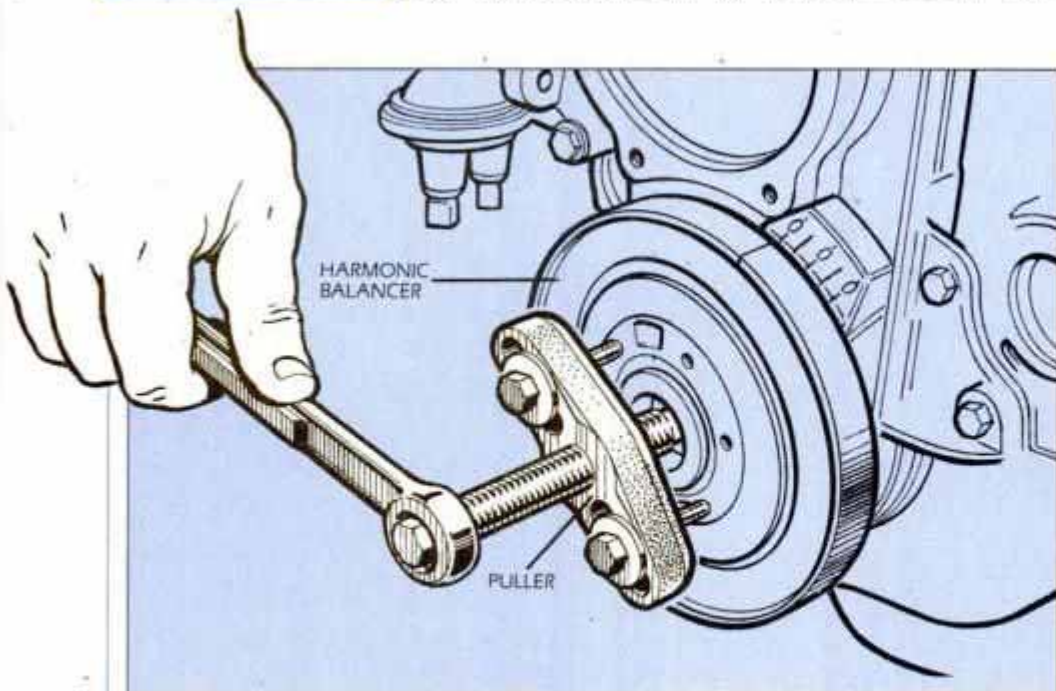
## Crankcase front cover seal removal

The seal on the front of the crankshaft is usually the more reliable of the two crank end seals. But it does fail, and replacement is relatively easy on rear-drive cars. On many front drivers, it requires lifting—or even removal of—the engine and may be a job best left to a pro. The 2.2-liter and 2.5-

Rope-type rear main bearing seals can be removed without pulling the crank by using a special tool to pull them out. A body-shop-style slide hammer fits the bill.







1 A hub puller for removing the crankshaft hub can be rented from auto parts stores.

liter Chrysler engines require special tools for seal removal.

On some rear-drive cars, the radiator is so close to the front pulley and drive belts that you'll want to remove it before attempting to service the crankshaft seal. On others, you can do the job with radiator in place. On most cars, you'll have to remove the fan shroud. On many applications, you'll be able to remove and replace the seal without removing the front crankcase cover, or timing cover, as it's frequently called.

Begin by removing the fan, drive belts and crankshaft pulley. The pulley is usually secured to the heavy crankshaft harmonic balancer—that big round wheel on the front of the crank—by several small bolts. This balancer is sometimes called a harmonic damper, and on other vehicles

it's not used at all. There's simply a pulley or hub that bolts onto the crankshaft directly. On some cars, you'll have to remove the water pump to provide good access to the balancer and seal. Whatever you have, we'll be referring to it as a hub, and it's got to come off. Once the pulley is off, remove the retaining bolt. That's the big bolt in the middle. On stick-shift cars, you can put the transmission in gear and apply the parking brake to keep the crank from turning while you wrench the bolt off.

On automatics, try wedging a big pry bar in the transmission torque plate (flywheel) after removing the trans bellhousing dust cover. If there is no dust cover, look for an access hole on the engine side of the trans bellhousing. If you have a big air compressor and a 1/2-in.-drive impact

wrench, you can usually spin the bolt off without holding the engine.

You'll probably need a hub puller (Fig. 1). A puller designed specifically for this purpose can be purchased at most auto parts stores. Some stores will rent the tool.

