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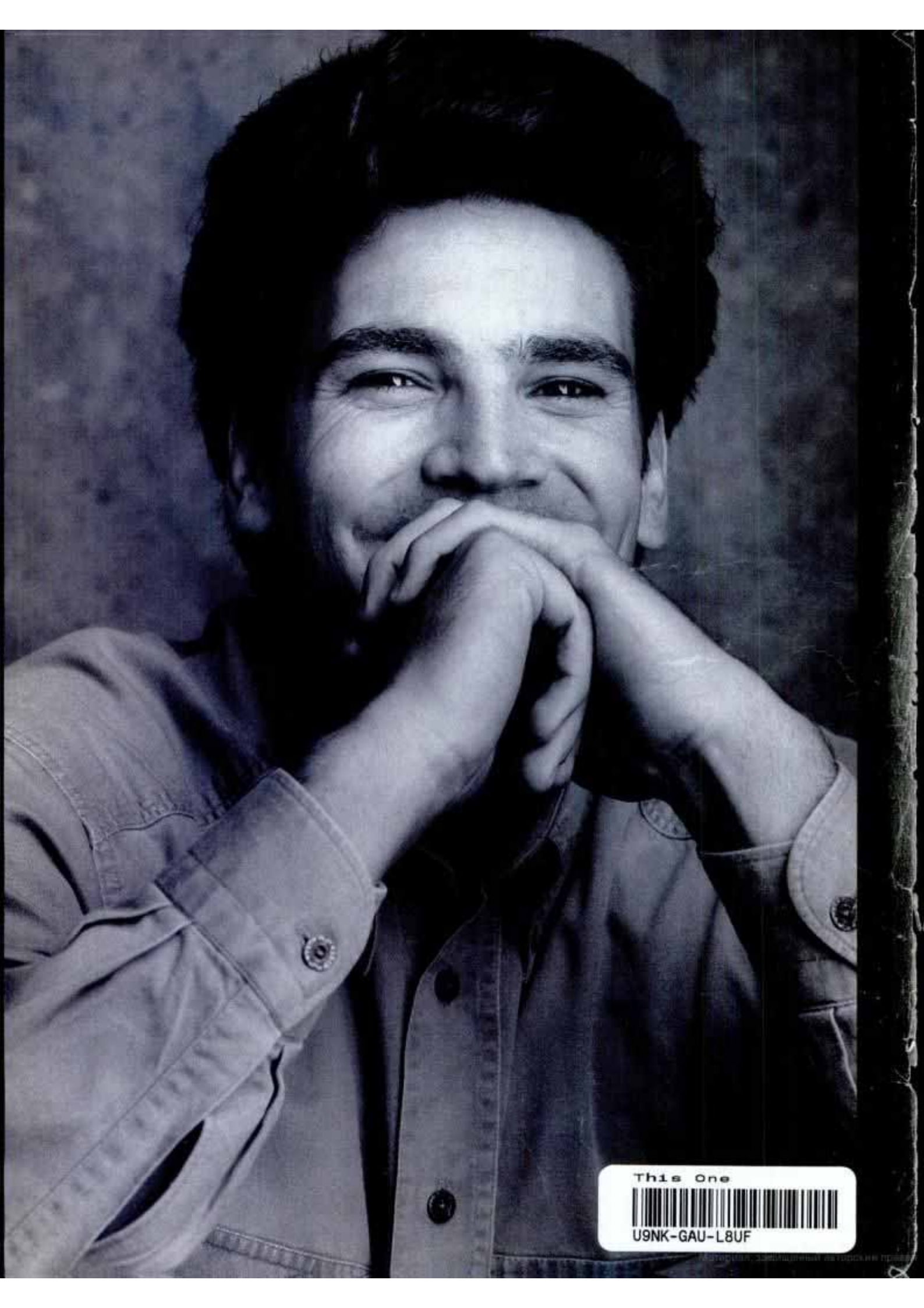
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**8mm CAMCORDER COMPARISON TEST**  
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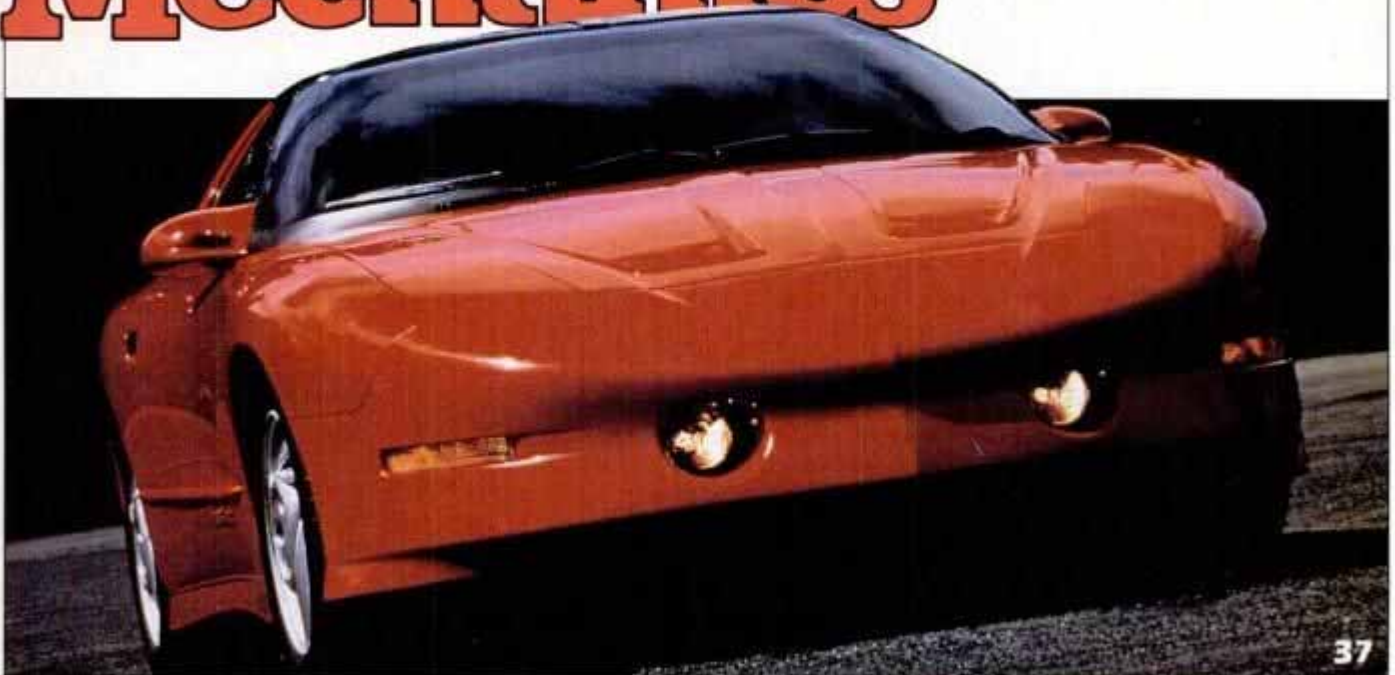


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# Popular<sup>®</sup> Mechanics

OCTOBER 1992  
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NO. 10



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# EDITOR'S NOTES

● This has been one of the most exciting new-car seasons in years. There are lots of new models out of Detroit for '93 as the Big Three gear up for the most competitive decade in history. General Motors, Ford and Chrysler know they must have the product out there to hold onto present customers and to woo some of their old customers back from the Japanese and European car companies. And they know it must be a top-quality product. The result is one of the biggest and most exciting crops of new cars in years. Our extensive coverage was put together by a team headed by Automotive Editor Tony Swan that also included Detroit Editor Jim Dunne and Associate Automotive Editor Mike Allen. Our coverage will continue in the December issue. Meanwhile, excitement '93 begins on page 37. . . . **For even more information on the '93 crop of new cars, look for the POPULAR MECHANICS New Car And Truck Buyers Guide on**

sale at your newsstand beginning Nov. 9. This brand-new publication will have photos, specs, features, options and prices on every 1993 car and light truck sold in America. Or you can use the coupon in this issue to order direct as soon as it comes off the press. If you're a car guy (or girl), you've got to get this thing. . . . **Things were plenty exciting recently in Bowling Green, Kentucky, as the one millionth Chevrolet Corvette rolled off the assembly line. When the first one rolled off the old St. Louis plant line in January 1953, I wonder how many people predicted the car would still be America's premier sports car 40 years and 999,999 units later? Number one million will tour the country for a while, then go into the National Corvette Museum adjacent to the plant in Bowling Green. Happy 40th birthday, Corvette. . . .**

**When contributor David Freeman told us about the life-saving helicopters operating in Cleveland, Ohio, a light went off in our heads. It's such a simple idea, why don't more communities operate specially outfitted helicopters that can be dispatched to accident scenes and begin preserving life immediately on the scene? After reading Freeman's report, you'll wonder too. . . . If you live in the Chicagoland area, mark the dates: April 16-18, 1993. It will be the first Chicago AutoSport Expo, sponsored by POPULAR MECHANICS, Montgomery Ward and Sears. Come to McCormick Place and meet famous race drivers, see their race cars up close, learn how to make your car look and run better and last longer at the car care demonstrations, see muscle cars, Corvettes, collector cars, customs and monster trucks on display. And that's just for starters. More information to come. Till next time.**



Number one million and me.

  
Joe Oldham

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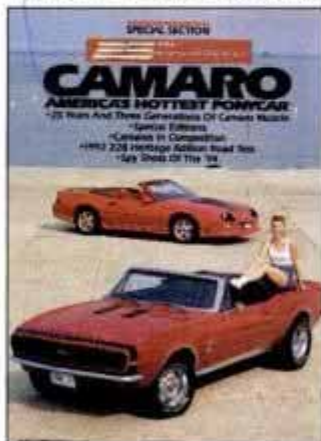
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# LETTERS

July 1992  
1992

## The Heartbeat Of America



I really enjoyed your coverage of Chevrolet Camaro's 25th anniversary. I have been a Camaro enthusiast since I can remember. My favorite-year Camaro has always been 1969. I have a red '69 coupe with the 300-hp 350 V8, Turbo Hydramatic 350 transmission, and a functional ZL2 cowl-induction hood. Other features include the deluxe black-and-white hounds-tooth interior, air, console and front and rear spoilers. It's a real pleasure to drive and always attracts a lot of attention.

GREGORY QUINN  
IRVING, TX

An incorrect statement was made in the "Heritage Hurricane" article in the Chevy Camaro section. It read: "There are only a few cars in the world that can run a quarter-mile quicker than that [14.30 E.T.], and they all cost at least \$25,000 more than the Z28." My stock 1990 Ford Mustang LX 5.0, which cost \$14,251, ran a 14.2 quarter-mile at Atco Raceway in Atco, New Jersey, the first time at the dragstrip. The LX is faster and less costly than the Z28, with the best

bang-per-buck ratio on the planet. Talking about the Heartbeat is fine. Just don't forget about the Hoofbeat.

VICTOR J. BURRIS  
CLAYMONT, DE

## Fahrvergnügen

After a recent article about another of Detroit's make-believe cars, GM's Ultralite, reader Lawrence Hooker responded with a letter praising the R&D efforts of American auto manufacturers. He was also critical of those who didn't buy American cars. His whining admonition to those who buy foreign cars was "Out of work? Hungry? Eat your foreign car!" In 1964, I bought a new Volkswagen bug for about \$1700. Running on its third engine and original transmission, the car now has more than 546,000 miles on it. And it's still in fine shape. My bug has never been garaged and I drive it daily. Right now I drive about 80 miles a day. My answer to Mr. Hooker's suggestion to "eat my car" is this: I do! Twenty-six years without car payments buys a hell of a lot of food.

BILL STONE  
DALLAS, TX

*But your VW doesn't have air, automatic, power steering, brakes, windows and door locks and the premium stereo sound system.*  
—Ed.



Reader Gregory Quinn's 1969 Chevrolet Camaro coupe.

## Maintenance Basics

I must take issue with some of the information you presented in "Choosing The Right Engine Oil." You state that the highest oil specifications available are SG and CD—since the CD classification was issued, we now also have CD-II, CE and CF-4. In addition, the "C" designation is for all commercial applications, gasoline and diesel, not merely diesel as you claim.

ROLF U. ENGELFRIED  
WILTON MANORS, FL

Contributing Editor Don Chaikin replies: *We're both right. While many new oil service classifications have been licensed by the American Petroleum Institute (API), those licenses may not be in use. In other words, while oil refiners have the technology and the rights for producing oils of certain classifications, they are not exercising those rights by selling that oil. As a do-it-yourselfer, the most currently rated oil you will find on shelves will be SG-CD. And the API says that though the "C" does stand for "commercial," the designation is for diesel engines only, not gas engines.*

## A Sunken Legend

In my opinion, the *Titanic* did not have to sink. After four years in the U.S. Navy

and 33 years with a New York-based marine towing and transportation company, I have gained much practical knowledge of various marine vessels. The *Titanic* had reciprocating steam engines that were equally powerful in forward or reverse. If the rudders were put amidships and a reverse speed of 10-15 knots could have been reached, the water moving along the outside of the hull would have created a siphon effect drawing the water from the hull. If the ship did not answer the rudders, steering could have been accomplished by making an outboard propeller push in the opposite direction the ship was moving. This would have had to be tried right after the collision, while the ship was on even keel and the propellers were in the water.

GEORGE HERMANN  
WHITSTONE, NY

I read everything I can find about the *Titanic*, and there are a lot of things written that don't ring true to the book I have, *The Sinking Of The Titanic*, edited by Logan Marshall. Unknown to the passengers, the *Titanic* was on fire from the day it sailed. The fire started in the No. 6 coal bunker. With all this heat and the steam pressure coming from the 24 double-end and five single-end boilers, plus the 25 knots it was going when it hit the iceberg, I speculate that the seams could have opened on the side of the boat. The cold water hit the boilers causing them to explode, blowing the boat apart.

GEORGE AIGUIER  
RED FEATHER LAKES, CO  
*(Please turn to page 15)*

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

JULY 1992

ONE CAR COMPANY JUST REDEFINED  
HOW QUALITY SHOULD BE MEASURED.

IT GOES FURTHER THAN THE LAB,  
FURTHER THAN THE TEST TRACK.



A circular logo with a red-to-orange gradient background. The words "REAL WORLD" are written in white, uppercase letters along the top inner edge of the circle. The words "TESTED" are written in white, uppercase letters along the bottom inner edge. In the center of the circle, the number "100000" is displayed in large, white, bold digits on a black background that resembles a digital odometer display. The logo is superimposed on a map of the Phoenix, Arizona area, showing roads, landmarks like the Arizona State Fairgrounds, and various cities.

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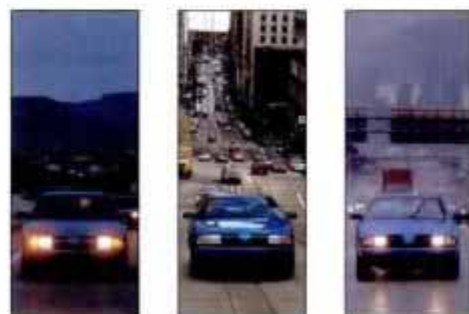


## THE TEST.



It began when consumers confirmed our belief that the true measure of quality isn't 50,000 miles. Or 75,000

miles. But how a car performs over 100,000 miles...in the real world. As a standard of measure, we included two benchmarks of quality: the Honda Accord and Toyota Camry. Then A.C.I., an independent automotive testing firm, bought the cars off dealership lots, and performed a 100,000-mile over-the-road test under the same weather and road conditions, and kept track of maintenance, repair and operating costs. With real people behind the wheel, not professional drivers.



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Vehicles**	Maintenance†	Repairs	Operating Cost††	Total Cost
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ACCORD	\$2,756	\$ 366	\$4,098	\$7,220
CAMRY	\$1,499	\$1,283	\$4,358	\$7,140

\*Consumer experience may vary. \*\*3 Acheiva S, 3 Acheiva SL, 3 Accord DX, & 2 Camry DX models. †Based on manufacturer's recommended maintenance schedule. ††Includes fuel, fluids and routine wear-outs.

total cost, which includes maintenance, repair and operating costs. It's quality redefined. Measured not in a lab or on a test track, but in the real world. A new definition where real costs can be calculated and defined as the measure of quality. Because the real world is where quality like this counts most of all.

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## Flying High

I wish to congratulate you on the story about the Strike Eagle. As a retired flight-test crew chief for the U.S. Air Force, I could not explain to my wife the sensation of being in the rear seat of a fighter-bomber jet the way Science/Technology Editor Abe Dane did. Excellent story! SGT. MARVIN JARMAN, RET. KINSTON, NC

Dane's F-15E Strike Eagle story sold me the magazine. It was a straight from the hip, no macho b.s., spell-binding story. The pictures were crisp and detailed. The whole article made me want to charge right up to my local Air Force base and demand a taxpayer's promo flight from the first jet jockey who would take my 500 bucks.

VAUGHN MCMILLAN  
CALGARY, CANADA

## Caught In The Act

In the '94 Cadillac De Ville Spy Report in the June issue, you wrote: "Though this prototype is heavily disguised, some features are visible." Including the finger the driver is giving your photographer.

WALTER H. WINNARD  
FRONT ROYAL, VA

*How foolish of the driver to think that a mere obscene gesture would keep us from publishing the spy shot.*

—Ed.

## Magnetic Water Treatment

As environmentally concerned citizens and corpo-

rations look for non-chemical solutions to the treatment of water, many find magnetic treatment the prudent and cost-effective alternative for solving hard-water scale problems. We would like to thank PM for its fine coverage of a subject that some individuals still view as controversial. However, we would like to inform readers that Mr. Raber, chairman of the committee that investigated the non-chemical treatment for the National Association of Corrosion Engineers, observed the dissolving of hard-water scale at Victoria Towers, our San Antonio installation, and we protest his comment that magnetic treatment is fiction, since he was a witness to the successful de-scaling demonstration.

PETER KULISH, PRESIDENT  
THE MAGNETIZER GROUP

You missed the point. One of the biggest advantages of using a focused magnetic field on water lines is to reduce or eliminate the scale buildup in the water heater, thereby saving lots of dollars in fuel costs for operating this major appliance. Calcium scale is a very effective insulator. A  $\frac{1}{8}$ -in. buildup of scale in a typical home water heater means an extra 55% gas or electric expense to heat your water. A  $\frac{1}{2}$ -in.-thick scale coating requires a 72% increase in fuel costs. The magnetic treatment device can pay for itself in less than a year just by eliminating this one nuisance.

JOE MUMBACH  
WHOLLY WATER  
WATER TREATMENT  
EQUIPMENT



Cadillac De Ville's driver indicates own IQ for our Spy camera.

## Kitplanes

In Editor's Notes you stated that ultralights were "flimsy little things powered by lawnmower engines" and "you sort of rode on top of, rather than in, them." You also described kitplanes of 10 years ago as "contraptions." It is not necessary to belittle one category of aircraft to emphasize another. Kitplanes today are great, but they do not replace or simulate the advantages ultralights offer. In the early '80s, ultralight aircraft came within one unit of matching the sales of production aircraft. They were affordable and easy to build—attributes unattained in kitplanes today. Although I am a rated FAA commercial pilot, a majority of my flying time came in ultralights. The ultralights I flew all used aircraft-grade aluminum and stainless-steel cable. All of the hardware was AN-grade. The engines were not from lawnmowers, but rather, from snowmobiles specifically modified for aviation application. When was the last time you came across a 40-hp lawnmower? Today's Rotax engines, used in many popular kitplanes, began their existence as snowmobile engines. Unfortunately, the cost of today's engines are more than the cost of the Pterodactyl ultralight kit I purchased, all inclusive, 10 years ago. DOUG BOYLE FORSYTH, GA

## The First Ornithopter

I assumed your report would tell of the culmination of one of humankind's oldest dreams: the flight of

a full-scale, piloted ornithopter. I was disappointed to find, instead, your story about a radio-controlled, gas-powered model. Rubber-powered model ornithopters were flying before the Wright brothers. They've been built and flown in competition at least since the 1930s. Model ornithopters have flown on rubber, gas, diesel and electric power with flight times exceeding De Laurier's and Harris's 1 minute and 46 seconds. The real problems of flapping flight arise when you scale up to a



size capable of carrying a 160-pound pilot.

WARREN A. BERGER  
LOUISA, VA

## Possible Dreams

Because of inventors, and those with dreams, we have many items that make life easier. I was surprised to see items in the Possible Dreams exhibit at the Henry Ford Museum that were invented and demonstrated many years ago that we think of as new today. It's nice to see where we've been, but more exciting to see where we're going.

AMY OHMS  
CEDAR CITY, UT

I was very excited to see the hand-built hydroplane twin-sponson boat from a 1963 issue. I, too, built an 8-ft. single-person racing hydroplane from your plans and it changed the course of my life. I became an engineer and have been with Cadillac Motor Division ever since.

J. REED  
DEARBORN, MI

# TIME MACHINE

90 YEARS AGO: OCTOBER 1902

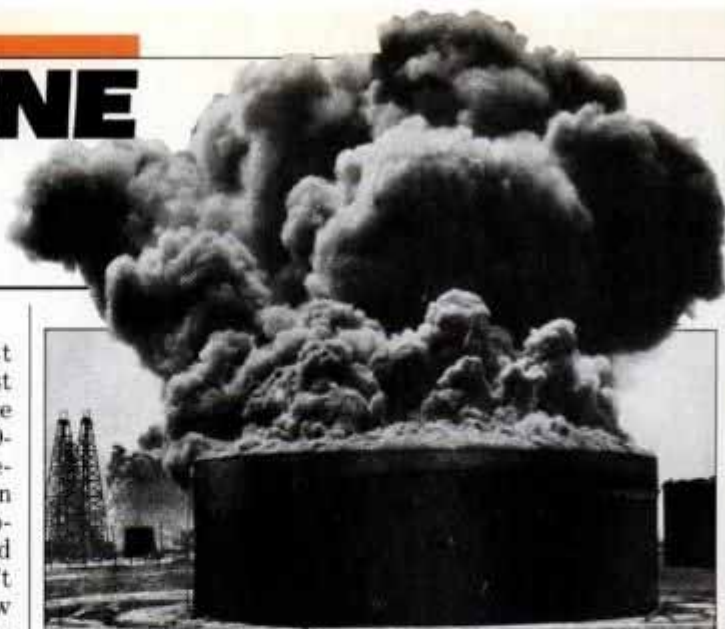
## POPULAR MECHANICS

Rope Bridge Moored to Mountain Peaks



### Flying Bridge

Sometimes the simplest structures offer the biggest thrills. Take the rope bridge that swung between two 300-ft. crags on the coast of Ireland. Gale-force winds often blew in from the sea, whipping the span into a frenzied oscillation. But that didn't stop locals, who knew how sturdy it was, from parading across. Even on the calmest days the bridge tended to sway—after all, it was the sole route between a salmon fishery and the Old Bushmills distillery.

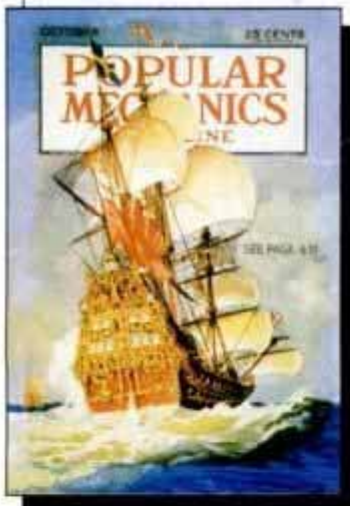


### Petro Inferno

The Beaumont oilfields had made Texas a boom state. A year later, they exploded into flame. Firefighters had never battled a conflagration

of this scale. Wells spouted 200-ft. columns of fire for three days. Steam hoses kept the blaze in check, but in the end, the flames mysteriously went out on their own.

60 YEARS AGO: OCTOBER 1932



### Latest Model

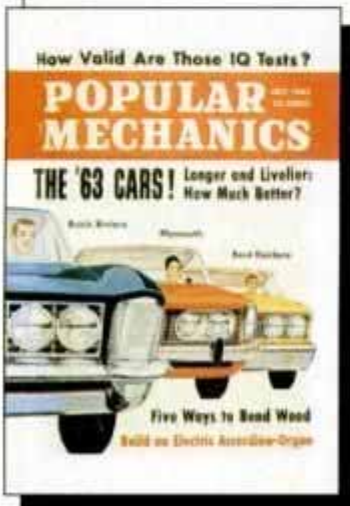
Ship model plans have frequently into our pages during the '30s. One of the grandest we detailed was *The Sovereign Of The Seas*, shrunk to a 2-ft. length and lathed from white pine. The original, a gaudy 100-gun leviathan twice the size of a Spanish galleon, was the vehicle by which 17th-century England rose to maritime supremacy. Faithfully reproduced down to the baroque ornamentation, our model took a 9-part series to present in full.



### Tin Man

"Robot" had been a part of our vocabulary for a decade, and mechanical men enjoyed prominence in popular culture. Inventors sought to capitalize on the phenomenon—typically with bizarre results. One British tinkerer spent \$18,000 building an all-purpose automaton. He claimed the machine could talk, sing, whistle, laugh or carry on a conversation for an hour and a half. In addition, it could read the newspaper and fire a revolver—no doubt at the same time.

30 YEARS AGO: OCTOBER 1962



### Sharper Image

The fins of the '50s had finally yielded to the squared-off styling of the early '60s. Sheetmetal creased to a crisp edge defined automotive anatomy back then, most noticeably in the new Dodge Dart and Buick Riviera. But one car swam against these tides—the Corvette Sting Ray, with its aquatic silhouette. At a time when yearly mechanical improvements were conservative, Chevy changed everything but the engine and transmission on the low-slung bombshell.

### Boggy Buggy

Toying with the hovercraft concept, Vickers built the VA-3, a Land Rover skirted

with an air-cushion system. While the wheels didn't lift, the Rover could still tiptoe through swampy terrain. **PM**





# Gillette<sup>®</sup> Sensor<sup>®</sup>



***The only razor that senses and adjusts to the individual needs of your face.***

Gillette Sensor: the shave personalized to every man.

It starts with twin blades, individually and



independently mounted on highly responsive springs. So they continuously sense and automatically adjust to the individual curves and unique needs of your face.



Innovation is everywhere. You can feel it in the

textured ridges and the balance of the Sensor razor. You appreciate it in the easy loading system and the convenient shaving organizer.

Even rinsing is innovative. The new blades are 50% narrower than any others — allowing water to flow freely around and through them, for effortless cleaning and rinsing.



All these Sensor technologies combine to give your individual face a personalized shave — the closest, smoothest, safest, most comfortable.

The best shave a man can get.

© 1991 The Gillette Company [USA]



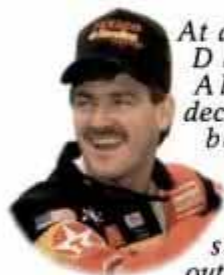
**Gillette**

**The Best a Man Can Get™**

**FURTHER PROOF:**

# Driving the unseen.

An interview with



At age 12, Davey Allison decided to become a race driver. He started out sweeping

garage floors after school. By age 14 he was taking engines apart and by age 15 he was putting them back together. Now he's one of NASCAR's brightest young stars. He finished the 1991 season by leading more miles and more major NASCAR races than anyone. He began the 1992 season by winning the Daytona 500. He owns his own Grand National team and drives a Ford Thunderbird for the prestigious Robert Yates Racing team. The homework Davey did as a kid gave him a unique feeling for equipment. He knows that what a modern race driver doesn't see can be as important as what he does see.

"I watch videos of wind tunnel tests," Davey says. "Then when I'm on the track I visualize air currents as colored smoke passing over the car. If you did the same, you'd see why the slingshot maneuver is a thing of the past in stock-car racing. Because of today's improved aerodynamics, you don't get as much vacuum behind a car you're following. If you don't have another car to draft with you when you pull out to pass, it's like hitting a wall of air."

## Road Tracks vs. Oval Tracks.

Other unseen laws of physics apply to the tracks themselves. And physics make today's stock cars a mighty handful at the two road tracks on the NASCAR calendar. Davey says: "We've got 3500-pound cars. Compared with Trans-Am cars, ours are heavier, our brakes are smaller, and our tires are narrower.



Yet we're running on road courses that Trans-Am cars are built for."

Davey did more homework. He went to a road-racing school four times, and the result was victory. "You approach a turn differently on a road course," Davey explains. "Typically, you come in easier, braking and maybe trail-braking. You take a later apex and try to get on the throttle early. On an oval track, you drive into a turn hard, use the brakes to set the car, maybe drag the brakes through to keep the car positioned, then pick up the throttle a little later. On a road track you use most of the chassis coming out of a corner, whereas on an oval track you let the chassis do the work in the corner itself."

## The Biggest Unseen Force — Teamwork.

Davey credits chassis setups by crew chief Larry McReynolds, along with engines built by team owner and manager Robert Yates, for much of his recent success. But it takes a driver who understands equipment to communicate with the people who make it work.

"We have power and reliability that are just unreal," Davey says. "It used to be that a good racing strategy was to save the car for the final laps. Some drivers still do that, but I don't. Today's technology is so good that reliability is no longer a big part of the equation. I tend to push per-

formance to the limit for the whole race."

Davey also credits Texaco products for their contribution to technology: "We've seen technology improve in NASCAR, and we've seen it improve in the petroleum industry. I know that's true of Texaco products because I use them, on the track and off.

"For example, on the road, Havoline Formula<sup>3</sup> Motor Oil helps protect your engine from heat stress, starting friction, and engine dirt. And on the track, we haven't had a single oil-related engine failure in 6 years of racing with Havoline right out of the bottle."

As for gasoline, Robert Yates has used a special racing blend of Texaco System<sup>3</sup> in engine development. And the entire World Challenge racing series of the Sports Car Club of America (SCCA) is run only on the identical super-unleaded System<sup>3</sup> you can use in your car. Davey offered some thoughts on the subject:

"In everyday driving, System<sup>3</sup> works in places like your fuel and induction systems and your intake valves. If you could look in there, you'd see how it can constantly clean your car's engine. That helps an older car run younger and a new one keep running in top shape. And you get all that performance in every single octane grade of Texaco System<sup>3</sup> Gasolines."



TEXACO SYSTEM<sup>3</sup>® AND HAVOLINE FORMULA<sup>3</sup>®

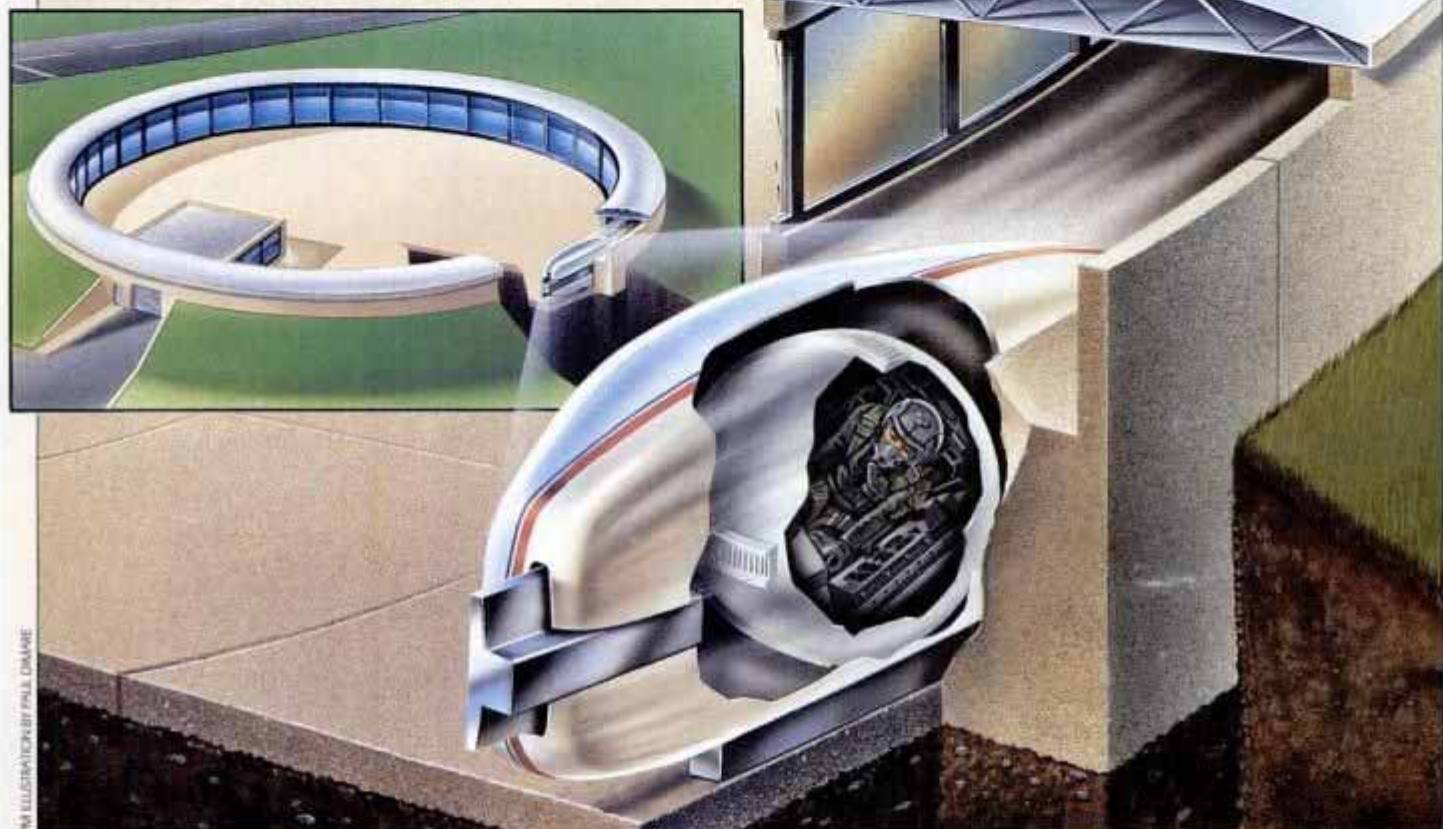
**THE ENERGY TO GO FURTHER.™**

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# TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DIMARE

## Super Centrifuge To Jump-Start Future Jet Jocks

BROOKS AFB, TX—The uncanny agility of emerging fighter jets presents a quandary for the Air Force. How can the service prepare pilots to handle the complex g-forces wrought by supermaneuverable aircraft like the F-22 and its successors?

One answer may be a proposed flight simulator that makes those old training centrifuges seem like merry-go-rounds.

At the Air Force's Armstrong Laboratory, engineers have outlined an electromagnetic vehicle that would whip around a ring of track roughly 600 ft. in diameter. Speeds would reach between 275 and 300 mph. The track could accommodate dif-

ferent vehicles, some even simulating spacecraft.

Inside, a sphere containing the trainee would spin freely on any axis—or several axes at once. The rotation would be driven by a proprietary traction mechanism that features arrays of wheels or ball bearings on the sphere's outer face.

Dubbed the Combined Acceleration Flight Simulator, or CAFS, the facility would depend on lightning-fast computers to synchronize motion with visuals. Flat or slightly curved electrochromic displays would line the inner face of the sphere.

Editor: Abe Danc  
Assistant Editor: Greg Pope  
Contributors: Lisa Busch, Mike Fillon,  
Ed Jacobs, Herb Shuldiner

Currently at the preliminary concept stage, CAFS has not received further funding from the Pentagon.

Catching g's from multiple angles, a pilot trainee gets supermaneuverable in CAFS simulator.

## Highlights This Month

- **If Fish Could Talk**—Edible beepers tag deep-sea denizens.
- **One-Man Train**—Personal rapid transit comes of age.
- **Skydiving Tanks**—Army's future air-droppable armor.
- **World's Biggest Water Balloon**—The latest scheme to export Alaskan water.
- **Mechanical Milkmaid**—Robots invade the dairy parlor.
- **Traveling Wheels**—Japanese car folds into a suitcase.



## Bottom-Feeder Finder

ABERDEEN, SCOTLAND—Marine biologists would like to tag and track the denizens of the deep the way terrestrial zoologists use radio-beacon collars on wildlife. Now Scottish researchers have developed a system to do just that.

The Aberdeen University Deep Ocean Submersible, or AUDOS, is an aluminum skeleton fleshed out with cameras, hydrophones, tape recorders and other instruments.

Also, tied loosely to the framework are a number of miniature acoustic transmitters smeared with mackerel

flesh. Tethered to a buoy, AUDOS operates 15,000 ft. below the surface.

First, fish eat the bait-coated transmitters, which stay undigested in their bellies for days. Each transmitter broadcasts a unique sonic signal, which is captured by the hydrophones and tape-recorded. One scanning hydrophone picks up the direction of a fish's movement, while two vertically spaced units pinpoint its height in the water column. Signal strength helps to estimate the fish's range.

After a spell, AUDOS releases its ballast and pops to the surface, the data secure in pressure bottles.

The Aberdeen zoologists have tested AUDOS on dozens of missions, studying scavenging grenadier fish in the Atlantic and Pacific Oceans.

**Grenadier fish swallow baited transmitters that broadcast their whereabouts to AUDOS.**



## All Aboard The X2000

BOSTON, MA—Sweden's X2000 tilting train (see *Tech Update*, page 16, May '91) will debut on Amtrak's Northeast Corridor next spring on a test basis.

On the fully electrified track between New York and Washington, the X2000 will likely replace a Metroliner express train.

On the New York-Boston run, however, the tracks are only electrified between New York and New Haven,

Connecticut. For now, two RTL gas-turbine power cars will roll with the X2000 locomotive, to pull the load on the unpowered stretch.

Because the RTL cars can't take curves as fast as the X2000, the time savings won't be dramatic. But by 1996, when the whole route is electrified, today's 4½-hour trip will shrink to 3 hours.

**Amtrak's Northeast patrons will soon ride the X2000, which takes curves at 125 mph.**



## Rover's Swinging Legs

PASADENA, CA—Engineers at NASA's Jet Propulsion Laboratory just can't seem to stop making planetary rovers smaller and smaller. One of their latest is Go-For, an 8-pound wonder approximately the size

of a miniature poodle.

The rover runs on four motored wheels mounted on struts that can rotate completely about the body.

This arrangement lets Go-For right itself if accidentally turned turtle. Torque tubes,

driven by worm-gear assemblies, connect left and right struts.

In addition, the mechanism lets the mini-rover redistribute its weight beneath either front or rear wheels to gain extra traction for climbing obstacles.

**JPL's Go-For windmills its legs to climb obstacles or right itself.**



# The Minivan Company.

*One automotive company  
has earned that title.*

*The company that in 1984  
invented the minivan.*

*The company responsible for such  
technological innovations  
as the first minivan airbag  
and the first built-in child seat.*

*The company that has sold  
more minivans than all other  
companies combined.*

*The Minivan Company.  
It has a more formal name:*

*The Chrysler Corporation.*



# Ask any of the three helped make Chrysler



Ask the woman who baby-sits in one.



Ask the family in a Honda



Ask the engineer who hadn't owned an American car in over ten years.



Ask the maga one to the

Dodge Caravan and Plymouth Voyager were this country's first minivans.

Ten years later, they're still America's first choice. And no one else even comes close.

The McDonough clan can tell you why. They own six Chrysler minivans.

With our minivan airbag, rear shoulder belts and our anti-lock brakes,<sup>†</sup> America has chosen us for the safest of reasons.

Ask the Cartwrights, who ran right into a concrete abutment. And walked away with only a few bumps and bruises.

# million owners who've The Minivan Company.™



who used to be  
commercial.



1993 Dodge Caravan ES

Ask the family  
that owns six.



zine that took  
Arctic Circle.



1993 Dodge Caravan SE

Ask the family who survived  
a collision in one.

Thanks to Town & Country, Chrysler minivans have been selected for the most luxurious of reasons, as well.

Just ask David Tarnosky. His '92 Town & Country is the first American vehicle he's owned since 1979.

And our choice of lengths, seating options and built-in child seats<sup>1</sup> have made us a natural for growing families everywhere.

Three million owners can tell you why.

Call 1-800-876-MINIVAN and tell us your story.  
Maybe we'll use it, too.

To buy or lease, see your Dodge or Chrysler-Plymouth Dealer.

# The Minivan Com

**1984** Chrysler introduces the minivan. **1985** Selected as one of the "Ten Best Cars" in America by *Car and Driver*. **1987** V-6 power and a long wheel base model. *Automobile Magazine* "All-Star." **1988** 1,000,000th Chrysler minivan sold. *Automobile Magazine* "All-Star" and a *Family Circle* "Family Car of the Year." **1989** *Automobile Magazine* "All-Star" and *Motor Trend* "Ten Best." **1990** 2,000,000th Chrysler minivan sold. Town & Country, the first luxury minivan. *Automobile Magazine* "All-Star" and *Motor Trend*



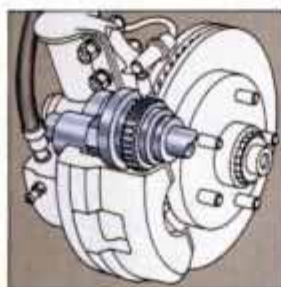
Plymouth Voyager



# pany: A History.

"Ten Best." **1991** The second generation of America's best selling minivan debuts. Chrysler offers anti-lock brakes, all-wheel drive and quad seating. And introduces the first minivan driver's airbag.<sup>†</sup> *Automobile Magazine* "All-Star" and *Motor Trend* "Ten Best." **1992** 3,000,000th Chrysler minivan sold. The built-in child seat, *Motor Trend* "Ten Best" and a *Prevention Magazine* "Safe Car of the Year." **1993** Ten model years and still number one. With the highest owner loyalty rating of any minivan on the road.\*

See limited warranties at dealer. Exclusions and restrictions apply.



<sup>†</sup>Ask about available V-6, built-in child seat, anti-lock brakes, all-wheel drive and quad seating. Our standard driver's minivan airbag provides added safety when seat belt is worn. So buckle up for safety. \*1991 Minivan Owner Loyalty Study, R.L. Polk & Co., July 1992.



Call 1-800-876-MINIVAN for more information.



Dodge Caravan



Chrysler Town & Country

## Personal Rapid Transit

CHICAGO, IL—As traffic jams continue to choke the Windy City's suburbs, the Regional Transportation Authority (RTA) is mulling a radical new form of public transport. Personal rapid transit has waited patiently since its conception in the 1950s, but now appears ready to coax suburbanites out of their cars.

The concept calls for a fleet of fully automated cars running on tracks, hustling small groups of riders nonstop between stations. The vehicles, driven by linear motors, cruise at 30 mph.

Computer control ensures that an empty cab awaits passengers at every stop or is no more than 3 minutes away, even during rush hour. Station-gate machines that sell magnetic tickets automatically hail an unused



Personal rapid transit, shown here in TAXI2000 form, may come to Chicago's suburbs.

transport vehicle.

RTA officials are calling for a 2-mile test track in the suburbs, and two groups of contractors have submitted bids. Boston-based Stone & Webster Engineering leads

one team, with plans for 3-person bubble cars designed by TAXI2000 Corp. The rival group is led by the Swiss firm Intamin AG, promoting its boxy 4-person vehicles.

This fall, the RTA board

will vote on proceeding with the project, picking a location for the test track and a contractor team to build it. With a green light for construction, the test track would go into service in 1995.

## Transforming Chopper

MESA, AZ—A new breed of convertible rotorcraft boasts significant advantages over other vertical-takeoff aircraft, say its developers at McDonnell Douglas.

Called a canard rotor wing, the vehicle builds on the old stopped-rotor concept. In hover mode, exhaust from a turbofan engine would drive the 2-bladed rotor. Featherable canards and a horizontal tail would augment lift during forward

flight. Speed could reach Mach 0.7 if the rotor blades stop at an oblique angle.

The concept obviates complex tilt-rotor drivetrains and the labyrinthine air piping in the late DARPA/Sikorsky X-Wing project.

McDonnell Douglas says an unmanned prototype would take two years to build, given funding.

**Canard rotor wing halts blades and gains lift from other surfaces during forward flight.**



## New Tanks To Drop In

SANTA CLARA, CA—The Army's on-again/off-again Armored Gun System program (see "Tanks For Tomorrow," page 68, May '88) is officially on, with FMC Corp. getting the nod to build the light tank.

Destined for rapid deployment forces, the vehicle will replace the M551 Sheridan, now used exclusively by the 82nd Airborne.

The AGS's autoloader will mark a first for the U.S. Army. The 12-round-per-minute mechanism will cut crew size from four to three

and allow a bulkhead to insulate personnel from ammo, increasing survivability.

The 105mm gun will be the XM35, originally developed for the Marines. Four shock absorbers soften recoil.

The vehicle itself weighs only 35,500 pounds in air-droppable configuration. But crews can bolt on two additional layers of armor.

The Army hopes to buy 300 of the vehicles, with production beginning in 1996.

**Armored Gun System, shown here with older M68A1 cannon, will support light infantry.**

# ROLLBACK

# '92!



**DORAL**  
**ROLLS BACK**  
**PRICES\***

While other brands raise prices, DORAL announces that we are reducing our manufacturer's list price. At participating outlets, you will enjoy a new everyday low price each time you buy DORAL, and save up to \$2.60 on every carton and 26¢ on every pack when you buy without coupons.\* That makes DORAL the everyday lowest-priced top ten brand in America. In fact, it's priced as low or lower than any other leading national branded savings cigarette! And with our special coupon promotions, you'll receive even greater value. So if you're a DORAL smoker already, thank you. If you're a smoker who hasn't tried DORAL, there's never been a better time. DORAL, the unbeatable combination of taste and value.

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

\*Based on mfr.'s list price reduction.

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

© 1992 R.J. REYNOLDS TOBACCO CO.



ILLUSTRATION BY ED VANKURSKY

water—enough to supply 400 homes for a year.

Sun Belt envisions filling the bags at a pumping station near an Alaskan river. A treatment barge anchored offshore could chlorinate and fluoridate the water. Then a tugboat would haul the bag south.

Alaska, which enjoys 400



MEDUSA PHOTO

## Monster Water Bladders

JUNEAU, AL—Congress's Office of Technology Assessment has condemned the subsea aqueduct idea (see [Tech Update, page 14, Feb. '92](#)) as a pipe dream. Now the state of Alaska has thrown support behind a new plan: huge floating bags to

export fresh water to Southern California.

The idea comes from two venture companies: Calgary, Alberta-based Medusa Corp., which has designed the bags, and Santa Barbara, California-based Sun Belt Water Inc., which would buy

the water from Alaska and sell it to California.

Made of water-proof canal-liner plastic, the bags would be crisscrossed with heavy nylon strapping to prevent any rips from propagating. At 1000 ft. long  $\times$  250 ft. wide, each would swallow 72 million gallons of

Towed by tugboats, floating Medusa bags could transfer Alaskan river water to Southern California.

in. of precipitation a year in some spots, has recently legalized the export of water for a fee. Meanwhile, Medusa has also proposed the bags for transporting water in the Middle East.

## Gunpowder Fingerprinting

GAITHERSBURG, MD—Police labs may soon have a powerful new weapon: a fast way to help prove that a suspect fired a gun.

The technique is called micellar electrokinetic capillary electrophoresis, or MECE. The idea is to match a firearm with the unique mix of chemical residues that adheres to the hand of someone who has recently shot a gun.

Detectives first obtain a sample by sticking masking tape to a suspect's hand. Technicians then dissolve the residues in alcohol and inject the solution into the MECE apparatus.

MECE uses an electrical field to force the solution through a narrow capillary. Micelles, **Gunpowder fingerprinting pinpoints the unique patterns of residue that characterize a gunshot.**



NO PHOTO

which are spherical molecular clusters like detergent particles, act as traffic regulators in the capillary. They slow down the different residues to different speeds, de-

pending on the residues' chemistry, so that identical compounds group together.

As the bunched residues pass a light source, a photodetector identifies them. The sensor's output can pinpoint residue patterns characteristic of individual lots of ammunition.

MECE is faster, cheaper and simpler than current tests. NIST engineers believe it is ready for transfer to national forensic labs.

## Graphite Pistons



DAIMLER BENZ PHOTO

Graphite piston runs clean but costs a pretty deutsche mark.

STUTTGART, GERMANY—Daimler-Benz has installed pistons made of polycrystalline graphite in a series of Mercedes-Benz 190Es. The result: 40% fewer hydrocarbon emissions and a 30% cut in carbon monoxide output. Fuel economy went up by 4% as well.

Graphite keeps combustion gas temperatures hotter and weighs less than aluminum. It's also a lot tougher. But with current technology, graphite pistons cost 100 times more than aluminum equivalents.

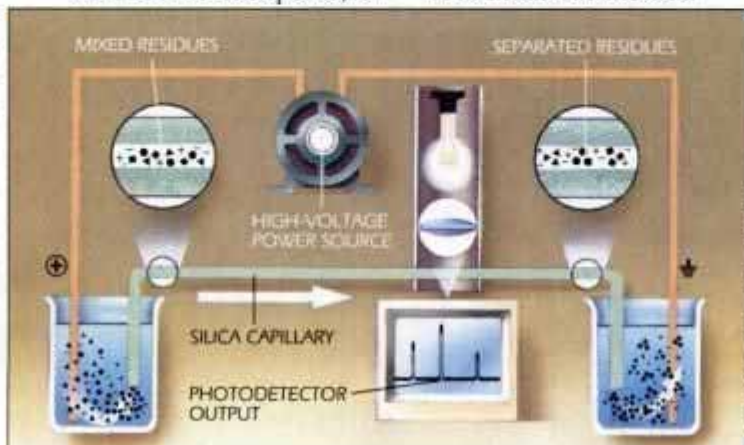


ILLUSTRATION BY ADRIAN E. BERTHANY

## IQZOOM 90WR

Neither rain,  
Nor snow,  
Nor gloom  
of night...

**T**he new weather resistant IQZoom 90WR from Pentax means fantastic pictures without worry, no more missed opportunities, and a lot more fun.

**U**ntil now you had to be careful or moisture and dirt would destroy your camera whether you were white-water rafting or having a water fight in the back yard. Now the IQZoom 90WR brings weather resistant zoom lens technology to action photography.

**I**n addition to weather proofing, the IQZoom 90WR features a unique remote control that allows operation of both zoom and shutter. The IQZoom 90WR also has red-eye reduction, automatic zoom flash, multi-beam or spot auto focus, and full auto back-light compensation to make sure your selected subject is beautifully photographed.

**W**et or dry, the 90WR from Pentax is *the* camera for active lifestyles.



# PENTAX

## Udder Automaton

SILSOE, ENGLAND—Gentle, foolproof milking robots have remained a dairyman's dream, but now it looks as if the British are closing in on a working model.

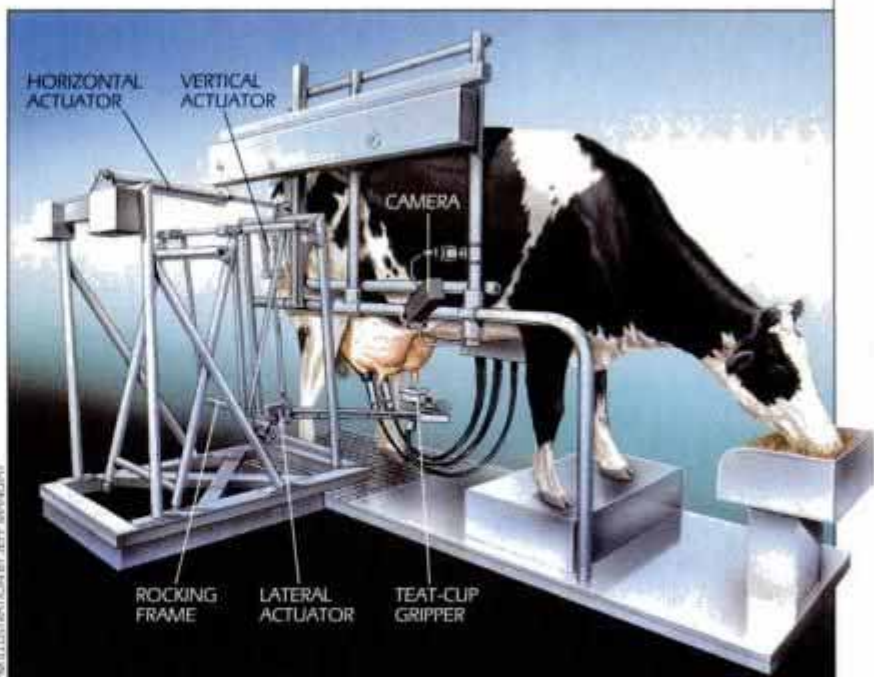
Developed by the Silsoe Research Institute, the prototype automaton is built around an arm on a rocking frame. Three actuators, driven by compressed air, shift the arm into position. The pneumatic cylinders won't contaminate milk as hydraulics could. They also provide shock absorption, which prevents injury to both cow and robot.

Using a conical gripper, the machine first picks a teat cup from a magazine. Then it hunts for a teat, guided initially toward the udder by dead

reckoning based on stored data. The robotic dairy parlor is arranged so that the udder always winds up in roughly the same location.

For fine positioning, the robot relies on an array of photoelectric cells that creates a grid of light beams around the gripper's top. This sensing technique allows the gripper to attach the teat cup even if the cow won't keep perfectly still.

The machine is working well enough that engineers are now devising future re-



finements, including a camera-based selective teat-cleaning mechanism.

**Milking robotic framework features rocking arm positioned by pneumatic cylinders.**



## Suitcase Convertible

HIROSHIMA, JAPAN—Trust the Japanese, who suffer through some of the world's worst traffic jams, to come up with a novel solution. It's a single-seat car that folds out of an innocent-looking Samsonite suitcase.

