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# Popular Mechanics

**BOATING 1991 PREVIEW**  
**HOT NEW BOATS, MOTORS, GEAR**

## **BUILD YOUR OWN SPORTS CAR**

Pick Your Dream Machine—  
Classic To Exotic. Today's Kit Cars  
Are Easy To Assemble  
And Fun To Drive



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Testing The 5 Top  
Fuel Mileage Cars

**CORDLESS PHONES WITH CRYSTAL-CLEAR SOUND**  
Lab-Testing 10 New  
Multi-Feature Models

**HOME IMPROVEMENT WORKSAVER**  
The Easy Way To  
Paint Interiors



PHOTO: JEFFREY M. HARRIS

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# Popular Mechanics®

FEBRUARY 1991  
VOLUME 168  
NO. 2



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## 23 COVER STORY

From classics to exotics, specialty car kits help you build your dream.

—PM cover photo by Rich Cox



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# EDITOR'S NOTES

● Ever dream of owning a Ferrari 365GTB4 Daytona Spyder? Or a Lamborghini Countach? Or a 1930 Mercedes-Benz SSK? Or even a Ford Deuce Coupe? Sure, who hasn't? The only trouble is, the current asking price for a Daytona Spyder is around a mil and a half. That's right—\$1,500,000. And Ferrari imported only 14 of them in 1969. So what are the chances of owning one? About the same odds as me getting a date with Nicolette Sheridan. One thing you can do is build yourself one out of the many kits available. This will get you a car that looks a whole lot like a Daytona, or any of the other cars you've been dreaming about. Kit cars have come a long way in the past 10 years. The result being that you can end up with a real car that looks cool and drives great, for a mere fraction of the cost of what a classic Mercedes or Ferrari or '32 Ford coupe will cost. Yes, it takes some mechanical skill and lots of patience and perseverance. But all of it is well within the realm of the average POPULAR MECHANICS reader. First, check out our cover story on the latest kit cars, beginning on page 23. You'll be amazed at the variety of kits that are available. Then, read about our own experiences building the



Special thanks to Judy and Bob Smith of Bartlett, Tennessee, and their Classic Roadsters Marlene 500 K for helping out on our kit car article.

again have women in bathing suits in some of the photos because that's how the women we know dress when they're on a boat. However, in deference to the women who wrote to me last year, we also have *men* in bathing suits this year. I hope this satisfies all of you who called me a sexist, anti-feminist male chauvinist. . . . Do you dread a visit to the dentist as I do? According to our report on page 35, pain associated with dental work may soon be a thing of the past. No more drills. No more scraping and digging and pulling. Instead, computers, chemical washes, lasers and soothing music—they say. Let's hope this vision of the future comes to pass as quickly as possible.

. . . Is there a gas crisis or not? Who knows? Gas prices shot up last summer right after the invasion of Kuwait by Iraq. But oil company officials conceded that there was plenty of oil around. But *in case* there was a crisis, they wanted to be prepared, so they raised prices immediately. Well, *in case* there is a gas crisis, better check out our comparison test of the most fuel efficient cars sold in America. We know they get good gas mileage. That's a given. But how are they to live with day to day? Are they real cars? That's what we tell you beginning on page 39. Till next time.

Joe Oldham

# Popular Mechanics

Editor-In-Chief Joe Oldham

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## Editorial Offices

224 West 57 St.,  
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# The Velvet Touch

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# LETTERS

## Honda Discord

I have been a PM subscriber for a long time. I enjoyed reading it and respected the opinion of your editors—until I read Joe Oldham's report on the 1991 Honda Accord in your November issue. As an owner of an '88 Accord, and after reading his report, I have to conclude the following: Either Mr. Oldham did not really test an Accord, or else he is a total idiot.

ABED ZANTOUT  
SYCAMORE, IL

lute pleasure to drive. I'll let you have the Ford Escort. I'll keep the Accord and keep smiling.

BOB ALBRIGHT  
YORK, PA

Shocker! I don't know what this Joe Oldham was driving or if he was on some medication or something. But my wife, a buddy of mine and I all drive Accords, and we were all flabbergasted.

LARRY MARTIN  
DENVER, CO



Where did you find this car? Drive one for 100,000 miles and you will find it to be a troublefree means of transportation.

JOHN GOHRING  
GARNERVILLE, NY

The engine roars when asked to furnish more power? I have never heard an engine as quiet or as smooth running. And the Accord doesn't need a 4-in. blanket of fuzz under the hood to damp out the engine sound.

TED BOWER  
SIDNEY, OH

I couldn't agree with you more. I, too, would like to know what all the fuss is about. Underpowered, undersized and overpriced. Wow, what a bargain!

STEVEN C. SMITH  
FOXBOROUGH, MA

I was shocked to read your comments. I recently purchased an Accord and have found none of your comments about the Honda to be valid. It's silky smooth and an abso-

I found your long-term test of the Honda Accord a real source of comfort.

STEVEN D. AXELROD  
AKRON, OH

If you weren't obviously biased in your reporting on automobiles, you might then utilize what intelligence you have and realize that the Accord outsells everything else for one reason—quality. Why don't you write about something you have at least some knowledge of and leave the automotive reporting to your automotive editors.

JACK COX  
DENTON, TX

## Slow Stealth

Mike Allen says that the Dodge Stealth R/T Turbo will embarrass both the Corvette L-98 and the Nissan 300ZX Turbo. I'd like to refer him to the *Motor Trend* road test of these three cars. The Dodge was not only slower to 60 mph than the 300ZX and Corvette, but was also slower in the quarter-mile. The Dodge ran a 14.5 second/93.5 mph quar-

ter. The Nissan 300ZX ran 14.1/101.0 and the Corvette 14.3/97.1. Let's be accurate please.

CAY DIZON  
MACON, GA

*Mike Allen replies: I have no way of knowing why the Motor Trend car was so slow. Maybe it was the person driving who was slow, not the car. I tested the Stealth last spring at Mitsubishi's proving grounds in Kitsuregawa, Japan. That day, both the Stealth and a companion 3000GT were turning quarter-miles consistently under 14 seconds. We call them the way we see them.*

## Off The Beam

I was disappointed to see the article on radar detectors. It was so one-sided the words nearly slid off the page. While police radar is not infallible, the vast majority of people who obey the law are not stopped. Perhaps next month you'll publish an article on how to slip weapons past airport security. I'm sure "enquiring minds" want to know.

SAM CARMAN  
PITTSBORO, IN

## Dee-Fense

I wish everyone in this great nation would read your November editorial comments about defense. It would take more pages than you have for me to tell you about all the times that *POPULAR MECHANICS* has paralleled my thoughts on various issues. Let's face it, we do not need expensive, exotic weapons until we need them. Thanks for expressing this for us all.

LAWRENCE J. HOOKER  
AMHERST, NY

I thoroughly enjoyed your article on the Grumman F-14 Tomcat. The cover illustration, cutaway sketch and carrier photographs made it feel

as though I was in the cockpit with my finger on the pickle button. Just one correction: The AIM-7 Sparrow Missile is radar-guided, while the AIM-9 Sidewinder is the heat seeker.

CHARLES ROMANO  
SAYVILLE, NY

## Stripmining

Joe Skorupa's article on "Stripmining The Sea" (page 106, Nov. '90) was frightening. The article gave sobering insight to the morals of some of the major nations on the Pacific Rim. Countries showing scant regard for our environment—Korea, Japan and Taiwan appear to be the major offenders—do not deserve the huge trade success that they currently enjoy.

RAYMOND GORK  
TORONTO, ONTARIO

## Tread Lightly!

I was interested to read about the Tread Lightly! program in your country which, as I understand it, is an educational effort designed to improve people's off-road driving habits. As we in Scotland have similar problems in some areas, I would like to know where to get more information.

BERNARD D. RODGE  
SCOTLAND

*You can write to Tread Lightly! at P.O. Box 149, Ogden, UT 84402; or call (800) 966-9900. Also, be sure to catch our own special section on Tread Lightly! coming in next month's issue.*

## Correction

The photo of the Vickers Supermarine Spitfire flying over the Statue of Liberty in New York Harbor (page 132, Nov. '90) should have been credited to photographer Jim Koepnich/Experimental Aircraft Association. **PM**



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**Dir. of Marketing** Robert A. Schu  
**Dir. of Promotion** Susan A. McCorkindale  
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**Business Manager** Agnes P. Maillaro

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## ADVERTISING OFFICES

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224 West 57 St.,  
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### Classified

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**Adv. Production Mgr.** Patricia A. Tanner  
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# TIME MACHINE

## 75 YEARS AGO: FEBRUARY 1916



### Ski Run And Shoot

Motion-picture pioneers went to great lengths to capture sports action. To reproduce the impact of a downhill dash, a Michigan moviemaker put his camera on the back of a bobsled and chased a skier through his course. While an assistant steered, the cameraman cranked away, keeping the camera trained on his weaving subject. The mobile film crew opted not to pursue the skier over a jump, however, and veered away to frame the scene from the ground.

### Mine Spotter

Submerged naval mines savaged merchant and fighting vessels alike during World War I, and mariners needed help keeping shipping lanes open. One American solution was a powerful searchlight mounted below the waterline near the bow of a battleship. Swiveled in conjunction with a modified periscope, the lamp could light up submerged objects as far as 2000 ft. away. If the device's operator spotted a mine in the vessel's path, he'd call for a torpedo launch and then

watch the underwater detonation through the scope from the forward deck.



## 50 YEARS AGO: FEBRUARY 1941



### Silent Invaders

The British, braced constantly for invasion, worried whether Germany might lift an idea from Russian experiments: silent trains of giant gliders, each carrying eight fully armed shock troops. A powered aircraft could tow a line of these stealthy craft to 20,000 ft., then cut them loose to coast soundlessly across the channel. British fears proved unfounded, however. As it turned out, it would be the Allies who augmented their D-day invasion with glider-borne troops.

### Rotor Rooters

Meanwhile, autogyro advocates aired ideas for turning the quirky rotorcraft into a fighting force. Gyro guru R. G. Kellett foresaw fleets of his flying machines, armored and launched from ships to tackle divebombers, or leaping over enemy lines in surprise raids. But the fortunes of military rotorcraft would rise only with the true-vertical takeoff abilities of the strange, spidery contraptions lofted in the early '40s by a Russian-born engineer named Igor Sikorsky.



## 25 YEARS AGO: FEBRUARY 1966



### Watchman's Ancestor

As far back as the '60s, video engineers were laboring to produce a flat-screen TV. The best they could do was the flat CRT. Twin electron beams shot vertically from the tube's shaft. Transparent plates then deflected each beam 90° to scan back-to-back screens. Thus, you could watch from either side of the tube, although one of the pictures would be reversed. But mass-production problems punctured the flat-tube approach.

### Missile Medicine

The gyros, accelerometers and other components of '60s-era ballistic missile guidance systems were some of the most complex and finicky devices ever made. To maintain them, the Air Force sank \$50 million into a facility for diagnosing and treating missile disorders. Part of the lab rested 60 ft. underground, built on solid rock and insulated from elec-

tromagnetic fields. There, engineers tested rebuilt guidance systems before returning them to duty. **FM**



# A GREAT CATCH



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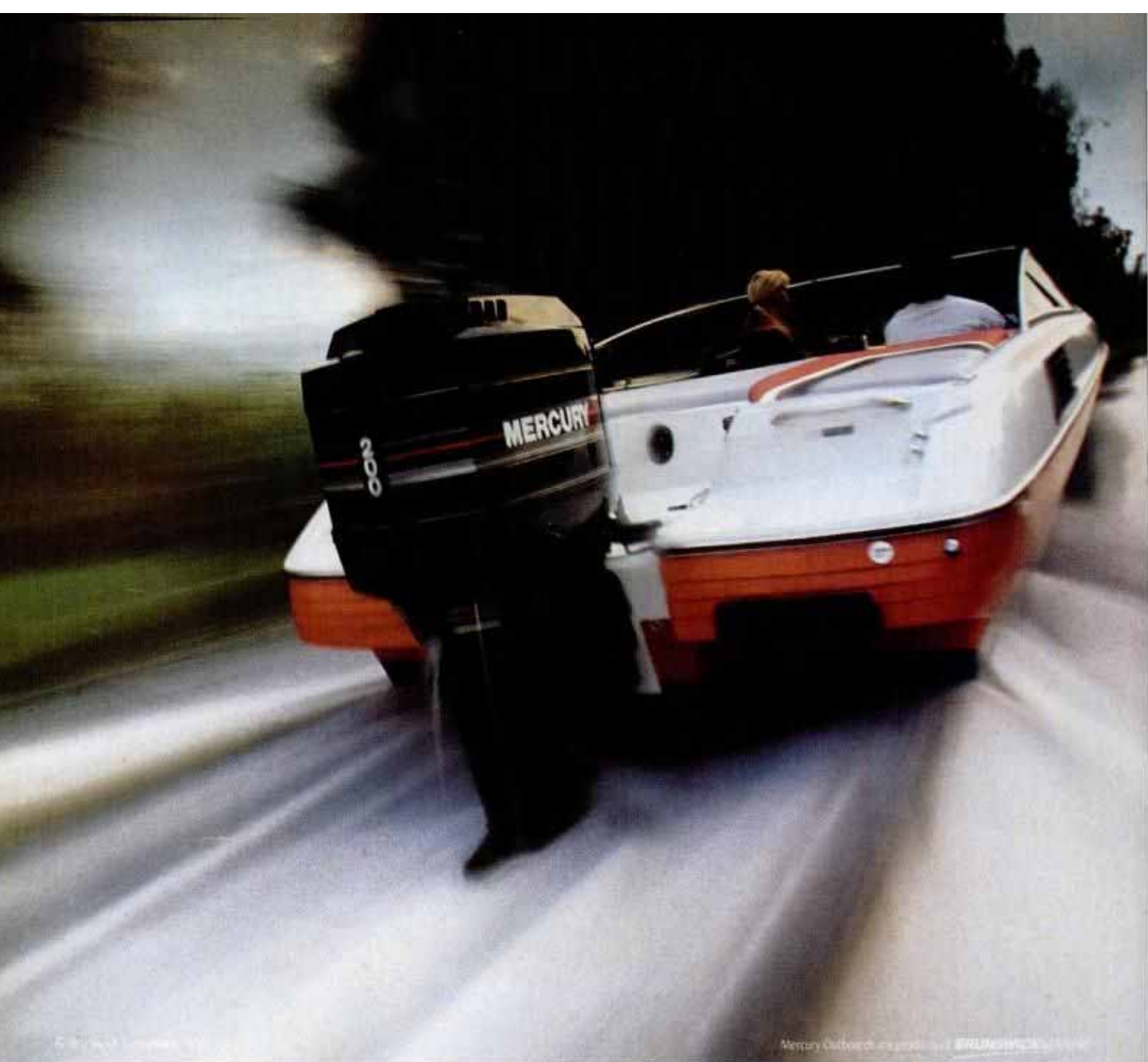


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# TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY ED VALIGURSKY

## Electric Tanks Fend Off Missiles And Mines

FORT MONMOUTH, NJ—Army engineers are planning future tanks that will both move and defend themselves by channeling the output of megawatt-size electric generators.

The Army's Tank-Automotive Command and Electronics Technology and Devices Laboratory are collaborating in pursuit of these all-electric fighting vehicles. The idea calls for a gas-turbine generator to charge high energy-density batteries or capacitors. These would feed electric hyper-velocity guns, defenses, propulsion, active suspension, turret actuators and sensors.

The scheme would bring to

life countermeasures such as pro-active armor, whereby segments of the tank's plating launch themselves electromagnetically to intercept enemy fire. Also tied in are high-power microwave transmitters that detonate antitank mines at a distance and scramble guidance systems on incoming missiles. Electric motors would provide individual-wheel drive. The prime technical hurdle remains the weight of the energy-storage and power-conditioning equipment. Developers hope to roll out an integrated prototype by 2004.

Editor: Abe Dane  
Assistant Editor: Greg Pope  
Contributor: Bob Scheier

Electric tank deflects helicopter-launched missile with microwave blast. Pro-active armor, triggered by microradars, flies at incoming missiles. In background, sister tank clears mines with microwaves.

### Highlights This Month

- **Deep Tracks**—Bottom-crawling caterpillar buries transoceanic phone lines.
- **Electric Shocks**—Magnetic forces cushion your ride.
- **Eye-In-The-Sky Bullseye**—Satellites guide howitzer assault.
- **Glide Ride**—An automatic transmission for bicycles.
- **Ulysses' Odyssey**—The solar probe must first hang a right at Jupiter.
- **Drop Everything**—Japan digs world's deepest microgravity shaft.

## Deep Sea Cable Cat

MORRISTOWN, NJ—A big, versatile submarine tractor will soon roll across the seafloor, burying transoceanic telephone cables that now lie exposed to damage.

The remotely powered and operated vehicle, built by AT&T, will roll from beaches down to a depth of 4500 ft. It will accept an arsenal of interchangeable tools.

To bury cable in soft seabed, a rear-mounted jetter sled will blast away with water jets, while a dredge pump sucks up soil to clear a trench. A fair-lead guides cable 3 ft. under the seafloor. To lay and bury cable in one step, operators can rig the tractor with a powered spool/jetter combo.

The tractor can also run a



mechanical chain trencher or a rock wheel cutter to buzz through hard clay or rock. Smaller tools—such as a por-

table dredger or a cable cutter—are deployed from a forward rack by a robotic manipulator.

**Seabed tractor, powered from ship, uses jetter sled to bury cable, which might otherwise fall victim to shark bites.**

PM ILLUSTRATION BY DEAN ELLIS

## Magna-Ride Shock Absorbers

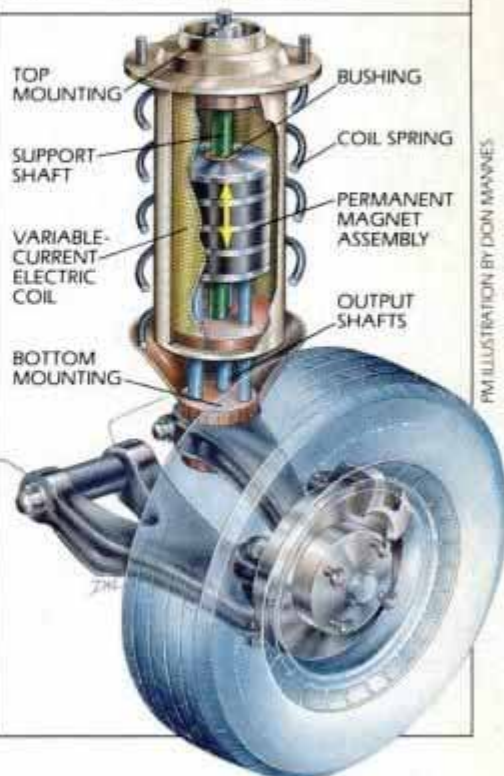
EL SEGUNDO, CA—A shock absorber that controls wheel motion with magnets will let a car ride like a Cadillac but handle like a Porsche, say its developers at Aura Systems. The effect would be like that of hydraulic active suspensions now on a few high-end cars, but would be far cheaper and simpler.

The magnetic actuator at the heart of the system is a piston within a cylinder, much like a conventional hydraulic shock absorber. But an electric coil lines the cylinder while the piston contains four permanent magnets.

Accelerometers in the car would detect unwanted motion and feed data into a computer. This processor would con-

trol electricity fed to the coil in each actuator, allowing the wheel to follow road contours.

A conventional coil spring supports the car's weight, so the actuator need produce only enough force to steady the car. A current prototype generates 500 pounds per wheel, but the next version should triple that.



**Magnet assembly slides up and down, gripped or released by electric coil as needed to smooth out ride.**

PM ILLUSTRATION BY DON MANNES

EASTPORT INTERNATIONAL PHOTOS AND ILLUSTRATION



**CURV III (left) and future version (above) on drawing board. Previous version surfaced Challenger wreck (below).**



## Navy's Deep-Salvage Drone

UPPER MARLBORO, MD—The Navy's deepest-diving salvage robots can now plunge 20,000 ft. beneath the sea, beating previous models by 6000 ft. The latest is called CURV III (for Cable-controlled Underwater Recovery Vehicle), built by Eastport International.

During sea trials, CURV III plunged to 20,100 ft. in the Puerto Rican Trench. An experimental vehicle operated by the Naval Ocean Sys-

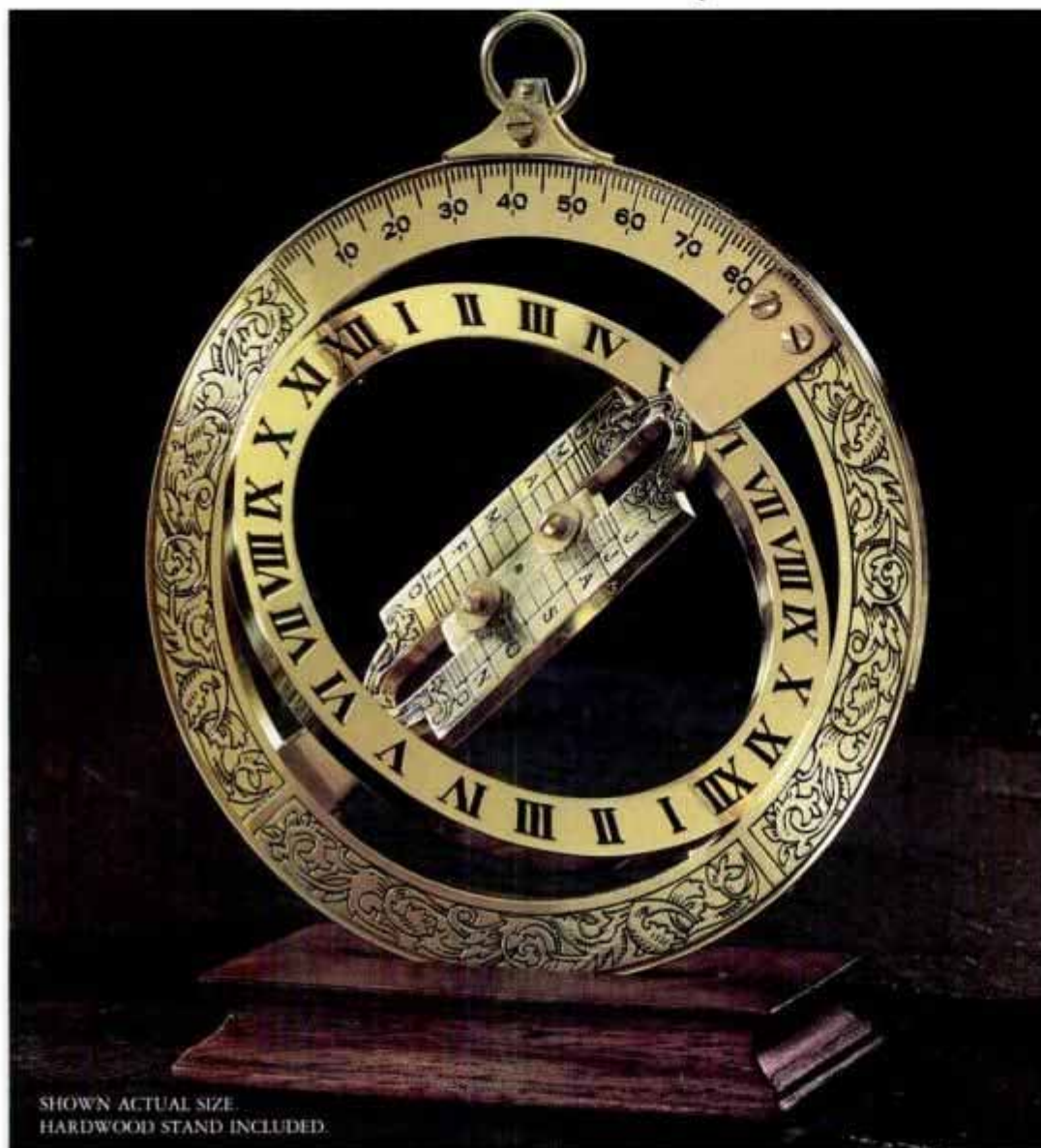
tems Center out of San Diego has since lowballed that record dive by 500 ft.

CURV III is substantially upgraded from an earlier 10,000-ft. version that recovered wreckage from the *Challenger*, among other exploits. Improvements include a new titanium pressure hull and autonomous depth and position control.

The new vehicle opens up 97 percent of the ocean's volume to salvage.



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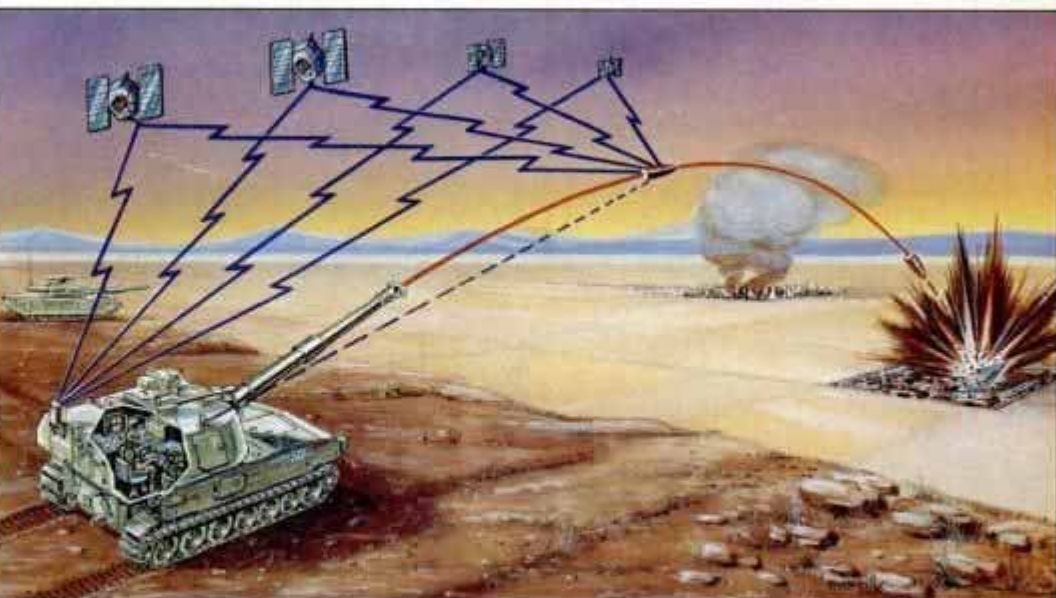
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## Satellite Fire Control

ABERDEEN, MD—Next-generation artillery shells may have the smarts to radio their trajectories back to a howitzer while in flight, enabling aim to be corrected before more rounds are fired.

The scenario calls for a Global Positioning System (GPS) receiver packaged in with the round's fuse. As the projectile arcs through its flight, it picks up continuous signals from three or more GPS satellites. Positioning data provided by the GPS signals bounce back to the howitzer's computer, via a radio transmitter in the fuse compartment.

The howitzer's computer pinpoints its own position by



PM ILLUSTRATION BY PAT RUGGERO

picking up GPS broadcasts directly. It then calculates the round's trajectory and uses the data to correct sub-

sequent firing rounds.

Three U.S. Army labs are collaborating to study the practicality of this scheme.

**Armed with a GPS receiver and S-band antenna, howitzer round radios its trajectory to gunner's computer.**

## Automatic Bicycle Transmission

SAN FRANCISCO, CA—A former auto racing engineer here has invented a bike transmission that uses a computer and a magnetic speed sensor to shift gears automatically.

The heart of the system is a 24-tooth, rear-wheel sprocket,

divided into six segments. Able to expand and contract into 11 discrete sizes, this system can produce 11 gear ratios without changing sprockets. Segments overlap with each other as the sprocket's diameter shrinks, like the iris plates of a camera

lens aperture, keeping a perfect-toothed circle for the chain to grip.

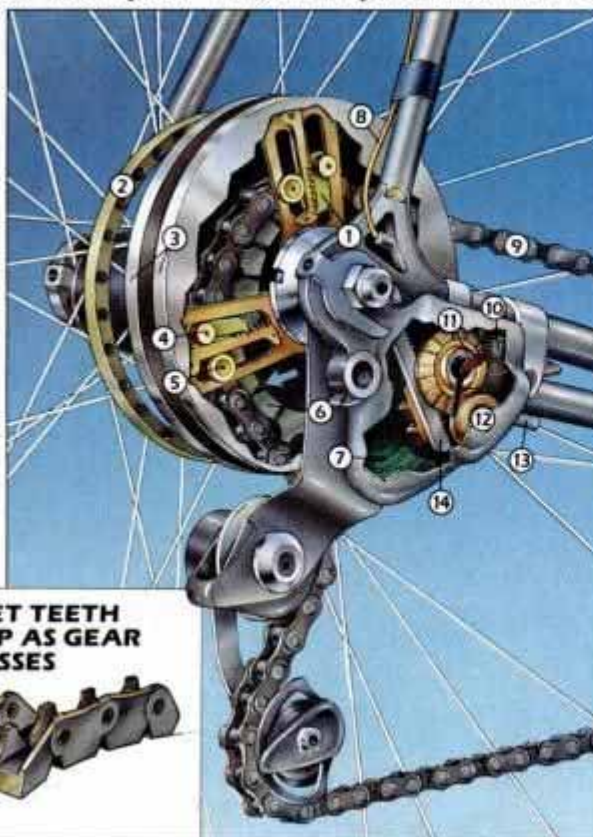
A computer under the seat governs these changes in sprocket diameter, based on data from a speed sensor on the rear-wheel hub. The aim is to keep the biker pedaling

at an efficient 75 rpm.

Inside the sprocket housing, a motor responds to signals from the computer by moving a gear selector. This in turn moves a guide pin, shifting the sprockets in or out when they aren't engaged by the chain. A ratchet mechanism locks the six segments in place until the

computer orders another gearshift. Inventor Keith Chilcote is designing a computer program that will allow a biker to customize his rpm to suit the terrain. If trials in Germany go well, the automatic bike transmission will become available in the United States in 1992.

- 1 SEGMENT-POSITION RATCHET LOCK
- 2 MAGNETIC SPEED SENSOR
- 3 SPROCKET HOUSING PLATES
- 4 RATCHET PILOT PIN
- 5 SPROCKET-SEGMENT GUIDE PIN
- 6 EXPANDING SPROCKET SEGMENT
- 7 PRINTED CIRCUIT BOARD



- 8 COMPUTER/DISPLAY PANEL CABLE
- 9 DRIVE CHAIN
- 10 MOTOR
- 11 SWEEP SWITCH
- 12 MANUAL-CONTROL GEAR
- 13 MANUAL-CONTROL LEVER
- 14 GEAR-SELECTOR RACK

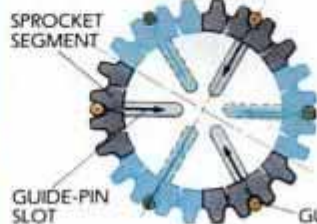


Expanding 6-segment sprocket is key to operation of automatic bike transmission. Sprocket grows from complete overlap to no overlap (bottom).

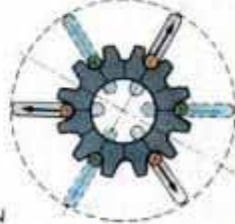
### SPROCKET TEETH OVERLAP AS GEAR COMPRESSES



### EXPANDED GEAR

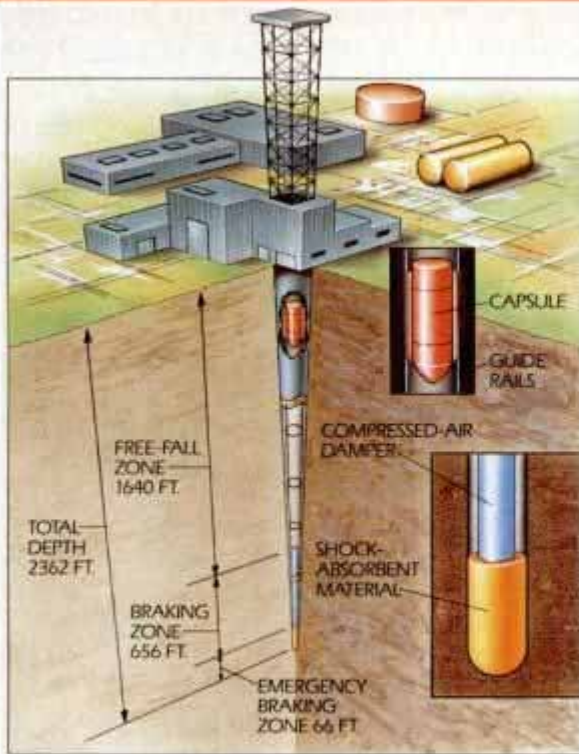


### COMPRESSED GEAR



PM ILLUSTRATIONS BY DON IMANINES

AUTRA-BIKE PHOTO



## Microgravity Mineshaft

**KAMISUNAGAWA, JAPAN**—Japanese companies appear so keen on exploring the industrial possibilities of microgravity that the government is sinking the world's longest drop-tower into an old coalmine shaft located on Hokkaido Island.

Starting next summer, 10 seconds of microgravity, at a bargain rate of \$600 per second, will be available on a first-come-first-drop basis.

Experimental capsules will free fall for 1640 ft., then decelerate through a compressed-air braking zone before being seized by a mechanical brake. As a fail-safe, 66 ft. of cushioning material

**Materials that collapse under normal gravity will form as they plunge down world's deepest free-fall shaft.**

underlies the brake.

A shorter drop-tower is also under construction near Tokyo. Approximately 320 ft. deep, the less ambitious project will use a bellows system for braking.

While waiting for the new drop-towers to be completed, Japanese materials engineers have been carrying out various experiments in NASA's KC-135 aircraft, which dips into parabolic loops for up to 20 seconds of weightlessness.

The drop-tower experiments will enable researchers to duplicate inexpensively the conditions in Japan's module on board Space Station *Freedom*. Supplementing these efforts will be suborbital launches of a small booster rocket to give up to 6 minutes of microgravity.

## Head-Up Computer For G.I.

**FORT MONMOUTH, NJ**—Military planners are putting new emphasis on individual troop technology. For example, the Army is developing a tiny computer that will extend command, control and communications down to the soldier level.

The system would consist of a belt-slung processor linked with a thumb-actuated joystick, a voice-input microphone and a small, flat-screen display that swings down from the helmet. Random-access memory in the

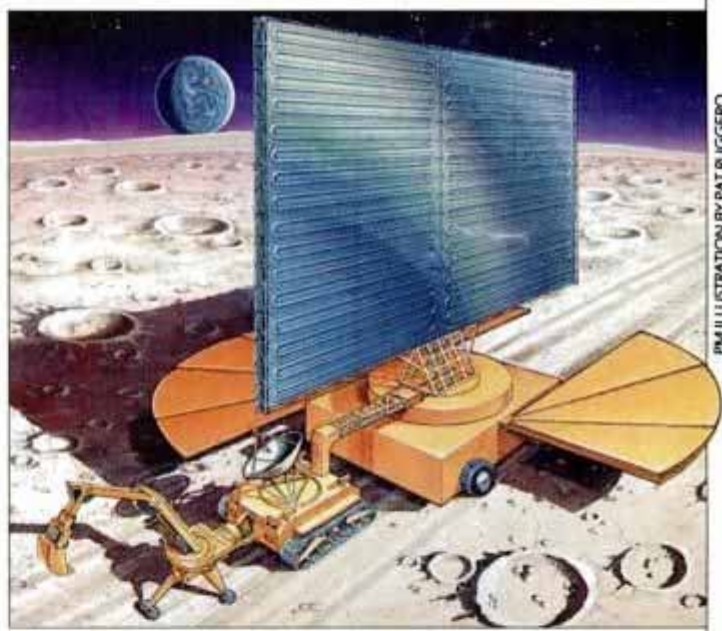
processor unit might hold such data as equipment maintenance instructions.

A data radio would enable soldiers and officers to relay information to each other across a local area network. The processor unit would also hook into a Global Positioning System (GPS) receiver and would superimpose position data onto a map for display.

The system's feasibility is currently under study at the Army's Communications-Electronics Command.



**Soldier's computer would feature 1-thumb operation, voice input, datastream radiolink to other personnel and GPS reception. The aim: to include individual soldiers in the command network.**



## Robot To Build Moon Base

**NORFOLK, VA**—NASA hopes that teleoperated robots can tackle the dirtiest work involved in erecting a permanent lunar station.

With space agency support, engineers at Old Dominion University are designing a remote-control heavy-construction vehicle.

An autonomous coupling interface will allow the vehicle to operate several tools, including a backhoe, bulldozer, grader and hoist.

Because the Moon lacks air to whisk heat from machinery, designers envision a huge

**Rover with backhoe tows heat-rejection trailer, shown with radiator raised and ground shades partially deployed.**

trailer with a movable radiator and folding shades to block ground-reflected sunlight. A telescoping truss would support coolant and power lines between trailer and vehicle, allowing the vehicle to rove about a site while the trailer remains stationary.


Currently, fuel-cell power is envisioned, but future research will focus on an alternative design using solar panels.

The Plymouth Voyager has been the world's best-selling minivan for seven years now.\* That's a tough act to follow. Unless of course, you add available all-wheel drive. Then following becomes much easier. Introducing the all new 1991 Plymouth Voyager. Its new all-wheel drive system provides superior straight-line acceleration and cornering, as well as better traction and handling under adverse conditions. It also improves your hill-climbing ability and makes

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\*Based on a 1984-1990 cumulative sales comparison of other manufacturers' minivans.  
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# ONE FOR SEVEN YEARS, WANT TO GO BUT UP.