Install the puller on the hub with the two or three bolts provided. Once the bolts have been threaded well into the hub, turn the shaft screw in to remove the hub.

Inspect the area of the hub that rides against the seal. If it's worn or grooved, you'll need a new hub.

Pry the seal out of the cover with a large screwdriver (Fig. 2). *Don't* scratch the crankshaft surface. Find an object that you can use to drive the seal into the cover. It should contact the outer metal portion of the seal all the way around. A used disc-brake piston works on some applications, but a pipe fitting, large socket or even a piece of wood will do.

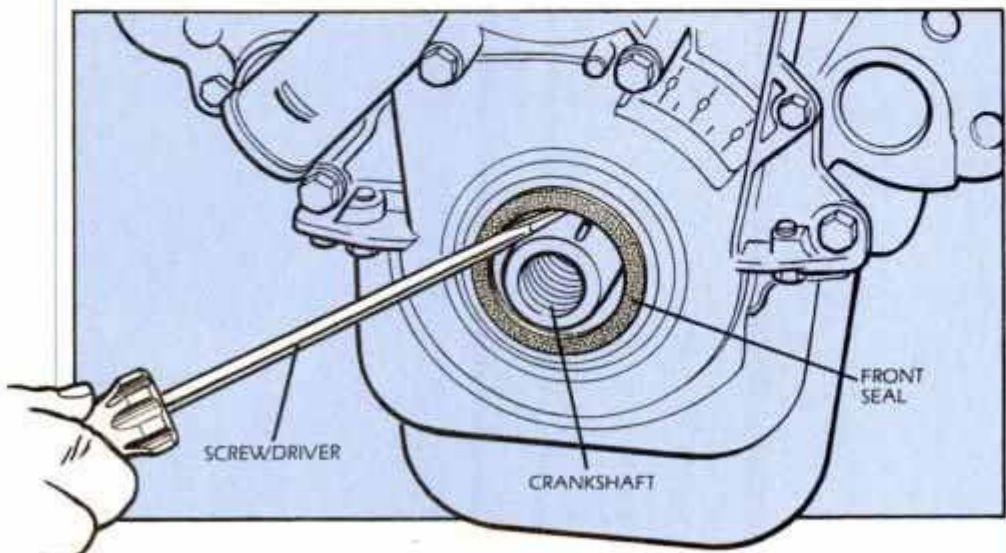
## Crankcase front cover seal installation

Be sure the seal's bore is clean and free of burrs. Oil the outer diameter of the seal lightly to ease the way. Don't use gasket sealer, RTV, or anything else but clean oil. Lightly tap the seal in, with the spring/lip side inside.

Generally, seals are installed with the part numbers legible from the outside, as is the case here. If you've got it started straight, no problem. But if there's a burr, or you start it crooked, you stand the chance of tearing the rubber coating off the metal insert. It'll still seal to the rotating crankshaft, but oil will seep between the timing cover and the seal body almost as fast as the old seal leaked it. However you do it, push the seal home until it sets flush with the appropriate lip in the bore. That's probably also flush with the surface of the timing cover. But you may want to measure the seal and the bore beforehand to get an idea of how deep it's supposed to go.

Align the hub keyway with the crankshaft key and reinstall the hub on the crankshaft. Don't pound on the outer area of the hub. You could knock it off-center and cause an out-of-balance condition. If you have to beat the hub back on, use discretion and tap lightly near the center using a wooden block and alternating from side to side. Check for burrs and misaligned keyways if it seems like there's too much effort involved. A light film of grease might help.

Better yet, use a hub puller that can also be used as a hub installer. This



2 Use a large screwdriver to carefully pry the seal out of the front cover.



will make sure the thing is started on straight, which is most of the battle.

## One-piece rear main seal removal and replacement

Some engines, including the GM 2.0-liter and 2.5-liter 4-cylinder engines, 2.8-liter and 3.1-liter 6-cylinder engines and the Chrysler 2.2-liter, 2.5-liter and 2.6-liter 4-cylinder engines, as well as most late-model Ford and GM engines, have a 1-piece rear main seal that can only be accessed from the back of the engine. Thus, to service these seals, the transmission must be removed, a good-sized job.

If you do decide to brave removing the tranny, replacement of the seal itself is quite easy. Don't even attempt removal of an automatic transmission without a trans jack. This device can be rented from most tool rental stores.