Built by a Mazda engineer as part of the company's Fantasiad design contest, the car weighs only 70 pounds and runs on a 1-cylinder, 2-cycle Zenoa engine, which delivers 1.7 hp. A centrifugal clutch and chain drive couple the

**Mazda's Suitcase Car lets you literally walk away from traffic jams.**

engine to the rear axle.

Although the vehicle falls rather short of the engineer's stated performance target—the Mazda RX-7—it can hit nearly 20 mph. An added bonus is its nifty 5-ft. turning radius.

Motorcycle-type handlebar levers control braking and speed. There's even a miniature entertainment center with a TV and stereo.

## Daddy-Longlegs Crane

GAITHERSBURG, MD—A spindly tripod crane designed at the National Institute of Standards and Technology offers surprising stability and strength.

NIST's 20-ft.-tall prototype—known as Spider—can lift five times its own weight. Between its three legs, a triangular platform hangs on six cables, two running to each of the platform's corners. Each cable is controlled by its own winch.

An operator wields a 6-axis joystick, which commands individual winches to reel in or release cables. Working in concert, the winches can move the platform left or right, up or down, and forward or backward, in addition to controlling pitch, yaw and roll. The design basically turns an existing flight motion simulator mechanism upside down.

Beyond hoisting jobs, the platform is suitable for machine-tool and toxic-waste

cleanup applications. Combined with a camera and three tracked "feet," Spider could also carry out exploration or remote-control construction on the Moon or Mars. Huge versions, borne on barges, could support deep-sea drilling and excavation. **TU**



**Spider moves on three tracked vehicles and uses tilt-neck camera for remote operation.**

# Win one of these Slick '50s Classics!



1956 Ford Thunderbird

1955 Cadillac Eldorado

1957 Chevrolet Corvette

## Slick 50—Classic preventive maintenance.

Slick 50 Engine Formula is your key to prolonging the life of your engine—the most expensive part of your car—because a one-time treatment will protect your engine at start-up. So make sure you treat your engine with Slick 50 at your next oil change... because with a little care, today's cars can become tomorrow's classics!

And now Slick 50 might also be your key to winning one of these beautifully restored, classic cars or one of 50,000 cash prizes! Just compare the license plate number on the attached game piece to the license plate numbers on the displays at participating Slick 50 retailers, and see if you've won instantly!\*



## Starting your engine without it is a terrible thing to do.

Independent laboratory tests showed that a one-quart, one-time treatment of Slick 50 Engine Formula:

- Protected engines at start-up.
- Reduced engine wear by 50% for 50,000 miles.

By reducing engine wear, Slick 50 Engine Formula will help your engine last longer, so your car may become one of tomorrow's classics, too!

## Win one of three classic cars instantly! Over 50,000 winners in all!

Visit your Slick 50 dealer today to see if you've won one of three fully restored classic cars or one of 50,000 cash prizes! Even if the license plate number on your game piece doesn't match a license plate number on the display, you may have a second chance to win an unclaimed classic car. Just answer the four questions on the game piece, complete the information requested at the bottom of the game piece, and mail the pre-addressed card to enter the classic car second chance sweepstakes. Answers to the questions are found on Slick 50 Engine Formula packages.

But hurry! Your entry must be received by November 15, 1992!

**SLICK**<sup>®</sup>  
The Engine Wear Protector. 50

**No purchase necessary.** Must be residents of Continental U.S. who are licensed drivers 21 years of age or older to enter. All Match & Win prize claims and second chance entries must be received by November 15, 1992. See game piece for details and condensed official rules. To obtain game piece and complete rules, send self-addressed, stamped (State of Washington residents send unstamped) envelope to: Slick 50 Game Piece, P.O. Box 92118, Libertyville, IL 60092 by October 20, 1992. Void where prohibited. Sponsored by Petrolon, Inc., Houston, TX.

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# If you feel the need to spend more, you can always stash a few grand in the glove compartment.

## CHEVROLET CAPRICE CLASSIC

With its newly restyled silhouette, limousine-like ride and a wealth of standard features, Caprice doesn't look like one of the most affordable full-size cars in America. Life is full of surprises, isn't it?

### **Rarely has fiscal restraint been this luxurious.**

Feel the support of the generously padded seats.

Adjust the standard tilt steering wheel and air conditioning to your liking.



Look into the vanity mirror. And tell yourself that you bought the new Chevrolet Caprice purely for economic reasons.

**Caprice's standard V8:**  
**Proof that power can be used responsibly.**

You're an adult. You don't need horsepower to impress





your friends. But when accelerating smoothly up a steep incline with a full trunk, or towing a trailer along a winding coastal highway, Caprice's 5.0 Liter V8 will make a powerful impression on you.

**An investment as safe as it is attractive.**

Caprice's flowing lines hide a heart of steel. A safety cage



incorporates "crush zones" engineered to help absorb impact in a collision. Rigid side-guard door beams add an extra measure of protection in case of side impact. And every Caprice offers the security of a full-perimeter steel frame, driver's-side air bag\* and standard anti-lock brakes (ABS). Without a doubt, you can spend more on a new



luxury automobile. Or you can buy Caprice Classic, and take comfort in the knowledge that you spent your money wisely. What else would you expect from the Heartbeat of America?



**THE HEARTBEAT  
OF AMERICA™**



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NASA's most successful mission ever.

**W**hen the space shuttle Endeavour climbed into the beckoning sky, it carried aloft the ultimate in state-of-the-art technology—including a specially-designed Rayovac battery. Our advanced engineering made us a natural choice for the mission. That same high technology is yours in all Rayovac batteries. It's there every time you turn on your personal stereo or your kids send a remote control fire truck careening across the carpet on an emergency call. Rayovac turns in one of the best performances on earth or off it.

**RAYOVAC**<sup>®</sup>

When Performance Really Counts.



# AMERICA GOES INTERNATIONAL



**EAGLE VISION**

Led by Chrysler's LH sedans, 1993's new vehicle crop reflects fundamental changes in what is—and isn't—an American car.

BY MIKE ALLEN, Associate Automotive Editor, and JIM DUNNE, Detroit Editor

● While most of the names remain the same, it's clear that the time-honored concept of the all-American car is undergoing considerable revision. Most Honda Accords, for example, are assembled in Ohio, with enough local content to qualify as U.S. domestic cars. Meanwhile, the Ford Crown Victoria, an all-American name if ever there was one, is being assembled in Canada and qualifies as an import.

There are dozens of examples of this phenomenon, and there will be even more in the years ahead as U.S. manufacturers juggle component sourcing and final assembly points to keep costs down and quality up. But from the point of view of the guy who signs a new car contract—you—there's only one thing that really matters.

Whether it's a Big Three player joining forces with an import maker to produce a superior hybrid—the Mercury Villager/Nissan Quest minivan and the Ford Probe/Mazda 626/MX-6 come to mind—or an

American manufacturer venturing north of the border to harness its most modern plant for production of an all-new line of cars like the outstanding Chrysler LH sedans, the result is the same: more choices and better cars.

Our rundown of the internationally flavored Big Three lineup for 1993 follows.

## **Chrysler**

Beginning with the LH cars—Chrysler Concorde, Eagle Vision and Dodge Intrepid—Lee Iacocca's final legacy at the helm of the Chrysler Corp. was to shovel dirt onto the grave of the K-car. In its myriad of guises, the K-car saw Chrysler Corp. through several crises, providing showroom traffic and much-needed cash flow during its most difficult times. But it's been almost a generation since the K-car was born—a contrast to the industry's standard of new vehicle introductions every three to five years.



The all-new LH owes nothing to any K-car component. Springing from a lean, mean engineering team of only 700 or so, the LH platform went from the styling studio to showroom in just a little more than three years—just about as long as it takes Japan to design an all-new vehicle.

Borrowing its north-south engine/transmission layout from fine European marques such as Audi and Saab, the new cars have remarkably smooth and predictable handling, without the traditional Teutonic harshness of the German autobahn-burner or the lack-of-steering feel associated with even the best of the Japanese cars. Two engines are available, a slightly revamped version of the proven 3.3-liter V6 and an all-new 24-valve 4-cam 3.5-liter V6.

Mounting the engine fore-and-aft

permitted better control of engine movement and improved packaging enough to permit the windshield to be brought far forward—almost to the center of the wheel-well arch. This allowed unprecedented utilization of space for excellent front-

and rear-seat legroom and a cavernous trunk with a full-size spare nestled in the well. LH prices will start just under 16 grand.

The K-car-based Dodge Dynasty, Chrysler New Yorker and Dodge 600 will fade slowly away as LH production ramps up in



## DRIVE REPORT

### DODGE INTREPID

● If athletic handling is the goal, high chassis rigidity is the starting point. It's the trait that distinguishes great sport sedans—BMW's, for example—from competitors, and it's the trait that distinguishes all of Chrysler's new LH sedans. No surprise, as Team LH used several European cars as benchmarks during development.

Our sample car here is a Dodge Intrepid ES. It included Chrysler's new 3.5-liter sohc 24-valve V6, as well as performance-oriented suspension tuning, ABS (optional) and the most aggressive wheel/tire package Chrysler will offer across the LH series.

With its excellent torque characteristics and 214 peak horsepower, the 3.5-liter V6 has a significant edge in grunt over the basic 3.3-liter version. However, the engine's performance is diluted a bit by the car's hefty curb weight of 3315 pounds and the absence of a manual-transmission option. Chrysler's

second-generation computer-controlled 4-speed automatic is smooth and flexible, but automatics, like curb weight, soak up power. Manual transmissions are slated for next year, though.

Weight is no friend to handling either, but in this car it's beautifully controlled. Like all the LH cars, the Intrepid changes direction like a halfback, tracks like a train and allows all sorts of liberties—like jumping on the brakes mid-corner—without a trace of skittishness.

On a back road it's hard to remember that the Intrepid is a front-drive car. If these cars don't emerge as the best-handling entries in the entire midsize, midprice sedan segment, we'll be surprised.

—Tony Swan



### Specifications

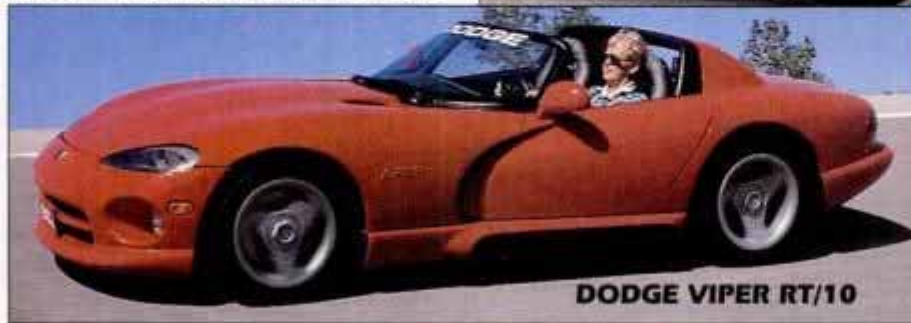
Layout	Front-engine, front-drive
Body style	4-door sedan
Engine	214-hp sohc 24V 3.5-liter V6
Transmission	4A
Wheelbase	113 in.
Track, f/r	62/62 in.
Length	201.7 in.
Width	74.4 in.
Height	56.3 in.
Curb weight	3315 lb.
Brakes, f/r	Disc/disc, ABS

the next year or so. Those of you interested in one of these more formal-looking (that means squared off and upright) sedans should order it soon. You should be able to get a good deal, while—as the expression goes—supplies last.

Just as new are the Mitsubishi-built Dodge and Plymouth Colts and Eagle Summit, including a 4-door sedan version to complement the coupe. Kiss the hatchback version of the Summit goodbye, though. And kiss a lighter, more solid and roomier chassis hello in return. Available with



**JEEP GRAND CHEROKEE**



**DODGE VIPER RT/10**

a base 92-hp 1.5-liter 12-valve sohc Four, as well as an optional 113-hp 16-valve sohc Four, the Summit/Colt rides on a 96.1-in. (2-door) or 98.4-in. (4-door) wheelbase.

Laser/Talon buyers, for the first time, can get an automatic tranny served up along with the all-wheel-drive Turbo option.

If you've been holding back on buying a Viper because your wife doesn't like red (the only color available on

any of the 500 or so 1992 models manufactured), you can get one in black this fall, emerald green in the springtime and yellow next summer.

Jeep introduces its Explorer-fighter as the Grand Cherokee, featuring a port-injected 5.2-liter V8 option. But you'll have to settle for the 4.0-liter Six if you want to go bare-bones and get the manual tranny or the 4x2 version. Got a big trailer? The trailer-towing package, which includes the

220-hp V8, is rated at 6500 pounds. In fact, Jeep will revive the Grand Wagoneer name in a loaded, woodgrain-sided V8 version of the Grand Cherokee this fall. The top-of-the-line Grand Wagoneer version is aimed straight at the market-dominating Eddie Bauer high-roller Explorer, and intended to recapture the term "Colorado Cadillac," coined to refer to the old high-zoot Grand Wagoneer.

Dodge truck buyers get a trio of heavily revised engines, dubbed "Magnums" with a 3.9-liter V6, and a pair of V8s at 5.2 and 5.9 liters of displacement. With sequential port injection and a barrel-shaped intake manifold, these engines share only a few (around 30%) of the components from last year. Aside from improvements in reliability, there's more horsepower this year.

## DRIVE REPORT

### EAGLE SUMMIT

● Also known as the Dodge and Plymouth Colt Vista, the Summit is completely new for the '93 model year. It manages to be roomier, yet at the same time, lighter than last year's version. Gone is the hatchback, replaced by a 4-door sedan. Hatchbacks, once a hot segment of the small-car market, seem to be less in favor as of late.

The liter-and-a-half base motor is adequate, if uninspiring. Avoid ordering this car with this particular engine and automatic transmission unless you always go downhill. More sprightly is the multivalve 1.8-liter, which can be had with a much better 4-speed automatic—but the emphasis is still on good mileage, not on leaving traffic behind you.

Reinforcing that notion is the handling, best characterized as predictable. Understeer prevails, which discourages brisk cornering. Brakes are light and responsive.

Interior appointments are well done, with good use of plastic, vinyl and fabrics. The instruments are thankfully easy to read, although spartan. I found the seat-rack adjustment nearly impossible to find or move, although the other controls were intelligently placed and operated smoothly.

Access to the rear seat and trunk are good, and the general structure was tight



and rattle-free. Wind noise is a problem, though, especially at freeway speeds.

Chrysler has a pretty specific niche for this car to fill—one where low cost of ownership reigns above any other consideration. Low initial price, low maintenance costs and low insurance premiums are where this car shines. Prices hadn't been set at press time, but I bet they'll be aggressively pegged against competitive makes. Maintenance costs are hard to assess for a brand-new vehicle with a brand-new drivetrain, but Mitsubishi-built vehicles have traditionally been in the ballpark on that score.

I don't think anyone will get wildly excited about this car—but by the same token, it doesn't seem to have any real deficiencies either. The Eagle Summit is just good basic

transportation. I would buy one for my mother in a minute.

—Mike Allen

#### Specifications

Layout	Front-engine, front-drive
Body style	2-door, 4-door
Engines	92-hp sohc 12V 1.5-liter I-4 113-hp sohc 16V 1.8-liter I-4
Transmissions	5M, 3A, 4A
Wheelbase	96.1 in. (2-dr)/98.4 in. (4-dr)
Track, f/r	57.1/57.5 in.
Length	171.1/174 in.
Width	66.1 in.
Height	51.4 in.
Curb weight	2085 lb. (2-dr)/2195 lb. (4-dr)
Brakes, f/r	Disc/drum, disc/disc ABS

**LINCOLN MARK VIII**



**FORD F-150 LIGHTNING**



**Ford**

Scheduled for midyear is the completely revised Lincoln Mark VIII. Propelled by a 280-hp aluminum-block, 32-valve, 4-cam version of the 4.6-liter modular engine, it's mated to a new electronically controlled transmission capable of dispensing 700 ft.-lb. of torque.

Details were sketchy at press time, but brief glimpses of the car show a

definite family resemblance to other Ford products, while continuing the distinctive Mark bloodline.

Probe—still related mechanically to the Mazda MX-6, which is manufactured in the same Flat Rock, Michigan, plant—is all-new from the ground up. Handling is superb, devoid of torque steer with either the 115-hp 2.0-liter 16-valve

**DRIVE REPORT**

**FORD MUSTANG COBRA**

● With the next Mustang still a year away, Ford is keeping the image of its popular ponycar hot for '93 with this special edition of the current car.

And special it is. Though the exterior treatment by ASC is subdued, Ford's new Special Vehicle Team has been busy where it counts with the chassis and powertrain. To provide some extra oomph—about 40 hp more—Ford's familiar 5.0-liter pushrod V8 got bigger intake and exhaust valves, bigger intake and exhaust porting and new roller rocker arms. The intake manifold has also been revised to accommodate the increased flow of the new fuel pump and fuel injectors.

There's a new clutch to handle the increased output, feeding power to a revised T5 5-speed transmission and strengthened driveshaft. The SVT team also added vented disc brakes at the rear, and 17 × 7.5-in. aluminum wheels with Goodyear 245/45ZR17 tires.

As you'd expect, there have been chassis refinements. What you might not expect, though, is that the overall setup is softer. And this adds up to a ponycar that's much easier to drive at its limits than the traditional stiff-as-a-bridge setup, particularly on bumpy surfaces. The extra muscle shortens



straightaways, and the improved braking was overdue.

Ford plans to build about 5000 Mustang Cobras, with a price premium of about \$2500

above a 5.0-liter GT. Besides being the best Mustang of the modern era, it's certain to become a collectible.

—Tony Swan



**Specifications**

Layout	Front-engine, rear-drive
Body style	2-door coupe
Engine	245-hp 5.0-liter ohv V8
Transmission	5M
Wheelbase	100.5 in.
Track, f/r	56.6/57 in.
Length	179.6 in.
Width	68.3 in.
Height	52.1 in.
Curb weight	2775 lb.
Brakes, f/r	Vented disc/vented disc

dohc Four or the 164-hp 2.5-liter 24-valve V6. Both of these engines are new, as well. Checking off the box marked "GT option" on the order form gets you 16 x 7-in. alloy wheels, body cladding and console.

Potential SHO Taurus buyers who just have to have an automatic tranny are in luck. They also get a bump in displacement to 3.2 liters, as well as slightly less cutting-edge (softer) suspension calibration. It's now a much more civilized "gentleman's express," capable of uncivilized speeds when necessary.



FORD PROBE



MERCURY VILLAGER

Don't worry—the 5-speed version is still gnarly inside and just as big a sleeper on the outside.

Built in Ohio in joint venture with Nissan, Mercury Villager is smack in the middle of the minivan segment with front-wheel drive for maximum packaging space and a very car-like driving experience—and it can carry

seven passengers. Riding on a 112-in. wheelbase and hauled around by a 3.0-liter V6, Villager is aimed at buyers who aren't interested in the conventional rear-wheel-drive Aerostar. Fleet buyers, anyone who prefers a real truck or individuals who need to tow a trailer will still be able to get the Aerostar, though.

The Ford Ranger has received an overdue exterior and interior freshening, with aero styling, flush glass and limousine-style doors for reduced wind noise.

If you're confused in the dealer's parking lot, it's because the grille on the 4x4 version is much different than the 4x2 version, adding some differentiation that the marketing guys think will make the two trucks appeal to different buyers. To complement the cosmetic revisions are a 3.0-liter V6 to replace the 2.9, and upwardly revised payload ratings.

Explorer buyers will no longer find it necessary to order 4-wheel ABS as an option—it's standard equipment for '93.

## DRIVE REPORT

### FORD RANGER

● Now 10 years since its 1983 model-year introduction, Ranger has garnered 25% of the small-pickup market, and done so at the expense of a number of terrific Japanese competitors.

Ford managed to do that with a combination of performance, ruggedness and price. The new Ranger isn't really new—most of the mechanicals are basically the same. But the hoodline has been lowered 4 in., the entire body has been updated and aerocized, the interior has been restyled and the doors have lost their drip rail and have been melded into the roof, limousine-style.

All in all, a pretty thorough restyling. The new bodywork is remarkably devoid of squeaks and rattles, wind noise and dust intrusion. The interior seems more spacious, and the super-cab versions even have this neat little horizontal window-blind arrangement to hide some things in between the swing-out rear seats.

If you're looking around at the Ford dealer for the truck pictured here, don't be confused—this 4x4 has a different grille treatment than the 4x2 version, a move intended to differentiate the two to different groups of potential buyers. Complementing that are some new colors and some wild side-striping jobs. I guess that somebody figured out



that there were plenty of people willing to spend a couple hundred bucks on after-market stripe kits.

Drivetrains are largely unchanged, with a 2.3-liter twin-plug inline Four, a 3.0-liter V6 (uprated from the previous 2.9), and the excellent 4.0-liter Six. The torquey 4.0 is definitely the engine to have if you plan to do any serious towing or heavy load-hauling.

There's a manual or automatic transfer case for the 4x4s—although I found the automatic version reluctant to drop out of either 4wd or low range.

—Mike Allen

### Specifications

	Front-engine, rear-drive
<b>Layout</b>	100-hp 2.3-liter I-4
<b>Engines</b>	145-hp 3.0-liter V6
	160-hp 4.0-liter V6
<b>Transmissions</b>	4A,5M,4WD
<b>Wheelbase</b>	107.9/125 in.
<b>Track, f/r</b>	62/62 in.
<b>Length</b>	181/193 in.
<b>Width</b>	69.4 in.
<b>Height</b>	56.7 in.
<b>Curb weight</b>	NA
<b>Brakes, f/r</b>	Disc/drum



**CHEVROLET CAMARO**

**General Motors**

General Motors stretched its 1993 car unveilings to the limit. Cadillac's Fleetwood Brougham first appeared in auto shows last January. Eleven months later—this December—Chevrolet's Camaro and Pontiac's Firebird will debut. In the meantime, Chevrolet's Geo Prizm will stick to tradition and go on sale this fall. The four cars offer the biggest styling changes in GM's 1993 model lineup.

The Fleetwood and Fleetwood Brougham are the new names for Cadillac's flagship 6-passenger sedans. Rear-wheel drive and a 5.7-liter pushrod V8 engine make Fleetwood unique among the front-wheel-drive Cadillac offerings. With a wheelbase of 121.5 in. and an overall length of 225.1 in., Fleetwood is the largest production sedan on the American market. And weighing in at 4367 pounds, it's the heaviest, too.

Just right for trailer towing? You bet. Fleetwood Brougham's trailer-

ing package—don't buy it for everyday driving—is major league, rated at an impressive 7000 pounds.

Northstar engines are big news at Cadillac, too. The dohc 295-hp aluminum V8 engine is standard on Allanté, Seville STS and the new Eldorado



**GEO PRIZM**

Touring Coupe. A slightly detuned version, with 270 hp, powers the Eldorado Sport Coupe.

Cadillac redesigned the suspensions of Northstar cars to cope with the higher performance. All Seville and Eldorado models share in the

changes. Stabilizer bars are thicker in the front and rear, and the rear suspension now has short/long arm geometry in place of struts. The change offers better ride and stability at all speeds, thanks to better wheel alignment.

Strong as the Northstar is in performance, it's a pussycat around town. Most times, at low speed and idle, you can't hear the engine. It's so quiet that Cadillac installed a starter interrupt that prevents the driver from cranking the engine while it is running.

Eldorado likes to run fast on the highway. In a number of sample highway drives with other Cadillacs, the

Touring Coupe consistently shouldered its way to the lead. For Touring Coupe owners, each highway mile will present the challenge of keeping to legal speeds.

In another name change, De Ville's top model is the 60 Special, and it no

**DRIVE REPORT**  
**PONTIAC**  
**FIREBIRD**

● The long-awaited renewal of GM's F-car twins—Chevrolet Camaro and Pontiac Firebird—has finally arrived, and our first drive of a Firebird Trans Am prototype makes us think you're going to be pleasantly surprised. Not only will these new all-American hot rods offer a lot more punch, they also promise to be much more pleasant to live with on the bumpy roads of life.

Wary of endless criticism concerning the

Trans Am's harsh ride, Pontiac's chassis team has made extensive suspension revisions aimed at producing better compliance without excessive compromise in handling. The result is a Trans Am that's capable of delivering sports-car handling on rough surfaces as well as smooth ones.

Beneath its stylish new skin, much of it fashioned from plastic composites, the Trans Am's chassis is basically the same rear-drive live-axle setup as before, although there have been a number of revisions to the front suspension geometry. But there's certainly something new under the hood. Both the Trans Am and Camaro will of-

fer Corvette 5.7-liter LT1 V8 power, mated to a 6-speed manual transmission. Although adapting the LT1's exhaust plumbing to the Trans Am's engine bay cut output a bit, there's still some 280 hp on tap and the 6-speed makes the most of it. And there's also more of that most endearing of big-inch V8 traits—torque. If you like to light up the rear tires, you'll like the new Trans Am.

The net result is a traditional Yankee pony-car that won't loosen your fillings, but will out-haul anything in its class and will also look extremely good doing it.

—Tony Swan



**Specifications\***

<b>Layout</b>	Front-engine, rear-drive
<b>Body Styles</b>	2-door coupe 2-door convertible
<b>Engines</b>	280-hp 350-cu.-in. LT1 5.7-liter V8 160-hp 3.4-liter V6
<b>Transmissions</b>	6-speed manual 4-speed automatic
<b>Wheelbase</b>	101 in.
<b>Track, f/r</b>	60.7/60.6 in.
<b>Length</b>	195.6 in.
<b>Width</b>	74.5 in.
<b>Height</b>	52.0 in.
<b>Curb weight</b>	3350 lb.
<b>Brakes, f/r</b>	Disc/disc (ABS V) Disc/drum

\* (PM estimates)





CADILLAC FLEETWOOD

longer carries the Fleetwood badge.

Camaro and Firebird, GM's F-cars, get their first major styling change in 11 years. Plastic front fenders, doors and roof offer smoother, more rounded contours, but the styling is clearly GM ponycar.

Only two engines are available, a 160-hp 3.4-liter 60° V6 as standard, and a muscular 280-hp 5.7-liter V8 option. Chassis details are familiar, with proven rear-wheel drive and a rigid rear axle as the building blocks. A 6-speed manual transmission matches the torque output of the V8, but a 4-speed automatic is also available.

F-car overall dimensions are only slightly larger than the 1992 models, but the car appears to be lower and much longer, thanks to the softer styling lines and the sharply raked windshield. A major passenger cabin bonus is the addition of airbags for both front-seat riders.

In lock step with its Toyota Corolla cousin, the Chevrolet Geo Prizm is newly styled for 1993. Body lines are blended into one smooth shape, instead of separate housings for engine, passengers and cargo. In addition, a 2-in. stretch in the wheelbase contributes to a sleeker profile.

Interiors are quieter. Noise reduction changes extend from new doors that wrap up into the roof to reduce wind whistle to hydraulic engine mounts. Sound barriers were also added to A-pillars, headers and carpeting as part of the effort to move Prizm upscale in measuring passenger comfort.

Other changes in the GM product lineup are less spectacular. But improvements stretch across just about every model line.

Chevrolet's big Caprice presents new appearance changes in critical areas. Sharp-eyed critics will see a full wheel cutout at the rear and revised taillight trim. The rear-end changes are aimed at slimming the big bustle view of 1992 and earlier models.

## DRIVE REPORT



## CADILLAC ELDORADO

● You must examine closely to find the differences on the outside. But under the skin, the 1993 Eldorado Touring Coupe's changes are radical—and comprehensive.

Under the hood, nestled behind the new body-colored grille with its Cadillac wreath and crest, is the 295-hp Allanté Northstar 32-valve V8 engine. From a standing start, the Northstar will jolt you from 0-to-60 mph in about 7.5 seconds.

Northstar's enormous power, driving through the front wheels, forced Cadillac engineers to make major improvements in the chassis. Front and rear antiroll bars are thicker to hold the body flatter. And a new short- and long-arm suspension system in the rear keeps the cabin stable.

Touring Coupes also have Allanté's new Road Sensing Suspension (RSS) that can electronically read the road at the rate of 1 in. at 60 mph. Its instant response to a firm set-

ting reduces body motions like roll, vertical heaving, lift and dive. RSS is an upgrade from the Speed Sensing Suspension used on the standard Eldorado. What you get with RSS is a stable chassis that's a big part of the Touring Coupe's personality.

Antilock brakes, traction control and speed-sensitive steering are other parts of the Touring Coupe's active safety package.

GM's traction control for Eldorado is a 2-part, simultaneous system. When the drive wheels spin, the spark to individual cylinders—up to five—is cut off. At the same time, brakes on the front wheels are applied.

Touring Coupe is the premier model in the Eldorado lineup. The Eldorado and Eldorado Sport Coupe fill out the line. Both use the carryover 4.9-liter V8, but Sport Coupe buyers can order a detuned—270-hp—version of the Northstar 4.6-liter dohc as an option.

—Jim Dunne



### Specifications

Layout	Front-engine, front-drive
Body style	2-door
Engine	295-hp dohc 32V alloy 4.6-liter V8
Transmission	4A
Wheelbase	108 in.
Track, f/r	60.9/60.9 in.
Length	202.2 in.
Width	75.5 in.
Height	54 in.
Curb weight	3604 lb.
Brakes, f/r	Disc/disc, ABS

POPULAR MECHANICS  
**NEW CARS**  
1993

**SATURN WAGON**



GM's APV van line gets a convenient automatic sliding-door option that should be ready for sale by early 1993. The door on Chevrolet APVs, Pontiac Trans Sports and Oldsmobile Silhouettes can be controlled from the driver's seat. Or from a key chain fob. Push a button, the door opens. Push again, the door closes. The door can be opened only when the transmission is in the Park position. But it can be closed anytime. If the door meets an obstruction when closing—a hand, a child, a package—it reverses and opens to full-wide position.

Less extensive revisions are seen in other General Motors product lines. Cavalier models are quieter running now, thanks to a noise package that includes a better muffler and more seals around the doors and between the outside mirrors and their inside controls. Also, Cavalier windshield wipers now have six mounting points in place of four in order to cut down on wiper chatter when the car is travel-

ing at high speeds.

Output of the Corvette ZR-1 V8 engine is boosted to 405 hp from 375 by an increase in intake ports. Buyers can get even more power by installing a standard aftermarket exhaust system. Better exhaust flow from the aftermarket unit will boost output to a nose-flattening 445 hp.

chain drive cover is made of noise-isolating laminated materials. An exhaust line resonator is now positioned closer to the engine to quiet exhaust noise. Certain models with 4-cylinder engines now have thicker floor and dash padding to improve noise suppression.

Buick's Regal line has a new grille



Quad Four and sohc 2.3-liter 4-cylinder engines are quieter thanks to a number of changes. Engine blocks are stiffer, to resist stretching, and the

that appears, from a distance, to be a close Mercedes lookalike. Buick says the Regal front end now integrates the appearance of grille, hood and



**WHERE THEY'RE MADE**

• While most American brand-name cars are still built in the United States, an increasing number of familiar names acquire foreign accents every year. To find out where your favorite car was built—or one of the several places it may have been built—check this quick rundown of the American-brand supermarket for 1992.  
—Jim Dunne

**CHRYSLER CORP.**

- CHRYSLER**  
Fifth Avenue Belvidere, IL  
Imperial Belvidere, IL  
LeBaron Newark, DE  
New Yorker Belvidere, IL  
Town & Country Bloomington, IL
- DODGE**  
Caravan Windsor, Ontario

- Dakota Pickup Warren, MI  
Daytona Sterling Heights, MI  
Dynasty Belvidere, IL  
Grand Caravan Bloomington, IL  
Intrepid Bramalea, Ontario  
Ram 50 Pickup Okazaki, Japan  
Ram Pickup Warren, MI  
Ram Wagon Pilette, Ontario  
Shadow Sterling Heights, MI  
Spirit Newark, DE

- Stealth Nagoya, Japan  
Viper Detroit, MI
- EAGLE**  
Summit Normal, IL  
Talon Normal, IL  
Vision Bramalea, Ontario
- JEEP**  
Cherokee St. Louis, MO  
Wrangler Brampton, Ontario
- PLYMOUTH**  
Acclaim Newark, DE  
Grand Voyager Bloomington, IL  
Laser Normal, IL  
Sundance Sterling Heights, MI  
Voyager Windsor, Ontario

**FORD MOTOR CO.**

- FORD**  
Aerostar St. Louis, MO

- Bronco Wayne, MI  
Crown Victoria St. Thomas, Ontario
- Econoline Van, Club Wagon Lorain, OH  
Escort Wayne, MI  
Explorer Louisville, KY  
F-Series Pickup Kansas City, MO  
Nortolk, VA  
St. Paul, MN  
Oakville, Ontario  
Seoul, Korea  
Dearborn, MI  
Fiat Rock, MI  
Edison, NJ  
Louisville, KY  
Atlanta, GA  
Chicago, IL  
Kansas City, MO  
Oakville, Ontario
- Taurus  
Tempo



**BUICK REGAL**

headlights in one unit. In the Century, a 2.2-liter 4-cylinder engine matches the 2.5-liter Four it replaces for performance and fuel economy. But it runs smoother and quieter. (Olds Ciera gets this switch, too.)

Two major names are dropped from the Oldsmobile line, the Toronado and the Custom Cruiser station wagon. However, a 4-door replacement for the Toronado is planned for next year and Olds believes that the Silhouette minivan can take the place of the Custom Cruiser.

Forgetful drivers will thank Oldsmobile for its Battery Run Down Protection system that's standard on Achieva models. Leave an interior light on when you leave the car and it will automatically shut off after 20 minutes. Or, leave the car unused for 24 days and the clock, radio and locking systems will shut down to preserve battery power. All systems are reactivated when the ignition is switched on.

In the light-truck lineup, Blazer and Jimmy get longer wheelbases—up 5 in. to 111.5 in. That change improves the ride and increases rear-seat hiproom by 3.5 in.

All 4.3-liter engines in the Chevrolet and GMC light-truck line now have a balance shaft to offset vibration and noise. In light-truck styling, look for widespread use of monochromatic paint schemes on GMC models. Grilles, wheels and fender moldings will be painted body color on special models. Electronic-control automatic transmissions are now available on just about all light-duty GM trucks, except high-performance vehicles like Typhoon.



wagons feature a top-hinged rear door and separately folding rear seats.

Saturn's new coupe is the SC1, and the carryover upscale coupe is renamed the SC2. SC1 shares wheelbase and interior dimensions with the more expensive model, but exterior styling differs in its exposed headlights and smaller taillights. **PM**



**CHEVROLET CAPRICE**

Thunderbird	Lorain, OH
<b>LINCOLN</b>	
Continental	Wixom, MI
Mark VIII	Wixom, MI
Town Car	Wixom, MI
<b>MERCURY</b>	
Capri	Melbourne, Australia
Cougar	Lorain, OH
Grand Marquis	St. Thomas, Ontario
Sable	Atlanta, GA Chicago, IL
Topaz	Kansas City, MO Oakville, Ontario
Tracer	Hermosillo, Mexico
Villager	Lorain, OH
<b>GENERAL MOTORS CORP.</b>	
<b>BUICK</b>	
Century	Shreveport, LA Oklahoma City, OK Ramosarizpe, Mexico
LeSabre	Flint, MI
Park Avenue	Wentzville, MO

Regal	Oshawa, Ontario
Riviera	Hamtramck, MI
Roadmaster	Arlington, TX
Roadmaster Wagon	Willow Run, MI
Skylark	Lansing, MI
<b>CADILLAC</b>	
De Ville	Orion Township, MI
Eldorado	Hamtramck, MI
Fleetwood	Arlington, TX
<b>CHEVROLET</b>	
Astro	Baltimore, MD
Beretta	Linden, NJ Wilmington, DE
Blazer	Janesville, WI
C/K Pickup	Ft. Wayne, IN Pontiac, MI Oshawa, Ontario
Camaro	Ste. Therese, Quebec
Caprice	Arlington, TX
Caprice Wagon	Willow Run, MI
Cavaliere	Lordstown, OH
Corsica	Linden, NJ
Corvette	Wilmington, DE Bowling Green, KY

Lumina	Oshawa, Ontario
Lumina APV	Tarrytown, NY
S-10 Blazer	Moraine, OH
S-10 Pickup	Pontiac, MI Moraine, OH Pontiac, MI Flint, MI
Sport Van	Scarborough, Ontario
Chevrolet/GMC Suburban	Janesville, WI
<b>GEO</b>	
Metro	Ingersoll, Ontario
Prizm	Fremont, CA
Storm	Fujisawa, Japan
Tracker	Ingersoll, Ontario
<b>GMC</b>	
Rally Van	Scarborough, Ontario
S-15 Jimmy	Flint, MI Moraine, OH Pontiac, MI
Safari	Baltimore, MD
Sierra Pickup	Fort Wayne, IN Pontiac, MI Oshawa, Ontario

Sonoma Pickup	Moraine, OH
Yukon	Shreveport, LA Janesville, WI
<b>OLDSMOBILE</b>	
Achieva	Lansing, MI
Bravada	Moraine, OH
Cutlass Ciera	Oklahoma City, OK
Cutlass Supreme	Doraville, GA
Eighty Eight	Flint, MI
Ninety Eight	Wentzville, MO
Silhouette	Orion Township, MI Tarrytown, NY
<b>PONTIAC</b>	
Bonneville	Wentzville, MO
Firebird	Ste. Therese, Quebec
Grand Am	Lansing, MI
Grand Prix	Fairfax, KS
LeMans	Inchon, Korea
Sunbird	Lordstown, OH
Trans Sport	Tarrytown, NY
<b>SATURN</b>	
All Models	Spring Hill, TN

# ENGINEERING

The newest from Detroit is under the hood.

BY PAUL WEISSLER

● The midnight oil has burned profusely in Detroit for all three domestic manufacturers this model year. Sure, there are some new vehicles to show for it—but most of the effort seems to have gone into refining and extending existing technology and hardware. The unending quest has been to increase fuel economy and power while reducing emissions, and at the same time improve driveability and lower noise and vibration levels.

## Chrysler

### LH sedans

There's lots of high-tech in the optional 4-valve 3.5-liter V6 that powers Chrysler's new Concorde, Dodge Intrepid and Eagle Vision. However, just as with the design of Ford and Cadillac's 4.6-liter V8s, reliability, smoothness and quiet come ahead of performance.

There's a "tuning valve" butterfly mounted between two otherwise separate sections of the intake manifold. The valve opens at 3200 rpm and stays open until 4000 rpm. This boosts torque throughout the rpm range by up to 15 ft.-lb.

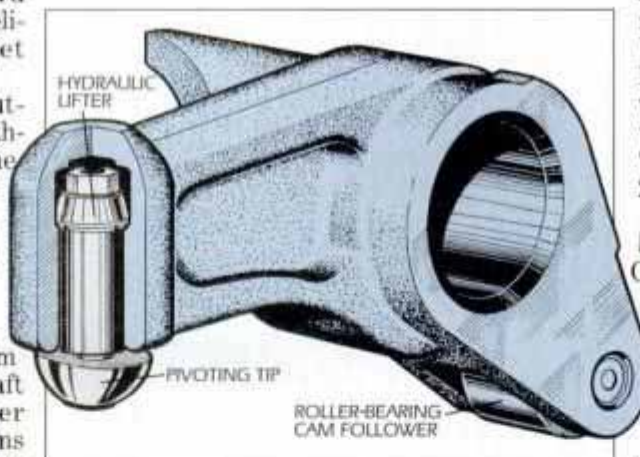
The engine's block is cast-iron, the heads are aluminum and there's just a single camshaft at each bank, with two rocker shafts for the valves. The cams are spun by a premium timing belt rather than a chain, but at 30mm wide, the belt could live for 100,000 miles or more. The belt cover is plastic-layered metal, which should mean super-quiet operation. Unlike some engines, there's clearance between the valves and pistons. So if a belt snaps, you don't face a major repair bill from a piston chewing on the valves.

Other engine enhancements include plastic valve covers, a hydraulic/rubber front engine mount, air-sandwich-layered metal heat-shields, plastic fuel supply rails (to damp injector noise) and two knock sensors wired to the engine computer. To further cash in on all of this quiet and smoothness, the front-drive powertrain is installed longitudinally

(north-south), which is smoother than a transverse installation.

Other details include roller-bearing valve rocker arms that have integral hydraulic lifters with a tip that pivots to maintain contact with the valve, regardless of minor rocker-arm shifts during engine operation. Valve-stem seals have the valve-spring seat built in, and a garter spring at the top of the seals keeps the seals in position.

Main bearing shells have "hinged" thrust surfaces, so they align near-perfectly with the block and crankshaft to absorb thrust loads evenly, instead of possibly edge-loading, which would shorten their life. They also are shaped to maintain an oil film on the thrust surfaces, so there should be almost no thrust-bearing wear.



Rocker arms in the LH sedans are of low-friction roller design, with built-in pivoting hydraulic lash adjusters.

The center main bearings are cross-bolted in racing fashion to add rigidity. Built into the oil pan gasket is a windage tray (baffle) to minimize the amount of oil the crank must churn through. This design not only saves a separate part, but also about 6 hp at 6000 rpm.

The starter motor has welded—no soldered—connections for durability, ensuring minimum resistance for consistent performance in hot restarts.

### Returnless fuel injection

Every multipoint fuel-injection system has had a pressure regulator at the injector rail with a line back to the tank to return excess fuel—until now.

The 1993 Dodge 5.9-liter V8 (on Ram models) has the regulator atop the fuel pump in the tank. This goes against the conventional wisdom which says that cold fuel flowing through the rail helps purge vapors on hot restarts. The new system overcame this by using a regulator with a very low leakdown rate to hold fuel pressure for hot restarts.

One of the benefits of this system is that fuel vapor emissions are 65% lower. Less fuel leaves the tank so the fuel stays cooler and there's less for the filter to screen, so it lasts longer.

### Grand Cherokee V8

The Jeep Grand Cherokee, introduced with the 190-hp 4.0-liter inline Six, gets the 5.2-liter V8, as predicted, this fall. The engine compartment was originally sized for the V8, so installation was no problem, but minor exhaust modifications from other 5.2-liter V8s were required. Thus, it produces "only" 220 horsepower, versus 230 in other models.

### R-134A a/c

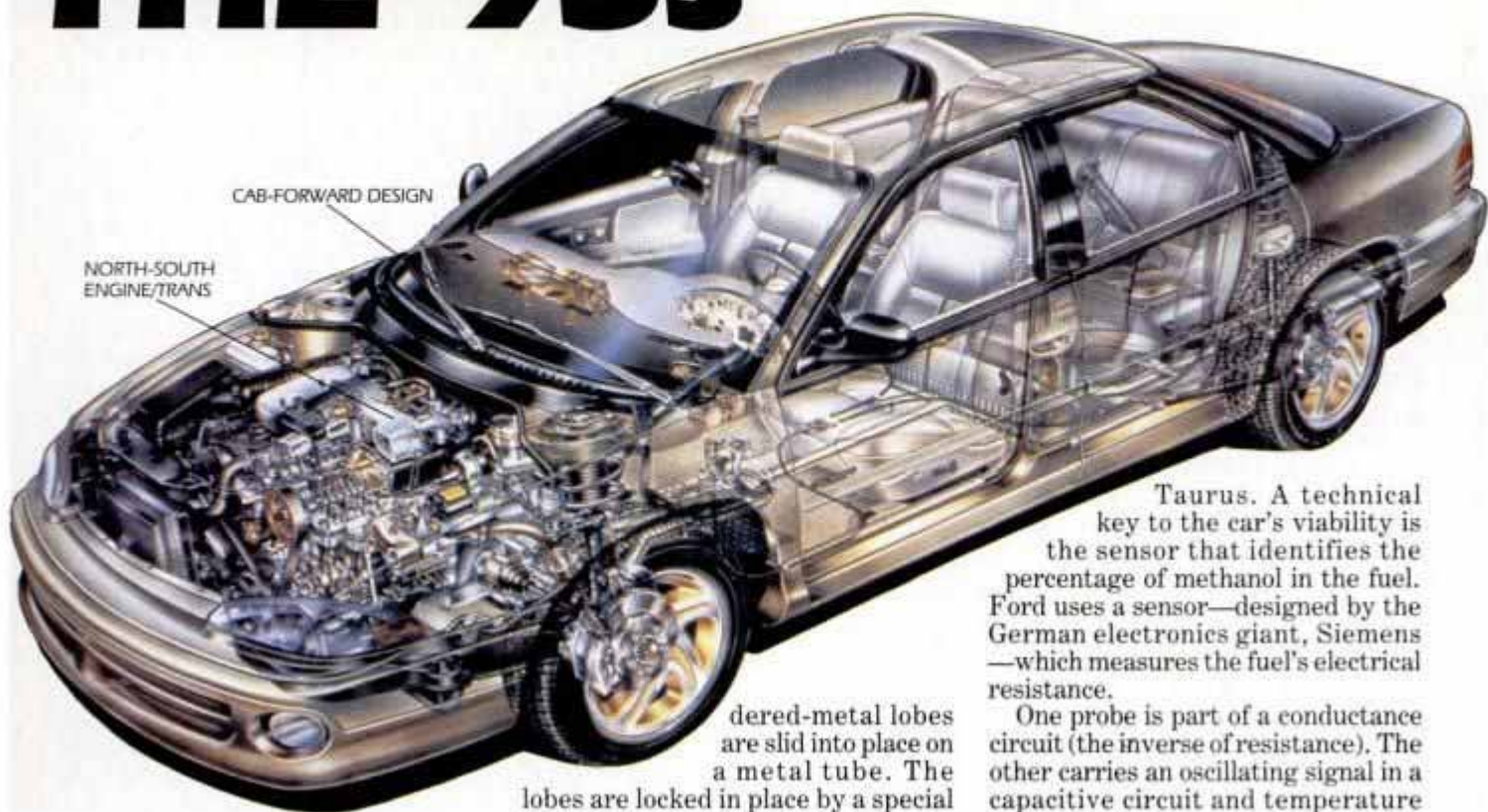
Chrysler should end up as the leading domestic installer of R-134A refrigerant in its '93 air-conditioning systems. Concorde, Intrepid, Vision and the minivans all get it, joining the Grand Cherokee. R-12 production stops in 1995, so those vehicles that have R-134A systems now won't face the grim possibility of scratching around for hard-to-find R-12 or the expense of conversion to another refrigerant in later years.

## Ford

### Mark VIII

The ultimate module in Ford's modular engine lineup—an all-aluminum 32-valve, dual overhead-camshaft V8—is ready for 1993. This engine goes first into the new Lincoln Mark VIII, scheduled for midyear production. The engine will be rated at 280 hp at 5500 rpm—more performance than either the current Lexus or Infiniti V8s—with the performance numbers developed at a lower rpm

# THE '93s



while delivering better fuel economy.

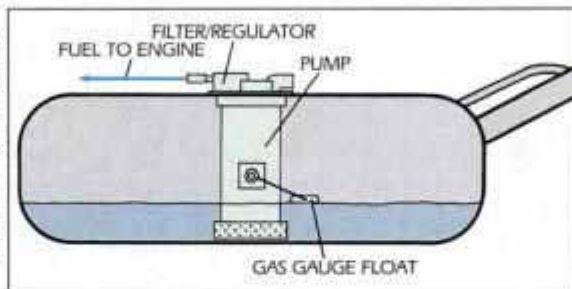
The aluminum-block design has pressed-in iron liners and a beefy deep skirt for rigidity and quiet, as well as four vertical bolts and two through-the-block crossbolts per main-bearing cap. There are also twin throttle bodies—instead of one as on the 2-valve—staged for smoother control at low speed.

The intake manifold has 16 runners, one for each intake valve, and each runner ends in a completely separate intake port for each valve rather than being Siamese. One set of runners, ports and valves comprises the primaries. These stay open until about 3200 rpm. They're shaped for good air swirl, so the fuel mixture burns quickly and almost completely, which results in good torque. The design also permits a relatively large volume of exhaust gas recirculation, for low emissions and good fuel economy. At 3200 rpm, the engine computer operates a solenoid vacuum valve/diaphragm unit, which opens all butterfly valves in the secondary runners for maximum airflow at high-end.

The four camshafts are Ford's lightweight hollow design, manufactured using a process in which pow-

dered-metal lobes are slid into place on a metal tube. The lobes are locked in place by a special tool which expands the tube.

Also interesting is the engine's cooling system, which has the thermostat at the water-pump inlet, where it maintains a more uniform temperature for incoming coolant and no coolant crossover passage between the cylinder heads in the intake manifold. Instead of the passage, an external pipe at the front of the engine serves the same purpose. Cool air



Fuel injection in Dodge Ram pickups has a regulator at pump in the tank for reduced fuel vapor emissions.

helps keep the front cylinders running cooler, developing more power.

The 4-cam V8 is bolted to a wide-ratio version of Ford's electronic overdrive automatic transmission, introduced in 1991 on the Town Car.

## Flexible-fuel Taurus

The first of the flexible-fuel cars to go to market in '93 is Ford's entry—a

Taurus. A technical key to the car's viability is the sensor that identifies the percentage of methanol in the fuel. Ford uses a sensor—designed by the German electronics giant, Siemens—which measures the fuel's electrical resistance.

One probe is part of a conductance circuit (the inverse of resistance). The other carries an oscillating signal in a capacitive circuit and temperature probe. A microprocessor converts the probes' readings to digital for the engine computer. The frequency of the signal (in a 50- to 150-Hz range) indicates the type of fuel. For example, 50 is gasoline, 150 is pure methanol and different percentages of methanol produce numbers in between, in a straight line (135 would be M85—85% methanol).

When the computer gets the information, it regulates current flow to the fuel pump through a resistor pack to speed up the fuel flow for lower-energy-content methanol blends or to slow it down for pure gasoline.

## More from Ford

- The SHO Taurus gets an automatic transaxle and a 3.2-liter version of the Yamaha 3.0-liter V6 for extra torque (up from 200 to 215 ft.-lb.).

- Ford's race headquarters (Special Vehicle Team) will offer a 250-hp version (up from a stock 200) of the 5.8-liter V8 in an F-150 Lightning pickup to compete with Chevy's 454 Sport Truck. The engine originally was designed for an anniversary Mustang that never was built. There will also be a high-output 5.0-liter V8 in the Mustang Cobra.

Two new Ford vehicles have ties to

## ENGINEERING THE '93s

Japanese manufacturers.

• The Mazda-engineered Probe (built in a jointly owned Michigan plant) is all-new, with a 115-hp 2.0-liter Four with scrapers in the valve guides to remove carbon deposits as they form, protecting driveability. Optional is a 164-hp 2.5-liter V6, replacing both the 2.2-liter turbo and 3.0-liter V6. Dropping the turbo version (with its sudden torque increases) and reworking the front-end geometry minimizes torque steer for '93.

• The Mercury Villager, designed by Nissan (which markets it as the Quest) and built by Ford, has a rarity: a 2-valve Japanese 3.0-liter V6. But a van needs torque and the 2-valver produces 174 ft.-lb., to go with 151 horsepower.

### General Motors

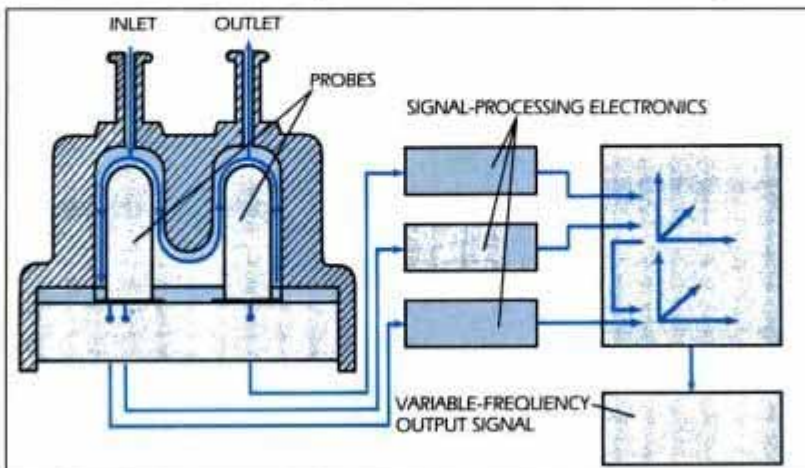
Cadillac's Eldorado and Seville, '92's beauty pageant winners, get more underhood muscle in '93: the 295-horse

Northstar V8 and a transaxle rated at 460 ft.-lb. will handle the Northstar's 290 ft.-lb. of torque with plenty of margin for future development.

Northstar takes all-aluminum 4-valve, chain-driven 4-cam technology several steps ahead to a new state of

low. A chain at each bank wraps around both cams and runs to an intermediate sprocket, which has a third chain attached to the crank. The chains are lightweight with a fine pitch and the sprockets are large with many small teeth, so the mesh is gentle and quiet. Dual tensioners at each cam chain are calibrated, one for engine start and low speed, the other for high speed. The drive chain uses cam-shaped pins in eccentric slots, instead of round pins in almost-round holes. The cam design guides the meshing of chain links to sprocket teeth for smooth, wear-free power transfer.