1991 Plymouth Voyager now available with all-wheel drive.

## Voyage To The Sun

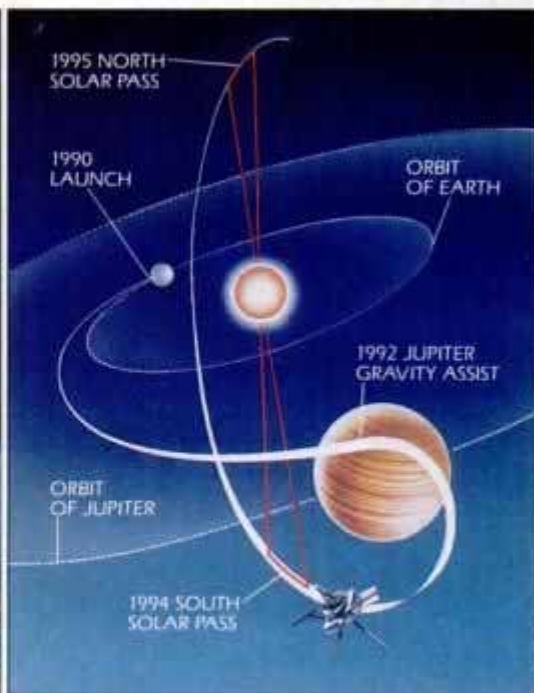
PASADENA, CA—Hurling faster than any man-made object in history, *Ulysses* is now on its way to Jupiter for a 1992 rendezvous. The big planet's gravity will then catapult the probe out of the solar system's orbital plane and into a perpendicular trajectory around the Sun.

A 2-rocket combo, merging boosters never before deployed together, put *Ulysses* into its 16-month, 34,000-mph trajectory.

The probe itself, made in Germany for the European Space Agency, will ultimately pass below and above the poles of the Sun. Although it will venture no closer than 130 million miles, it will provide an unprecedented glimpse of those regions.



*Ulysses* bristles with instruments to measure solar wind, radiation and magnetic fields.



The data will enlighten solar researchers, who are currently limited to studying the Sun's equatorial region.

*Ulysses* deployed from Shuttle *Discovery* last October (above left), before beginning on its Jupiter trajectory (above).

## Mixed-Breed Rockets

HUNTSVILLE, AL—Hoping to field a foolproof booster, NASA's suppliers are pushing to develop so-called hybrid rockets that combine the best attributes of solid- and liquid-fueled engines.

Current solid rockets, such as the Shuttle's twin boosters, burn rubbery fuel laced with an oxidizer. But hybrids house fuel and oxidizer in separate tanks, combining them only at the

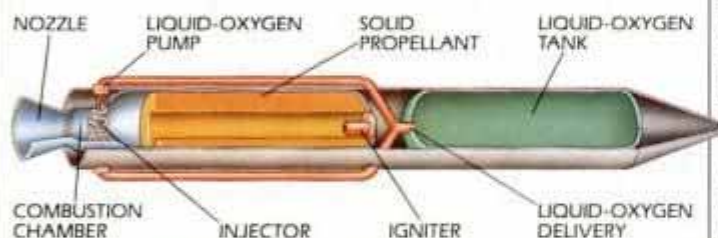
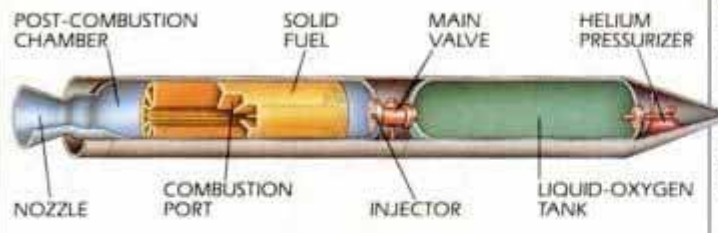
moment of combustion.

The advantages? A far smaller chance of explosion, no ozone-layer destruction and a booster that can be throttled.

Two approaches are under study. In the classic, or forward-injector hybrid, liquid oxygen sprays through solid fuel riddled with combustion ports. In the aft-injector variant, an igniter gasifies solid fuel with traces of oxidant. The gas burns with liquid oxygen pumped to an injector at the rocket's base.

So far, only a classic hybrid has been built—a 75,000-pound-thrust version tested by American Rocket Co. Rocketmakers are seeking funding to develop boosters with 40 times that thrust.

**Hybrids could be forward injected (top) or aft injected (middle). AMROC has test-fired the former (bottom).**



Sensor-laden robot practices mapping and avoiding unforeseen obstacles.

## Robot Maps Nuke Waste

ALBUQUERQUE, NM—Robots that clean radioactive waste from leaky storage tanks must think for themselves, because humans can't step in to rescue them from hidden obstacles.

At Sandia Labs, engineers have outfitted a gantry robot with ground-penetrating radar, active computer vision and enough computing power to convert everything it senses into a 3D map. The robot follows the map to stay away from buried snags.

Department of Energy officials plan to use the technology on trouble spots such as the Hanford, Washington, weapons plant.



AMERICAN ROCKET CO. PHOTO. PM ILLUSTRATIONS BY HANK IKEN

NASA PHOTO. PM ILLUSTRATION BY ADOLPH E. BROTMAN

SANDIA PHOTO



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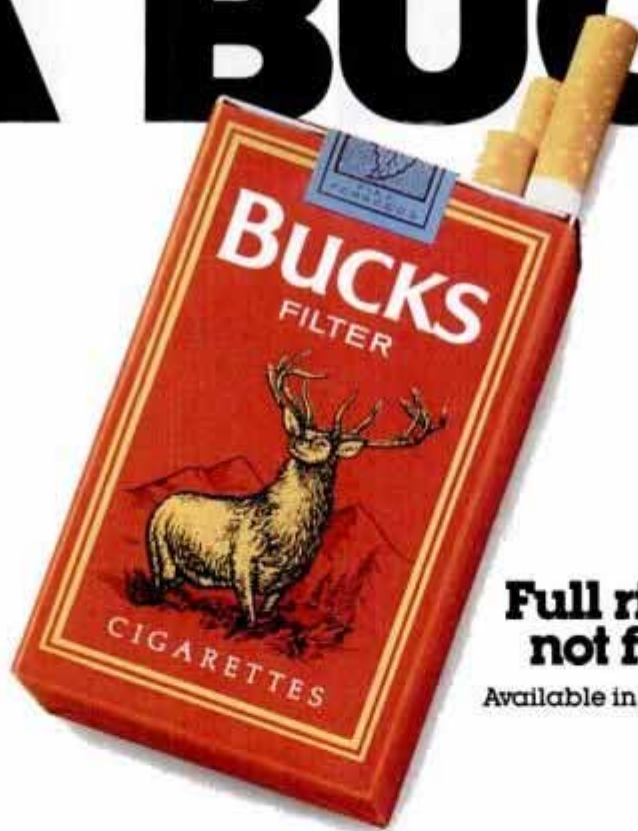
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COBRA 427SC  
EVERETT-MORRISON

# SPORTS CARS YOU BUILD YOURSELF

From classic Jaguars to storming Cobras, replica kits help you build your dream.

BY CLIFF GROMER

● Zero-to-100-mph-to-zero in 13 seconds! Sound like the newest megabuck exotic? Far from it. We're talking about the mid-'60s 427 Cobra—a car you could have bought from your local Ford dealer for about \$7000 and change. Oh, you can still pick up an original copy of one of the hottest sports cars of all time. Collectors are letting the competition model go—for about a million bucks a piece (give or take a few thousand).

Today, while some car enthusiasts simply dream about owning a Cobra, others are turning their dreams into reality by building one. The Ford Cobra, as a matter of fact, heads the list as the most popular homebuilt car on the market. Completed cars look startlingly close to the real thing, and they offer a viable investment with a track record of appreciating in value. They also take the worry out of having priceless bodywork rear-ended at a stop sign by some guy in a Fairmont.

As a matter of fact, there have been more Cobra replicas built in the past

18 or so years than there were originals. And unlike the originals, some of the homebuilts offer better handling and creature comforts—more suited to the street than the thinly disguised

DUCHESS  
CLASSIC ROADSTER

pure race cars that rolled off Carroll Shelby's assembly line.

But Cobras are only the tip of the homebuilt iceberg. An entire industry called specialty cars, commonly referred to as kit cars, has evolved. The industry offers everything from replicas of the classic sports legends, such as the '30s Auburns and Mercedes-Benzes, to the '50s MGs and Alldards to the '60s Austin-Healey 3000 to the '70s Lotus Elan to the up-to-the-minute Lamborghini Countach. If you really want something different, you can choose an original exotic-looking design that resembles nothing else on the planet.

Select a homebuilt to fit your specific budget, skill level and degree of patience. At one end of the spectrum is a completed turnkey automobile, fully custom built for you with your selection of drivetrain and options. At the other end, figure on receiving several large boxes on your doorstep containing a chassis, body, assorted hardware and an assembly manual. Here,



**SAXON  
CLASSIC ROADSTER**

you supply the drivetrain and possibly the interior, plus what may seem like endless hours of valuable labor.

Kit cars, like everything else, demand a good degree of consumer awareness. The quality of kits and components vary, and some manufacturers may throw you a low ball price. But bargains have a way of evaporating on closer inspection. And you may find that the basic kit consists of just a chassis and steering wheel—everything else being an extra-cost option. The rule of thumb here is to see exactly what you get for your money, check out the company's track record and, very important, talk to people who have bought the project car you're looking at. You want to be aware of any quality or construction problems and if it's even possible to build the car at all, before you plunk down your cash.

Kit car manufacturers, as we discovered, are for a good part a transient breed. Every time we turned around, some new guy was sending us



**MARLENE 500 K  
CLASSIC ROADSTER**

his brochure with the ink still wet, while others were disconnecting their phones and running for cover.

The sampling of cars shown here will give you an idea of the variety of homebuilt sportsters that are available. A complete directory of just about everybody in the business is available in *The Complete Guide To Specialty Cars* (see Source List on page 26).

### **Classics**

Classic and neo-classic replicas have a charm all their own. They harken back to the look of the '20s and '30s, and include models

that were produced in the '50s with '30s styling. Classic Roadster's Duchess—a knockoff of the 1952 MGTD—is an example of this. The T-series MGs became popular in the U.S. when they were brought back by returning WWII G.I.s. The Duchess, at \$7495, is Classic Roadster's lowest-priced kit, and you can build it from the chassis up. Drivetrain is either 4-cylinder Ford, GM or VW. No painting is required.

Turning the clock back even farther is Ironsmith's 1927 Bugatti Typ 35 Gran Prix. This little racer captures an age of speed and simplicity. Bugatti was one of the first race car builders to enclose the mechanical parts within an aesthetically pleasing, streamlined body. Kit features include a 50/50 weight distribution, custom jig-welded chassis with factory-installed suspension and drive-



**JAGUAR SS-100  
TIME MACHINE  
MOTOR CARS**

PHOTO BY RICH COX



**GT**  
ERA REPLICA AUTOMOBILES



**KMC 5000**  
KUSTOM MOTORCARS

train mounts. The engine bay offers room for a Four or V6, and the gelcoat fiberglass body needs no painting.

A classic buff's classic, that's the 1936 Mercedes-Benz 500 K. The model was born when screen star Marlene Dietrich commissioned Daimler-Benz to build her a car. Original examples are up in the \$2- to \$3-million bracket, but you can get Classic Roadster's Marlene 3/8-scale replica (easier to drive and park) for considerably less. As with Classic's other models, the chassis is based on a custom full-length box steel frame. You supply your own suspension components, or opt for Classic's suspension package. Designed to use the 302-cu.-in. Ford V8, the car is loaded with comfort features and has a removable hardtop. The gelcoat finished fiberglass body comes in 10 different colors.

Speed is the essence of a sports car,

and back in 1937, the Jaguar SS-100 could top 100 mph. That, plus catlike handling and a timeless profile, has made the car a coveted classic. Time Machine's replica uses a strong rectangular steel tubing frame, long wheelbase, authentic Lucas-style headlamps and choice of Four, V6 or V8 power.

If you are a real sports purist, the way to go is a bare-bones race car that can be driven to the race circuit on Sunday and then to work on Monday. That is the idea behind the Lotus Super-Seven. HS Engineering has captured the essence of this

split-personality machine with its Sabre Seven. The heart of the package is a TIG-welded tubular space frame that's capable of handling 100 to 300 horsepower. A competition-type suspension helps keep the greasy side down.

Less serious, but just as much fun is Burly Industries' Büffel Koupe 1937-40 Ford conversion of the lowly VW Beetle. You can add a front end, rear end or both. The former is a bolt-on operation, but you need to sharpen up the old hacksaw to cut off the rear of the roof for the rear-end treatment.

Hot rods are a special form of sports machine, and the mainstay of the hobby has been variations of the deuce coupe ('32 Ford). Total Performance's '32 highboy is just one of a line of '32s, plus other rods, in their catalog. Forget about chopping, channeling, sectioning, and so on. It's all done for you with a custom frame and fiberglass body. The '32 Ford coupe kit comes complete and is set up for a variety of engines. Just add flames.



**ULTIMA MK III**  
NOBLE MOTORSPORTS



**ALLARD J2X LASER  
HARDY MOTORS**

**SOURCE LIST**

- *The Complete Guide To Specialty Cars* (\$12), Homebuilt Publications, P.O. Box 4397, Glendale, CA 91202; (818) 244-5007
- Burly Industries, P.O. Box 10, Mendon, UT 84325; (801) 752-4359
- Everett-Morrison Motorcars, 5137 W. Clifton St., Tampa, FL 33634; (813) 887-5885
- Total Performance, Inc., Rt. 5, Wallingford, CT 06492; (203) 265-5067
- The Ironsmith, Inc., 9621 189th Ave., Forest Lake, MN 55025; (612) 464-2331
- HS Engineering, 3735 Transport, Unit C, Ventura, CA 93003; (805) 858-2500
- ERA Replica Automobiles, 608-612 E. Main St., New Britain, CT 06051; (203) 229-7968
- Classic Roadsters, Ltd., 1617 Main Ave., Fargo, ND 58103; (701) 293-8866
- Hardy Motors, P.O. Box 28338, San Diego, CA 92128; (619) 562-9660
- Richard Brengman, Noble Motorsports, 1317 Moffat St., Alviso, CA 95002; (408) 262-8249
- Time Machine Motor Cars, 9124 Sikkes-Cowpen Rd., Brooksville, FL 34601; (904) 796-6860
- Kustom Motorcars, P.O. Box 230, Hereford, TX 79045; (806) 364-1811



**'32 FORD COUPE  
TOTAL PERFORMANCE**

Ford Cobra—you'll find about a dozen different manufacturers, including Everett-Morrison, cranking out kits. E-M's 427SC style model uses a MIG-welded, 4-in. tubular steel ladder frame. You also have the choice of Mustang II, Jaguar or Corvette suspension and either Ford or Chevy small-block or big-block V8.

Equaling the Cobra's appeal is the Ford GT-40—one of the most formidable competition machines of the '60s, trouncing some of the world's most prestigious marques at tracks such as Daytona, Sebring and LeMans. ERA's GT, a faithful reproduction of the street version, uses a fiberglass body mounted on a semi-

monocoque chassis that's set up for small-block Ford power. All trim items are available from the factory.

**Exotics**

The Lamborghini Countach probed the outer limits of design and performance when it debuted in 1973. And its visceral impact hasn't diminished over the years. Kustom Motorcars KMC 5000 offers a very exacting replica that includes a complete platform package and fiberglass body. The custom chassis with semi-monocoque frame is set up for a 350 TPI Corvette engine hooked to a Porsche transaxle. Wheels, tires, radiators, and heating and air-conditioning systems are included.

If it's something unique you're looking for, the Ultima MK III from Noble Motorsports is an example of an original design in the exotic genre. Based on a race-bred chassis and suspension, the Ultima, weighing in at 1700 pounds, is a spirited performer with V6 or V8 power.

**PM**

**Contemporaries**

Back in 1962, the Austin-Healey 3000 was the big-man-on-campus, Ivy-League-favored sports car. But the car had big problems with excessive cabin heat, unreliable electrics and more. Classic Roadster has dumped the bugs and retained the nice parts with their Saxon replica. Powered by your choice of a 4-, 6- or 8-cylinder engine, it's available with amenities such as tilt wheel. The car is so popular, Classic is even exporting righthand-drive versions to England.

When it comes to the all-time favorite replica—the



**BUFFEL KOUPE  
BURLY INDUSTRIES**



**1927 BUGATTI  
TYP 35 GRAN PRIX  
THE IRONSMITH**



**SABRE SEVEN  
HS ENGINEERING**

## PROJECT



PHOTO BY RICH COX

# GETTING IT ALL TOGETHER

Your Quality Is Job One.

BY CLIFF GROMER

● Drive the dream! Kit car brochures and salespeople make it sound easy. Too easy. A couple of weekends and a screwdriver, and there you are—soaking up the sunshine in a top-down sports car, drawing envious looks from everyone in sight. It doesn't happen that way. Homebuilts have their problems and pitfalls. The hard fact is that only a small percentage of kits that are started is ever completed. The half-baked remains are usually relegated to a corner in the back of the garage as the cornerstone for piles of unwanted home furnishings and Christmas ornaments. Or, the project gets blown out at a bargain price through a classified ad. Kit car publications are loaded with them.

On the other hand, many of today's kit cars *are* easier to build than earlier versions. They are more complete, so there's less actual fabricating on your part. Advanced manufacturing techniques and quality control assure better fit and finish.

Detailed assembly manuals break



Miami Spyder features Ferrari look.

the job down into bite-sized subassemblies and systems. In many cases, components come predrilled and prewelded so critical alignments are factory assured.

Completed cars are not only fun to tool around in, but can often be turned for a healthy profit if it became necessary to sell. Some models, notably the Cobras, are real hot movers, but nostalgia plays a big part in a model's popularity and subsequent value. Quality of the kit and your workmanship also figure into the value equation.

To find out what's involved in putting together a typical kit car, we asked Carl Roberts, of Roberts Motor Cars (2596 Bloomingdale Pike, Kingsport, TN 37660; (615) 288-5421), to build one for us. Roberts manufactures several component car packages, including the Miami Spyder that you see here. The Miami Spyder bears more than a passing resemblance to a Ferrari Daytona Spyder and is one of several Ferrari look-alikes on the market. Ferrari itself doesn't buy the old adage of imitation being the sincerest form of flattery, and has gone to court for a fistful of cease and desist orders. Which means if you're looking at one of these Enzo-mobiles, check with the company on its legal status. Don't be left at the starting line because the kit manufacturer was suddenly put out of business. Roberts tells us that he is involved in a legal battle with Ferrari, but expects to be able to crank out Spyderys in early '91.

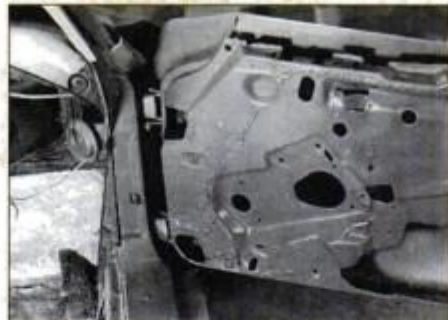
As with any homebuilt, you have to

PHOTO BY BILL ASH

# GETTING IT ALL TOGETHER



Front clip is removed as a unit after cutting cowl area and separating fenders from cowl by prying apart factory epoxy bond.



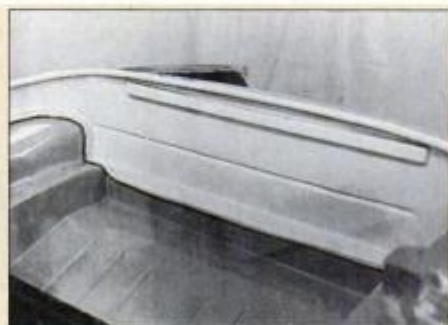
Doors are removed. Stock wiring (for electric windows), hinges and jamba simplify re-installation and alignment.



Front frame extension bolts onto chassis. Header support rod attaches to nose and is used in aligning body.



Lightweight, handmade, 1-piece reinforced body is lowered onto chassis and secured by stock mounts.



Rear bulkhead finishes off rear of cockpit and mounts convertible top cable and trunk hinges.



Front inner fenders anchor body to chassis along with header support rods that attach to front frame extension.

come up with everything needed to complete the project that's not supplied by the kit manufacturer. Since our Miami Spyder is a body/interior conversion based on the 1968-'82 Corvette, we obviously needed a Corvette to get our project rolling. A 1976 Corvette T-top in decent shape filled the bill. The key was finding a car with a sound frame (straight and no rot) and tight chassis at the right price. We paid \$3800 for ours. The mechanicals—drivetrain, trailing arms and brakes—are more important than body condition as the stock exterior is removed anyway, and the car will only ride as good as the chassis. If your Vette does have a good body, you'll find a ready market for the parts that you replace—provided you don't follow the rip-and-strip school of auto bodywork.

## Check it out

It's important to go over the chassis to make sure everything is in top condition. Now's the time to repair, refurbish or replace questionable items. Check out everything, including hoses and brake and fuel lines. This is where you build reliability and safety into your project. We upgraded handling with suspension components from Vette Brakes. We also used its stainless-steel brake calipers and brake accessories.

Roberts' kit will work with any Chevy V8. Since the 350-cube small-block in the Vette was well up in miles and ready for the old-engine retire-

ment home, Chevrolet provided us with a 5-liter 305-cu.-in. V8—complete with tuned port injection—that came out of a Camaro. Replacement engine components and accessories from B&M Automotive Products, Lingenfelter Racing and Digital Fuel Injection gave us some help in the show-and-go department.

A green puddle under our car told us our radiator was out to lunch, so we picked up a replacement from Modine.

A special wiring harness supplied by Howell Engine Developments allowed us to run the engine without the electronic control module (on-board computer) needed by TPI-equipped production vehicles.

The Miami Spyder Phase I exterior package sells for \$8995, and comes with everything you need to convert a 1968-'82 Corvette into a Miami Spyder, less wheels and tires.

The entire project will take a trained body man about 80 to 120 hours to complete. Figure two or three times as long for someone not in the business.

Wheel choice is a matter of personal taste, and we liked the set offered by Momo, as it was attractive and looked a lot like the original Campagnolos that came on Ferrari Daytonas. We also tried on a set of Zenith wire wheels that resemble the Borrani wires that were optional on Ferraris. Rolling stock was rounded out with a set of 245/50VR16 Goodyear Eagle VR Gatorbacks.

## Insert tab A into slot B

Roberts started by taking the Vette down to its chassis and passenger compartment tubs (floor pans). Doors and hood unbolt easily, as do the grilles and light assemblies and hardware. But removing the entire nose or front clip—from the cowl forward to the bumper—takes some doing. He unbolted the front frame extension and removed the bolts from the sides of the radiator support located under the front wheel-well housings. After cutting the cowl area, the factory-bonded front end can be removed by prying the fenders loose from the cowl and along the back edge of the fenders with a putty knife. A heat gun is first used to soften up the bonding strip. The windshield and cowl remain in place. The front clip will lift off after unplugging the factory wiring harness at the left side of the cowl and the vacuum lines that go to the headlights.

The entire rear clip is also removed as a unit. Drill out the rivets in the lower part of the floor pan at the rear of the B-pillar. Remove the door striker pins and the bumper energy absorbers. T-top models have the center bar spot welded to the upper windshield frame and B-pillars. Drill out the spot welds and cut the outside edge of the door jamb from under the step plate all the way up to the top of the B-pillar. Then, unbolt the two body mounts at the rear of the frame and disconnect the taillights. Lift off the rear clip and tub section, which



Rear clip consists of nine separate fiberglass components bonded together, and is removed as a unit.



Rear chassis is modified by lowering cross-rails to accept new rear tub and bolting on a frame extension.



Rear tub assembly installs in stock location of original tub. Note the well in trunk area for 16-in. spare tire.



Inner fenders are held in place by self-tapping screws and later bonded. They also attach to the radiator support.



Metal door assembly is modified by cutting components with a die grinder and then re-assembling. Welding is necessary.



Modified door with repositioned crash beam is test fitted on car. New skin is bonded on to match body contours.

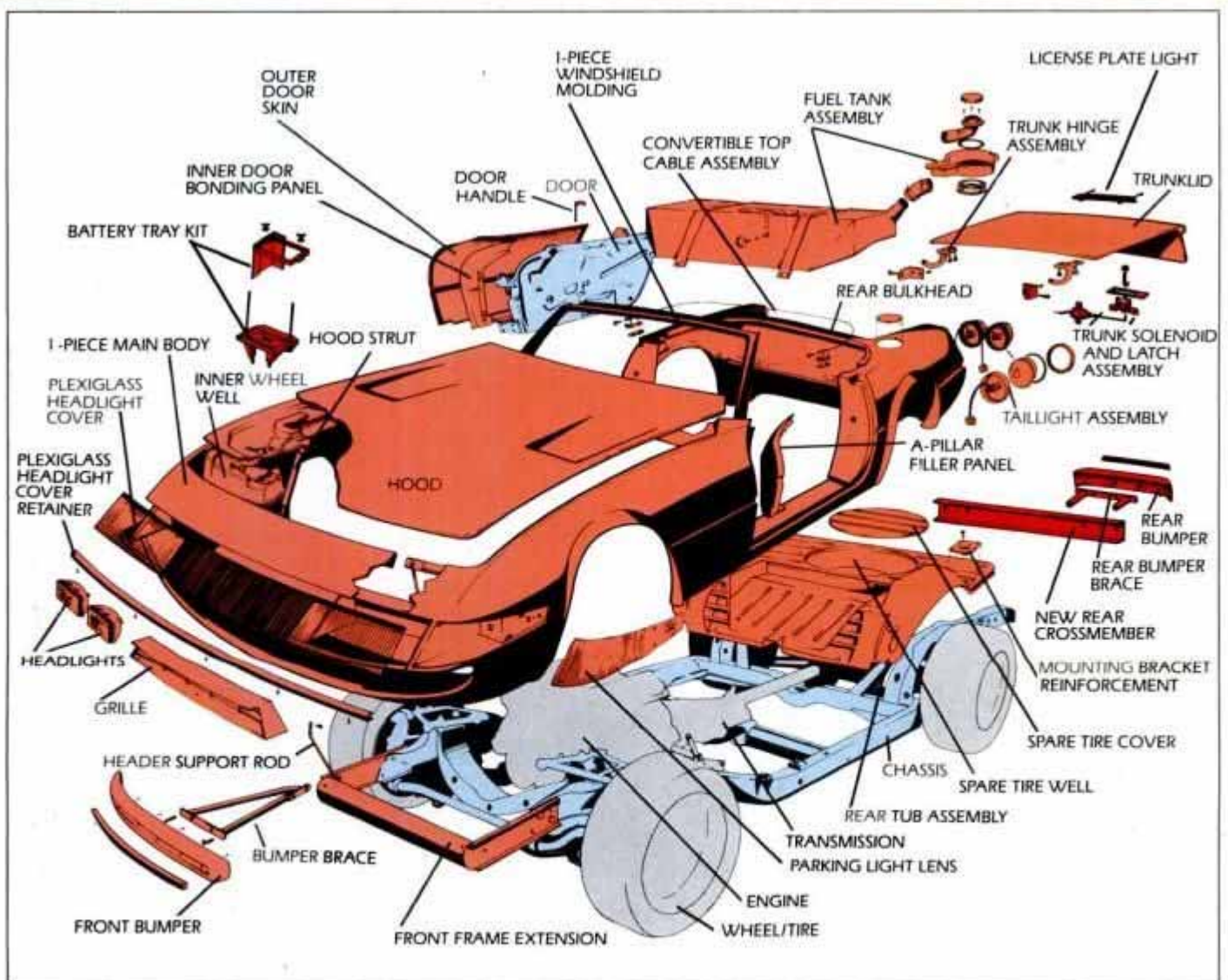


PHOTO ILLUSTRATION BY MIKE WILLIAMS/ROBERTS MOTOR CARS

## GETTING IT ALL TOGETHER



PHOTO BY RICH COX  
PHOTO BY BELLAHE

Sexy, Euro lines of the Miami Spyder are a real headturner. Dash and gauge cluster is part of standard interior package. High-impact color leather seats are optional. Chevy 305-cu.-in. V8 uses a special wiring harness for injection system to work without computer.

consists of about nine different fiberglass components bonded together in a single section. Then remove the gas tank and straps.

Modifications to the stock chassis are minor and consist of cutting the top of the B-pillars to accept the new body. A front frame extension is bolted to the subframe chassis to support the new bumper assembly. Two header support rods brace the nose and aid in aligning the hood.

Rear frame crossrails on '68-'79 models are dropped 2 in. to accept the new rear tub section and to allow for the 16-in. hidden spare tire which lies flat in the trunk. The rear of the chassis is cut to accept a new rear cross-member, which bolts to the chassis and is predrilled to mount the rear bumper braces and bumper, trunk latch assembly and solenoid. The 1-piece main body, minus hood and trunklid, weighs about 115 pounds and can be lowered onto the chassis by three people.

### Full-body support

The body itself is handmade of fiberglass and reinforced with core mat—a sandwich material that gives structural support, but prevents the weave of the material from showing through on the surface (readout). The 1-piece body construction eliminates the need for any bonding application to the exterior and the need to align the door openings.

You can flex the body at the rocker

panel and slide it down onto the chassis. The rear section lowers first, and then the nose, which is supported by header support rods attached to the front frame extension.

As the front comes down, the front inner fenders are held in place temporarily with self-tapping screws until they are permanently bonded. The hood hinges are installed next and the hood is aligned. The job is simplified because holes are predrilled.

Once the hood is aligned to fit the opening, you are ready to bolt your inner fenders to the side of the radiator support.

Moving to the rear deck, the rear bulkhead is bonded between the upper body panel and the rear tub section. The bulkhead finishes off the rear of the cockpit, and mounts the trunk hinges and the convertible top cable. Hinge brackets are installed for the rear decklid, which is attached and aligned.

The trickiest part of building the car is the doors. The stock doors have to be modified to fit the contours of the new body. After removing the doors from the car and removing the inside door panel, you have to separate the outer fiberglass skin from the inner metal frame. This is done by heating the metal frame to soften the epoxy bond, and using a hammer and putty knife to break the bond.

The metal frame is cut with a die grinder according to templates supplied, and the crash beam is repositioned.

Some welding is necessary when reassembling the metal frame. A special bonding panel holds the new outer door skin to the metal frame. The door is installed and aligned in the opening, using thin paint-stirring sticks to get an even gap all around. A body filler panel installs between the front fender and the door to fill the gap created by the new contour.

The convertible top frame goes on next, and the stainless-steel bumpers mount on braces that bolt to the new frame members. The Lexan headlight cover is then installed and secured by the front retainer.

Much of the original stock wiring is retained, but ours was worn so we replaced it with a new harness from Dr. K's wiring.

You have a choice of keeping the stock Corvette interior, or going with something a bit more European-looking, such as Roberts' Miami Spyder Phase II interior package for \$2695. It comes complete (with gauges), less steering wheel, seats, carpet and upholstery. We went for the optional leather seats and wool carpet. We also ordered a neat-looking Nardi steering wheel from Electrodyne.

Roberts' Eurostyle S.S. shifter, and his instrument panel, with its classic white needles and numerals on black face dials, give the cockpit a totally new personality. Drive one of these machines and we guarantee that you'll take on a new personality, too.

PM



COMPARISON TEST

# RANGE WAR

Manufacturers say cordless phones are better than ever. We test 10 to find out if they're right.

PM PHOTO BY ROY ATTAWAY

BY FRANK VIZARD, Electronics Editor  
and FRANK C. BARR, President,  
Advanced Product Evaluation Laboratories

• Cordless telephones promised to cut the umbilical cord that tied us to within a few feet of a table or wall while we talked. The price of freedom, though, was often poor reception, interference and a limited range that just felt like a longer leash.

True freedom is now promised by a new generation of cordless phones. These new models, say the manufacturers, incorporate new circuitry, yielding sound quality comparable to traditional corded models. And because these phones are quieter, their useful range should increase as well.

To evaluate these claims, PM put 10 cordless phones to the test. The models picked vary in price from \$120 to \$230. Price variations





mostly had to do with the number and type of convenience features offered. Some of these features do become the primary reason for purchasing a product. One model tested includes an answering machine, for example, while two offer an intercom that could be used to monitor a nursery.

While convenience features can help you differentiate between competing products, a more difficult aspect to evaluate is the feature that first got you interested in purchasing

a cordless phone: usable range.

In preparing for our range war, PM first put each phone through a series of standardized tests that checked basic operation—tests that all 10 models passed. All the cordless phones were charged according to manufacturers' instructions prior to making any measurements.

Field testing was done in a large area approximately 1500 × 600 ft. The field was devoid of trees or large metal objects that might cause interfer-

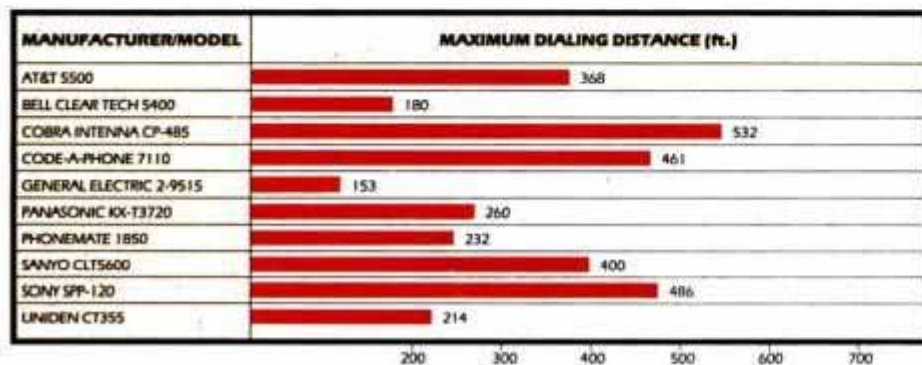
ence. The results of the field testing for range and sound quality are shown in the accompanying graphs. The graphs for Maximum Dialing Distance and Maximum Distance On/Off show how far away from the base station you can be while still being able to dial out or turn the phone on or off.

Sound quality is evident in the Maximum Signal Strength graph. The 82 dBA cutoff figure corresponds to the point where communication between the handset and the base station was unacceptable due to high background noise levels.

Only half the cordless phones PM tested have an audible alarm to warn you when you are getting out of range of the base station. The five models with alarms are the AT&T 5500, General Electric 2-9515, Northwestern Bell Clear Tech 5400, PhoneMate 1850 and Sanyo CLT5600.

### 10-to-1 odds

While there is no direct correlation to range or sound quality, it's clear some



SANYO  
CLT5600



AT&T  
5500



NORTHWESTERN BELL  
CLEAR TECH 5400



SONY  
SPP-120



GENERAL ELECTRIC  
2-9515



cordless phones should have an easier time making a connection than others. The Federal Communications Commission (FCC) allotted only 10 radio channels for cordless phones. As cordless phone use increases, the chances of two cordless phones vying for the same channel grow dramatically.

Half of the models PM tested could switch among all 10 channels to find the best line of communication. The Cobra CP-485 offers a choice of three channels, and the GE 2-9515 has two. The Code-A-Phone 7110, PhoneMate 1850 and Uniden CT355 offer only one channel.

A more mundane but equally important concern is knowing when there is an incoming call. The GE, PhoneMate and Panasonic KX-T3720 have no ringer on the base station.

Of those cordless phones with a ringer on the base station, the Code-A-Phone 7110 and the Uniden CT355 have the loudest ringers. Both base station ringers for these phones measured 89 dBA at a distance of 1 meter.

The lowest ring belonged to the Sanyo CLT5600 which measured 64 dBA.

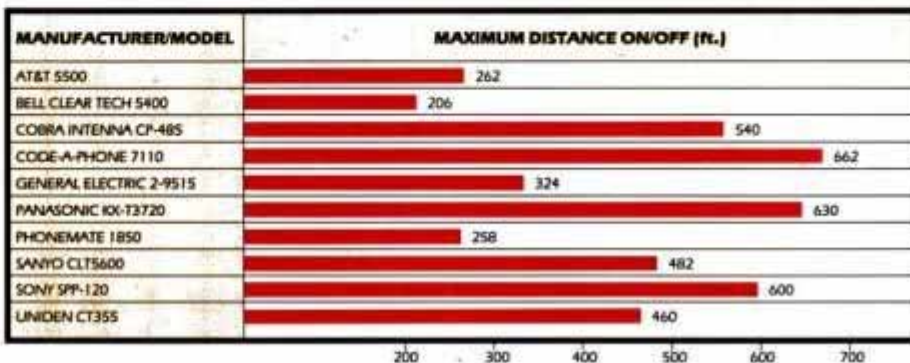
All of the handsets include ringers. The handsets for the PhoneMate 1850 and Sanyo CLT5600 both have low- and high-volume switches. There is a 9 and 8 dBA difference, respectively, between each position.

In any event, the ringers on the handsets of the Code-A-Phone 7110 and Uniden CT355 were also the loudest. Both handsets registered 87 dBA levels in our tests. The Panasonic KX-

T3720 registered the lowest with a 68 dBA reading. The PhoneMate 1850 registered 60 dBA in the low-volume position.

One last problem being tackled by the new generation of cordless phones is the piracy issue. With older cordless phones, unauthorized calls could sometimes be made through another base station. All of the cordless phones tested offer some type of electronic security to prevent piracy.

The level of security does vary,



## RANGE WAR

however. The AT&T 5500, Northwestern Bell Clear Tech 5400, PhoneMate 1850 and Sony SPP-120 use thousands of security codes that are automatically and randomly applied to transmissions between the handset and base station. The other samples in our group offer fewer codes—often only one or two—and they must be adjusted manually, if at all.

### PM picks

What follows is a ranking of the 10 cordless phone samples PM tested, their list prices and some comments concerning each one.

**AT&T 5500, \$230**—The 5500 is the best all-around performer of the cordless phones PM tested. While the range wasn't always the best, sound quality was consistently clear. Both the included speakerphone and intercom operated cleanly as well. Both the handset and base station have keypads.