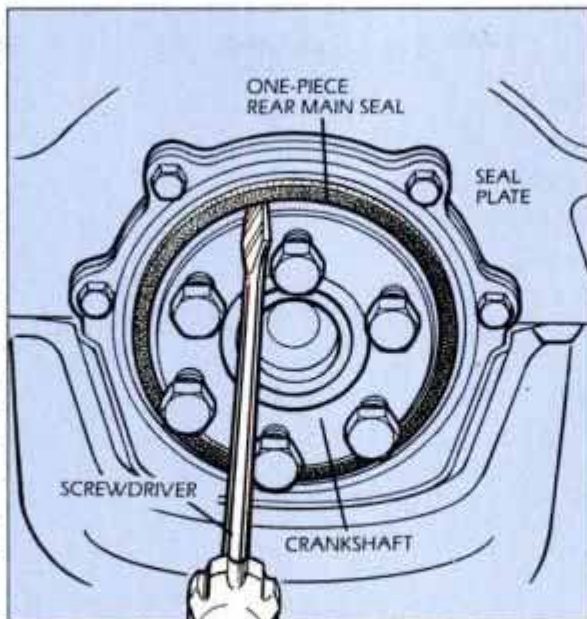
Ramps or proper jackstands are a must here. Be sure to block the wheels, as well as setting the parking brake. You'll need to remove the driveshaft, which obviates the use of PARK to keep the car from rolling off and squishing you.

Metal-jacketed 1-piece rear main seals can be removed by punching a hole in the seal cover with a sharp awl. Then, screw a threaded slide hammer into the seal. Yank the assembly out of the block. If there's not enough metal to allow for the use of a slide hammer, pry the seal out with a screwdriver, but take care not to scratch the crankshaft's seal surface (Fig. 3). Some of these engines have a removable seal carrier that can be unbolted from the block to allow you to replace the seal while standing up comfortably at a proper workbench, rather than lying on your back in the driveway. Be sure to replace the gaskets or seals associated with the seal carrier, if you go this route.

Installing the new seal is similar to installing a front seal—you have to find a large round metal cup or similar object that will mate with the circumference of the seal. The seal is then tapped into its recess in the engine block.

Install the seal with lip or spring (if applicable) pointing toward the engine. Lubricate the seal with clean engine oil.

Most vehicle manufacturers

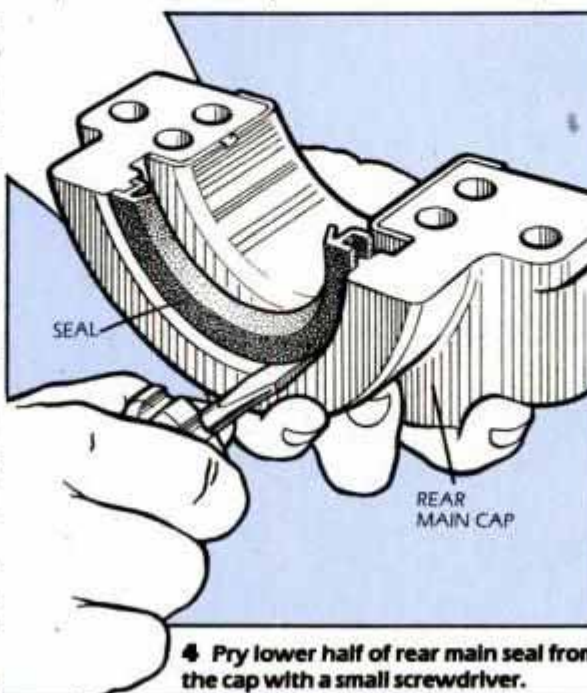


3 A 1-piece rear main seal can usually be pried out with a screwdriver without removing the seal plate.

provide a special tool for installation of the 1-piece rear main seal. This tool locates on the back of the crank by means of dowel pins or bolts and pushes the new seal into its bore via a screw-jack mechanism. Again, getting the seal started in straight is half the battle. Don't use sealer of any sort between the seal and the bore where it rests.

## Two-piece rear main seal removal

There are two types of 2-piece rear main seals in use today. One type is called a rope seal, because the packing-type seal resembles a rope. The other type is a molded-rubber lip seal. Removal and replacement of molded-



4 Pry lower half of rear main seal from the cap with a small screwdriver.

rubber seals is time consuming, but not very difficult. Removal and replacement of the rope-type seal is a lot tougher, and sometimes not completely successful, unless the engine is completely disassembled.