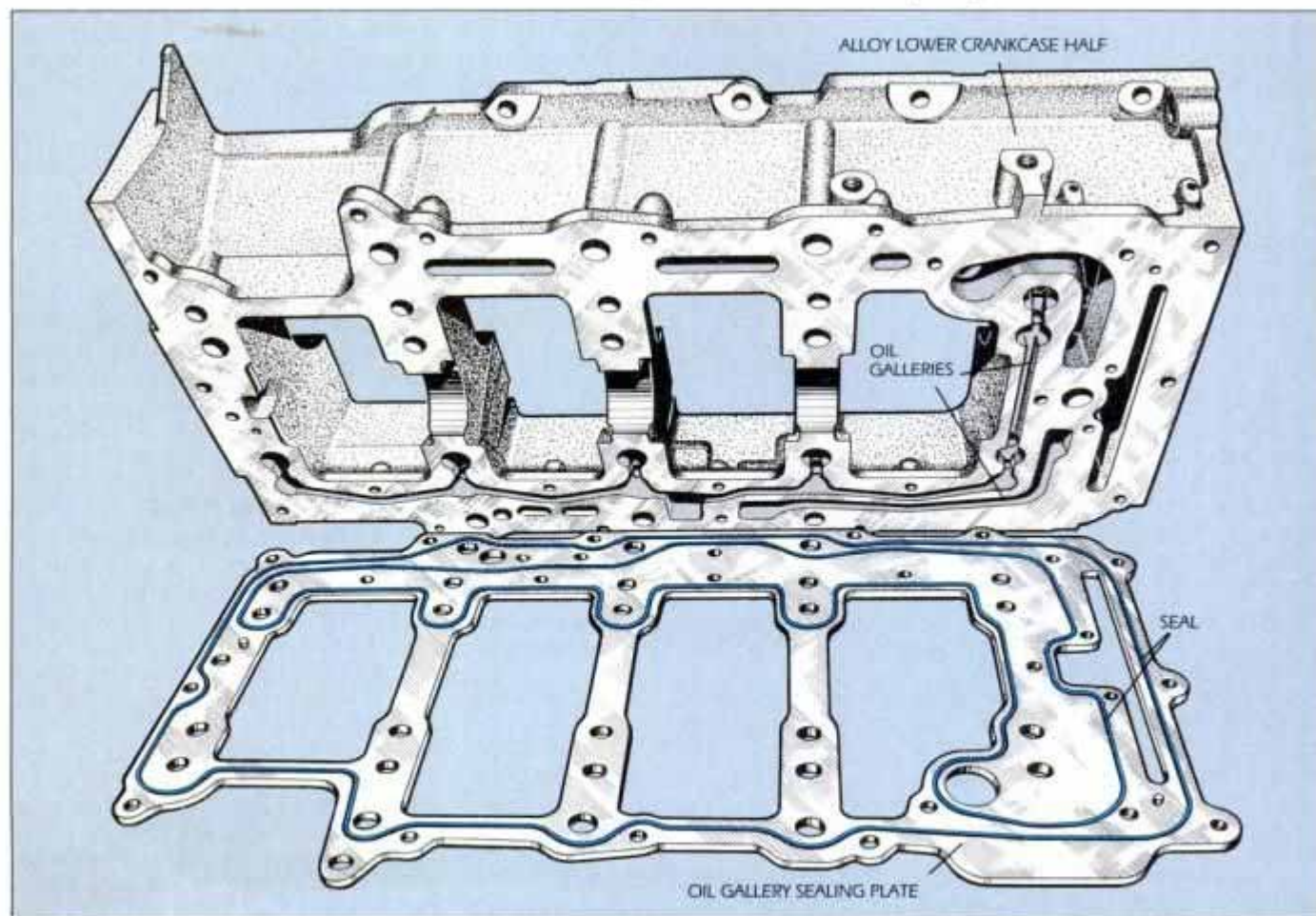
The aluminum block is cast around the iron cylinder liners without pressing-in or special sealing. The water pump is on the back of the engine for packaging reasons, and the thermostat is at the inlet for more consistent temperature control. Coolant passages are routed to balance flow



Flexible-fuel Ford Taurus sensor provides digital input for the engine computer.

the art. The tuned intake manifold has an insert with plastic runners that is so smooth, the airflow equals that of larger, almost straight pipes. The valvetrain is ultra-lightweight so camshaft-bearing and chain loads are

pressing-in or special sealing. The water pump is on the back of the engine for packaging reasons, and the thermostat is at the inlet for more consistent temperature control. Coolant passages are routed to balance flow



Northstar V8 utilizes cast-in (not drilled) oil galleries and sealing plate, rather than drilling the block.

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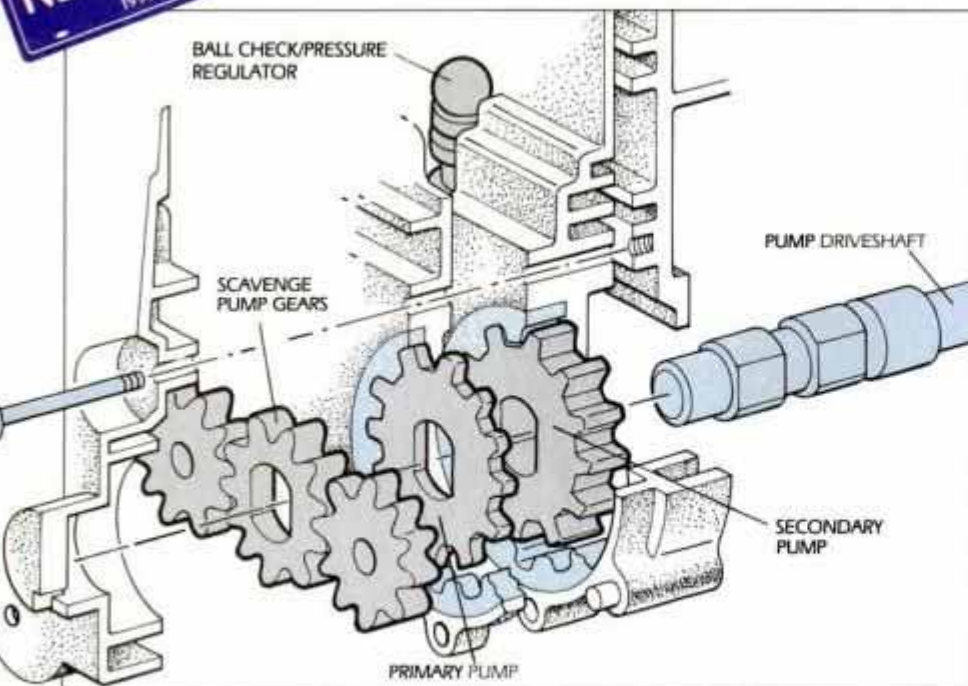
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A scavenge pump moves oil from pan to reservoir, secondary pump assists at low speeds.

and temperatures. Unlike the typical variation of 20° to 40° F between inlet and outlet, the coolant typically gets only 5° to 8° hotter on its path through the Northstar. If engine coolant temperature hits 270° F, the engine computer automatically protects against destructive overheating. It pulses the fuel injectors for one bank, lets the engine run for about 80 rpm, then shuts off that bank and pulses the injectors for the other.

The engine has a racing-inspired 2-piece crankcase (split at the crankshaft center line, with main bearing supports in the lower piece). Instead of trying to precision-drill long oil feeds through the block, and possibly weaken it, Cadillac cast open passages into the bottom of the lower piece, and sealed them with a cover.

The electronically shifted transaxle features dry-sump lubrication, which reduces pan depth to less than an inch, so the box fits into a low-slung engine compartment. The oil-pump shaft operates a scavenge pump, to suck up oil from the pan into a reservoir in the side cover, and a tandem pump for hydraulic operation. A secondary pump assists low-speed operation. When transmission speed builds up enough for the primary pump alone, the pressure regulator pushes a valve that redirects secondary pump output back to the input, saving energy.

Solenoids execute the shifts (reducing the size of the valve body) in conjunction with one-way clutches, so there's no tricky timing of hydraulic clutches and bands which tend to

make for harsher shifts. There's a specifically calibrated accumulator for each forward shift, for maximum smoothness, and a pulsing solenoid to gently apply the torque converter clutch. The torque converter itself is a high-efficiency design, averaging close to five percentage points better than GM's smaller electronic transaxle, and that translates to .5 mpg.

Northstar is standard on Allanté, Seville STS and Eldorado Touring Coupe. A 270-horse version is optional on Eldorado Sport Coupe.

### More from GM

- The 40th anniversary Corvette gets power boosts on both V8s. The exhaust valve cam lobe on the 300-hp pushrod engine was reworked to slow valve closing for quietness. One thing led to another with small valve timing

and lift changes and torque rose from 330 ft.-lb. at 4000 to 340 ft.-lb. at 3600 rpm. The LT-5 overhead-cammer goes from 375 to 405 hp—recapturing its horsepower lead from the Viper V10—thanks to mild changes in intake ports and slightly more valve overlap. In addition, a chamfer to the

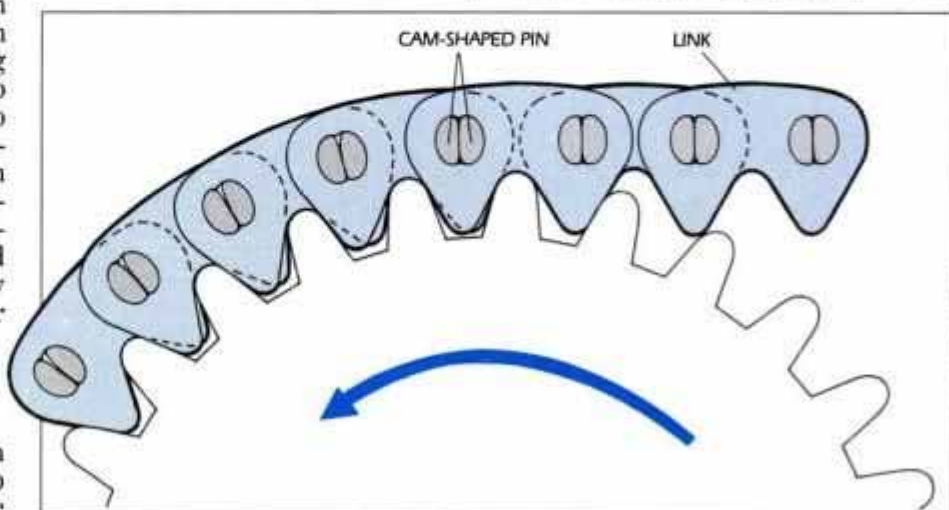
intake valve face and seat provides a smoother air path, increasing airflow 10%, at the valve's mid-opening. Torque is up to 385 ft.-lb.

- GM's workhorse 3800 V6 has an intake manifold with an upper half made of two plastic sections, one containing the runners. Smooth plastic improves airflow and keeps the air cooler. Roller rocker arms and thinner, low-friction piston rings, among other "directionally correct" changes, result in up to 0.4 more mpg.

- The 3.1-liter 60° pushrod V6 was bored out to 3.4 liters. With a new intake manifold and compression ratio bump (8.5 to 9.0), horsepower goes from 140 to 160 and torque from 180 ft.-lb. to 200. Camaro/Firebird versions get cast-iron heads, while the front-drive versions get aluminum.

- The battery in 1993 compacts (Olds Achieva, Buick Skylark, Pontiac Grand Am) won't run down if an interior light is left on or if the car is parked for a couple of months (while the electronics keep drawing power). After 20 minutes, a short-term timer shuts off the lights. After 24 days, a long-term timer cuts power to the clock, radio and keyless entry.

- The plastic vans (Chevy Lumina APV, Olds Silhouette and Pontiac Trans Sport) will offer an optional electronically operated sliding door. Like Mercedes' express-up window, it's an adaptation of garage-door technology, including an automatic stop-and-reverse if it is obstructed. **PM**



Northstar's chain uses cam-shaped pins for smoothness.





AH-64A APACHE HELICOPTER

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BUT IT CAN'T  
THINK LIKE A LEADER.**

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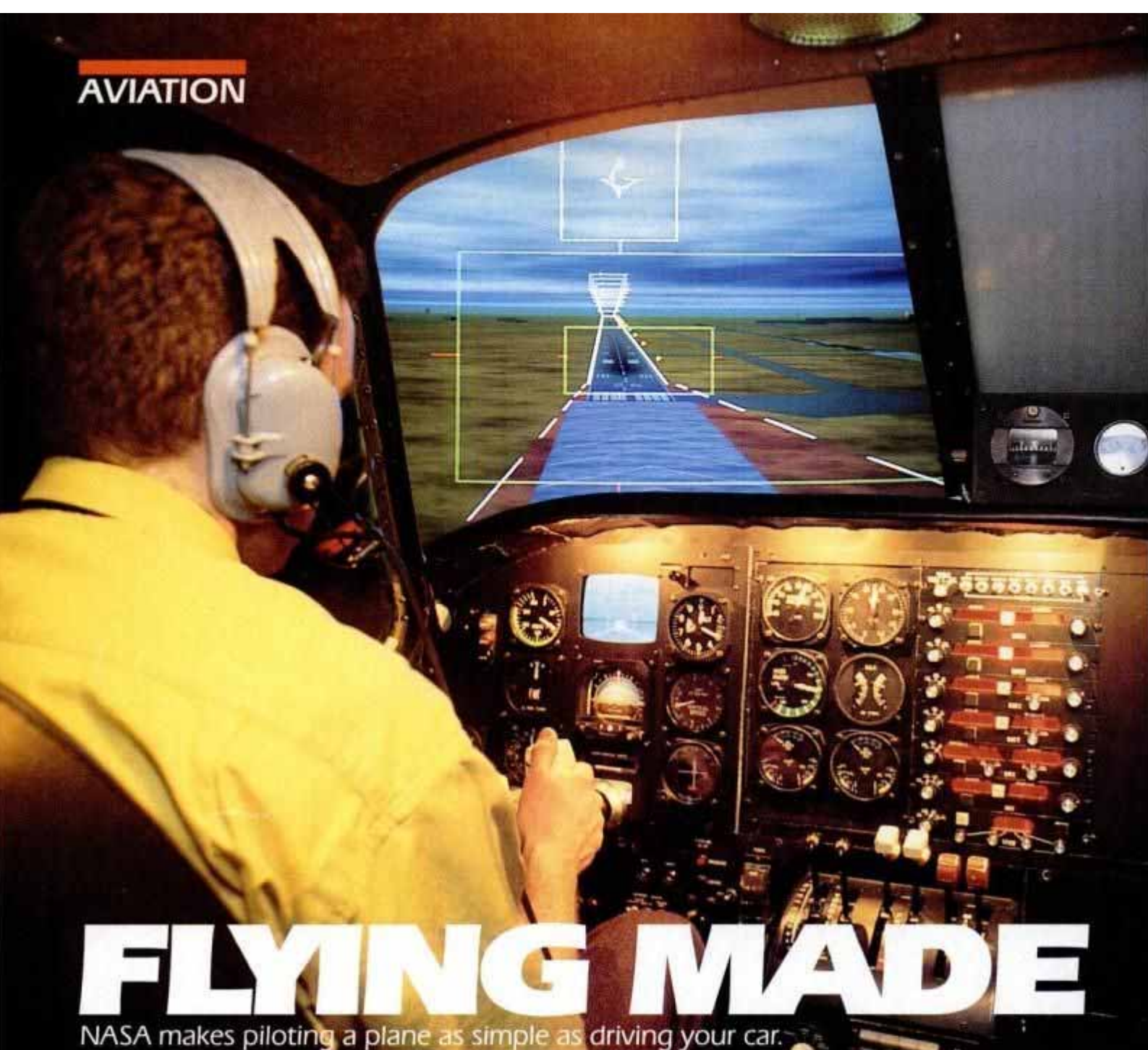
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# FLYING MADE

NASA makes piloting a plane as simple as driving your car.

BY GREGORY T. POPE  
 PM Photos by Frederick Sutter

● Outside the cockpit window, a dull gray blanket of clouds hovered 200 ft. above the runway, blocking out the sky completely. I knew my task: to launch into the soup, fly an oval race-track pattern at 2500 ft. and touch down again. It was an exquisite test of my ability to fly under instrument meteorological conditions—only I'd never been trained in instrument flying.

In fact, I'd never flown a plane in my life.

Nevertheless, I pushed the twin throttle levers to the 200-knot tick. Engines growled, and the runway slipped past faster and faster, until I pulled back on the yoke and the cloud bank loomed ahead.

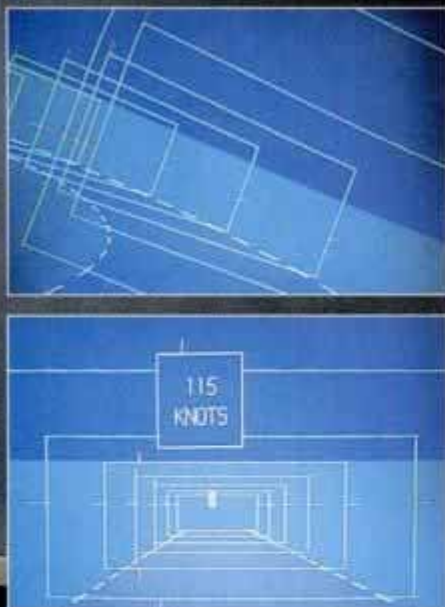
But instead of climbing into pea-soup oblivion, I nosed into a ghostly tunnel of receding green rectangles. Signs popped into view, reminding me to raise my gear and slow to 140 knots. Red lights danced along the edges of each rectangle to spell out my flightpath. The tunnel swung through the racetrack pattern and back down to Earth, narrowing to usher me onto the runway.

At no time during my flight did my eyes stray from the cockpit windshield to the instrument panel. At no time did my mind race through the interplay among airspeed, attitude and altitude that normally commands a pilot's attention. It was like driving a car on cruise control.

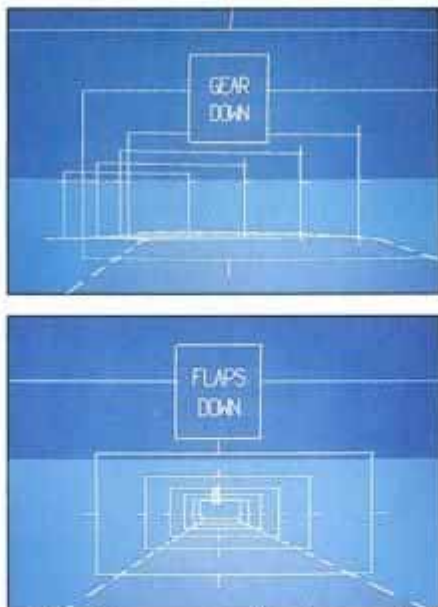
In reality, of course, I'd never left the ground. I was riding a flight simulator—a sawed-off Beech Baron in a

basement lab at NASA's Langley Research Center. The green tunnel of rectangles that led me through my maneuvers was an image on a head-up display (HUD). That I could climb, turn and change speeds without a pilot's training was the work of a novel flight-control system managed by a nearby minicomputer.

The display, called Highway In The Sky, and the control system, called EZ-Fly, are the twin brainchildren of NASA research engineer Eric C. Stewart. These programs have emerged from a decade-old Langley effort to parlay advanced military flight technology into a user-friendly private plane. Together, EZ-Fly and Highway In The Sky may spark the revolution that finally puts general aviation in the hands of the general population.



Approach and landing are the tasks that slap the most stress on rookie pilots. With Highway In The Sky, a sequence of rectangles appears on a head-up display to outline the terminal glide slope. As the aircraft nears touchdown, the rectangles narrow from 1000 ft. to 150 ft. wide to focus the flightpath on to the runway's center. Like overhead highway signs, reminders appear periodically. The system is geared to land the plane 1000 ft. down the runway, assuming you can manage a perfect flare maneuver.



action. Programmed to know what conditions could trigger a spin or stall, the processor can make the control surfaces move in a safe way no matter what the pilot does.

"Once you have that kind of system," says Stewart, "you might as well tailor it to make it easy to fly." EZ-Fly achieves that end by using a fly-by-wire computer to isolate, or "decouple," a plane's multiple responses to a single command from the cockpit.

The result: When a pilot turns the yoke, the plane simply turns *without* losing altitude and gaining airspeed. Not only does the EZ-Fly computer shift ailerons, it adjusts the throttle and elevator to keep the aircraft at a fixed height and velocity during the turn. Similarly, when the pilot pulls back on the yoke, the plane climbs *without* the normally concomitant drop in airspeed.

### Tunnel vision

But streamlining basic flying skills isn't enough to pin wings on a layman. Stewart's other invention—Highway In The Sky—aims to simplify navigation. At the same time, the concept knocks down the wall between visual and instrument flight rules (VFR and IFR). The difficulty of learning the complex IFR system now keeps many amateur pilots grounded in inclement weather.

Highway In The Sky makes unnecessary the scan across a panel of dials and instruments to determine attitude, position and heading. Instead, the pilot simply steers through the tunnel of rectangles that seems to float before the aircraft, courtesy of the head-up display. Typically, six rectangles show up at a time to define roughly a mile's worth of flightpath. New rectangles continuously appear at the far end of the tunnel as the

plane penetrates the closest one. White "lane markers" link the rectangles at the lower corners.

In addition, red marks skirt the edges of the tunnel, acting like crosshairs to indicate the plane's projected path. The pilot steers to keep the marks as close as possible to the center of each of the rectangle's sides. Complementing these trend marks, flight direction arrows occasionally appear above the tunnel, pointing out the corrections the pilot should make to his trajectory to get back on an ideal flightpath. Signs bearing suggested airspeeds and landing instructions also pop up.

Implemented in a real plane, Highway In The Sky would harness substantial computer horsepower, both in the cockpit and on the ground. To bring up the display, a pilot would key in his destination. Then the cockpit computer would ask an air-traffic control computer via data-radio to approve an air route that stays clear of other traffic. Once in the air, a Global Positioning System satellite or LORAN-C receiver would constantly update the system, so it could illustrate the plane's progress along the route on the HUD's tunnel display.

What happens if the plane strays far from the planned route, or reacts to avoid a surprise obstacle—such as another aircraft? "That's what we're working on right now," says Stewart. "We want the display to draw you a new road that curves back on to the original."

### Welcome to the real world

Fly-by-wire and head-up displays are already making the transfer out of military aviation and into commercial airliners. But Stewart argues that these systems would better serve private pilots. "The doctor who flies once a month is the one who needs these systems," he says, "so he doesn't have to train, train, train to stay proficient."

And Stewart is not the only engineer to pursue that goal. Research at the University of Maryland, Wichita State University and elsewhere is focused on finding ways that hard-won gains in military flight-system technology can pay dividends in general aviation.

NASA-Langley's new assistant director for aeronautics, Bruce Holmes, believes the technology surge could open up the skies for "nonenthusiast" aviators—people who simply want to get from point A to point B. "For the first time," says Holmes, "it's possible to conceive of small airplanes for travelers. That would be a paradigm shift for the industry." **PM**

# EASY

### Wire service

Stewart himself, a Langley hand for 25 years, can't fly. "That's an advantage coming in," he insists, because he understands the layman's dismay at the complication of the cockpit. "To me," says Stewart, "the controls aren't intuitive. To me, they're equivalent to having a car in which you'd swerve off the road if you stepped on the gas."

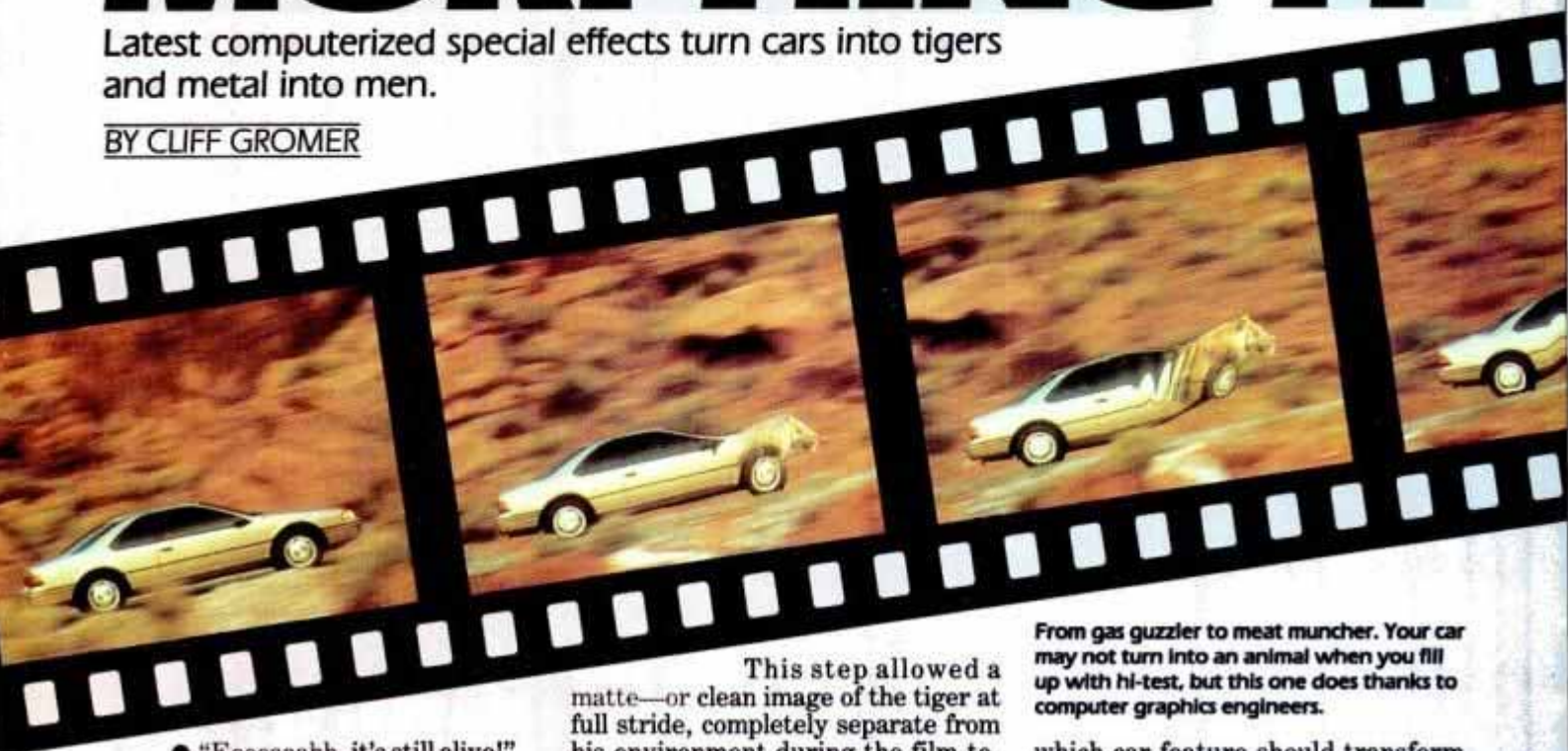
But EZ-Fly makes the plane behave the way an uninitiated flyer thinks it should behave. The control system evolved from a Langley project that used fly-by-wire control to prevent a pilot from stalling his plane or throwing it into a spin.

In a fly-by-wire system, a microprocessor reads the pilot's shifting of cockpit levers and sends electrical signals that drive aileron and elevator

# MORPHING IT

Latest computerized special effects turn cars into tigers and metal into men.

BY CLIFF GROMER



● "Eeeeeaaahh, it's still alive!"

We just love getting shocked out of our seats at the movies, and Hollywood knows it. The problem is new special effects get old fast, and we crave newer, more dazzling ones. You might say we've become an audience of special-effects junkies, and what we want is what we get. The hottest effect these days is called "morphing," or the seamless changing (metamorphosing) of one character or image into another. You've seen it on TV in the Exxon commercial, where an automobile ripples flawlessly into a running tiger, and in Michael Jackson's music video, "Black Or White," where he morphs into a panther.

To illustrate morphing in its simplest form: Say you have a red rectangle (the source) and a blue rectangle (the destination) on the screen. If you want to go from the source to the destination in one step, the computer would generate a rectangle just that size (if they were the same size) that would be exactly halfway in between blue and red. If you wanted the transition to take longer in real time, you could increase the number of steps in the transition to three or 100—realized by just a computer and software.

To realize the Exxon commercial's car-into-tiger morph, the tiger was first filmed running (after his trainer who was holding a chunk of raw meat) on a blue stage, against a blue screen.

This step allowed a matte—or clean image of the tiger at full stride, completely separate from his environment during the film-to-tape transfer—to be obtained.

The car was filmed on a road in the desert—also against a blue background screen attached to a truck that paced the car. The sequence had to be repeatable, so the crew used a motion-control camera—essentially a special camera that has gears and a computer attached to it so it will automatically repeat an already-filmed

## How did they do that?

sequence as many times as required. Here too, a clean image of the car was obtained with no background in the shot. Next, just the moving blue screen was photographed as a clean background on which to work with the images. Lastly, footage of the desert road was shot for the background from a moving vehicle.

At this point, there are the film elements of a "clean" tiger, car and real background. The computer graphics engineers took these elements and transferred them onto digital videotape, from which they could be scanned into the computers. This is where the actual morphing process began. Decisions were made about what the transition should look like—

From gas guzzler to meat muncher. Your car may not turn into an animal when you fill up with hi-test, but this one does thanks to computer graphics engineers.

which car feature should transform into what tiger feature, and how quickly the events should occur.

Once the morph, which was still "clean" at this point, was satisfactory, the images were composited onto the real background for the final product. The only thing left to do then was to send Exxon the bill.

More complex morphs, like the ones realized by Industrial Light & Magic in "Terminator 2," require banks of near-super computers, dozens of specialized software programs and the talents of scores of computer graphics engineers and model-makers. One of the most dramatic and technically challenging scenes in the film is when the T-1000 liquid-metal terminator character walks out of the burning wreckage of a truck and transforms from a metallic state into the live-action actor Robert Patrick.

One of the first steps in designing the transformation of the T-1000 was to define four distinct stages in the shape of the metal creature. In the first stage, it is an amorphous blob of liquid metal. In the second, it is roughly human-shaped, but featureless. By the third stage, it is a distinctly defined metallic man. And in the final stage, it is a virtual chrome replica of Robert Patrick.

The process was refined by creating small real models of the T-1000 at each stage. This gave the animators



and computer software engineers something real they could study, and provided a sense of how the character should finally congeal into a man.

Another key aspect of the sequence was making sure that the metal T-1000 moved like its human form: the actor Robert Patrick. The audience would see Patrick walking and running throughout the film, and the challenge here was to match the movements of the chrome version to the live actor's as closely as possible.

To do this, ILM filmed Patrick in motion with a network of grid lines drawn on his body. This information was then scanned into a computer to provide reference points that would allow Patrick's body shape and movements to be replicated in the computer model of the T-1000.

Based on that data, ILM's chief animator built a computer model of Patrick in wire-mesh form. This form could be pushed and pulled like "digital putty" into the various shapes of the metal T-1000. At that point, the animation process began.

Animating the chrome man as he emerged from the fire was among the most difficult computer graphics tasks in the film. The challenge of creating realistic human motion is nothing new. Computer graphics people have been trying to do this for 20 years. The spectacular effects achieved in "Terminator 2" are the result of intensive refinement. Sequences were drawn and redrawn on the computer maybe 30 times a day. Each time there would be slight mannerism changes—swiveling the hips just a bit, twisting the wrist a little more, adding a slight head movement—to bring across the realism and

personality of the character.

Once the animation was completed, a program called *Body Sock* allowed the ILM engineers to connect the distinct and separate pieces of the body that had been modeled, smoothing out the joints between those pieces. *Body Sock* moved specific points while maintaining continuity to create a smooth skin. T-1000's chrome appearance is the product of another ILM-developed program called *Polyalloy Shade*.

The final step in the process is combining the computer images with the background plate photography, with an ILM camera crew shooting live-action scenes on the set.

Because of the reflective quality of the T-1000's chrome "skin," realism also demanded that the surrounding scenery be reflected in the character's surface. Still photos were taken on the set to record a panoramic view around the space the T-1000 would occupy, and then this information was scanned into the computer. Likewise, light reflections from the T-1000 onto the ground and surrounding objects were also taken into account. Finally, other environmental tie-ins—shadows, smoke and even film grain—were added. It's those fine details that make the character appear real. Without them, the computer character would look like a cookie-cutter shape pasted on top of the live action.

Finally, the computer images and background plates were merged through digital compositing. This was a critical step, since any discontinuity between the computer and live-action images would have undermined the credibility of the entire scene.

It's a good thing too, because without those great, realistic special effects, a film is risking *hasta la vista* at the box office, baby. **PM**



Actor Robert Patrick is one hot number in "Terminator 2," as his image is gradually morphed from a chrome blob into a human form.

# LIFE FLIGHT

Three days aboard an airborne emergency room reveals the technology and teamwork required to save a life.

BY DAVID W. FREEMAN; PM Photos by Brian R. Wolff

● First word of the emergency reaches Cleveland's MetroHealth Medical Center just before 5 o'clock on a gloomy summer afternoon. Within 3 minutes, the time it takes me to race from the first-floor communications center to the rooftop helipad, the pilots and medical crew of Life Flight Three have already assembled and the rotors of the yellow Sikorsky S-76A are slowly starting to spin.

After days of waiting, I'm poised to fly with the second-busiest—and quite possibly the best—hospital-based air medical service in the United States. It's a moment I've anticipated with a mixture of excitement and dread. I'll get to see the

amazing things that aeronautical and medical science can do to save a life. But I also know that the hard reality is that it may not be enough.

Crouching to avoid the perilous droop of the titanium-and-graphite rotorblades and squinting against the building downwash, I scramble toward the sleek aircraft and climb aboard. Inside, I grab a seat alongside a gurney piled high with medical supplies and pull on a noise-canceling radio headset. Opposite me in the cabin, beneath a bulkhead festooned with ventilator hoses and a suction canister, flight physician Robert Sawyer, M.D., and flight nurse Pat Radey, R.N., are finishing final preparations for takeoff.

Boyishly handsome in sunglasses rimmed with fluorescent plastic, Dr. Sawyer is a neurologist and 2-year veteran of Life Flight, one of four full-time and 50-odd part-time flight doctors in the program. Nurse Radey, whose deep tan hints at a life outside this realm of injury and death, is a former intensive care nurse.

After stowing two units of chilled O-positive blood, Dr. Sawyer and Nurse Radey fasten 4-point safety harnesses across their electric-blue flight suits. Meanwhile, on the far side of the vinyl curtain that separates our cabin from the cockpit, pilots Joe Laliberte and Frank Leszczynski are finishing their own



preflight checklist. Like all Life Flight pilots, Laliberte and Leszczynski are instrument rated and have long experience flying under the most demanding conditions.

Moments later, Life Flight dispatchers radio the final go from inside the communications center. Our giant bird of mercy rises gingerly from its aerie, executes a crisp but oddly disquieting pirouette, then climbs swiftly away, its rotors tracing a hazy arc in the humid air.

Using coordinates supplied by the dispatchers, Laliberte and Leszczynski vector our \$3-million

On scene rescue runs, Life Flight pilots make do with whatever landing area the terrain provides.





mobile emergency room toward a small community hospital 50 miles to the southeast. There, awaiting transport to a better-equipped facility, a critically injured preschooler hovers uncertainly between life and death. As we leapfrog snarled rush-hour traffic, the dispatchers radio ahead with our ETA. Cruising at 180 miles an hour, our run should be mercifully quick.

### The golden hour

"The key to saving critically injured patients," says flight surgeon Raghavan Chari, M.D., "is providing quality medical care within the first 60 minutes of their injuries. If help arrives much beyond this 'golden hour,' survival rates fall off quickly."

Chari, known to his colleagues as "Ragu," estimates that Life Flight's helicopters typically reach patients about twice as fast as ambulances. "Because we don't have to follow streets and highways, each air mile equals about 2½ miles on land," he explains. "And once we get there, we've got more sophisticated equipment and better-trained personnel than a typical ambulance."

Jay Carter, M.D., Life Flight's silver-haired associate medical director

The S-76A has room for in-flight medical procedures (left) and can carry equipment to monitor a fragile newborn (right).

and himself a private pilot and flight physician, concurs. "Studies proving the benefit of an air transport system over ambulances are hard to come by, but it's clear that we're saving lives that would otherwise be lost. Any EMT [emergency medical technician] can get you to the hospital with a shattered tibia. But if you have a heart arrhythmia or some other bad problem, you need the kinds of equipment and the skills we have."

Carter likes to call Life Flight "the ultimate rescue squad." Judging from the thank-you cards that flood in from former patients, it's by no means an unpopular notion. A card from a man whose lower leg was amputated by a train reads: "Thanks for saving my life and being so quick about it! What happened out there was a miracle! May God bless all of you."

Life Flight began operations in 1982 with a single lightweight chopper. Today, 10 years and more than 16,000 accident-free flights later, the program flies not one but three medically configured aircraft. A fourth is kept in a hangar at nearby Burke-Lakefront Airport, local headquar-

ters for Petroleum Helicopters, which owns and maintains the helicopters used by Life Flight and a dozen other U.S. medical transport programs.

Weather permitting, the program's three S-76A's fly around the clock, seven days a week, 365 days a year, within a 250-mile radius of Cleveland. That encompasses all of Ohio and parts of Michigan, Indiana, Kentucky, West Virginia, Pennsylvania, New York and even Canada.

On rare occasions when "lake effect" precipitation or other inclement weather rules out even instrument flight, Life Flight responds with a Chevrolet C-70 truck rigged as a mobile intensive care unit (MICU). The MICU is also used to transport patients between hospitals in close proximity to Metro, especially those without landing zones.

Obviously, such an ambitious program is costly. Life Flight charges \$400 per flight, plus \$15 per mile, but health insurance usually picks up the tab. When patients are uninsured, or claims adjusters deem a flight "medically unjustified," the hospital where the patient is ultimately admitted generally absorbs the cost. Says Mary Jane Klempay, Life Flight's adminis-



trative director, "We're not checking for Blue Cross/Blue Shield when we go out to pick up patients." Life Flight never takes into account the patient's ability to pay, only his medical need.

Klempay says that Life Flight averages 10 rescue flights during a typical 24-hour period, though 20- or even 25-flight days are by no means uncommon. About 16% of these missions are so-called "scene runs," made directly to the sites of car wrecks, industrial accidents and the like. The rest involve shuttling patients between the 65 regional hospitals that participate in the program. On occasion, Life Flight ferries surgical teams to "harvest" hearts, livers and other organs for transplantation.

### A life in the balance

Two minutes into our flight, Nurse Radey radios Life Flight dispatchers to request information about our patient. The facts are sketchy but starkly chilling. Our patient is a 4-year-old who sustained a severe blow to the head while playing outdoors.

Silently, Nurse Radey sets to work calculating pediatric drug dosages. Curiously, the clipboard she uses contains not paper but—more reliable in such a windy environment—several strips of cotton surgical tape laid edge to edge.

Minutes later, beneath a gentle rain, the helicopter sets down in an empty hospital parking lot. Though our landing spot is within quick walking distance of the emergency room, an ambulance is waiting to help speed the final leg of our trip. To save even more precious time, Sawyer and Radey opt for a "hot" off-load, freeing the gurney from its floor locks, then flinging open the copter door while the rotors are still spinning. She and Dr. Sawyer bolt for the ambulance, gurney in tow. I trail behind, trying to stay close without getting in the way, praying that we've arrived in time. It's now 5:10 pm.

The scene awaiting us inside is almost unendurable. The little girl, her pretty face discolored and horribly swollen, lies unconscious beneath a thicket of breathing tubes and IV lines. The only evidence of life is the steady beeping of a heart monitor. Dr. Sawyer and Nurse Radey stay only long enough to perform a quick examination, transfer her to their

gurney and, to prevent spinal injury, immobilize her head with tape and coiled towels. As the child is wheeled out to the waiting ambulance, her parents bid her a final, anguished farewell. "I love you," her mother cries, "I love you." I hear her, but I cannot

few people expected him to survive, much less resume a normal life. Yet, thanks to Life Flight—and several operations and months of physical therapy—he did just that.

Another unexpected save came when Life Flight responded to a call from a small town southeast of Cleveland, where a hapless skydiver had broken her back in a skydiving accident. "Her chute just didn't open," recalls flight nurse Betty Kovach, who was on the rescue run. "She was stuck in about a foot of mud in a swamp, and the doctor lost both of his shoes when we went out to get her. But we got her back to the hospital and she managed to pull through." Actually, she did more than that. "Just a couple of weeks ago," says Klempay, "I read in the paper where she went skydiving again."

### Mercy bird

The Sikorsky S-76A used by Life Flight is the largest, most powerful medical transport aircraft currently in use. Designed primarily for offshore oil platform duty, it boasts an impressive 3000-pound payload capacity—enough for two patients and four attendants, plus a room full of medical equipment. Powered by two 650-horsepower Allison 250-C30SE turboshaft engines, it has a range of 404 nautical miles and a top speed of 155 knots.

Cockpit equipment for this configuration includes full dual flight controls and instrumentation, plus dual VHF and NAV radios, R/NAV 50i Loran, weather radar, radar altimeter and Wolfsberg Flexcomm transceivers capable of using 22,000 frequencies.

Because the aircraft often operate at night, taking off from and landing at makeshift landing zones illuminated only by automobile headlights, they have an unusually full comple-

ment of lights: one 650,000-candlepower swiveling searchlight mounted under the nose, plus a 750,000-candlepower belly light, and two 450,000-candlepower fixed main gear lights. The tail pylon is illuminated to help keep people unfamiliar with helicopters from walking headlong into a spinning tail rotor. For forced water landings, the helicopter is also equipped with flotation bladders that inflate with pressurized nitrogen.

Inside, the aircraft is  
(Please turn to page 138)



Speed in the air is wasted without speed on the ground, so crews scramble every inch from helicopter to emergency room.

bring myself to watch.

Given the extent of the little girl's injuries, everyone in the room senses that this may be the final farewell. Yet, over the years, Life Flight has pulled off its share of miracles.

Three summers ago, a Life Flight team set down on a Lake Erie beach to rescue a swimmer who had been almost cut in two by a speedboat propeller. The man had lost so much blood and his injuries were so horrific that



## EXHIBIT

# POSSIBLE DREAMS

America's dreams are alive as we look to the future with enthusiasm from the past.

BY MARY SEELHORST

● Americans love to speculate about the future almost as much as we love to drive cars. So it should be no surprise that Henry Ford Museum chose a futuristic concept car to represent the "Rage of the Future" in "Possible Dreams: POPULAR MECHANICS and America's Enthusiasm for Technology."

The Possible Dream Machine—a satiny red Ford Probe—is displayed before a winding road stretching to a distant horizon—forever the road-lovers' symbol of future possibilities, new places and things unseen. The car is the fifth in a series of concept vehicles created to probe the outer limits of aerodynamic design in driveable automobiles.

If its sleek, rounded form looks vaguely familiar, it is because some of the lessons learned from the Probe-series have already been incorporated into the now-familiar aero-look of trend-setting cars like the Ford Taurus. Current Probe production models also reflect ideas predicted by Probe V. But some features—like the car's flush-glass greenhouse—must wait on new, auxiliary technologies before they prove feasible.

The goal of the design team was to produce the most aerodynamic driveable automobile possible, developing ideas and innovations destined for use on production models five to 10 years out. When Probe V was being designed in 1985, the drag coefficient of production automobiles ranged from .32 to .52. Reducing wind resistance through aerodynamic styling has become an important factor in cutting fuel consumption.

Twelve promising designs were first sketched by hand and then rendered on a Computer-Aided Design



(CAD) system, where designers and engineers could examine their potential in detail. This particular design survived the selection process and went on to become first a  $\frac{3}{8}$ -scale model for wind-tunnel testing, then a full-scale clay model, followed by a fiberglass version. The final fabrication was done by hand at Ford's Ghia Design Studio in Italy.

And the result? One hot-looking car with an unbelievable .137 coefficient of drag. A fully sculpted underbody contributes to the car's efficient aerodynamics, as does the flush-glass greenhouse, fully integrated into the car's form without the traditional separate windshield, windows and backlight. Engineers are currently examining ways to convert a wrapover expanse of glass from opaque to clear—the key to incorporating the concept on a production model.

Even the car's headlights contribute to the overall aerodynamics. The low-profile "mini-quads" (a fiberoptic technology) follow the front-end contour and allow for a lower hoodline. Probe V's profile discloses an early foray into the much-discussed cab-forward design concept, in which the passenger compartment is shifted toward the front end. All wheels are fully skirted, the front covers displacing as the wheel turns and returning to their original [\(Please turn to page 99\)](#)

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

# Quality Performance begins with quality parts. Motorcraft Quality Parts.



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# THE MAGIC BOAT

This integrated boat/camper combo is the ultimate recreational vehicle.

BY JOE SKORUPA, Boating/Outdoors Editor; PM Photos by Robert Holland

● "Where do the wheels go when the Boatmobile hits the water?" People who encounter the Boatmobile for the first time are frequently confused. After all, the Boatmobile isn't your typical water-oriented craft. Dualie wheels and V-hulls rarely mix in the same integrated structure. Besides, when was the last time you had to kick the tires on your new boat?

Fortunately, the Boatmobile's designer, Luis Avillez De Basto, wisely solved the wheels-in-the-water problem before building his first prototype. I tested this prototype recently in Miami's Biscayne Bay and discovered that his solution is simple: When the boat goes in the water, the wheels stay on the land. In other

words, the boat and trailer are two separate elements, similar to a typical trailer/boat rig, except that they function together like no other craft. This point is made especially clear on land where several integrated components unfold to turn the Boatmobile into a multipurpose water-going RV.

A little more than two years ago, De Basto, who is a successful yacht designer from Sao Paulo, Brazil, decided to move to Miami, Florida. In order to launch his U.S.-based firm in a bold way, he decided to create a design for a totally unique craft—a dual-purpose land and water vehicle. De Basto researched the history of amphibians from the military "Duck" to the family-size Amphicar of the 1960s,

as well as a number of other less successful designs. The research left him with the conviction that nothing that had been developed to date could truly live up to modern levels of comfort and performance. Much was lost in the effort to integrate land and water capabilities.

Since De Basto didn't want to make the same mistake, he set three goals for the Boatmobile: 1. It had to perform like a true boat, 2. It had to have true land mobility, and 3. It had to have true RV luxury and access.

The result of his effort is a vehicle that isn't an amphibian in the strict sense of the word, but one that rides like a boat, accommodates campers like an RV and achieves surprisingly high standards in both areas.



On land, the Boatmobile converts to an RV, complete with an easy-to-use stairway, large storage compartment and other built-in features. On water (right), it becomes a sleek, luxury cruiser.

## Amphibious RV

"How do you drive down the highway from the flying bridge?" This is the second most-asked question among Boatmobile novices. Naturally, De Basto solved this problem, too. The only time you drive the Boatmobile from the flying bridge is on the water. On the road, you drive it from behind the wheel of a tow vehicle—and a powerful one at that. Combined boat and trailer weight is 10,000 pounds.

I received my first Boatmobile driving impression from behind the wheel of a Ford F-250 crew cab dualie. After cranking the ignition, I shifted the automatic transmission into Drive and smoothly accelerated into traffic. Since the Boatmobile will endure more road miles than the typical trailer/boat rig, I was curious to see how it handled on highways and tough city streets. To my surprise, it was the smoothest riding load on the road, well balanced and well behaved at all speeds.

The dual-axle trailer has four contoured longitudinal bunks that snug



the boat at the hull's strongest structural point—its stringer line. This means that when the boat settles into the trailer bed, it's not only balanced and rock steady, but also supported in the least damaging way.

Another outstanding feature on the trailer is its unique suspension, which uses a top-of-the-line torsion-bar axle instead of the typical array of leaf springs, hangers, equalizers, shackles and shocks. This system, which is more commonly found in RVs, has a hexagonal exterior axle made of tubular steel that holds a 3-sided steel shaft surrounded by rubber inserts.

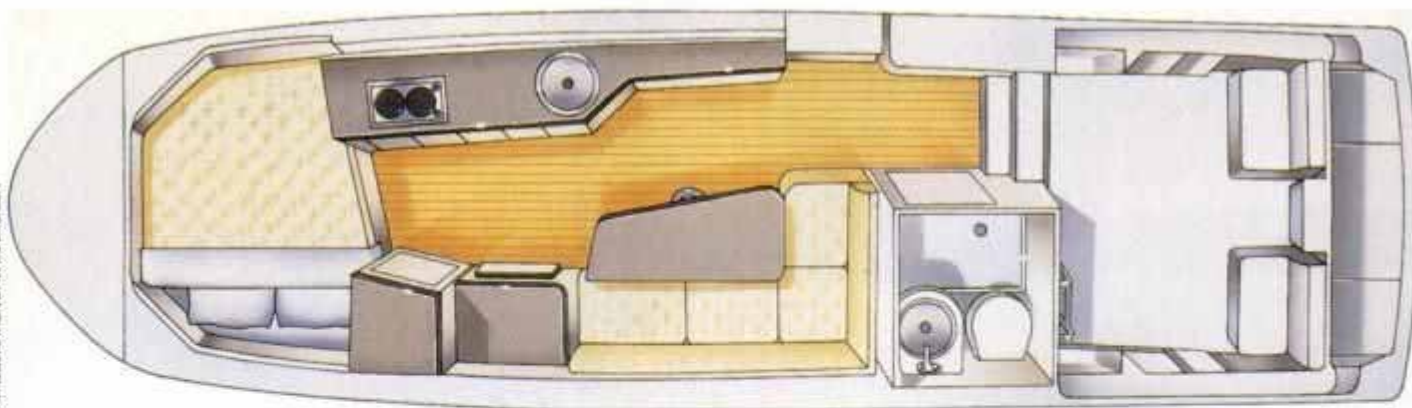
Spindles are connected to the inner shaft, and the wheels are connected to the spindles.

When a wheel goes over a bump, the spindles transfer a twisting force to the inner shaft and the rubber inserts absorb it. The effect while driving on the road is an incredibly smooth and rattle-free ride. Another advantage is that it's maintenance-free.

There are many other noteworthy features and systems on the Boatmobile's trailer, including built-in stairs that lead to the boat's ingenious starboard-side door and huge forward storage compartments, but I wanted

# THE MAGIC BOAT

ILLUSTRATION BY MARC ERICSEN



to postpone inspecting these elements until later. Now, I was anxious to get out on the water.

## Sea trials

With the aid of an electric winch and a double set of keel rollers, the Boatmobile effortlessly separates into its distinct boat and trailer components. A quick glance at the trailer reveals that its modular fiberglass panels aren't load bearing, but instead are intended to provide aerodynamic efficiency at highway speeds, modern lines for feeling at home in marinas and RV campgrounds, and enclosures for storage space.

After climbing into the flying bridge, I cranked the ignition, pushed the throttle forward and idled smoothly into Biscayne Bay. Since De Basto is primarily a yacht designer, I was especially interested in seeing how the Boatmobile performed as a marine vessel.

Safely out in the Intracoastal Waterway, I pushed the 7.4-liter MerCruiser/Bravo II power package to wide-open throttle and reached a top speed of about 30 mph. Noticeable sensitivity to outdrive trim, trim tabs and movement in the steering wheel required a short period of adjustment, but once the settings were nailed down, overall handling and feel were good.

A boat of this size shouldn't shy away from offshore waters, so I headed out of the Stiltsville channel and looked for some rollers. All I could find on this day were 2- and 3-footers, but it was enough to show that the Boatmobile can run at speed in a variety of conditions and still offer a dry, smooth ride.

Sightlines from the flying bridge were outstanding, as was the layout of the helm and generously instrumented dash. For the driver there's a swiveling captain's chair, and for passengers, an L-shaped bench and a port-side lounge. More passenger

**Layout shows a forward berth, a galley with alcohol/electric stove and a dinette that converts into a second berth.**

seating is located down in the aft cockpit, which is large enough to offer room for fishing.

## Land duty

On either land or water, the Boatmobile's well-designed interior offers spacious and deluxe accommodations, but on land its uniqueness really shines. After dropping down the electric tongue jack, unfolding the trailer steps and opening the specially designed starboard-side door, the Boatmobile becomes a functional RV.

Conventional shore power and water hookups enable operation of an air

conditioner, microwave oven, double-burner electric/alcohol stove, exhaust fan, huge 7-qt. refrigerator, shower, radio/cassette player and numerous other features. Amenities include an L-shaped bench seat, a large dinette table, two double berths for comfortable overnighting and an optional, fold-down double bunk.

Like all well-designed RV interiors, there's a feeling of true roominess in the Boatmobile. This is partly due to its 6-ft. 3-in. headroom and the copious amount of light streaming in through its wraparound tinted windows. Storage space is roomy, too. In addition to the trailer compartments, which are big enough to fit a generator, several lawn chairs and a barbecue grill, there's a tremendous amount of space beneath the seats and in the many cabinets.

What makes this interior setup unique to the Boatmobile is the way it works on land. A deck-level door with a 4-point locking system swings away to enable an ingenious set of steps to fold down to meet a companion stairway on the trailer. Although the door is located above the sheer line, its design is based on the watertight, compressed-gasket doorways used on ships. De Basto also points out that the top and bottom of the doorway meet

at the boat's upper and lower deck levels to maintain maximum hull integrity.

At the time I inspected the Boatmobile, it was literally the first boat off the line and had yet to be named. Since then it has been dubbed the Boatmobile Freedom Sport, and other models are planned. Future models will be smaller than the 30-footer I tested in order to reduce the towing weight (currently 7000 pounds for the boat and 3000 for the trailer), and to lower its \$110,000 price tag.

The Boatmobile may not be a true amphibian, but it more than fulfills the function of a dual-purpose craft. And it does it very well. **FM**



Is it an RV or a boat? Deluxe amenities make it hard to tell from this forward-facing view of the cabin.

## Specifications

Boat length	29 ft. 8 in.
Beam	8 ft. 6 in.
Trailer length	35 ft. 6 in.
Boat weight	7000 lb.
Trailer weight	3000 lb.
Fuel capacity	150 gal.
Water capacity	30 gal.
Bridge clearance	9 ft. 6 in.
Draft with drive down	37 in.
Cabin headroom	6 ft. 3 in.
Hull type	19' Mod-V
Price as tested	\$110,000
Boatmobile, 1395 Brickell Ave., Miami, FL 33131; (305) 373-1500	

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**AC Delco AC Spark Plugs.** New plugs help improve car performance and save gas.