**Sony SPP-120, \$230**—The SPP-120 performed very well in all tests. Its most interesting characteristic, though, is the battery. Cordless phones are typically recharged when the handset is placed in its cradle. Sony, however, supplies two batteries. One works in the handset, while the second lies freshly charged in the base station. Each battery holds its charge for about one week. Unlike the other models tested, you bear the responsibility of keeping the handset charged.

**Sanyo CLT5600, \$120**—Along with the Sony SPP-120, the CLT5600 scans the available 10 channels automatically. These two models are the only cordless phones in our group with this feature. The CLT5600 is also

just one of three models in the group to have low- and high-volume settings, the former being used to increase signal strength if necessary.

**Uniden CT355, \$130**—With only a single channel available, the CT355 may not seem to be on the cutting edge of technology. Well, it's not. This is a basic cordless phone with few frills. Yet, the sound quality is very good, and the range is exceptional.

**Panasonic KX-T3720, \$130**—While the KX-T3720 gives you a pick of 10 channels, no channel number is displayed. This makes it difficult to learn which channels are clearest in your area. Of the 10 models tested, only the KX-T3720's handset antenna does not retract fully.

**Cobra Intenna CP-485, \$230**—This is the only cordless phone in the group with no external antenna. At its maximum operating distance, the CP-485 is a tad noisier than most others, but its performance is quite remarkable for a cordless phone with an internal antenna.

**General Electric 2-9515, \$130**—From a performance standpoint, the dial-out range is disappointing, particularly considering the signal range. The 2-9515 is the only one of the 10 tested that comes with a separate recharging cradle. This means the handset can be placed far from the base station and still be recharged.

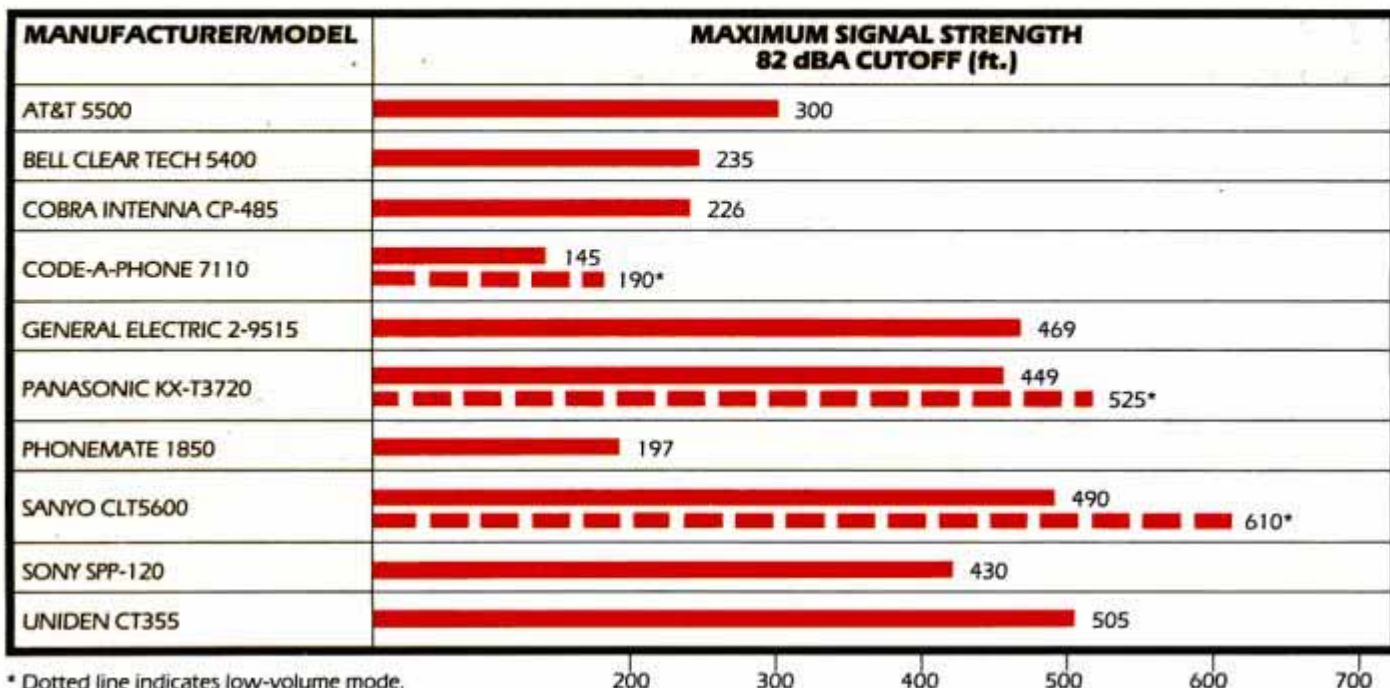
**Code-A-Phone 7110, \$130**—While the on/off range is very high, so is the accompanying noise level. This model has only one channel for handset-to-base-station communication. This is also the only model in the group that doesn't offer memory capability for storing favorite phone numbers. The 7110 also requires an optional kit for

wall mounting. On the plus side, both the handset and base station have keypads. The speakerphone and intercom functions also work well.

**PhoneMate 1850, \$230**—The product design is somewhat futuristic, but this is an uncomfortable future. The handset is large and awkward. Sound quality is relatively poor, and the overall construction quality could be better. The 1850 does include an answering machine, but this feature alone doesn't compensate for its performance as a telephone.

**Northwestern Bell Clear Tech 5400, \$170**—This phone offers the most problems of any in the group. In maximum range tests, the results were not always repeatable. The 5400 has both a low- and high-volume switch. In the low position, the phone would shut itself off before our 82 dBA threshold was reached. Our graphs show results for the high position only. The maximum signal strength range figure is also about the point where the phone shut itself off while operating in the high position. Once out of range, communication between the handset and base station wouldn't resume until both were within close proximity of each other.

Based on PM's test, the promise of corded sound quality for cordless models is kept by some manufacturers better than others. If you don't plan to stray too far from the base station, then all the samples in our test perform adequately. But if you're planning to romp around the backyard, range becomes a big issue. If a lesson can be learned from this test, it's that range varies considerably among the samples tested and, presumably, among all models. **PM**



## TECHNOLOGY



# NEW-AGE DENTISTRY

Dentistry isn't the same old drill anymore, with lasers, computers and other high-tech tools working together to make pain obsolete.

BY OLIVER FULTZ

● Since ancient times, dentistry has been nearly synonymous with pain. And being no more fond of suffering than anyone, 30 to 40 million Americans make a habit of ignoring those cheerful reminders mailed out by the dentist's office at checkup time. A

surprising number won't be swayed until they start losing their teeth. But there's new hope for the fearful.

After years of neglect, during which researchers focused on more life-threatening diseases, exciting new systems are finally reaching the dental arena. With these high-tech tools in hand, dentists are finding

Futuristic dental suite incorporates laser, AcuCam and radiovisiography machine—all of which are currently available.

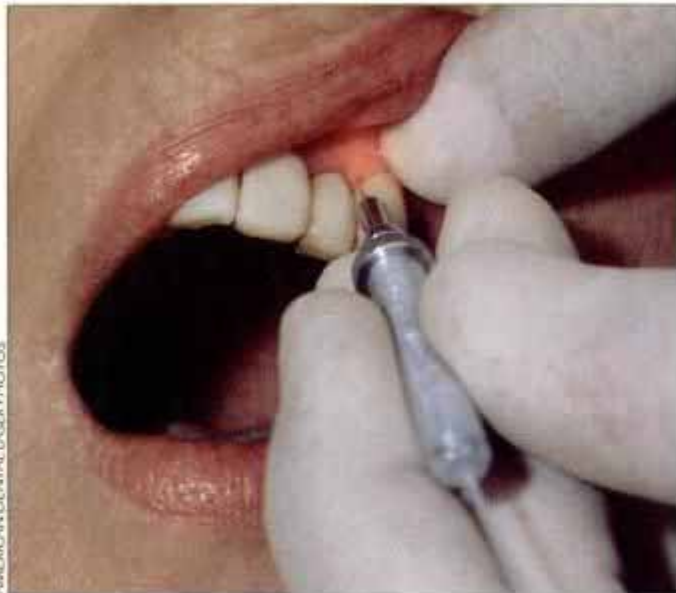
they need no longer be quite so cruel to be kind to your teeth.

Today, cavities can be treated with lasers that silently vaporize tooth decay, patients can have their teeth checked by an X-ray probe that instantly creates crystal-clear pictures without film and with far less radiation, and crowns can be made by computer-controlled milling machines, which eliminate the need for impressions made by wearing goo-filled bite-plates. If all this fails, unsalvageable teeth can be replaced with titanium implants that are stronger than natural teeth.

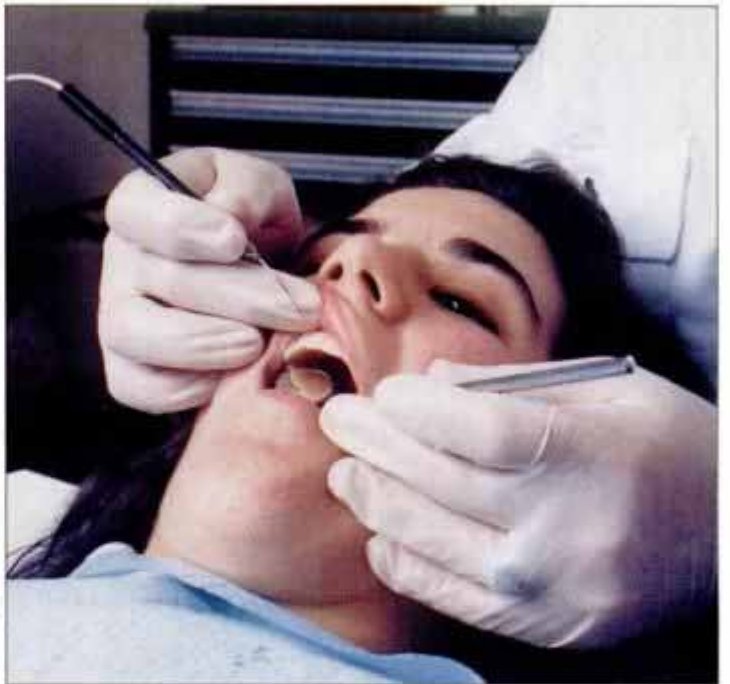
### TV teeth

Despite these new developments, treatment still begins with a trip

# NEW-AGE DENTISTRY



Little larger than a personal computer, the laser (right) sends power to tiny handpieces (above and above right).



to the dentist's office. The well-equipped practitioner can now start the examination by surveying your teeth with a tiny color video camera. No larger than a dental mirror, these intraoral cameras can be used for diagnosis or to provide real-time information during complicated dental work.

One such system, the DentaCam from Fuji Optical Systems, has a wide-angle lens that enables its camera to visualize areas ranging from a single tooth to a full upper or lower arch. Because it has its own light source, the DentaCam can peer into the darkest recesses, even when the mouth is completely shut. An air jet built into the handset prevents fogging and keeps debris from blocking



Dentists need no longer be so cruel to be kind.

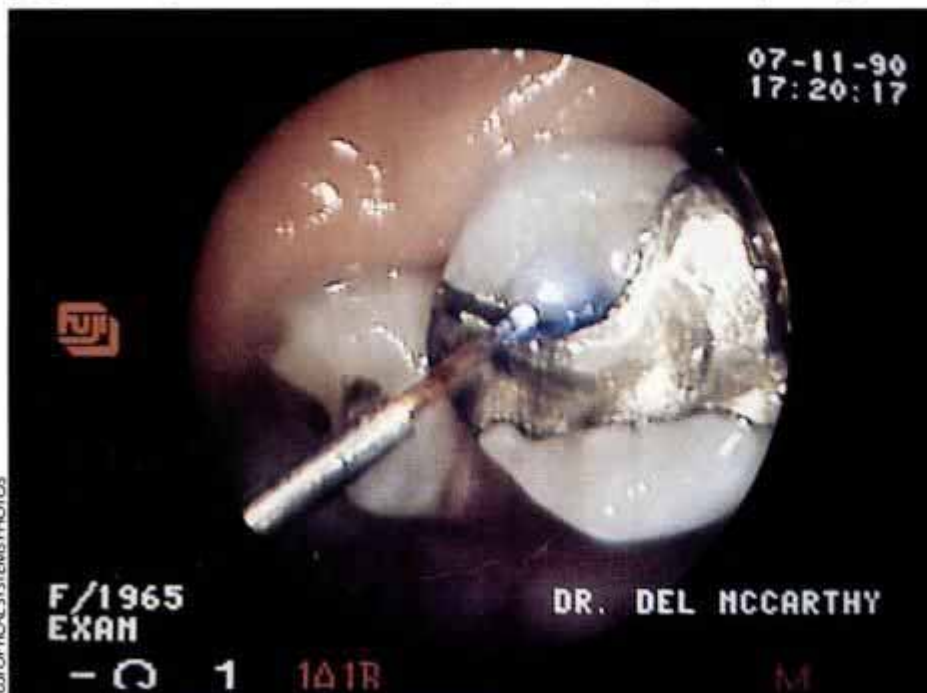
the lens. Images from the camera appear magnified 18 times on a high-resolution color monitor.

The DentaCam can also permanently save images. It comes with a video recorder that can record an entire examination, so the dentist can send a videotape home with the patient or keep one at the office for his records.

In an attempt to bring such systems

into wider use, a newer, lighter dental video system, the AcuCam, has just reached the market. Its developer, Michael Williams, president and founder of AcuImage Corporation of San Carlos, California, also worked on the Fuji system. He was able to develop a lightweight, less-expensive dental video system by borrowing technology already developed for consumer video cameras.

"The processor of the AcuCam weighs about 2 pounds, and the camera is about half an ounce," says Williams. "While other systems are pushed around on large carts, the AcuCam is very portable." He adds that the price is about half to a third the price of other intraoral camera systems on the market.



Tiny light, air jet and video camera are incorporated in Fuji DentaCam (above), which produced the image at left.

AMERICAN DENTAL LASER PHOTOS

FUJI OPTICAL SYSTEMS PHOTOS

Unlike the Fuji camera, the Acu-Cam doesn't need its own light source. Williams says he set the lux power to range between 3 and 10 lux, "so it can be used with overhead ambient light or just a dental chair light." Such simple, low-cost systems may be the key to getting intraoral cameras into more dentists' offices.

### Low-dose X-rays

Even something as familiar as dental X-ray film may now be obsolete, thanks to a new technology called radiovisiography (RVG) developed by Dr. Francis Moyen and manufactured by Trophy Radiology in Vincennes, France. Its high-resolution images improve the dentist's ability to make accurate diagnoses, while reducing the amount of radiation that patients and technicians are exposed to during the examination.

The heart of RVG technology is a

need for interruptions while waiting for processing.

### Lasers against pain

Once a cavity has been found, is it time for the dreaded drill? Not if your dentist uses the latest in dental technology—the American Dental Laser. This neodymium yttrium aluminum garnet (Nd:Yag) laser is the first approved by the Food and Drug Administration for dental use.

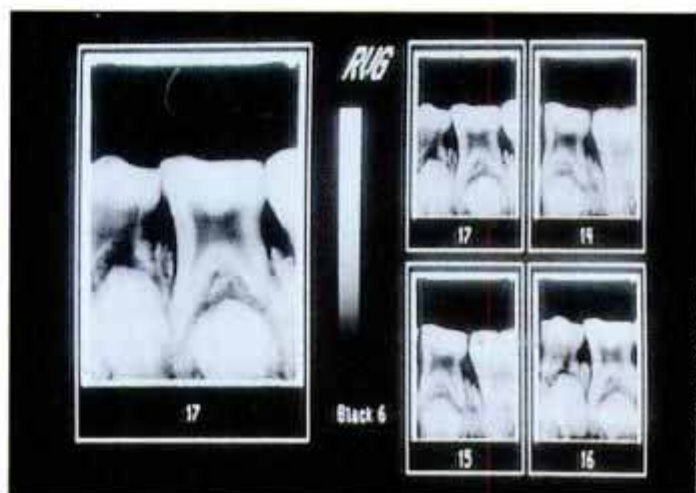
Patients report experiencing less pain when being operated on with the dental laser than with drills. Part of the reason for this is that the laser does not cause many of the psychological components of pain. The loathsome whining noise and vibrations associated with conventional dentist drills are absent. In addition, the laser beam is delivered in pulses that last only 30-trillionths of a second, which is much less than the time need-

involved in many procedures. And, while the speed of the procedure is comparable to traditional methods, the manufacturer claims lasers offer superior accuracy.

### Robo teeth

Suppose a tooth is totalled beyond repair. Years of junk food have taken their toll. Time for a replacement. An expensive but increasingly popular alternative to dentures is the titanium dental implant, a remarkably strong, naturally functioning permanent tooth prosthesis.

To begin the installation, your dentist creates a hole in your jaw at the site of the missing tooth and fills it with a tight-fitting titanium cylinder. Within three to six months, the bone and gum tissue grow around the cylinder, anchoring it firmly in place. At this point, the top of the implant is surgically exposed, and an artificial



Radiovisiography uses conventional X-ray machine set at low intensity to reduce radiation exposure (left). The images that result can be manipulated by computer (above).

small X-ray sensor, which is positioned in the patient's mouth in place of conventional X-ray film. A standard X-ray unit is used to expose the sensor to X-rays, but because of the sensor's high sensitivity, the radiation used is 80 percent less than that needed to make an image on traditional X-ray film.

After the exposure is made, X-ray images appear instantly on a video monitor where they can be viewed by the dentist and the patient simultaneously. A printer produces hard copy for patient records.

Unlike regular X-ray films, image data from RVG can be electronically manipulated to bring out diagnostic information. Specific areas of the radiograph can be enlarged by up to a factor of four. A split-screen feature allows several images to be viewed simultaneously. And images can be made during treatment, so there is no

ed to trigger a pain nerve.

The manufacturer stresses that the American Dental Laser is not just for cavities, but is also an important tool for treating diseases of the gums. "Gum disease is the major unsolved problem in dentistry today," says Bob

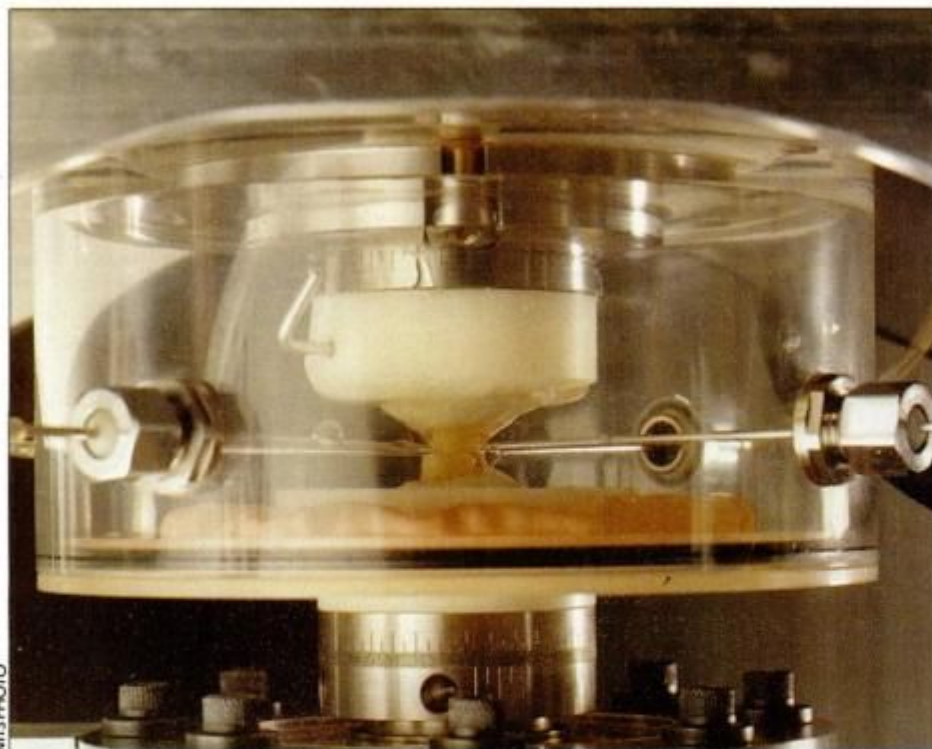
**The laser is delivered in pulses that last less than the time needed to trigger a pain nerve.**

Dalton of American Dental Laser. Surprisingly, people are more likely to lose their teeth from gum disease than from tooth decay. Lasers help by reducing the amount of pain felt during and after treatment. They also reduce the amount of blood and bacteria

tooth made of porcelain or plastic resin is bolted to the implant. This results in a false tooth that is as strong as the real thing.

Titanium is popular for surgical applications because it is compatible with human soft tissues and bone. While titanium is a relative newcomer to dentistry, it is many times stronger than gold and resists corrosion from saliva better than nickel, cobalt or chromium alloys.

Eugene E. LaBarre, D.D.S., chairman of the department of removable prosthodontics at the University of the Pacific, San Francisco, believes that the use of titanium has made implants a far more attractive option. "The consensus now is that there should be a 75-percent success rate after five years of service. Some studies have demonstrated a 5-year success rate approaching 100 percent," he says.



MTS PHOTO

LaBarre explains that "titanium is so inert that bone will actually grow into irregularities on the surface of the implant itself. If the side of the implant is threaded, the bone will fill right into those threads." The result is that the bone develops a tremendously strong grip on the implant.

"In the far future, it is possible that the need to wear dentures will completely disappear," LaBarre says. However, he adds, "At the moment, it is strictly a Cadillac treatment."

### Instant teeth

Because of the high cost of implants (\$1500 to \$2000 per tooth), most people still opt for crowns and bridges to replace weak or missing teeth. In fact, there are 30 million crowns cast in the United States each year. Typically, these are made by technicians toiling in dental laboratories working with impressions made from patients' teeth. But the manufacture of crowns is catching up with the latest computer-based technology. Researchers have borrowed the technique of computer-aided design and computer-aided manufacture, known as CAD/CAM, for restorative dentistry.

To use a CAD/CAM system, the dentist first measures the tooth with an imaging device, such as a laser scanner. The resulting dimensional information is fed into a computer, which creates a model on a video screen. The dentist then modifies the model for optimum function and appearance. Lastly, a computer generates instructions that direct a milling machine to precisely cut the crown or inlay.

Patients appreciate the fact that no impressions need to be taken. Also, the process requires fewer visits and less anesthesia is needed to install crowns. Another plus is that the new crown is ready within an hour, and the process is done with much less opportunity for human error.

### Motor mouth

Future dental technologies are now being tested on the dental researcher's equivalent of a crash dummy. Developed by Drs. Ralph DeLong and William Douglas of the University of

**In the far future, it  
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dentures will  
completely disappear.**

Minnesota, a hydraulically powered artificial mouth simulates the complex forces that occur in human chewing. The device may be used to test the endurance of the many new types of materials being explored for use in dentistry.

"The concept was first sketched on a paper napkin as Bill Douglas and I kicked the idea around at a hamburger joint near the University of Minnesota," says Bob Hunter, of MTS, an Eden Prairie, Minnesota-based servo-hydraulics company that collaborated with DeLong and Douglas in the mouth's development. MTS has



IMPLANT INNOVATIONS PHOTO

**Titanium implant (above) is stronger than natural tooth. Tomorrow's prosthetics may be developed in the artificial mouth (left).**

worked extensively with devices that simulate long periods of stress in short amounts of time to test the endurance of materials and vehicles. The artificial mouth can put a year's worth of stress onto dental samples in just one day.

Test teeth in the artificial mouth are mounted in an environmental chamber, which is fully enclosed and then exposed to a continuous flow of fluid as the hydraulically powered artificial jaws grind away. "We can bring in artificial saliva, we can use natural saliva, or we can just use distilled water—since most of your saliva is water—and that seems to function very well. It's also less messy," says co-developer DeLong.

The operators of the artificial mouth have used it to test amalgam fillings, porcelain teeth, new dental composites and other materials. An important benefit of the system is that it can reveal problems with dental materials before they are tested in humans.

Experiments such as these promise to advance dentistry beyond the present level of simply reducing pain and take it to a point where mouths can literally be remade. While it will take time for many of the newest procedures to find their way out of the lab and into dentists' hands, recent successes prove that medical technology can not only save lives, but make them more comfortable as well. With further research, many of the more fear-inspiring tools of today's dentists will seem as primitive to us as dental pliers. And that's something to smile about.

**PM**





● The pattern is becoming all too familiar. The Middle East oil supply goes from merely uncertain to totally unpredictable, and we respond with renewed interest in economy cars. Since Saddam Hussein's reckless annexation of Kuwait, gasoline is higher than it's been in a decade, econobox sales have soared and mpg is once again a fashionable cocktail party conversation topic.

Accordingly, we decided to take a little different look at this subject. First, to see if these cars can actually deliver the kind of fuel economy the Environmental Protection Agency says they can. (The agency's 1991 ratings show 75 different models capable of 30 mpg or better.)

Second, and more important, we wanted to see what kind of penalties you have to pay for high mpg in terms of comfort and convenience.

A word on EPA ratings: While 75 cars on the EPA's over-30 list is certainly good news, we have our doubts about the accuracy of these numbers. The EPA test consists of the car being "driven" on a chassis dynamometer. There are specific speed and gear changes to simulate city driving and highway driving. The EPA then weights the two test cycles—55 per-

# 40 something

You can buy as much fuel economy as you want today. But what do you really pay?

BY DON CHAIKIN; PM Photos by Humphrey Sutton

cent for city and 45 percent for highway—to develop its combined fuel economy number.

Even without a degree from MIT you know that a set of rollers in the floor of a test lab doesn't really approximate the outside world.

Then there's the Inertial Weight Class factor. The dyno's rollers are preset to simulate the rolling resistance that goes with weight. If the

manufacturer can push a car into the next lighter inertial weight class by leaving a few items out—say a couple of floor-mats and some sound-deadening material—the car will test better than the same car rated one class heavier.

Then there's the upshift light (officially, the Shift Indicator Light, or SIL). SIL-equipped cars are given an economy credit—usually about 1 mpg—over otherwise identical cars because the EPA assumes that all drivers actually pay attention to these devices, shift as early as they suggest, and thus achieve optimum miles per gallon.

To get some variety into our test group, we picked cars from five different manufacturers: the Geo Metro XF1, Honda CRX HF, Suzuki Swift GA, Daihatsu Charade SE and Volkswagen Jetta GL Diesel. All are in the EPA top 10, and all have highway fuel economy ratings of at least 40 mpg—hence our title.

There's nothing fancy here. All of these cars are front-drives, all have 5-speed manual transmissions, and only one of them offers more than 65 hp. And with the exception of the Jetta, each has a base price of under \$10,000.

In order to find out what these cars

were like to live with, as well as what their real-world fuel economy would be, our test consisted of lots and lots of driving—some 3500 miles in all. We also took them all over a controlled fuel economy loop that combined 265 miles of parkway, 2-lane country roads and urban streets. And, of course, we drove the cars at the track to see how they performed at their limits. After all, there's more to driving than just stopping to fill the tank.

When the last lap was over and the last refill logged in, some impressive fuel economy numbers had emerged, as well as a consensus favorite with the test crew.

## Honda CRX HF

The No. 2 car on the EPA's frugality list rates tops with us. The Honda CRX HF delivers a blend of economy, comfort and panache that seems almost self-indulgent, particularly in contrast to some of the other mpg specials. The CRX can do more tricks than just drive by filling stations.

The CRX HF engine is similar to the 108-hp 16-valve Four in the hot CRX Si—minus eight valves, about 100 cc in displacement and 46 horsepower. Still, the 1.5-liter HF engine pulls 90 ft.-lb. of torque at a low 2000 rpm. And thanks to tall gearing, 2000 rpm in fifth gear yields more than 60 miles per hour.

The engine is smooth and quiet, from 1000 to 5000 rpm. You could cruise all day and forget to shift past third gear—this is one car where the upshift light actually serves a useful purpose. And it'll run all day at any speed range. If you're in a hurry, the

**43 MPG**  
SUZUKI  
SWIFT GA



Suzuki Swift's spirited 1.3-liter sohc 4-cylinder engine helped offset bare-bones interior and so-so handling with quickest acceleration in test group and 51 mpg on the PM test loop.

car will be quick for you. The HF was second fastest through the quarter-mile. If you want to be thrifty, it will be thrifty.

Of course, the CRX is not quite as cheap as the other cars, except the Jetta. The extra dollars on the sticker add up to amenities befitting a real car: comfortable seats (only two of them) with thigh bolsters and lumbar support, plus construction that feels

tight and stays quiet over bumpy and broken roads.

The ride is firm, but not harsh. The steering is quick and responsive, and the handling sure-footed. Although it lacks the Si's power, this is still a driver's car, one that makes a day on the road seem like something more than mere routine.

The CRX has its quirks, to be sure, like the translucent panel beneath the rear hatch that makes the rear view confusing and distorted. But it also has some undeniable charms, not the least of which is its EPA economy rating of 49 city/52 highway/50 combined. Our car delivered 46.7 mpg for the test and 51.3 mpg on the mileage loop.

## Volkswagen Jetta GL Diesel

This car is an enigma. The only reason that a car of this class and quality is in this test group is also the only reason you may not want to buy it.

If you don't care at all about performance and don't mind the minor inconveniences of a diesel, then this could be the best car in the group for you. It has all the standard Volkswagen strengths and charms: a tight, solid body covering excellent engineering and a comfortable, high-quality interior.

The Jetta's handling is also superb—it was quickest through the slalom, and would have been substantially

## EPA Top 20 & Bottom 10

● The top-five cars on the EPA fuel economy list are really three cars with a couple of variants. There are three different versions of the Geo Metro in there, too. This is because the carmakers must certify each engine/transmission and body configuration of every model they make.

### The 20 Best

Geo Metro XFI*	53/58/55
Honda Civic CRX HF*	49/52/50
Geo Metro LSI*	45/50/47
Geo Metro*	45/50/47
Suzuki Swift*	45/50/47
Honda Civic CRX HF	43/49/45
Suzuki Swift GA*	39/43/40
Volkswagen Jetta GL Diesel	37/43/40
Daihatsu Charade SE	38/42/39
Ford Festiva	35/42/38
Geo Metro LSI (Automatic)	36/39/37
Geo Metro (Automatic)	36/39/37
Suzuki Swift (Automatic)	36/39/37
Daihatsu Charade	35/38/36
Honda Civic	33/37/35
Subaru Justy* (2-barrel)	33/37/35

Subaru Justy* (EFI)	33/37/35
Toyota Tercel	33/37/35
Ford Escort FS*	31/41/35
Subaru Justy (ECVT)	33/35/34

### The 10 Worst

Lamborghini Diablo	9/14/11
Rolls-Royce Silver Spirit	10/13/11
Rolls-Royce Corniche III	10/13/11
Bentley Turbo	10/13/11
Bentley Eight/Mulsanne	10/13/11
Bentley Continental	10/13/11
Ferrari Testarossa	10/15/11
BMW M5	11/20/14
Ferrari F40	12/17/14
BMW 750iL/850i	12/18/14

\* Equipped with Shift Indicator Light

quicker with a different engine.

And that is literally what holds this car back. The Jetta Diesel would lose a stoplight drag race to just about anything this side of the Goodyear blimp. It took the Jetta twice as long as the Swift to get to 60 mph at the test track.

The Jetta's mechanically injected 1.6-liter sohc diesel is the least powerful in the group, making only 52 hp, and that in a very narrow range. That's fine for a featherweight like the Geo Metro, but it just doesn't cut it in a car of the Jetta's size. Throttle application was pretty much digital—either on or off—and acceleration was slow enough to be marginally safe in traffic. Despite having the best seats, best ride, best handling, best comfort and best quality of any car in the group, no one on the test crew looked forward to driving it.

Another factor to consider before buying a Jetta Diesel is the cost of diesel fuel versus the cost of gasoline (not to mention the disparity between the Jetta's purchase price versus the rest of our test fleet). During the course of the test, we paid 15 percent *more* for diesel fuel than we did for gasoline. When you factor in the cost of refueling, and realize that you could travel 15 percent farther for your dollar on gasoline, you may wonder if the Jetta's obvious pluses outweigh the big minus of the diesel.

The anemic diesel's frugality produces an EPA rating of 37 city/43 highway/40 combined. Out on the road, the Jetta, driven with the pedal down hard most of the time, managed 35.8 miles per gallon of diesel, includ-

**52 MPG**  
HONDA  
CRX HF



Econo version of Honda's popular CRX 2-seater delivered comfort and a fun-to-drive ride along with outstanding fuel economy: 46.7 mpg overall, 51.3 on our test loop.

ing 42.7 mpg over our mileage loop.

And when it came down to assessing the total vehicle—with the caveat that this is not a car for people with tight timetables—our PM test crew ranked the Jetta second.

### Daihatsu Charade SE

It was interesting that the Charade, ranked No. 9 on the EPA list, was first in attracting attention from on-

**58 MPG**  
GEO METRO XFI



EPA's 1991 econo champ was also tops in our test with 50.6 mpg overall, and nearly 60 mpg in the test loop. Price for high economy is poor comfort and marginal handling.

## Fuel-Saving Tips For Savvy Drivers

● It seems every time we find ourselves in some kind of fuel crunch, a TV "expert" shows up to tell us everything we need to know about saving fuel. How many more times can we hear "Avoid jack-rabbit starts" before we all scream?

But still, you do wonder what you can do to stretch a gallon of fuel another mile or so. Start here:

- Be sure the family bus is at least running the way it was designed to by going in for tuneups on schedule.
- Use API-rated EC-II Energy Conserving oil of the lightest viscosity range recommended for the season.
- Inflate the tires to the maximum recommended pressure—maybe even a couple of pounds more—for decreased rolling resistance.
- Be sure the alignment—of all four wheels—is correct.
- Remove extra weight from the trunk, such as ballast you no longer need for traction come springtime.
- Don't warm up your car. Start it up, and drive away normally.
- Run all of the errands for the day at once—not spread hours apart—so your car will always be warmed up.
- Use your cruise control on level stretches of open highway.
- Try not to use the a/c in town.
- On the freeway, at steady-state speeds, using the a/c is more economical than leaving the windows open, because of the decreased aerodynamic drag.
- Consider replacing your belt-driven radiator fan with an electrical fan.

lookers during our test. Maybe that's because not too many people around the country know just what a Daihatsu Charade is.

Daihatsu has been selling its cars in the United States for the past few years, but only in 22 states, primarily in the Pacific Northwest and the Sun Belt. The Charade is a pleasant-looking little 4-passenger Honda Civic clone with a well-built and solid feel.

Despite the fact that its liter-sized 3-cylinder engine was the least powerful of all the gas engines in this group, the car felt surprisingly peppy—third quickest through the quarter-mile—and willing at most speeds. Unfortunately, like so many 3-bangers, it's also rough, particularly at idle. Even though it's topped off by modern sohc valve gear, it still feels and looks pretty agricultural.

We also found the Charade's ride quality to be on the harsh side, and we'd characterize the handling as somewhat below average. The slow, imprecise steering and tall, skinny 145/80R13 tires combine with an uninspired chassis to make driving this car something that requires attention and patience.

On the other hand, we were impressed with the Charade's interior appointments and overall quality. Although the bucket seats don't offer much in the way of lateral support, they're comfortable, and front-seat legroom is good.

On balance, we think that with an EPA rating of 38 city/42 highway/39 combined and its affable interior, the Charade may be ready to make some new friends. By delivering 38.3 mpg throughout our test, including 47.2 over the economy loop, it made friends with our group of test drivers who voted it third.



Charade's tiny 3-cylinder engine was rough but willing, and delivered 47.2 mpg on PM econo loop. Front-seat legroom was good, and overall quality was impressive.

## Suzuki Swift GA

Take the miserly Metro, graft another cylinder onto that engine and presto, you've got the Suzuki Swift GA, No. 7 on the EPA list.

What a difference that extra displacement makes. While it's true that this Swift suffers from the same sort of low-end econocar cheapness that afflicts the Metro, it's somehow more palatable here because the Swift GA is truly quick.

The 4-cylinder engine is the most powerful in this group, with 70 hp. The power's up high, at 6000 rpm, so you have to make the engine sing for the car to run. And this naturally takes a bite out of fuel economy. But we also expect that's the way the little Swift will be driven most of the time,

because with a little bit of throttle, it's a lot more fun.

The Swift's interior is depressingly plain and cheap, just a notch or two up from the Metro XFI's. The seats are the same hard slabs. The materials used on the dash and door panels are the same. The instrumentation is marginally better, and the controls for wipers and headlights are mounted on easy-to-find steering column stalks.

The Swift's ride is a trifle better than the Metro's, as is the handling, thanks largely to 155/70R13 tires versus the Geo Metro's smaller 12-inches.

Thanks to its additional engine muscle, extra tire grip and incrementally higher weight, the Suzuki Swift

## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL	BASE PRICE/PRICE AS TESTED	ENGINE/DISPLACEMENT (ci/cc)	ENGINE HP, NET/TORQUE (ft.-lb.)	ENGINE/DRIVE LAYOUT	TRANSMISSION TYPE	WHEEL-BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)	CURB WEIGHT (lb.)
<b>Daihatsu Charade SE</b>	\$6597/ \$7052	L3 SOHC 60.6/990	53 @ 5200 rpm/ 58 @ 3600 rpm	front/ front	5-speed manual	92.1	144.9	63.6	54.5/53.7	1820
<b>Geo Metro XFI</b>	\$6795/ \$7456	L3 SOHC 61.0/996	55 @ 5700 rpm/ 58 @ 3300 rpm	front/ front	5-speed manual	89.2	146.1	62.0	53.7/52.8	1620
<b>Honda CRX HF</b>	\$9405/ \$10,312	L4 SOHC 91.4/1493	62 @ 4500 rpm/ 90.4 @ 2000 rpm	front/ front	5-speed manual	90.6	148.5	65.9	57.1/57.3	1967
<b>Suzuki Swift GA</b>	\$6399/ \$7808	L4 SOHC 79.2/1298	70 @ 6000 rpm/ 74 @ 3300 rpm	front/ front	5-speed manual	89.2	146.1	62.0	53.7/52.8	1720
<b>Volkswagen Jetta GL Diesel</b>	\$10,385/ \$12,060	L4 Diesel 97.2/1588	52 @ 4800 rpm/ 71 @ 2000 rpm	front/ front	5-speed manual	97.3	171.7	65.5	56.3/56.0	2375



DAIHATSU CHARADE SE



GEO METRO XFI



HONDA CRX HF

is a marginally more civilized car than the Geo Metro, and certainly more fun to drive. But its harshness, noise and generally tinny feel left it ahead of only the Metro.