Some manufacturers, however, specify a molded-rubber seal as replacement for the original rope seal. One such application is the Chrysler V8. At least one gasket manufacturer, on the other hand, recommends against this procedure, claiming that the manufacturing tolerances for rope-seal engines aren't accurate enough to ensure a good oil-tight job when the rope seal is replaced with a molded-rubber seal. We'd say that rather than trying to install a new rope seal—a job that's touch-and-go at best—we'd opt for using the recommended replacement molded-rubber seal.

You're going to start with the most difficult part of this job: oil pan removal. The parts you have to remove to get the pan off vary somewhat from car to car, but you can tell by crawling under there and eyeballing the situation. You should also consult your factory manual, which will provide a detailed list of everything that has to come off first. On all cars, you should start by disconnecting the negative battery cable.

On most Chevy V8 applications, for example, you'll continue by removing the air cleaner and the upper fan shroud.

Next, block the rear wheels, check to make sure the transmission is in park or in gear if it's a manual. Then raise the vehicle and support it securely on ramps or jackstands in factory-recommended jacking locations. Once it's up in the air, drain oil pan.

On that Chevy, you'll have to disconnect the Air Injection Reactor (AIR) hose at the converter pipe. Then, disconnect the AIR pipe at the exhaust manifold. Remove the exhaust crossover pipe at the manifold and at the point where it joins the catalytic converter.

Remove the starter and the flywheel cover. Then, disconnect the transmission oil cooler lines at the transmission oil pan. Next, remove the engine mount bolts that run through the mounts from front to rear. This allows separation of the mount for lifting of the engine.





**5** Tap the rear main bearing seal into the block (left), then tug on the protruding edge with needle-nose pliers while turning the crank to spin it out (right).

Unbolt the oil pan and lower it as far as possible. Turn the crank until the forward crankshaft throw and counterweight are tucked up into the block and not extending downward. Jack the engine up at the front of the trans bellhousing. Then, reinstall the engine mount through bolts under the mounts so that they hold the engine in a slightly elevated position. You now should be able to wiggle the oil pan out of there. On some vehicles, you may need to remove the crossmember or more of the exhaust system.

If the oil pump is mounted on the rear main bearing cap or in a position that interferes with access to the rear main bearing cap, you'll have to remove it. In most cases, this is just a matter of removing one or two bolts and lowering the pump and pump driveshaft.

Next, determine if the seal is in the rear main bearing cap or in a seal carrier behind the bearing cap. Then remove the main bearing cap or seal carrier. Pull the oil seal out of the bearing cap by prying it from below with a small screwdriver (Fig. 4). If the seal is in a seal carrier, there will be some other gaskets on the sides of the carrier. Remove these as well.

To remove the upper half of a molded-rubber rear main bearing seal, tap one edge with a small drift or screwdriver, pushing the edge of the seal up into the block. This will push the other edge of the seal out of the block. Tug on the protruding edge as you turn the crank and rotate the seal out of the engine block (Fig. 5).

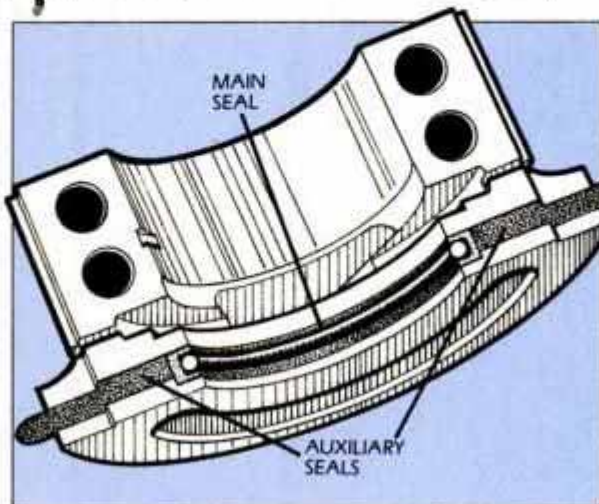
To remove the upper half of a rope seal (which will be replaced with a molded-rubber replacement seal), screw the threaded end of a small slide hammer into one end of the seal and tug on the

seal while you turn the crankshaft toward the slide hammer (lead illustration). You can also try tapping on the opposite side of the seal with a drift that is almost as wide as the seal. On rebuilt engines, some rope seals are glued in place. If this is the case, you might be in for quite a struggle.