It's like buying time. In popular sizes for many GM cars and light trucks. Sold in 4-, 6-, and 8-packs only.

4-Pack **2 for 9.00**

6-Pack **6.75**

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the price you want.

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**Kraco KF-1105** Anti-Theft, AM/FM Auto-Reverse Cassette Player. With high power wattage; jack for portable CD; plus, pull-out chassis with carrying handle. **109.00**



**Jensen CS2500 ETR** AM/FM Stereo Cassette Player. Includes automatic program control, seek tuning, and 18-station presets. **99.00**

**Jensen CS5400 Deluxe ETR** AM/FM Stereo with Auto-Reverse Cassette Player (not shown). **119.00**

**Kawasaki KR262** Ready-To-Install, 50-Watt AM/FM Stereo Auto-Reverse Cassette Player. Advanced design fits into GM and Chrysler cars without installation hassle for easy upgrade with original equipment fit, for the do-it-your-selver.

**Kawasaki KR260** Stereo Cassette Player (not shown). Custom for Ford/Import. Your choice. **169.00**



**Kraco KID-B588D** AM/FM Auto-Reverse Cassette Player. With fast-forward, rewind, and local/distance and stereo/mono selector. **54.00**

**Kraco FX-95** 2-Way Box Truck Speakers (not shown). **89.00**



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**Uniden Bearcat Programmable Scanner.**  
 Ready to use, 16-channel scanner covers  
 10 bands, including police, fire, and rescue.  
 Instant NOAA weather broadcasts. Com-  
 plete with AC adaptor and antenna.  
**#BC560XLT. 99.00**

Check with local law enforcement officials for  
 regulations governing this product.



**Cobra C20 40-Channel  
 CB Radio.** Compact design  
 features digital readout,  
 squelch, LED signal  
 strength meter, and  
 instant emergency  
 channel. **59.00**  
 C23 Plus (not shown).  
**74.00**

**Cobra RD300 Stealth Trapshooter.**  
 Detects X, K, and KA band radar.  
 Adjustable mounting bracket and  
 six-foot power cord. **79.00**  
 Wideband RD302 (not shown). **129.00**  
 Not available in  
 CT or VA.



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ELECTRIC CORPORATION



**Schumacher 10-Amp Automatic/Manual Battery Charger.** For 6- and 12-volt batteries. Special circuit for maintenance-free, deep-cycle, and conventional-type batteries. Automatic circuit breaker. #SE-50MA. **39.97**

**Schumacher 10-Amp, Deep-Cycle Battery Charger.** Designed for charging 6- to 12-volt batteries. Marine and recreational. Charges within 3 to 5 hours. #SE1010. **29.97**



**Schumacher 6/2-Amp Battery Charger.** 6-amp medium-rate charge for auto or light truck batteries. Plus, 2-amp rate for other battery-powered equipment. #SE-82-6. **26.97**

**Whistler WH680 Radar Detector.** Triband reception (X, K, or KA band). Audible band identification. Three-segment LED display. Rotary volume control. **79.00**

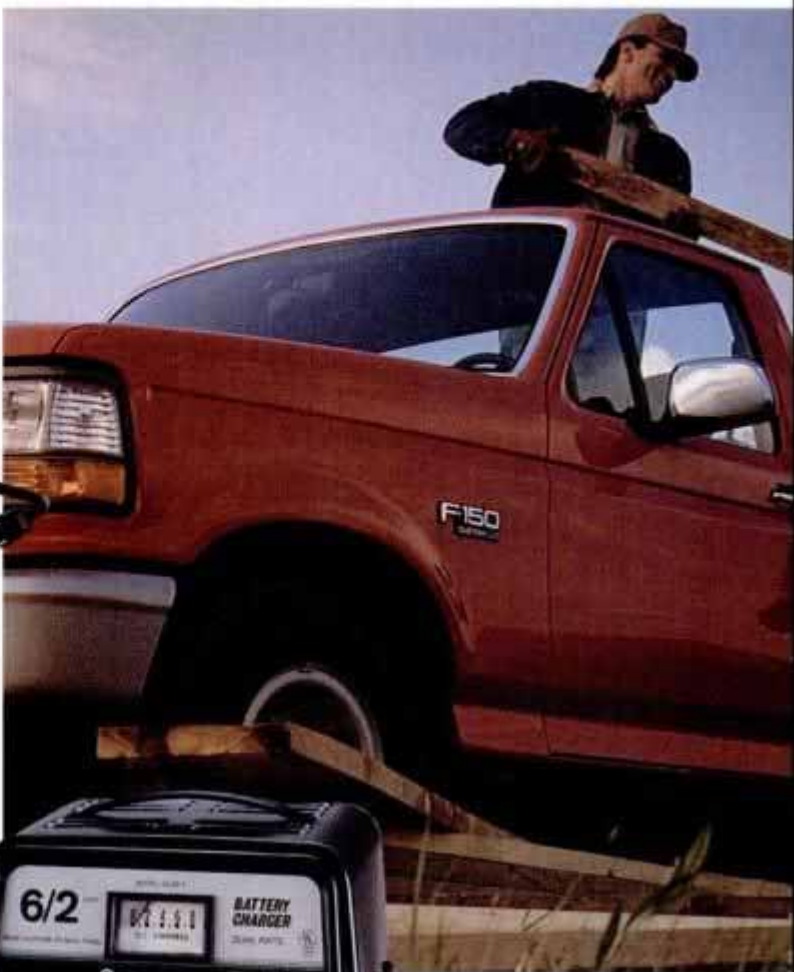
**Whistler WH880 Radar Detector (not shown).** **169.00**  
Not available in CT and VA.

**Whistler WH480 Radar Detector.** Six-segment, LED array lights, opaque alert bar. X and K band monitoring. City/Highway mode switch and full-range volume control. Includes dash/visor bracket. **44.00**

Not available in CT and VA.



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**Rubbermaid Action Packer Storage Container.** 15½-gallon or 24-gallon. Your choice. **16.00**



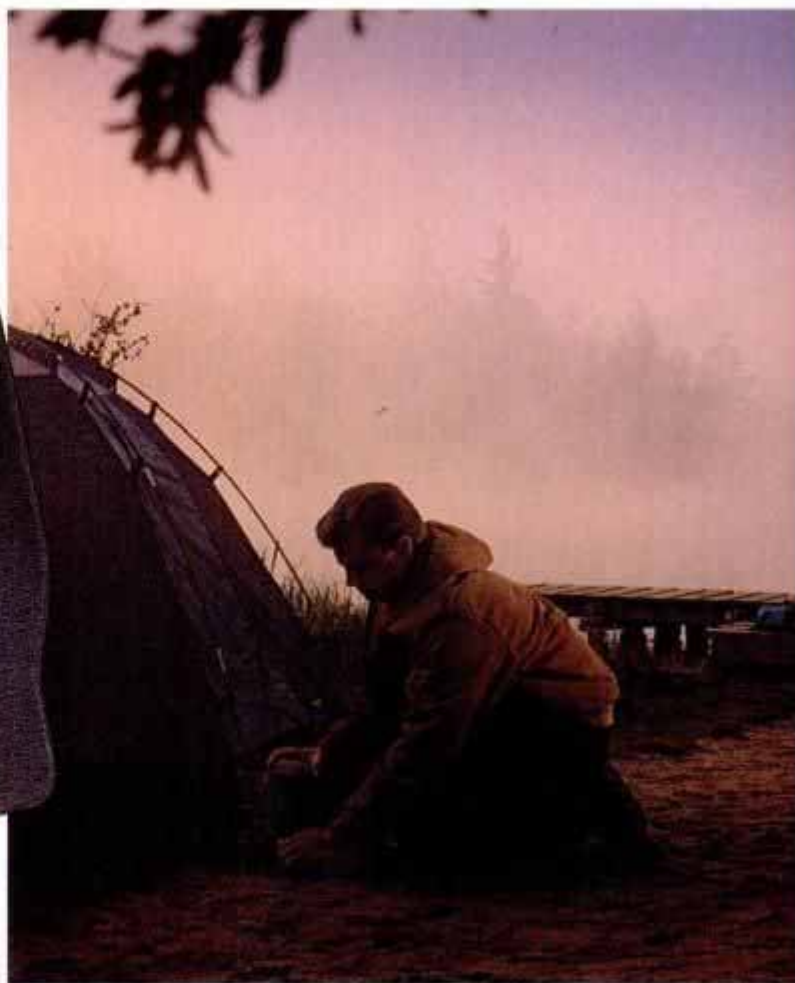
**Contico Workbox Truck Toolbox.** Maintenance-free polyethylene construction. Sets directly on floor of truck. For many full-size or mini-trucks. Contico Mid-Size Truck Toolbox (not shown). Your choice. **72.88**



**The Truck Club.** Specially made for truck security. Tempered-steel construction for high visibility and protection. Police-tested. Use on pickups, vans, RVs, 4x4s, and semis. **47.67**



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**Ultima Luxurious Automotive Mats.** These mats won't slide. 4-piece car, 3-piece van, or 2-piece truck. Assorted colors. Stain-resistant, and easy to clean. Your choice. **19.97**

**Black & Decker Auto Vac.** 12-volt cord plugs into cigarette lighter. #9509. **9.97**



**Black & Decker Handy Orbit Polisher.** Compact, lightweight buffer for waxing and polishing all metal surfaces. #9555. **49.97**





**Blazer Yellow or Clear Fog Light Kits.** Includes one pair of lamps with grilles and covers. 55-watt, quartz halogen bulbs, switch with panel cables and terminals. **24.94**  
Driving lights also available at everyday low prices.



**GE Halogen Headlights.** Low beams, H4656 and H5006. And high beams, H4651 and H5001. **5.47**

Dual Beams and Composite Bulbs. H6024, H6054, H9004, and H9006. **10.47**



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**INDYCAR**  
**CO-SPONSOR**

**Bosch Platinum Plugs.** The ultimate spark plugs. Available for many cars, vans, and pickups. U.S. or import. Sold in 4-packs only. **8.97** per pack\*

\*Save \$1.00 more per 4-pack with mail-in manufacturer's rebate. See store for details.

**BOSCH**



**Champion Resistor-Type Spark Plugs.** For many U.S. cars and light trucks. Sold in 4-, 6-, and 8-packs only. **1.25** per plug\*

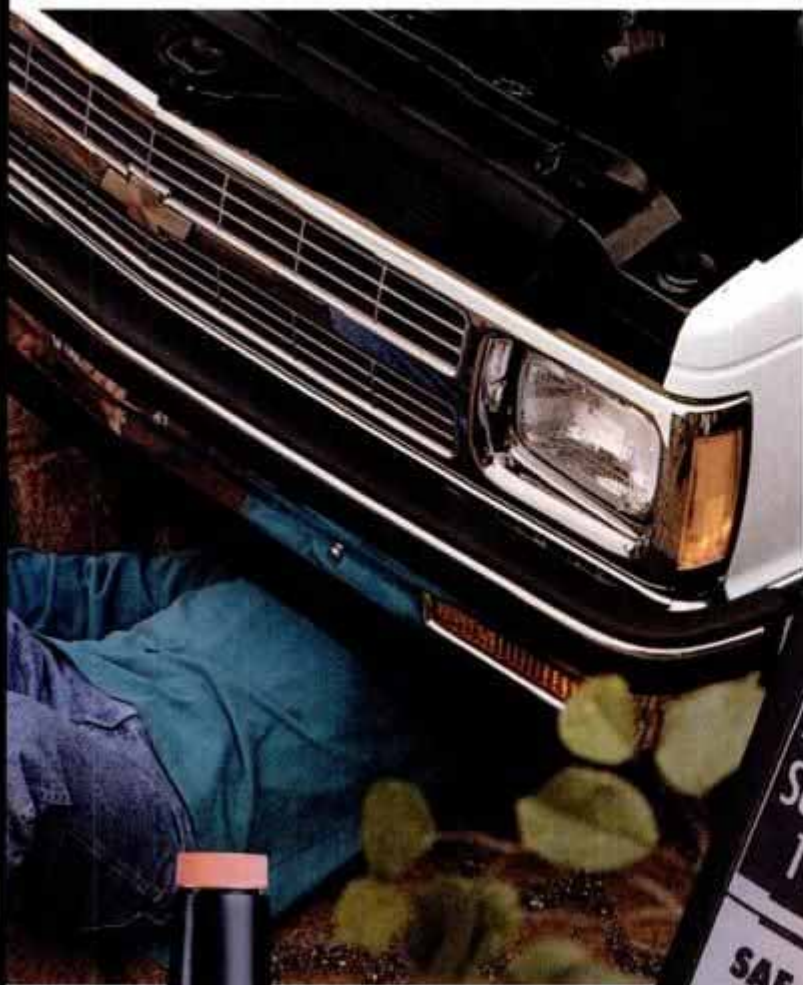
\*Save 35¢ more per resistor plug with a mail-in manufacturer's rebate. See store for details.



**Champion Premium Gold Spark Plug.** For easier starting and optimum engine performance. Patented zirconia-strengthened insulator. Now available at an **Everyday low price.**



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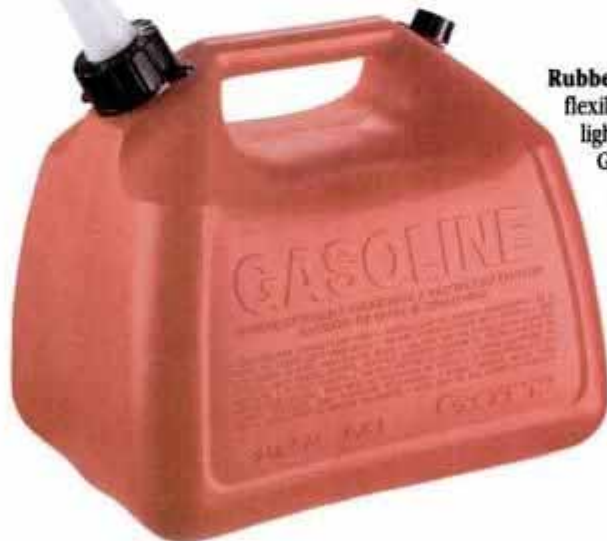


**Kendall Superb 100** Motor Oil. Cleans and improves engine performance. Pour in the protection. In 10W30 and 10W40 formulas.

**1.04** per quart. Limit 12.  
\$12.48 per case (not shown).  
Get a case, and as your bonus, receive three issues of a favorite magazine. See store for details.



**Slick 50 Engine Treatment.** One time, 50,000-mile, engine treatment. Helps reduce friction and improves performance and gas mileage. One quart. **19.88**



**Rubbermaid 2.5-Gallon Gas Can.** With flexible spout. Made of crush-proof, lightweight plastic. Safer than metal. Great for cars, boats, and many industrial uses. **3.77**



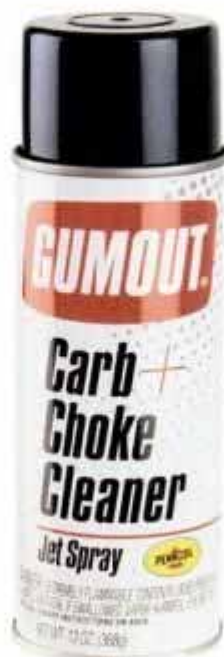
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**Turtle Wax Clear Coat Paint Sealant.** Seals and protects up to one year. Same formula used by auto dealers. 16 fl. oz. **12.97**



**Turtle Wax Zip Wax Car Wash.** Cleans and shines. Mild, rich, deep-cleaning suds float away dirt and grime, leaving a sparkling turtle wax finish. In 64-oz. economy size. **3.27**

**Armor All Tire Foam Cleaner.** Cleans, shines, and protects, in one step. 14 oz. **2.88**



**Gumout 12-oz. Liquid Carburetor, or 13-oz. Jet Spray Cleaner.** Dissolves dirt and grime in your car's choke, linkage, and carburetor. Your choice. **1.77**



**Armor All Protectant.** Helps protect and beautify rubber, vinyl, and leather. 32 oz. **6.27**





**Simple Green All-Purpose Cleaner.** Great for wheels, tires, floor mats, and seats. Concentrated. This bottle makes 3 gallons of household cleaner. 32 fl. oz.

**4.77**

**Simple Green Economy-Size Refill.** 67 fl. oz. concentrate (not shown).

**6.77**



**Westley's Bleche-Wite Tire Cleaner.** Economy-sized whitewall/black-wall tire cleaner comes with handy pump. 32 fl. oz.

**2.47**

**Westley's Bleche-Wite.** One gallon (not shown). **5.47**



**Blue Coral AutoFom Liquid Sealant.** Auto service treatment with Fomblin A® Forms a protective barrier impervious to chemicals and pollutants. 16 fl. oz.

**9.97**

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**STP Super Concentrated Fuel Injector Cleaner.** Improves engine efficiency. Keeps fuel injectors and carburetors clean. 32 fl. oz. **5.47**



**STP Fuel Injector and Carburetor Cleaner.** Fights power loss and reduces exhaust emissions. Plus, protects against rust and corrosion. Effective in all gasoline, gasohol, and diesel fuel. 32 fl. oz. **3.27**



**STP Gas Treatment.** Helps clean carburetor and improve engine performance. Removes water from gas line. Three 8 fl. oz. bottles per pack. **2.50**

**Spill Saver Spout.** Twist on, oil flows. Twist off, flow stops. For adding oil, transmission fluid, and more. Save 25¢ off the Spill Saver Spout when you buy two quarts of Pennzoil. See store for details. (Redemption by Spill Saver.)



**Pennzoil Motor Oil.** Provides outstanding protection against thermal breakdown, engine deposits, and wear. In HD30, 5W30, 10W30, and 10W40 viscosities. **Everyday low price.**

Performance.  
Protection.  
Quality.™

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Our firm intention is to have every advertised item in stock on our shelves. If an advertised product is not available for purchase due to any unforeseen reason, Kmart will issue a rain check on request for the merchandise (one item or reasonable family quantity) to be purchased at the sale price whenever available or will sell you a comparable quality item at a comparable reduction in price.



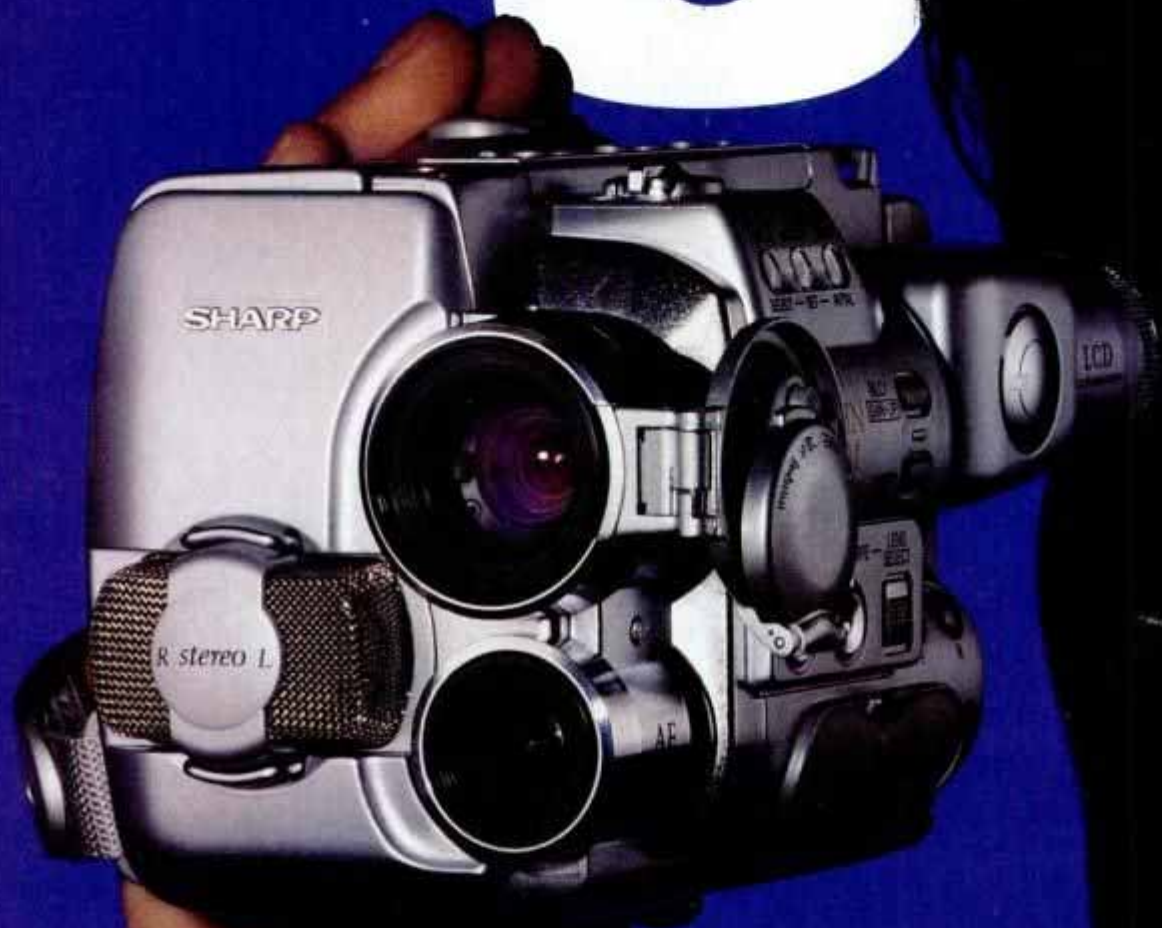
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ELECTRONICS

# PIECES OF 8

Small 8mm video camcorders take the technological lead.



SHARP VL-MX7U

BY STEPHEN A. BOOTH, Contributing Editor,  
and FRANK C. BARR, President, APEL  
PM Photos by Brian Kosoff

● This year, palmable 8mm movie-makers will account for half of the 3-million-plus camcorders that Americans purchase. VHS full-size and compact (20-minute tape) models will split the difference. In 8mm, there are more than 75 models from 23 brands to choose from—only JVC, Panasonic and Quasar don't offer one. Prices range from \$700 for point-and-shoot models to \$3000 for do-everything imagers that even the pros envy.

To get an overview of the features and degree of performance available from the current crop of 8mm camcorders, POPULAR MECHANICS rounded up five models for lab testing and hands-on evaluation. The styles range from simple point-and-shoot at \$700 to a loaded \$1900 model of the Hi8 format—the latter's picture resolution is superior to broadcast TV.

The bench tests were done at the Advanced Product Evaluation Lab-

## PIECES OF 8

oratory (APEL) in Bethel, Connecticut, and the results are unambiguous. All of these camcorders perform well, to the point where selecting one instead of another becomes largely a question of added features.

Weight isn't even much of an issue. The heaviest camcorder here tips the scales at 3½ pounds, the lightest at 2 pounds 2 ounces—and that includes battery and tape. In case you're wondering, the 8mm name comes from the width of the recording tape, about one-third of an inch compared with the half-inch width used for VHS and VHS-C. The recording material is powdered metal (MP) or evaporated metal (ME), which can record more signal per square inch than the metal oxides used in VHS tapes. This is why 8mm cassettes can be smaller than VHS.

Nor does the 8mm format concede anything in image quality to conventional VHS. Both video recording formats deliver about 240 to 260 lines of horizontal resolution on your TV. That's short of the 330 lines available from live TV broadcast. Better-than-broadcast quality is available from the more expensive Hi8 (for High-Band) and S-VHS (Super) formats—theoretically about 420 lines but more like 380 to 400 in practice.

S-VHS hasn't made much headway in the United States because most people perceive VHS as a home VCR format and there are few rental mov-

ies in S-VHS. Meanwhile, Hi8 has grown more popular because 8mm made its name as a camcorder format, and for live videomaking, the more resolution the better. VHS does offer the convenience of letting you pop the cassette into your home VCR for TV viewing. But many TVs and home VCRs now have front panel jacks to connect a camcorder, and many 8mm camcorders have a remote control (four of the five PM tested do), so viewing 8mm tape right from the camcorder is getting easier.

When you read the APEL test report data, keep the following in mind: Minimum Illumination, measured in lux, denotes the minimal amount of light needed to register any image. The lower the number, the better—but APEL considers optimal illumination (no supplemental lighting needed) to be 1600 lux.

You'll see the difference between the two statistics in our Video Signal-to-Noise (S/N) ratings. These numbers indicate the amount of usable video signal for various forms of noise. S/N ratio is measured in decibels (dB)—the higher the better. All of these camcorders have very good (high 30s) to excellent (mid-40s) S/N at optimal illumination. Recordings at minimal illumination are noisier.

White Balance (purity of whites) and Color Contamination (unwanted color in a black-and-white image) are measured on the Institute of Radio

Engineers scale of 0 to 100. The lower, the better. Although not included in the chart, APEL tested for Color Purity, Color Saturation (depth) and Phase Accuracy (true color versus tints). Reproduction of the difficult color red was tested.

Color Purity was excellent for the Sharp and Sony camcorders, and very good for the others. Canon and Fisher had normal saturation, but reds were slightly oversaturated for the others. In Phase Accuracy, red had a slight magenta tint in the Fisher and Sharp entries. These variations can be fixed by adjusting the TV's color controls.

Basic videomaking with any of these five camcorders couldn't be easier. All have desirable features such as autofocus and auto exposure, power zoom lens, auto white-balance for accurate color under different lighting, shutter speeds faster than the standard 1/60 second for sharp pictures in slow-motion playback, in and out fades for smooth scene transitions and a flying erase-head for razor-sharp editing. Operationally, the only differences among these camcorders are the levels of complexity.

Sharp's retro-styled VL-MX7U has the looks of a '50s motion film camera, but is thoroughly state of the art under the hood. The dual-lens system on this camcorder makes it the most interesting of the bunch.

The top lens is a conventional 8X variable power zoom, and the lower one is a fixed focus, super wide-angle optic. This 4mm lens (equivalent to about 32mm in a film camera) is ideal for those tight indoor shooting conditions where it's tough to get everyone in the frame. While you're shooting super-wide, a white rectangle in the viewfinder outlines the field-of-view of the topsiotelephoto lens. You can switch between the two at the touch of a button, thereby creating "instant" zooms. But there's more:

Sharp's picture-in-picture function lets you inset one image or the other—wide panoramic or telephoto portrait—into the frame you're currently shooting. Another button lets you position this PIP left to right across the frame, wherever it fits the composition best. Still another button creates a "wipe" transition, letting the scene from one lens gradually replace the other. About the only drawback we found to the VL-MX7U is its color LCD viewfinder. Compared to standard tube-type screens, its 200 lines of resolution make it too coarse to ascertain accurate focus. You can trust the autofocus function, but in manual focus, the thrill of color isn't really worth all of the anxiety.

Both Fisher's FVC-730 and Sony's

## Pocket-Size Projection TV

● Small and portable is the name of the game in 8mm camcorders. So why not have a small, portable means of viewing your movies on the road? Fuji's P-40U Color LCD Projector fits the bill. It weighs 1 pound, and is about the size of a paperback book. The P-40U projects a very decent image at 20 in. diagonal. Larger sizes are possible, but brightness drops off quite a bit. Its list price is \$699, but it sells for at least \$100 less in stores.

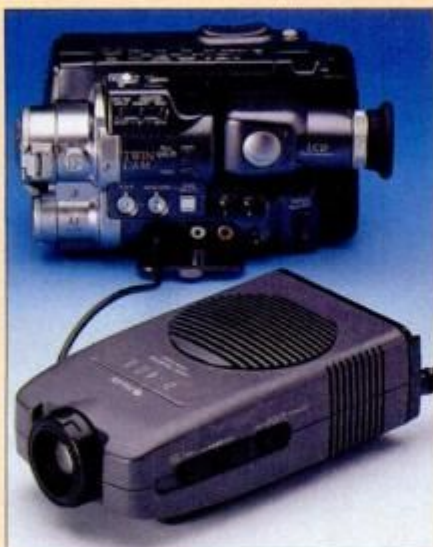
With our sample product, APEL measured resolution to be 240 lines. This is good enough for conventional video, and largely a function of the single, 1-in. liquid crystal display panel of 89,000 pixels. Brightness at the 20-in. diagonal size was 1.2 footlamberts—decent in a darkened room. Brightness drops to a dim 0.3 at the maximum rec-

ommended size of 40 in. The image virtually disappears at 100 in. This is largely due to the limitations of the small 18-watt halogen lamp.

The P-40U is easy to use. It connects to a camcorder or other source through standard cables. It runs off of a camcorder battery for 13 to 30 minutes, or off of AC power. You adjust the lens ring to focus the image on a white wall or screen. Built-in speakers and amp provide acceptable stereo sound at 42 dB S/N. Color and brightness controls are built into the unit.

LCD is where the future of TV is going, at least for large, projected pictures. Larger

projectors (up to 120 in.) are available for \$2000 and up. Fuji's little traveling partner is a small step in the right direction, particularly because the P-40U, unlike its larger cousins, is very mobile.





**YASHICA KD-H170**

**CANON E250**

**SONY CCD-FX410**

**FISHER FVC-730**

**SHARP VL-MX7U**

CCD-FX410 deliver good-looking images with point-and-shoot simplicity. Each is specifically designed for informal family moviemaking. Virtually every function that determines picture quality is automated. Sony's entry even has a 4-mode Programmed Autoexposure dial with settings for normal operation, portraits, sports and high shutter speed (when you want clear slow motion or freeze frames to find a hitch in your golf stroke or home-run swing).

Of the Canon E250's many features—including a 12X zoom—what we found to be most important was its *automatic* backlight-compensation system. Backlighting is the problem where strong illumination *behind* your subject turns it into a blacked-out puppet show silhouette. All of the other camcorders here require you to manually activate a "BLC" switch.

The surest way to beat backlighting is with front-lighting and Canon's got that too—an accessory halogen lamp that runs off the E250's battery. But in the heat of battle—especially out-

doors, where backlighting is most prevalent—you're no more likely to hit the lamp switch than a manual BLC button. Kudos for auto BLC.

Yashica's KD-H170 is the odd-man-out in this test. It's the only camcorder here that uses the Hi8 format, thereby delivering better resolution and signal-to-noise ratios than the conventional 8mm models. Yet operationally, it's basically a point-and-shooter. Everything is simple to use, and like the Sony entry, it has a Programmed Autoexposure selector.

The extras that Yashica brings to the table are subtle. Although the fastest shutter speed is  $1/10,000$  second, the selection is automatically varied among 27 different speed settings, according to exposure conditions. Also, for would-be Hitchcocks and Scoreceses, the KD-H170 offers the state of the art in home editing. It's called Realtime Code (RC), an 8mm exclusive that pinpoints scenes by minute and second. This, and the Index Marker function, will let you cut and paste your raw footage into a

professional-looking production.

As neat as all these features might sound, the 8mm format still has room to grow. Lately, automatic image stabilization has been added to the 8mm's ordnance. This benefit, which calms the seasick motion of camera shake from handheld videomaking, was exclusively a feature of VHS and VHS-C camcorders until recently.

More recently, Minolta and Sony have announced pro-like 8mm camcorders that use multiple image-pick-ups—that is, separate sensors for the red/green/blue components of the color spectrum. This promises much more accurate color rendition and greater picture resolution. Additionally, Canon has an 8mm camcorder with interchangeable lens, a feature that adds flexibility to your videomaking.

These bits of innovation won't come cheap at the get-go, but they'll give the 8mm format more of the versatility that made those old Spanish pieces-of-eight the most popular currency in early America. **PM**

## CAMCORDER TEST RESULTS

BRAND/ MODEL	CANON E250	FISHER FVC-730	SHARP VL-MX7U	SONY CCD-FX410	YASHICA* KD-H170
PRICE	\$ 1499	\$ 700	\$ 1699	\$ 1100	\$ 1899
Minimum Illumination (lux) <sup>1</sup>	3.8/1.7	2.7	3.2/1.6	1.8	3.6
White Balance (IRE)	10	6	5	5	5
Color Contamination (IRE)	10	6	10	5	3
Resolution (Lines; Video Out)	250	250	250	260	380*
Video S/N (dB; Video Out) (Chroma/Luminance)					
Optimal Illumination	39.8/39.6	41.2/39.5	39.4/39.3	42.2/39.1	46.0/40.3*
Minimal Illumination	37.6/33.6	38.4/33.7	37.5/35.6	42.1/32.6	42.5/34.2*
Audio S/N (dB)	58.5 <sup>2</sup>	58.1	NA <sup>2**</sup>	50.1	63.1 <sup>2</sup>
Close Focus (in.) (Telephoto; Macro)	26; 1/16	47; 3/8	47; 3/8	37; 3/8	46; 1/8
PowerZoom Time (sec.) <sup>3</sup>	9.5	6	12/6	10/3	7
Top Shutter Speed (sec.)	1/10,000	1/4000	1/10,000	1/4000	1/10,000
Remote Control	YES	YES	NO	YES	YES
Weight (Including battery/tape)	2 <sup>3</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub>

1. Measured in lux. First figure indicates normal mode, second "gain up" mode. 2. Stereo audio. 3. First figure is normal mode, second is high-speed mode.

\* Hi8 format, using ME (metal evaporated) tape.

\*\* No provision for external microphone; testing therefore not possible.

# HOW TO RESTORE



## Part 3: Assembling The Suspension And Drivetrain

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

● Last month we reconstructed the unibody of our 25-year-old Camaro—difficult, finicky work that can try the patience and skill of even the most enthusiastic restorer. This month, we start the much easier task of turning our Camaro into a “roller,” sitting firmly on its own four wheels. We’re obviously showing you one particular restoration, but just about everything we’re doing to Camaro No. 4524 is applicable to bringing any vintage automobile back to life. As a relief from the rigors of



Our Camaro, back on its wheels and ready for bodywork and paint (top). Trial fitting of the front subframe (above).

welding the unibody, we did the easiest mechanical subassembly first: the rear axle. We sandblasted and painted the axle housing, rebuilt the rear drum brakes and installed new half-shafts, bearings and retainers.

We swapped the differential ring and pinion from the stock 2.73 to a 3.70 supplied by DTS. With the overdrive transmission we fitted, this should give us tire-smoking acceleration in the lower gears, yet relaxed cruising on the highway. To complete this rear subassem-

# AN OLD CAR



bly, we hung the axle on new multileaf springs from PST—fitted with graphite-impregnated polyurethane bushings—then lowered the unibody on the lift to match up with the axle resting on sawhorses. Just six bolts, and the rear suspension was back in.

Like many other cars built in the past 25 years, our Camaro has a rear unibody from the firewall back, then a front subframe that attaches to the unibody and supports the engine, transmission, front suspension and front bodywork. We built a rack out of scrap tubing to hold this front subframe at waist height. You could just as easily use scrap lumber to build the rack, as long as the result is strong enough to support 1000 pounds or so.

We sandblasted the front subframe and welded in new plates to replace rusted areas around the crucial holes where the subframe bolts to the unibody. Then, we primed and painted the subframe and bolted it to our con-

venient rack. The first items to go onto the subframe were the engine and transmission. You will remember that the original 327 V8 for our Camaro had been lost years ago. We threw out the tired 307 that someone had installed in its place, as well as the primitive 2-speed Powerglide.

Chevrolet dealers offer the HO 350 "Bowtie" replacement V8 (part No. 10185072) at an unbelievably low price, usually under \$2595. Chevrolet rates it at 345 hp. Thanks to this great engine, there is really no reason to rebuild an old Chevy V8 anymore, at least not for a modified car where the engine and chassis numbers can never match. The HO 350 is a better engine than you could build for the price.

We connected ours to a late-model TH700 4-speed overdrive automatic. By using the stock motor mounts and a transmission crossmember from a late-model Camaro, this engine/transmission combination was a bolt-



Ken Barnes taps a seal into our new front disc brakes. The new brake callipers are on the table in front of him.



With the completed front subframe on its rack, Ken lowers the unibody until the locating pegs line up, then bolts them together.



Ken tightens the antiroll bar mounting. This PST bar is considerably heftier than stock.



The new 3.70 ring and pinion should give our Camaro good snap off the line.



This was the first time our Camaro had moved in nearly six months.

## It's A Clean Machine

● Each of the six stages of our restoration project seemed to require at least one special tool. Disassembly, for example, depended largely on air-powered cut-off tools, air chisels and air shears. Assembling the



Contributing Editor Rich Taylor bead blasts the engine mounts using TIP Skat Blaster.



Blasting cabinet has a light and high-volume vacuum to keep down the dust.

unibody meant weeks with the Mig welder. Working on the suspension and drivetrain, we seemed to spend most of our time cleaning parts and then bolting them together.

There is only one sure way to clean small parts—a glass bead cabinet. Ours is a Skat Blast from TIP Sandblast Equipment. A bead blaster is just a big metal box with a light, a window to see through and an inverted pyramid at the bottom to collect the abrasive for reuse after it has been fired from the nozzle of the blast gun.

Most people spray small glass beads, but you can use anything from cutting sand to crushed walnut shells.

We've found that glass bead abrasive can be sifted to remove impurities, and recycled almost indefinitely with only a small loss in cutting action. A cheap pair of leather work gloves fitted over the expensive rubber cabinet gloves prolongs their life significantly. —R.C.T



Parts washer takes off remaining dust preparatory to priming and painting.

in. Obviously, if you have the original engine and transmission for your car, you'll want to rebuild them and preserve the car's originality.

Our next step was to bead blast, prime and paint all of the front suspension pieces, then fit them with new polygraphite bushings from PST. New KYB shock absorbers, springs and a stiffer-than-stock anti-roll bar went on too, upgrading the Camaro's handling to match its new horsepower.

The majority of front suspension work is familiar to any Saturday mechanic—new bearings, tie rods, ball joints. We switched from weak drums to strong '67 Camaro front disc brakes that were an option when our car was new. Installing them was an easy bolt-on operation.

All of these parts and many more came from one of two sources. General Motors Service Parts Operations, known as SPO, still has millions of parts for many older GM models. What's available is listed in *Models Through 1975 Chassis and Body Parts* and shown in *Models Through 1975 Chassis and Body Illustrations*. These are GM parts manuals 11 and 11A, respectively.

SPO and Equity Machine Inc. also have a licensing agreement with some 65 aftermarket parts manufacturers to reproduce parts that GM no longer stocks. All of our parts came from D&R Classic Automotive—probably the best Camaro restoration parts supplier in the country, and one of EMI's first licensed GM parts sources. Steve Drucek at D&R not only was able to find us the most obscure parts, but he was a reliable source of information and advice.

Except for the front fenders, which have to go on after the unibody and

### Nuts To You

● At least in the Northeast, one of the biggest problems with an old-car restoration is surface rust on fasteners. Within weeks, low-grade nuts and bolts start to look shabby. We solve this problem by using Wurth Grade 8 fasteners plated with yellow chromate.

Grade 8 yellow chromate hardware is obviously more expensive than hardware store nuts and bolts, but the difference is small compared to the jump in quality. Judged against the total cost of restoring a car, skimping on hardware to save a few dollars is really a false economy.

—R.C.T

### SOURCE LIST

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

- Auto Body Specialties, P.O. Box 455, Middlefield, CT 06455; (203) 346-4989 (Body parts)
- Campbell-Hausfeld, 100 Production Dr., Harrison, OH 45030; (513) 367-3130 (Air compressor and air tools)
- Chevrolet Division, General Motors Corp., 30007 Van Dyke Ave., Warren, MI 48090; (313) 492-8855 (Engine and transmission)
- Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; (800) 251-6336 (Reproduction old-style tires)
- Daytona Mig, 1821 Holsonback Dr., Daytona Beach, FL 32117; (800) 331-9353 (Mig welder)
- D&R Classic Automotive, 31 W. 208 Diehl Rd., Suite 107, Naperville, IL 60563; (708) 369-2030 (Camaro restoration parts)
- DTS, 22250 Scheman Rd., Warren, MI 48089; (800) 521-0628 (Rear axle ring and pinion)
- Eagle Equipment Co., 23 Wetherill Place, Plainville, MA 02762; (800) 535-0016 (Lift)
- The Eastwood Co., 580 Lancaster Ave., Malvern, PA 19355; (800) 345-1178 (Specialized restoration tools)
- Gearbox Grannies, 3944 Indian Ripple Rd., Dayton, OH 45440; (513) 429-5642 (Even more specialized restoration tools)
- General Motors Service Parts Operations, 6060 W. Bristol Rd., Flint, MI 48554; (313) 635-6980 (Body, suspension and trim parts, plus a free consumer guide to restoring GM vehicles)
- Goodyear Tire and Rubber Co., P.O. Box 9125, Akron, OH 44305; (216) 796-2490 (Contemporary tires)
- Kanter Auto Products, 76 Monroe St., Boonton, NJ 07005; (800) 526-1096 (Springs, shock absorbers)
- Minisport, Jackson Hill Rd., Sharon, CT 06069; (203) 364-0311 (Complete auto restorations)
- OEM Glass, P.O. Box 362, Route 9 East, Bloomington, IL 61702; (800) 283-2122 (Auto glass)
- PST, P.O. Box 396, Montville, NJ 07045; (800) 247-2288 (Suspension bushings, antisway bars)
- Sharon Auto Body, Route 343, Sharon, CT 06069; (203) 364-0128 (Finish bodywork and painting)
- TIP Sandblast Equipment, P.O. Box 649, Canfield, OH 44406; (800) 321-9260 (Sandblaster, bead blast cabinet, paint sprayer)
- Wurth USA, 93 Grant St., Ramsey, NJ 07446; (800) 526-5228 (Fasteners, i.e. nuts and bolts)

subframe are mated, we completely assembled everything that could go onto the front subframe, including the new quick-ratio steering box, heavy-duty radiator and radiator support, even the battery tray and NVH canisters. Working around the naked subframe is so much easier than bending over bodywork to get at things.

When the subframe subassembly was completed, we raised up the unibody on our lift, rolled the subframe into position, lowered the unibody and bolted the two together using new polygraphite body mounts and new hardware. It was a scene right out of those old movies of Henry Ford's Model T body drop—we bolted together the body and chassis, then rolled the whole thing out the door.

Next? We'll finish the bodywork, paint the edges of the unibody and hang the doors and front fenders. Then our Camaro will be sprayed eye-popping Matador Red. Next month we'll tell you what went into prepping the car for paint and show you how we gave it a show-quality finish. **PM**



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COMPARISON TEST

# HAMMER DRILLS

Ten tough hole busters line up for top honors. Here's what happened when the dust settled.

BY THOMAS KLENCK,  
Associate Home Improvement Editor



- When it comes to boring holes in wood or metal, you simply install a bit in your electric drill and go to it. As the bit turns, its cutting edges actually slice their way through the material. But boring a hole in concrete, masonry or stone is a different issue altogether. These materials don't want to be cut. And if you try, the process will have more of an effect on your drill bit than on the material you're trying to bore through.

Of course, the first strategy is to use a carbide-tipped bit designed for cutting masonry products. The edges on this type of bit are not shaped for slicing, but more for scraping. And, while you will make some headway with a masonry bit in your ordinary drill, what you really need is impact—a hammering action that actually pulverizes the material. The tool for the job, of course, is the hammer drill. A hammer drill turns the bit like an ordinary drill, but is also capable of applying short, rapid hammer thrusts as the bit turns.

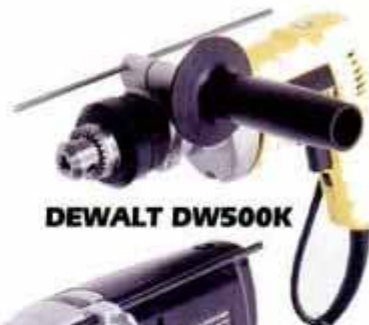
All standard hammer drills can be set for either normal drilling—without the hammer action—or hammer drilling. Except for one of the tools in our group, the Skil 600, the hammer action is always accompanied by rotating action. How do they work? First of all, the spindle to which the chuck is attached is designed so it can slide in and out a short



**PORTER-CABLE 7738**



**MILWAUKEE 5374-1**



**DEWALT DW500K**



**HITACHI DV 14V**



**SEARS 11411**

distance. The spindle is spring loaded to keep the chuck in the forward position. In normal-drilling mode, the sliding action is typically locked by a cam or eccentric shaft that holds the spindle in its forward position (see drawing, page 75).

Linked to the spindle is a disc with ratchet-like teeth. Adjacent to this is a matching disc that's fixed to the tool frame. In the hammer-drilling mode, the sliding action of the spindle allows the two ratchet discs to come into contact when pressure is applied to the bit. When this happens, the teeth of the two discs literally bounce over each other to provide the hammering action. Because the teeth are angled in one direction, hammer drilling can't be performed when the bit rotation is reversed. Hammer speed is noted in blows per minute (bpm).

Hammer drills are not to be confused with rotary hammers. Where hammer drills have 3-jaw chucks, rotary hammers use special bit holders designed for standard shanks such as spline, taper and SDS shanks. Also, a typical rotary hammer uses an electropneumatic hammering system that impacts the output spindle.

Like standard drills, hammer drills are available with varying features and capacities. Our comparison test focuses on variable-speed, reversible tools with a single-speed range. For extra torque when using larger bits, choose a dual-speed model that adds a lower-speed-range option.

Our hammer drill sample fell into two design classes—those with the hammer mechanism mounted directly behind the chuck and those with the mechanism placed inside the tool housing. In the former case, the tools seem to be modifications of standard drills and have the drilling-mode switch in the form of a ring behind the chuck. The second type, with the internal mechanism, usually has a dial on the housing to switch modes.

To test boring speed, we put each tool through a series of fixed-load tests with  $\frac{3}{8}$ - and  $\frac{1}{2}$ -in. carbide-tipped bits, boring holes in a solid concrete block. While our findings might not be conclusive due to variations in the concrete aggregate, we did find that certain tools were consistently slower. We also measured the travel distance of the hammering mechanism of each tool (see Specifications

Chart, page 76). When combined with rpm, bpm and amperage specifications, we found that most of our subjective results were confirmed.

All else being equal, the cutting speed of a hammer drill depends, primarily, on the length of hammer travel and bpm. In general, we found that the tools that ranked at the top (Milwaukee and DeWalt) and bottom (Skil and Sears) in performance, followed suit in hammer travel and bpm. If, however, tool power—the ability to handle heavy loads—is weighed in, the higher amperage tools (Porter-Cable and Bosch) move up.

## AEG SBE-10RL

Like most AEG tools, this offering shows respectful attention to design details. The trigger and lock button are comfortable and easy to operate, and the drill has a collar-mounted auxiliary handle and depth-stop assembly. Like several other models, a single thumbscrew tightens both the handle and the depth stop. The single thumbscrew means that if you readjust the handle, you might have to re-adjust the stop, as well. The depth stop is a hexagonal rod with depth



**AEG SBE-10RL**



**SKIL 600**



**BOSCH 1195VSR**



**MAKITA HP 1030W**



**RYOBI PD-1410AVRK**

PHOTOGRAPH BY THOMAS KLENCK

graduations in millimeters.

This is one of three test tools that comes with a 1/2-in. chuck—and both the chuck and the chuck key are substantial. It's also equipped with a heavy 16-gauge power cord. Except for the Milwaukee drill, all other tools have lighter 18-gauge cords. Although maximum bpm is almost the lowest in the group (20,800), we meas-

ured the hammer travel at .035 in.—the highest. This ample hammering action probably accounts for the drill's fine showing in performance trials—just below the Milwaukee and about on par with the Hitachi.

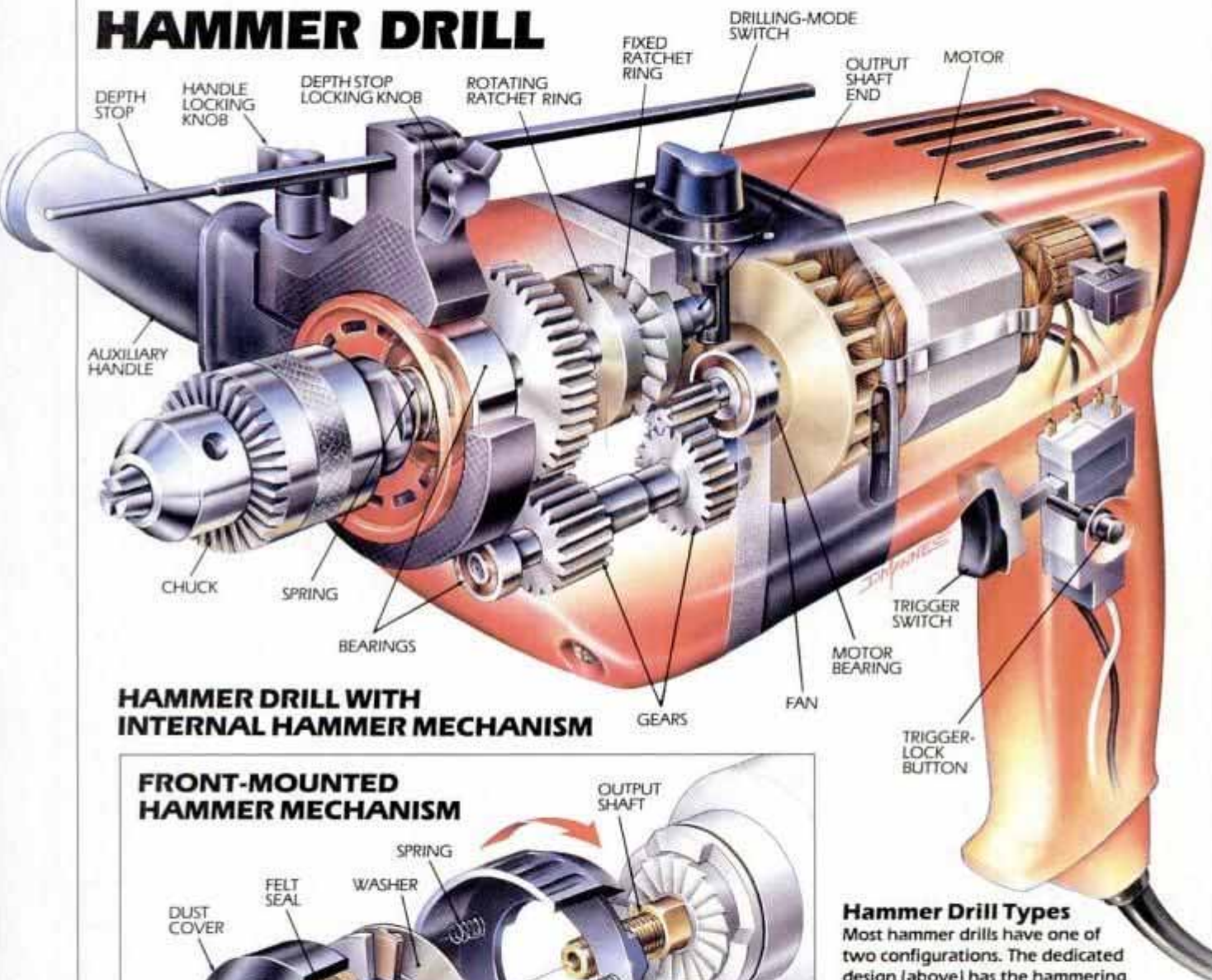
## Bosch 1195VSR

This tool is the single-speed-range partner to Bosch's model 1194VSR

dual-range hammer drill. Except for the gearing and a heavier 1/2-in. chuck on the dual-range model, both tools are the same.

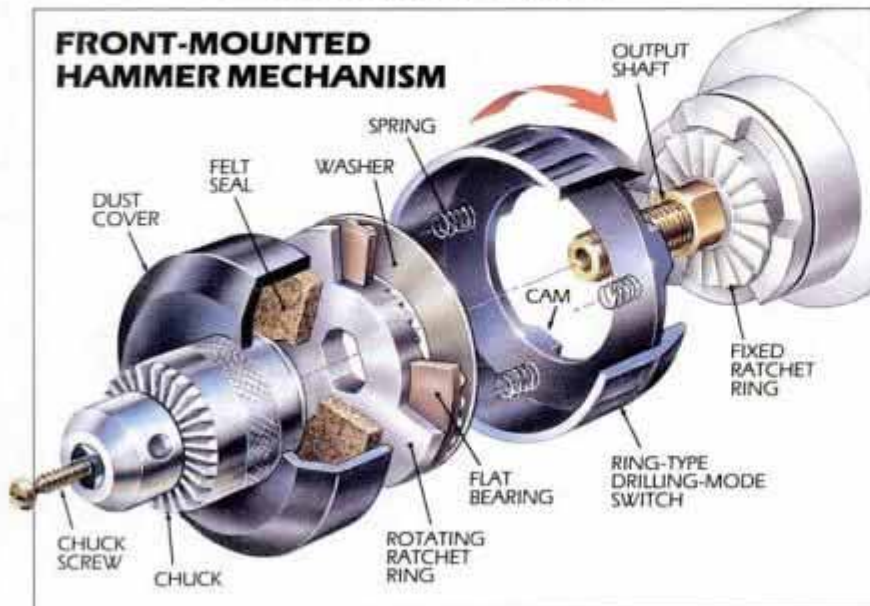
Like all Bosch tools we've tried, performance is very smooth, and the tool shows few compromises to production efficiencies or profit margins. The trigger is designed to fit around the top of your finger so it doesn't rub

## HAMMER DRILL



## HAMMER DRILL WITH INTERNAL HAMMER MECHANISM

### FRONT-MOUNTED HAMMER MECHANISM



### Hammer Drill Types

Most hammer drills have one of two configurations. The dedicated design (above) has the hammering mechanism in the gear housing. The output shaft is supported on a bearing behind the chuck and inside the fixed ratchet ring. In hammer-drilling mode, the shaft slides back under load, allowing the ratchet discs to contact each other. The second configuration features a front-mounted hammering mechanism (left). Here, an extended shaft makes room for a ratchet assembly that drives the chuck. For normal drilling, the drilling-mode ring is turned to keep the shaft from sliding back.

against the reversing control that's directly over it, and all other controls are equally considerate.