However, the added weight and engine displacement also serve to slide this car down the EPA's list to 39 city/43 highway/40 combined. The Swift delivered 38.9 miles per gallon overall in the test and distinguished itself on the mileage loop by going 51 miles per gallon.

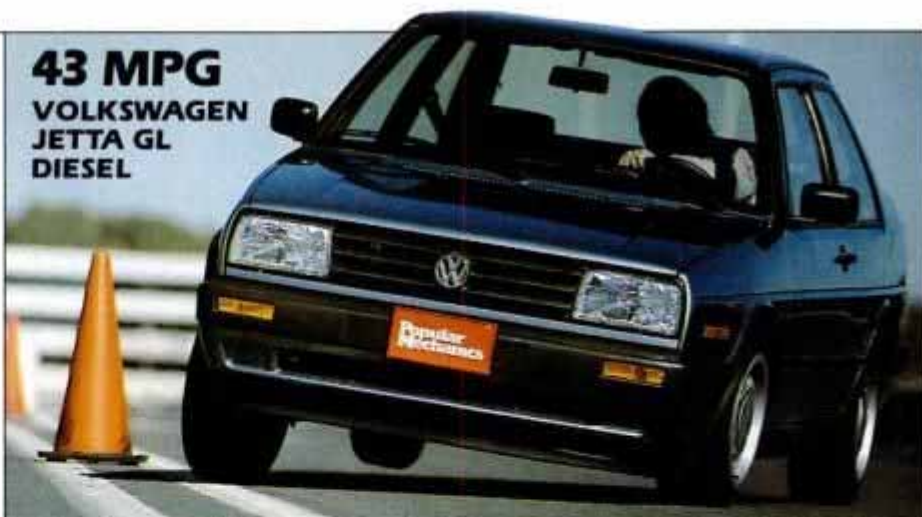
### Geo Metro XFI

This is the car that tops the EPA charts for 1991, and is one of four different Geo Metro models to make the EPA top 10. The XFI edition also happens to be the meanest, barest car of the lot.

There's no deep secret to the XFI's fuel economy—just look under the hood. Harness a tiny-but-efficient overhead-cam 1000-cc 3-cylinder engine to a 1600-pound car and you're bound to get impressive economy numbers. But you don't get much else. As soon as you sit behind the wheel, you know that you're experiencing bare-bones transportation. The seat is flat and hard. The steering wheel is skinny and interior materials are oppressively plastic.

The instrument panel is sparse, with a coolant temperature gauge, fuel gauge and a speedometer. That's it. There's not even a trip meter to help you appreciate the car's fuel economy. The controls for wipers, lights and hazard flashers are push-buttons around the top and sides of the instrument cowl. Unfortunately, the steering wheel's rim is just thick enough to block the view of the controls for most drivers. But the buttons reflect off the inside of the

### 43 MPG VOLKSWAGEN JETTA GL DIESEL



Bigger and substantially more expensive than the other econocars, Jetta was comfortable and nimble. The diesel engine was thrifty, but bog slow in acceleration.

windshield so you can find them just the same.

Minimalism also extends to the Metro's dynamic traits. The ride is harsh and bumpy. Handling is skittish, and stability suffers in crosswinds, due in large measure to the car's narrow track and ridiculously tiny P145/80R12 tires.

However, the little Three is surprisingly willing. While 55 hp and 58 ft.-lb. won't ever snap a neck, it's enough power to accelerate the Metro and keep it moving with traffic—provided you keep the gear selection matched to the engine's narrow powerband. That's the antithesis of

thrifty driving, of course, but the Metro's thirst is so small that it really doesn't seem to matter much.

All things considered, the combination of noise, vibration and harshness, coupled with the monastic interior, makes this car the least attractive in this group.

But if your priority is unbeatable fuel economy, then the Metro XFI is worth a test drive. The EPA rates this car at 53 city/58 highway/55 combined. In our real-world test, the XFI delivered an honest, if somewhat merciless, 50.6 mpg all-around, and an amazing 59.9 mpg over the economy loop. **PM**

### TEST RESULTS

STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/hwy. PM test)	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING <sup>1</sup> ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. <sup>2</sup> SLALOM (mph)	200-FT. <sup>3</sup> SKIDPAD (G)	EPA CARGO VOLUME (cu. ft.)	INTERIOR VOLUME (cu. ft.)
Manual rack & pinion/ 4.0	F: 9.20-in. disc/ R: 7.10-in. drum	38/42 38.3	12.9 19.1 @ 70.3	12.1	151	52.3	.66	15.0	79.0
Manual rack & pinion/ 3.6	F: 8.39-in. disc/ R: 7.09-in. drum	53/58 50.6	13.5 19.3 @ 65.5	13.3	153	53.1	.65	10.2	79.0
Manual rack & pinion/ 3.67	F: 9.09-in. disc/ R: 7.09-in. drum	49/52 46.7	11.7 18.5 @ 72.9	10.7	150	56.3	.71	23.2	N/A
Manual rack & pinion/ 3.6	F: 8.39-in. disc/ R: 7.09-in. drum	39/43 38.9	9.95 17.3 @ 76.5	9.8	142	57.1	.71	10.2	82.0
Manual rack & pinion/ 3.2	F: 9.40-in. disc/ R: 7.10-in. drum	37/43 35.8	19.8 21.9 @ 62.4	18.9	156	57.8	.76	17.0	88.0



SUZUKI SWIFT GA



VOLKSWAGEN JETTA GL DIESEL

1. Times from a steady-state 40 to 70 mph.  
2. Best speed achieved while weaving through seven cones placed in line, 100 ft. apart. Speeds provide index of transient response.  
3. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best clockwise and counterclockwise.

# Quality is Job 1.<sup>SM</sup>

## Profile in Quality #33: Innovation

Craig Metros  
dreams cars.  
The kind of quality  
cars you'll be  
driving years  
from now.

Craig is one  
of over 366,000  
Ford people  
worldwide who  
are committed to  
making quality  
Job 1.

Our goal is to build  
the highest quality  
cars and trucks  
in the world.



"Today we're  
designing cars that  
are great looking  
and fit the  
environment."

Craig Metros, Designer  
Ford Employee for 5 years.

# Ford Motor Company

FORD, MERCURY, LINCOLN, FORD TRUCKS

Buckle up — Together we can save lives.

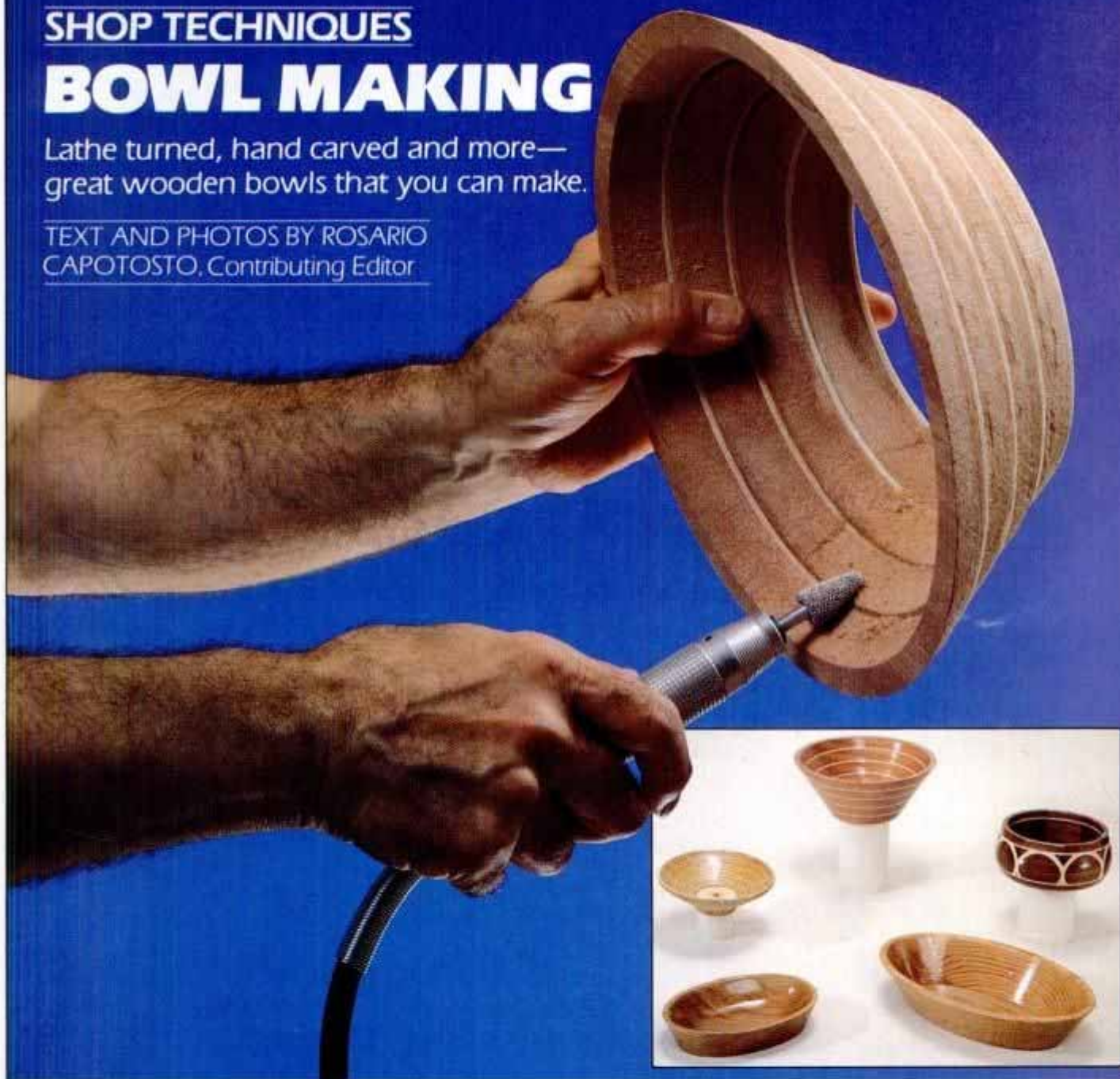
# JOURNAL

## SHOP TECHNIQUES

# BOWL MAKING

Lathe turned, hand carved and more—great wooden bowls that you can make.

TEXT AND PHOTOS BY ROSARIO  
CAPOTOSTO, Contributing Editor



● If you're interested in woodworking projects that can be completed in a few evenings or over a weekend—and are more than just a set of plans and instructions—then bowl making may be the answer. You can make bowls that are traditional or contemporary, useful or decorative, and in an infinite variety of shapes and sizes.

Of course, the most typical wooden bowl is lathe turned from a single, solid piece of wood that's mounted on the lathe faceplate. However, we're

about to show you that lathe turning need only be one component in your repertoire of bowl-making techniques. There are many ways to shape a bowl—by hand or machine—and each way lends itself to certain forms and surface patterns. In fact, experimenting with different construction techniques is a great way to come up with new and different designs.

To help inspire your creative flow, we'll explain how to make five different bowls based on their construction

techniques. The exact shape and size of each bowl is up to you, as is the wood you use. Although hardwoods are preferred, many softwoods—and even plywood as you'll see—are suitable for bowl making.

Bowls that you'll use to hold food should be finished with a nontoxic finish, such as Behlen's Salad Bowl Finish or mineral oil, rubbed in well and buffed. Decorative bowls can be finished with any wood finish. We used Deft Gloss Clear Wood Finish.

**Carved Bowl**



The most basic way to shape a bowl is to carve it by hand. To shape the inside of the butternut bowl shown, we used a 25mm, No. 8 bent gouge. For heavy waste removal, we resorted to a router and band saw.

Begin by screwing a gripping block to the workpiece so the stock can be held in your vise. Place the screws in the waste area of the blank. After marking the inside and outside wall outlines, start shaping the interior walls with the bent gouge, leaving the waste in the center (Photo 1). Secure an oversize base to your router so that it can span the bowl edges. Then, rout away most of the center waste with a 3/4-in. corebox bit (Photo 2). Finish shaping the inside with the gouge, and follow with sanding (Photos 3 and 4). Although the outside of the bowl can be carved as well, you can also cut it on the band saw. Set the band saw bevel angle so that it conforms to the angle of the carved inside wall, and then cut to the line.



**1** Hold carving blank in vise by means of a 2 x 4 screwed to waste area. Bent gouge shapes inside bowl wall near edge.



**2** Use a router and 3/4-in. corebox bit to quickly remove waste at center. Oversize base supports router on bowl perimeter.



**3** After most of the waste has been removed with the router, resume with bent gouge until desired shape is achieved.



**4** Rub carbon paper in bowl to mark high spots for trimming. Shape outside by carving or band sawing at bevel, then sand.

**Band-sawn Bowl**



This large bowl is easy to make because all of the waste is quickly sawn away on the band saw. While we based its shape on an ellipse, the method is suitable for a variety of other regular and irregular shapes. The depth of the bowl is only limited by your band saw capacity.

We started with a 3-in.-thick oak blank, roughly 10 in. wide x 18 in. long. If solid stock of this size isn't available or you want a larger bowl, simply make a laminated blank from smaller pieces. To lay out the bowl's elliptical outline, first center two nails on the long axis of the bowl blank so they're about three-quarters of the bowl length apart, and mark the bowl ends. Place a string loop around the pins and adjust its length so that when it's held taut along the bowl axis, it reaches an end mark. Then, run a pen-

cil around the inside of the taut string to produce the ellipse (Photo 5). You may have to adjust the string length or move the nails to get the proportions correct. After the inside and outside lines are marked, cut the blank in half on the band saw.

Next, adjust the band saw for a 30° bevel and saw to the inside wall lines on each half (Photo 6). Then, glue the halves back together to form a single block with the interior walls shaped (Photo 7). Note that the waste stock needn't be thrown away—you can use

it to make a smaller band-sawn bowl of the same shape. This smaller bowl will nest in the large one.

Smooth the inside with a drum sander mounted in a drill. Then, glue a 1/8-in.-thick bottom board to the bottom of the blank. When the glue has dried, use your band saw set at 30° to cut the outside wall (Photo 8). Carefully smooth the rough-sawn surface with a belt sander equipped with 100-, and then 120-grit belts. Then finish smoothing with 180- and 220-grit paper and orbital sander (Photo 9).



**5** Lay out ellipse with two nails and string loop. Ellipse size and proportion are controlled by nail placement and string length.



**6** After sawing bowl blank along centerline, set band saw for 30° bevel and cut to the inside wall line on each blank half.

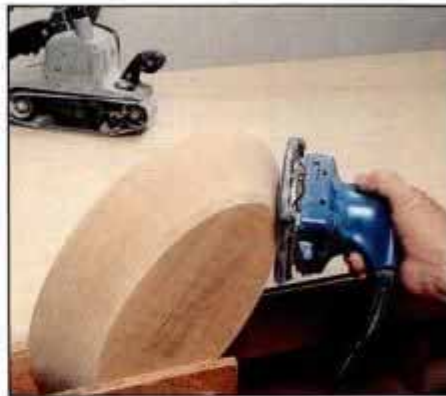




**7** Glue the two sections back together to form a single block. Headless nails in waste area serve to keep pieces aligned.



**8** After smoothing inside walls and gluing bottom to bowl blank, saw to bowl outside line with the band saw set at 30°.



**9** Begin finishing outside with belt sander, and move to orbital sander with 180- and 220-grit paper for final smoothing.

## Stacked-Ring Bowl



Of course, removing stock isn't the only way to shape a bowl. You can just as easily build the bowl by gluing pieces together. One advantage here is that the depth of the finished bowl isn't limited by the stock thickness.

The stacked-ring bowl shown measures about 4½ in. high and 11 in. in diameter. It's made by gluing together rings cut from a 1 × 12 mahogany board and a ½-in.-thick piece of poplar plywood.

Begin by cutting both the board and plywood to 11½ in. sq. and gluing the plywood to a board face. When the rings are stacked, the plywood edge will appear as a light, contrasting ring. Next, set the band saw to 30° and saw an 11-in.-dia. circle that will be the outer edge of the topmost ring. To accurately cut this circle, and the ones that follow, we used a circle jig similar to the one described on page

72 in the January '88 issue (Photo 10). You can also lay out the circles with a compass and cut them freehand.

Then, saw the board into a series of four rings, each 7/16 in. thick. The rings are made by entering and exiting the circular cut at the same place on the board. Position the entry cuts so that they are parallel to the grain, and alternate them from one side to the other on adjacent rings. The solid disc that remains is used for the bowl bottom.

Glue shut the entry cuts (Photo 11). When the glue has dried, apply glue to

the adjoining ring faces, stack the assembly and apply pressure with weights (Photo 12). Don't glue the bottom disc in place yet to facilitate smoothing the inside walls of the bowl.

We leveled the stepped interior wall with a flexible shaft tool and a cone-shaped, structured-carbide bit. You could also use a sanding drum, half-round rasp or Surform tool (Photos 13 and 14). Then, hand sand the inside wall smooth. After gluing the bottom disc in place, level and smooth the outer wall in the same way.



**10** Circle jig guides 30° cut when making 7/16-in.-wide rings. Circles also can be drawn with a compass and cut freehand.



**11** Glue together entry cuts on each ring before assembling rings. Small spring clamps apply pressure until glue sets.



**12** Apply glue to all mating surfaces and allow to become tacky before assembling. Then, use weights for uniform pressure.



**13** Level the inside and outside of bowl walls with rasp or flexible drive tool. Bottom is installed after smoothing.



**14** For final smoothing, use a large diameter drum sander. Then, glue bottom in place, complete sanding and apply finish.

## Telescoping-Ring Bowl



Another novel way to obtain a 3-dimensional bowl from a flat board is to cut the board in a series of rings that telescope apart. Once glued together, the assembly is then turned on the lathe.

The rings are cut on a scroll saw with the table set a few degrees off horizontal. Both the thickness of the saw kerf and the bevel angle determine the degree to which each ring telescopes beyond the next. If the kerf is large and the angle small, the rings will slide completely by each other. If the kerf is small or the angle too severe, the rings won't telescope very much beyond each other. Ideally, the kerf size and the bevel angle should combine to allow each ring to overlap the next one half the stock thickness. You may have to cut a few test rings to get the right combination of kerf width and bevel angle.

To avoid splitting, we used  $\frac{3}{4}$ -in.-thick Baltic birch plywood. This material has 13 uniform layers that provide an interesting striped effect in the finished bowl. You could substitute a quality veneer-core plywood. An 8-in.-sq. board will yield an 8-in.-dia.,  $2\frac{1}{2}$ -in.-high bowl.

Lay out the rings starting with an 8-in.-dia. circle (Photo 15). If you use equally spaced rings, the bowl will have a uniform taper. We started with a  $\frac{7}{16}$ -in.-thick ring and increased each succeeding ring by  $\frac{1}{16}$  in. to achieve a slightly curved profile.



**15** Use a compass to lay out the series of circles. Bore a  $\frac{3}{16}$ -in.-dia. blade entry hole on each ring for the scroll saw blade.



**16** Tilt scroll saw table to about a  $5^\circ$  angle to cut beveled rings. Use larger angle to reduce telescoping if kerf is too wide.



**17** Apply glue to contact areas of rings. Align and press each ring into the next and let the glue dry. Clamping is unnecessary.



**18** Mount work on lathe faceplate. Use sharp gouge to trim steps on bowl surface. Stop cutting when steps disappear.

Bore a centered  $\frac{3}{16}$ -in.-dia. blade entry hole at each circle and stagger alternately from side to side. Cut the rings on the scroll saw (Photo 16) and begin gluing with the bottom piece and smallest ring. Apply glue to the side walls and press the parts together (Photo 17). Align the entry holes for proper orientation. After the glue has dried, rebore the entry holes to clean out excess glue, and glue short dowels in place to plug the holes.

To mount the assembly on the

lathe, first turn a  $\frac{3}{4}$ -in.-plywood disc on the lathe faceplate, and mark the center while on the lathe. Remove the disc from the faceplate and bore a small, perfectly straight hole in the center. Slip a nail through the hole so that the center of the disc can be aligned with the compass center point on the bowl bottom. Then, glue the disc to the bottom and remount the disc on the faceplate. Trim the bowl surface until the steps of each ring are eliminated (Photo 18).

## Laminated And Turned Bowl



This lathe-turned bowl owes its unique appearance to the laminated construction of the turning blank. It's made of sections that feature light, thin poplar plywood sandwiched between dark, solid walnut. The laminated stock is then cut and assembled

in a ring shape that becomes the blank for the bowl. When the blank is turned on the lathe, the contrasting plywood is revealed in a regular geometric pattern on the bowl surface. The possibilities of this technique are as varied as the ways you can glue different woods together. And, you'll notice that the surface pattern changes as you shape the bowl on the lathe.

The first step in creating the bowl shown is to glue up the laminated stock as shown in Photo 19. The size of this laminated piece can vary according to the size bowl that you're producing. For our  $3\frac{3}{4}$ -in.-high, 8 $\frac{1}{4}$ -in.-dia. bowl, it measured  $1\frac{1}{2} \times 3\frac{3}{4} \times 32$  in. Begin by gluing a strip of poplar plywood between two different thick-

nesses of solid stock so that the plywood strip is off-center. Then, true the edges on a jointer and add a layer of light and dark wood to the top and bottom to create the H-shaped cross section shown. Finishing nails inserted into pilot holes help to keep the pieces aligned while gluing.

After the glue is dry, joint the edges straight and square. Set your table saw blade to a  $22\frac{1}{2}^\circ$  angle, and cut the eight mitered staves that make up the bowl circumference (Photo 20). The 8 $\frac{1}{4}$ -in.-dia. bowl that we made requires about  $3\frac{1}{2}$ -in.-long mitered sections. Be sure to cut the stock so the off-center plywood strip in each piece will be closer to the outside of the ring when assembled.

To maintain a continuous grain pattern around the bowl, number the pieces so that they'll be assembled in the original order. Check the pieces to make sure they fit correctly, apply glue and use a band clamp to hold the assembly together (Photo 21). Make sure that the pieces are aligned so that the plywood lines on the finished bowl appear uniform and continuous.

The bowl bottom is made by first gluing together four mitered pieces of  $\frac{3}{16}$ -in.-thick walnut to create a square slightly larger than the finished diameter of the bowl. Lay out an oversize circle and saw to the line with a band saw or sabre saw. Then, center

and glue the walnut bottom piece to a  $\frac{3}{4}$ -in.-thick plywood disc for mounting on the lathe faceplate.

Next, turn a second plywood disc on the faceplate so the diameter equals the distance between the outside corners of the mitered bowl ring. Center and glue the plywood disc to the ring (Photo 22). Mount the assembly on the faceplate and turn a  $\frac{3}{8}$ -in.-deep rabbet on the inside edge that will accept the circular bottom piece (Photo 23). Secure the bottom assembly to the faceplate, and turn down the diameter of the bottom until it fits snugly in the rabbet (Photo 24).

Glue the laminated ring to the base

and use a parting tool to cut away the plywood disc on the bowl top (Photo 25). Then, use a gouge, spear-point and skew chisel to shape the outside to the desired contour (Photo 26). Finish shaping the inside with a spear-point and roundnose chisel while continually checking wall thickness with a caliper (Photo 27). We finished with a wall thickness of about  $\frac{5}{16}$  to  $\frac{1}{2}$  in. Sand the bowl on the lathe, finishing with 220-grit paper. Separate the bowl from the plywood disc base by cutting in with the parting tool to within about  $1\frac{1}{2}$  in. of the center. Cut through the remaining stock with a handsaw, and sand base smooth. **PM**



**19** Sandwich of contrasting poplar plywood and walnut is made in two stages. Holes for alignment nails go in waste area.



**20** Miter laminated stock into eight equal segments. Number each piece in order so grain will be continuous in final assembly.



**21** After carefully aligning parts, use band clamp to hold ring segments in place after glue is applied to mating surfaces.



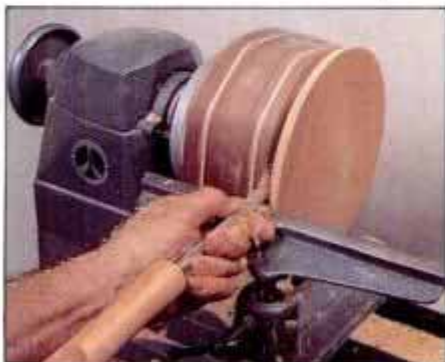
**22** Glue plywood discs to top of bowl and to mitered walnut bottom piece. Discs permit work to be secured to lathe faceplate.



**23** Mount bowl blank on lathe and use a skew chisel to shape rabbet on inside bottom edge of ring for bowl bottom.



**24** Then, attach the bottom piece to lathe faceplate and turn down diameter until the piece fits snugly in bowl rabbet.



**25** After bottom has been glued in rabbet, use a parting tool to remove the plywood disc that's glued to the bowl top.



**26** Shape the outside profile of the bowl while periodically checking the design. Stop when contour and pattern look right.



**27** Turn inside wall of bowl with bowl scraper or roundnose turning tool. Check wall thickness regularly with caliper.

**NEW TOOLS**  
**TOOL UP**

Twenty tools to handle the tough assignments.

BY ROY BERENDSOHN, Assistant Home Improvement Editor



**Smooth Operator**

The new Super Sawzall is easier to operate, says Milwaukee, because its drive mechanism has been counter-balanced with tool steel plates to nearly eliminate vibration. Equipped with an 8-amp, 1-hp motor, the saw's cutting speed is adjustable up to 2000 rpm or can be set at 2800 rpm. A quick-release lever unlocks the saw's shoe. The blade takes a 1 1/4-in.-long stroke, and a blade removal hex key snaps onto the saw's boot for storage. The saw comes with a quick-snap detachable cord, for quick replacement if damaged, or a standard cord. It costs about \$300 (detachable cord) and \$295 (standard) at industrial suppliers and hardware stores. Write to Milwaukee Electric Tool Corp., 13135 W. Lisbon Rd., Brookfield, WI 53005.



**Join In**

Skil enters the plate joiner market with its 6-amp Model 1605:02. Designed to be rugged enough for professionals, yet inexpensive enough for hobbyists, it runs at 12,000 rpm and is equipped with a ball-bearing blade support, 3-position depth stop

and a 12-tooth carbide blade. It also has on-tool wrench storage, a locking ON/OFF switch and an 8-ft. cord. It comes in a blow-molded plastic carrying case and costs about \$145 at hardware stores and home centers. Write to Skil Corp., 4300 W. Peterson Ave., Chicago, IL 60646.



**Coffee Break**

Panasonic says you can recharge its new line of cordless drills and screw guns in the time it takes to have a cup of coffee (about 15 minutes). The 12-volt model shown has a 3/8-in. keyless chuck and a 6-position clutch. Its charger accepts 9.6- and 12-volt Panasonic batteries, and its signal lights let you know when charging is complete. The 4-pound drill costs about \$200 (as do the other 15-minute recharge models) at industrial suppliers. Contact Panasonic, 1 Panasonic Way, Secaucus, NJ 07094.



**Around The Corner**

Drive or remove screws in tight spots with this new offset powerhead designed for cordless screwdrivers. It operates up to 400 rpm and has permanently lubricated steel gears. It's equipped with a thumb flange that spins 360°, so you can brace against the driving force from any angle. Also, its magnetized hex socket accepts any slotted, Phillips, Torx or other bit with a 1/4-in. hex shank. It costs about \$24 at hardware stores. For more information, contact AEG Power Tool Corp., 3 Shaw's Cove, New London, CT 06320.

### Spin Off

Porter-Cable has added an industrial Jacobs keyless chuck to its ½-in. pistol-grip drill. Just spin the chuck to remove or tighten a bit. The variable-speed, reversing 5-amp drill is capable of boring with 1½-in.-dia. bits in wood and ½-in.-dia. bits in



steel. It costs about \$215 at hardware stores and industrial suppliers. For more information, contact Porter-Cable, 4825 Hwy. 45 N., P.O. Box 2468, Jackson, TN 38302-2468.

### Steamed

This wallpaper steamer takes advantage of lightweight plastics to make it easier to use. Its steam plate weighs only 8½ ounces. To use it, fill the tank with hot tap water, place the steam plate on the wall, and in 10 to 20 seconds the steam starts loosening the paper. Its manufacturer says it also loosens multiple layers of wallpaper. The steamer has a 5-quart capacity and provides steam for 1 hour, 45 minutes. It costs about \$60 at hardware stores and home centers. Write to Wagner, Consumer Products Division, 1770 Fernbrook Lane, Minneapolis, MN 55447.



### Less Is More

Powermatic's 10-in. Artisan table saw has features normally found on larger machines, while holding the line on cost. The basic saw costs about \$725 and is equipped with a 1.5-hp, 115-volt motor with a lockable ON/OFF switch, cast-iron open-grate table

extensions and a heavy-duty Vega fence. Equipped as shown, with accessory castors, a sliding table and 50-in. fence extension rails, the saw costs about \$1200. It's sold at Powermatic equipment dealers. For more information, contact Powermatic, McMinnville, TN 37110.



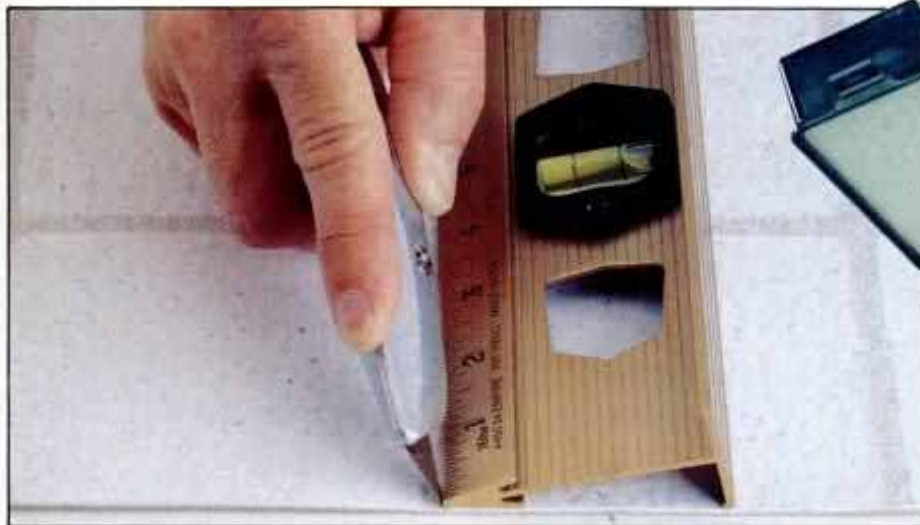
### Full Featured

This 8¼-in., 2½-hp radial-arm saw has a 2¼-in. maximum cutting depth (blade at 90° to worktable) and a 2-in. cutting depth with the blade at 45°. Its automatic miter index lets you quickly set up for angle cutting at 22½° left/right and 45° right. As a safety feature, the ON/OFF switch has a removable locking key. The particleboard worktable is 21½ in. wide × 30 in. long. A leg set is available as an accessory for about \$40. The saw costs about \$280 at Sears retail outlets and through the catalog. Write Sears, Marketing Communications, Dept. 727R, BSC 2307, Sears Tower, Chicago, IL 60684.

### Cornered

The recently introduced quick clamp now comes as a kit with a corner clamp attachment. The corner bracket and its matching pad slip over the clamping jaws. Squeeze the trigger and slide the corner pad into position, then squeeze the handle to apply pressure. The 6-in. bar clamp is made from impact-resistant plastic and steel. Its jaws are glass-reinforced nylon. The kit includes two soft clamping pads and two oversize clamping pads, and costs \$30 at hardware stores. Write to American Tool Companies, Inc., P.O. Box 337, DeWitt, NE 68341.





**On The Level**

The top of this 3-vial level is arrow shaped so it's easier to score, draw or cut on the level's edge. Made of ribbed aluminum with a gold-anodized finish, the level has inch and metric scales and three acrylic vials with sonically

welded cover plates for permanent vial alignment. It comes in 24, 36 and 48 in. lengths (\$13, \$18 and \$22, respectively, at hardware stores and home centers). Contact Empire Level Mfg. Corp., P.O. Box 868, Waukesha, WI 53226.



**Molding Maker**

Make dental and other moldings with this attachment for your router. It's made from steel and high-impact polystyrene, and accepts routers with a 6-in.-dia. base and a 3-hole face-plate. Screw your router to the Mill-Works Molding Maker carriage, set

the index pins and cut precise dentils. Fix the carriage in place, and you can use it to cut fluting or edge molding. It costs about \$40 at Sears stores and through the catalog. Write Sears, Marketing Communications, Dept. 727R, BSC 2307, Sears Tower, Chicago, IL 60684.



**Safety First**

These dado blades are designed to cut more safely than other saw blades, say their manufacturer, because each tooth has a shoulder which prevents it from biting too deeply. The design is supposed to reduce kickback and the chance that the board will climb on the blade. Its tooth tips stay sharp longer because they are made from a tungsten-carbide, titanium-cobalt alloy. The 24-tooth, 8-in.-dia. set cuts a groove  $\frac{13}{16}$  in. wide and costs about \$218 through woodworking supply catalogs and at hardware stores. Write to Freud, 218 Feld Ave., High Point, NC 27264.

**Cool It**

This glue gun reduces the risk of burns from hot adhesive because it uses glue that melts 155° F cooler than comparable adhesives. Stanley says the glue can be used to fasten plastics that would melt from hotter adhesives. The gun accepts oval-shaped glue sticks to prevent accidentally using high-temperature adhesives in it. It costs about \$20 at hardware stores. For more information, contact Stanley Parker, 149 Washington St., Worcester, MA 01610.



**Switch Hitter**

This 12-pound, 2-hp vacuum blower has a 20-ft. cord for yardwork and adjustable suction. Included with the model 17958 are two extension wands, a hose grip, blower, utility and squeegee nozzles, dusting brush and air deflector. It costs about \$80 at Sears retail stores and through the catalog. For more information, write Sears, Marketing Communications, Dept. 727R, BSC 2307, Sears Tower, Chicago, IL 60684.



**High Pressure**

This 3/4-hp air compressor is lighter (11 pounds), more powerful and more durable than its competitors, says Sears. It delivers a peak 125 psi and reduces vibration with five internal and four external isolation points. An in-line pressure regulating valve on the 15-ft. air hose lets you adjust pressure without returning to the compressor. It costs \$100 at Sears retail stores. Write Sears, Marketing Communications, Dept. 727R, BSC 2307, Sears Tower, Chicago, IL 60684.

**Take It Off**

This heat gun has a built-in scraper for stripping paint at 1020° F, but the scraper is easily removed when using the low-heat setting (about 500°F) for thawing pipes. Its handle can be used as a pistol grip. It costs about \$40 at hardware stores. Write to Black & Decker, 10 N. Park Dr., P.O. Box 798, Hunt Valley, MD 21030-0748.



**Quick Change**

To change the blades on these 4.8-amp sabre saws, just press a button in the saw's top handle, then turn the handle. No tools are needed. The saw's foot plate tilts left and right to 45°, and its blade moves in either a straight-reciprocating pattern or in a full-orbital pattern for aggressive cutting. The saws come in three variations—a single speed, a variable speed and a variable speed with a dust removal port (\$220, \$250 and \$270, at industrial suppliers). Write Robert Bosch Power Tool Corp., 100 Bosch Blvd., New Bern, NC 28562-4097.



**Low Overhead**

Arrow's 7.2-volt cordless electric staple gun can drive hundreds of staples per charge into construction lumber. And, its manufacturer says, its drive mechanism is jamproof, and its battery recharges in an hour. With a battery and charger, it costs about \$200 at hardware stores and home centers. Write Arrow Fastener Co., 271 Mayhill St., Saddle Brook, NJ 07662. **PM**



**Snug Plug**

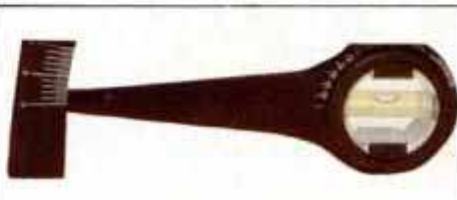
These plug cutters are reamed to produce a cone-shaped plug that fits its hole snugly (see left plug). This results in a neater fit. They are made from high-carbon tool steel, and come in three sizes: 1/4, 3/8 and 1/2 in. diameters. A set of three cutters costs about \$26 through woodworking catalogs. Write Veritas Tools, Inc., 12 E. River St., Ogdensburg, NY 13669.



**Angle Level**

The Angle-finder level reads angles 0° to 90° to within a half a degree, says its manufacturer. It's made of extruded aluminum and finished with a powder coating (shown) or anodized surface. Its acrylic plastic vials are guaranteed

leakproof for three years. It comes in 2, 3 and 4 ft. lengths (\$25, \$29 and \$33, plus \$4 postage), plus intermediate lengths (the 28-in. length shown, about \$28), from Excalibur Hand Tools, Ltd., 10621 S. Lockwood St., Oak Lawn, IL 60453.