### Two-piece rear main seal installation

Once the seal halves have been removed, clean all sealant and other junk from the bearing cap or seal carrier and the crankshaft. Inspect all surfaces for nicks or burrs that could interfere with the seal.

There are several types of tools intended to ease rope seal installation. You can make a sort of shoe-horn out of shim stock to prevent nicking the seal. But it requires feeding the seal in carefully, turning the crank over while doing so, and has the danger of nicking the crank seal surface. Try to find the Chinese-handcuff type of tool that pulls the seal over the top of the crank. Coat the seal lips and bead with engine oil. Whichever tool you



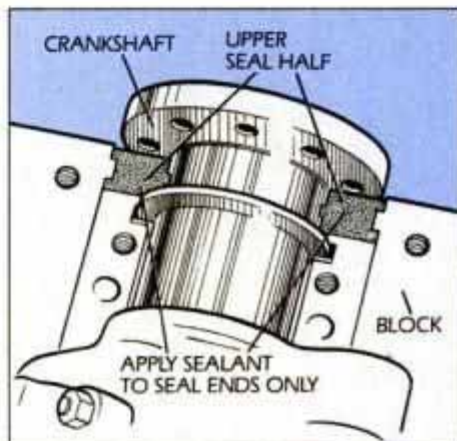
**6** Some rear main bearing caps and seal carriers are grooved for auxiliary seals.

use, pull or push the seal around the crankshaft into the engine block. When the seal has been rolled all the way in and is flush with the block on both ends, remove the tool.

Install the other half of the seal in the bearing cap or seal carrier.

Install any additional gaskets as required. Glue them to the carrier with a gasket compound that dries fully (Fig. 6). After the gasket cement has dried, use an RTV engine gasket compound on the other side of the gaskets. Apply RTV sealant to the mating ends of the seal. Make sure you use high-temperature, oil-resistant RTV (Fig. 7). Install the rear main bearing cap or carrier and torque to manufacturer's specification.

If the rear main bearing cap is the thrust bearing, tighten the cap to ap-



**7** Coat the mating ends of a 2-piece rear main seal with RTV sealant.

proximately 10 lb.-ft. initially and tap the crankshaft rearward and forward to align the thrust surfaces before torquing the bearing cap to full tightness. Check for proper end play after the cap is fully torqued.

Clean the oil pan and oil pump with solvent and a brush. Reinstall the pump with a new gasket.

Make sure the oil pan mating surfaces are flat. If the area around each bolt hole protrudes, flatten it using a piece of wood and a brass hammer. When the pan is dry, glue the pan gaskets and seals in place with a quick-drying gasket compound. Apply a thin coat of RTV engine sealant to the top side of the pan gasket and seal, making sure that you fill any cracks between joints. Install the pan and torque the bolts to specification. Install all the pan bolts a few threads with your fingers before you tighten any of them, and then work side to side tightening them gradually. **PM**

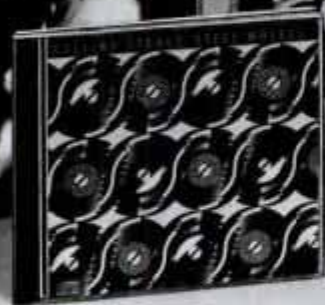


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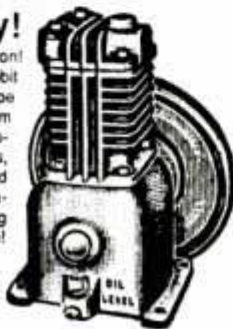
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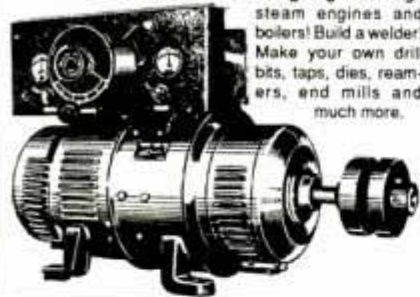
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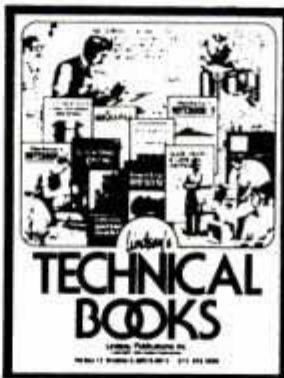
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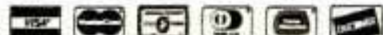
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(Continued on next page)



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