The hexagonal depth rod, graduated in centimeters, is notched along its length so it won't easily slip out of position. There's a separate thumbscrew for the depth stop and auxiliary handle, and the assembly is collar mounted for 360° flexibility. One design feature we were less thrilled about was the chuck key holder. It's a flexible ring with a star-shaped hole that's mounted on the cord. The problem, for us at least, is that it's easy to misplace the key.

In cutting speed, we found the tool to be slightly behind the AEG. However at 6 amps—only the Porter-Cable compares—this tool is ready to be pushed a little harder than much of the competition. The drill also has one other characteristic in keeping with our Bosch power tool experience—its power cord falls well below the average length.

## DeWalt DW500K

In case you haven't noticed, the new DeWalt line of portable power tools bears an uncanny resemblance to Black & Decker's professional and industrial offerings. According to DeWalt, however, the DW500K hammer drill (yellow-body clone of the old B&D 5070) has an improved switch and the housing is made out of tougher plastic.

Well, switch, housing, color and brand name aside, this is one fast boring hammer drill, and the tool's specifications support this conclusion. At 50,000 bpm, only the Milwaukee compares. Combine this with an impressive .033-in. hammer travel and it's hard to believe the tool could perform poorly. This model also boasts an above-average 5-amp motor, and its

compact size makes it easy to handle.

While the ring-type drilling-mode switch works fine, its size means that you have to disassemble the handle collar to take off the handle—most other collar systems simply slip over the chuck. And, the handle only rotates about 270° with the depth stop in place. It was also a little disconcerting to find on our tool that the ratchet discs—the parts that bounce against one another in hammer drilling—were hardly lubricated. At least there were no globs of grease characteristically found in high-wear areas.

## Hitachi DV 14V

Hitachi has opted for the dedicated hammer drill design with the hammer mechanism behind the gears and between the spindle bearings. As opposed to the typical dial that switches the mode from hammer drilling to plain drilling, this tool has a very convenient button system. Like the Makita, Ryobi, Skil and Sears entries, Hitachi includes a speed dial on the trigger so any speed can be locked on with the trigger-lock button.

We did find other trigger designs that were more comfortable, and the forward/reverse switch, usually a lever located above the trigger, is at the top and back of the handle, which makes reversing a 2-handed operation. The auxiliary handle and depth-stop assembly is collar mounted, and a single thumbscrew loosens both the collar and the round, ungraduated depth stop. Like AEG and P-C, the inside of the collar has radial notches that match a lug on the housing so the collar locks in preset positions.

In terms of performance, we found the DV 14V to be comparable to the other professional tools in the group. Plus, it's one of the most comfortable hammer drills to hold.

## Makita HP 1030W

Compared with the models already covered, the HP 1030W clearly falls on the light-duty side of the spectrum. Makita does offer two other heavier models with dual speed ranges, however.

This compact 4-amp unit features a drilling-mode dial on top of the housing. The dial is recessed and among the more difficult to operate. As is Makita's practice, the forward/reverse switch is at the bottom of the handle, so reversing is a 2-handed operation. The auxiliary handle is screwed into one of the tapped holes on either side of the housing, and the depth-stop assembly is clamped between the handle and the housing. A speed dial on the trigger permits locking on the trigger switch at any speed.

We found that the screw that locks the depth stop refused to stay tight when hammer drilling. And, while extra attention should be paid to adequately tightening the chuck on all hammer drills, this unit seemed prone to losing its drill bit.

Of course, one of the best things about this model is its compact size and light weight. If you'll only need the hammer-drilling feature occasionally, and really don't need the depth stop, the Makita HP 1030W makes an adequate, all-purpose drill.

## Milwaukee 5374-1

Based on Milwaukee's Magnum line of drills, this unit is heavily built and features some of the more imposing specifications and performance test results. Like the DeWalt, this model ranks at the top for bpm and rpm. Being a modified standard drill, it also features the behind-the-chuck hammer mechanism. It has a heavy ½-in. chuck and a 5.4-amp motor.

Although we're impressed with the

## HAMMER DRILL SPECIFICATIONS\*

MANUFACTURER	MODEL	PRICE <sup>1</sup>	AMPS	CHUCK SIZE	MAX. RPM	MAX. BPM	CONCRETE CAPACITY (dia.) <sup>2</sup>	LENGTH	WEIGHT (lbs.)	CORD LENGTH	NOISE (dba) <sup>3</sup>	HAMMER TRAVEL <sup>4</sup>
AEG	SBE-10RL	\$211	4.5	½"	1300	20,800	½"	12"	4	10'	86	.035"
Bosch	1195VSR	\$211	6	¾"	2500	40,000	⅝"	12½"	4.9	6' 4"	86	.026"
DeWalt	DW500K	\$239	5	¾"	2500	50,000	½"	11½"	4.4	8'	89	.033"
Hitachi	DV 14V	\$210	5	¾"	2600	41,800	⅞"	11"	4.6	8' 4"	86	.025"
Makita	HP 1030W	\$210	4	¾"	2700	29,700	⅜"	9¾"	3.5	6' 9"	96	.025"
Milwaukee	5374-1	\$259	5.4	½"	2500	50,000	⅞"	11¾"	5.25	8'	89	.023"
Porter-Cable	7738	\$205	6	¾"	1000	20,000	¾"	12½"	5	9' 10"	92	.033"
Ryobi	PD-1410AVRK	\$199	3.8	¾"	2700	29,700	⅜"	10"	3.5	6' 6"	87	.025"
Sears	11411	\$115	3.2	¾"	1200	25,200	.725"	11½"	5.4	10'	90	.012"
Skil	600	\$117	3.4	½"	800	36,000	½"	11"	4.25	5'	88	.010"

\*All hammer drills tested are variable-speed, reversible, single-speed-range models. 1. Suggested retail price—tools may be sold for less. 2. As stated by the manufacturer. 3. Noise level measured at maximum speed without hammer action engaged. 4. Length of in-and-out motion measured at chuck in hammer mode.

drill's performance and solid construction. Milwaukee might do well to follow the lead set by Bosch, P-C, AEG and Hitachi by paying more attention to user-friendly details. The drilling-mode control is on a ring behind the chuck. We never really got the hang of operating it, to the point that it became an annoyance. And, we had to shift the depth-stop rod out of the way to get at the ring. Like other Magnum drills, the forward/reverse lever mounted above the trigger is too small, but not nearly as difficult to operate as the tiny trigger-lock button.

If you're willing to forego a few creature comforts in lieu of performance and reliability, this drill may be a good choice. It also sports the standard Magnum Quik-Loc replaceable power cord.

### Porter-Cable 7738

When compared with the group averages, the 7738 is a slow-running tool. In fact, just going by the rpm and bpm

specs (1000 and 20,000 respectively), you might want to write it off as being outclassed. Fortunately, our performance trials suggest otherwise and indicate that there's something else going on here. For starters, this P-C's hammer travel is measured at an ample .033 in.—the same as the DeWalt. Combine this with a group-leading, heavy-duty 6-amp motor and the picture starts to make more sense. While we can't honestly rate the 7738's performance at the top, it's somewhere in the ballpark.

For features, this P-C has a collar-mounted auxiliary handle and depth stop that's locked with one thumb-screw. The depth stop doesn't have a scale, but is notched so it stays in place. Although the tool is comfortable, we found the standard P-C forward/reverse switch, located above the trigger, to be too small. Since running our hammer drill tests, P-C has updated the 7738 with a 1/2-in. chuck. It's now the 7739 and the price is the same.

### Ryobi PD-1410AVRK

This hammer drill is similar in scale to Makita's HP 1030W, and is well suited to those who only want one drill, but want hammer-drilling capacity.

This and the Skil entry were the only models that didn't have a depth stop. The auxiliary handle screws into a tapped hole on either side. The drill has variable-speed, trigger-lock capacity and a well-designed forward/reverse lever above the trigger. Like Makita's entry, the drilling-mode switch is a top-mounted dial, but this one is easier to use. Less impressive is a rather kinky, plastic power cord.

In terms of tool performance and specifications, we found Ryobi's entry to be on par with Makita's. With the Ryobi, you'll get a motor with a slightly lower amperage draw and much lower noise level. You'll have to do without a depth stop, but Makita's didn't work well anyway. And at this niche in the hammer drill market, a depth stop might actually be a frill.

## More Drills And Hammers

Life would be a lot simpler if there were one saw for all cuts and one drill for all holes. Even within the family of percussion-effect drills, there's no room for relaxation. The specialized designs and variations offered today mean that, no matter what your job, there's a hammer drill or rotary hammer built just for your needs.

If you're looking for a basic heavy-duty hammer drill that doesn't have any pretensions to driving drywall screws, then you may be interested in something like the Black & Decker 5036 (about \$336, bottom left). This 7-amp tool features a D-shaped end handle and an auxiliary handle that simply screws solidly into the gear housing side. B&D gives this tool a 3/4-in. concrete capacity at 1300 rpm and 19,500 bpm. And, although the tool will reverse, the speed isn't variable.

Skil's model 6850 EMH (about \$204, bottom middle) is a hybrid between a typical hammer drill and a rotary hammer. It has an electromechanical hammering mechanism that's claimed to

drive the chuck spindle forward more effectively than the ratchet system used on hammer drills. The 4-amp tool comes with a 1/2-in. chuck and has variable speeds up to 1500 rpm and 5000 bpm.

When you really want to bust through in a big way, look for a rotary hammer. The Milwaukee 5347 (about \$765, middle right) is an 8.5-amp, single-speed, 500-rpm tool that's rated at 4100 bpm. It takes spline-shank bits up to 1 1/2 in. in diameter, and can handle core bits up to 6 in. in diameter. With its stop-rotation control, it can also set up to 3/8-in. self-drilling anchors.

Rotary hammers also come in small packages. The Hitachi DH 22VB (about \$336, bottom right) is a compact variable-speed, reversible version that's rated at a 3/8-in. concrete capacity, and 2 in. with a core bit. Speed is variable up to 1000 rpm and 4200 bpm, and the tool is powered by a 4.6-amp motor.

And, when a power line is out of reach, you can still get the job done with AEG's APH 14 XS cordless rotary hammer (about \$585, top right). This innovative

tool uses a 12-volt battery pack and can handle a 3/8-in.-dia. hole in concrete. Its single speed is rated under load at 780 rpm and 3540 bpm. It comes with one battery pack and a charger. —T.K.



AEG APH 14 XS



MILWAUKEE 5347



BLACK & DECKER 5036



SKIL 6850 EMH

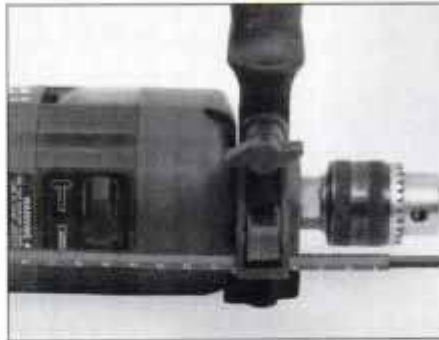


HITACHI DH 22VB

PHOTO BY THOMAS BLECK



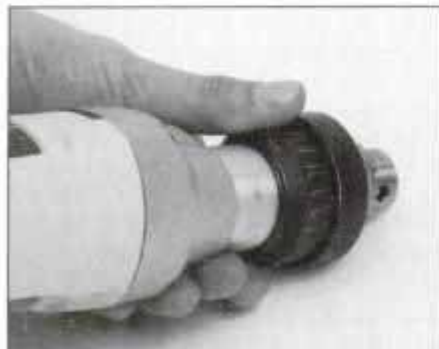
AEG, Bosch, DeWalt, Milwaukee, P-C and Skil have the reverse lever above trigger. Thumb controls trigger-lock button on most.



Collar-mounted auxiliary handle holds depth-stop rod on most units. Bosch (shown) has notched rod for positive locking.



Hitachi hammer drill has convenient button to switch drilling modes. Most other drills of this type have a top-mounted dial.



Drills with behind-the-chuck hammering mechanisms have a ring-type mode switch (DeWalt DW500K shown).



On Ryobi, Makita, Skil, Sears and Hitachi, dial on trigger controls lock-on speed. Other drills lock on at maximum speed.



Round depth-stop rod on Makita HP 1030W is held with locking screw. This tends to loosen when hammer drilling.

## Sears 11411

On the outside, this tool differs in its midhandle design, which provides excellent balance. Its depth-stop rod mounts through a hole in the housing. And, the literature on this tool indicates it has an auxiliary handle that mounts in a tapped hole on top of the gear housing. Our tool came with a handle, but no hole. Sears assures us that this oversight won't be a problem when you go to buy the drill.

This drill's most unusual, and awkward, feature is its forward/reverse switch. It's mounted above the trigger like many other models, but it's spring loaded to stay in forward rotation. To reverse, you have to hold the lever over while operating the trigger switch.

The marginal .012-in. hammer travel is probably responsible for a generally lackluster performance, along with light-duty, 3.2-amp motor. The chuck quality doesn't compare to the rest of the group, and the transition through the variable-speed range is rough. Switching from hammer drilling to regular drilling is easy, however—it's controlled by a ring behind the chuck.

This is another hammer drill that might work as your only drill if you thought you might need to handle masonry boring at some time. Unfortu-

nately, the spring-loaded forward/reverse switch makes the tool impractical for screwdriving chores.

## Skil 600

Like most manufacturers, Skil makes several hammer drill models. And, if you're looking for a Skil tool that's in keeping with the level of most of the other tools in this group, you'd do well to check out the dual-speed range model 6875. The Skil 600 that we tested, however, is unique in that it offers hammer action without rotation, as well as ordinary drilling and hammer drilling.

As far as hammer drilling goes, we place this tool just above the Sears 11411. It's a slightly more powerful drill with significantly higher maximum bpm, although its maximum rpm is two-thirds of the Sears' rpm.

Skil has a typical above-the-trigger forward/reverse switch that gives this tool screwdriving capacity, and there's a speed dial to set maximum lock-on speed. The tool doesn't have a depth stop and the handle screws into a hole on the left side only.

For the hammer-alone feature, it's difficult to evaluate its effectiveness. Equipped with a wood chisel, the Skil 600 does speed up work across the grain, although not without a price in terms of vibration and excessive

noise. With the grain, you'll probably do just as well to unplug the cord. Skil also offers accessories for scraping, and grout and mortar removal.

## The best borers

Based on performance, we'd have to recommend the DeWalt DW500K and the Milwaukee 5374-1. The DeWalt is easier to handle, but the Milwaukee looks like it will last longer. It's interesting that both use a behind-the-chuck hammer mechanism. If there's a down side to this design, it may be the extra spindle extension that could increase the load on the spindle bearing. However, if you need to replace the ratchet discs, this design may make it easier.

If you factor in design features and fit and finish, the Bosch, Hitachi, AEG and Porter-Cable drills all score high marks. The Bosch tool, in particular, combines excellent performance with careful design and construction.

Of the four remaining, Makita and Ryobi will both handle hammer drilling jobs with respectability. And, their size makes them good dual-purpose compromise units when you're only going to own one drill. The Sears and Skil models are the least effective at hammer drilling. However, they'll do the job faster than an ordinary drill—and, that's what counts. **PM**





## TOOLS

# RAKES

Variations on a theme for the well-tuned landscape.

BY THOMAS KLENCK,  
Associate Home  
Improvement Editor  
PM Photos by Stan Silver

● You don't need a rake if you leave grass clippings on your lawn. You don't need one if smoothing out and cleaning up topsoil, mulch, gravel or sand isn't a priority. And, you don't need one if you're not bothered by a thick, seasonal blanket of fallen leaves. However, if any of the above

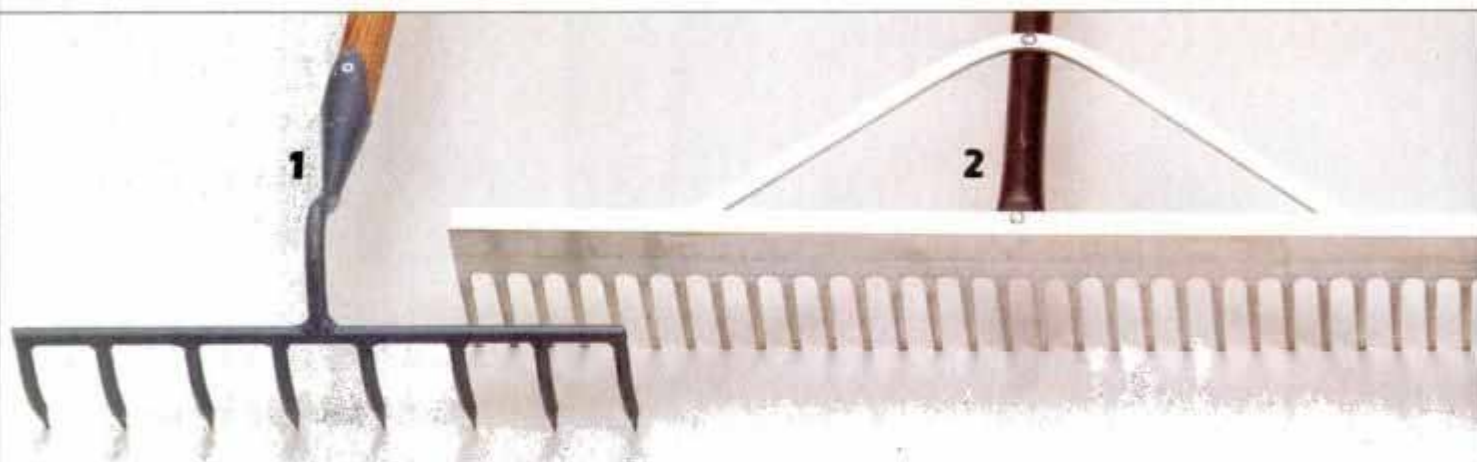
are a concern, then chances are you've already developed a working relationship with this tonsorial tool for landscape maintenance.

The basic rake, no matter which version, is comprised of a row of tines designed to comb through your landscape medium. Unlike hoes, which simply pull and push broad sections of soil, a rake selectively distributes loose material over a broad area. In this way, it serves as a tool for leveling out and smoothing soil and gravel. The tines also act as a filter to pick up large debris while leaving finer bits in a uniformly dispersed layer. This filtering action allows rakes to be used as selective collectors in leaf or grass clipping cleanup jobs. The tine structure also makes the tool light. Imagine trying to clean up your lawn with an oversized hoe and you'll begin to

appreciate why a rake is shaped the way it is.

Like many other garden implements, rakes were at one time made of wood—you can still buy lawn rakes that are made of bamboo. Most of today's versions still use wood for the handle, however lightweight, strong aluminum tubing is becoming commonplace. The tine material depends on the kind of rake it is, which in turn, corresponds to the specific raking job at hand. All rakes fall into one of two categories: rigid-tine rakes and flexible-tine rakes.

The business end of a standard, wood-handled, rigid-tine rake is generally made from forged steel. The more expensive and more durable models have a one-piece forged rake head. Welded construction is more often used on economy rakes. Standard



rigid-tine models come in two styles: bow rakes and level-head rakes. You'll recognize a bow rake by the curved teeth and the two curved arms that connect the head to the shaft. Level-head rakes have straight or slightly curved teeth and the handle joint is centered directly behind the head. The straight-tooth version is best suited for leveling material such as gravel with a back-and-forth raking action, while the curve-tooth design, on the other hand, offers better gathering ability in garden work. Both the bow rake and the level-head rake have a metal ferrule around the handle to keep the wood from splitting around the rake tang.

Flexible-tine rakes are often called lawn or leaf rakes, although you'll find uses for them in your garden, as well.

This type has steel tines that are arranged in a fan-shaped configuration. Bamboo and plastic versions are also available.

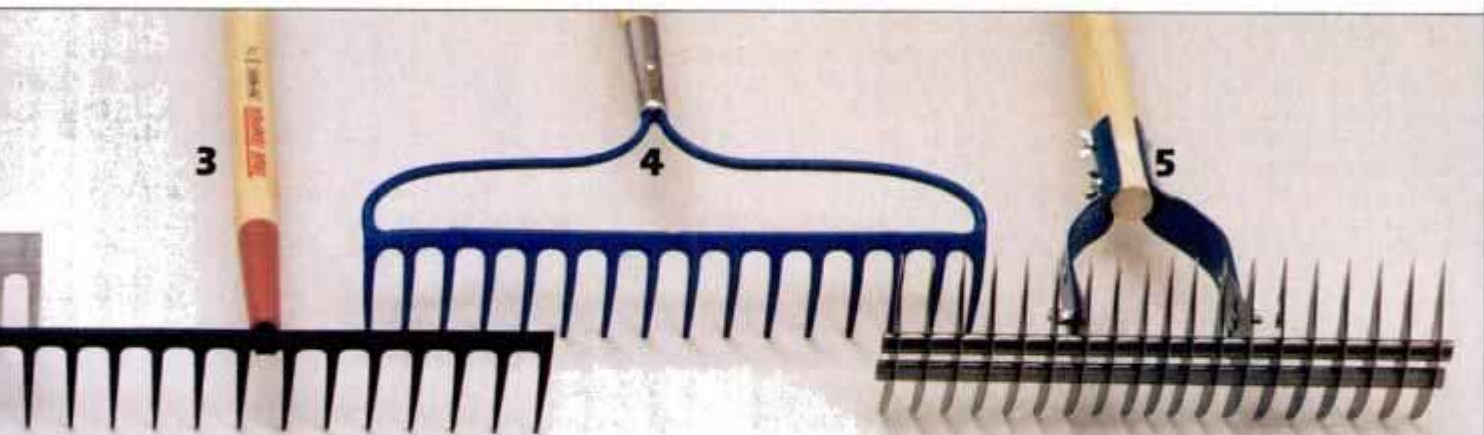
Lawn rakes either have a straight tine edge or a curved edge that permits a sweeping action. Both versions are designed to be light and flexible. Although they're not suited for heavy-duty chores such as leveling topsoil or gravel, they're ideal for grass clippings, leaves and other light cleanup jobs.

In addition to the standard configurations, variations are available that are either designed for a specific use or increased effectiveness. Other examples of rakes more common to the construction scene than to the backyard and garden are the concrete rake, the asphalt rake and the lute. A con-

crete rake has a long hoe-type head that is similar to a typical rake in proportion only. It is used to spread and level concrete. Asphalt rakes and lutes have similar functions. The rake is characterized by long straight teeth and an extra-long tang that joins the head to the handle. Lutes generally have 36-in.-long heads with a saw-tooth-tine configuration. The following cross section of rake designs should give you a good idea as to the best tool for your landscape maintenance chores.

**1. Swan-neck garden rake**—This garden tool is distinguished from most other rakes by its coarse, 8-tine configuration. The wide spacing means you can use this rake to clear rocks and loosen soil. And, the curved tines are diamond shaped and pointed to make digging into tough soil easier. Also, unlike ordinary rakes, the head is joined to the handle with a curved shank—a feature usually reserved for hoes. The curved shank extends into a heavy metal socket that's secured to a 60-in.-long ash handle with a pin. This particular version features welded





construction and is a good choice for heavy garden raking. The swan-neck rake (model 2-274) costs about \$35, and is available from Gardener's Supply, 128 Intervale Rd., Burlington, VT 05401.

**2. Landscape rake**—When you're covering a lot of area, you'll want a lot of rake so the job goes faster. The landscape rake shown has a straight, 30-in.-wide head that's made from an aluminum extrusion to keep weight down. It's connected to a 66-in.-long tubular aluminum handle with a one-piece aluminum brace to strengthen the assembly. The landscape rake is best suited for lawn maintenance, seeding and leveling mulches and topsoil. This rake is one of a line of model 610 leaf/landscape rakes, which also includes 24-, 36-, 42- and 48-in. versions with prices ranging from about \$40 to \$59. The 30-in. model shown costs about \$44. For more information, contact Leslie-Locke Inc., Box 723727, Atlanta, GA 30339.

**3. Level-head rake**—Rakes with straight heads are generally best for flattening, smoothing and grading.

Because the handle is connected directly to the top bar of the rake head, this tool is often used upside down for final smoothing operations. The model shown has a 14 $\frac{3}{4}$ -in.-long, one-piece forged head with slightly curved 2 $\frac{3}{4}$ -in. tines. The head connection to the 66-in. wood handle is reinforced by a metal ferrule. Other steel level-head rakes are available up to around 17 in. wide.

The level-head rake shown is model T14 and costs about \$30. For more information, write to True Temper, Box 3500, Shiremanstown, PA 17011.

**4. Bow rake**—If you're looking for a good general-purpose garden rake, a model like the bow rake should serve you well. Bow rakes generally range from about 14 to 17 in. wide and have curved tines that are well suited to breaking up soil, weeding and collecting debris and small rocks. The curved arms provide a small degree of flexibility to the rake head, while also offering increased strength over the typical level-head design. They also help to prevent snagging on shrubs and low branches as the rake is drawn

across the ground. The model 18-813 shown costs about \$34, and has a 60-in.-long wooden handle and a forged rake head. Less expensive models feature shorter handles and welded-head construction. For more information, write to Ames Lawn and Garden Tools, Box 1774, Parkersburg, WV 26102.

**5. Multipurpose rake**—Although much of the effectiveness of a basic garden rake is due to its simple design, a few manufacturers have attempted to go one better. Instead of the usual row of tines, the multipurpose rake has sickle-shaped blades. The idea behind this unusual configuration is that the rake collects grass clippings, leaves and other debris when pulled, and is self-cleaning on the return push stroke. In operation, the tool is more like cleaning your carpets with a vacuum cleaner than ordinary raking.

It's useful for cleaning and dethatching lawns, as well as light cultivation. Also, unlike typical rakes, the tines on the multipurpose rake extend up and down. On one side, the blades



have a slightly flared edge that alters the raking effect and helps prevent gouging on the return stroke. The head assembly is adjustable so the most comfortable and effective raking angle can be achieved. The version shown is the model 19-140 Lawn-Groom rake, and it costs about \$29. Contact Ames Lawn and Garden Tools, Box 1774, Parkersburg, WV 26102.

**6. Lawn and leaf rake**—When it comes to simply removing leaves and grass clippings from your lawn, most folks want a tool that's light, relatively inexpensive and effective. And the most common choice is a fan-shaped design. The model HTR26 (about \$9) is fairly typical of modern versions. It features flexible steel tines that are secured to a lightweight polypropylene frame. To add the stiffness to the plastic frame required for lawn grooming—and retain flexibility—double coil-spring arms extend from the handle joint to the tine edge of the frame. For light-duty leaf cleanup jobs, models without spring reinforcement are available with lighter, more flexible

tines. The handle on this model is 54 in. long, and the head width is 26 in.

The variations on this design are abundant. You'll find it available with full-length steel tines that extend back to the handle, completely molded in plastic and, of course, as the traditional bamboo lawn rake. Most types come with either a straight edge, as shown, or a curved edge. The curved-edge models are used most effectively with a sweeping action. Handle variations include screw-in designs for simple replacement, and telescoping aluminum handles. The model HTR26 is manufactured by True Temper, Box 3500, Shiremanstown, PA 17011.

**7. Rubber-tine lawn rake**—This 20-in.-wide rake looks like a rigid-tine garden rake, but instead, flexible rubber tines are substituted for steel. The soft tines make it ideal for working around shrubs and plants where a normal garden rake would do more harm than good. And, if you've ever used an ordinary leaf rake on concrete or a paved driveway or street, you'll appreciate an extra benefit of the rub-

ber tines—they're quiet. The model 9149 is called the Wizard Rake and is offered by Smith & Hawken, 25 Corte Madera, Mill Valley, CA 94941. It costs about \$34, and is also available in a shorter, 9½-in. size.

**8. Extra-wide lawn rake**—If you don't like to rake leaves—or simply want to get the job done faster—you might give this tool a try. At 42 in. long, it covers about twice the area of an ordinary lawn rake in the same amount of time. It features flexible 7½-in.-long steel tines that are mounted in a tubular steel rod. The tines are replaceable if any become damaged or broken. The rake-head assembly is mounted to a 60-in. wooden handle, and the angle is adjustable to suit your specific requirements.

The long, straight edge of this rake makes it especially useful for cleaning up areas near fences, house foundations and other straight obstructions. The model WLR extra-wide lawn rake shown costs about \$11. For more information about this tool, write to True Temper, Box 3500, Shiremanstown, PA 17011. **PM**

Craftsman Collector Series

# The Most Versatile Tool Box Craftsman<sup>®</sup> Has Ever Offered.

Ever try to carry your power tools in a conventional tool box? Good luck. And those big, metal tool chests never were designed to go with you on the job. Which is why Craftsman is now offering an ingenious tool storage system that's both roomy and portable, and it's only a phone call away.

**Sit on it, stand on it, tote your power tools in it.** We call it the Craftsman SST (Sit, Stand, Tote). Thanks to a 9-inch deep bottom tub, it can hold your power tools and their accessories. And thanks to a three-way tote system (a top handle, two side handles, and shoulder strap), it's a snap to carry.

The SST has a standing capacity of 250 lbs. Use it as a step stool or as a seat. Other features include a 5-inch deep removable tote tray, a 3-inch deep tool organizer tray and a groove on the lid to hold dowels and pipes for cutting. It's great for camping, fishing, and hunting too.

**Use your credit card and order by phone.** The Craftsman SST measures 21 ¼" long by 13 ½" wide by 16 ¾" high. And it's an outstanding value at just \$39.99. Shipping and handling \$4.95. Want to make your life easier? Just pick up the phone. SearsCharge and Discover Card orders are welcome.

**Call 1-800-326-1760**



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Upon Can Count on Me.  
**SEARS**

# APPLIANCE CLINIC

BY STEVE TOTH,  
 Contributing Editor

## Dryer Safety

The U.S. Consumer Product Safety Commission estimates that there are 14,000 clothes-dryer-related fires every year. Some of these fires occur when lint builds up in the filter or exhaust duct. When lint blocks the airflow, heat builds up, and this can cause a fire.

To prevent dryer fires, clean the lint filter after each load of clothes. While the dryer is running, go outside and make sure the exhaust air is coming out of the duct. If there seems to be a restriction, remove the duct and look inside of it from both ends. Remove any lint. If the dryer seems to be operating hotter than normal, the temperature-control thermostat may be malfunctioning. In this case, replace the control.

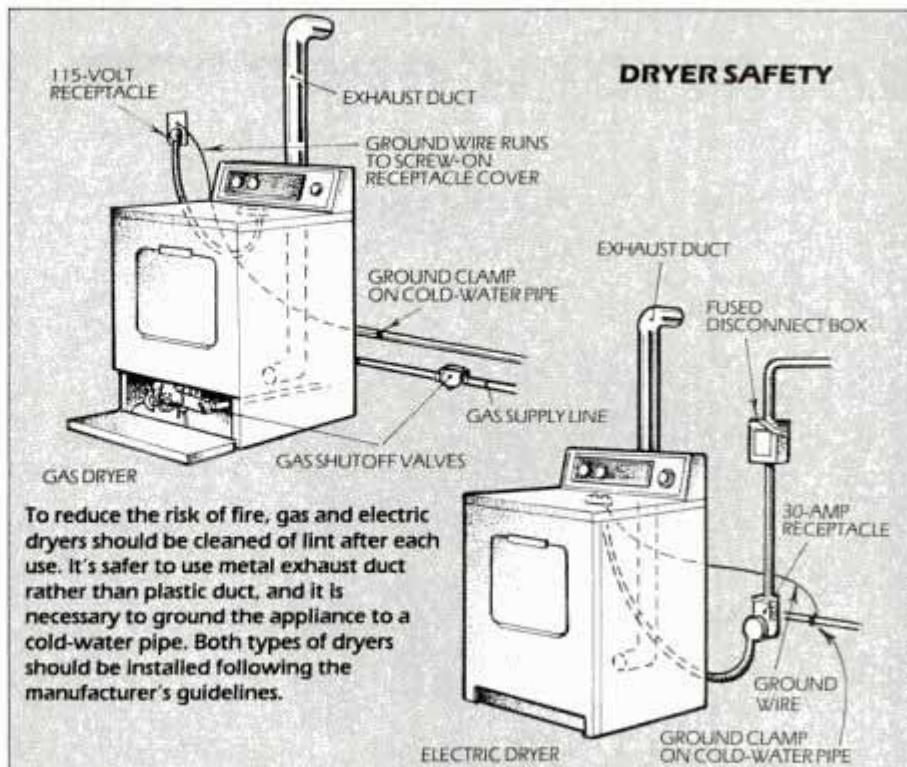
The illustration shows the correct methods for installing both gas and electric dryers. Metal exhaust duct is shown in the drawing, and is specified by most manufacturers. It is considered safer than plastic duct or corrugated-plastic hose in that it is less likely to trap lint. If you have your dryer installed, insist on metal exhaust duct unless the installer can verify that the manufacturer permits the use of plastic duct. Metal duct can be purchased at hardware and appliance stores and home centers. For more information, contact the manufacturer of your appliance.

## Kenmore Wiring Diagram

I am having trouble locating service or technical information to repair a Sears Kenmore gas range, model No. 103.7377042. It was originally built by Roper for Sears. The wiring diagram, repair parts list and wiring harness are no longer available. What appears to have been a resistor in the locking circuit for the auto-clean feature is burnt.

ORVILLE E. KERSEY  
 CROWN POINT, IN

To get a copy of the original wiring diagram for your 1976 range, write to Sears with the model and serial numbers, and they will furnish you with a photocopy of the original diagram. Send your letter to Sears Roebuck and Co., Sears Tower, Chicago,



IL 60684, Attn: Customer Relations.

A replacement resistor (18,000 ohms, 2 watts, 5% tolerance metal oxide) can be ordered from any Sears repair parts center in your area. It's available from Division 57, Source 528, part No. 46-6844-3, or you can stop by an electronics store and ask for a metal-oxide resistor with the above value. It's important to get a metal-oxide resistor. These resistors are able to withstand the heat generated during the cleaning cycle, whereas resistors made from other materials may not.

## Rusting Racks

I own a KitchenAid dishwasher. The upper and lower racks are showing signs of wear. Metal is poking through the coated surface and is causing rust stains on the dishes. I am told that the two racks cost almost \$200 to replace. Is there a paint I can apply to the racks to increase their life? Also, I would appreciate a source to get new racks in case I need to purchase new ones.

ROBERT C. MANTLER  
 WARE, MA

KitchenAid is now part of Whirlpool Corp. To get parts or information about KitchenAid appliances, call the KitchenAid consumer assistance center at (800) 422-1230. The center can supply you with the name, address and phone number of an authorized parts distributor in your area, or you can order the part directly

from the center.

As far as the rust on the racks, KitchenAid makes a touchup coating for dishwasher racks. A 4-ounce bottle costs about \$8. It is part No. 675579. Also, there is a tine-tip repair kit which is available in blue, part No. 675506, or white, part No. 675679. The kit contains 150 tips, enough for two racks. The tips slip over the ends of the tines, and prevent them from rusting. The kit costs about \$10.

You may want to purchase some silastic sealer, part No. 834595, to put on the tines before slipping on the tips to hold them in place. This white sealer comes in a 3-ounce tube and costs about \$8. If the racks are white, this sealer can also serve as a touch-up. Before applying the sealer to the tine or elsewhere on the rack, use a wire brush or scraper and remove as much of the rust as possible. Wipe off and dry the area thoroughly before applying the sealer.

Follow the directions that come with the sealer, and let it dry completely before using the dishwasher.

These coatings only temporarily repair the racks. Over time, the rusting will probably reappear and you may need to replace the racks. **PM**

## DO YOU HAVE AN APPLIANCE PROBLEM?

Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

**NEW PRODUCTS**  
**YARDWORK GEAR**

BY ROY BERENDSOHN, Assistant Home Improvement Editor



**Wheel And Deal**

Wheel the Garden Way Chipper/Vac over your lawn and deal with small sticks and leaves by turning them into mulch. The Chipper/Vac sucks leaves through its 20-in.-wide snout and shreds them. Feed sticks up to 1½ in. in diameter into its chute, and it chips them. The machine is powered by a 4-hp Tecumseh engine and is equipped with a 3-bushel bag. An optional hose vacuum attachment is also available for cleaning out under bushes and other obstructions. The Chipper/Vac's handlebar folds to help you store the machine in tight places. It costs about \$440 (freight included) from Garden Way Inc., 102nd St., Ninth Ave., Troy, NY 12180.



**Torque On Demand**

To handle tough mulching and leaf shredding with this mower, just move the throttle to the position on its plate marked Power Mulch. Lawn Boy says the mower's commercial engine is designed to produce maximum torque at this speed setting. That way, as the mower blade encounters thick grass and leaves—generally a problem for mulching mowers—the engine delivers enough torque to handle the load. Several Power Mulch models are available. The 21-in. model shown is powered by a 4-hp, 2-cycle engine. It costs about \$570 at Lawn Boy dealers. Write Lawn Boy, 8111 Lyndale Ave. S., Bloomington, MN 55420.



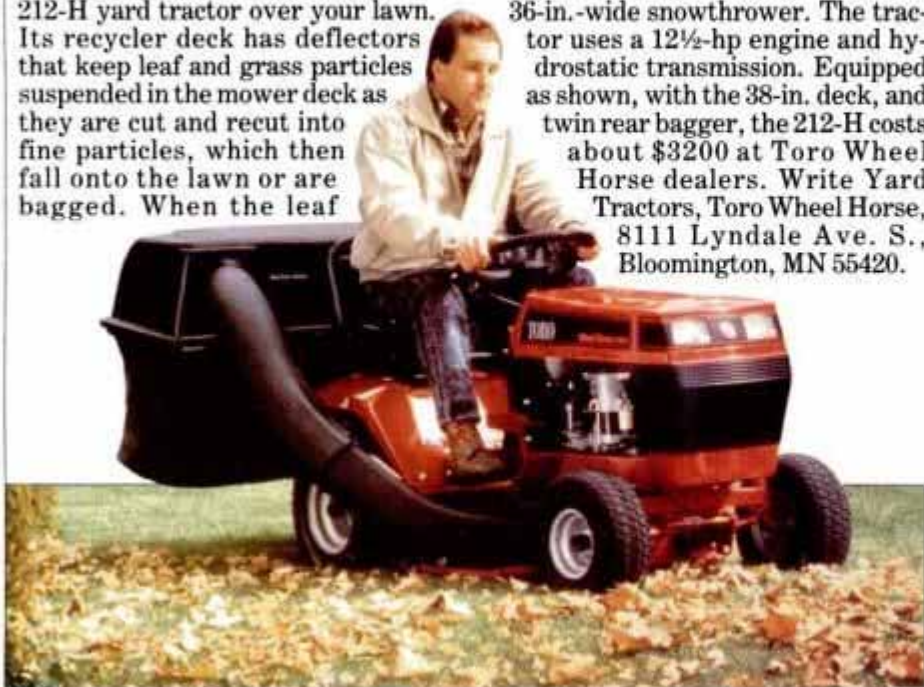
**For Your Chain Saw, Not Your Salad**

Stihl introduces this vegetable oil bar and chain lubricant. It flows well at temperatures as low as -4° F and does not form resinous deposits when mixed with tree sap and sawdust the way petroleum-based oil does, the company says. Excess bar and chain oil usually flies off the end of the saw chain and onto your lawn or the forest floor. Stihl says its lubricant is less toxic to plants and outdoor microorganisms, compared with petroleum-based oil. A 1-liter container costs about \$5.50 at outdoor power equipment dealers. Contact Stihl Inc., P.O. Box 2015, Virginia Beach, VA 23452-2015.

**Rake-Free Leaf Work**

Put the rake away and drive the Toro 212-H yard tractor over your lawn. Its recycler deck has deflectors that keep leaf and grass particles suspended in the mower deck as they are cut and recut into fine particles, which then fall onto the lawn or are bagged. When the leaf

work is done, you can equip the tractor with a 42-in.-wide snow blade or a 36-in.-wide snowthrower. The tractor uses a 12½-hp engine and hydrostatic transmission. Equipped as shown, with the 38-in. deck, and twin rear bagger, the 212-H costs about \$3200 at Toro Wheel Horse dealers. Write Yard Tractors, Toro Wheel Horse, 8111 Lyndale Ave. S., Bloomington, MN 55420.



# TorqueForce<sup>®</sup> outguns Makita, decks DeWalt and leaves Milwaukee behind



Ryobi's 12-Volt TorqueForce Cordless Driver/Drill delivers more power than any of these competitors. At higher speeds, too. In fact, the TorqueForce Series offers the most powerful range of cordless driver/drills in the world. So visit your Ryobi dealer and get your hands on a TorqueForce. You'll see why the competition is eating our dust.

## Compare TorqueForce

	Ryobi	Makita	DeWalt	Milwaukee
MODEL	TFD222VRK	6093/6095DW	DW945K	0401-1
VOLTS	12	9.6* <small>*Makita's most popular drills.</small>	12	12
MAXIMUM TORQUE (in-lbs)	220	95	175	156
	TorqueForce packs 26% more turning power than DeWalt, 41% more than Milwaukee and a whopping 132% more than Makita.			
MAXIMUM SPEED (RPM)	1300	1100	1300	1000
	While DeWalt manages to match Ryobi's speed, TorqueForce runs 18% faster than Makita and a full 30% faster than Milwaukee.			
SPARE BATTERY INCLUDED	Yes	No	No	No
	Only TorqueForce includes a spare battery in every cordless driver/drill kit so you're always charged and ready to go.			

For more information about TorqueForce Driver/Drills call 1-800-525-2579.

# RYOBI

Making Innovative Concepts A Reality™

Ryobi America Corp., 5201 Pearman Dairy Road, Suite 1, Anderson, SC 29625-8950 © Ryobi America Corp. 1992

### Fall Debut

This fall Simplicity rolls out its Coronet series of riding mowers, designed for an acre or less of lawn. The largest mower in the series, a 12-hp hydrostatic-drive model, has an accessory leaf-shredding kit (about \$100) for its 34-in., 2-blade deck. The mower costs about \$2300. The company also offers two gear-drive models with 30-in. decks—one is 8 hp (\$1850) and the other 12 hp (\$2100). The mowers have a 12-in. turning radius and a pivoting rear axle to allow even mowing on uneven ground. The mowers' decks adjust to 1- to 3½-in. cutting heights, and can be removed in minutes without tools. To make the machines as easy as possible to drive, shift- and deck- adjustment controls are located on the steering column. Write Simplicity Manufacturing Inc., 500 N. Spring St., Port Washington, WI 53074.



### Cut And Dried

PM last mentioned a battery-powered mower 17 years ago when we tested Toro's Carefree Electric. Now comes the CM500, an 18-in. electric mower from Black & Decker that runs for about 1 hour and is recharged in 20 hours. It's supposed to be quieter than gas mowers, too. It costs about \$500 at hardware stores or direct from Black & Decker at (800) 258-6003.

The BV400 blower vacuum is powered by an 8.4-amp motor so it can pull in leaves, mulch them and blow them through an 8-ft.-long hose into a trash can. It costs about \$120 at hardware stores and home centers. Contact the Communications Dept., Black & Decker, 10 North Park Dr., P.O. Box 798, Hunt Valley, MD 21030.



### Hired Hand

The FarmHand chain saw (\$210) uses the flywheel to force dirt away from the saw's air-intake tube. The result,

says Poulan, is a saw that runs 10 times longer before the filter needs changing than comparable chain saws. The FarmHand is powered by a



2½-cu.-in. engine, and it comes with a 16- or 18-in. reduced kickback guide bar and low kick chain. The saw's forged connecting rod and 2-counter-weight crank shaft increases the durability of its engine, Poulan says. It has a spring-mounted handle that absorbs engine vibration. It is available at most home centers. Write to Marketing Dept., Poulan/Weed Eater, 5020 Flournoy-Lucas Road, Shreveport, LA 71129.

### Adaptable

The Trimmer Plus starts out as a trimmer, but by snapping on attachments, you can change it into a vacuum, a forced-air sweeper, an edger or a cultivator. Its powerhead is a 31-cc, 2-cycle engine. The attachments click on and off the power shaft without the use of tools. They are secured by an interlocking button and wingnuts. The complete gas-powered Trimmer Plus costs about \$300. It's available at home centers and department stores. For more information, contact Ryobi America Corp., 5201 Pearman Dairy Rd., P.O. Box 1207, Anderson, SC 29622-1207.





# Does your cigarette wear out as the day wears on?

Thanks to Lark's  
unique, charcoal filter  
it won't.

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

How does an activated  
charcoal filter do that?

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



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

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

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

Get your money back if  
you don't agree.

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

Available in king size and 100's, full flavor and lights.

Money Back Guarantee: If not completely satisfied, please send your receipt with purchase price circled, (1) empty Lark pack and your name, address, zip code and the statement "I certify that I am 21 years old or older" hand printed on a 3" x 5" piece of paper to: The Lark Challenge, P.O. Box 1680, Church Hill, MD 21690. OFFER EXPIRES 3/31/93. Refund limit, 1 to adults 21 years and older. Club responses void. Offer good only in U.S.A. Void where prohibited. Please allow 6 to 8 weeks for delivery.

**SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.**

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

# HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

## Ceiling Fan Direction

We have a 2-story, contemporary home with a ceiling fan downstairs in the living room and another upstairs in the loft area. In the summer, we open the windows in the loft above the fan and run both fans so they blow air up and out the windows. In the winter, we run the fans down so they blow the warm air from the second floor down to the first floor. Recently I was told this is not the correct way to use the fans. Is it?

GENE ROBINSON  
 POCONO LAKE, PA

*A ceiling fan is not intended to be used as a whole-house fan—which is how you are using it during the summer. Whole-house fans are very effective, and if that's what you want, you should use a fan that is designed for that purpose.*

*Ceiling fans are designed to circulate air in a "closed" environment. According to the Casablanca Fan Co., a ceiling fan should force air down during the summer. This downward airflow cools your skin as it moves over it. During the winter months, the company recommends that the fan rotate so it produces an upward airflow.*

*During the winter, heated air rises toward the ceiling, and cool air settles toward the floor. Depending on the room size and shape, there could be a 15°F difference between the floor and ceiling. Intuitively, people want the fan to pull warmer ceiling air down during the winter and vice versa during the summer.*

*The fan speed should be fast*

*enough to break up stagnant air trapped in the corners and in the peaks of sloped and cathedral ceilings, but slow enough so it doesn't create a draft.*

*An easy way to determine whether the fan airflow is up or down is to look at the fan blades as they rotate. The blades are installed on a slight angle. If the leading edge of the blade (the edge facing the direction of rotation) is up, the airflow will be down. And when the leading edge is down, the airflow will be up.*

## Preheat Water Heater

I have a 50-gallon electric water heater. However, I would like to switch to a 40-gallon gas-fired water heater. Would it be feasible (costwise) to use my electric heater as a warming tank and heat the water by gas? How would I hook the two together as a unit? Any information you have on this subject would be appreciated.

FRANK GAMSBY  
 WATERLOO, SC

*If you have the space in your utility room for an extra tank, it would be worthwhile to use the electric water heater as a prewarming tank rather than discarding it, assuming the tank is sound and doesn't leak.*

*The tank should be connected in series with the gas-fired water heater. Connect the cold-water supply to the cold-water inlet pipe on top of the tank. The hot-water outlet pipe should then be connected to the inlet pipe on the gas-fired water heater. Also, disconnect the electrical wiring*

*to the old water heater so that the unit functions purely as a storage tank. In order for the tank to be effective as a prewarming tank, you have to remove the insulation that surrounds the tank. This may be difficult because the insulation is located between the tank and the outer casing.*

*If condensation develops on the tank during the summer months, you can control it by installing a dehumidifier in the room.*

*The advantage of a prewarming tank for the domestic hot water is twofold: It reduces the amount of gas needed to heat the water, and it increases the heater's recovery rate, which enables you to have more hot water over a given period of time.*

## Well Water Odor

I have a problem with my well water. It smells like rotten hard-boiled eggs. The water is soft and I have no rust problem. I like the water except for its smell. What causes this smell and what can I do to eliminate it?

BRENDA DE COOPMAN  
 RICHMOND, MI

*The rotten-egg odor is caused by hydrogen sulfide gas in the water.*

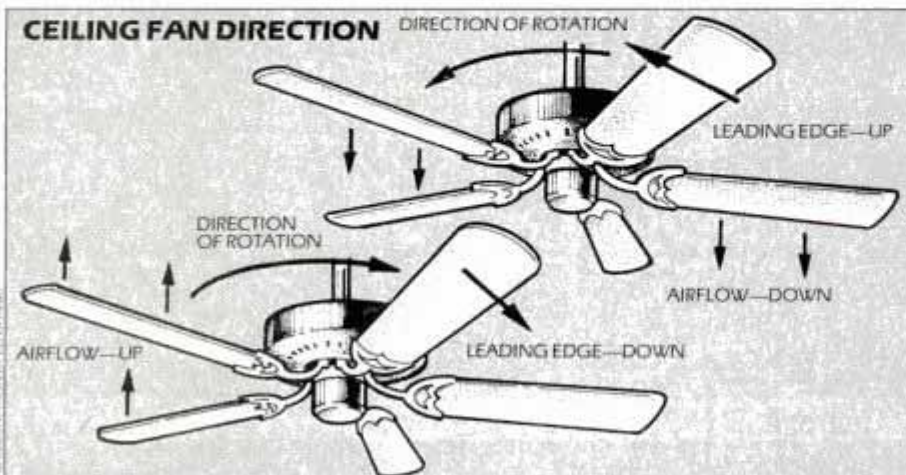
*Hydrogen sulfate is commonly found in well water and is changed into hydrogen sulfide gas by the activity of nonharmful water-borne bacteria. You can stop the biochemical reaction that forms the gas by killing the bacteria with chlorine. Check with your local health department to determine how much chlorine to add to your well.*

*Hydrogen sulfate also may be turned into sulfide gas in the water heater (you won't smell the rotten-egg odor at your cold-water tap). In this case, the bacteria react with a magnesium anode in the water heater, and this forms sulfide gas. The anodes are called sacrificial. They corrode instead of the metal heater tank, thus preventing the tank from rusting. You can stop the formation of hydrogen sulfide gas by removing the anode, though this causes the tank to rust out more quickly than it would otherwise. Or, again, you can chlorinate the well.*

PM

## DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

*Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.*

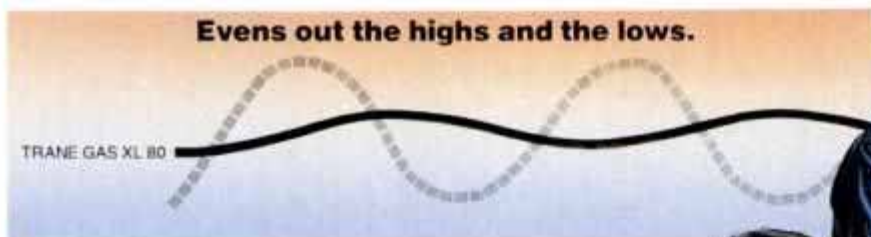


**A ceiling fan should force air down during the summer and up during the winter. This works even though it seems just the opposite of what one might expect.**

# NOTHING EVEN-HEATS LIKE IT.

## The Trane XL 80 Gas Furnace

It saves money and energy because it heats evenly—reducing those old-fashioned on-again-off-again cycles.



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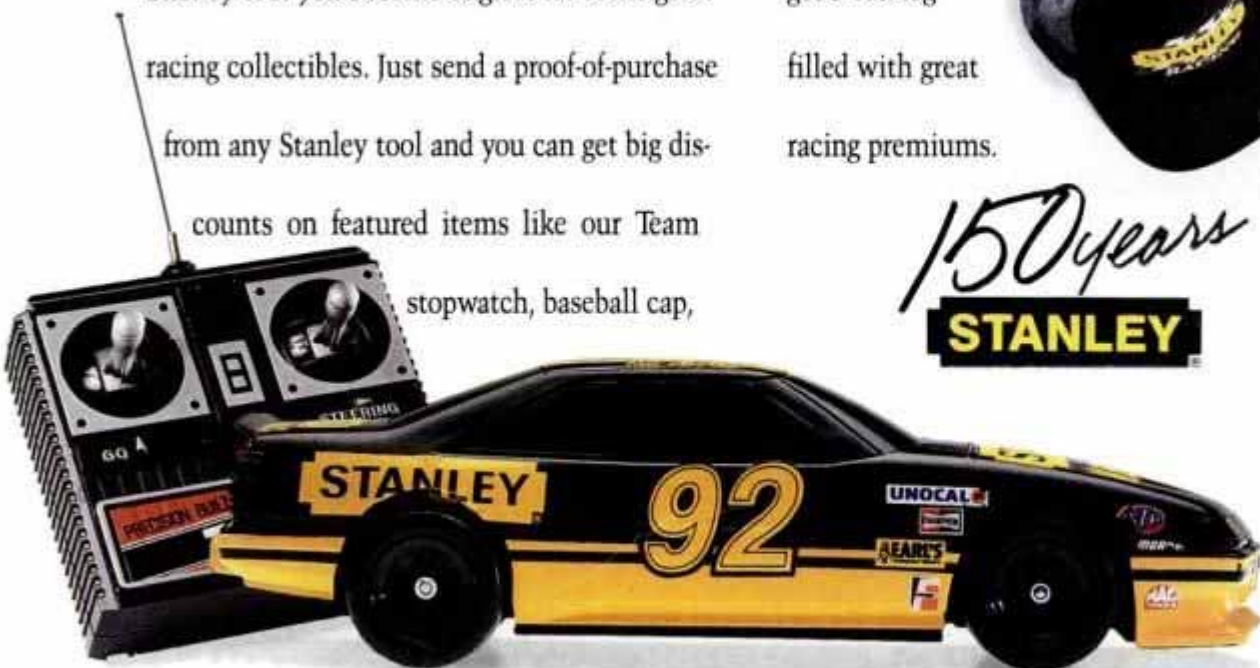
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HOME  
IMPROVEMENT

INSTALLING A  
DISHWASHER

With standard cabinets, switching a base unit for a dishwasher is easy.