# APPLIANCE CLINIC

BY STEVE TOTH,  
Contributing Editor

## Gasket Troubles

I have a GE electric self-cleaning oven, model No. JBP22005HA. The woven gasket on the inside of the door is starting to show signs of wear. I'm rather handy and would like to replace it myself. I would appreciate any assistance.  
GEORGE DUFFY  
BREWSTER, MA

*You need to remove and disassemble the door to replace this gasket. The replacement door gasket is GE part No. WB2X3138, and it costs about \$80 from any GE parts center.*

*To remove the old gasket, disconnect the power to the range. Open the door all the way and check the bottom corners of the inner door panel near the hinges. Some ranges have two screws, one on each side, that hold the inner door panel to the hinge, others don't. If your door has the screws, remove them.*

*Next, close the door to the broil position. Grab the door on both sides, and lift it off the hinges. Place the door handle-side down on a throw rug or blanket on the floor.*

*Now, separate the inner and outer door panels. To do this, remove the two screws at the top of the larger inner door panel that go through the door and attach the handle. Remove all screws along the door's bottom edge that hold the panels together.*

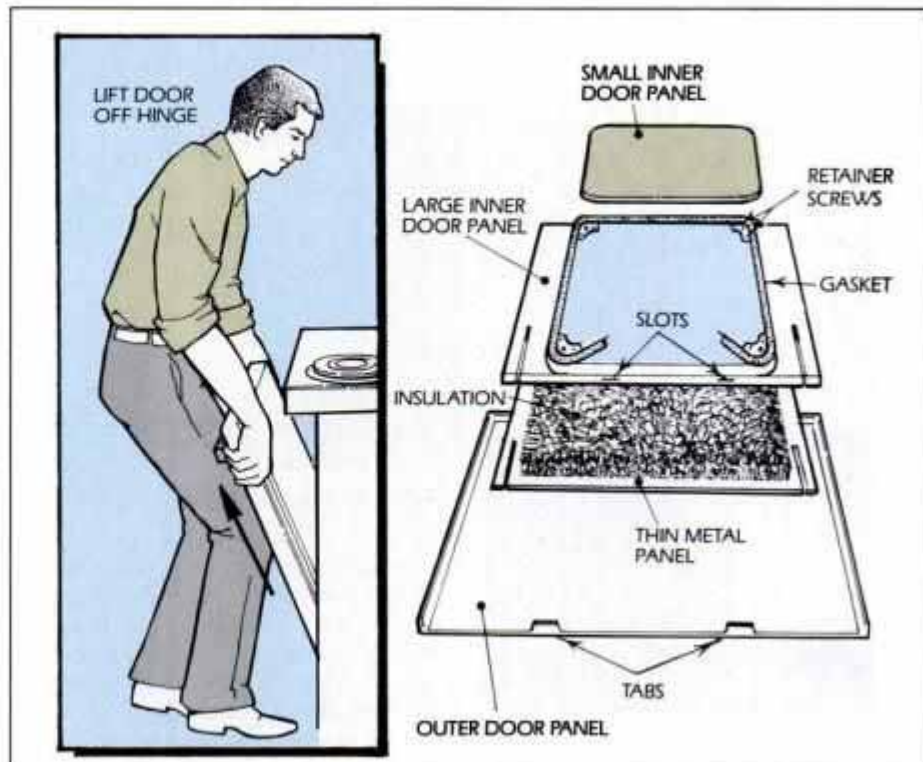
*Slowly separate the panels at the top, freeing the tabs on the outer panel from the slots on the larger inner panel. Set the inner panel beside the outer door panel on the blanket.*

*Now, flip over the larger inner door panel and remove the thin metal panel on the inside of the door and the insulation behind it. This gives you access to the screws and clips that hold the smaller inner panel to the larger inner panel.*

*After the screws and clips are removed, turn the larger inner panel over and remove the smaller inner panel. Remove the retainer screws holding the gasket. Slip the new gasket under the retainers and tighten the screws. Reassemble the door.*

## Furnace Parts

We have a Magic Chef forced-air L.P. gas furnace, model No. G65-80D2C-



Disassemble range door panels to gain access to worn gasket. To replace gasket, loosen retainer screws, remove gasket and slide new one in place.

20, serial No. A17488A98. We need new burners, plus the bracket for holding the pilot light. Where can we get these parts?

HAROLD PAULSON  
CLAYTON, WI

*In 1989, Magic Chef sold its heating and air-conditioning division to Lennox Heating and Air Conditioning Co. Call Armstrong Air Conditioning Co., a division of Lennox, at (419) 483-4840. Armstrong sells to heating wholesalers only. Ask Armstrong for the name of a heating wholesaler in your area. Next, call the wholesaler and ask for the name of a heating contractor in your area. The parts may not be available as Magic Chef, but may be called Armstrong Air or Johnson Air Ease.*

## Wants To Convert

The sensi-temp unit on our GE range, model No. J374X1WH, requires constant costly repairs. I would like to eliminate the sensi-temp part and convert to a manual burner, like the other large burner at the back of the range. I would appreciate any help you can give me.

M.H. IRVIN  
PORTLAND, OR

*According to GE, the automatic sensi-temp surface unit on your range can be converted to a standard*

*operating burner. Just pick up a new burner control, GE part No. WB21X163 (about \$70), and a parts package kit, GE part No. WB21X168 (about \$38), from a GE parts distributor in your area.*

*Both parts are packaged with instructions, but I strongly suggest you contact an authorized GE servicer to do the conversion for you.*

## No Ice

I have a 1979 refrigerator/freezer model No. FPCI-206T8, made by G.M. The icemaker has stopped working, and I can't seem to find parts for it anywhere. Can you help?

L.C. PARRISH  
BADIN, NC

*Unfortunately, the icemaker and parts are no longer available anywhere in the nation. Try calling an authorized Frigidaire dealer. Your refrigerator was built by G.M. and sold under the Frigidaire brand name. Ask the servicer whether he or she can adapt a Frigidaire icemaker, model No. IK-8, to your refrigerator. To locate your nearest Frigidaire servicer, call (800) 451-7007. **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.

PM ILLUSTRATION BY ED LIPINSKI



# WIRING A DOORBELL EXTENSION

BY PAUL BARRETT  
PM Illustrations by  
George Retseck

● In many homes, the door chimes are located in the foyer, near the front door. That's a good central location, but if you spend a lot of time in your kitchen, den or far end of the house, you may not hear the chimes when they ring. You can solve this by installing a chime in the room where you spend a lot of time.

For this story, we installed a chime in a recreation room above an unfinished basement. This is the easiest kind of installation since there is complete access to the wiring from the unfinished basement.

We hooked up a new transformer (one capable of handling the existing chime plus the new chime) and reconnected the wires to the existing chime as they were before. We then placed the new chime and ran bellwire from it to the existing chime. We didn't modify the doorbell button wiring or the wiring from the transformer to the existing chime.

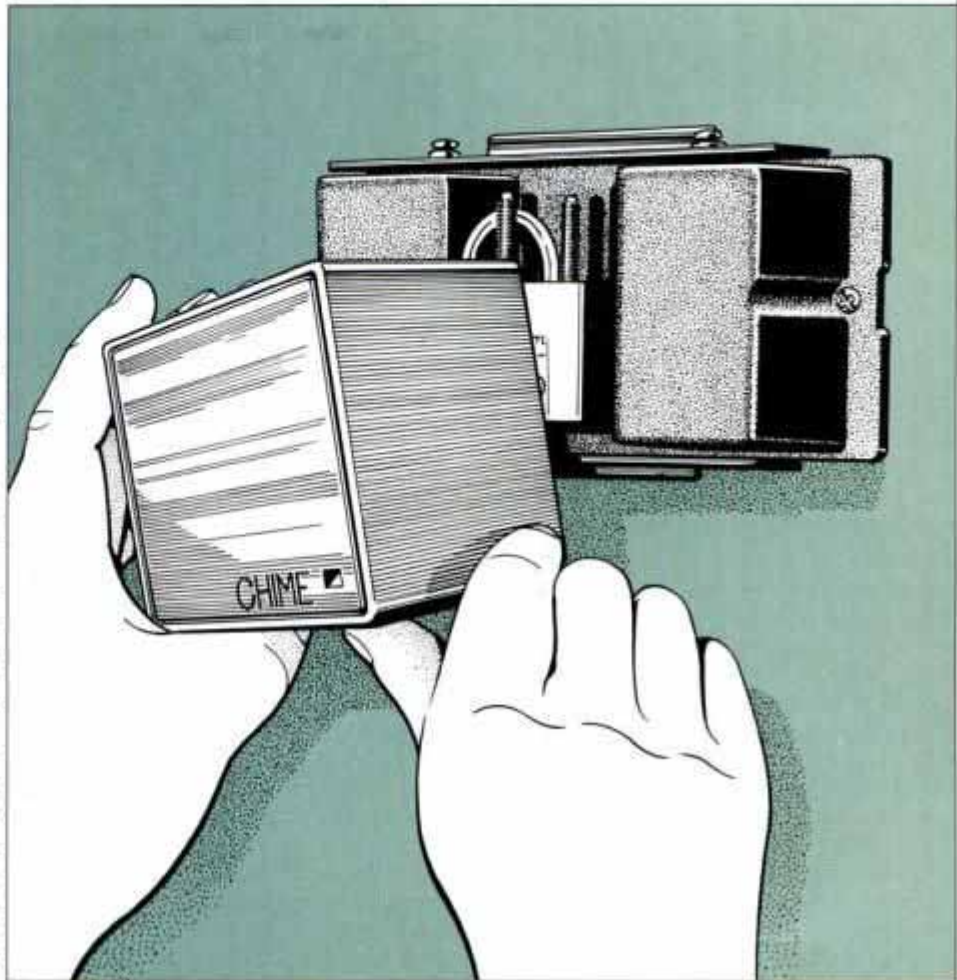
Map out a route for the wiring before you begin the job, so you'll have an idea of the amount of wire you need and the scope of the job ahead.

## Choosing a chime

A trip to your electrical supply house will reveal a wide variety of chimes. Electronic chimes are very versatile. Some can be programmed to play up to 24 notes, so you can greet callers with a melody instead of the usual chime tones.

You should be able to hear the chime you're selecting before you buy it. After all, you're going to hear it every time someone's at the door. If you're looking for a bell sound, avoid the electronic units, because they just don't sound the same as the real thing. Even the cheapest electro-mechanical chime produces its tones by striking a tone bar, making a distinctive sound.

Mechanical chimes have at least two notes. One will sound when the rear doorbell is pressed, and the other will sound for the main entry. It is possible to have as many as eight notes in a mechanical chime, but the 4- and 8-note units require a larger



transformer than a 2-note unit.

If your home is very large and you want to avoid running wires, you might be interested in a wireless unit. These are powered by a battery, and once you mount the sending unit on the door jamb, you're free to place the receiver anywhere in the house. You can also buy an extra receiver and leave one in a permanent location, while carrying the spare with you into the garden or workshop.

The other alternative is a plug-in unit, which can be powered from any standard outlet. You mount the sending unit on your chime, plug in the receiver, and the plug-in remote unit will sound when the button is pressed.

Of course, the sound of these units will differ from the sound of your present door chime, and they cost more than typical 2-note chimes. If, however, your installation looks like it may be a difficult one, the extra cost will be outweighed by the amount of labor saved.

## Transformers

Chimes require between 10 and 24 volts and between 5 and 30 watts. This is considerably less than the 120 or even 220 volts it takes to run the ap-

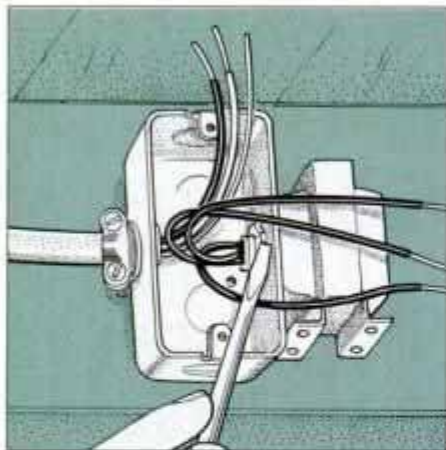
pliances, lights or equipment in your home, so a transformer is used to reduce the voltage. Transformers are available in different sizes, and because you are increasing the load on the doorbell system with an additional chime (and additional wire), you will probably need a transformer with more capacity.

To determine the size transformer you need, simply combine the wattage of the chimes. For instance, a standard 2-note chime uses 10 watts, so if you add a second 2-note chime, you need a 20-watt transformer.

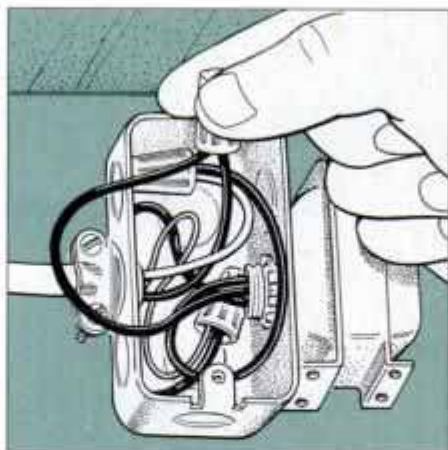
Also, buy a transformer equipped with overload protection. Check with your electrical supplier when you purchase the chime and the transformer, and read the literature supplied with the chime and transformer for this information.

Observe several precautions when connecting a transformer to its power supply. First, although the bell circuit is low voltage, the supply circuit is a full 110 volts, so disconnect power to the doorbell system at the circuit panel before beginning this job. Test the doorbell system to make sure that the power is off.

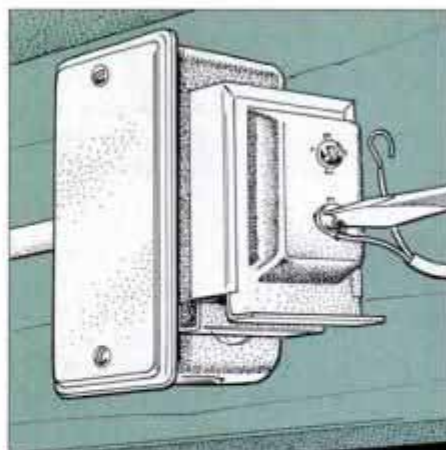
Also, the National Electrical Code



**1** Mount new transformer to a junction box. Run transformer's power supply wires through knockout and tighten nut.



**2** Make connections using wirenuts. Ground wires are hooked together, then to ground screw. Cover box with faceplate.



**3** Reattach the chime wires to the new transformer. Use the wires' color code to help position them as they were before.

prohibits running low-voltage bellwire in the same electrical box with power conductors, unless there is a metal divider separating the two types of wiring. Attach the transformer to the outside of a junction box, and make the supply-side connections inside the box. Make the connections with wirenuts, then attach a face cover to the box.

To connect the chimes to one another, you'll need bellwire, which is rated to carry a maximum of 30 volts. It's available as individual insulated wire or in cables containing up to five color-coded wires.

The National Electrical Code has rules governing the installation of low-voltage cable to ensure that none of the low-voltage wires become charged with house current. Keep bellwire more than 2 in. away from light and power conductors. Do not install bellwire and power conductors in the same conduit or allow bellwire to become exposed to the power conductor.

### Connecting the transformer

With the power disconnected, remove the junction box cover and disconnect the power leads to the transformer. Next, remove the wires on the face of the transformer that run to the existing chime. Note which colored wire was connected to which terminal, so you can replace them in the same order on the new transformer. Loosen the nut that holds the transformer to the box, and remove the transformer.

Next, mount the new transformer with its power supply side facing the junction box knockout. Run the transformer's wires through the knockout and tighten the nut on the inside of the box (Fig. 1).

Connect the power leads and ground wires with the appropriate size wirenuts (Fig. 2). The new transformer will probably have a ground wire where the old transformer probably did not have one. Hook the transformer's ground wire, the power

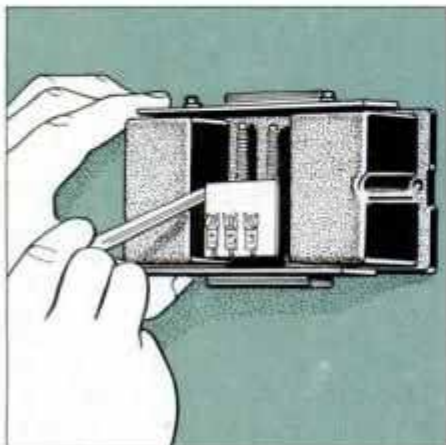
source ground and a connecting ground wire together with a wirenut. Attach the connecting ground wire to the grounding screw in the side of the junction box. This applies to metal junction boxes only, not plastic boxes.

Next, replace the box cover, and reconnect the two wires on the face of the transformer (Fig. 3).

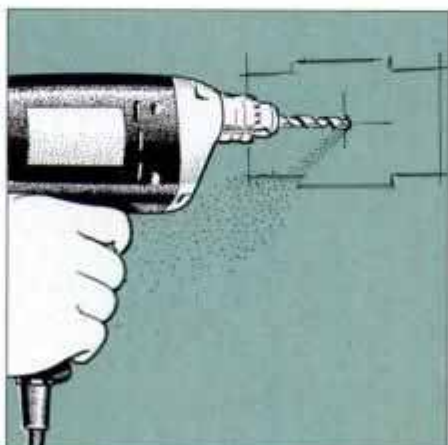
### Running the wire

In general, plan the wiring route to be economical and to create the least disturbance in the wall and ceiling. The primary obstacles to overcome are the top and bottom wall plates and, of course, the floor.

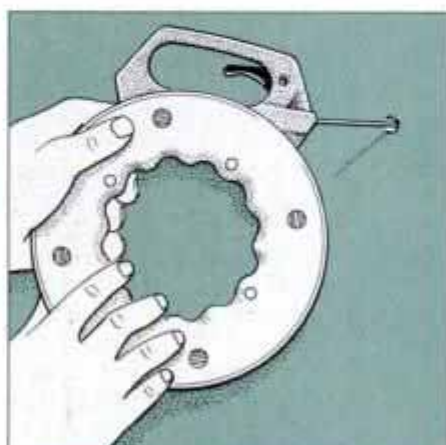
Locate your new chime on an interior wall, so you won't have to contend with insulation when you route the wiring. Examine the wall to determine if it is free of obstructions. Plumbing fixtures, heating and cooling registers, lights, and electrical outlets on either side of the wall indicate that the wall contains mechanical services which may get in your way as



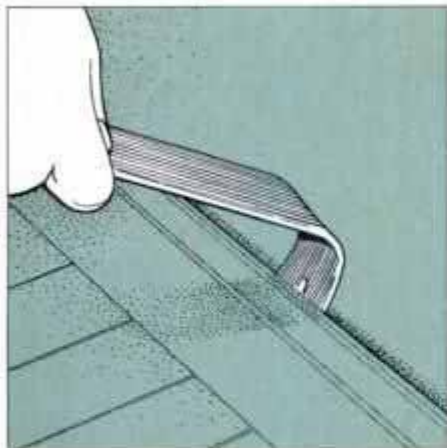
**7** Hold the mounting plate for the new chime against the wall and mark the holes for the bellwire and screw anchors.



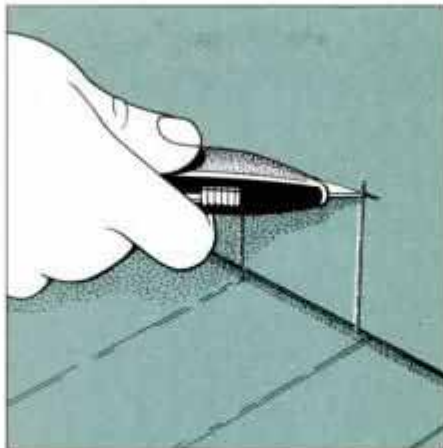
**8** Bore a 3/8-in.-dia. hole for bellwire, and bore a pair of holes for screw anchors to attach the chime mounting plate.



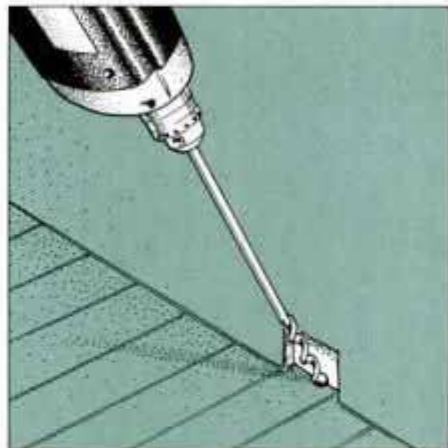
**9** Insert the fishtape's end into bellwire hole and run tape into basement. Connect the bellwire to the tape and retrieve it.



**4** Remove baseboard under new chime. Pry with a flat bar and avoid denting the wall. Pull nails from behind baseboard.



**5** In wall behind baseboard, cut a 2-in. square with a razor knife. Remove the dry-wall to gain access to the wall plate.



**6** Using an extra-long 1/2-in.-dia. auger bit, bore a hole through the plate to run bell-wire up from the basement.

you run the bellwire.

Remove a section of the baseboard directly below where you will locate the new chime. With a flat prybar, gently pull the baseboard away from the wall without piercing the wall surface. Then, pull the nails through from behind the board with locking pliers (Fig. 4).

Next, remove a 2-in. square of wall material at the floor, to reveal the bottom plate of the wall framing (Fig. 5). Using a 1/2-in.-dia. auger bit, bore a hole through the bottom wall plate and the subfloor (Fig. 6).

Hold the new chime's mounting plate on the wall, directly above the hole in the floor. Use a plumb bob or level if necessary to position the plate above the hole in the floor. The chime must be mounted within the same stud cavity as the hole in the plate and subfloor. Trace the mounting plate on the wall with a pencil, including the location of the mounting holes and the larger hole for the bellwire (Fig. 7). Since the chime is located over a cavi-

ty and not a stud, you must drive screw anchors into the drywall and attach the plate by screwing into the anchors. Bore the holes for the screw anchors and a 3/8-in.-dia. hole for the bellwire (Fig. 8).

Run a fishtape through the hole for the wire and feed it through the wall cavity, the hole in the wall plate and into the basement. Attach the end of the fishtape to the bellwire and pull up the fishtape and bellwire through the hole for the chime (Fig. 9).

Next, insert the screw anchors in their holes. Remove the bellwire from the fishtape, and thread the bellwire through the mounting plate. Attach the plate to the wall with the mounting screws (Fig. 10).

Strip the insulation from the bellwire cable and from the individual wires, and attach the wires to the chime terminals (Fig. 11). Make note of the colors of the wires and the terminal screws to which they're attached. Then, route the wire to the primary chime.

## Running the wire between the chimes

You should run the wire as directly as you can from one chime to the other. Fasten the wire to the underside of the floor framing with insulated staples, without piercing or crushing the wire.

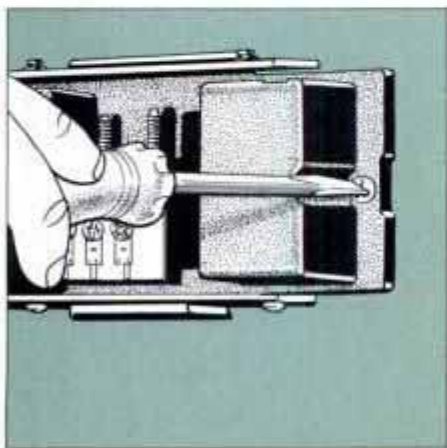
Next, remove the cover from the existing chime (the old chime), unhook the bellwires—noting their position—and remove the unit from the wall. You should be able to use the holes in the wall for the original bellwire to fish the new line.

Remove the baseboard directly below the chime, and pull the nails through as before. Remove a section of the wall material, and bore a hole down through the subfloor. Then, feed the fishtape into the hole at the chime and down through the hole in the floor.

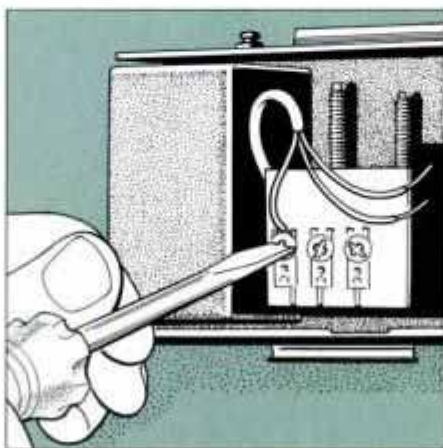
Hook the wire from the new chime to the end of the fishtape, and pull it up to the old chime. Reinstall the chime, replacing the old wires from where they came.

Attach the new wires on top of the existing wires. Both old and new wires should run between the same terminals on each chime. The screws are labeled on the chime as front (for the front doorbell), rear and trans (for transformer). The wire that runs from the front terminal on the new chime should connect to the front terminal on the old chime, and the same for the other wires.

Replace the baseboard at both locations, fastening them with 6d finishing nails and putty over the nail holes. Turn the power on and test the system. If the doorbell works okay, snap on the chime face covers. If not, you should recheck the chime and transformer connections.



**10** Feed the wire through the mounting plate, then screw the mounting plate to the wall. Avoid crimping the bellwire.



**11** Strip the insulation from the bellwire cable, then from individual wires. Screw individual wires to the chime terminals.

# HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

## Hardwood Flooring Over Concrete

I would like to install a strip oak tongue-and-groove floor on top of an above-grade concrete slab. However, I've heard horror stories of costly wood floors buckling from moisture. How can I avoid problems caused by moisture that might accumulate in the area under the slab? I'd appreciate your advice.

LEE GOFBERG  
WOODLAND HILLS, CA

*A hardwood floor can be installed on a concrete slab at or above grade. The Oak Flooring Institute recommends against below-grade installations.*

Moisture is the chief culprit in hardwood floor buckling, so test the slab for dryness. Tape 1 sq. ft. of clear polyethylene sheet to the slab, sealing its edges with plastic tape. If after 24 hours, no clouding or moisture droplets have formed under it, the slab is dry enough to install a wood floor.

To prevent moisture from reaching the underside of the hardwood floor, place a vapor barrier of either building felt or polyethylene plastic over the slab prior to the installation, such as shown in the drawing.

A Hardwood Flooring Installation Manual costs 50 cents from the National Oak Flooring Manufacturers

Assn., 22 N. Front St., 660 Falls Building, Memphis, TN 38103.

## Shingle Query

The shingles on our roof are worn, and we want to have the roof resingled. We don't know whether to use asphalt or fiberglass shingles. Your opinion would be appreciated.

MICHAEL AND BEVERLY FITZSOUSA  
NEW BRITAIN, CT

*Either type of shingle will work for you. Your choice depends on aesthetics, availability and your budget. Generally, the more expensive shingles come with a longer warranty, some of which can reach 20 to 25 years. Hire a reputable roofer who can supply references.*

Many people, even roofers, confuse fiberglass and asphalt shingles. Fiberglass shingles are made with asphalt and should be referred to as fiberglass-asphalt shingles.

An asphalt shingle has a felt-base mat made from rags, paper and wood pulp. The mat is saturated and coated with asphalt, then surfaced with mineral aggregates. Fiberglass-asphalt shingles have a glass fiber mat coated with asphalt and surfaced with mineral aggregates.

The difference between organic and fiberglass-based shingles is

more of a concern to the roofer than the homeowner. Fiberglass-based shingles were developed because roofers found that asphalt shingles, softened during hot-weather installations, were easily damaged. Fiberglass-based shingles are coated, not saturated, with asphalt and are not as easily damaged in hot weather.

However, in the northern United States, organic mat shingles are often used. Fiberglass shingles are difficult to work with in very cold weather because they become brittle and can crack if flexed.

Fiberglass shingles have a better fire rating than organic shingles. Nevertheless, the latter is acceptable.

## Faulty Relief Valves II

In the October '90 Homeowners Clinic (page 56), I discussed why two pressure relief valves in a house's plumbing system discharged. A number of readers wrote in suggesting other causes. I have included two of the letters here.

Some pressure-reducing valves do not allow water to flow back to the street. Thus, when the water heater is used, expansion of water volume occurs. If the home is large and has lots of pipes, this may not be a problem. If not, the pressure increase will push open the relief valve. In most homes, the increased volume/pressure backs up to the street, but with a check valve-type, pressure-reducing valve, it cannot.

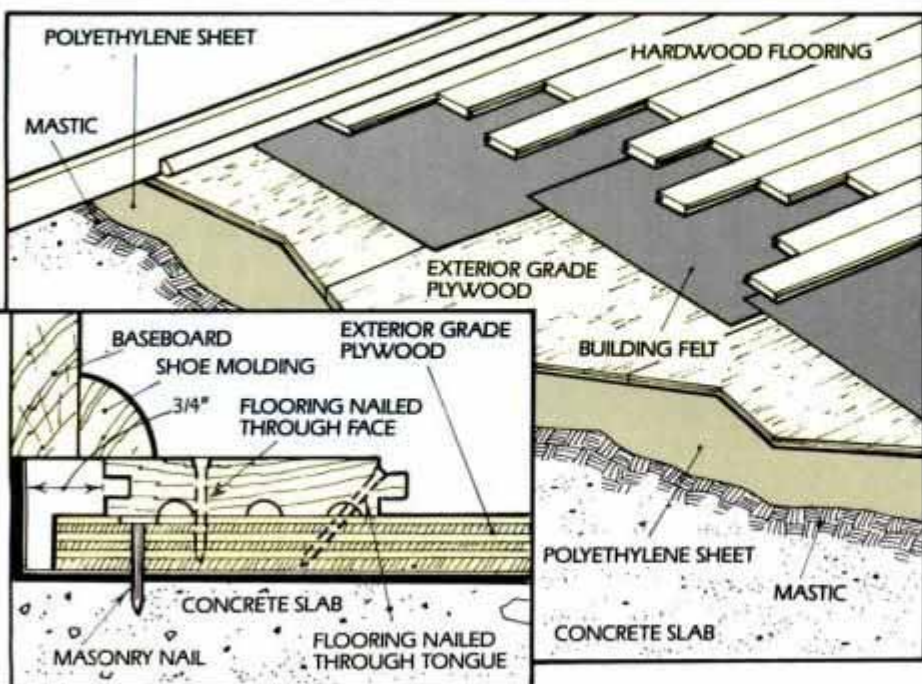
CHARLES KIMBLE  
NAZARETH, PA

Regarding your diagnosis for the slight discharge on the relief valve, I have seen this problem several times and can offer an alternate solution. If the pressure-reducing valve or the city water meter does not have bypass capabilities, then thermal expansion in the water heater will cause the relief valve to discharge. Our solution is to replace the valve with a bypass model or install an expansion tank in the water system.

R. E. EVERS  
EVERS-HUMPL PLUMBING  
& HEATING CO.  
CULLMAN, AL

## 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 hardwood floor can be installed over an above-grade concrete floor if measures are taken—like the ones shown—to prevent moisture from reaching the flooring.

# PAINTING WALLS AND CEILINGS

BY KATIE & GENE HAMILTON  
PM Illustrations by  
George Retseck

● Painting is the most popular do-it-yourself project for two very good reasons. Learning to paint is relatively easy, and your investment in paint and equipment is minimal compared to the dramatic change created by a fresh coat of paint.

The secret to a professional-looking, long-lasting paint job is preparation. Unless your walls and ceilings are in unusually good condition, you will probably spend more time preparing to paint than actually painting.

## Painting equipment

Many time-saving painting gadgets are now on the market. Some are designed for professional use, but many can be economically used by the weekend painter. You'll find the best selection of paint equipment in a store that sells to painting contractors and consumers. A word of advice: Buy good quality equipment and paint.

Invest in a couple of canvas dropcloths. These are heavy enough to withstand rugged foot traffic and will save your carpeting or hardwood floors from wear and tear. Paint splatters are absorbed in a canvas dropcloth, unlike plastic, on which they dry, then flake off in a snowlike flurry. An 8 × 10-ft. canvas is convenient to move around and costs about \$30. Buy more than one dropcloth if you're painting a large area at one time, such as the entire top floor of a house. It's inefficient and messy to constantly have to move one dropcloth as you paint.

Plastic dropcloths cost from \$3 to \$5. If there's a choice, go for the heaviest (highest mil number) plastic dropcloth. You can use these alone or under old sheets, blankets or draperies. Check to see that you do not have a slippery combination because some fabrics will slide on plastic.

Even though most of your painting will be done with a roller, you still need a brush to *cut in* or apply paint in the corners. A 2½-in.-wide brush is the best tool for cutting in. It carries enough paint for easy coverage but is lightweight and easy to handle. Nylon or polyester bristle brushes can be



used with latex or oil (alkyd-based) paints. Bristle (also called China, hog or natural bristle) brushes are used with oil paints and go limp from the water in latex paints.

A 9-in.-wide paint roller is a good choice for the do-it-yourselfer. Buy a roller handle that accepts a screw-in extension pole. The roller handle's frame should be stiff enough to resist flexing. A cheap handle will flex, leaving an uneven coat of paint, and the roller will keep running off the handle. A stiff handle frame allows the roller to be worked into corners.

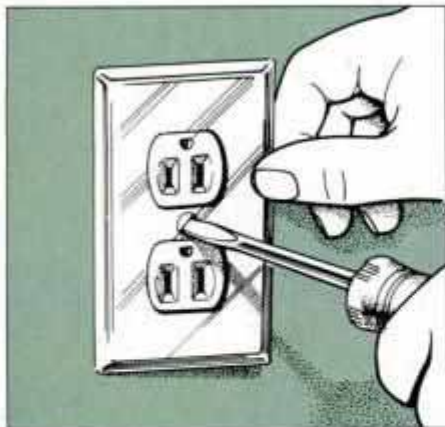
Most good quality roller handles are sold without rollers (sometimes called covers or sleeves). Buy a roller labeled for walls and ceilings or one with a nap between ⅜ and ½ in. long. If you're painting a heavily textured surface, such as walls and ceilings that have received a stucco treat-

ment, get a roller with a longer nap (more than ½ in. long).

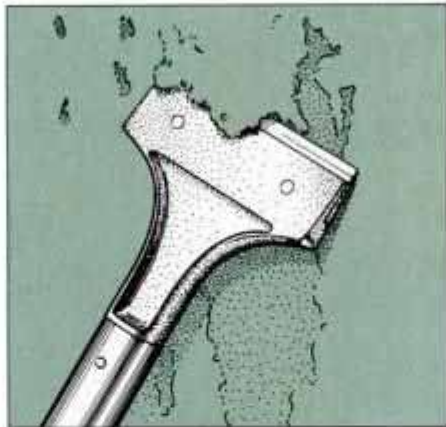
The roller should fit snugly on the handle. The better quality rollers have a plastic core and will provide years of service if you clean them properly. You'll also find a cheaper line of disposable rollers with cardboard cores. Some are made of a spongelike material.

Purchase a sturdy metal roller pan. Inexpensive plastic pans are flimsy and flex when you pick them up, spilling the paint. A metal pan is sturdy and has legs or corner brackets so you can hook it over the top of a ladder.

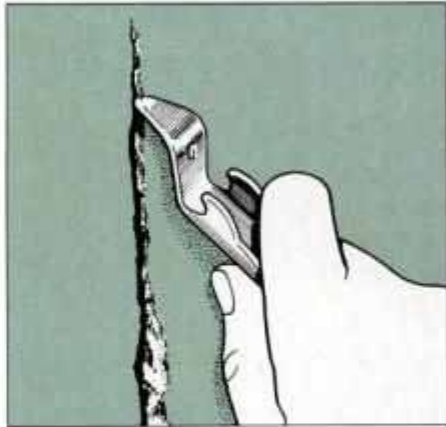
If you're painting several rooms the same color, use a 5-gallon paint bucket with a lid and a roller screen that hangs in the bucket. You can buy a roller screen at paint stores that sell to professionals. The screen hooks over the bucket's edge and hangs in



**1** Turn off the electricity and then remove switch plates and outlet covers. Store them and their mounting screws in a plastic bag.



**2** Scrape off loose paint, dirt, old wallpaper glue and high spots with razor scraper. Change the scraper blades frequently.



**3** Widen small cracks in plaster walls into a wedge shape with a bottle opener. An old screwdriver blade also works well.

the container.

Fill the bucket with a couple gallons of paint, dip the roller into it, and work the roller up and down the screen to push out excess paint.

Screw an extension handle into the roller handle, and you can paint the walls and ceilings without using a step ladder. The extension handle also allows you to spread paint on the roller without bending over. When it's time for a break, just drop the grate into the bucket, snap on the lid, and wrap the roller in aluminum foil.

### Estimating how much paint you need

Figure 1 gallon of paint covers about 350 sq. ft., slightly less if the walls are unpainted drywall. To estimate the amount of paint you need, determine the paintable wall and ceiling area. Add the length of all the walls and multiply this by the ceiling height. From this figure, subtract 20 sq. ft. for each door and 15 sq. ft. for each window. Divide this figure by 350 to find how many gallons of paint you need for the walls. Multiply the ceil-

ing's length times its width to determine its area and divide it by 350 to arrive at the required gallons.

Wall and ceiling paint is sold in gallons and quarts, so round your paint estimate to the nearest quart. For example, if you need 1.33 gallons, purchase 1 gallon and 2 quarts. If you need more than 2 quarts, buy a gallon. You can use the extra paint for touching up later on.

You will need two coats of paint to cover dark colors or if the walls are heavily patched. In this case, use a high-hiding (high solids content) wall primer which is less expensive for the first coat. Ask your paint store to tint the primer to bring it close to the final paint color.

### Choosing paint

Oil-based (alkyd) and water-based (latex) paints are the two major types of paint to use on walls and ceilings. Alkyd-based paints are durable and washable, but tools that are used to apply them must be cleaned with paint thinner.

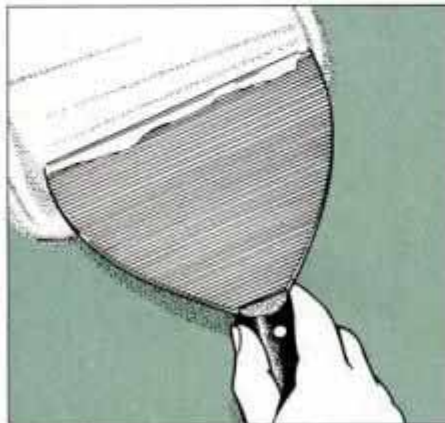
Tools used to apply latex paints are

cleaned with soap and water. Also, latex doesn't have the strong smell of alkyd-based paints—an important consideration if you're painting indoors in the winter and ventilation is less than ideal. Both alkyd and latex wall paint are available in a flat or semigloss finish.