BY MERLE HENKENIUS  
PM Illustrations by  
George Retseck

● Of all the rooms in your home, your kitchen is probably the most space hungry, while at the same time being the most difficult to modify. Adding another major component to an already overcrowded kitchen may, therefore, seem like an impossibility.

If you've wondered how you could squeeze a dishwasher into your kitchen, however, you might consider sacrificing a base cabinet to create the needed space. While this isn't always an acceptable tradeoff, in many cases it's the only affordable alternative.

Cabinet-for-dishwasher swaps won't work in every home, however. Cabinets that were built in place or were not built to standard dimensions simply pose too many problems. Another roadblock can be a countertop that was nailed or screwed down from the top before the plastic laminate was installed. In this case, removing a base cabinet for a dishwasher means you'll have to look at a new countertop, as well.

Luckily, the best cabinets for this switch are also the most commonly installed. These are factory-built, modular units that are screwed together through their stiles, which makes them easy to remove. They also come with corner brackets mounted on the inside walls of each unit near the top. The countertop is screwed to the brackets from underneath so it can be easily removed.

If your kitchen has these types of mix-and-match cabinets, and you find a 24-in. base unit near the sink, you can install a standard dishwasher (there are also models available that fit into an 18-in.-wide base cabinet space). In our conversion, we chose to remove a door unit and save the bank of drawers on the opposite side of the sink.



**Basic requirements**

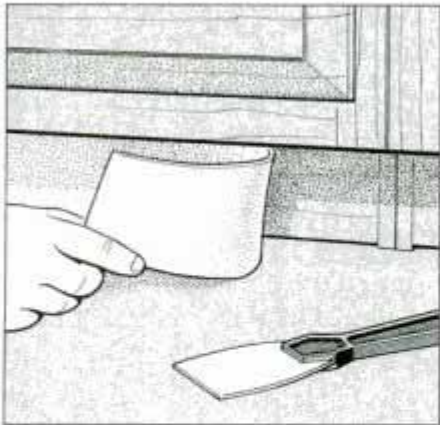
In addition to the dishwasher, you'll need a 6-ft. drain hose and two standard hose clamps. If your sink has a garbage disposal, you'll need a dishwasher connector kit to connect the dishwasher drain hose to the disposal. Without a disposal, a dishwasher waste tee that is spliced in the sink drainpipe is required. In either case, the hose you buy must be heat and detergent resistant. You can find ready-made dishwasher drain hoses, but a  $\frac{3}{8}$ -in. automotive heater hose is a common alternative.

To bring water from the sink's hot-water pipe to the dishwasher, you'll need about 5 ft. of  $\frac{3}{8}$ -in. O.D. soft copper tubing and a dishwasher ell—a right-angle fitting with a  $\frac{3}{8}$ -in. male pipe thread on one side and a  $\frac{3}{8}$ -in. compression fitting on the other—to

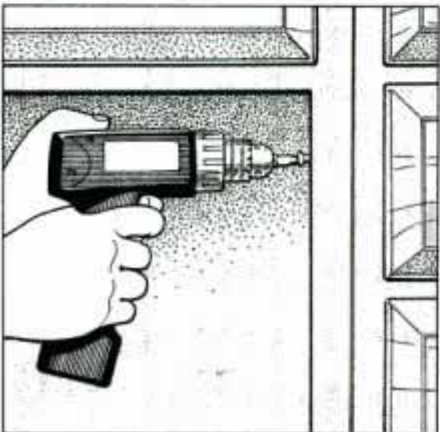
attach the tubing to the dishwasher. You'll also need a dual compression stop to replace the single compression stop that's on the hot-water pipe connected to the faucet. A compression stop is a valve that controls the water supply to the faucet. Both hot and cold stops are usually found at the base cabinet floor, and they're connected to the pipes with compression fittings.

Your electrical code will require a dedicated circuit for your new dishwasher, so don't be tempted to pull power from a nearby receptacle. In some jurisdictions, a dishwasher may share a circuit with a garbage disposal, but each appliance will need its own disconnect switch inside the sink base cabinet. Codes vary, so be sure to check.

To run power from a dedicated cir-

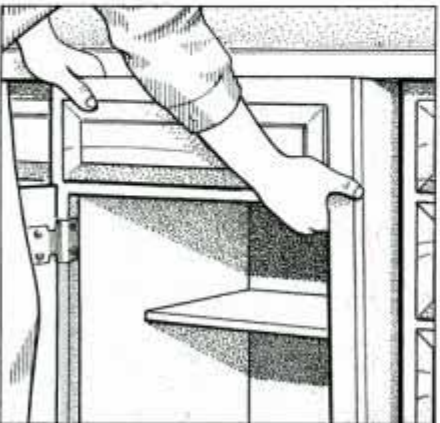


**1** Begin freeing the cabinet by removing the toe-kick trim. This will be cut to fit around dishwasher and reinstalled later.

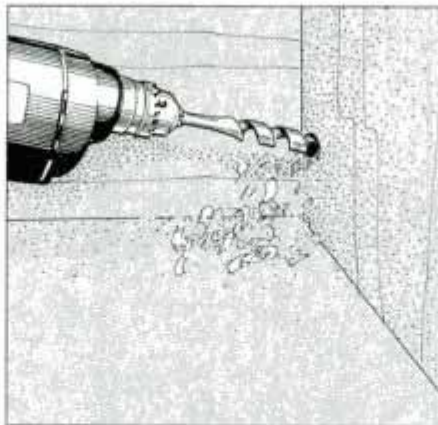


**2** Remove screws in stiles that secure the cabinet to adjacent units. Then, remove countertop and back screws.

cuit, you'll need a free slot on your service panel, a 15-amp circuit breaker and at least 6 ft. of flexible metal conduit to house the wires in the sink and dishwasher area. To carry the power, you'll need enough 14/2 w/g cable (14-gauge, 2-wire cable with ground) to bring power from the panel to the sink cabinet, plus insulated black, red and green wire to go from the sink cabinet



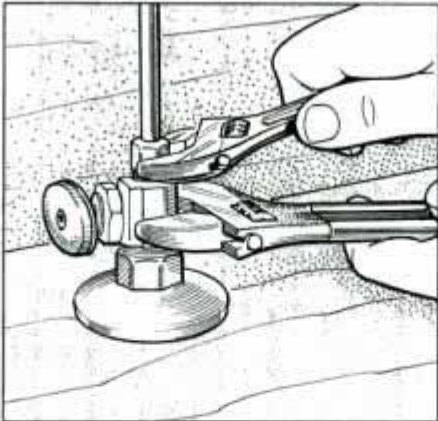
**3** Pull out cabinet from wall. A standard modular base cabinet should leave a space 24 in. wide and deep by 34½ in. high.



**4** Bore two ¾-in. holes and one 1 ½-in. hole through the side of the sink unit wall for water supply, conduit and drain hose.

to the dishwasher. You can also run insulated black, white and green wire in standard conduit from the service panel to the sink. You'll also need box connectors, a grounding clip, a single-pole switch and a surface-mount switch box with cover plate.

And finally, double check that the modular cabinet space will be adequate for a standard dishwasher. The cabinet space dimensions must be 24 in. wide, 24 in. deep and 34½ in. high, measuring from the floor to the bottom of the countertop edge band.



**5** Use two wrenches to loosen and remove the hot-water compression stop (valve) within the sink base cabinet.

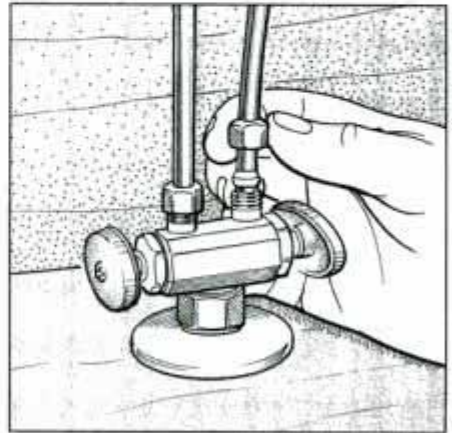
### Removing the base unit

You'll probably find the base cabinet screwed to the kitchen wall, the countertop and to the stiles of adjoining base units. It will also be locked in place by the trim that spans the toe kick along the bottom of all the base units. This may be glued-in-place vinyl, as in our example, vinyl-wrapped particleboard, wood or hardboard. In most cases, it's easier to remove the entire trimpiece and then cut it to fit when the dishwasher is installed (Fig. 1). After the toe-kick trim is freed, re-

move the screws from the counter, back cabinet wall and stiles (Fig. 2). Then, simply grasp the front of the cabinet and ease it out a little at a time (Fig. 3).

### Plumbing provisions

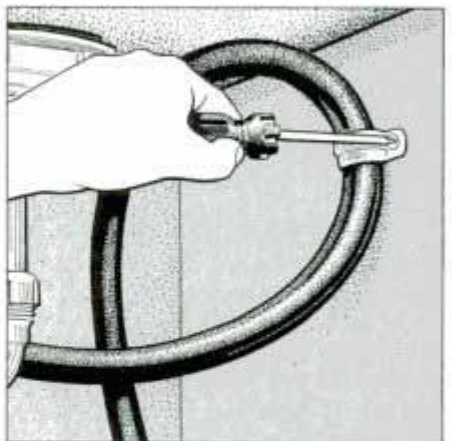
Before installing the dishwasher, it's best to run the plumbing and electrical conduit into the opening. The dish-



**6** Install a dual stop in place of the original valve. Then, reconnect the faucet pipe and attach the dishwasher supply tubing.

washer can then be pushed in place and the final connections can be made at the bottom front of the unit with the dishwasher's front access panel removed.

Begin by boring three holes in the sidewall of the sink base cabinet adjacent to the dishwasher space and near the cabinet floor. Be sure to arrange these holes vertically, within 1 in. of the back wall to avoid interference



**7** Loop the drain hose high in the sink cabinet and secure it to the side with a conduit bracket or hose strap.

with the dishwasher frame. Make one hole 1½ in. in diameter and the other two ¾ in. (Fig. 4).

Feed the drain hose through the larger hole and pass the copper tubing through one of the smaller holes. The

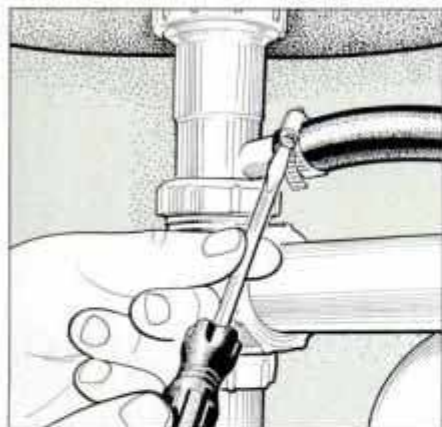


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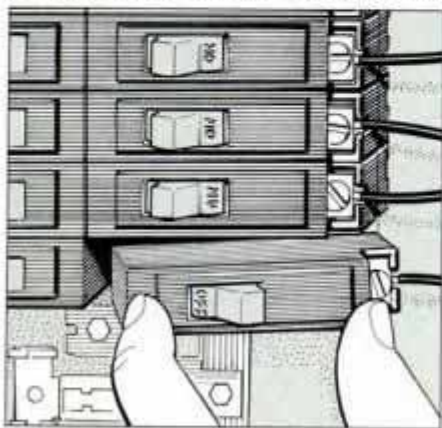


**8** Join the end of the drain hose to the dishwasher drain tee installed in the sink drain. Secure with a hose clamp.

remaining hole is for the conduit. To connect the copper tubing that supplies hot water to the dishwasher, first shut off the main valve to turn off the water supply to the house and drain some water from the pipes. Then, disconnect the hot-water supply pipe to the sink at the top of its compression stop and remove the stop. The compression nuts and ferrules from this valve will remain on their respective pipes (Fig. 5).

In place of the single compression stop, install a dual compression stop and connect the faucet's hot-water supply pipe to one side with the existing ferrule and nut. Fasten the dishwasher supply line to the remaining port using the nut and ferrule supplied with the new valve (Fig. 6).

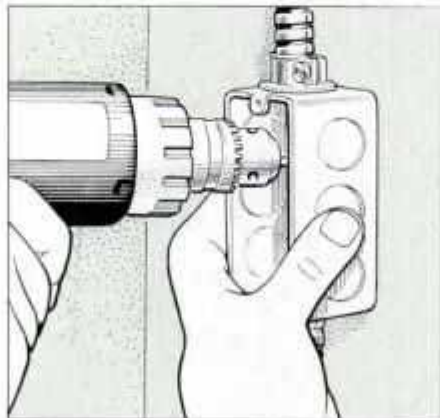
One critical drainage requirement must be met before connecting the drain hose to the sink drain. To protect against a contaminating backflow, the hose must be looped and secured high inside the sink cabinet. Simply loop the hose at the top of the cabinet and fasten it with a hose strap or a conduit bracket (Fig. 7). Some



**9** Install a new 15-amp circuit breaker in panel for a dedicated dishwasher circuit. Work with the power off.

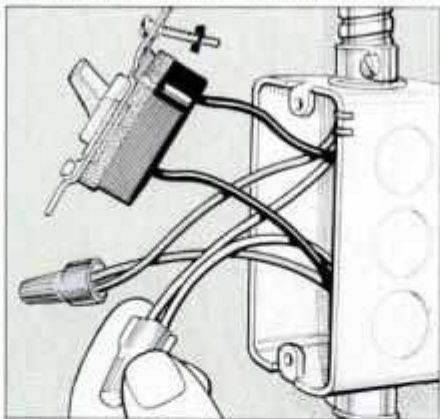
codes may also require a vacuum breaker in the drain line. In this case, install the vacuum breaker in the extra fourth sink hole next to the faucet, or through the countertop. Be sure to check your local code to see if a vacuum breaker is required.

If your sink has a garbage disposal, use a screwdriver to knock the plug from the disposal's dishwasher inlet



**10** Join incoming and outgoing conduit to switch box with connectors, and screw box to sink cabinet floor.

fitting and then connect the drain hose with a dishwasher connector kit. In our case, we spliced a dishwasher waste tee into the sink drainpipe. Simply cut away a portion of the drain tailpiece that extends down from the sink and install the tee in its place. As

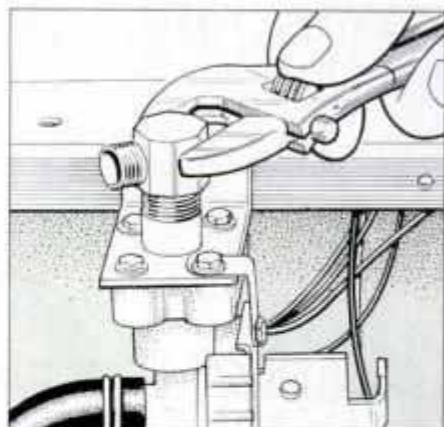


**11** Wire switch by joining white to white, both blacks to switch, and ground to box via pigtail and grounding clip.

plastic waste kits use nylon compression washers, the nuts need only be hand tight. With the tee installed, slide the hose over its fitting and secure it with a hose clamp (Fig. 8).

### Electrical provisions

Begin by shutting off the main disconnect switch on your breaker panel. Then install a 15-amp circuit breaker in an open slot of your service panel (Fig. 9). If you are not completely con-



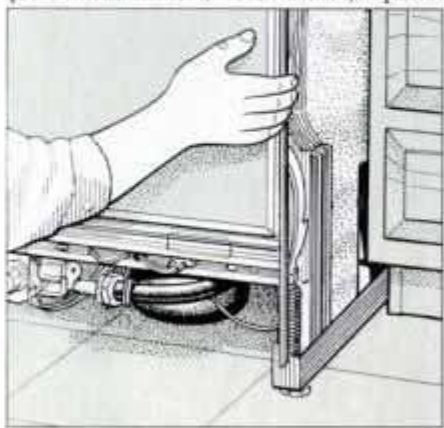
**12** Thread dishwasher ell into solenoid, and tighten with wrench. Use pipe compound or Teflon tape on threads.

fident of your electrical skills, hire an electrician to install the breaker and make all panel connections. Then, run 1/2 w/g cable from the service panel to the sink cabinet. Just before the cabinet, run the wires through the conduit. You can either strip the plastic sheathing back to the cabinet and feed the wires through the conduit—allowing some overlap between the conduit and plastic sheathing—or feed the sheathed cable through the conduit.

Once inside, install a metal switch box on the wall of the sink base cabinet (Fig. 10). Use box connectors to join the incoming and outgoing conduit to it, and pass the outgoing conduit through the remaining hole into the dishwasher space. Then, feed one black, one white and one green wire through the outgoing conduit. Install a single-pole switch in the box, ground the box with a pigtail and grounding clip, then finish with a cover plate (Fig. 11).

### Installing the dishwasher

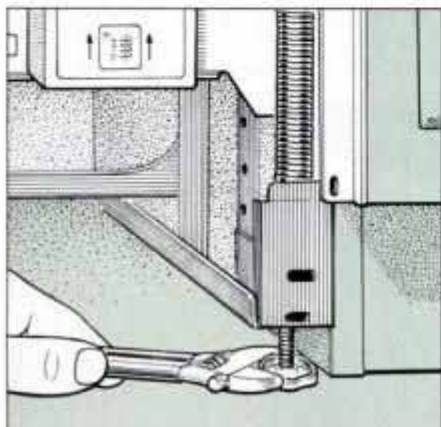
With the plumbing and wiring completed within the sink base, tip the



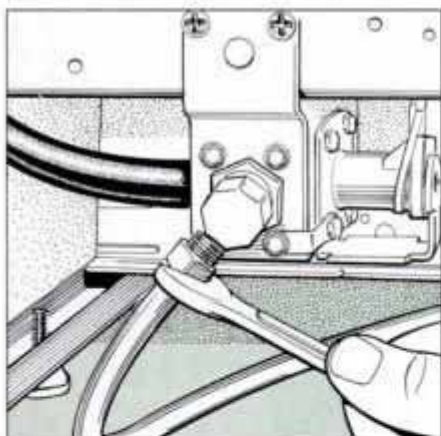
**13** After screwing in adjustable legs all the way, carefully slide the dishwasher into its cabinet space to avoid marring floor.

dishwasher on its back and thread the four extension legs in completely so the dishwasher will slide under the counter easily. Next, coat the threads on the dishwasher ell with pipe joint compound or Teflon tape and thread it into the dishwasher's solenoid fitting (Fig. 12). Then, tip the dishwasher up and, without scarring the floor, slide it into the cabinet space (Fig. 13). Placing an old towel or floor mat under the dishwasher legs can make sliding the unit easier and prevent damaging the floor.

Press the dishwasher against the



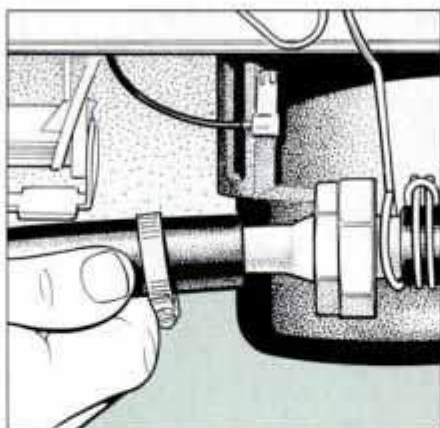
**14** Raise and plumb the dishwasher by extending the legs until the counter brackets meet the edge of the countertop.



**15** Carefully bend the supply tubing to meet the dishwasher ell, and join the tubing with a compression nut and ferrule.

back wall so that its frame is flush with the cabinet stiles, and adjust all legs upward until the front of the unit is plumb and the counter brackets at the top front of the dishwasher meet the bottom of the countertop edge band (Fig. 14).

Carefully bend the copper water-supply tubing to meet the dishwasher ell and slide the compression nut and ferrule over the tubing end. Then, thread the nut onto the ell and tighten (Fig. 15). To connect the drain hose,



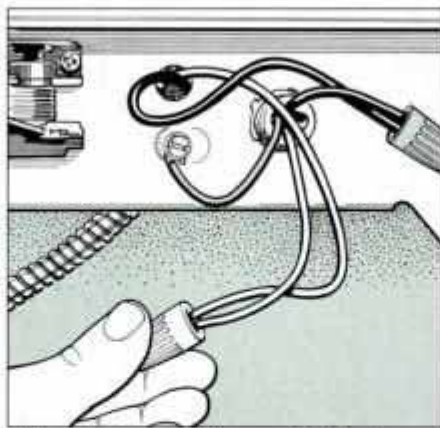
**16** Slip a hose clamp over the drain hose and slide the hose over the pump's discharge fitting. Then tighten hose clamp.

simply slide it over the hose fitting on the discharge pump and tighten a hose clamp over it (Fig. 16).

To complete the wiring, remove the unit's electrical box cover and fasten a box connector to the dishwasher's frame. Then, using twist connectors, join the black circuit wire to the black dishwasher lead, the white wire to the white lead and the green ground wire to the grounding screw on the frame (Fig. 17). Finish by covering the wires with the unit's electrical box cover (Fig. 18).

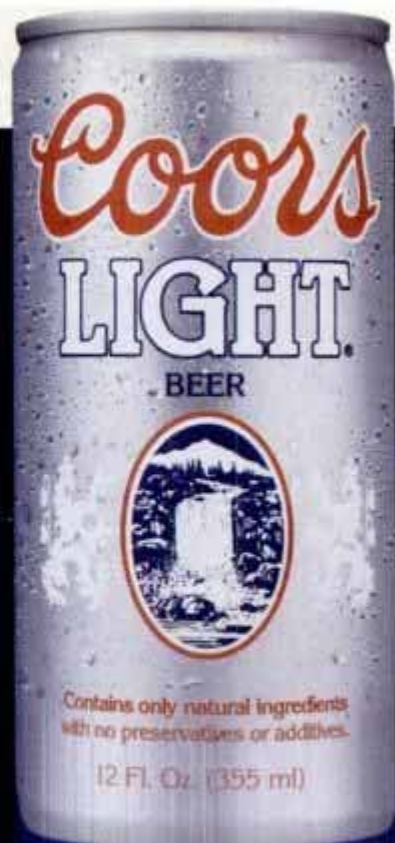
#### Finishing touches

Turn on the water and screw the dishwasher's counter brackets to the bottom of the counter's edge band (Fig. 19). Then, turn on the circuit and run the unit through one complete cycle to



**17** After connecting conduit to frame, join black and white wires to like-colored leads. Join green wire to grounding screw.

check for leaks and balance. If a compression nut leaks, tighten it one more turn. If the dishwasher vibrates excessively, look for a leveling leg that's not carrying its share of the load. And if you find water backing up into your sink, you'll have to clear the



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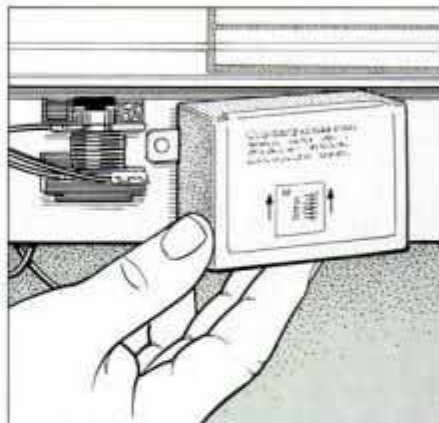


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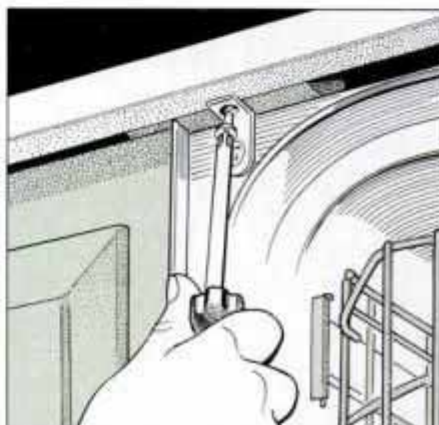
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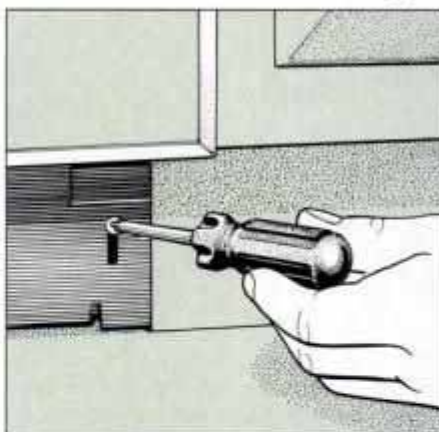
## HOME & SHOP JOURNAL



**18** Finish wiring by installing the dishwasher's electrical box cover over wires. Then, turn on circuit power and water.



**19** Secure dishwasher to countertop by screwing through dishwasher's counter brackets into underside of counter edge.



**20** After checking for leaks and proper balance, replace dishwasher access panel and reinstall toe-kick trim.

drain line with a snake or hire a specialist to do it. Once cleared of soap and grease, the force and heat of the discharged water will keep it clean. To finish installation, first replace the dishwasher access panel (Fig. 20). Then, measure the toe-kick area on both sides of the dishwasher, cut pieces to fit from the original toe-kick trim and install the trim. **PM**

position as the turn is completed.

Some visitors to the exhibit have asked why the museum picked this particular concept car. Its record-setting aerodynamics were certainly a factor. But the rest of the equation will be obvious when you visit the museum in Dearborn—the car we picked had to be small enough to fit through the gallery door. And this car could have squeezed through even with its doors open. Wrapover doors slide toward the back of the car, with the tracks and operating mechanism completely concealed. Need to get at the Probe's transversely mounted midship engine? The power-operated, clear plexiglass canopy slides rearward, allowing easy access.

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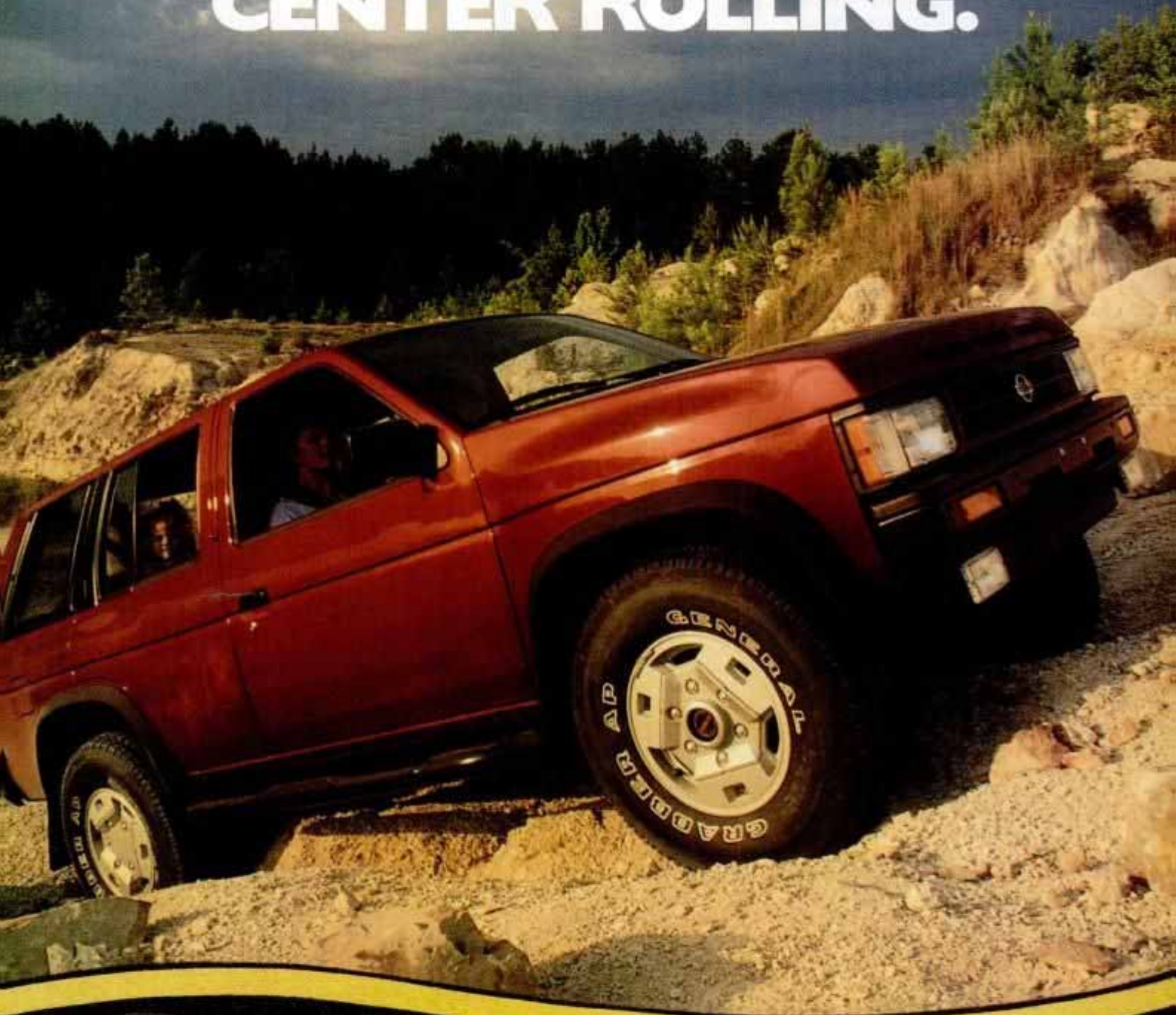
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Rubber Queen's new Grip-Lock car mats keep the driver's-side mat in place using a patented fastening system. The system is easily installed with a screwdriver and allows the mat to be attached directly to the car's carpeting. The mats also feature a special moisture barrier inner lining beneath the mat's deep-pile carpet. This keeps water from soaking through and prevents the mat from wrinkling. *Contact: Sue Catrow at Rubber Queen, 437 Cambridge Rd., Coshocton, OH 43812; (800) 837-9160.*

### Protectant

Armor All Protectant is now available in its most easy-to-use form yet—handy Sponge Packs. The Sponge Packs are made up of small applicators filled with protectant that offer one-time cleaning. They eliminate the storage space required by bottles. One Sponge Pack contains enough sponges to treat four tires. Available at auto parts and mass merchandiser outlets. *Contact: Armor All Products Corp., 6 Liberty, Aliso Viejo, CA 92656; (714) 362-0600.*



### Exterior Trim Care

Black Again cleans, renews and protects all color vinyl, rubber, plastic and flat black metal on car exteriors. It also contains a sunscreen to block out damage from UV sun-rays. Unlike other spray-on products, Black Again penetrates rubber and vinyl for longer protection. It is available for \$10.95 at auto parts outlets. *Contact: Rhino Industries, 14512 N. Nebraska Ave., Tampa, FL 33613; (800) 329-TUFF.*



## AUTO PARTS GUIDE

### Sport Seat Shield

Sport Seat Shield is a waterproof cover for your car seat. The cover slips on in seconds to protect the seat against sweat, spills, rain, snow, sun and sand. It's handy to use after sports, after the gym, after a day at the beach or when traveling with pets or young children. The cover rolls up for easy storage and has a suggested retail price of \$24.99. Sport Seat Shield is available at local auto parts outlets. **Contact:** Grant Products Inc., 700 Allen Ave., Glendale, CA 91201; (213) 849-3171.



### Car Covers

Covercraft's new Ultralyn custom car covers use a multi-layered polyester knit fabric with superior storm resistance. The covers repel rain and snow. And any moisture that gets under the fabric easily evaporates. A soft inner layer protects your vehicle's surface. **Contact:** Covercraft Industries, 19731 Nordhoff St., Northridge, CA 91324; (818) 407-6600.



### Appearance System

The Liquid Glass Total Appearance System includes Liquid Glass Polish/Finish, Liquid Glass Pre-Cleaner,



Liquid Glass Wash Concentrate and Connoisseur's Choice Cleaner and Protectant, both with mink oil and guaranteed to last a minimum of three full months. These products have been developed to chemically crosslink with each other to create a total appearance system for maximum beauty and protection. Liquid Glass products are available through auto parts and other retail stores. **Contact:** Liquid Glass Enterprises Inc., P.O. Box 1170, Teaneck, NJ 07666; (800) 548-5307.

### Tire Cleaner

Forget tire-cleaning hassles, No Touch Tire Care is the only one-step, no-mess product that cleans, shines and protects tires simultaneously. One spray application removes road dirt and restores the original shine. All you need to do is spray it on and walk away. **Contact:** No Touch North America, 8001 Irvine Center Dr., Suite 1170, Irvine, CA 92718; (800) 348-5999.



**No matter where your car is from,  
only one plug guarantees better performance.**

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## TOOLS AND EQUIPMENT



### Fuel Injector Kit

This professional fuel injector cleaning kit was designed and engineered in cooperation with Ford Motor Co. The kit can be used to service both central and multipoint EFI systems. During operation, fuel supply to the engine is shut off and the fuel return line is blocked so all of the cleaner runs through the injectors. The kit (\$619.80) comes with an illustrated instruction manual and will service 100% of Ford and Lincoln Mercury EFI vehicles, as well as 95% of other domestic and import EFI vehicles. Available from your local Motorcraft retail outlet, or Ford or Lincoln Mercury dealer. *Contact: Ford Parts & Service Div., 3000 Schaefer Rd., P.O. Box 1902, Dearborn, MI 48121; (800) 662-6891.*

### Wiper-Arm Remover

If you've ever tried to remove a windshield wiper arm with a screwdriver or other common tool, you may be familiar with the traumatic experience of gouging a nice paint job or mangling part of the wiper assembly. GearBox Grannie's now has a special tool designed just for the job of popping off stubborn wipers. The tool is made in the U.S. and is extremely easy to operate. Just slip the tool under the wiper arm, give a firm squeeze and off comes the arm. The all-steel wiper-

arm remover features a pad on the lower jaw to protect the car's finish. It also has plated construction for corrosion protection. *Contact: GearBox Grannie's, 3944 Indian Ripple Rd., Dayton, OH 45440; (513) 429-8509.*



### Socket/Wrench Set

Mettrinch sockets and wrenches grip the walls of the fastener, not the corners. This design allows each socket and wrench to fit both metric and in-size nuts and bolts. It's like getting

twice as many tools in one set. The tools will work on rounded and stripped nuts and bolts and are available in complete sets of 1/4-, 3/8- and 1/2-in. drives. A professional master socket and wrench set of 71 pieces includes all three drives and 11 combination wrenches. Mettrinch tools are made of chrome vanadium steel and come with a factory lifetime guarantee. *Contact: Unitec, 33 Plainfield Ave., Bedford Hills, NY 10507; (800) 446-5257.*



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

There are a lot of spark plugs that claim they'll give your car better performance. At Bosch, we guarantee it.

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For the Bosch retailer nearest you, call 1-800-882-8101.

\*See store for details. ©1992 Robert Bosch Corporation, Sales Group. The Bosch name and symbol are registered trademarks.



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**Portable MIG Welder**

Ready Welder is a cordless, portable 200-amp MIG welder. Powered by two 12-volt auto or marine batteries, the welder can handle up to 1/2-in. steel and 3/4-in. aluminum. Cost is kept low because the operator uses his own variable-speed electric drill to feed a standard 4-in.-spool-fine wire electrode. Fingertip heat control is accessed by adjusting the wire feed at the drill trigger during welding. With the use of an optional protective shielding gas, you can weld stainless steel and aluminum with less smoke. Suggested price is \$249.95. *Contact: Omniverse Research Inc., P.O. Box 33243, Los Gatos, CA 95031; (800) 762-7032.*



**Locking Extensions**

These locking extensions lock and release sockets by pulling back a button. Adapters also are available to add these locking and quick-release functions to regular socket wrenches or extensions. *Contact: MCT&D Innovative Tool Co., 300 Quaker Ln., Suite 7, Warwick, RI 02886; (401) 821-1810.*

**Cooling System Flush**

Prestone Total Flush Plus, is a 2-step cooling system treatment that combines a power flush to remove deposits and a conditioner to protect the system and promote cooler running. *Contact: First Brands, 83 Wooster Heights Rd., Danbury, CT 06813; (203) 731-2300.*



**Power Charger**

Innova's 15-volt, 10-amp cordless power charger can jump-start a vehicle by charging the battery through the cigarette-lighter socket in 30 minutes or less. In addition, the 8-pound unit can be used to recharge other 12-volt batteries or power packs, and will power all 12-volt negative ground equipment. The power charger itself is recharged via AC adapter or the vehicle's lighter socket. *Contact: Innova Electronics Corp., 17287 Mt. Hermann St., Fountain Valley, CA 92708; (800) 544-4124.*

**Top Dead Center Tool**

Finding the top dead center (TDC) for a piston rising inside the cylinder of an engine is critical for a number of repair and tuning operations. Using a rod or pencil to feel when the piston has risen to its highest point is frequently imprecise. Eastwood's Whistle Stop TDC tool is essentially a whistle that screws into the spark-plug hole. As the piston rises in the cylinder, the compressed air escapes through the whistle. When the whistle stops, the piston is at TDC. The Whistle Stop costs \$29.95, and comes with a 30-day money-back guarantee. Eastwood's catalog also includes a complete line of restoration products. *Contact: The Eastwood Co., 580 Lancaster Ave., Box 296, Malvern, PA 19355; (800) 345-1178.*



**Body Gauge**

The pocket-size Spot Rot autobody damage gauge can accurately determine what lies beneath the paint. The magnet end of the gauge is placed on the car body and the other end is then pulled off to give a reading that indicates solid metal, repainting, rust or collision damage.



The gauge costs \$14.95. *Contact: Pro Motorcar Products Inc., 22025 U.S. 19 N., Clearwater, FL 34625; (800) 323-1090.*



**G-Force Gauge**

How quick is your car? This dynamic motion instrument can now quantify that seat-of-the-pants feeling for how fast your car accelerates, how hard it brakes and how well it corners. The gauge measures out the amount of g-force holding the vehicle to the surface in tenths of 1 g. A longitudinal reading gauge with a 240° sweep dial costs \$49. A longitudinal/lateral model with dual 120° sweep dials costs \$59. *Contact: G-Force Inc., P.O. Box 23374, Richfield, MN 55423; (612) 831-2953.*

**Battery Clamps**

These Instant Battery Clamps replace conventional clamps that are secured to the battery terminal with a nut and bolt. Instant Clamps are securely attached to the terminal like a clothespin using a pair of pliers. The clamps use a stainless-steel spring so they won't corrode. They will accommodate cable sizes ranging from No. 2 to No. 6 gauge. *Contact: Instant Battery Clamp Inc., P.O. Box 1038, Pinellas Park, FL 34664-1038; (800) 749-8821.*



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**Gold Spark Plug**

Champion Spark Plug's new "Premium Gold" plug is engineered to give your automobile increased power, quicker acceleration, lower emissions and better fuel economy. Key features of the new spark plug include a fine-wire center electrode, gold palladium tip for improved spark concentration and an inverted V-tip ground electrode for smoother idling. The new plug also has a patented copper core ground electrode for less gap growth, resulting in longer life. The Premium Gold spark plug is available at a select group of automotive retail stores. *Contact: Champion Spark Plug Div., P.O. Box 910, Toledo, OH 43661; (419) 535-2431.*



**Cooling Fan**

Hayden Thin-Line electric fans are an efficient replacement for belt-driven fans. The fans do not draw engine horsepower like their belt-driven counterpart. They feature a thin, aerodynamic profile, and are pre-assembled at the factory. Quiet in operation, the fans have a full finger-guard shroud and reversible push/pull blades run by a long-life 12-volt motor. Also available are Hayden's high-performance models for additional airflow. *Contact: Hayden Inc., 1531 Pomona Rd., Corona, CA 91718; (800) 442-9336.*

**Transmission Cooler**

Towing a boat or RV loaded up with vacation gear and other types of extreme driving conditions can over-heat your automatic transmission and shorten—or end—a transmission's life. Imperial's Maxi-Kool automatic transmission-fluid cooler features an exclusive crossover network of 16 passes of copper tubing for better fluid cooling. The 1¼-in.-thick aluminum fins make the Maxi-Kool the most effective automotive heat transfer unit on the market. The cooler is available at retail auto parts stores. *Contact: Imperial Products, Marketing Dept., P.O. Box 2508, Fort Worth, TX 76113; (800) 433-5501.*



**Lifetime Wipers**

Tripledge Lifetime Wipers are the original, patented, multiple-edge wiper blades. They feature a synthetic squeegee that resists heat, cold, ozone, road chemicals and distortion. The blades are guaranteed never to tear, crack, split, rot, stick, freeze or melt to the windshield. The wipers include top-quality frames and adapters for easy installation on virtually any vehicle. Tripledege Lifetime Wipers are available in auto parts stores and by mail for \$19.95 per pair, plus \$4.50 shipping and handling. Rear blades are \$9.95, plus \$2.50 shipping and handling. *Contact: Lifetime Automotive Products, P.O. Box 871179, Dept. PR, Dallas, TX 75287-1179; (800) 552-5327.*



**Transmission Filter**

Wix inline automatic-transmission filters (\$28.44) come with a powerful built-in ceramic magnet that attracts and holds 95% of the metallic debris in transmission fluid. They also have a pleated cellulose media that traps other particles too small to see. A pressure relief valve ensures continuous flow of transmission fluid if the cellulose filter becomes clogged. *Contact: Wix Filters, P.O. Box 1967, Gastonia, NC 28053-1967; (704) 864-6711, Ext. 3306.*



**Shifter Lock**

Hurst Shifters' innovative S/S Shifter Loc is not only a theft-deterrent security device, it also doubles as a safety lock, preventing anyone, especially young children, from moving the shifter out of the Park position when the handle is locked—even when the engine



is running. The S/S Shifter Loc replaces the handle on most General Motors vehicles that have an automatic transmission with a floor-mounted button-activated gear selector and ½-in.-diameter stick. *Contact: Hurst Performance, 8700 Brookpark Rd., Cleveland, OH 44129; (216) 398-8300.*

**Performance Muffler**

DynoMax Ultra Flo mufflers feature a unique straight-through design and smooth, perforated tube for maximum flow. The mufflers use high-temperature fiberglass for a throaty, mellow tone. *Contact: Walker Mfg., 1201 Michigan Blvd., Racine, WI 53402; (800) 767-DYNO.*





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Unlike other finishing families, the Liquid Glass System works because each highly-refined product chemically bonds with the next. The concept is simple. The results – simply spectacular. All five products are perfectly safe for use on Clearcoated surfaces, and help retard acid rain and hard water spotting. When used together as a Total Appearance System, they cross-link to give you maximum protection and beauty.

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

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

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

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**Chevy Manifold**

Weiland's "Stealth" intake manifold for the small-block Chevrolet is a dual-plane, 180° design that rivals single-plane units in terms of power output. Dyno testing has shown the new manifold to be better than the Chevy Z-28/LT1 design. The intake is best suited to small-block engines that are 350 cu. in. and larger, and features an exceptionally broad powerband. The manifold is available through local automotive outlets and has a suggested retail price of \$148.42. *Contact: Weiland Automotive Industries, P.O. Box 65977, Los Angeles, CA 90065; (213) 225-4138.*



**Oil Pan Magnet**

Metal particles that result from normal engine wear are best taken out of oil circulation as soon as possible. Mr. Magnet (\$19.95) easily attaches to the underside of the oil pan where it exerts 60 pounds of magnetic pull so it won't fall off. Magnetic attraction

**Prelubrication System**

Safety-Start is a low-cost electronically controlled prelubrication system that delays both car engine fuel and ignition for 5 seconds, allowing the oil pump time to lubricate vital engine parts. The system includes a temperature sensor that bypasses delayed starting when engine temperature indicates prelubrication is not necessary. The unit costs \$75 and can be installed in 15 minutes. *Contact:*



*Decision Makers, 42 Nickerson Rd., Newton, MA 02167; (617) 332-6188.*



**Gas Strut**

StrongArm gas-charged lift supports are replacement units for hatchbacks, front hoods, rear trunklids, and so on. The supports feature a self-cleaning piston assembly and exclusive triple-lobe rubber seal for the piston rod, allowing superior sealing and reliable operation. The Strong Arm supports are available at retail automotive outlets. *Contact: AVM Inc., Hwy. 76 E., Box 729, Marion, SC 29571; (803) 464-7823.*

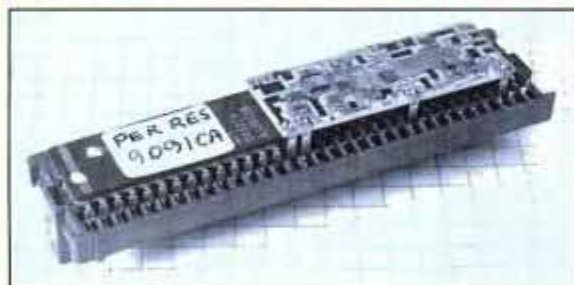
holds and isolates microscopic ferrous particles inside the pan. The magnet can also be positioned above the oil-plug hole to attract magnetic debris during oil changes. *Contact: VG Industries, P.O. Box 740521, Dallas, TX 75374-0521; (800) 572-5792.*

**Low-Profile Tire**

Firestone's Firehawk F'TX all-season sports touring performance tire line has been expanded with three new sizes: P195/50R15, P205/55R16 and P245/50R16. The new sizes will fit performance vehicles like the Chevy Camaro, Pontiac Grand Am, Pontiac Firebird and Dodge Daytona. The T-rated Firehawk F'TX features a 5-rib tread design for balanced traction in dry, wet and snowy conditions. You can find the F'TX all-season tire line by contacting your local Firestone outlets. *Contact: Bridgestone/Firestone Inc., P.O. Box 140992, 1 Bridgestone Park, Nashville, TN 37214-0992; (615) 391-0088.*



**TRUCK ENHANCEMENTS**



**Hot Truck Chip**

Performance Resource's proven high-performance replacement computer E-prom (chip), designed expressly for sport trucks and tow vehicles, boosts torque up to 25% for super throttle response and much quicker acceleration. The chips pro-

vide better all-around driveability and up to 15% better fuel economy, especially when towing. The Eprom chip is also easy to install, and can be used in all 1987 and newer Chevy and GMC 4.3-liter, 305, 350, 454 and SS454 pickups, vans and sport/utilities. *Contact: Performance Resource, 12 Barbara Dr., Fairfield, NJ 07004; (201) 343-0680.*

**Truck Tent**

The Sportz Truck Tent custom fits into the box of virtually all pickup trucks found in North America. The tent is roomy enough to comfortably sleep three adults, and it sets up easily in less than 10 minutes. Construction features include a coated nylon shell for good weather resistance and

a polyethylene mesh floor. The tent comes with shock-corded fiberglass poles and is secured by bungee cords. When not in use, the tent can be rolled up into a small pouch and stored easily behind the seat. *Contact: Sportz Product Inc., Suite 161, 2315 Whirlpool St., Niagara Falls, NY 14305-2400; (800) 567-2434.*





### Truck Organizer

Storage space is usually at a premium inside any pickup-truck cab. Articles sometimes have a habit of being strewn about in a haphazard fashion, making organization a real challenge. Dash Designs has come up with a solution to this problem. It's called The Pickup Pack pickup truck organizer, and it attaches to the rear of the cab. The storage unit has handy slip pockets and sealable pouches for quick and easy access to tools, cans, jumper cables, flares and maps. The organizer also stores bulky items with adjustable Velcro straps. Available in a variety of colors, The Pickup Pack has a suggested retail price of \$39.95. *Contact: Dash Designs Inc., 600 W. 24th St., Tempe, Arizona 85282; (800) THE-DASH.*

### Jeep Trunk

Add-A-Trunk from Mopar fits in the cargo area behind the rear seat of the Jeep Wrangler and works with the locking tailgate to form a safe, secure storage enclosure. Made from heavy-duty 16-gauge steel and protected with a durable black powdercoat finish, Add-A-Trunk provides the security and protection offered by a regular automobile trunk. Other features of the trunk include neoprene gasketing, which provides a weather-resistant seal to completely protect trunk contents. There's also quick-release hardware for fast, easy removal. In addition, Add-A-Trunk offers removable carpet cover kits, color matched to Wrangler interior carpets. *For additional information, contact your local Jeep dealer.*



### Running Boards

Warn's 4X Boards are designed specifically for 4-wheel-drive owners. They offer the convenience of running boards on-road and maximum ground clearance for off-road driving. These sleek-looking, but tough, running boards attach to a frame-mounted substructure with retention pins and can be removed in minutes for off-roading. Unlike other running boards, 4X Boards attach to the frame for maximum strength and require no drilling of sheetmetal. The boards are made of fully enclosed extruded aluminum with internal reinforcement. They are anodized and bright dipped for a durable mirror finish. *Contact: Warn Industries, 13270 SE Pheasant Court, Milwaukie, OR 97222; (503) 786-4462.*

### Folding Ramp

The Fold-A-Way Ramp makes one-person loading and unloading of heavy equipment onto pickup trucks, utility trucks and trailers safe and easy. The 8-ft. ramps fold down to a 4 ft. size for convenient storage and transport. The Fold-A-Way can be used as a single unit for loading motorcycles or as a pair for loading 3- and 4-wheel vehicles, such as ATVs, lawnmowers and garden tractors. A single ramp supports 750 pounds, while a pair has a load capacity of 1500 pounds. The ramps are made of square, heavy-duty 14-gauge steel tubing for strength and durability. The ramp tread is made of 14-gauge expanded metal. One ramp weighs 46 pounds. *Contact: Hi-Lift Jack Co., 46 W. Spring St., Bloomfield, IN 47424; (800) 233-2051.*



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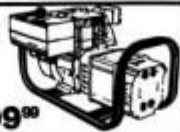
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Rugged woven blue or green poly tarps are water-resistant. Rustproof grommets every 3 feet.

Cut Size	Sale Price
6' x 8'	\$2 <sup>99</sup>
8' x 10'	\$3 <sup>99</sup>
10' x 12'	\$5 <sup>99</sup>
12' x 16'	\$8 <sup>99</sup>
12' x 20'	\$11 <sup>99</sup>
16' x 20'	\$16 <sup>99</sup>
20' x 30'	\$34 <sup>99</sup>
30' x 40'	\$59 <sup>99</sup>
30' x 50'	\$67 <sup>99</sup>
30' x 60'	\$84 <sup>99</sup>

Sale \$14<sup>99</sup>

### EZ-Stacker Firewood Crib Brackets

You just add 2x4's. Tough, black ABS. 7-year warranty. Adjusts to any length.  
Item# 15850

Sale \$19<sup>99</sup>

### One-Swing Log Blaster

12 lb. Lumberjack maul splits most logs with one stroke. 35-1/2" L.  
Item# 11911

### Gas Engines

1000s of vertical and horizontal engines in stock.

Horizontal	Sale
5 HP	\$139 <sup>00</sup>
8 HP	\$209 <sup>00</sup>
10 HP	\$249 <sup>00</sup>



### Barrel Stove Kit

Cast iron kit converts any 55 or 30 gallon drum (not included) into a wood-burning heater. Includes door, legs, collar.  
Item# 16160



### 1500 PSI Pressure Washer

5.5 HP OHV. BIG cleaning power! Blasts 3 GPM at up to 140°. Low oil shutoff. Triplex plunger pump. 30-ft. hose, gun.  
Item# 157148

Sale \$699<sup>00</sup>

Send for your FREE 136-Page DISCOUNT CATALOG!

Name \_\_\_\_\_  
Address \_\_\_\_\_  
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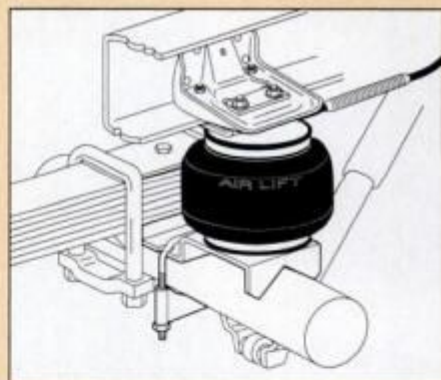
Key #23064 SEND TO: NORTHERN,  
P.O. Box 1219, Burnsville, MN 55337-0219

## AUTO PARTS GUIDE



### Radial Truck Tire

Goodyear's Workhorse Radial is a new entry-level radial light-truck tire in the company's mainstay Workhorse line. The Workhorse Radial is priced only slightly higher than the Workhorse bias tires. The radial is an all-wheel-position, all-season tire for both highway and off-road driving. Two steel belts add strength and durability, while radial-ply construction and polyester cord offer a smooth ride. Self-cleaning read grooves give the tire increased traction and better handling in mud and snow. Contact your local auto parts or tire outlet, or call (800) GOODYEAR.

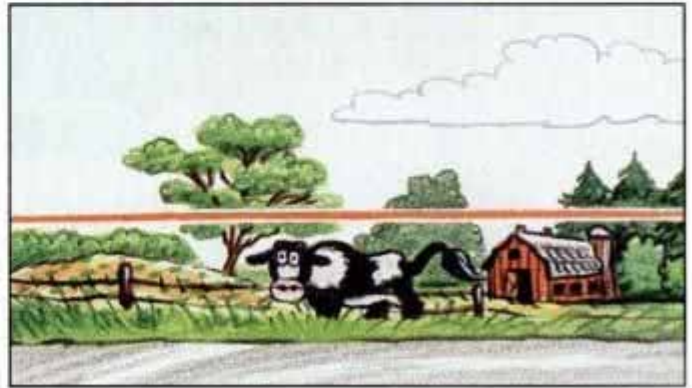
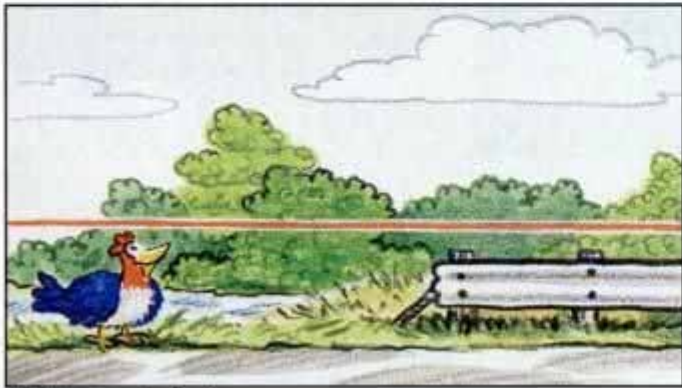
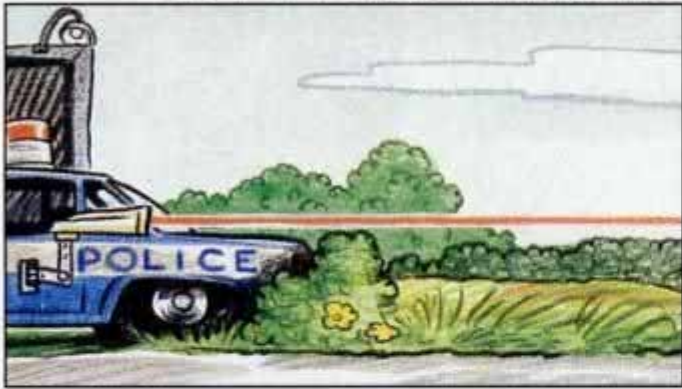


### Air Springs

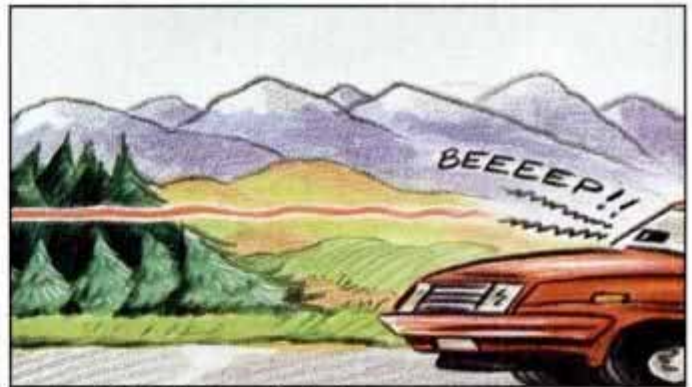
Loadlifter 5000 air springs support 5000 pounds of load when used with an 8-in. spring. With a 6-in. spring, the support is 4000 pounds. They are ideal for use in vehicles with a 1-ton chassis, and are also applicable to full-size vans, conversion vans and Class A, B and C motorhomes. The Loadlifter 5000 overcomes poor handling and the sag and drag caused by weakened springs or off-center loads. The system features a fail-safe jounce bumper molded right into the unit to prevent collapsing and ruining the bag in case of low air pressure. Air Lift suspensions are available for front and rear axles. The unit installs with no cutting or welding. Contact: Air Lift Co., P.O. Box 80167, Lansing, MI 48908-0167; (800) 248-0892.



# WE'VE GOT LASER GUNS BEAT BY A MILE.



1/2 mile. Laser gun's effective range.



1 1/2 miles. Cobra LASER Detector's effective range.

## INTRODUCING THE NEW COBRA LASER DETECTOR.

**MYTH:** Laser guns can measure speed at any distance with pinpoint accuracy.

**FACT:** A laser gun is only effective to about a half mile. At that distance its detectable beam has spread to over eight feet.



Attaches to any radar detector for a complete detection system.

**THE NEW COBRA LASER DETECTOR (Model LD-200)** can detect a laser beam up

to 1 1/2 miles away in all conditions. It can also be attached to every existing radar detector (mounting kit included) or it can be used by itself.

Stay alert with a complete detection system, only from Cobra. For dealer locations call 1-800-COBRA 22.



**Cobra LASER DETECTOR**

Innovation that's clearly ahead.

**Intercooler System**

Gale Banks' new high-efficiency intercooler system for Dodge trucks, equipped with the Cummins 5.9-liter engine, adds more than 55 hp, and cuts 0-to-60 mph acceleration times in half. The system features a streamlined high-flow cooler and tank design, rugged 3-point shock-absorbing mount that allows for cooler expansion as it heats and cools, high-temp hump hoses for vibration isolation, a "swan-feed" air-inlet elbow and custom chrome grille. The system is designed for bolt-on installation and is engineered to withstand the heavy-duty use associated with most diesel engines. *Contact: Gale Banks Engineering, 546 Duggan Ave., Azusa, CA 91702; (818) 969-9605.*



**Stainless-Steel Hubs**

Ramsey's 400-series Locking Hubs fit a range of domestic and import 4wd vehicles and come in four different styles, including a premium all-metal, chrome-plated flange-style hub. The hubs have a limited lifetime warranty to the original owner. *Contact: Ramsey Winch, P.O. Box 581510, Tulsa, OK 74158; (800) 283-9740.*



**Floor Liner**

Black Armor floor liner is made to look like original equipment fit into the cargo area of sport/utility vehicles, vans and station wagons. It protects both the floor and the back of rear seats, and can be installed and removed easily in seconds without tools. *Contact: Highland Group Industries, 31200 Solon Rd., Suite 1, Solon, OH 44139; (216) 498-0001.*

**Tonneau Cover**

Covercraft's new Rail System Tonneau Cover uses a full-perimeter anodized-aluminum frame that mounts to the bed without drilling, screws or adhesives. Only a 9/16-in. wrench or socket is required for easy installation. *Contact: Covercraft Industries, 19731 Nordhoff St., Northridge, CA 91324; (818) 407-6600.*



*Independent research shows:*

**NordicTrack preferred six to one over ordinary exercisers.**

In 1988, Burke Marketing Research conducted a survey among NordicTrack owners who also own exercise bicycles and hydraulic cylinder rowers. Their findings showed that by a margin of 6 to 1, respondents prefer their NordicTracks.

They have several good reasons.

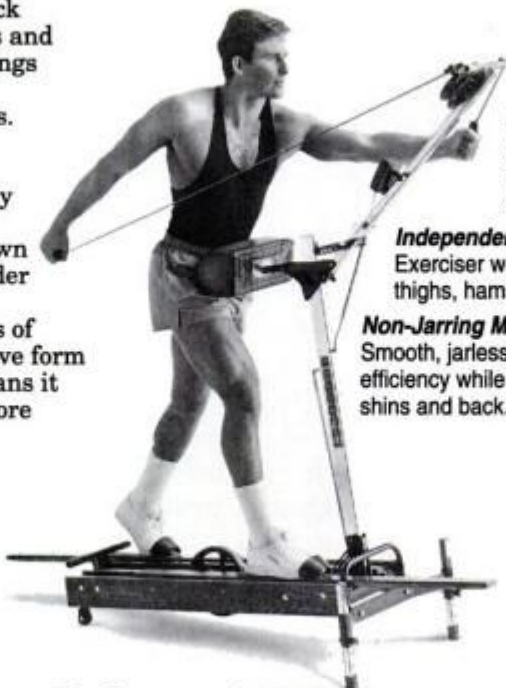
NordicTrack's upright position is more absorbing and fun, both mentally and physically, and provides greater freedom of movement than the sit-down positions of bikes and hydraulic cylinder rowers.

NordicTrack simulates the motions of cross-country skiing—the most effective form of aerobic exercise known—which means it burns more calories and conditions more muscles in less time than bikes and hydraulic cylinder rowers.

All of which means that owners have found that they can achieve their fitness goals more quickly and easily with NordicTrack than with bikes and hydraulic cylinder rowers, and without risk of injury.

**Patented Flywheel**

Patented flywheel and one-way clutch mechanisms provide continuity of motion, making exercise more pleasant and easier to sustain.



**Independently Adjustable Upper-Body Exerciser**

Upper-body exerciser works extensor muscles of the back, trunk rotators, biceps, triceps, shoulders, chest and upper back.

**Stand-up Position**

Comfortable upright position is more natural, more stimulating and allows greater freedom of movement.

**Independently Adjustable Lower-Body Exerciser**

Exerciser works hip flexors, gluteus muscles of the buttocks, thighs, hamstrings, knee extensors, ankles and calves.

**Non-Jarring Motion**

Smooth, jarless, aerobic motion ensures maximum workout efficiency while eliminating the risk of injury to the knees, shins and back.

**Call today for a 30 day in-home trial!**

Models priced from \$299 to \$1299.

Call or Write for a

**FREE VIDEO & Brochure**

**1-800-328-5888**

EXT. 275J2

NordicTrack, Dept. #275J2, 141C Jonathan Blvd. N., Chaska, MN 55318

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**POPULAR MECHANICS • OCTOBER 1992**

**NordicTrack**  
A CML Company

## ACCESSORIES



### Emergency Kit

Highway Hero is an emergency car kit that conveniently fits around the spare tire to take advantage of otherwise wasted space. It has a heavy-duty case with an integral belt and reflective markings for night safety. Packed into the foam-lined compartments is a 26-piece first-aid kit, an emergency blanket, flat-tire inflator, flashlight, batteries, warning flare, waterproof matches, tools and tie-down strap. Electrical tape, pencil and pad, distress flag and the proverbial baling wire are also included. Available through mail order for \$49.95 (including shipping). Contact: High Q Enterprises, P.O. Box 539, Townsend, MA 01469; (508) 597-8495.

### Sunshade

The Shade is a fan-type of windshield sunshade that mounts, via Velcro or screws, to one A-pillar and fans open to a securing catch mounted on the other A-pillar. Installation takes 5 minutes. The Shade is self-storing and hardly noticeable when it is retracted. A locking device built into the top and bottom cover prevents accidental opening. Tests indicate that The Shade was more effective than cardboard or metalized pleated shade devices in reducing interior temperatures inside a closed car. The Shade is compatible with all interiors. Suggested price is \$34.94. Contact: The Shade, 1044 Willow Ln., Cocoa, FL 32922; (800) 833-3641.



### Massager

Cruis'In Comfort is an automotive backrest equipped with massager and heat, providing soothing comfort and support. The backrest plugs into any 12-volt cigarette-lighter socket and provides 8-way variable upper/lower back massage. An inflatable lumbar pad adds lower-back support and 240 accupressor nodules improve circulation on long drives. Flexible side panels conform to virtually any seating configuration. Suggested price is \$100. Contact: Homedics, 6841 N. Rochester Rd., Rochester Hills, MI 48306; (800) 333-8282.

Amazing results:

# After five years, 7 out of 10 NordicTrack owners still use their machines more than 3 times per week.

The most effective aerobic exercise machine on the market.

In 1988, Maritz Marketing Research conducted a survey among NordicTrack owners who had owned their machines for more than five years. Their findings showed that fully 69% of respondents still use their machines an average of 3.5 sessions per week, 25 minutes per session.

Their reason is simple. They have found that NordicTrack not only exercises more muscles and burns more calories in less time than many other machines on the market, but that it's mentally and physically more stimulating and enjoyable as well.

**Cross-country skiing — the best aerobic exercise.**

NordicTrack duplicates the motion of cross-country skiing, which experts agree is the best form of aerobic exercise. Better than biking, hydraulic cylinder rowing, running or swimming.

It works all the major muscle groups in your body: arms, shoulders, back, stomach, and legs. Which means you achieve your fitness and weight-loss goals quickly and easily.

Patented flywheel and one-way clutch mechanism provide true cross-country ski action.

NordicTrack features proportional resistance, which places primary effort on the rearward stride just like cross-country skiing.

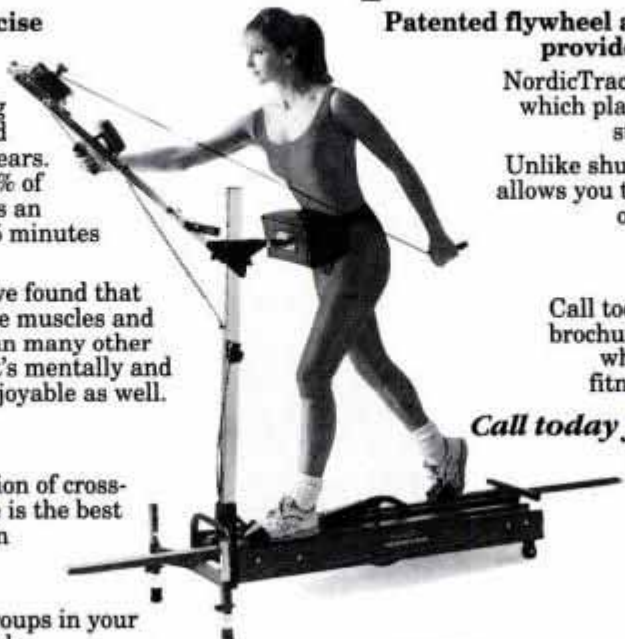
Unlike shuffle-type ski exercisers, the system allows you to develop a rhythm and continuity of motion that makes exercise more pleasant and easier to sustain.

**Discover for yourself.**

Call today. We'll send you a free full-color brochure and video that describe in detail why 7 out of 10 users have kept their fitness and weight-loss goals on track.

**Call today for a 30 day in-home trial!**

Models priced from \$299 to \$1299



# NordicTrack

A CML Company

Call or write for a  
**FREE VIDEO**  
& Brochure

**1-800-328-5888**

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NordicTrack, Dept. #275J2,  
141 Jonathan Blvd. N., Chaska, MN 55318  
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**Hanger Extension**



Hangthing attaches to the interior clothes-hanger hook in any domestic vehicle to hold up to 20 garments. It is priced less than \$3. **Contact: Ultimate Concepts Inc., 16666 Northchase Dr., Suite 300, Houston, TX 77060; (713) 873-6338.**

**On/Off Spout**

Spillsaver spouts screw onto 1-quart bottles of motor oil and transmission fluid and 1-gallon antifreeze jugs. The spouts twist to start and stop fluid flow so you can avoid spills. **Contact: Flo-Tool International Inc., 135 E. Alton Ave., Santa Ana, CA 92707; (800) 334-3062.**



**Security System**

Smart Switch is an easily installed anti-theft device that uses an automatic-arming electronic starter lock. The system is easily disarmed by turning on an installer-selected accessory switch, such as the parking lights. Smart Switch costs from \$49.95 to \$64.95. **Contact: DSK Int'l Products Co., P.O. Box 116, New Baltimore, MI 48047; (313) 598-9330.**



**Fire Extinguisher**

First Alert's new FESA5 auto fire extinguisher packs 5BC-rated fire-fighting power into a compact 2BC-size canister. The fire extinguisher is specially designed to fight grease, oil and electrical fires, and is small enough to fit anywhere in your vehicle. A unique bracket prevents accidental discharge and allows mounting under the seat or in the trunk. The extinguisher has an easy-hold handle and easy-push trigger for simple operation. **Contact: First Alert, 780 McClure Rd., Aurora, IL 60504-2495; (800) 323-9005.**



**Phone-Mount Kit**

Mr. Bracket's universal phone-mount kit for portable cellular phones offers easy do-it-yourself installation. The bracket positions your phone in a convenient location for easy reach at all times and a minimum of interference. **Contact: Mr. Bracket, 24746 Crestview Ct., P.O. Box 2996, Farmington Hills, MI 48333-2996; (800) 626-4902.**



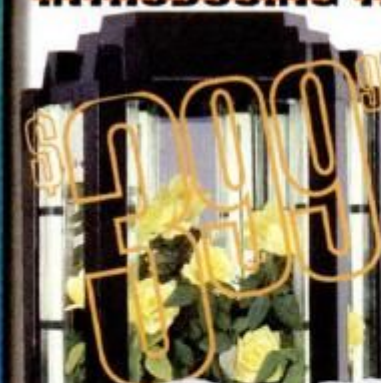
**AS POWERFUL AS THE SUN AT THE LEAF SURFACE**

**INTRODUCING THE**

**Bios IV TURBOTRON**  
**TRIPLE** The Growth Rate of Any Plant...  
**GUARANTEED!!!**

**24-HOUR CUSTOMER SUPPORT**

**USER-FRIENDLY INSTRUCTIONS**



"Hello! My Name is Jeffery Julian DeMarco, President and Founder of Pyraponic Industries, Inc. II and inventor of the original Phototron. I am dedicated to delivering results to my customers through state-of-the-art biotechnology."  
"My most recent development is the Bios IV TurboTron, and I personally guarantee..."  
• I'll TRIPLE the growth rate of any plant.  
• I'll TRIPLE the budding sites of any plant.  
• I'll TRIPLE the flavor of fruits and vegetables.  
• I'll TRIPLE the potency of herbs & spices.  
• I'll TRIPLE the fragrance of flowers.

The Bios IV the following improvements:  
• 6 'Biox' lamps (DOUBLE the light output of the Phototron III).  
• 2 state-of-the-art power generators (instead of one) lining the lamps.  
Right now as an introductory incentive, the Bios IV TurboTron (unlike the basic Phototron III) is fully equipped with our state-of-the-art Automatic Watering System (\$69 value), and a fully automated light cycling system (\$34 value) — a \$105 value: **FREE** (For a limited time only!)

**Over \$100 Million Phototrons Sold to Over 150,000 Satisfied Customers WORLDWIDE!**

**DOUBLE THE GROWTH RATE OF ANY PLANT ... GUARANTEED!!!**

**I PERSONALLY GUARANTEE IT!!!**

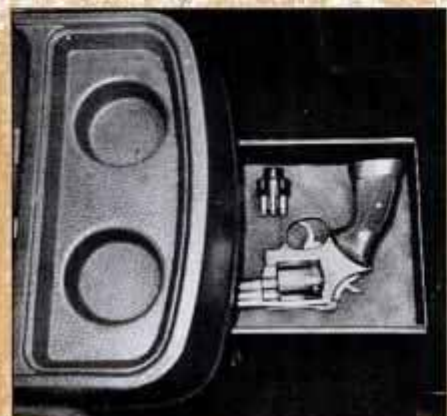
- 1. Raw power:** the Phototron has been awarded 17 patents in 9 different countries. It contains the most powerful power supply in the world: it produces 30% more lumen output, yet runs 30% cooler.
- 2. A State-of-the-Art Soil Analysis** and nutrient mix prescription for each individual Phototron for optimum growth of all plant parameters based upon over 150,000 completed soil samples, user-friendly instructions and follow-up reminders every 15 days guarantees your success in growing any plant. So easy that the National Science Teacher's Association (NSTA) uses the Phototron to teach Photosynthesis to kindergarten through 12th grade students.
  - 650 Schools, laboratories, and universities worldwide are using the Phototron, including Harvard, Oxford, USDA and NASA.
  - 90 day payment plan: 39¢ down.
  - Over \$100,000,000 worth of Phototrons sold — with never a single one returned!

When You Call Remember to ask about the **FEED-A-TRON** Pyraponic's own Automatic Watering System

**PYRAPONIC INDUSTRIES, INC. II**  
P.O. Box 27809, Dept: PM-10D  
San Diego, CA 92198-0198  
Fax: (619)673-3525  
**Phone: (619)451-2837**

## Auto Safe

Auto-Safe is a solenoid-operated, spring-loaded security storage drawer that is mounted to your vehicle. The unit is designed to allow quick access to your valuables while keeping them securely stored when you are gone. Auto-Safe is made of heavy-gauge steel and is virtually impregnable. The only access is by pushing a hidden switch or optional key switch that instantly releases the spring-loaded drawer. Auto-Safe is available in three sizes, including one for under-dash mounting. It has a suggested price of \$64.95. Contact: D&L Industries, 16303 Piuma Ave., Cerritos, CA 90701; (310) 403-2641.

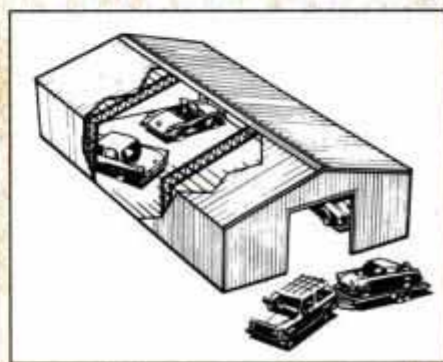


## Steering-Wheel Collar

CarGuard's new Universal Uni-1 steering-wheel collar forms a virtual barrier to car thieves, preventing them from starting or steering your car or truck. The Uni-1 is made of stainless steel and high-tech aluminum. The collar uses Medeco's proven biaxial security lock and also sounds the horn on most vehicles when tampered with. The collar is easy to use and store, and fits most import and domestic cars, trucks and sport/utility vehicles. Suggested retail price is \$159.95. Contact: CarGuard, 8813 Knight Rd., Houston, TX 77054; (800) 448-0267.

## Steel Garage

Miracle Truss all-metal garages offer excellent value, come in a wide range of sizes and colors, and offer easy, do-it-yourself construction. Unique truss design provides 100% usable space with large door clearances, rafter-free overhead area clear to the peak and no floor-space obstructions. The garages feature sheeting weather lap design, and unique siphon grooves on the sides of each panel interlock to form a weathertight seal. The buildings can be easily insulated at the time of assembly, or later with common fiberglass insulation. A full floor or simple concrete piers can serve as a foundation. Contact: Miracle Truss, 435 Ford Rd., Suite 265, St. Louis Park, MN 55426; (800) 843-8275. **PM**



# Save \$46 with this saw special from Poulan PRO.



Now, when you buy either the rugged Model 255 with our Super Clean™ air filter system or the hardworking 335, you'll save \$46 on a package deal that includes a deluxe carrying case, a 3.2 oz. bottle of 2-cycle engine oil, a quart bottle of bar & chain lube and a pair of work gloves. A special like this doesn't come along every day. And it certainly doesn't last forever.

So hurry to your local Poulan PRO dealer, and help us celebrate our 46th anniversary by saving \$46\*.

\*Prices good while promotional supplies last at participating dealers. Models 255-16" and 335-20". See your Yellow Pages under Saws for the dealer nearest you.

**Poulan  
PRO**  
The Pro Approach

*“I spend a lot of time  
comfortable. Even though my*



*Ask your Ford dealer about the 1993 model F-Series Preferred Care Program.  
“Best-selling” claim based on sales by Division. Buckle up—together we can save lives.*

***in a truck, so it has to be  
Ford pickup's built to stand up to***

***almost anything, it's a  
pleasure to be in. My wife  
likes  
the  
seats***

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

***and touches like the  
coffee cup holder. She  
also likes the fact we  
can take the kids along.  
Times have changed.  
And the Ford full-size  
pickup's changed right  
along with them."***



THE BEST-SELLING AMERICAN TRUCKS  
ARE BUILT FORD TOUGH.

## HOME IMPROVEMENT

# PROBLEM SOLVER OF THE MONTH

BY JEFF WILLIAMS, Contributing Editor

### Earth Care Carpet Treatment For Fleas

● By now many of us have been battling fleas all summer and think the battle is about to end as cool weather comes our way. For the outside environment, this may be true. But inside, where we live with our pets, the fleas will be breeding just like in the hot summer. How do we get an infestation of fleas in our home? Is it because the dog or cat brings them in? Well, that answer is only half of the story.

Fleas are small wingless insects with a complete life cycle. When your dog goes outside for a walk in the park, there is a good chance that a flea will jump on for the ride back home. But fleas don't spend a lot of time on your dog or cat. Usually they stay just long enough to have a meal. After that, they often lay eggs. Every female flea has the capability of laying 15 to 30 eggs a day until they have laid 200 to 400 eggs. If they lay eggs on your dog (which is very likely), then those eggs are going to wind up in your home. So, you'll have 15 to 30 eggs a day from every flea that comes in contact with your pet. And, all those eggs falling off your pet will wind up on your carpeting, furniture and hardwood floors.

Next, most of these eggs will hatch into larvae within two weeks, although some will take longer depending on humidity and temperature. Each larva has 13 body segments, a chewing mouth and no legs. They feed on all kinds of organic debris, growing substantially in just a couple of weeks.

These larvae are rarely seen by any of us and spend much of their time entwined in the fibers of the carpet and furniture. Because of the way they attach to the fibers, they are hard to pick up with a vacuum. The mature larva spins a cocoon, or enters the pupa stage, becoming covered with sand and other debris which also helps to camouflage it. These pupas will

hatch into adult fleas usually within two to 14 days. Under the right conditions, they can take up to a year to emerge. The adult flea will live an average of seven to 10 days.

So, how do we control these pests? For years, people have sprayed the floors and carpeting, shampooed their pets and, when these methods did not

Families are then in direct contact with the treated areas, and for many of us, this is not acceptable.

Recently, I found an alternative to all of this: a product that is environmentally friendly and very safe. Earth Care Carpet Treatment for Fleas is a 2-part system that controls adult fleas with natural pyrethrins at the larva stage, followed by an application of a borate-salt-based carpet deodorizer. These are the same basic materials used by commercial flea-control companies, and they have been tested and used commercially for years in southern Florida where the flea problem is worse than in most other areas of the country.

The results are nothing short of outstanding. Within six weeks of applying this product, you will have broken the life cycle of the fleas in your home and they will not be back. The natural pyrethrins (made from chrysanthemums), as well as the natural borate-based deodorizer, make your home a place where fleas cannot exist—all without the use of pesticide sprays or foggers.

The commercial companies charge anywhere from \$150 to \$300 to apply these products. You can save money by doing it yourself. All you have to do is sprinkle the

product on the carpeting and in the wells of the furniture, then broom it in. It took me about an hour to do my 1800-sq.-ft. home.

A 5-pound bucket and 14-ounce shaker can of Earth Care Carpet Treatment will treat 2000 sq. ft. of carpet and furniture. The cost is \$49.95 plus \$6 shipping, and may be ordered from Earth Care, Box 282, Palm Harbor, FL 34682. **PM**



work, some people even have gone as far as sending their pets away. But doing this only makes matters worse. When the adult fleas emerge from the pupa stage, instead of biting your pets, they'll bite you or your children.

The newest development in controlling fleas is the use of something called *insect growth regulators*. These are chemicals that break the life cycle of the flea, usually in the larva stage. They are often mixed with insecticides and applied as a spray or in a fogger. In this age of environmental awareness, this method is sometimes questioned. In order for this to work, you must apply the insecticide to the carpeting, floors and furniture.

Jeff Williams is the host of "The POPULAR MECHANICS House Doctor," a satellite broadcast radio talk show about home improvement. Anyone interested in submitting problem-solving products for review in future issues of this column should send information to Jeff Williams, 4275 34th St. S., No. 340, St. Petersburg, FL 33711.



WHAT ELSE WOULD YOU CALL  
A PERSONAL BUSINESS MAGAZINE  
FROM THE WRITERS OF  
THE WALL STREET JOURNAL?

So you want to know what's in a name?

Well, in the case of SmartMoney, everything.

You see, SmartMoney is a magazine with 500 Wall Street Journal writers from around the world analyzing, exposing and most importantly, giving you their advice on significant money matters.

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It's got articles on everything from the inner workings of Magellan to building wealth now, and ten years

from now. From how to fire your stockbroker to how to buy your own bar.

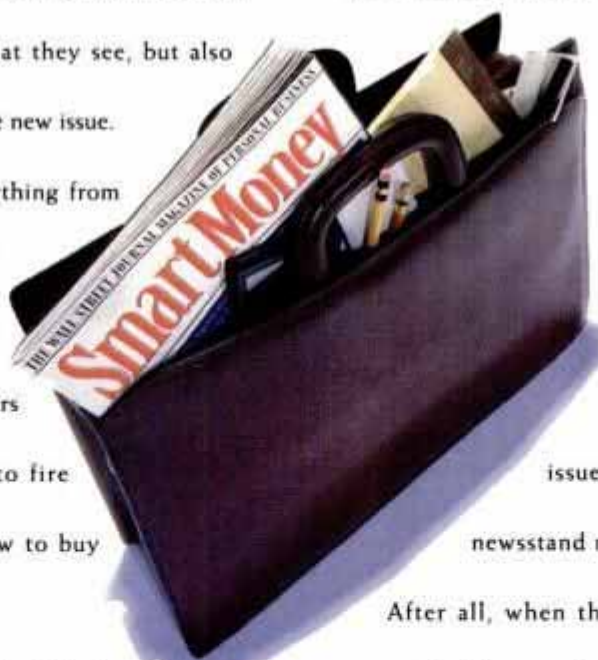
All with one goal in mind. To help you be as smart as you can about your money.

What's more, there are also stories that look at big business and how it affects you. Like ten things your lawyer will never tell you. And the Underachievers Club, a review of the CEO's who are the biggest busts in the business world. And how that impacts the performance of their company's stock.

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Or look for the latest issue at your neighborhood newsstand now.

After all, when the name of the game is money, is there anybody you trust more than the people who write the Journal?



**SmartMoney**

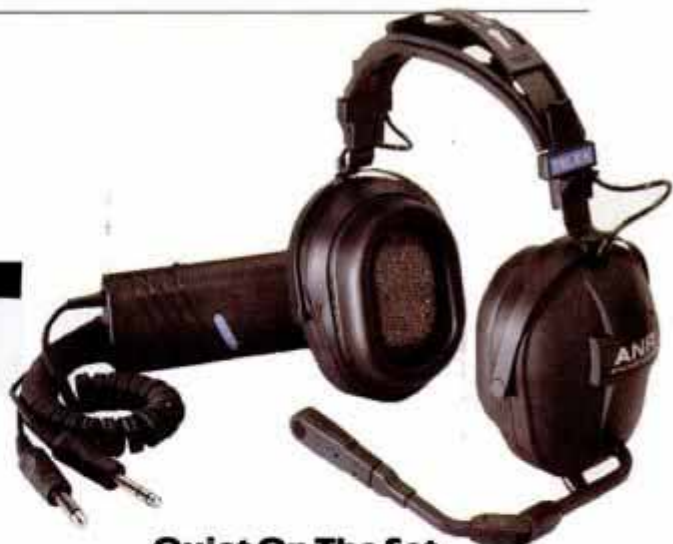
BY SMART PEOPLE. FOR SMART PEOPLE.

For single copy sales, send a check or money order payable to SmartMoney for \$2.50 to Single Copy Sales Department, 230 W. 57th St., NY NY 10019, or call 1-800-444-4204 (please have your credit card ready - a \$2.50 charge per copy). SmartMoney is a trademark of SmartMoney, a joint venture of Dow Jones & Company, Inc. and The Hearst Corporation.

# THE FLIGHT STUFF

Equipment that makes the skies a little friendlier.

BY GREGORY T. POPE



## Quiet On The Set

What, no cigarette lighter? Where do you plug in your noise-cancellation headphones? The Telex ANR headset (\$949.95) needs no power mod. Its battery pack provides 10 to 40 hours of operation. Telex Communications, (612) 884-4051.



## Point Well Taken

One day you may have to hack your way clear of an aircraft in a hurry. The Mk. I "Escape Tool" (\$267) attaches to your shoulder strap for just such an emergency. Each knife is milled from a single, massive piece of 440C stainless steel, ground and polished by hand. The blade is 1/4 in. thick. Davison/East Inc., (201) 729-9878.



## Pass The Test

Get a taste of the private-pilot written test with FAA Exam Tutorial software (\$29.95). The program, for IBM-PC compatibles, throws together simulated exams from actual test questions, then refers you to a Jeppesen Sanderson textbook for help when you give the wrong answer. Jeppesen Sanderson, (303) 799-9090.

## Total Recall

With PCR digital-recording headphones (\$375 to \$475), you can store complex radio transmissions and listen again. Or, plug in the Push-To-Record switch (\$295) if you have a headset.

Colorado Computer Associates, (800) 321-2359.



## Crud Cutter

With the Gasoline Analysis Test Separator jar (\$14.75), there's no need to dump those preflight fuel samples on the ground. Inside this 12- or 16-ounce fuel tester, a screen filters out debris, while a float indicator signals water or jet-fuel contamination. Pour the clean fuel right back into the plane. Sporty's, (800) 543-8633.

## Lightning Bug

Stormscopes display the output from directional antennas that pick up the electrical discharges characterizing thunderstorms. The WX-900 (\$3995) is the cheapest version yet. The liquid-crystal display shows storms within 25, 50 or 100 miles of the aircraft so you can steer clear. And a built-in voltage monitor keeps a weather eye on your battery. BFGoodrich FlightSystems, (800) 544-5759.



(Please turn to page 125)

## AVIATION

### Laser Horizons

The last thing SR-71 Blackbird pilots want to confront is spatial disorientation. So why should you? The Peripheral Vision Horizon Display (\$8200) supplements your attitude gyro with technology lifted from the Blackbird. A helium-neon laser beam throws an artificial horizon across the instrument panel for a reference. Aero-Vision Research, (800) 858-6009.



### Easy On The Eye

Getting eyeglasses to fit beneath your headset can be a headache. Lear Visions (\$85 nonprescription, \$165 prescription) eliminate the squeeze by replacing temple pieces with thin plastic cables that hook into earpieces. They also stay on your head. Lear Vision, (800) 451-3935.

### Firefighter

Right now, the hottest high-tech flightwear fabric is flame-retardant Nomex. Air Force and Navy pilots wear the mil-spec CWU-36/P Nomex flight jacket (\$195). But don't stop there: Full suits, gloves, socks and even flame-retardant underwear are available in the aramid fiber. Flight Suits Ltd., (619) 440-6976.



### GPS To Go

When the question is "Where?", the answer these days is likely to come from a GPS receiver. Garmin's GPS 1000 AVD (\$3250) packs in the programmable features, plus a battery backup. Just pop it out of the panel and into your pocket. Garmin International, (800) 800-1020.



### Eagle Vision

Then again, you'll never hear an F-15E jock gripe about tucking his HGU-4/P's inside his helmet. Randolph Aviators (\$56) have been standard issue for U.S. military and NASA flyers for 15 years. Randolph Engineering, (800) 541-1405.

### Drain Brain

Don't trust your gas gauge? But why clamber over that high wing to see if your fuel tank is really full? You can keep both feet on the ground if you use Checkeze (\$64.95). Just poke the fuel gauge into the tank drain and a piezoresistive sensor measures fluid pressure. Electronic circuitry then converts it into approximate fuel level, displayed as a bar graph. Gleaves Tool Corp., (516) 271-2919.



### Know-All

Comprehensive airport data usually adds up to an obese wad of paper. But First Officer (\$139.95) puts all the information into your pocket. Eastern, central and western regions are covered by 4-megabyte plug-in chips (\$39.95). Laser Data Technology, (800) 274-0949.



### Map In Your Lap

You may have seen those glitzy moving-map displays, but balked at dropping a minimum of \$3000. A cheaper way to rig up your own is through LapMap software (\$495 to \$695) on a laptop, notebook or palmtop computer. Wire the computer to a LORAN or GPS unit, and half the screen becomes a map, with visual information on the other half of the screen. Peacock Systems, (800) 533-1012.

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## TELEVISION

TELEVISION: Call Mr. Lee Capitol

Tom Verlaine's unique and deep vocals set the tone for the timeless, innovative material on TELEVISION's self-titled new release including the new single "Call Mr. Lee". This highly anticipated album features the wild and distinctive guitar sound that was the trademark of their earlier recordings. TELEVISION is: Tom Verlaine, Richard Lloyd, Fred Smith and Billy Ficca.



## BODY COUNT

BODY COUNT: The Winner Loses Sire/Warner Bros.

Ice-T (lead vocals), Ernie C. (lead and acoustic guitars), Mooseman (bass), D-Roc (rhythm guitars) and Beatmaster "V" (drums) are the revolutionary metal band Body Count. At 1991's showstopping Lollapalooza appearances, on their debut album, and on their around-the-world 1992 tour, Body Count's words and music are as tough as they are smart.



## TORI AMOS

LITTLE EARTHQUAKES: Crucify Atlantic

Juxtaposing images of Charles Manson and ice cream, purring winsomely about crucifixion and violation. Through Tori Amos the rumblings of a soul are exposed. Her poetry persists, naked in its frank attempts to reconcile, or at least recognize, the disparities that surround her. Her music is unnerving, discomforting, yet absolutely compelling.



## AZTEC CAMERA

Spanish Horses: Sire/Reprise

Aztec Camera return to the spotlight with "Spanish Horses," the first release of their fifth Sire album. Singer/songwriter/guitarist Roddy Frame has been crafting soulful, smart pop songs for over ten years, and once again he demonstrates his talents with a beautiful collection of tunes.



## KYUSS

"BLUES FOR THE RED SUN" Green Machine  
Dall Records

Take 70's acid rock, add a super heavy bass and guitar sound and the result is - KYUSS - four young musicians from Palm Desert, Cal. who describe their sound as 'A fresh bong load of potent, sticky and hairy musical salvation.' "Green Machine" is the first single/video resonating

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## PANTERA

VULGAR DISPLAY OF POWER: This Love: Atco Records

"Power groove" is how PANTERA describes their sound "it's a heavy, riff-oriented feel." With non-sugar-coated lyrics which slice straight to the bone on matters of racism and close-minded self-righteousness, Pantera's angry voice supplies heavy, driving serious music to people who rely on it.

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## MATERIAL ISSUE

DESTINATION UNIVERSE: What Girls Want Mercury

Chicago's own MATERIAL ISSUE bring you the edgy pop tune "What Girls Want" from their second Mercury album Destination Universe. Hot on the tracks of their first album International Pop Overthrow, MATERIAL ISSUE is back with their signature three part harmony built around brilliant guitar work and complete with multiple pop hooks.



## HAPPY MONDAYS

YES PLEASE: Stinkin' Thinkin' Elektra

1990's PILLS 'N' THRILLS AND BELL YACHES and the hit single "Step On," drove HAPPY MONDAYS from ecstasy-stained club attraction to megawatt novas of Britain's dance-rock explosion. Produced by Chris Franz and Tina Weymouth, "Yes, Please," takes them the important next step. Prepare to move both mind and feet with HAPPY MONDAYS' new single "Stinkin' Thinkin'."



## SONIC YOUTH

DIRTY: 100% DGC

Gloriously unrefined, strikingly original, unafraid of controversy, SONIC YOUTH are widely acclaimed as the incontestable leaders of underground rock. Arresting both visually and musically, the "100%" video comes from their new album, DIRTY, a staggering sonic chronicle of life in and under America in the nineties.

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## OUTDOORS

# TROLLING THE DEEP, JIGGING THE REEF

BY JOE SKORUPA, Boating/Outdoors Editor



● We leave Lake Worth Inlet at 6:30 am and head into the mother of all warm-water ocean currents, the Gulf Stream. The spring dawn breaks clear and bright, painting a blue sky to go with a blue-water crossing. I can't help but feel excited. Our exact compass heading is 77°, a line that takes us slightly northeast from Palm Beach, Florida, to the fishing mecca of Walker's Cay, in the Bahamas. It's a 110-mile open-ocean trip and my first offshore crossing.

I'm riding in the lead boat of a convoy of three trailerable Mako fishing rigs, all equipped with dual V6 outboards. One is a 25-ft. walkaround cuddy. The other two are 26-ft. center consoles, including my boat, the *Marc VI*, which is captained by George Poveromo.

Typically, boats crossing the Stream are substantial Bertram and Hatteras battlewagons, but on a good day, even boats our size can make it in 4 or 5 hours. On a bad day, it can be a harrowing 10-hour ordeal of hammering waves, green water over the bow and intense battling for every inch of progress. This isn't likely to happen on a day like today, though.

Conditions, however, are less than ideal. A 15-knot easterly is blowing just south of our bow and whipping up

3- to 4-footers. Nevertheless, we push the tach to 3200 rpm and keep the boat on plane. The ride is lively, but solid Mako construction and a deep-V hull soften the pounding. Deep-cut re-

verse chines throw spray well away from the cockpit. Considering the conditions, it's a surprisingly dry and comfortable ride.

### Makos in the stream

After 6 miles, we reach the Gulf Stream, where the water turns a deeper shade of blue and the chop spreads out into long-duration rollers. This is a welcome development, because waves in the Stream often stack up to twice the size of surrounding water. With the wind favorably out of the south now, we bump the throttle to 3400 rpm.

After 15 miles, the tallest of the Palm Beach condos slips beneath the horizon. From here on, the only sights are our convoy companions.

After 50 miles, and well past the Stream, we reach a tiny outcropping called Memory Rock, which is notable not only because it's located virtually at the half-way point but because it marks the end of the deep water. The Little Bahamas Bank begins here, and the depth rises from the 2500-ft. abyss of the Stream to 30 ft. or less. Confidence and shallow water enable us to push the throttle to 4000 rpm.

As soon as a couple of trees pop above the horizon, hot-rod Poveromo

*(Please turn to page 130)*



Try lifting a 67-pound black grouper.

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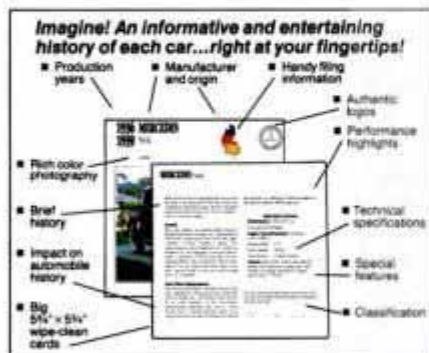
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100-acre Walker's Cay is a 110-mile boat ride across the Gulf Stream from Palm Beach, Florida.

nudges the Evinrudes up to a hair-straightening 4500 rpm. When the island is fully in sight, he shatters the 5000-rpm barrier and makes a blistering sprint to the marina. We smoke the other boats in the convoy and check the clock at the dock: Crossing time is just 4 hours, thanks to an impressive second-half kick.

### A fish called grouper

After dealing with the formalities of customs, immigration and a plate of conch fritters, we hit the reef. Poveromo guides us to a steep dropoff just north of the Cay (pronounced *kay* in the Bahamas and *key* in the States). We shut down the engines when the depthfinder reads 180 ft. and pick up short, stand-up Penn rod-and-reel fishing systems that consist of 100-weight blanks, 80-weight reels and a 50-pound test mono. Then, we drop the jigs to the bottom, reel back a couple of cranks and wait.

Most fishermen wouldn't hit a reef at this depth, but Poveromo is a big-fish specialist. We start jigging at 180 ft. and let the boat drift to 220 ft. Then we pull up and do it over again.

Our leader setups are a clever package. They consist of 3-way swivels with 12-ounce sinkers that have a short leader on one side and double-strength hooks with a longer leader on the other. Bait is thawed ballyhoo.

At one point, between catches of throw-back-size strawberry grouper, Poveromo asks me if I need a hard-plastic rod belt. I decline, and moments later, hook into a biceps-popping monster that bends the rod right down to the gunwales. Poveromo yells for me to hammer the drag and start reeling. I try, but progress is slow and painful, so I yell for the rod belt.

"Don't forget to talk to me, Joe," Poveromo says while clearing the other rods. "What's going on?"

"It feels like a bulldozer."

"Keep cranking, even if you only get half a crank. You've got to keep him out of the rocks."

Grunt. Deep breath. Several teeth-clenched exhales.

"Pull up the rod with your left arm," Poveromo says. "And push out with your hips."

And suddenly, I discover the key to stand-up rod fishing: the pelvic thrust. With my left hand way out on the long grip and the butt cradled in the belt, I'm able to generate tremendous leverage by arching my back and pushing out my hips. It may look undignified, but it works.

The fish turns out to be a trophy-size 67-pound black grouper, which I pull out of 197 ft. of water. Back at the dock, I give the ugly but good tasting beast to the restaurant, and provide the resort with enough fillets for the remainder of the week.

### Gone trolling

In addition to being a reef fisherman and hot-rod boater, Poveromo is crazy about blue marlin. For our first day of trolling, we head 30 miles north to the tip of the Little Bahamas Bank, where, frankly, we get skunked. Not even a nibble. This isn't unusual. If blues were easy to catch, they wouldn't be the greatest trophy in the sea. However, a small white marlin would have been nice, or a sailfish or a dolphin, or just about anything.

But you never lose hope, even when Poveromo pops Johnny Rivers into the cassette player, which is his way of saying that the fat lady is singing the final song. Back at the marina, we arrive just as resident charter boat captain Billy Black pulls the *Duchess* to the weigh station with a 13-ft. blue. It tips the scales at a whopping 640 pounds. With a little luck, it could have been ours.

Poveromo's trolling procedure is as

interesting as his jigging technique. He sets the throttles for about 10 knots and trails a 4-rod pattern of dark-blue and dark-purple artificial hard-head lures. Nothing unusual here, except that he sets the drag on the reels as light as possible. Most fishermen set a medium drag so that if a fish inhales the lure, the drag will generally set the hook.

With a light drag, everything changes. After noticing movement on the port-side outrigger during the second day of trolling, I look down and notice line slowly stripping off the reel. The fish has the bait, but doesn't know it's hooked. I pick up the rod, walk over to the fighting chair, sit down, place the butt in the gimbaled holder, and carefully hook the reel to two clip-on buckles—all of this with the fish on line.

Now completely ready, I hammer the drag. From here on, the fight resembles most exciting fish battles, except that I'm in total control from the start. Remember, we don't know what's on the line until it jumps. It turns out to be a respectable 30-pound, electric-yellow-and-green dolphin. If it had been a marlin, though, I would have been in a perfect position to win a 3-hour battle for the trophy of a lifetime. As it is, I get a stack of tasty mahi-mahi steaks to freeze and bring home for my barbecue grill.

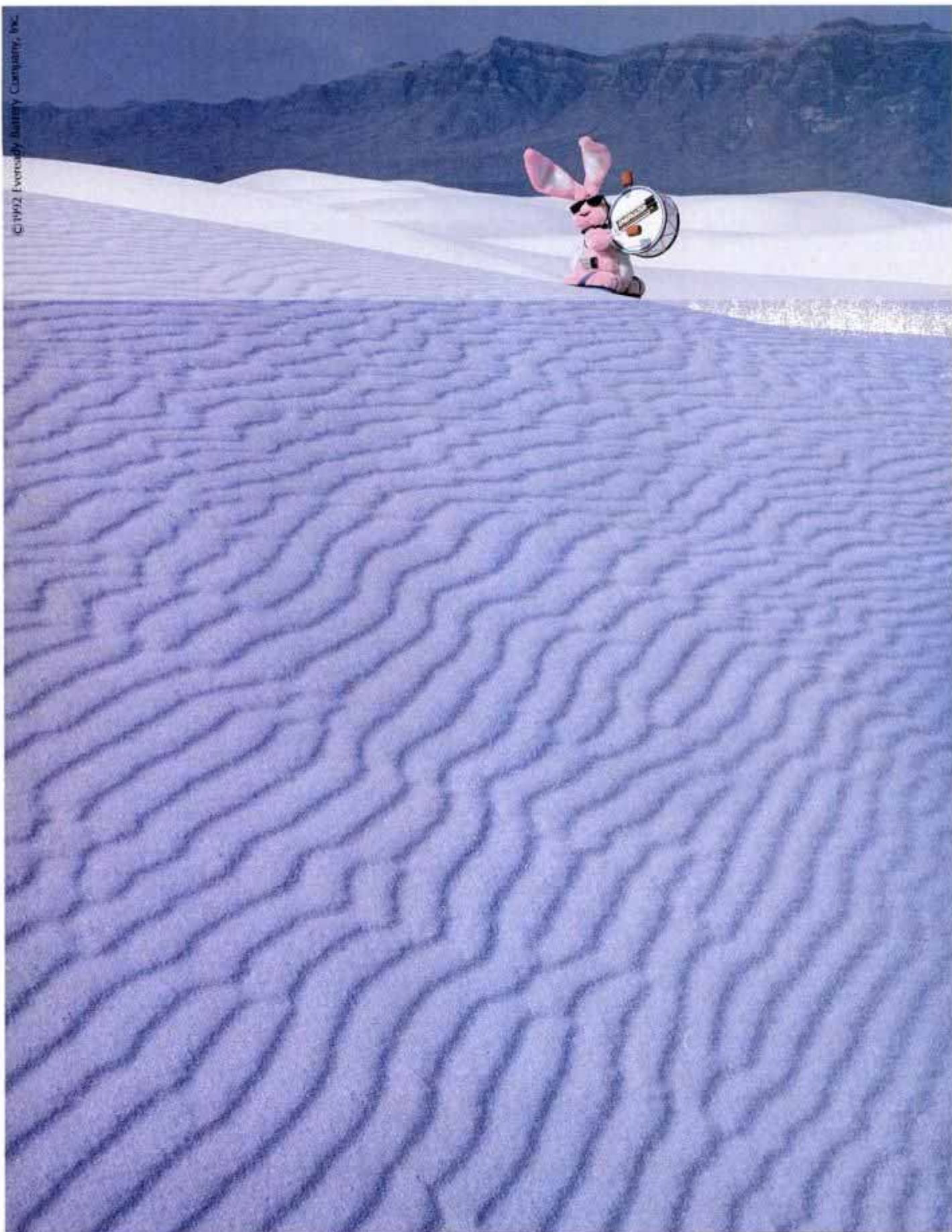
### Fishing paradise

No one in our informal tournament caught a blue or white marlin, but we caught a mess of other fish. My big grouper was the whopper, but equally impressive were a sailfish brought to boat and a handful of large dolphin. In addition to trophies, we bagged a large number of yellowtail, black fin and Nassau grouper; red, mutton and mangrove snapper; and a huge 10-pound bonefish in the flats. Small skip jack, cerro mackerel, strawberry grouper and barracuda were caught and released in great numbers, too.

The trip to Walker's was sponsored by Mako Boats, which adopted a relatively low-key presence during the informal tournament. But then, Mako didn't have to tout its well-built product. Every feature of Poveromo's 26-ft. center-console boat, down to the minutest detail, was impossible to ignore during the 70 hours I spent on it. Not only did it shine in both near-shore and deep-water fishing, but it put me onto my biggest fish, carried me through my first Gulf Stream crossing and took me in style around the gin-clear, fish-filled waters of celebrated Walker's Cay. What more could you ask of a fishing boat? **PM**



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## ELECTRONICS

# CARS THAT NAVIGATE

BY FRANK VIZARD, Electronics Editor

● Finding your way around a strange town can be nerve-racking and frustrating, especially if you get lost. The one place that's an exception is Orlando, Florida. Anyone can find their way, even to the most obscure address, within a 1200-square-mile area. The trick is to be driving an Oldsmobile Toronado rented from Avis and equipped with an experimental navigation system called TravTek.

The TravTek system is

basically a combination of dead reckoning and satellite tracking technologies that guarantees you'll never get lost. Anyone can rent one of the 100 Toronados equipped with TravTek, and on a recent trip to Orlando, that's exactly what PM did.

Experimental equipment always

has a few bugs, and indeed the TravTek system in our first Toronado had its share—an inability to find Disney World was a dead giveaway of a problem. Avis quickly supplied a second car and we were ready to go see Mickey Mouse and company.

TravTek is operated using a touch-sensitive video display screen installed in the dashboard. What you don't see are two 386 computers. One is for route information on 10,000 miles of roadway. The second computer stores what amounts to the five phone directories needed to cover the Orlando area.

Where do you want to go? You can tell TravTek your destination by punching in the address using on-screen keys. Or you can scroll through destinations arranged by categories such as shops, restaurants, hotels and parks. There's a CALL button which, when touched, automatically activates the cellular phone in the car and dials ahead, so you can make a reservation at a restaurant, for example.



TravTek uses wheel sensors tied to a computer. A backup satellite link uses a special antenna (left).



You can also call the TravTek center for help in locating a specific place, or in an emergency.

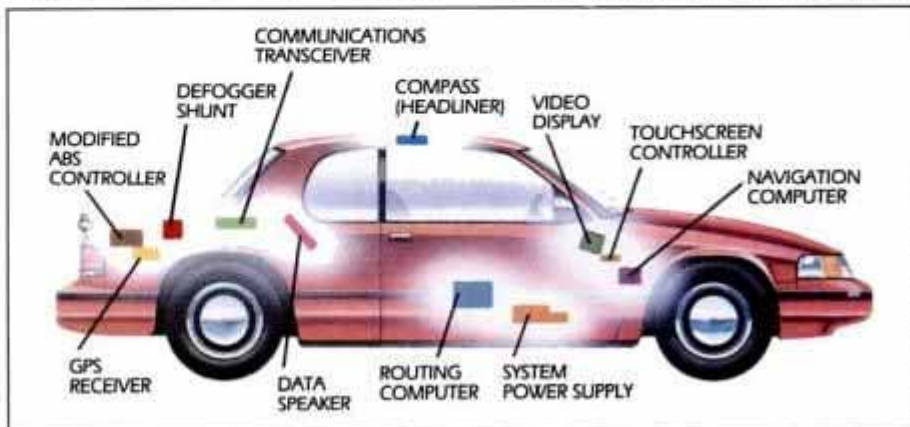
Once you've communicated your destination, TravTek selects the quickest route and displays a map on-screen showing both your location and your destination. You can zoom in and out at will to see more or less detail.

The distance in miles and the amount of time required to reach your destination is also displayed on-screen.

Once you're moving, it quickly becomes apparent that TravTek is a valuable driving aid. The car determines its position primarily by using a dead-reckoning system involving wheel sensors connected to a compass and the correlation of that information against the computer's database. In the past, dead-reckoning systems have been confused by doing spins in the parking lot or by entering a garage on one street and exiting on another. TravTek's navigation system is supplemented by a Global Positioning System (GPS) receiver. If there's any confusion, the receiver checks its position against the signal from an orbiting satellite. The antenna for the GPS receiver looks like an upside-down paper cup and it's mounted at the rear of the car. There's no escaping the bird in the sky, we found, unless you duck into a building or tunnel.