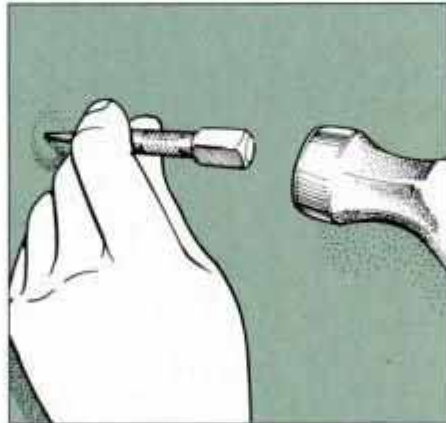
Generally, flat latex paints are the best choice for the do-it-yourselfer to use on most walls and ceilings. Flat paint is easy on the eye since it reflects minimum light.

In heavy traffic areas, like the kitchen, bathroom, hallway or a small child's bedroom, consider using a semigloss paint that can withstand several washings. Alkyd-based paint (flat or semigloss) is a good choice in the bathroom, especially if you like to take long, steamy showers, because it has good resistance to mildew. If mildew appears, it's easily removed with bleach and soapy water. The tough surface of alkyd semigloss finish withstands this kind of washing.

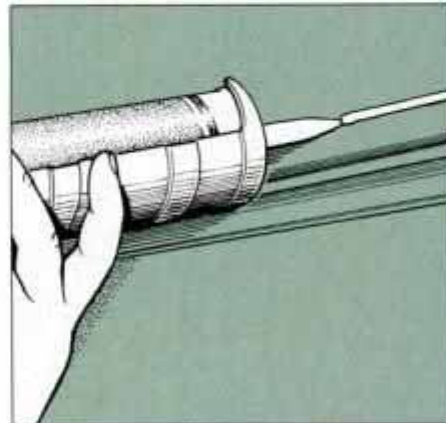
Quality paint gives better coverage and stands up better to washing than economy paints. Most good quality



**5** Use drywall joint compound on small cracks and as a top coat for large cracks. It hardly shrinks and is easy to sand smooth.



**6** Drive protruding drywall nails with a nail set. Place a new nail above the popped nail, then fill the combined nail hole.



**7** Fill gaps between walls or ceiling and moldings with inexpensive latex caulk. The caulk should be a thin, even bead.



4 Apply spackle to the crack with a putty knife. Press in spackle with blade at 30°. Scrape off excess with the blade at 45°.

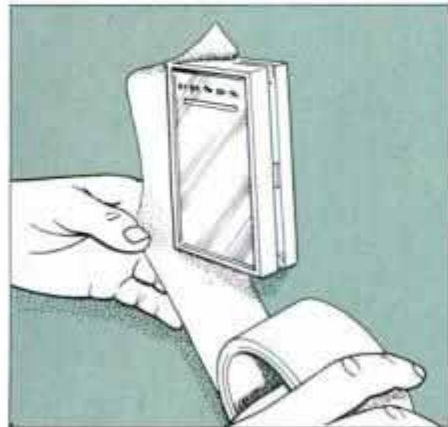
paints offer 1-coat coverage under normal conditions and are actually easier to spread and level than inexpensive paints. The cost of even the most expensive paint is modest compared to the value of the labor involved in preparing and painting the walls and ceiling. Given the extra durability and better finish offered by quality paint, it makes sense to spend the extra \$15 to \$20 per room to buy it.

### Getting ready

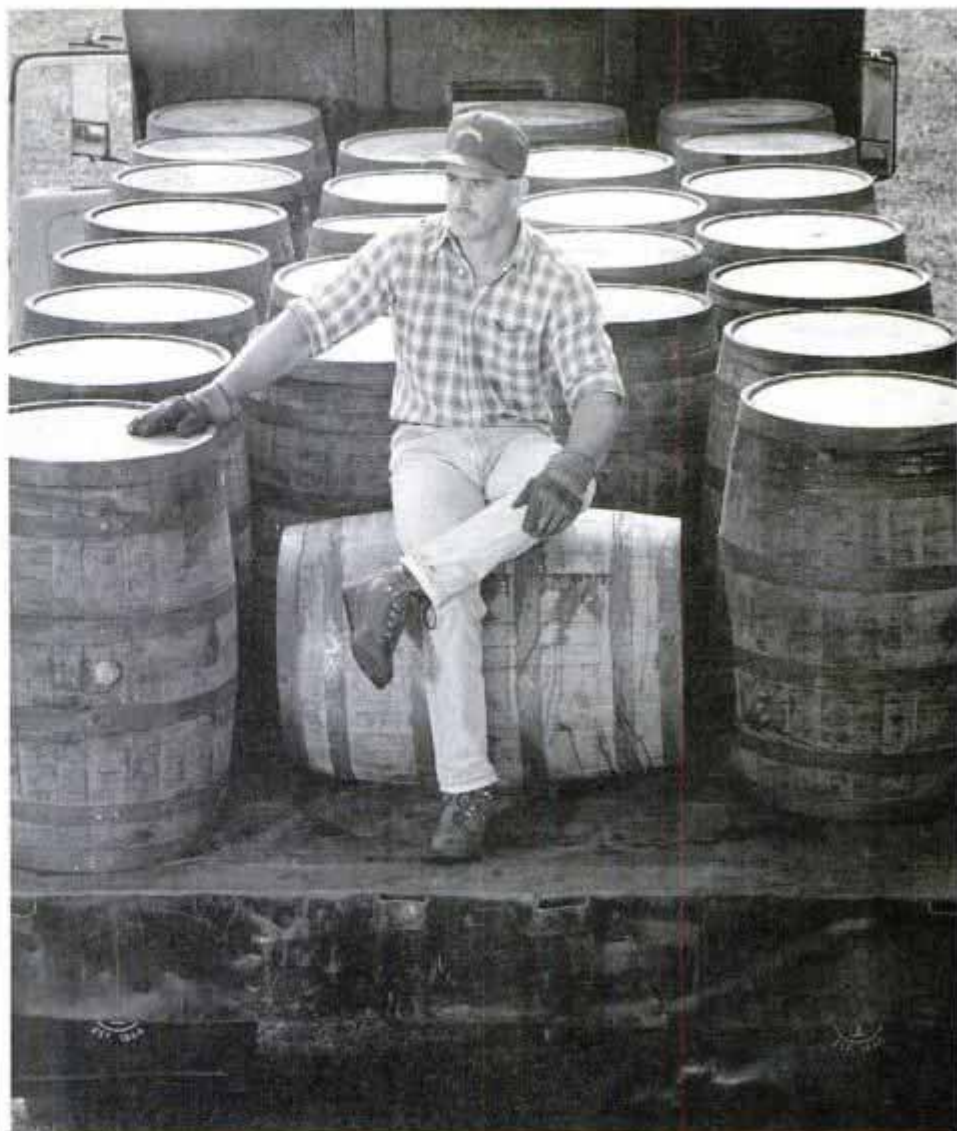
Move as much furniture as you can into other rooms. What can't be easily moved, place in the room's center at least 3 ft. from the walls. If it's a large room, stack furniture in two areas so there's ladder space in between.

Cover household furnishings and anything else left in the room with old bed sheets or plastic dropcloths taped closed. Completely cover wall-to-wall carpeting and hardwood floors with dropcloths, and remove area rugs. Dropcloths should overlap each other by at least 1 ft., and they should reach well into corners and under radiators.

Paint sticks better to a clean sur-



8 Mask off the thermostats, baseboard trim and wall fixtures to protect them from paint splatter thrown by the roller.



If you've never visited our Tennessee distillery, we hope you'll do so soon. We're just an hour below Nashville.

TO BE A JACK DANIEL'S BARRELMAN, it's most helpful to be on the husky side.

Jason Murray may not be straining himself at the moment. But when called upon to hoist an empty whiskey barrel, or to roll a filled one down a warehouse's length, he's up to the job. Jason likes to work hard. But he also enjoys restful moments. Which, come to think of it, describes a lot of the folks who like spending time with our smooth-sippin' Jack Daniel's Whiskey.

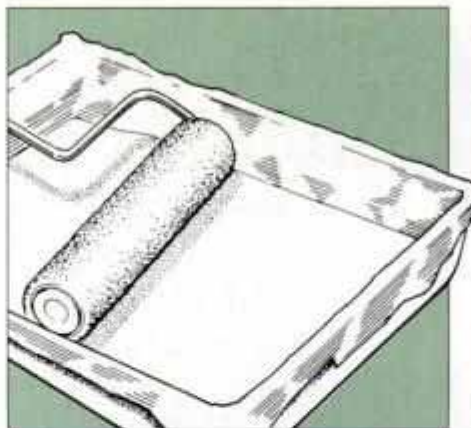
SMOOTH SIPPIN'  
TENNESSEE WHISKEY

Tennessee Whiskey • 40-43% alcohol by volume (80-86 proof) • Distilled and Bottled by Jack Daniel Distillery, Lem Motlow, Proprietor, Route 1, Lynchburg (Pop 361), Tennessee 37352  
Placed in the National Register of Historic Places by the United States Government.

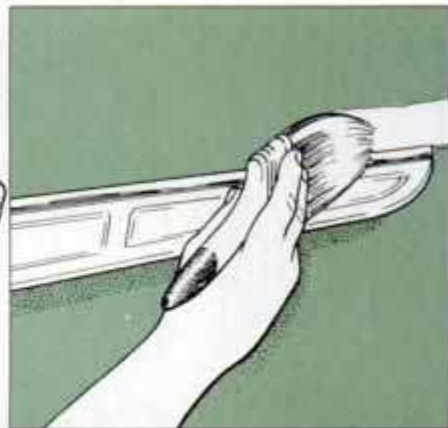




**9** Stains bleed through latex paint, so hide them with shellac-based primer. Apply the primer with a foam brush.



**10** Save cleanup time by lining paint pan with aluminum foil. At the end of the day, pour off excess paint, then dispose of foil.



**11** Hold an edge guard against the wall while you cut in the ceiling. Clean the guard occasionally by wiping it with a rag.

face, so thoroughly dust ceiling corners, baseboards and inside closets. Use a rag wrapped around a broom or a vacuum's crevice tool and duster attachment to reach difficult areas.

Wash dirty walls and ceilings with a solution of trisodium phosphate mixed with water or Spic 'n' Span to remove grease, grime and mildew. Use a strong household detergent if phosphate-based cleaners are not allowed in your area. Rinse the washed area with water, and let it dry.

Remove electrical switch plates and outlet covers. Store the plates, covers and mounting screws in a plastic bag (Fig. 1).

Before painting, make repairs to the drywall and plaster surfaces so they are completely smooth and free of cracks and holes. Caulk the gaps between the walls or ceiling and the baseboards (Figs. 2 through 7).

Protect woodwork and thermostats from the fine splatter tossed by paint rollers by gently applying 1-in.-wide masking tape to them (Fig. 8). For maximum protection, use a flat knife to tuck masking tape into the corner

where wall-to-wall carpeting meets the baseboard. The mastic used on masking tape will set if left in place too long, so remove all tape as soon as the paint has dried.

If it's feasible, remove hanging chandeliers and wall fixtures. Otherwise, wrap them in plastic bags taped closed. Tape carefully, making sure that paintable surfaces are not covered with tape.

If there are any ink or marker pen stains, cover them with a stain killer, such as BIN, a widely available pigmented shellac (Fig. 9). To save cleanup time, line the paint pans with aluminum foil. Dispose of or recycle the foil when you're done (Fig. 10).

### Paint the ceiling first

Paint the ceiling before you paint the walls. Since the paint roller cannot reach into the corners or paint right up to the woodwork, the first step is to cut in the ceiling (apply about a 2-in.-wide band of paint around the ceiling) using a 2½-in.-wide brush. You may want to use an edge guard while cutting in the ceiling (Fig. 11). Wipe the

guard frequently to avoid getting paint on the wall.

You don't have to complete the cutting in before you start rolling. One painter can cut in the ceiling, while another rolls on the paint. Allow the cut-in person to get a head start, then begin rolling. Don't let the painter cutting in get more than 20 minutes ahead of the painter with the roller. Should the painted band dry, the paint applied by the roller then acts as a second coat, and this 2-coat area becomes a lap mark.

If you use the same color on the walls and ceiling, it's not as difficult to make accurate cutlines where the ceiling meets the wall.

Regardless of whether the walls and ceiling are the same color, paint the cut-in line as heavily as you can without dripping. Spread the paint evenly, but don't brush it too much. Use a damp rag to wipe off the walls.

To paint the rest of the ceiling, use a 4-ft.-long extension pole screwed into the roller handle. Start rolling at one end of the room, and work the roller back and forth parallel to the longest



**15** Use a roller with a nap length more than ½ in. to paint rough surfaces, like textured stucco walls or ceilings.



**16** To make cleanup easier, use a paint stirring stick to scrape the excess paint from the roller before you wash it.



**17** Spin dry a roller after you wash it. Hold it in a bucket and pump paint spinner handle. Spinner also works on brushes.

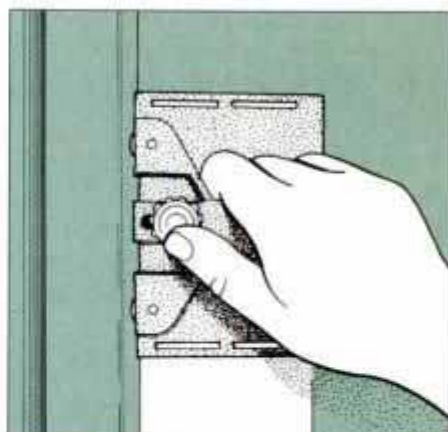




**12** Use a 4-ft.-long extension handle when painting ceiling and walls. The extension screws into the roller handle.



**13** To paint a large area, hang a roller screen in a 5-gallon paint pail filled with a couple of gallons of paint.



**14** Cut in around door and window trim with a wheeled paint pad. If trim is wavy, however, pad leaves a wavy cutline.

wall (Fig. 12). Work your way across the ceiling in 3- or 4-ft.-sq. patches. When you reach the opposite wall, go back to the first wall. This technique lets you spread paint into new areas, but prevents lap marks.

Dip your roller in the paint, but don't submerge it, to avoid getting paint inside the roller (Fig. 13). This can cause runs and drips when the paint begins to leak out. Dip frequently, and don't be stingy. If you try to spread the paint too far, you will not get even coverage. Similarly, don't roll on paint too heavily. This can leave lap marks and runs.

When you are finished, move everything to the center of the room so you have free access to the walls.

### Cut in and paint the walls

With the ceiling painted, start cutting in the corners of the room. Spread paint about 2 in. out from the wall-ceiling corner. Outline one wall at a time, working along the ceiling and into the corners. Then, cut in around door and window trim and cabinets.

Instead of a brush, a paint pad with wheels on one edge can roll along the side of the trim to help make a clean cut (Fig. 14).

The roller person can use the extension handle when painting the upper half of the wall, then remove the handle and finish the wall. Overlap your strokes in the wall's center since this area takes most of the abuse and it's the part that most people look at.

With a little practice, you can use the pole to paint the entire wall. Roll the upper third of the wall and work the roller down. Step back a bit to roll the center, then move closer to paint the lower section. Roll out small sections to avoid lap marks. Use a long nap roller for textured walls or ceilings (Fig. 15).

Take off your shoes if you have to walk off the dropcloth on to an area that is not protected. Otherwise, the paint on your shoe soles can easily be tracked onto clean floors.

Clean tools thoroughly when you're done. Before you wash the rollers, slice the paint out of them with a paint stirring stick (Fig. 16). Wash rollers and brushes in warm soapy water, then spin them dry with a brush/roller

spinner (Fig. 17). Use paint thinner to clean brushes and rollers used with oil paint. Then wash them, spin them, and let them dry.

Store painting tools in the wrappers they came in. Store dropcloths in a dry area—someplace where mildew is not likely to form on them. Finally, keep a brush and some paint handy, even after you clean up, to touch up scuffs left by moving furniture. **PM**



## IMPORTANT SAFETY WARNING TO OWNERS OF RUGER P-85 9MM PISTOLS



We have recently learned of a broken firing pin in a P85 automatic pistol which caused the pistol to fire as a result of decocking. This is the first report of this nature in over 200,000 pistols delivered to customers since 1987. No injury occurred because the shooter kept the pistol pointed in a safe direction during decocking.

Nevertheless, we regard this incident as important because it reveals a potential danger which we are prepared to eliminate in all P85 pistols now in use. This modification is very simple and does not alter the handling or appearance of this pistol, but it must be installed at the factory.

Accordingly, we urgently request that all owners of P85 pistols contact us immediately to obtain any further information they may desire, and to arrange for return of their P85 pistols to the factory for modification. Please contact us at:

STURM, RUGER & CO., INC.  
Dept. S, Ruger Road  
Prescott, AZ 86301

Or call us for P85 inquiries *only* at: 1-800-424-1886. Please have your pistol serial number available when contacting us.

We will schedule your gun for factory installation of a new safety/decock system free of charge. It will prevent this type of accidental firing even in the rare event of firing pin breakage.


This free safety modification applies *only* to pistols rollmarked "P85" on the slide. Pistols which are rollmarked "MKII" will have these modifications as part of their original manufacture, and are not subject to this modification.

We are also taking this opportunity to remind shooters of the most common and basic firearms safety rule:

### ALWAYS KEEP THE PISTOL POINTED IN A SAFE DIRECTION!

This is particularly important when loading, unloading, or decocking any pistol.

Entire contents © 1990 by Sturm, Ruger & Company

When you consider all the advantages of the 1991 Plymouth  **Plymouth Acclaim** Acclaim, we don't think you'll give the Honda Accord a second look. For one thing, Acclaim has available seating for 6. Accord only seats 5. Acclaim offers greater power than Accord, with available V-6 and turbo. Our powertrain warranty is longer, too—7 years or 70,000 miles.\* Safety? We feature standard driver's-side air bags and available 4-wheel ABS braking; Accord doesn't. The Acclaim also costs over \$1,500 less than Accord.† Call 1-800-PLYMOUTH for purchasing or leasing information. Test drive the Acclaim and you won't have second thoughts about owning one.

**WE'RE NOT SAYING THE  
ACCORD IS SECOND RATE.  
MERELY SECOND BEST.**



*Plymouth Acclaim*

\*Protects engine, powertrain and covers outerbody rust-through. See limited warranty at dealer. Restrictions apply. †Base sticker price comparison. Std. equip. levels vary. Buckle up for safety! © Plymouth/Chrysler Motors, 1990

SPECIAL SECTION

# BOATING '91

**THE HOTTEST TOYS OF SUMMER**  
• New Boats • Hot Motors • Great Gear



BOATING '91

# THE LAST DETAIL

Finally, the emphasis is on quality—in both fundamental design and innovative features—in new boats, motors and gear.



BY JOE SKORUPA, *Boating/Outdoors Editor*

● “God is in the details,” said architect Ludwig Mies van der Rohe, a man not known for subtlety. Look beyond the surface. Examine structure, components. Everything must work on its own terms and then integrate smoothly into a larger whole.

For too long, small-boat builders have been selling the *dream* of boating. The problem is that the dream

costs real money, and it often fades rapidly once you leave the dock. Dreams don't have manufacturer defects or need frequent maintenance.

To call a spade a spade, boat builders have tended to be underachievers. A boat should be more than a sound hull and an engine that starts daily. It should display craftsmanlike integrity from the upholstery to the hard-

ware. According to recent signs, the industry finally appears to be moving in this direction.

### **American original**

For 1991, Wellcraft pushes boating into a new era of cruising with its Genesis series, a recent POPULAR MECHANICS Design & Engineering Award winner. The breakthrough boat, pictured above, is studded with innovative features—sponson-assist-

The 20-ft. Wellcraft Genesis, pictured below, handles a bus load of passengers in beamy and feature-filled comfort. Cobalt rethinks fender storage, far left, and just about everything else in its new line. And Four Winns redefines the complete leaning post, at right. In its new line of Quest offshore fishing boats.



ed mod-V hull, bow swim ladder, retractable dock lines, see-through bottom port and many more. It comes as a 20-footer (\$24,495) and a 17-footer (\$17,995). Look for copycats to quickly follow Wellcraft's lead.

It's no surprise when Cobalt builds in quality, but some of this year's features are true originals—bow area headphone jacks, built-in fender storage, bow scuff plate and others. Credit designer Peter Granata for keeping

Cobalt on the cutting edge.

Four Winns, a builder noted for runabouts and cruisers, took a giant leap of faith when it introduced Quest, a new line of offshore fishing boats. Not content with simply producing a me-too model, the 217 Quest has an optional leaning post that redefines the component. In addition to rod holders, it has a complete bait station with a circulating livewell. If you're going to do something, do it right.

While most engine builders are holding back this year, OMC set a new industry standard by introducing the Johnson Silverstar and Evinrude Spitfire series of outboards, another POPULAR MECHANICS Design & Engineering Award winner. New concepts in gear include 3D sonar, night-vision binoculars and many more.

Attention to detail is the essence of quality and the basis for value. There's no better time for it. **PM**

BOATING '91

# NOBODY DOES IT BETTER



World-class boats, from fully loaded party platforms to dedicated fish fighters, combine cutting-edge glasswork with high-concept design.

## BY JIM YOUNGS

● First comes family, then comes fishing. Some people might argue the point, but there's no doubt that both priorities receive prime attention from boat builders this year.

People-pleasin' party platforms

and dedicated fishing machines aren't new to boating. In fact, they're the industry's bread and butter. But this is the year of getting back to basics. Basic designs. Basic values.

After previewing many of the new boats for 1991, it's clear that builders are concentrating on the simple con-

cept of quality—rich fiberglass work, wide-open deck spaces, careful detailing, plentiful features.

And there's never been a better time for it. U.S.-built boats are exploding on the worldwide export market, but they won't continue to set the pace if they don't deliver the steak



**FOUNTAIN 27**



**REGAL 17 VALANTI**



**BAYLINER  
RENDEZVOUS**

with the sizzle. Here's a roundup of 1991 boats that are as flashy as they are strong on fundamentals.

### **Party hearty**

Bayliner's new party platform, the Rendezvous, promises accommodation beyond the norm and delivers. The 26-ft. sportster comes with such desirable amenities as two sinks with foot pumps, built-in icebox, walk-through transom gate, dinette table,

fold-up futon and plenty more.

While it's as big and roomy as a classic pontoon boat, the Rendezvous rides on a fiberglass hull. Stability and speed come from a tunnel configuration that's easy to plane with a standard Force 120-hp outboard. Top speed is a brisk 35 mph. The base Rendezvous, which comes well-stocked, carries a list price of \$15,000.

A different variation on the party-platform theme is found in Larson's

innovative 20-ft. Legacy, which owes more to deck boats than to pontoons. The interior features seating around the whole perimeter of the boat. Under several of the cushions are hidden amenities, such as a head, flip-up sink, refrigerator and armrests.

This sterndrive-powered boat, which is built on a Delta Conic hull, has ultramodern styling from its rounded swim platform to its fighter-plane dash canopy. Some particularly

# BOATING '91

nice built-in features are an enclosed transom compartment for stowing wet ski lines, a hidden swim ladder and a cleanly laid-out helm station. Base price is \$21,325, with either a MerCruiser or Volvo Penta V6.

## Gone fishing

Offshore sportfishing achieves a new twist with Grady-White's Atlantic Flybridge. In addition to a sizable walkaround cuddy, this 27-footer has a raised flybridge like a much larger boat. The bridge enables the driver to get a bird's eye view of the action and increases headroom in the cabin.

The Atlantic Flybridge is specially configured for outboard engines up to 400 hp. The boat holds a whopping 202 gallons of fuel for long offshore runs. It has a complete galley, enclosed head and lots of fish storage.

The bridge itself has two bucket seats plus an aft-facing seat adjacent to the helm. Down below, there's a bait prep station, a transom door and an integrated swim platform. The list of standard and optional equipment is too long to run through here, but with a pair of 200-hp Yamaha outboards, the Atlantic Flybridge carries a suggested retail price of \$78,470.

For freshwater fishing, Sunbird introduces the hot new Prowler. This 17-ft. dedicated bass machine comes fully stocked with everything short of fishing rods—50-hp Johnson or Evinrude outboard, electric positioning motor, pedestal fishing chairs, aerated livewell, tackle trays, rod locker,



rod holders and Lowrance fish finder. Sunbird has tested the 50-hp rig to run a top speed of 35.6 mph with one person aboard. Price is \$7999.

## Sport boats

Even sport boats this year seem to be built on a smaller, family-oriented scale. Take Regal's 17-ft. Valanti, for example. This is Regal's first outboard since the mid 1980s and the smallest boat in its 1991 line. Standard power is supplied by an 85-hp Yamaha outboard, which produces speeds just shy of 40 mph.

The open-bow Valanti, which can

easily accommodate the whole family in an interior that features maximum seating, comes as a very complete package—integrated swim platform, trailer and full instrumentation. It carries a package price of \$12,609.

Another family runabout, the 186 Concept, debuts this year from Chris-Craft. This bowrider is also configured for outboard power and comes with a 115-hp Johnson or Evinrude engine that has trim and tilt.

The 186 is the eighth model to appear in Chris-Craft's successful Concept series. The distinctive white-on-white scheme and smoothly flowing lines surround a well-laid-out boat. It comes with full instrumentation, a split swim platform and a unique wraparound aft sunpad. The base package lists for about \$16,000.

Some folks like to party in the fast lane, but doing it in a boat that costs less than a second house is often difficult. Fountain Powerboats offers a way in 1991 by introducing its new 27, the first single-engine Fountain.

This everyman's Fountain has the hot looks and capability of an offshore racer, yet comes in a practical and affordable size. Like all Fountain boats, the 27-footer uses bi- and tridirectional fiberglass, a completely cored hull, full-length stringers and a glassed bond between hull and deck. It also features quality amenities—stand-up hydraulic bolsters in the cockpit, trim planes, Kiekhaefer controls and Stewart-Warner instrumentation. Standard is a MerCruiser 454 Magnum. Sticker price is \$58,000, which is a lot of boat for the money and emphasizes the twin 1991 themes of hot design and sound value. **FM**





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Today, the price of a Ford F-150 pickup is less than that of a comparably-equipped Chevy.\* But a lower price is just the start of today's value news.

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The study also predicts that the resale value of a 5-year old Ford will be higher than Chevy's.\*\*

Buckle up—together we can save lives.

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

\*MSRP Ford F-150 XLT Lariat (auto, trans.) vs. comp. equipped Chevy C1500. \*\*Complete Small Truck Cost Guide, 1990, IntelliChoice® Inc. Resale Estimate for F-150 and C1500 base models with selected options. Actual oper. costs and resale prices may vary. "Best-Built" claim based on an average of consumer-reported problems in a series of surveys of all '81-'90 lt. truck models designed and built in North America. Sales by Division.

# YEAR OF THE OUTBOARD

New engines get more out of less in radical redesigns and new-wave 4-strokes.

BY TIM BANSE

● The horsepower wars of the 1980s spawned massive outboards with awesome capabilities. The decade's power trip was basically accomplished through bigger cubes, but over time these monster motors evolved from being big, dumb and

happy into highly sophisticated machines that are hard-wired to electronic fuel delivery, computerized ignitions and precision oil injection.

Today, the advanced technology that first appeared on huge fire-breathers is now beginning to trickle down into affordable midrange engines. The new 1991 outboards—



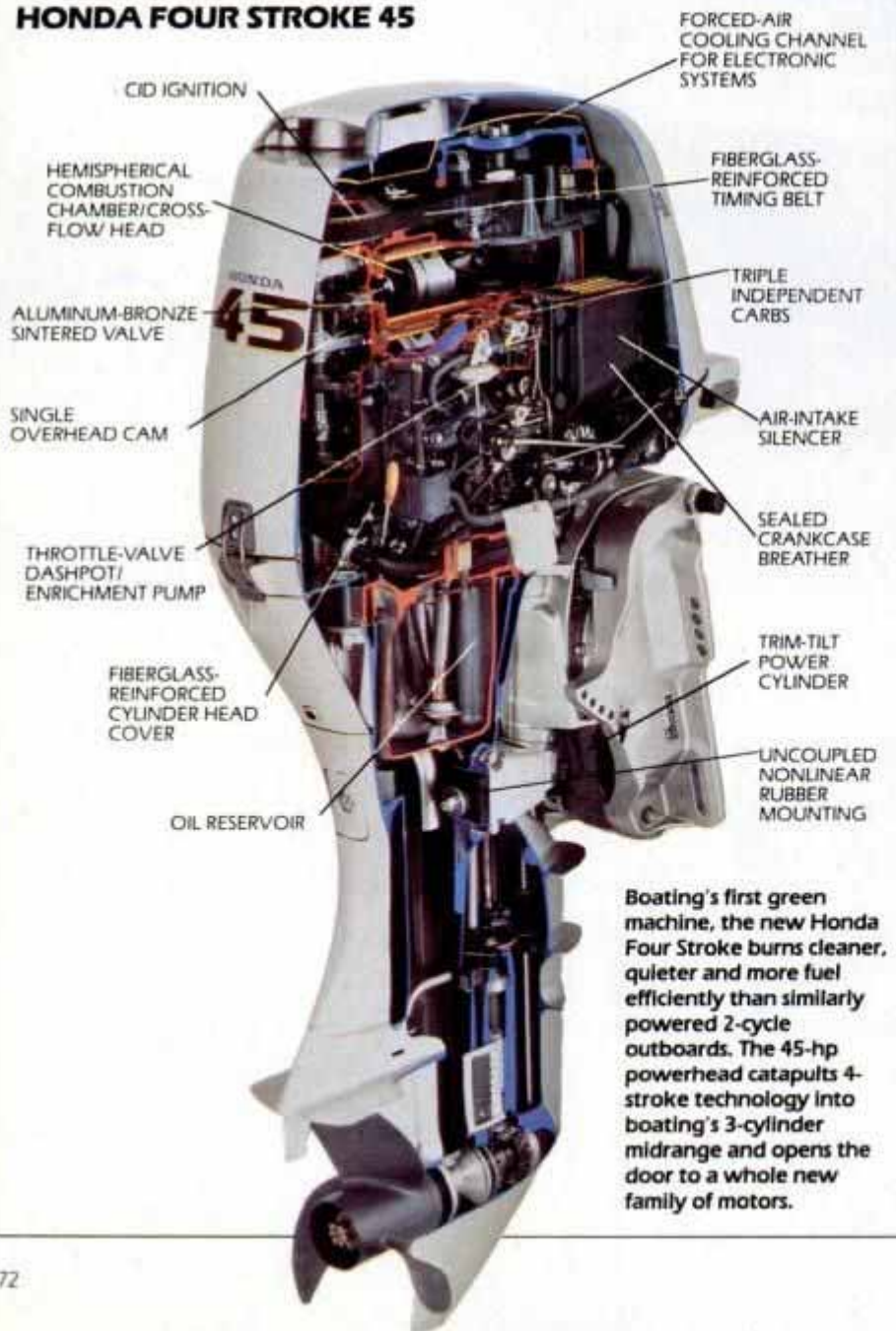
The landmark design of OMC Silverstar/Spitfire outboards required 43 patents. Innovations go from the faster, quieter midsection up.

there was very little action in stern-drive engines—cut a cleaner profile, hang lighter on the transom, generate more power, burn gasoline and oil more efficiently, run with less noise and last longer between tuneups.

### The OMC edge

The epitome of recent advancements is well-represented in OMC's new series of outboards, the Johnson Silverstar and Evinrude Spitfire series, winners of a POPULAR MECHANICS Design & Engineering Award for 1991 (page 27, January '91). Sophisticated hardware is abundant: optical/electronic ignition, magna-quench alternator magnets, easy on-and-off carburetor assemblies and finger ports, which are akin to 4-valves-per-cylinder performance. The list of refinements on this state-of-the-art engine, too long to run through here, is truly impressive and sets a new industry standard.

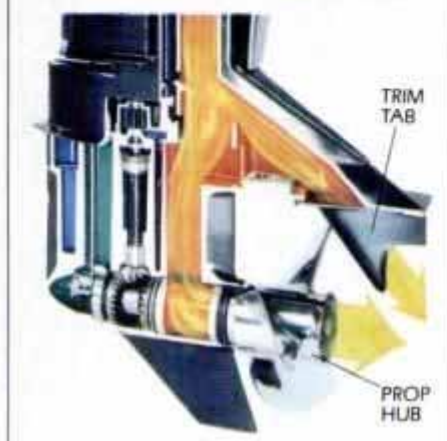
### HONDA FOUR STROKE 45



Boating's first green machine, the new Honda Four Stroke burns cleaner, quieter and more fuel efficiently than similarly powered 2-cycle outboards. The 45-hp powerhead catapults 4-stroke technology into boating's 3-cylinder midrange and opens the door to a whole new family of motors.



## FORCE DUAL EXHAUST



Power-draining backpressure is eliminated on Force outboard's 90 hp and up by channeling exhaust through the prop hub and the trim tab.

But lost in the shuffle of dazzling performance levels and advanced hardware is a brand-new midsection, called OMC FasTrak, which also debuted on new Silverstar and Spitfire outboards. This completely redesigned unit, which is the segment that bolts onto the transom, is as impressive as the new powerplant. It operates twice as fast and half as noisy as previous midsections.

The FasTrak midsection extends the trim range from 15° to 21°, and allows an additional 12° of tilt. If you've had trouble raising your engine entirely out of the water in the past, those days are over. To prevent the possibility of damage caused by excessive tilt, there are locks at several positions. But the really big news is that FasTrak isn't limited to the big, high-end Spitfire and Silverstar motors. Instead, it's coming on line for all Johnson and Evinrude outboards from midrange 3-cylinder models up through the V6s.

The new 60° V6 powerheads will be offered in eight models, four each by Johnson Silverstar and Evinrude Spitfire. Both 150-horse and 175-horse models will be offered using the

same basic powerhead—the difference will be in carburetion, porting and timing. Of the eight new models, four will be specially tuned for bass fishermen. These are called the Silverstar FastStrike and the Spitfire Intruder.

## Green machines

A prediction for the '90s: Look for more green machines (green as in ecology) as the environment becomes an even bigger concern. The problem with outboards in this environmental age is that, for the most part, they're 2-cycle technology. In other words, they're motors that mix and burn lubricating oil along with gasoline. Compared to automotive engines, whose emissions are heavily regulated, this is a relatively dirty process. The day will eventually come when environmental regulators take a closer look at marine technology.

Honda decided to get the jump on this trend by developing a new line of clean-burning, 4-cycle outboards. Honda has been making 4-stroke outboards since 1974, but production was limited, and the line only covered low-end motors to 15 hp. This year, Honda expands into the midrange, with new 3-cylinder, 35-hp and 45-hp motors, and takes the early lead in the green revolution.

Instead of burning oil with the fuel mixture, the new Honda Four Stroke engines lubricate bearings and pistons the same way that car engines do—with a recirculating, pressurized flow of crankcase oil. Since the engines don't burn lube oil in the combustion chamber and also don't discharge unburned fuel with the exhaust, hydrocarbon emissions levels are significantly reduced.

By simply using 4-stroke technology in outboards, a proven system that's been around for years, Honda gains an edge with environmentally conscious boaters. But clean-burning operation isn't the only benefit. The new Honda engines are also quieter and less prone to vibration than their 2-stroke counterparts. This is especially true at low-rpm trolling speeds. Boaters will pay a bit extra for Hon-



The 2.5-liter XRI continues Merc's industry leadership in electronic fuel injection. Displacement moves up from 142 cu. in. to 153 cu. in.

da's 4-stroke technology. They'll pay a weight penalty, too, since the engines tip the scales at about 200 pounds. But Honda is betting that improved fuel consumption and increased governmental regulation will eventually move the marine market in its direction. And when it does, Honda will already be a leader.

## Dual Exhaust

The big corporate news this year out of Fond du Lac, Wisconsin, is the melding of the Mercury, Mariner, MerCruiser and Force engine lines into a single unit called the Brunswick Marine Power Division. Don't be surprised to see some tried-and-true Merc componentry making an appearance on future Force outboards.

Force, however, introduces an interesting development of its own this year: a Dual Exhaust system that ap-

*(Please turn to page 75)*



Heavy-duty parts and low-ratio gears give the durable Yamaha Pro V 200 plenty of muscle.

## Engine Of The Decade: The Ubiquitous 454

● The word dominance comes to mind. Recently, Chevrolet boasted that its blocks are found on about 80 percent of all marine sterndrive and in-board engines. Even more impressive, its big-block engine, the durable Chevy 454, has a virtual lock on the production-line, high-performance market. Why is this? How did the 454 become boating's top gun?

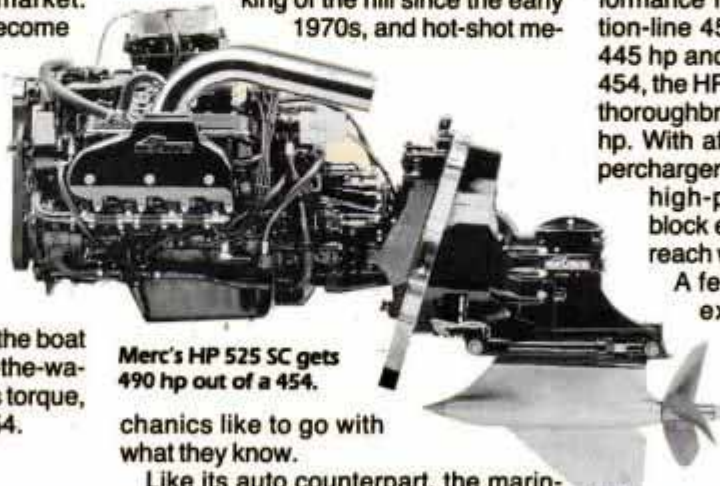
The simple answer is that Chevy's 454-cu.-in. V8 engine is a remarkable hunk of Detroit iron. With Jovian proportions (4.25-in. bore x 4-in. stroke), it cranks out an avalanche of torque. In boating, torque is the ultimate weapon. Maximum horsepower is achieved when the boat is moving. But to get a dead-in-the-water hull to leap on plane, it takes torque, and nothing supplies it like a 454.

### King of the hill

Another key factor for the 454's phenomenal success is availability. If you want one, you walk into a high-performance shop and pick one up off the shelf. Complete engines, partial long blocks, cylinder heads, crankshafts and internal components are also readily available at thousands of

General Motors dealerships.

Even better, aftermarket racing cams, carbs, valves, manifolds and other trick components are inexpensive when compared to pricey MoPar and FoMoCo equivalents. And, finally, familiarity breeds content. Chevy 454s have been king of the hill since the early 1970s, and hot-shot me-



Merc's HP 525 SC gets 490 hp out of a 454.

chanics like to go with what they know.

Like its auto counterpart, the marinized 454 boasts a multitude of personalities that run from mild-mannered family cruisers to scrupulously massaged, monster-cube screamers. Depending on how the block is dialed in, the dynamometer can peg the needle anywhere between 300 hp and more than 1000 hp.

MerCruiser, the pioneer in big-block

applications, marinizes sterndrives in a variety of flavors. The most common Merc big-blocks start with 300-horse 7.4-liter sterndrives and run up to brawny 454 Magnums, which are rated at 350 hp.

In the rarefied realm of high-performance racing, Merc offers production-line 454s that pump out 385 hp, 445 hp and 465 hp. The hottest Merc 454, the HP 525 SC, is a supercharged thoroughbred rated at a whopping 490 hp. With aftermarket intercoolers, superchargers, turbochargers and other high-performance parts, a big-block engine can be massaged to reach well-beyond 1000 hp.

A few years ago, OMC Cobra experimented with Ford's

460-cu.-in. block, a logical alternative to the 454, but recently dropped it from the catalog. The reason? Buyer acceptance played a part, but commitment to the marine market, or lack of it, by FoMoCo was rumored to be another.

There's no lack of commitment to boating at General Motors, and, for this reason, the preeminence of the Chevy 454 isn't likely to be challenged any time soon.

—T.B.

# Everything Moves Bet

Vehicles roll up more miles with the bumper-to-bumper wear protection our lubricants give.



All recreational equipment delivers more fun when our lubricants smooth the way.



Everything moves easier, faster, stronger and longer when our lubricants are smoothing the way. Any part that moves—gears, bearings, joints, hinges—on any vehicle or equipment deserves our protection.

Our quality lubricants are the best at reducing wear and tear because lubricants and lubrication equipment are the only things we make. So we make them better.

pears on 90-hp to 150-hp outboards and L-Drives. In addition to the standard through-the-prop exhaust, the new system also channels exhaust through the trim tab. By doubling the exhaust outlets, power-draining backpressure is minimized.

The main reason for directing exhaust underwater is to keep it quiet. The problem is that water acts as a resistant force and builds up backpressure, which requires the engine to use horsepower to push the exhaust out. Force's Dual Exhaust system solves this problem and improves performance at both low rpm and top end.

One technology worth monitoring in the decade ahead is Brunswick Marine Power's EFI (Electronic Fuel Injection). In 1991, Mariner offers EFI as an option on its carbureted 175 hp. Similarly, Mercury Outboards offers both its 175- and 200-hp models with the EFI option. Stay tuned as EFI begins to move down the lineup into the balance of its V6s and V4s. Other manufacturers will have to follow.

## Yamaha brawn

Yamaha is a company that does its best each model year to occupy prime turf on the leading edge, and 1991 is no exception. This year's eyebrow-

raising outboard is the Pro V 200, which is intended for professional fishermen and for high-performance waterskiers.

This hot V6 is reminiscent of a flame-painted muscle car. The powerhead is dialed in with high-output carburetors and pulse-tuned exhaust. The drive leg is fitted with heavy-duty, low-ratio gears especially intended to give the motor extra punch on acceleration.

The smart oil-injection system feeds a steady supply of lube at exactly the right ratio—no matter what the rpm or load. And hard rubber mounts hold the motor rock-steady during high-speed maneuvers. The Pro V is built to endure tough duty and deliver head-snapping power.

One major trend this year, which encompasses all builders and affects nearly every engine, is the pumping up of cubes within a given horsepower rating. For example, OMC's latest 150-hp outboard displaces 158 cu. in. Displacement on previous 150s was 149 cu. in. And Mercury's new 50-hp powerhead, for another example, displaces 51.8 cu. in. Its predecessor displaced 49.8 cu. in.

What's the reason for this upgrade? Marine engine builders are now re-

quired to rate engine horsepower at the propshaft instead of at the powerhead. The difference between the two measurements, in some cases, can run as high as 10 to 20 percent. Eventually, all engines will be beefed up within their power rating, and you'll be able to feel it at the throttle.

No doubt some boaters, especially sterndrive fans, may feel that the engine builders are holding back this year. It's no secret that the industry is in one of its cyclical slumps, so this approach may be understandable from a business point of view.

But the truth is that with the introduction of the new OMC 150-hp outboard series, the 1990s start off with a bang. This engine is truly a milestone achievement, and it may be a sign that the days of incremental engine development are drawing to a close. By the end of the decade, spurred on by environmental concerns and government regulation, we may see widespread acceptance of 4-stroke outboards, 2-stroke sterndrives, catalytic converters, fuel injection, four to six valves per cylinder, multiple cams and numerous other advancements.

The race for future marine engine leadership is just starting to heat up, and boaters are in for quite a ride. **FM**

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# GREAT GEAR

Super stowables for the boat locker.

BY JOHN WOOLDRIDGE

● Personal watercraft, the rad sport machines of the water, keep making waves. New models are slicker, quicker and, of course, more fun. Two-up cruisers appear to be the big trend of the 1990s.

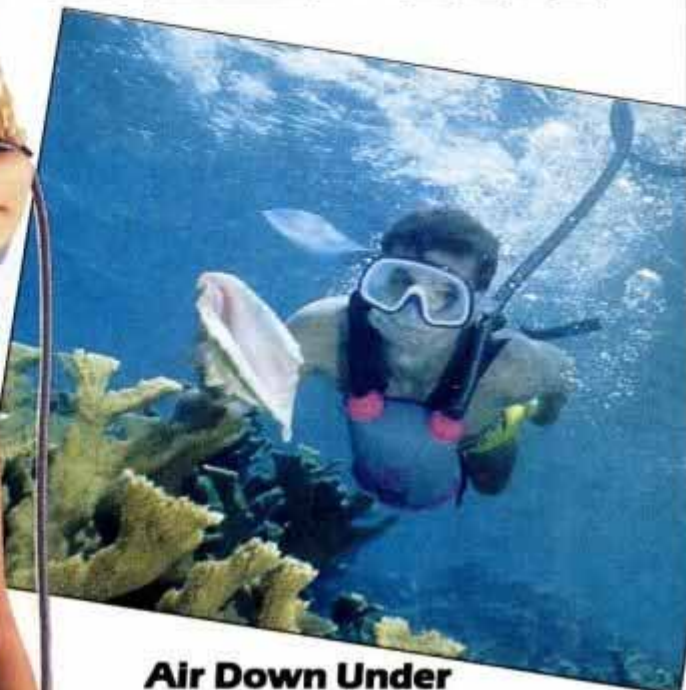
Marine electronics stay on the leading edge by improving night vision and making radio communications a private conversation through electronic scramblers. Software and hardware advances bring 3D imaging to sonar units for fish-finding.

Freedom afloat moves into new areas with a breakthrough multihull sailboard and a portable inflatable that folds up to the size of a suitcase.

Health and safety advances range from rugged cross-trainer deck shoes to inexpensive carbon monoxide detectors for the engine. Modular props are easy to repair and stow. Pop-up cleats are among the new accessories you can't live without.

Fishing gear keeps pace with turntable foot controls for electric trolling motors and high-tech reels with advanced ergonomics.

Someone once said the difference between men and boys is the price of their toys. This was amended to the guy with the most toys wins. But everybody's a winner with this year's lockerful of new gear.

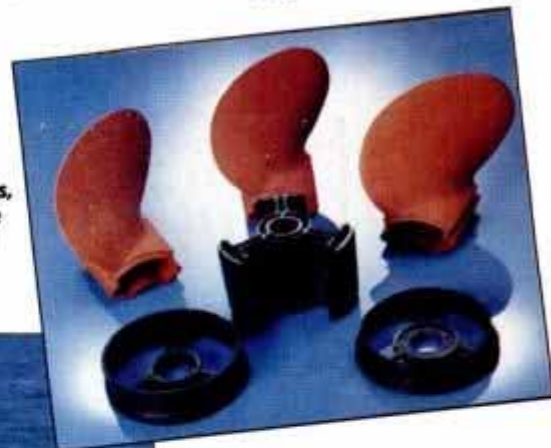


## Air Down Under

Enjoy diving to depths of 20 ft. all day with Diveman (\$479). It weighs just 11 pounds and stores in its own compact bag. An air pump is activated by normal swimming activity and provides an unlimited supply of air.

## Blade Simple

Changing pitch or damaged blades on Piranha Propellers (\$129) is a snap—remove the end cap, slide on the blades, and then retighten. Made of composite materials, it relies on a unique hub and tapered slots. Fits most Mercury and OMC outboards and I/O units.



## Wet & Wild

Yamaha's tandem-riding VXR (\$5099) is a new-generation WaveRunner with a mod-V bottom for tighter cornering. An aggressive 50-hp, oil-injected engine provides a new level of performance. A huge 7.9-gallon fuel tank means fewer pit stops.

(More Boating '91 on page 78)

Introducing

# Bolens One-Step Mulching Advantage

*No Bagging...  
No Raking...  
No Clean-Up PERIOD!*



Now, from the originators of mulching mower technology, a completely new generation of Bolens One-Step Mulching Mowers including...



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Bolens 1991 Lawn Tractor line-up features a revolutionary new One-Step Mulching System. It's an innovative attachment that lets you mow, fertilize... and practically eliminate grass clippings in *one easy step*. No bagging...no raking... no clean-up PERIOD!

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...The One-Step Advantage!

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## Wind Cruiser

Jim Drake and Yamaha New Sport debut a new outrigger cruising sailboard called the Waterspyder (\$2600). Stash your gear inside roomy compartments, and sail over the horizon. This collapsible multihull is light enough to carry. It stows easily on car tops. Operation is similar to a sailboard, but less tiring due to the outriggers.



## Straight Up Or Scrambled

Keep your VHF calls private. Digital Selective Calling (DSC), offered on Ross Engineering's DSC 500 Secure Marine Radio (\$1495), allows you to call direct using an electronic voice scrambler. It has audio and digital calling, a digital Mayday button and a loud hailer.



## The Flash Of Splash

Hang on for thrills with the new high-performance Sea-Doo XP (\$5699). Bombardier's latest personal watercraft comes equipped with a 60-hp Rotax engine and zips along at a brisk 45 mph. The performance equipment includes dual rearview mirrors, tach, fuel gauge and oil level indicator.



## Boat In A Bag

Most inflatables have separate floorboards. Avon's new Rover 3.15 Roll-Away (\$2275) doesn't. It uses nonslip decking that enables the 10-ft., 110-pound dinghy to roll up tightly for easy storage. Two independent air chambers provide buoyancy and stability for up to five passengers. Avon guarantees the inflatable for 10 years.



## Pick A Fish, Any Fish

Bottom Line's 6600 Specie Select (\$700) helps anglers select and use electronic features designed specifically for walleye, bass, salmon, trout, muskie, panfish and striped. Environmental selections include lake, river, salt water and ice.





## The Ultimate Fish Finder.

There are more than a handful of interesting gadgets around designed to help you catch fish. Not to mention the numerous secrets fishermen have shared over the years.

But if you really want to catch fish, knowing where they are is only part of your problem. Getting to where they are completes the equation, and that's where Evinrude® outboards come in.

To begin with, our outboards are designed with the specific needs of the fisherman in mind. That's why our gear case water intakes resist plugging in weeded areas.

We also realize that if you want to keep up with

a fish, you've got to have a few moves up your sleeve. So thanks to fuel-injection starting, you can always count on starting up fast. And with our patented VRO<sup>2</sup>™ oil injection system, we'll keep your outboard running smoothly no matter how many fish you're after.

To find out more about the outboards that hook more fishermen, call 1-800-255-2550 for the name of the Evinrude dealer nearest you.

You always thought you could fish with the best of them. As it turns out, you were exactly right. **EVINRUDE®**  
**Evinrude Owners Are Born, Not Made.**

# BOATING '91

## GREAT GEAR



### Pocket Loran

Pinpoint your position with Ray Jefferson's PL-99 handheld Loran-C receiver (\$700). This pint-size, portable unit stores up to 99 waypoints, or fishing spots. It has a 2-line, backlit readout and a self-contained, rechargeable battery. It can even get you back home in the fog.

### Tandem Time

Side-by-side seating on Kawasaki's Jet Ski SC (\$5599) affords operator and passenger a clear view forward. An adjustable steering yoke puts either rider in command. A peppy 635-cc 2-cylinder engine pumps out the power. A 6.6-gallon fuel tank helps make the fun last.

### Foot Patrol

Foot-controlled electric trolling motors aren't new. But MotorGuide's ESP (\$900) unit advances the idea. Instead of up-and-down pedal action, the ESP uses a revolving turntable. For precise, predictable steering, just point your foot in the direction you want to go.



### After Midnight

Fujinon's Marine Night Viewer (\$2295) lets you scope out the water ahead on the darkest night. Waterproof and compact for 1-hand use, it takes two AA batteries to power image intensifiers for 120 hours. The scope amplifies light more than 300 times.

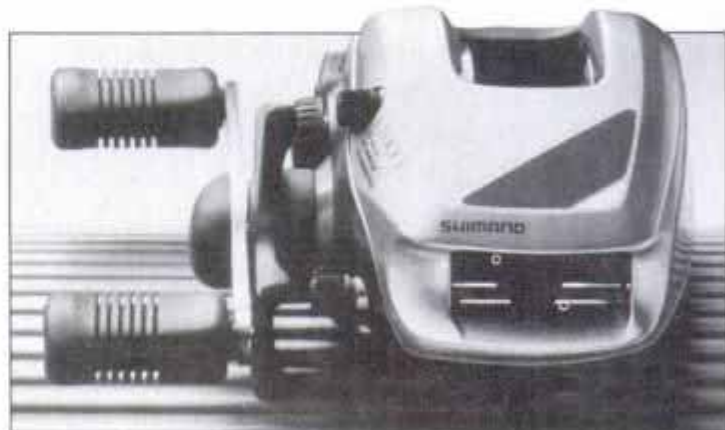


### Pushbutton Mooring

You'll never stub a toe or snag a line on the Pop-Up Cleat by Accon, a spring-loaded, flush-mounted cleat that releases at the touch of a button. It's available in four sizes (\$75 to \$160), from 4 to 10 in. in length. Each cleat is fashioned from highly polished stainless steel.

### Palm-Size Portable

ICOM's IC-M7 (\$549) marine VHF transceiver goes beyond handheld to palm size. This 5-watt mini-unit packs big-unit features into a compact size—1-touch Channel 16, 10 weather channels, automatic power saver and backlit screen for night use.



### Rad Reel

Grab onto a Shimano Bantam Chronarch baitcasting reel (\$105) and it feels custom-made. An ergonomically designed plate on one side lets you cradle the reel for optimum touch. An offset handle lets you crank with speed and power. Stainless-steel bearings make the action smooth.



## Land And Sea Shoes

Bo doesn't know this one. Boater's go one up with Omega's AWT Cross-Trainer XT (\$79.95), a waterproof shoe that's ready for anything on land or sea. Water-resistant leather uppers, removable inner soles and dual-density, slip-resistant bottoms give sportsmen an edge in the cockpit and on the playing court.



## Hold That Line

Several years ago, Suspenders, by Sporting Lives, came out with CO<sub>2</sub> inflatable flotation devices worn like suspenders. The newest model (\$180 to \$204) incorporates this concept with a harness that can be buckled to a safety line.

## CO-Tester

LabTec's Carbon Monoxide Tester (\$8.50) is an early warning detection system that enables boaters to determine if unsafe levels of carbon monoxide are building. The inexpensive device consists of reactive discs that change color when CO becomes trapped in dangerous levels.

## Carbon Monoxide

Testing Kit

Check For Carbon Monoxide Buildup From Furnaces-Cars & Trucks-Space Heaters  
Early Warning Of Carbon Monoxide Poisoning Includes Drowsiness Nausea Headaches Dizziness

### CO-Tester



Easy To Use!  
Disc Turns Dark When Exposed To Carbon Monoxide

- Reliable
  - Accurate
- Detects As Little As 50 ppm Parts Per Billion Carbon Monoxide



## Out With The Bad Air

Squeeze every drop of humidity out of your boat's cabin with a Day and Night Solar Vent (\$150 to \$185) from Micro Marine. An integral solar array and a 48-hour NiCd battery provide continuous ventilation. Comes with intake and exhaust blades in polished stainless, brass, and white or black ABS plastic.

## The 3D Zone

Fish-finding leaps into the 21st century with Dimension 3 from Humminbird (\$575), the first 3D screen display of bottom contours and fish locations. You can set bottom and fish alarms, monitor speed and temperature, and distinguish big fish from small.

## More Power To You

Fishing pros had their way with the newly redesigned Thruster (\$262 to \$968) series of electric trolling motors from Brunswick. The results are: 1-handed retraction, automatically latching locks, stainless-steel shafts, a die-cast aluminum foot pedal and motor housing, and a 3-year warranty.



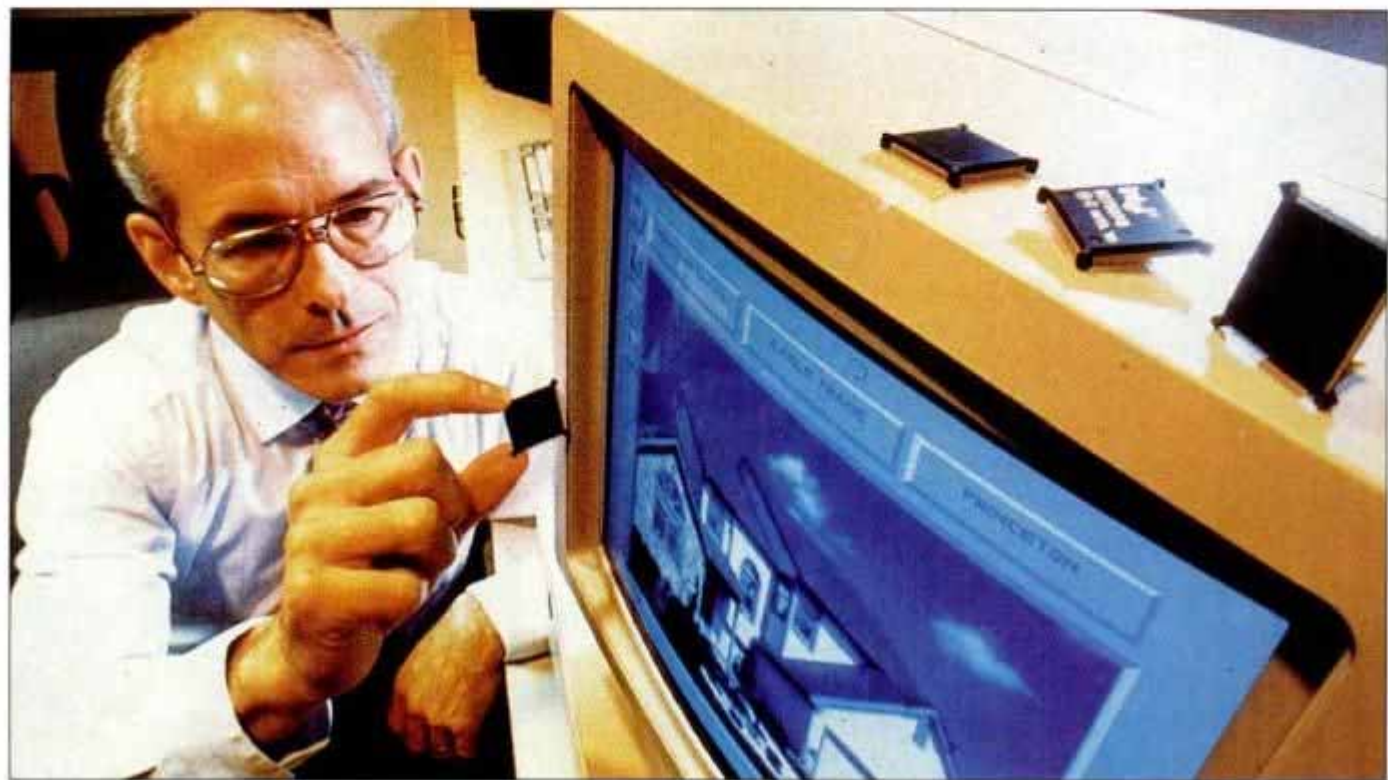
## Self-Adjusting Compass

Digital, fluxgate technology is the wave of the future for the trusty compass. With the new Azimuth 314AC (\$695), by KVH, not only can anyone dial in a unit without paying a compass adjuster, but navigators can read a solid heading that compensates itself to plus or minus one half a degree.



# FUTURE COMPUTING

BY FRANK VIZARD, Electronics Editor



● The next big buzz word in computers will be "multimedia." What does it mean? Read on.

Multimedia technology combines the best attributes of computing with audio and video. This means you'll be able to put video and text on a screen while listening to sounds associated with the topic you're investigating.

The ability to mix audio, video and graphics has been around for some time, but it's been prohibitively expensive as far as its use on consumer machines is concerned. Intel Corp., a powerhouse chip manufacturer, is making multimedia affordable.

Multimedia capability was something that used to cost about \$20,000 and required six or more computer boards. Intel has now put this technology on two small chips (see photo above) that are priced around \$100 in volume.

Company after company are now lining up to hop on the multimedia bandwagon. Hardware companies planning to introduce multimedia products include IBM, Tandy, AT&T, Zenith Data Systems, Fujitsu and NEC, to name just a few. Multimedia machines may also come from

noncomputer sources like Sony and Nintendo, say insiders. Microsoft Corp. is likely to be the developer of the software standard.

Multimedia computers will be different than their predecessors in that they will be equipped with CD-ROM devices. These compact discs will store the audio and video information to be used by multimedia machines. Compact discs give users instant access to any of the audio/video infor-

mation recorded on the disc. Instant access is a necessity if you want to do editing quickly.

Just how will you use multimedia machines? Let's say you want to learn about jazz great Duke Ellington. With multimedia technology, you'll be able to read biographical text and critical reviews, see film clips of his band performing, and hear his music—all at the same time. From an educational standpoint alone, multi-

media technology holds a great deal of promise. The computer of the future is one that uses multimedia technology. Fortunately, the future of this product doesn't look that far away.

## BattleTech

January's Tech Update (page 19) reported on BattleTech—a game that, with the help of a large computer net-

*(Please turn to page 87)*



Sharp computer graphics characterize the BattleTech world.



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work, gives participants a sense of being in an alternate reality. In this case, reality is the 31st century, and the landscape is peppered with 30-ft.-high war machines armed with lethal weapons. While players must go to Chicago to try their hands at BattleTech at its highest level, there is a new home version of the BattleTech universe called *The Crescent Hawk's Revenge*. While this is the third home computer game to use the BattleTech story, it's first rate in enjoyment.

A recordable compact disc promises to be the computer floppy disk of the future.



The plot line concerns the search for the main character's father and the defense of the realm against an invading force called the Clans. Making the action more riveting is a 256-color graphics display and a digital speech capability that articulates the problems and battle scenarios being experienced by soldiers under your command. The troops even complain about stupid orders. What's being simulated is the stress of command under battlefield conditions.

The BattleTech universe promises to be a large one. In addition to the computer games, there's a board game and a series of novels available. BattleTech is a trademark of FASA Corp., the outfit that developed the Chicago facility. *The Crescent Hawk's Revenge* computer game is a product of Infocom in Menlo Park, California. List price is \$50.

### Floppy CDs

Small 3 1/2-in. compact discs may soon replace the floppy disks we use to store computer-generated data. Two companies, Mass Optical Storage Technologies (MOST) and Ocean Microsystems, are currently developing the technology.

The use of what's called magneto optical (MO) compact discs as a storage medium for computers would be a big leap forward. One 3 1/2-in. disc equals the storage capacity of 100 standard floppy disks. This is also the

equivalent of 40,000 pages of single-spaced typewritten text. A 3 1/2-in. disc is more appropriate to the size restrictions of personal computers than a larger disc would be.

Until now, however, recording and erasing information contained on a compact disc has been a problem. To understand how the problem has been solved, you need to understand how information is recorded.

A data bit is formed on the disc when a laser, moving along a guide groove, fires a high-energy burst at a selected spot on the disc. As the laser heats the spot to about 200° C, the spot's magnetic properties can be altered by a strong magnet. The alteration creates a light reflection which is subsequently read by the laser and interpreted as 1 bit. Unchanged spots are read as zero bit.

To erase and record new data, the existing bit of information is heated by the laser beam while the magnet is turned on to reverse the spot's magnetic orientation. The spot is now interpreted as a zero bit, and new information can be recorded.

The 128-megabyte storage capacity of a 3 1/2-in. MO disc also offers some interesting audio and video applications, notes Nakamichi—the parent company of MOST. Even with current compression technologies, the possibility exists that 2 hours of full-motion video or 10 hours of high-fidelity music could be put on a 3 1/2-in. erasable and rewritable disc.

Whether such capability is utilized remains to be seen.

### Radiophones

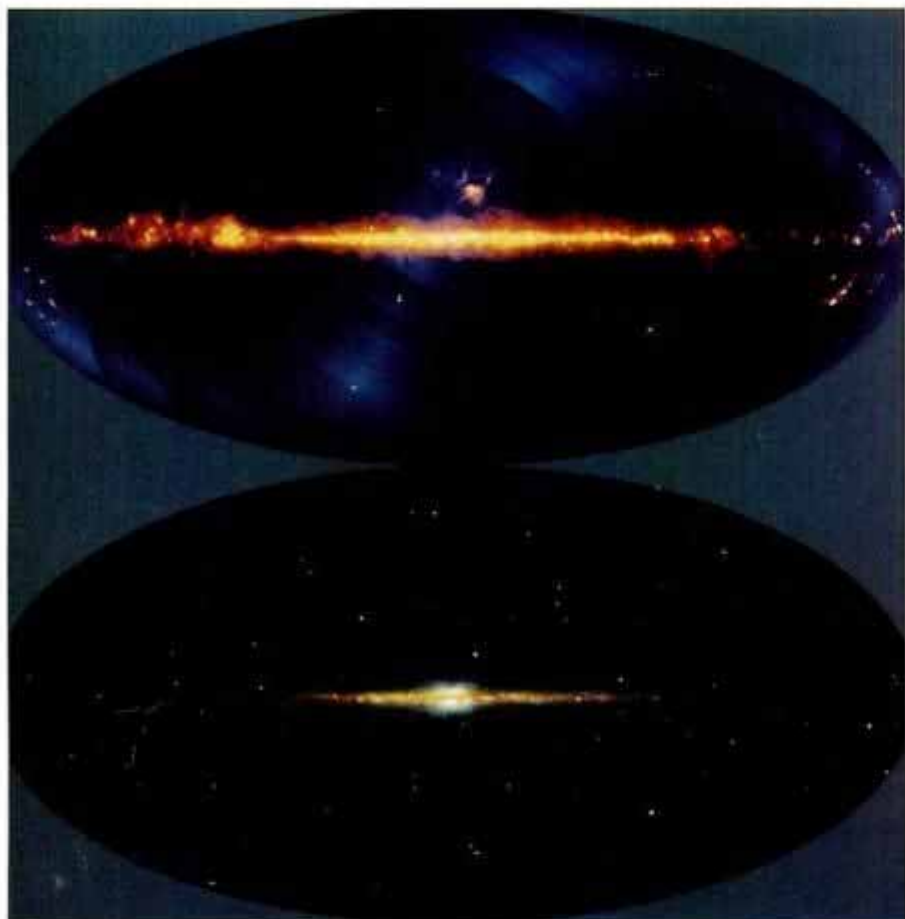
With most home offices being built around a computer and ancillary equipment, space for other gear can be at a premium. One of the newest space-saving devices available is a combination clock/radio/telephone made by Soundesign Corp.

The compactness of the model 7575 is principally due to the cellular styling of the phone. Placing the keypads on the back of the phone keeps the 7575 small and also makes on-hook dialing easier. As you might guess, the radio is automatically muted when the telephone is in operation.

The 7575 is also handy in that it's a 2-line telephone. Each line has its own set LED indicators, and there are separate ringers. There's also conference calling and a 14-number programmable memory. The clock has an alarm to remind you when to return calls or to tune in for news updates on the radio. The 7575 lists for \$90. The machine measures 8 1/2 in. wide × 4 1/4 in. high × 8 1/4 in. deep. **PM**

# IN THE BEGINNING

BY ABE DANE, Science/Technology Editor



● A little over a year ago, NASA launched a satellite called the Cosmic Background Explorer. The aim: To discover how the universe began.

Now, with data streaming back from the luxury-car-sized probe, scientists are baffled. It's not that they didn't get an answer. They did, and it's about as clear and unquestionable as they could have asked for. The problem is that the cosmic beginning COBE found seems to have nothing to do with the universe as we know it today. Cosmologists are thus faced with the mystery of how we got here from there.

The reason this question is so difficult to answer can be summed up in one word: Lumps. The present universe is full of them—planets, stars, galaxies, clusters and superclusters. But as far as COBE can make out, there weren't any lumps at the beginning.

The opening scenario COBE has certified to be correct is nothing new.

Known as the big-bang theory, it postulates that 10 to 20 billion years ago the entire universe was compacted into a tiny pellet of unimaginably dense matter. This then exploded, littering space with matter that coalesced into galaxies, stars, planets and everything else that exists.

A neat and entertainingly violent theory, which COBE backs up 100 percent. The problem is that COBE's instruments also indicate that the big bang must have been a very uniform explosion, which would have spread matter over space with extraordinary evenness. Ten to 20 billion years would not have been enough time for gravity to pull this smooth haze of substances into the clumpy patterns astronomers now see.

## Background on the cosmos

How can we know so much about an explosion that occurred 10 to 20 billion years ago? Because the conditions at the time of the big bang were unlike

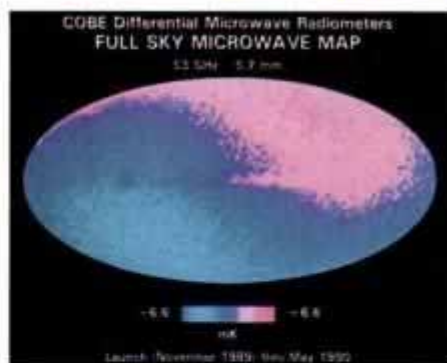
any that have existed since, and they have left a permanent and unmistakable mark on the universe. Temperatures 100-billion-trillion times those of a thermonuclear explosion threw out a burst of radiation that is still hurtling outward at the speed of light, defining the edge of our ever-expanding universe. By using instruments tuned to the frequencies of this cosmic background radiation, we can see the remains of the big bang still written in the afterglow.

Unfortunately, some of the most important wavelengths of the cosmic background are nearly invisible from Earth's surface. Hence, the COBE satellite. Launched into a 559-mile-high polar orbit aboard a Delta rocket, the craft flies far above the obscuring atmosphere and spurious terrestrial radiation.

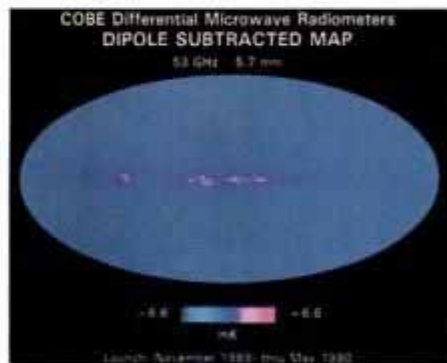
## COBE's components

Looking like a small *Apollo* capsule with wings, COBE probes the background with three instruments.

(Please turn to page 90)



COBE microwave data show effects of our galaxy's movement through the universe.



With effects of movement subtracted, lack of variation is puzzling to cosmologists.



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## SCIENCE (Continued from page 88)

● **Far Infrared Absolute Spectrophotometer**—FIRAS measures the intensity of radiation at 100 wavelengths between .1 to 10 millimeters, bridging the division between the longest infrared waves and the shortest microwaves. Chilled to  $-475^{\circ}\text{F}$  by 211 pounds of liquid helium in a vacuum-insulated flask, it picks up radiation 100 times fainter than earlier Earthbound and balloon-borne instruments.

Data from FIRAS is believed to be extremely reliable, partly because the instrument periodically calibrates itself with a manmade reference blackbody carried aboard the satellite. An odd, cone-shaped conglomeration of materials, including iron filings and epoxy, the blackbody exactly mimics the spectrum of an ideal big-bang universe.

Before the last of the liquid helium evaporated last September, FIRAS had nearly finished two complete surveys of the sky. But it took only 9 minutes of data, forming a perfect blackbody curve, to confirm the big-bang theory early last year.

● **Diffuse Infrared Background Experiment**—Immersed in the same liquid helium bath as FIRAS, DIRBE measures the glow from celestial objects at 10 wavelengths between 1 and 300 microns—nearly the full range of the infrared spectrum. According to current calculations, it is in these wavelengths that the earliest and most distant objects in the universe should be visible.

Output from the instrument is in the form of images such as those at the beginning of this article. In the top picture, the Milky Way galaxy, of which our sun is a part, is shown in wavelengths that emphasize the vast clouds of cold dust and gas that intermingle with the stars. The lower image shows the same objects at a group of slightly shorter wavelengths, emphasizing warmer objects, mainly stars.

Before the data can be interpreted, radiation from all these nearby objects must be laboriously subtracted, leaving a relatively uniform glow in which the story of the first celestial objects will be found.

Currently, virtually nothing is known about objects any older than a few billion years, largely because little of the infrared radiation ancient objects emit can penetrate the atmosphere.

● **Differential Microwave Radiometer**—Covering the 3.3-, 5.7- and 9.6mm wavelengths, the DMR will look for variations in the microwave background from one spot in the sky to another. It is this instrument that



Magellan shows craters of Venus to be uniformly large and young.

will play the greatest role in settling the question of whether the big bang threw out any significant lumps.

The only variations, or anisotropies, yet found are spread over very large portions of the sky. These indicate nothing more than the fact that our own galaxy is moving through the microwave background, causing a slight Doppler shift.

### Dark matter

Thus, although we're now more certain than ever about how the universe began, we seem to have lost some ground in making sense of it. The lack of primordial lumps means there are no starting points from which gravitational attraction could have begun snowballing matter together.

That's not to say that theorists aren't full of possible explanations. Numerous ideas have been put forward, including masses of invisible dark matter that would be detectable only through their gravitational pull. But for now, we must be satisfied with knowing how the universe began, and wondering how it got to be this way.

### Thin-Skinned Venus

Meanwhile, back in our own solar system, a space probe with a more clear-cut mission has been tearing the cover off of cloud-shrouded Venus. Traveling in a polar orbit while the planet spins beneath, the *Magellan* spacecraft has, as of this writing, exposed about a quarter of the hitherto invisible planet's surface with its synthetic aperture radar.

Scientists are awash in a windfall of bizarre topographic features. "We've seen so many things that are unbelievable that it takes a long time to absorb it," says Steve Wall, an experiment representative for the craft. Among the strangest features found to date have been 1/2-mile-high, almost perfectly flat discs about 15 miles in diameter. Dubbed "pancake domes," they look like spots where an extremely viscous and uniform lava has leaked through the surface. Such behavior is highly uncharacteristic of the basaltic lava found on Earth, and may indicate a planetary core with a large component of molten silicon.

Also of interest are the planet's craters, which are distributed in uneven splotches over the planet's surface, but seem to be uniformly young and large. The first two characteristics could be explained by a planetary surface that replaces itself frequently, most likely by lava flows spouting up from the interior. It's now estimated that the surface averages about 400 million years old—young compared to Earth's 1-billion-year-old surface. The lack of small craters is probably due to the extremely dense atmosphere, which breaks up small meteors before they can reach the surface.

Overall, the preliminary impression of Venus made by *Magellan* has been of a planet with a thin and brittle crust surrounding a core of sluggish magma. But the craft still has about six more years worth of propellant left. Barring technical problems, that should keep scientists amazed well into the next century.

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## AUTOMOBILES

# DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



### Oldsmobile's Supreme Bright Idea

● While it appears that Olds plans to brighten up the 1992 Cutlass Supreme with three headlights per side, a more likely explanation of the 6-light arrangement is that four are for normal headlights, while the two interior lights are fog or running lights.

The concept is similar to the layout used a few years ago by Pontiac to distinguish the original 6000 STE.

Besides lending a fresh look to the Supreme's front end, there's a practical aspect to the new headlamps, which appear to be the type that can be purchased and installed at a minimum cost.

This is a welcome contrast to some shaped headlight lenses that can cost more than a hundred dollars to buy and install. Olds apparently is listening to its money-conscious buyers.

### Eldorado '92

When Cadillac unveils the 1992 version of its Eldorado coupe later this year, it will be longer, wider and generally more massive in appearance.

Instead of its own chassis, code-named the E-body, the new Eldorado will be built with the same basic drivetrain and suspension system as the Cadillac DeVille. That means a continuation of the 4.9-liter aluminum V8 that has raised performance to respectable levels in the past year.

While the front end resembles that of the Allanté, the car is a hardtop

personal luxury coupe that seats four passengers.

As our spy shot indicates, side and rear views will be traditional Eldo.