The GPS signal is accurate within 100 ft. for civilian use, says Avis. We found 100 ft. to be a little generous but you'd have to be blind not to see your destination once TravTek says you've arrived.

That's right, TravTek talks to you.



The target price for all this extra TravTek navigation gear is less than \$1000.

Fortunately, it doesn't chat away endlessly. It does offer timely advice on when to turn. It also tells you—in a tone free of recrimination—when you've missed a turn. A touch of one of the eight function buttons on the steering wheel makes TravTek reconfigure a new route. Other steering wheel functions allow you to choose between two maps, have the last audible message repeated, tune in traffic reports and other tasks. Traffic congestion appears on-screen as icons blocking roadways so steps can be taken to avoid traffic tie-ups. By letting drivers take the initiative, it is hoped that traffic congestion will be redistributed more easily.

TravTek is a joint project involving General Motors, the American Automobile Association, Avis, federal and local governmental agencies and a variety of equipment suppliers. The cost of the project is estimated to be \$12 million, and it's due to be completed next spring. What conclusions will be drawn remains to be seen. Indeed, there are some minor inconveniences, particularly in terms of accessing some types of data.

Nevertheless, we drove out to Walt Disney World and The Magic Kingdom, swung over to the town of Kissimmee for shopping and lunch, and then spent the afternoon trying to get lost. We couldn't—and we tried hard.

More good news: The price tag for TravTek is targeted at between \$800 and \$1000. Considering the aid it provides, the price is very reasonable.

### Pocket Libraries

The electronic-book concept gets a big boost this fall from Franklin Electronic Publishers. Roughly the size of a calculator and weighing just 5 ounces, the *Digital Book System* packs the data equivalent of 10 Bibles on each of what's set to be a series of interchangeable cartridges.

Listing for \$250, the *Digital Book* can access two databases simultaneously. Each database contains 10 megabytes of memory. Three cartridges—a dictionary/thesaurus, a word game and a video guide—come packaged with the *Digital Book*. Additional titles will cost between \$29 and \$99, with as many as 50 titles being available by the end of next year.

Meanwhile, Sony, the originator of the electronic-book concept, is introducing a smaller, lighter version of its Data Discman. The DD-8 weighs just 17.5 ounces and the LCD screen size has been increased to 4 in. for easier reading. Each data disc holds up to 200 megabytes of memory.

List price is between \$380 and \$450  
(Please turn to page 134.)



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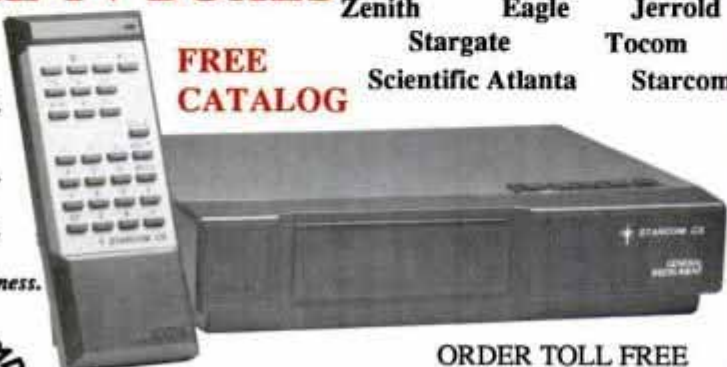
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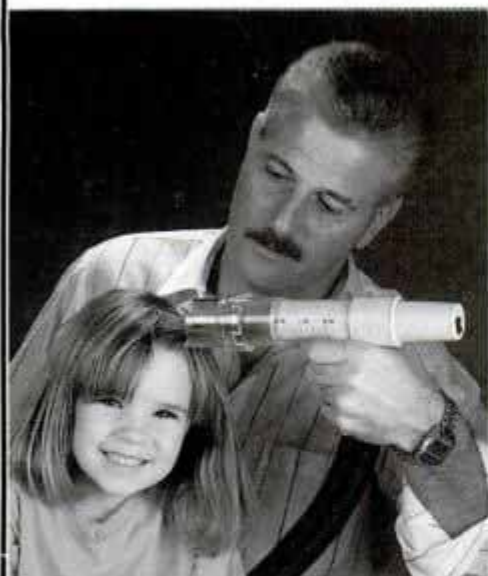
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## ELECTRONICS (Continued from page 133)

depending on which software is bundled with the player. You also can now buy an optional printer for a paper readout of the information contained on a disc.

### Learn Guitar Faster

Learning how to play the guitar can be a time-consuming and frustrating experience. Traditional teaching methods require you to match fingering positions with those in instructional books. This approach is like learning to type without the benefit of letters on the keys.

Now a company called Optek Music Systems Inc., located in San Jose, California, is putting fingering positions where they belong. The Fretlight acoustic (\$399) and electric (\$799) guitars have 132 microprocessor-controlled LEDs embedded in the neck of the guitar. The LEDs light up to display the fingering positions for more than 2500 chord, scale and note selections. You select the desired pattern using three onboard switches. The idea is to reduce the amount of time it takes to learn to play the instrument. For more information and details, call (800) 833-8306.

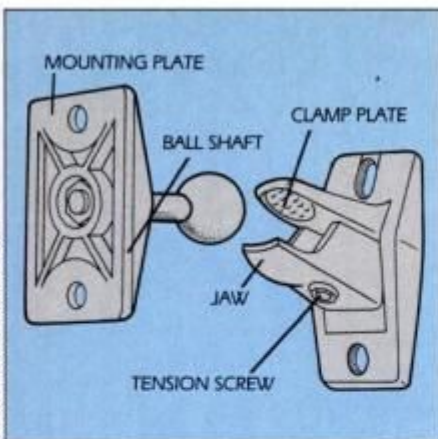
### Mount Anything

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Learning guitar is easier with a Fretlight model. LEDs on the neck light up so you know where to put your fingers.

PM ILLUSTRATION BY KEN CARBON



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space. However, finding strong, vibration-free brackets hasn't always been as easy as it might seem.

For loudspeakers, the OmniMount bracket is fast becoming an industry standard. This bracket uses a polymer ball bonded to a thick-walled steel tube as one element. The second element is a clamp/flange that wraps around the ball, thus allowing the speakers to be rotated in any direction. Due to the OmniMount's small size, the speakers appear to be hanging in midair. The overall look is very clean. In fact, many speakers are now built so that OmniMounts can be simply screwed into them.

OmniMounts are available in many configurations, corresponding to a variety of size and weight requirements. Prices range from \$50 to \$200. Information on OmniMounts can be received by calling (818) 766-9000.

OmniMounts also can be used to mount televisions, cameras and other electronic components.

Also offering TV mounting brackets is Lucasey Manufacturing Co. This company previously supplied brackets to hospitals, hotels and other institutions. Its Sightline brackets allow TVs to swivel 180° and tilt up and down. TVs up to 24 in. in size can be accommodated. For more information and details, call (800) LUCASEY.

### Video Dialtone

You can expect the TV of the future to be equipped with a telephone jack. The Federal Communications Commission is letting the phone companies into the video business.

It'll be some years before "Ma Bell" is a serious rival to cable, though. Existing copper wires need to be replaced with a fiberoptic network in order for the video dialtone concept to work. Once installed, however, you'd be able to transmit your camcorder footage, for example, to a friend by phone. **PM**

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## MOTORSPORTS

# HANGIN' IN

BY TONY SWAN, Automotive Editor



● Chasin' the setup. You've probably heard racing crew chiefs use this expression to explain why their car isn't leading. And it tends to leave most of us scratching our heads. After all, for a well-maintained street car, the right setup just means proper alignment, proper tire balance and proper tire inflation.

And even in Showroom Stock racing, a perennial pastime for us here at PM, there are almost no chassis adjustments to be made.

So what's to chase? In a purpose-built race car—cars like the Camaros, Mustangs and Dodges chasing the 1992 Sports Car Club of America Tide Trans-Am Tour title—there's almost too much. And the bewildering matrix of spring rates, antiroll bar settings and shock valving that works at one track will very likely be all wrong for the next.

For teams with previous Trans-Am experience, this summer-long series of mechanical orchestrations is enhanced by careful notes from the last time out.

For series newcomers, like the Archer Brothers' Shellzone POPULAR MECHANICS Dodge Daytona, there's a much higher element of guesswork. And when you stir in random variables like crashes, it gets to be a very tough proposition.

### Mosport blues

Crashes played a big part at Mosport Park—stop No. 4 on the Tour. Although both Tommy and Bobby Archer have driven countless laps on

this challenging Canadian circuit, nothing can really prepare a driver for that wonderful moment when the car in front spins without warning in a tight corner.

Mosport has a corner that's particularly well suited to this kind of nasty surprise. And sure enough, it presented Tommy Archer with an abrupt roadblock that resulted in bent sheet-metal and a struggle to salvage sixth place. Defending series champ Scott Sharp, meanwhile, scored his first win of the season.

### Loose talk

Though they filled the third row of the grid two weeks later on the streets of Des Moines, Iowa, the Archers found themselves chasing the setup once again. Even though new shock technology from Bilstein promises to trim seconds from their lap times as the season progresses, the Archers at-

tacked Des Moines with a pair of tail-happy Daytonas.

"Major loose," said Bobby.

Even so, the Archers were able to contend with all the front-runners, save for Sharp, whose Camaro was hooked up and long gone. Tommy ran as high as second, battling with Jack Baldwin's Camaro, a duel that eventually led to a spin and a seventh-place finish. Bobby drove a savvy race and came home third.

Though these were disappointing results after their outstanding effort in Detroit, the Daytona duo is still very much in the hunt, with Tommy trailing Sharp in the championship standings by a single point going into the Lime Rock, Connecticut, round.

### 1992 TRANS-AM CALENDAR

Sept. 12	Lexington, OH
Sept. 27	Juarez, Mexico
Oct. 4	Sears Point, CA



Tommy Archer (inset, top, and No. 3, above) ranked 2nd in Trans-Am season standings after 5 rounds. Bobby (No. 32, top) matched his season's best finish with 3rd place at Des Moines.

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**We Join The  
Grand Finale**

If you've been following the adventures of the Archer Brothers all season, you already know that October marks the climax of the 1992 Trans-Am Tour. The season's final showdown will be October 2-4 at Sears Point International Raceway, near Sonoma, California, and judging by results to date, we'll bet the championship will still be up for grabs.

What you don't know, however, is that we're extending our support of this outstanding racing series to include cosponsorship of the final event with our friends from Kenwood—the Kenwood/POPULAR MECHANICS Trans-Am Classic.

To understate our expectations a bit, this promises to be an exceptional show. Besides the action and thunder of the Trans-Am cars—including the white-knuckle heroics of the Kenwood Fast Five qualifying shootout—there will also be some sterling supporting events.

**SCCA World Challenge**

Tops in this category will be the final race of the 1992 SCCA World Challenge, a series featuring a broad range of production sports and sporty cars competing in four separate classes. This means a race within a race within a race, which in turn means plenty of action as the front-running Corvettes compete for track space with tiny Mazda Miatas and an even tinier Suzuki Swift GT.

Incidentally, you'll see the Archer Brothers' colors in this race, too. Mitch Wright's Archer Brothers Dodge Daytona is among the top contenders in the World Challenge B class, while the team's two Eagle Talons—driven by Neil Hannemann and Bill Saunders—have been dominating Class D competition, taking the top

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two spots in each of the first four races.

**Zoom with a view**

It's hard to think of a better venue for the season wrapup. Besides being one of the most challenging tracks on the Trans-Am Tour, the 2.53-mile Sears Point circuit is just about the best spectator layout in the country. Set on a sunny Sonoma County hillside about 50 miles northeast of San Francisco, Sears Point offers a rare variety of readily accessible vantage points, many of them within just a few yards of the track.

Besides its Trans-Am show, a Sears Point tradition dating to 1969, the track also features National Hot Rod Association national drag racing and NASCAR Winston Cup events each summer. And even though the Winston Cup cars command more national attention, it's interesting to note that the Trans-Am drivers regularly post quicker lap times at Sears Point than the good old boys.

Sears Point is on California Route 121, near California 37, 10 miles south of Sonoma. For ticket and other information, call (800) 870-7223. See you there.



decked out with almost every piece of medical equipment found in a modern hospital emergency room. In addition to the ventilator and suction equipment, there is a Life Pak 10 heart monitor/defibrillator, a Propak blood pressure monitor, a Doppler electronic stethoscope (for listening to the heart in the helicopter's noisy environment), a pulse oximeter (for measuring the pulse rate and oxygen saturation of the blood), an electric warmer for intravenous fluids and outlets for suction, air and pure oxygen—supplied not from bulky, heavy

gas cylinders, but from a \$10,000 liquid oxygen system housed in a compartment to the rear of the cabin. The roof is studded with high-intensity dome lights, radio heads and intravenous fluid bag hangers. Positioned along the walls are several 115-volt electrical sockets, a fire extinguisher, a space heater and a "sharps" container for infectious waste. Radio headsets are provided not just for medical personnel, but also for the patient. To help soothe especially anxious patients, there is even an Alpine stereo cassette radio. A set of nylon ruck-

sacks strapped to the gurney contain scalpels, breathing tubes and other small items, plus more than 40 different medications—perhaps 30 more than carried by a typical ambulance.

"Just about the only thing we don't carry onboard is an X-ray machine," says Dr. Carter. "But if someone has a broken ankle, who cares? Most of the time we're dealing with far worse injuries."

The demands of Life Flight work also require some modifications you might not expect. For example, the cabin floor is specially designed, not only to keep the medical crews from slipping while they're treating patients, but also to facilitate cleaning up afterward. Made of a fiberglass honeycomb material, it represents the second of three floor designs used on Life Flight helicopters. "The floor has to be able to take mud, dirt and all sorts of bodily fluids," says Dr. Carter, a member of the team that helped design the original Life Flight medical interior for the S-76 in 1986. "It has to be incredibly durable." Ed Haslow, Life Flight chief mechanic, agrees. "We used to think we had a problem with corrosion down in the Gulf, but it's nothing compared with the problem here. Blood is very corrosive."

To counter the ever present threat of AIDS and other blood-borne diseases, Haslow and the other mechanics often don gloves to do their work. All Life Flight mechanics, as well as the other crew members, have been vaccinated against hepatitis.

### Clinging to life

Eleven minutes after boarding the helicopter, our tiny patient still clinging to life, we touch down at the second hospital. Again an ambulance is there to rush us to the emergency room. Inside, as he and Nurse Radey hand off their patient to the waiting trauma team, Dr. Sawyer gives a rapid-fire medical report of the girl's condition. The trauma team orders an immediate CT scan and sets frantically to work.

At 6:20 pm, Dr. Sawyer, Nurse Radey and I are back in the copter and headed for home. For the first time all day the sun is shining brightly, yet the mood inside the helicopter is glum.

The little girl, I later learn, will die. Early CT scans revealed that she had hopelessly catastrophic brain damage from the moment she was injured. Nothing could have saved her. Still, this crew of toughened veterans takes it hard, powerless to wipe the tragic images from their minds until the clock begins to tick away the next patient's inexorable golden hour. **PM**

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## PM HOTLINES

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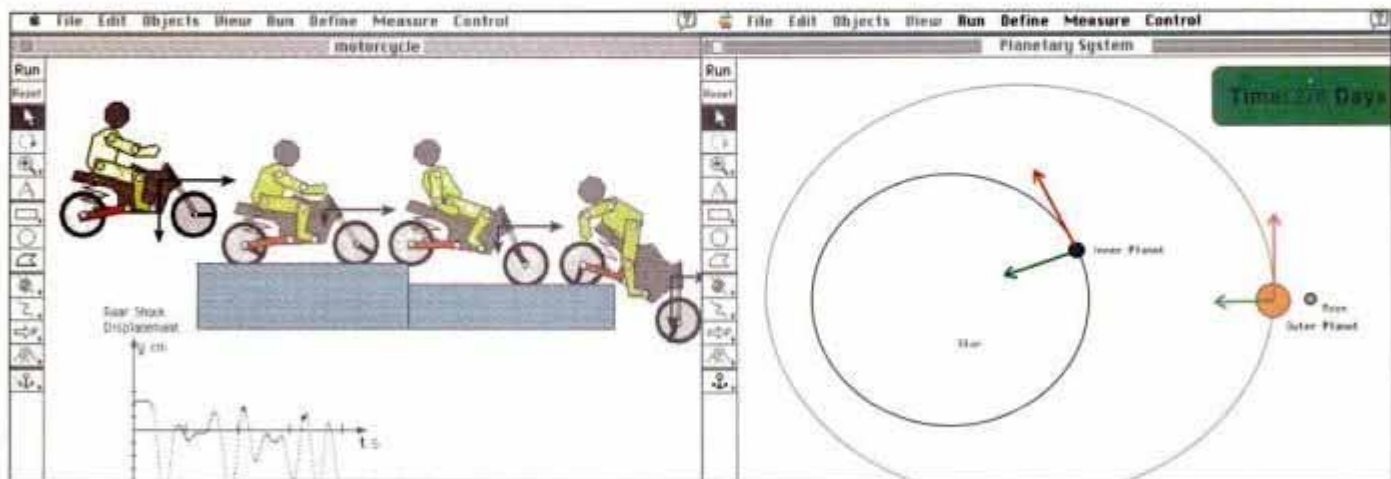
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## SCIENCE

# SILICON SCIENCE TEACHERS

BY ABE DANE, Science/Technology Editor



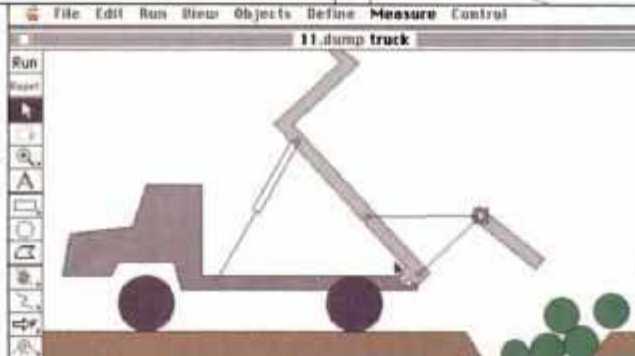
● Legend has it that the plummet of an over-ripe apple set Sir Isaac Newton on the path toward a few brilliantly simple laws that explain the motion of everything around us. Recently, an Apple of an entirely different kind reacquainted me with this 17th-century masterstroke.

The Apple was a Macintosh computer, and it was running a program that simulates motion exactly as Newton described it. It's one of those rare instances where a simulation is actually better than the real thing. By stripping away irrelevant and immeasurable factors that clutter up reality, the program makes plain the laws that it once took one of history's greatest minds to understand.

The result is a powerful engine of discovery for students, and for anyone else seeking a quicker, surer grasp of classical mechanics.

The program, titled *Interactive Physics II*, is part of a new generation of software that is finally beginning to realize the long-heralded potential of computers in education. Unlike earlier programs, which often reduced computers to expensive page-turners, *Interactive Physics* takes full advantage of the computer's graphical and number-crunching abilities.

What the program does is turn the Macintosh into a lavishly equipped first-year physics lab. You are given the tools to carry out just about any basic physics experiment and the instruments needed to monitor the re-



In these sample screens, the movements of a motorcycle's rear shock absorber are graphed over time (above left), the orbital mechanics of a solar system are demonstrated (above right) and the contents of a dumptruck bounce and tumble realistically (left). Slider-controls can be added to the screens to control a wide range of parameters as the simulations play out.

sults. Simple or elaborate systems can be set up using ropes, pulleys, springs, actuators, dampers, motors and objects of various shapes and masses. Atmospheric and gravitational conditions can be set to match those on Earth, another planet, outer space or some completely imaginary location. Spring rates, friction coefficients and actuator forces can be tailored, and measuring devices selected for the desired parameters. Then you click the mouse on "Run" and the whole system goes into action—just as it would in real life, except that moving objects sprout colored vectors, digital meters tick off numbers and graphs squiggle along, giving you a continuous, quantitative readout of what's pictured on the screen.

Although few would suggest that computers are now ready to replace the hands-on experience students get in a real lab, the program has been warmly received by educators. Prentice Hall, publisher of a best-selling college physics text, adopted the program to create computer-animated versions of many of the problems and

examples in two of its books.

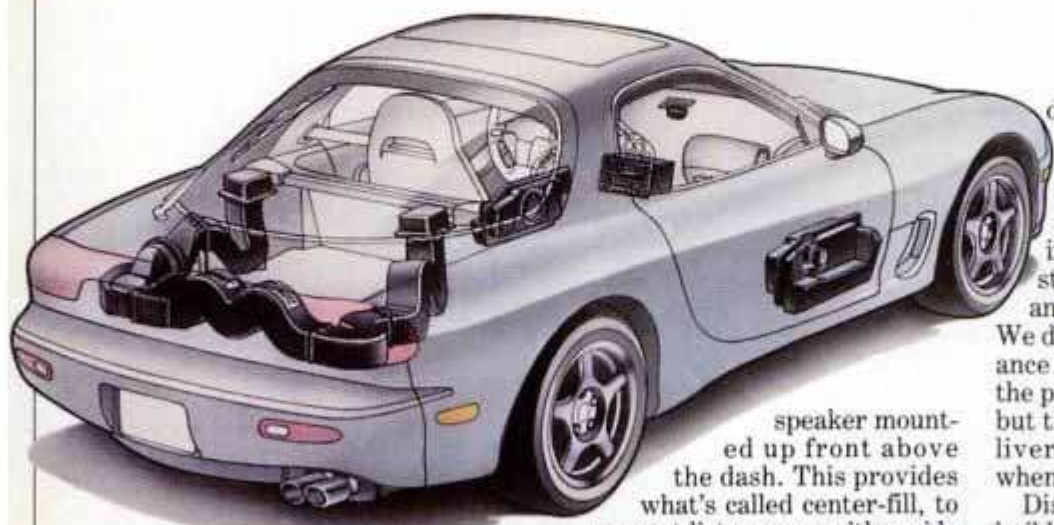
Tim Bozik, editor in chief, science and mathematics, in the company's college division, told me that he sees the program as a good complement to the texts, because they get past the limitations of the printed page. "What students are learning is how and why things move, and trying to develop some intuition. A book is a static being. It shows some pieces of art and the formulas. It doesn't show how you get from one place to another. And you can't play 'what if' games with textbooks," he says. The company expects to begin selling disks containing the simulations and a simplified version of the *Interactive Physics* software this fall for around \$20.

The full *Interactive Physics II* program, developed by Knowledge Revolution of San Francisco, California, lists for \$399. That's pretty steep for an individual who just wants to satisfy his curiosity about physics, or give the kids a little edge in school. But it'll make sense for a lot of academic institutions—a hopeful sign in these times of educational mediocrity. **PM**

## AUDIO

# RIDE THE WAVE

BY STEPHEN A. BOOTH, Contributing Editor



● Lift the hood of Mazda's third-generation RX-7 and you'll wonder where those 255 horses are hiding. The 85-cu.-in. rotary engine isn't only tiny, it's quiet too, despite twin turbos. Raise the hatch of this \$31,000 2-seater and you'll also wonder where the sound system's rear loudspeakers are.

You won't find pistons here either, not pistons in the form of the large speakers that you'd expect to deliver the kind of deep bass heard in the Mazda's passenger compartment. That's because the RX-7's stereo system is as unconventional as its powerplant.

The RX-7's sound system incorporates an "Acoustic Wave" technology developed by loudspeaker maker Bose, and represents the first use of this system in a car. Instead of trunk-mounting large speaker cones to create bass waves, the Acoustic Wave conceals two small (6.5-in.) woofers in a tube 110 in. long, folded and fitted to the interior contours of the RX-7's cargo bay. Much like an organ pipe, the tube is an efficient way to generate a large volume of sound. But, whereas an organ pipe is a One-Note-Johnny, the Bose waveguide tube is mathematically designed to deliver a range of sounds.

The sounds it delivers are quite good, in conjunction with the other elements of the system. These include front-door modules that combine a 4.5-in. full-range speaker with an amplifier and the equalization circuitry that is customized for the RX-7's interior. There's also an amplified, 2.5-in.

speaker mounted up front above the dash. This provides what's called center-fill, to prevent listeners on either side from getting an unbalanced stereo image owing to nearness to their respective door speaker.

Because it bounces sound off the windshield, this center-fill speaker also provides consistent frontal imaging for the Bose system. Sound never seems to emanate from the rear, although that is where the outlets of the waveguide tube are located. The waveguide's two self-amplified speakers handle only the lowest bass frequencies, which the human ear can't localize.

Bose has supplied audio systems for a variety of car brands, including Acura, Audi, GM, Honda, Infiniti, Mercedes-Benz and Nissan. To the ears of PM's "test drivers," the system packaged as standard in the Mazda RX-7 is Bose's best to date—and compares well to aftermarket-installed component systems.

Although we used compact discs, cassettes and AM/FM tuner to shake

down the Clarion-supplied front end, CDs were our reference for evaluating the Bose speaker/amplifier system. The sound was superb throughout. Stereo imaging—that imaginary soundstage—was always well balanced and always in front of the listener. We did prefer a slight shift of the balance knob to the driver's side when the passenger's seat was unoccupied, but the preset Bose equalization delivered perfect left/right balance when a passenger was present.

Distortion was nonexistent. Bose builds compression into its speakers, to prevent sound breakup at high volumes. Even our usual speaker-killer CD, an attack of the giant Japanese bass drum called "O-Daiko," failed to induce breakup.

As for the Clarion-supplied CD/radio/cassette player, performance and features are no less than what you'd expect from a high-end piece of electronics. The CD player won't skip on bumps, and FM was exceptionally good thanks to the dual-antenna diversity tuning system. Overall, the sound system in the RX-7 is one you'd be happy to have in your home. In this case, it's a mobile home. **FM**



Speakers wrap around the trunk interior (top) of the Mazda RX-7.

# MANAGING MONEY

BY RON SCIBILIA

● It's a fine fall day in 2001 and your family computer, the HAL 9000 Plus, has left a message for you. You click on your video display mailbox and the image of a smartly tailored woman appears on-screen.

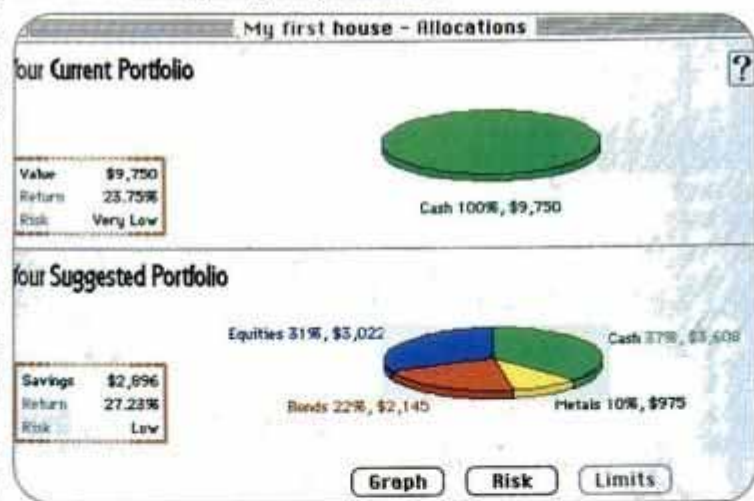
"Your financial plan is ready, Dave. I've examined your financial situation in light of current market data and trends, and I'm recommending that you shift 25% of your liquid assets from short-term corporate bonds to the Midas International Growth Fund. I also suggest you put another 5% of your assets into Japanese yen futures to hedge against the dollar." It points to a large, colorful graph that zooms out from a corner of the screen. "As you can see, you need more growth to reach your goal of early retirement. An increased international equity portfolio offers you an 88% probability of reaching your asset target by 2011 while lowering your overall risk level. Shall I re-deploy your assets now?"

While you're thinking it over, the computer continues: "By the way, I've transferred funds from your money market account to your bank to pay your home mortgage bill for this month, and I've printed out the profit-and-loss statement for your home business's fiscal year."

A far-fetched scene? Hardly. 2001 is more than eight years away, but low-cost personal computers, armed with an array of powerful and surprisingly inexpensive software, are dramatically redefining the ability of investors to control their own financial destiny. While computers aren't yet announcing their strategies in mellifluous tones, they're already providing much of that same information to



The MetaStock financial program (above) displays a variety of charts simultaneously for easy comparison. WealthBuilder's pie charts (below) make an investment strategy easily comprehensible.



the computerized investor—and promise to do much more in the future. It may be too early to predict dinosaur status for traditional accountants, brokers and financial planners, but there's little doubt that financial professionals in the '90s are going to be getting a lot more competition from do-it-yourselfers partnered with a PC-based planner.

Personal finance software has become one of the fastest-rising categories in the past few years, and software suppliers, eyeing an installed base of tens of millions of PCs, have been quick to cash in on the trend. Tax-preparation programs, such as

ChipSoft's *TurboTax* (\$80), MECA's *TaxCut* (\$90) and others, have become widely popular, out-selling tax-preparation books by a wide margin.

Meanwhile, so-called "electronic checkbook" programs, which can track cash-flows for home and small-business users and generate accountant-ready reports, are consistently among the best-selling programs on the market. The leader in this arena, Intuit's *Quicken* (\$70), available for DOS, Windows and Apple's Macintosh, reportedly has 1.5 million registered users and an actual installed base that may reach 5 million, according to industry sources. *Quicken* has sold so well, in fact, that software giant Microsoft recently came out with its own *Quicken*-like product, *Microsoft Money* (\$70).

The most interesting personal finance software available on the market right now, however, may be the financial planning and analysis category, represented by such diverse programs as MECA's *Managing Your Money*, Reality Technologies' *WealthBuilder* and *Smart Investor*, and EQUIS International's *Metastock*. More complementary than competitive, these titles could form a computerized investing arsenal.

The venerable *Managing Your Money* (\$80), now available in version 8.0, could be dubbed the Swiss army knife of personal financial programs. If you have a financial question, this program is likely to address it. A 12-module program designed to be a kind of one-stop money management center, it offers extensive record-keeping capabilities and a host of basic (and not so basic) financial calcula-

(Please turn to page 146)

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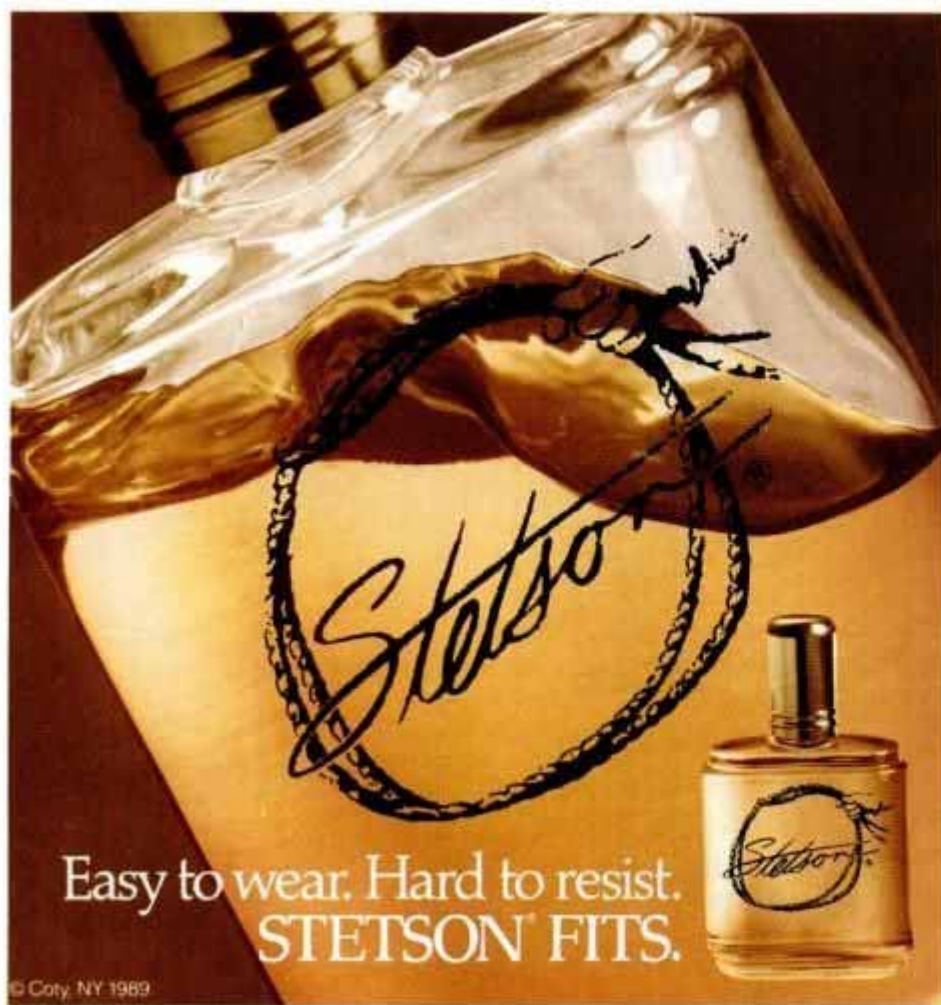
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## COMPUTERS (Continued from page 144)

tions. MYM can do tax, retirement and insurance planning, work out budgets and even pay your bills electronically using a modem.

The program's Tax module figures 1040s, and will also compute self-employment taxes and W-4s. At year-end, it can transfer the data you've stored there to MECA's formidable TaxCut tax-preparation package, one of the best on the market. The Analyze module can do sophisticated rental-property analysis, buy/sell/lease comparisons and advise you on whether or not it makes sense to refinance your mortgage. A Net Worth module pulls all data together to monitor your financial journey, and provides an asset-allocation model that suggests how to divvy up your wealth for the best return.

Reality Technologies' *WealthBuilder* (\$170), which comes to market under the sponsorship of *Money* magazine, takes a different tack. Rather than be a jack of all trades, *WealthBuilder* is essentially a financial planner in a box. This program's focus is on working up a personalized long-range strategy—much as a flesh-and-blood planner would—that will take you to your chosen financial goals. In addition to providing a sophisticated portfolio manager, the program offers expert—and elaborate—advice on how to allocate your assets by investment type, complete with colorful graphs. A "reality time line" shows you in graphical terms how you're likely to make—or not make—progress toward that target. What sets *WealthBuilder* apart is its inclusion of an extensive built-in database of specific investment vehicles—stocks, bonds and mutual funds—to help you get to your goal. This database can be updated quarterly for an annual cost of \$120 to \$200.

Another Reality program, *Smart Investor* (\$100), focuses, more narrowly, on short-term investment strategy and adds an on-line link that permits both downloading by modem of up-to-date investment data from a wide range of sources and the ability to do immediate on-line trading through discount brokers. *Smart Investor*, which is registered with the SEC as an investment adviser, will recommend the best-performing investment vehicles—specific mutual funds, for example—suited to an investor's profile, not just categories such as domestic stocks or international bonds. A flat fee structure offers unlimited access via local telephone calls—\$10 a month for mutual fund info, \$18 for the full universe of funds, stocks and options—

(Please turn to page 148)

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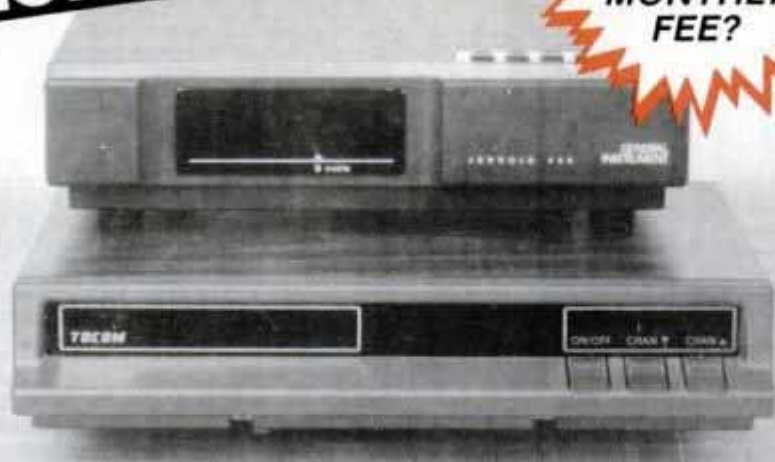
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## COMPUTERS (Continued from page 146)

and does away with the need for regular disk updates. (The next release of *WealthBuilder* will also incorporate on-line downloading and trading capabilities, according to the company.)

### A deeper look

While both *Managing Your Money* and *WealthBuilder* are aimed at the investor interested in such market fundamentals as earnings and dividends, so-called technical analysts and chartists can also find powerful software to serve their needs.

Investors who are devotees of technical analysis base their reading of the market on a security or an index price and volume market action, rather than company or industry fundamentals. This type of investor is likely to be thoroughly hooked on EQUIS International's *MetaStock*. This program offers a staggering array of analysis tools for chart-readers. *MetaStock's* new version 3.0 (\$349; upgrades \$99 to \$149) offers a new graphical interface and full mouse-support. A time-saving new feature called Smart Charts lets charts remember which indicators an investor selects to follow for any given security. There are more than 60 built-in indicators to choose from, not to mention user-created ones.

Perhaps the program's most compelling new feature, however, is a sophisticated trading system tester and optimizer, much improved from earlier versions, which figures out the most effective—in other words, most profitable—trading system to use for a particular security. The program will, as an example, test a wide range of moving averages of different periods and tell you exactly which moving average period—10 weeks, 30 weeks, 50 weeks—would have generated the most profitable trading system, creating detailed reports on how your stake would have fared.

EQUIS also offers a companion program, *The Downloader* (\$195), that can access on-line data from any of seven different data providers. On-line data costs can vary widely, but figure on spending a minimum of \$10 a month to track a typical "basket" of securities from an information service like CompuServe.

While these programs may never replace across-the-desk meetings with flesh-and-blood financial planners, they certainly offer a cost-effective alternative for the investor who wants to take charge of his money. At the very least, they provide both a "second opinion" about where hard-earned dollars should go and a financial education that will keep you in step with the experts. **PM**



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## AUTOMOBILES

### THE ALTERNATE FUEL REPORT:

# GM'S ELECTRIC CAR & DODGE'S CNG-FUELED VAN

BY JIM DUNNE, Detroit Editor



### GM's Impact Prototype

● Thanks to new laws in California and other states, the electric vehicle will be a small, but highly visible, part of our traffic mix in the second half of the 1990s. And, already, one of the most-talked about electric vehicles is General Motors' Impact. The Impact is a 2-seater that runs on the power of 32 10-volt lead-acid batteries. And when we say run, we mean run—0 to 60 mph in less than 9 seconds.

I drove a prototype version of GM's Impact earlier this year. The prototype is made up of a Geo Storm body and chassis outfitted with the actual electrical parts that the Impact will use when it is introduced for public sale in 1994. And during that drive, I found the Impact well suited to meeting the demands of today's travel.

I also discovered a number of basic flaws in the whole idea.

For openers, while the claimed maximum range for the Impact is 100 miles, GM recommends that the batteries not be run flat—totally out of charge. In reality, range is more like 80 miles. And this is further cut if you use the air conditioning. So, driving in hot or humid conditions cuts the car's true range to about 60 miles.

Cold weather also affects the Impact. Since it uses a heat-pump heater, the Impact produces heat when temperatures are below 40° F. In other words, when you need it.

One of the unnerving aspects of the Impact—as well as other electric prototypes—is the car's quiet. It's nearly

silent at slower speeds. Moving around town in such stealth seems almost eerie. But it's also dangerously disconcerting—especially in pedestrian areas, where those sharing the road with you don't hear it coming.

And when the charge is gone, it's not simply a matter of pulling into the next gas station and refilling the tank. Recharging the batteries is a 3-hour routine. Lead-acid batteries don't remain healthy on a diet of quick charges.

While all of the above are concerns, I have not given up on electric power. Far from it. For short drives, the Impact's drawbacks do not pose major problems.

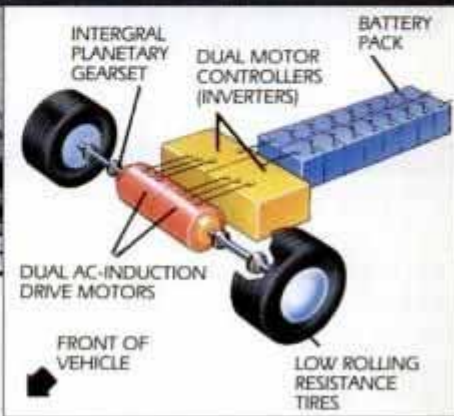
And the cost of driving an electric vehicle is rewarding, as well. GM says that Impact will be "priced to compete with conventional cars." Realistically, when the car is introduced in 1994, expect the sticker to read \$30,000 or less—well below the \$125,000 price for Chrysler's electric van.

Other than the unnerving quiet, Impact is simple to drive. Turn on the ignition key, push the "F" (forward) button on the instrument panel, and press down on the standard accelerator. The car moves out smoothly—and silently. Push even more on the accelerator, and the car jumps ahead, displaying the power of a small V8. Push the "N" button for neutral and "R" for reverse. Since the car does not creep at idle, you can't tell which gear you're using when stopped without checking the selector button or pushing on the accelerator. Also, since the Impact's transmission has no "Park,"

*(Please turn to page 153)*



No, this isn't really an Impact—but it is a Geo Storm wearing a prototype Impact drivetrain, permitting battery/motor development to parallel the chassis engineering.





you'll get accustomed to using the parking brake, or you'll spend a lot of time chasing your Impact as it rolls down hills.

GM's goal of making the Impact as efficient in the use of energy as possible makes for some other surprises, as well. Steering in the 2200-pound car is manual, to conserve the energy it would take to operate a power-steering system. You also occasionally hear the buzzing of the tiny motor, which drives the vacuum pump for the power-braking system.

Impact also has regenerative braking. This system recharges the batteries by using the braking forces of the electric motor. It's controlled by a dial on the instrument panel. Dial a high setting, and you get strong braking during coast-down, exactly like a 2-gear downshift. That means more energy pumped back into the batteries. Dial a low setting, and you get a freewheeling effect, with no retard during coast-down and no electric

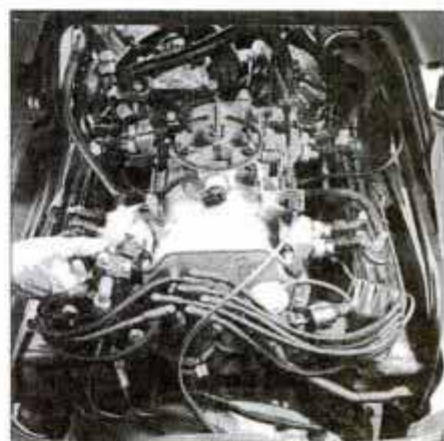


The badge on the tailgate and lack of exhaust odor identify this as one of 900 Dodge CNG-powered full-size vans. Gaseous-fuel engine uses 3000-psi tanks and lines—so refueling must be done at specialized facilities.

energy put back into the batteries.

The batteries drive the front wheels through an inverter and two electric motors, one for each front wheel. What you see under the hood is a large, rectangular aluminum box that houses the inverter and the motors. What you don't see are belts, distributor wires, fuel-injection tubing, radiators and intake and exhaust manifolds.

The GM Impact even looks a trifle strange inside. Cabin accommodations are tight. Impact is a 2-seater, with some storage space behind the seats. But a large tunnel that houses the batteries runs down the center of the floor, taking up more room than a typical center console.



Electric car industry boosters, like General Motors, claim that the cost-per-mile of an electric vehicle is well below that of a gasoline car. A few pennies per mile, at most. Still, there is the problem of replacing the lead-acid batteries every two or three years at a cost of a couple thousand dollars. That tilts costs in favor of gasoline power.

On balance, the battery-powered car of today can't match the convenience or range of gasoline. But newer batteries—with much higher energy storage, shorter recharging times and longer life—could tip the scales to a more even balance in the next 10 years.

### Dodge CNG Van

Electricity may be the *au courant* source of tomorrow's automotive energy at cocktail parties, but in the real world of today, carmakers are throttling full bore in several nonelectrical directions as well. Chrysler, for one,

(Please turn to page 154)

### GM Prototype Specifications

Body and chassis	Geo Storm conversion
Motors	AC induction, 57 hp at 0-6600 rpm each motor 47 ft.-lb. of torque at 0-6600 rpm each motor
Top speed	Electronically limited to 75 mph
Batteries	(32) Delco-Remy lead-acid, 10-volt, wired in series
Drivetrain	Front-wheel-drive, one motor per wheel
Tires	Low rolling resistance Goodyear P165/65R14
Steering	Rack and pinion
Recharge time	3 hours on 220-volt circuit
Practical range	80 miles per charge
Acceleration	0-60 mph in under 9 seconds
Emissions	Zero

As Seen in

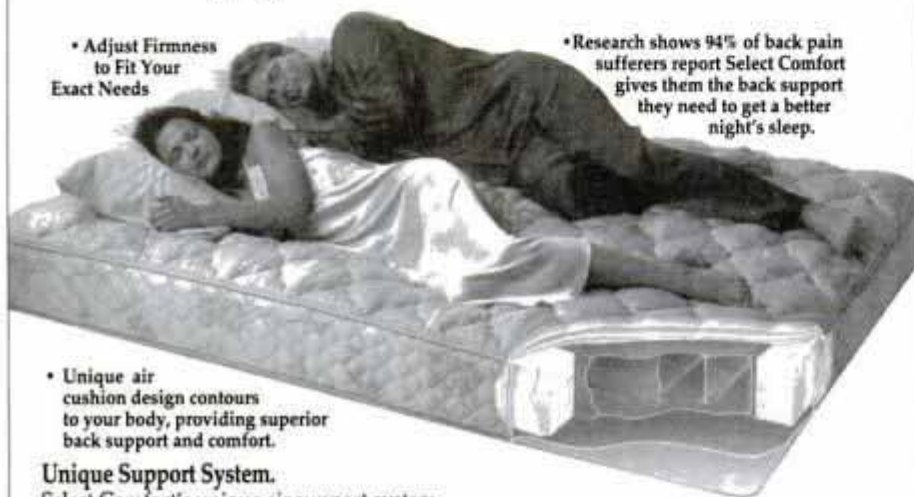
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## ALTERNATE FUELS

(Continued from page 153)

has developed vans powered by ultra-clean burning compressed natural gas (CNG) that are available right now—you can trot out and buy one if you so choose. To see what you get for your money—and if there is any discernible difference between the gas and gasoline versions—we drove one of the first of the 900 CNG-powered full-size Dodge Ram vans.

Compressed natural gas is the same fuel many of us have cooking our dinners and heating our houses. And as a source of automotive energy, it beats gasoline clean at the tailpipe. Since CNG burns more completely than gasoline and contains no liquid hydrocarbons, HC emissions are close to zero. Carbon monoxide is lower since the air/fuel mixture is leaner than with gasoline. And the NO<sub>x</sub> level, with the help of a catalyst, easily converts to nonpolluting gases.

Don't sign up just yet though—until you understand that the CNG-fueled 318-cu.-in. Magnum V8 in the Dodge puts out about 10% less power than the gasoline version. With CNG, max power is 200 hp at 4400 rpm, versus 230 hp at 4800 rpm with gasoline. Torque falls from 280 ft.-lb. at 3200 rpm to 250 ft.-lb. at 3600 rpm.

However, once behind the wheel and driving, it's hard to notice any penalty. Under heavy load—towing a trailer, for instance—the difference becomes more apparent. But during our drive, the CNG Dodge had good throttle response and more than enough muscle to keep up with traffic.

While actual fuel economy is roughly the same between CNG and gasoline, cruising range is much less, due to the smaller capacity of the CNG tanks. In fact, the Dodge holds the equivalent of 11 gallons of gasoline. That reduces range from about 350 miles to only 170 miles.

Which brings up the next problem: Outside of California, there are virtually no service stations equipped to build up the 3000-psi pressure needed to refuel the CNG system.

Chrysler must add about \$4000 to the price of an equivalent gasoline van to cover the costs of the 175 pounds of necessary hardware. This includes three tanks, special high-pressure tubing, a pressure regulator that lowers system pressure from 3000 to 100 psi in the induction system, an emergency shutoff valve and unique fuel injectors (which clatter like stuck hydraulic valve lifters).

But once you get past the initial price, the payback begins. CNG only costs what would be the equivalent of 60 to 70 cents a gallon when compared with gasoline.

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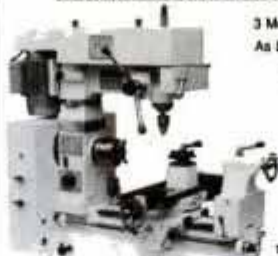
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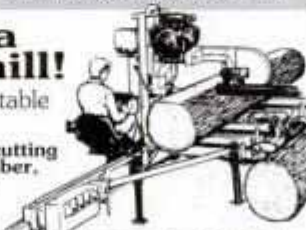
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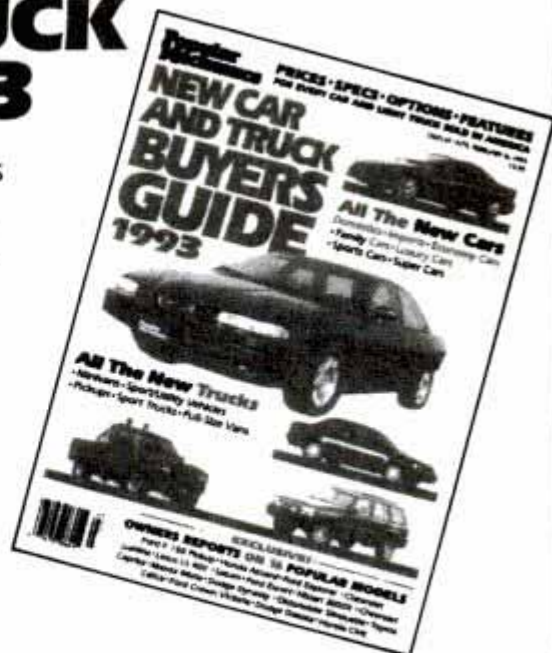
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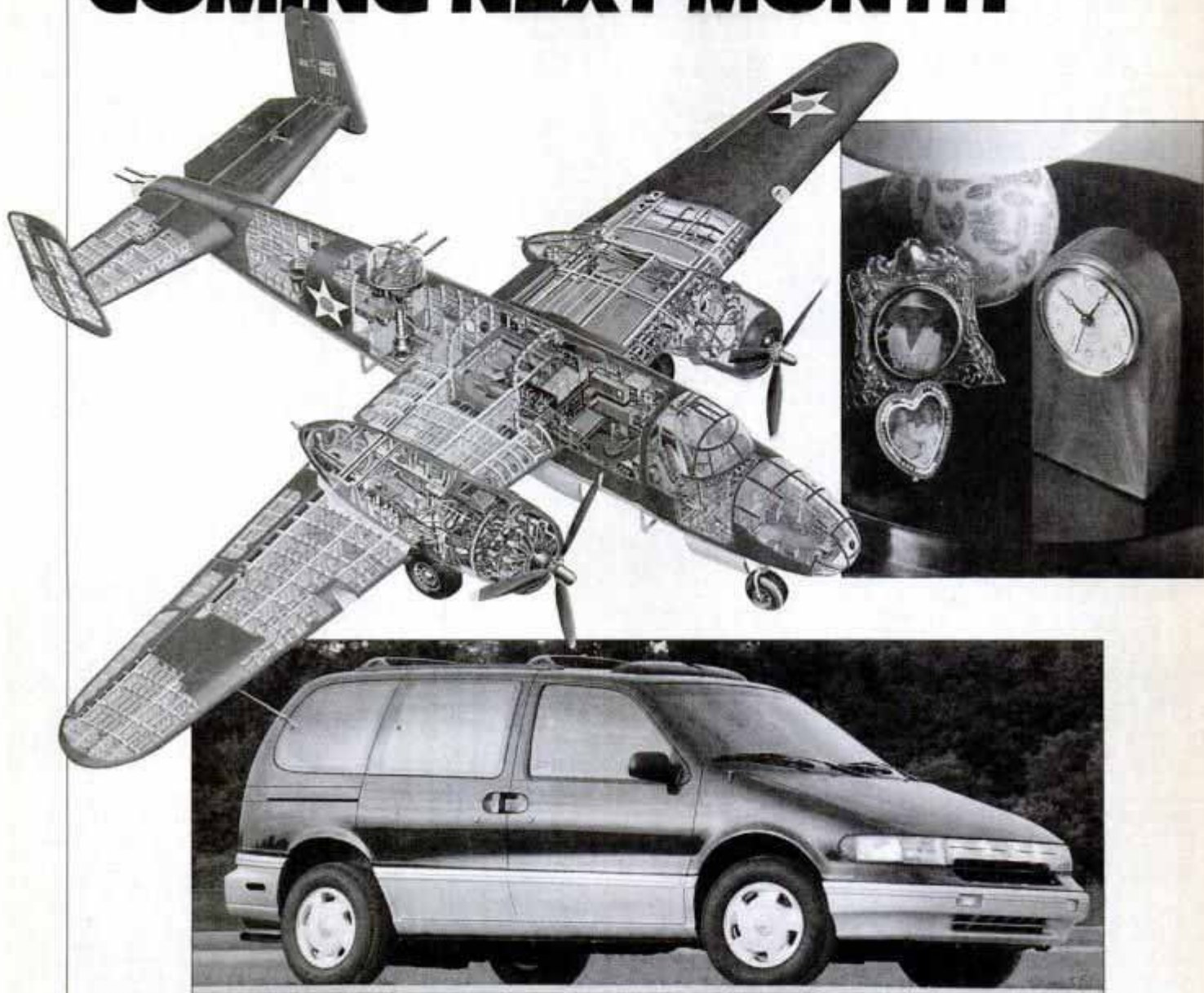
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