### Ford F-Series

You can't tell too much from this view, but Ford's 1992 Ford F-series truck line is due for a facelift.

Minor adjustments were made in the grille bars and in the position of the parking lights. But the major change is in the plan view—from the side or directly overhead.

The new front end is more rounded than on current models, much like the grilles in the GM pickups.

Early feedback from car dealers seems to suggest that Ford hasn't gone far enough with this change. The dealers want more radical styling. But they'll have to wait until 1994 before Ford

makes a major change in its bread-and-butter full-size pickup line.

### Ford Club Wagon

A new, softer front end, door handles, side styling and glass that fits more flush are highlights of the 1992 Ford Club Wagon and van that will make their appearance later this year.

While engine and drivetrain offerings are expected to remain unchanged, the sheetmetal for these full-size Ford vans will be all new. Interiors will be revised as well, though the load space inside will be unchanged.

### Air Bag Questions

What happens if your air bag doesn't inflate in a head-on crash? Do you sue the automobile company? Many liability questions like this come up in auto company law offices these days.

*(Please turn to page 94.)*



Due soon, new Cadillac Eldorado will have brawnier appearance.



New Ford F-series trucks will feature modest front-end revisions.

TECHNOLOGY UPDATE

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Ford's new full-size van and Club Wagon offer rounded, aero styling.

One precaution is already in place. If your air bag warning light goes on and you don't have the system serviced promptly, a record is kept in the car's computer.

Then, after an accident, the computer will reveal your failure to heed the warning. It could mean that your case might be thrown out of court because of your own negligence.

Other questions remain. Did you know that certain air bags require regular maintenance? Who is responsible for air bag systems in junk cars? With air bags coming into increasingly wider use, these questions will be important in the coming years.

### Chrysler 300 Concept

Powered by a whopping 8.0-liter V10 engine mated to a 4-speed automatic, this swoopy new Chrysler concept car has the appearance of a 2-door coupe, but is really a 4-door.

The 300 has footprints to match its muscle—275/40R19 front, 335/40R20 rear—and Chrysler styling chief Tom Gale says the car was conceived "to have future production possibilities."

Interior trim is different too, with the driver's compartment finished in black and the remainder of the car tan. Doors are hinged so that the center of the car opens wide for easy access, but rear doors cannot be opened unless the front doors are opened.

Rear-seat passengers will enjoy separate headphones, as well as a TV/VCR/cellular phone system.

Overall, the 300's appearance is intended to be a reminder of Chrysler's hot 300-series supersedans of the 1960s.

### Whitewall Blackout

In recent years, blackwall tires have become the option of choice on new cars. Whitewall tires, once ordered on almost 100 percent of all cars sold in the U.S., are losing favor at a surprising rate.

Oldsmobile reports that four out of 10 buyers of its 98 sedan model order

blackwalls. As recently as six years ago, every Olds 98 was delivered with whitewalls.

At Goodyear, where industry-wide tire trends are very easily tracked, 67 percent of the tires made for new cars are black—a complete flip-flop from just 10 years ago when only 25

percent of new car tires were all-black.

The influence of prestigious European names like BMW and Mercedes may be one reason behind the change in American tastes.

### Turbine Revival

Many times in the past 30 years the



Chrysler 300 concept car blends four doors into supercoupe styling.

auto companies have promised a turbine engine for passenger cars. But the supersmooth, emissions-clean engines just never made it into production. They were always too slow in response, too fuel-hungry, too difficult to build.

Now, however, GM believes it has a breakthrough. The secret—known for a long time, but never achieved in a low-cost material—is higher operating temperatures, around 2500° F.

New materials that are easily produced, inexpensive and able to withstand the high temperatures for long periods are being developed. Excited researchers at GM say an engine with ceramic turbine wheels could be put in cars sometime in the 1990s.

Up till now, the all-metal turbine wheels were incapable of withstanding operating temperatures much higher than 1800° F.

### Fast Warmup

The newest way to clean up a car's exhaust is to preheat the catalytic converter. Tests for emissions show that the first 60 seconds or so after starting an engine are the worst for emissions.

That's because the catalyst is still cold, and not ready to do its job. So electrically preheating the catalyst brings the temperature up quickly.

Look for preheaters to show up on cars within the next few years. They will be a big drain on battery power, especially in cold weather, so look for improved battery capacity to support these systems.

### Supercharging

GM is planning a supercharger for its slick 3800 V6 engine in a number of models next year.

Buick will offer a supercharged option in the Park Avenue Ultra, scheduled for introduction this spring. Later, Oldsmobile's 98 Touring Sedan and Pontiac's Bonneville SSE will get the supercharged engine.

Adding the blower will boost the 3800's output from its current 170 hp to 200.

### GMC Suburban

Chevy and GMC will offer this re-

styled version of their popular utility vehicle as a 1992 model.

While overall dimensions of the Suburban are nearly identical to the current model, a 6.9-liter diesel V8 will be offered as an option in place of the current 6.2-liter diesel.

More curvature in the glass and flush-fitting glass are major differences in the new model.

Chevy and GMC will offer similar styling in new full-size Blazers and Jimmys next fall. **PM**



Subtle styling changes distinguish '92 GMC Suburban series.

Car owners!

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## OLD HOUSE RESTORATION

# LOG HOMES

BY BOB VILA, Contributing Editor



● Nothing evokes the picture of early America better than a rustic log cabin sitting quietly beside a stream with a wisp of smoke curling from its chimney. Perhaps it is this image of a simpler life that's led many to consider log houses as their dwelling of choice today.

Once the decision to live in a log home is made, you have several options to consider. These range from restoring an original log house to building a new one.

As always, a good place to start this discussion is at the beginning, with a little history on log building. We'll take a look at how these old structures were notched and chinked, along with how these log homes are being restored today.

### Building log walls

Many early settlers didn't possess the high degree of craftsmanship necessary for post-and-beam construction. Stacking logs was the only framing technique they knew. And some of these buildings weren't even chinked. Instead, the exterior units were sim-

ply covered with clapboards to keep out the weather. A surprising number of these early sided houses exist today, but because the logs are hidden, many don't realize they're essentially log structures.

Found in most of the wooded areas of this country, many original log homes were small 1- or 2-room affairs. The room size, of course, was dictated by the length of the logs. It's common to find rooms that measure 18 or 19 ft. by 20 to 22 ft. Stone foundations, often dry laid, or stone pillars were commonly used as supports. In some of the cruder structures, the logs were left in their natural round state, with the bark still covering them.

But in homes that were meant to be more permanent, you're likely to find hand-hewn logs that fit snugly to-

Countless log homes were built as the U.S. expanded westward. Many, like the one on the left, are still standing, though the logs were covered with siding (below) prior to restoration work.

gether by means of basic woodworking joinery.

### Joinery

A variety of notches were used to join the logs together. Some of the more common notches I've seen are also the simplest to make: the square or flat notch, half-dovetail, saddle notch and V-notch. One of the more difficult ways to join logs is with the full dovetail joint, like the one used in furnituremaking.

To make the logs weathertight, it was necessary to chink the spaces between them. One common way to do this was to fill these voids with chips of wood or stones, then daub them on both sides with a mixture of mud or clay. Materials like animal hair or straw were sometimes used as fillers. Of course, this rudimentary daubing mixture was apt to wash out and usually required periodic maintenance. Often times, it was the job of the women and children to rechink the log walls with fresh mud or clay.

Many of the original log houses still standing today are located in the hills and hollows of the land. Since this backwoods location is not desirable for most people, a number of these log houses are disassembled then re-stacked and chinked on a new foundation elsewhere.



"Home Again With Bob Vila" is the title of our contributing editor's new TV show.



## Adaptive reuse

Log houses are taken apart in much the same way historic houses are. Usually, photos are taken of the building in its original state. Then the pieces are painstakingly numbered as they are taken down. Because the original structures are usually so small, it's fairly common to design a home around them. For example, the original log house may be used as a living room, den or library. Then the rest of the house, often designed with the same rustic feel as the old log portion, is built around it. Sometimes, two or more original structures are put together, creating one house.

It's not unusual to find a few rotten or spoiled logs, particularly under window sills where the old wood has been continually exposed to moisture. Since the folks who regularly do this kind of work find lots of structures that are more rotted than good, they usually have an inventory of old logs. So replacing the spoiled logs with salvaged ones is generally no problem.

Of course, you should not use new wood for replacement in antique reconstruction. Aside from the obvious aesthetic reasons, you don't want any shrinkage or warpage in the reassembled structure. So, you should try to match the dried old wood.

## Rebuilding

Once at a new location, the logs are cleaned and restacked on a new foundation, then rechinked. Traditional methods of chinking have been replaced with more modern methods that last longer and require less, if any, maintenance. Some restorers fill the void between logs with fiberglass batt insulation, sandwiched between wire lath, then apply a chinking mixture on both sides.

Unless you're doing a museum-quality restoration or are a purist restorer, using a modern chinking formula is generally appropriate for most jobs. There is no one magic mixture, but most of the ones I'm familiar with use one or more of the following as a binder instead of clay: lime, masonry cement or portland cement. Sand is commonly used as an aggregate along with, of course, water.

Many factors are involved in a log builder's decision on what chinking mix to use. These include things like the size of the logs, the structure's geographic location and orientation to the weather, how much overhang there is, the type of wood used, the type of foundation and sometimes even how much water vapor the house's occupants will generate. As you can see, it's a decision that should be made with some thought.

## A new log home

For those who desire a new log home, there are two routes to go. Most of you are probably familiar with the variety of factory-made log house kits available today. Many of these designs eliminate the need for chinking by using a variety of techniques to join the logs together horizontally. One of the common ways this is done is with a tongue-and-groove joint, coupled with foam strips and caulking.

There are different kinds of log home kits, ranging from just a basic precut exterior shell package to a complete kit that includes everything needed for the exterior and interior. When choosing a log kit, it's important to take into consideration your skill level and, of course, the time you have to complete this project.

Any log home kit manufacturer should be able to give you decent estimates for how long it would take to build any given kit. The manufacturer should also supply you with some references, people who have successfully completed a kit like the one you want.

Make a point of contacting these people. Of course, their reactions will all be positive—otherwise, the manufacturer would not use their names—but you will at least get some idea of what the project requires. A visit with current owners will also let you ask about any maintenance problems, average utility bills and other *hidden* costs that only appear over time. They should also be able to give you a feel for log-home living on a daily basis and maybe even give you some good decorating tips for later.

Depending on where you live and the availability of logs, you can also choose to build a log home from scratch. This involves finding a source for the species of wood you wish to use. This can range from a local saw mill where you can purchase the logs to actually cutting and hauling them from your own or another's land. Some of these new log homes aren't even chinked, instead each log is carved by hand tools—with such precision that it fits perfectly flush against the one below it.

If you decide to go this route, it's a good idea to look into one of the seminars or schools dedicated to teaching the log-building craft. Handcrafting a custom log home yourself is a big job that demands planning and special woodworking skills. But the rewards are endless.

Whether you're a purist looking for an authentically restored cabin or a new homebuilder who likes the old-time, easy look of a log home, you may find life a bit simpler in a log house. **PM**



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# MAZDA'S CENTURION

BY TONY SWAN, Automotive Editor



● What would be your best guess at the all-time winning model in International Motor Sports Association (IMSA) GT racing? Porsche RSR? Porsche 935?

Good guesses, but the title belongs to the rotary-powered Mazda RX-7.

Mazda recently celebrated its 100th IMSA RX-7 victory when Pete Halsmer's 4-rotor rocket (shown above) took GT Over 3.0 liters) honors at San Antonio. The string dates back to the RX-7's debut: first and second in GTU (GT Under 3.0 liters) at the 1979 Daytona 24-Hour.

Since then, the RX-7 has claimed eight IMSA GTU championships (1980-'87) and contributed to two others ('89 and '90). RX-7s have also claimed GTU honors in five of the last six Daytona 24-hour runs.

The '90 GTU title, incidentally, went to Lance Stewart, driving Mazda's MX-6 coupe. Ironically, Stewart, a gifted and personable young driver from Florida, found himself looking for a ride at season's end when Mazda elected to make room on its roster for Price Cobb.

In any case, the RX-7's IMSA record is enviable indeed, one we're willing to bet will stand for a long time to come.

## Porsche Power

Although Porsche didn't exactly cover itself with glory in Indycar racing, the kids from Stuttgart are set for another run at open-wheeled competition—specifically, a return to Formula One—with an all-new V12 engine.

Displacing 3.5 liters, the new engine is an 80° layout, with four valves per cylinder and four cams. An interesting feature is the power takeoff and cam drive machinery, which is in



Porsche returns to F1 in '91 with this new 80° V12. The V12 will ride in an Arrows chassis.

Mazda's RX-7 made its IMSA racing debut in the 1979 Daytona 24-Hour (top), finishing first and second in class. Pete Halsmer (above) scored victory No. 100 in San Antonio.

the middle of the engine, rather than at either end.

Like all engines built to the current F1 formula, the new V12 is normally aspirated. Porsche isn't talking about output, but anyone coming to a 1991 F1 grid with less than 700 hp isn't going to be in the hunt.

Porsche will debut the V12 March 10 at the Phoenix Grand Prix in a new Footwork Arrows FA12 chassis. Michele Alboreto and Alex Caffi will handle the driving chores.

## Chevy Sweep

Speaking of engines, Chevy's Indy V8 compiled an enviable batting average in 1990—16 for 16, the first clean sweep in Indycar racing since the Ford Cosworth V8 won all 17 events in 1986.

The Chevy Indy V8 also accounted for 15 of 16 pole positions. (Porsche, with Teo Fabi driving, broke the string at Denver.) Since its introduction in '86, the Chevy engine has powered winners in 48 of 74 events (65 percent), and claimed 52 poles. **PM**

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## IMPORTS

# A STUTTGART HOT ROD

BY TONY SWAN, Automotive Editor



M-B's potent 32-valve 5.0-liter V8 makes 326 hp at 5700 rpm, 354 ft.-lb. of torque at 3900. Fitting the V8 required substantial firewall revisions.

is a lot of car to move here—3740 pounds, almost 300 more than the 300-series sedan—the V8 hustles the 500E to 60 mph in about 6 seconds, and

keeps right on hustling.

Mercedes rates the top speed at 155 mph. In our own all-too-brief touring on the German autobahns, we saw more than 160 mph several times, and felt supremely secure doing so.

Braking, as well as high-speed stability, has a lot to do with this feeling, of course. The 500E sports big ventilated rotors (11.8-in. front, 11.0-in. rear), plus an antilock system. Aggressive 225/55ZR16 tires help put all that braking power on the ground.

We expect to see the 500E here in June. It sells for about \$90,000 in Germany, and U.S. prices may be lower. We have to say we envy those of you with the budget to step up to this subtle stormer. This is hot rodding raised to the level of fine art. **PM**

● America can legitimately claim to have invented the hot rod, but here's proof that the idea is open to foreign interpretations. The Mercedes-Benz 500E is classic hot-rod practice—small car, big muscle—with the addition of the kind of refinements you'd expect of something from Stuttgart.

The basic marriage is Mercedes' 300-series chassis with the company's superb 32-valve dohc 5.0-liter variable valve-timing V8—the same powerplant used in the new 500SL roadster. But this is much more than a mere engine transplant.

First, there was the fundamental problem of dimensions. The 300-series was designed for an inline Six, leaving precious little room for the broad-shouldered 90° V8. More power and more weight meant suspension refinements and chassis strengthening. Plus more brakes. And more tire.

Owing to the low volume projected for the car—about 3000 per year—Mercedes elected to farm out development and production to Porsche. The development work was handled at Porsche's outstanding R&D facility at Weissach, where the Porsche and Mercedes engineers first strengthened the chassis crossmembers, wishbones and steering linkage, then set about tuning the suspension.

In order to match the car's robust performance potential without sacrificing ride quality, the development

team installed a combination of moderate springs, special shock absorbers with progressive damping and urethane bump stops that provide progressive resistance over the last 5mm of suspension travel. The rear suspension is augmented by hydro-pneumatic load leveling, and the car rides 23mm lower than a standard 300-series sedan. Low and mean.

What all this and 50/50 weight distribution add up to is excellent handling—not as hard-edged as the BMW M5, which seems to be M-B's target, but supple, smooth and wonderfully stable at high speeds.

Speed, of course, is what this leather-lined burner is all about. Although there's little beyond the modest fender flares to suggest its potential, the

500E is one of the hottest sedans going. The V8 pumps 326 hp and 354 ft.-lb. of torque—22 more than the SL, thanks to revised intake plumbing and a new engine management system—through a 4-speed automatic transmission to a 2.82:1 differential bolstered by traction control.

Although there



Badge and subtle fender flares are only clues to 500E's performance.

The New Rich!

# THE BEST KEPT secret!



I would like to invite you to join with me in a "New" Money-Making Venture that could change your life forever, and show you how to earn up to \$20,000 every thirty days.

### It's So Different, It Just May Surprise You!

Last month I made \$22,560.00 dollars working four hours a day, five days a week. This month I expect to do over \$25,000.00 dollars and take one week off to spend on my Country Estate.

No! I Am NOT a Salesman!

I Am A Businessman with a very Unique Business, that is PERFECTLY LEGAL and does not take a lot of talent or special business education to run.

### Let Me Introduce Myself.

My name is Steven A. Houseman. I am 38 years old, and in Business for Myself. My office phone number is 703-450-4780. My accountants name is Everett Callaway, CPA, and he has a copy of my financial statements showing that my business earned over \$275,000.00 last year.

Believe me I am Not bragging, but in the last twenty four months I went from driving an old jalopy to owning a \$53,000 BMW. In the past thirty six months I went from living in a small home in an old neighborhood, to owning my own estate valued at seven hundred thousand dollars.

NO! It has Nothing To Do With Real Estate. WAIT! Before we go any further, let me make this point VERY CLEAR. This New Money-Making Program has NOTHING to do with: Investing In The Stock Market! Gambling of Any Kind! Pyramid Schemes!

and No Telephone or Door-To-Door Selling!

### Let's Get One Thing Straight!

This program is perfectly honest, legal and moral in every sense of the word. If it wasn't, believe me, I wouldn't be involved in it.

Furthermore, I am not trying to invite you to join in a money making venture so you can make a "couple of hundred dollars a week" working out of your dusty old basement. Nor do I want you to keep the program if it doesn't fit into your future plans.

The main thrust of this message is aimed at changing your life so, you too, can perhaps enjoy a new home without worrying about how you're going to make the payments month after month. Or perhaps buy a new luxury automobile of your choice, without feeling the "stress" wondering whether or not you will qualify for the loan.

### Start The Program Part-Time! Or "Short-Term" If You Like.

Yes, I know not everyone wants to quit their job and start working this program full time. Some of you may have been with the company you are working for, for a long, long, time and don't want to give up the seniority you have built up over the years.

### Use It "Short-Term" Only When You Need An Extra Three Thousand Dollars!

Others may be looking for something "short-term" not long-term. Perhaps a money making program you can put into operation for the next two months, to maybe pay off some overdue bills. That's okay. You can put the program into operation only when you need an extra \$3,000 dollars. Start out part time on weekends or in the evenings after 5:00 PM. Then you would have the best of both worlds. You would be free to work whenever you like. Save up for that long overdue vacation to Hawaii, or perhaps pay off your car in three months instead of three years. Then again you could save up the down payment for the home of your dreams. You can do it either way. You can operate the program part-time or "short-term" right from your own home.

### You Don't Need A Lot of Money To Start This Program!

Was I Lucky? Or did I have a lot of money to start with? Not the case at all. My money making program can be started with limited funds. In fact, right now, I know several people, from all walks of life, who have already started making money by applying my money making formula, and have been making thousands of dollars in their spare time with it. The most amazing thing about the program is that it has the ability to produce more money in one weekend than most people earn in thirty days.

### And Don't Forget, All The Money You Make Is Yours To Keep, You're NOT Working For Anyone But Yourself!

I've already received several Telephone Calls from people from all over the country thanking me for what I have done for them.

### Believe Me, It Really Works!

A Chicago businesswoman, that I know, uses a similar program to make \$3,000 a week.

A man, from Denver, Colorado started with the same program as I did. Recently he told me over the phone his income was already over \$13,000 a month.

A man in Ohio told me he was currently running a \$120,000 Dollar-A-Year operation out of his home; putting in only four hours a day.

### Beginners Write To Me Everyday From All Parts of The Country!

Here's some letters From Some of The People already using my money making program.

(Actual letters on file in my office.)

#### \$3,000.00 In One Week.

"The Best Kept Secret of The New Rich!" is the best information I have ever seen before on how to make big money fast. It's truly different, complete and easy to put into operation. It's great. I can't thank you enough. I made \$3,000.00 in one week.

A.R., Landover, Maryland

#### \$11,600.00 In Five Weeks.

It seems like all my life I've been faced with bills, bills, and more bills. I was always up to my ears in debt. There just never seemed to be any let up. Just as soon as I was starting to get a little ahead my car would break down. Then it was the TV that needed a new picture tube. One thing after another.

Then I sent away for "The Best Kept Secret of The New Rich," and today after applying your money making program for only fifty days I made \$11,600.00. Thank you for saving me from a life of always being in debt.

L.G., Raleigh, North Carolina

#### \$14,500 Full Time.

"I just thought I would drop you a line, to let you know that the information and the money making program are excellent. My son and I want to thank you for letting us in on The Best Kept Secret of The New Rich. Within months after applying the program we were generating an income of over \$14,500.00 a month. Thank you for everything you have done for us. We will always be in your debt."

S.R., Pennsylvania

### Here's What This New Money Making Program Can Do For You!

It's titled: "The Best Kept Secret of The New Rich", and it is written in a Step-By-Step format to make it easy to read and easy to follow. It's a Large Volume, 150 pages altogether. With 20 illustrations and exhibits, plus closely guarded information that is used in putting your Money-Making Program into operation. This New Program will teach you more than how to start earning up to \$20,000 in thirty days. It will show you a powerfully written plan on how to build a solid life time income of your own.

### Order Today! Take A FREE Look!

You've got nothing to lose and everything to gain. There is NO RISK on your part, because I won't cash your \$20 check for 30 days AFER I have mailed the materials to you.

### 100% Money Back Guarantee!

I'll Give You A Full 90 Day Money-Back Guarantee. If at any time after receiving "The Best Kept Secret of The New Rich!" you want to return it, for any reason, do so. I will immediately refund your \$20 along with my congratulations to you, for at least having given it a try. There will be No questions asked! No delays! Just a cheerful and prompt refund.

### Don't Pay For It Now. Postdate Your Check For 30 Days!

In fact, if you still feel a little uncertain about mailing a check to someone you don't know. You can: Postdate Your Check For 30 Days From Now. I can't deposit your \$20 postdated check or money order for 30 days after you get my materials. Use the new program in "The Best Kept Secret of The New Rich!" during that time. Then, if you don't think it's for you, just send the materials back and I'll return The Same Check You Sent Me Uncashed.

Take the time "Right Now". Pick up your pen. Fill out the "Order Form", and mail it in Today! In a few days time you will have "The Best Kept Secret of The New Rich!" Use the information and start making big money with my Money Making program. I think you'll see very quickly that it's everything I say it is and just by following the step-by-step guidance it offers, you'll soon see how it can make so much money for you, that it just may surprise you.

All ORDERS ARE MAILED OUT THE SAME DAY  
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### No Risk Order Form

Steve Houseman  
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Dept. PM-26, P.O. Box 139  
Sterling, Virginia 22170

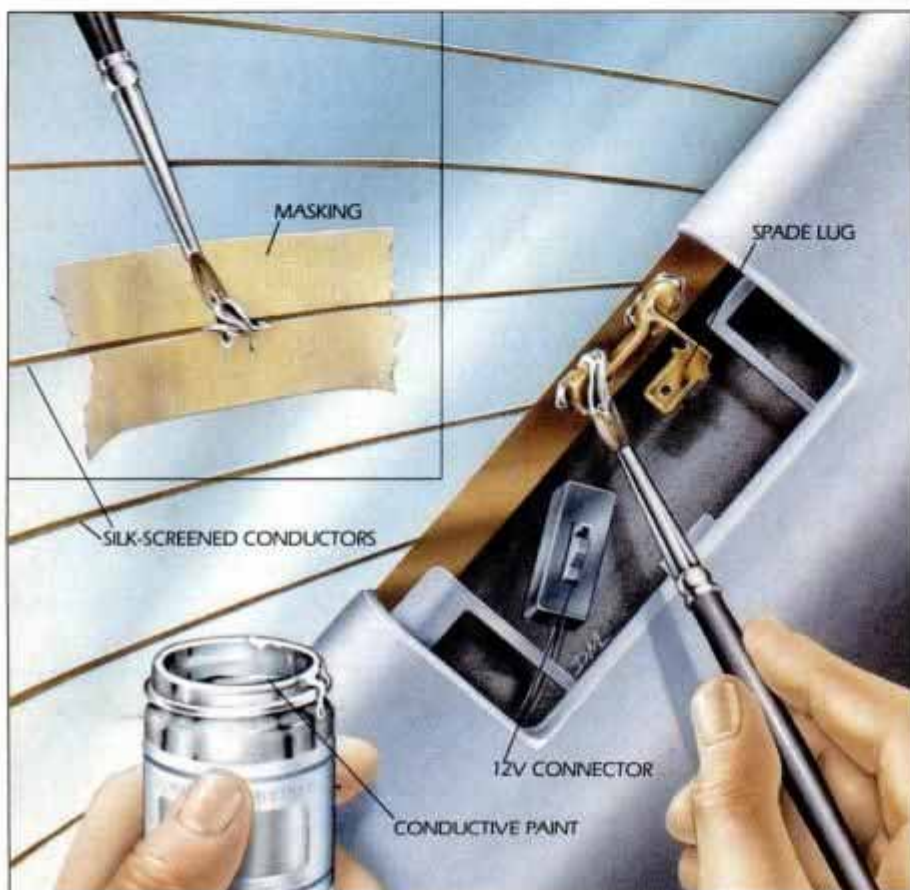
**Yes!** please RUSH me my copy of "The Best Kept Secret of The New Rich!" only with the understanding that I have a full 90 days to test your program. If I am not completely satisfied, for any reason, I may simply return the materials, and you will immediately refund the full purchase price to me. What's more, I can postdate my check for thirty days. On that basis here is my twenty dollars.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_

## AUTOMOBILES

# CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PM ILLUSTRATION BY DON MANNES

### Fogged In

I have a Mercury Marquis with the printed-on rear-window defogger grid. The connecting terminal has broken off of the grid right at the glass. The dealer and a local glass dealer have told me that the only repair is to replace the window. The dealer says he can repair the elements, but not this. ALEX TINKER  
CONNERSVILLE, PA

*You can sure give it a try, Alex. The repair may be a little fragile, but you've probably learned your lesson about not scraping the elements or banging into the exposed terminals.*

*Go down to the auto parts store and get a kit that's intended to repair the printed-on defroster grid elements and another kit intended to reinstall bonded-on rearview mirrors.*

*The first kit will have some masking material for matching the width of the printed circuits, as well as some conductive paint. The rear-*

*view-mirror kit should have some cleaner/primer and an adhesive.*

*Following the instructions on the package, use the cleaner/primer on both the window and the broken terminal's mounting pad. Be careful not to touch either with your fingers after cleaning them. With the window warm enough to permit the adhesive to cure, follow the directions on the package and glue the terminal back down. You'll probably need to use some tape to keep it stationary while it bonds, so don't disturb it for at least 12 hours. If you can, clamp it securely, or wedge something solidly against it, to be sure it's really flush and tight with the glass.*

*Then, use the conductive paint to reestablish electrical contact between the terminal and the grid. Brush on a generous coat, and allow it to dry thoroughly—at least an hour. Then repeat for three or four coats. This terminal carries a considerable amount of current, so the layer of conductive paint needs to be thick enough*

*to carry it without heating up.*

*If it's possible, you should try to do this with the wire attached, to avoid the trauma of pushing the spade lug and its mating connector together. If not, then you can carefully reattach the wire. I'd suggest a careful covering with some clear RTV sealer for mechanical support as well.*

*If the repair is exposed, and the difference in color between the silvery paint and the coppery heating grid bothers you, you can darken the silver with some household iodine.*

### Fogged Out

I have a 1988 Ford Mustang GT. After about 20 minutes with my headlights and fog lights on at the same time, the headlights blink intermittently.

VICTOR ALBERICO  
WATERTOWN, MA

*I rarely find the answer to a Car Clinic problem covered in a TSB, but every now and then . . .*

*Ford TSB 89-17-11 says this is caused by overheating in the headlamp circuit. It's a phenomenon affecting '83-'89 Escorts, '83-'87 EXPs and '87-'88 Mustangs. You'll need to replace the headlamp and dimmer switches, several connectors, and then bypass the wiring in the circuit with new 12ga wire run alongside the original harness. It's supposed to take 1.3 hours for a service technician to do this, and you ought to see if the dealer will still do the repair under warranty.*

### All Bent Out Of Shape

Both front tires of my Ford Club Wagon have been wearing badly on the outside lip since the vehicle was new. I just went to the dealer for an alignment.

*They told me that to align my van, they would have to bend the front axle beams with a big hydraulic press—and they don't have one. I'd have to go to a specialty alignment shop.*

*I have never heard of such a thing. Won't this weaken the metal, or was I just being given a story? If both axle beams need to be bent, isn't this a defect in the manufacture of the vehicle?*

WAYNE MITZNER  
BALTIMORE, MD

Ford's van uses a unique, heavy-duty front suspension that is absolutely bulletproof. It's very rare that the camber settings change, unless there's some serious trauma inflicted. On the other hand, some drivers seem to chew up the outside lip of their front tires with great regularity. In fact, a good friend of mine has a Ford pickup with the same front suspension—and so do I. The alignment settings are identical on both trucks, and he has your wear problem. I don't. It must be something to do with driving style. The fix is to add some negative camber.

Ford never designed any type of camber adjustment into these vehicles—so the answer is, yup, bend the axles. It's a straightforward procedure, but the forged steel axles take plenty of persuading to move—hence, the special hydraulic tool.

Don't worry at all about weakening the axles unless you need to get the alignment changed a number of times.

### High-Mileage Bugs

I was going to ask you to help me solve my problem, but since I've figured it out myself, I hope you'll share it with *(Please turn to page 106)*

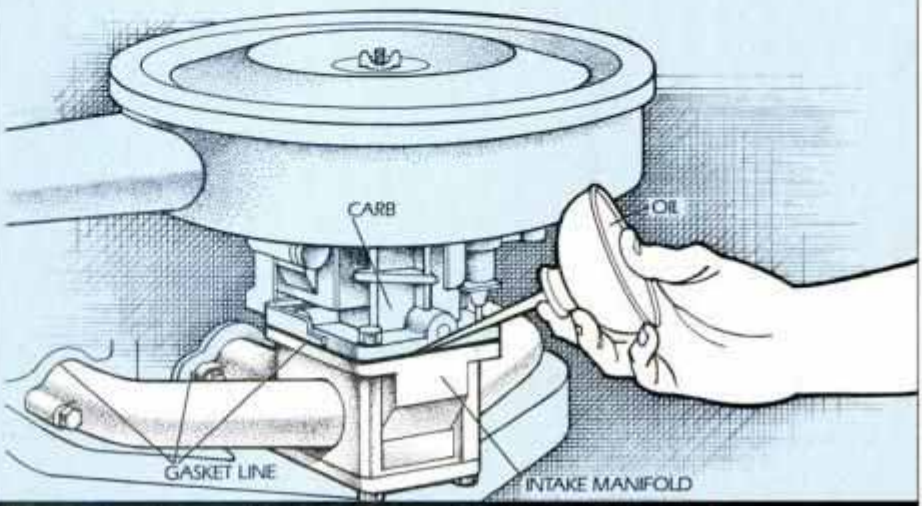
### Oil That Leak

● A whole lot of driveability problems can be blamed on vacuum leaks. Modern, fuel-injected engines aren't immune to this either. In fact, the computer will reestablish a more-or-less correct idle speed, and leave you with a stumble or hesitation that defies electrical diagnosis.

That's because the computer won't account for where the extra air is coming from at idle. It's leaking into the intake without passing through the Mass Air Flow (MAF) sensor. Carbureted cars are a different story—they'll idle poorly because of the excessively lean mixture.

Try squirting some engine oil carefully onto suspected areas, like the manifold gaskets, while the engine is idling. When the oil gets sucked into the leak, it'll momentarily plug the hole, and the idle will change for a few seconds until the oil gets pulled through.

Messy, but effective.



FM ILLUSTRATION BY ADOLPH E. BROTMAN



The Sebring 5000  
'62 Austin-Healey reproduction



The Marlene  
'36 Mercedes 500K reproduction

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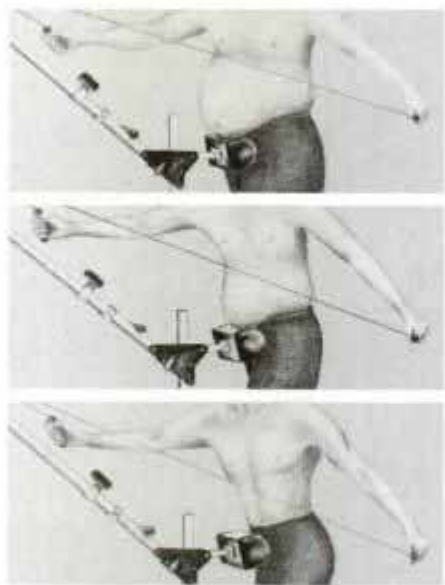
Meanwhile you can strengthen your heart, tone your muscles and improve your stamina.

NordicTrack duplicates the motion of cross-country skiing, the most efficient and effective way to get exercise.

NordicTrack helps you lose weight & keep it off. Permanently. It's more effective than dieting. And it's a lot less stressful on the body than high-impact sports.

## This is the way to look as good as you feel.

NordicTrack boosts your productivity and creativity and lowers your stress. All while helping you lose weight.



## NordicTrack provides a total-body workout.

Unlike most in-home exercisers, NordicTrack works all the major muscle groups including the arms, legs, buttocks, shoulders and yes, stomach.

## It's time to change the spare tire.

So what are you waiting for? Call NordicTrack today.



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**275B1**

## CAR CLINIC (Continued from page 105)

other Car Clinic readers.

I've owned several Olds '98 Regencies. They all gave about the same mileage—28 to 30 mpg on the highway. Except for the one I have now—an '86 that only gets about 25. The dealer said everything was fine, but I knew the mileage should have been better, as the car really runs great.

The only difference on the car is the plastic bug deflector above the front of the hood. So I took it off to experiment, and saw an immediate 3 mpg gain!

FRANK SIMON  
VENICE, FL

*Thanks, Frank. This doesn't surprise me a bit. Modern, post-OPEC cars have pretty good aerodynamics, and adding a couple of square feet of frontal area obviously can have a profound effect.*

## Flying Escort

I'm moving from the East Coast to Denver. I understand the thinner air has an adverse effect on the air/fuel ratio of my engine. I'm going to be taking my 1.6-liter Escort to Denver with me, and I wondered if you could

give me recommendations about carb jets, timing modifications and so on.

If not, could you refer me to another source of information.

PHILLIP REXROTH  
DENVER, CO

*This is easy, Phillip. The mechanics who work in the Denver area are all too familiar with this problem. The car companies are painfully aware that when the air is thin, the supply of fuel to the engine has to be cut back to match. Any Ford dealer will have the smaller jets to prevent your car from running too rich. Denver is a difficult environment for cars, especially carbureted cars like your Escort. A fuel-injected or turbocharged car would be less susceptible to the thin-air blues.*

*Just remember that there is going to be less performance available from your normally aspirated car than someplace where the air is thicker. But at least you'll have a vehicle that runs properly.* **PM**

## DO YOU HAVE A CAR PROBLEM?

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

## SERVICE TIPS

- Chrysler TSB 21-19-90 suggests that if the transmission of your '87-'90 Ram Van or Dakota pops out of gear when it's cold, the problem isn't really in the transmission. It's the rubber boot, stiff from the cold, trying to straighten back out and moving the shift lever. Chrysler's got new detent springs for the linkage to keep it in gear.
- Toyota All-Trac Turbos produced between September '87 and June '89 may lose coolant from the overflow if the engine is shut off immediately after high-speed driving. TMS-SVC:155 details replacement of the radiator and overflow reservoir.
- Honda now has an exchange program for '86-'89 Accord automatic transmissions. Honda will supply the dealer with a rebuilt transmission instead of having the dealership disassemble and repair the trans themselves.
- Ford says that if the daytime running lights on a Canadian-spec Ford product flicker at startup or go off when the a/c blower is turned on, it's perfectly normal.
- Some 1990 Nissan Sentras may have excess crankshaft endplay, according to TSB 90-029. This condition was supposed to have been caught at the dealership before the cars were delivered to customers. The procedure specified in the Nissan TSB calls for dropping the oil pan, and checking the endplay at the No. 3 main-bearing cap with feeler gauges. If the crankshaft endplay is more than 1.7mm, the engine should be replaced.



NEW! From the maker of Passport



## Self-powered SOLO

Finally, a radar detector so advanced,  
you'll never be bothered with a power cord

Until now, high performance radar detection required a messy power cord. Plugged into your car's lighter. Dangling across your dashboard. And tangling in your pocket.

Now, there is a better way.

### No Power Cord

SOLO is a totally new concept in long-range radar detection. All you do is clip SOLO to your visor or windshield, and switch it on. It's that simple.

You'll never need a power cord. Unlike any other radar detector, SOLO has its own power source — inside its compact magnesium housing (SOLO is 3/4" x 2 1/4" x 4 1/2" — just 5 1/2 ounces).



SOLO comes complete with all accessories, including visor and windshield mounts that instantly conform to any car, but fold flat for convenient carrying. Both designs are patented.

### How It Works

After years of research, our engineers (who also designed ESCORT and PASSPORT) developed circuitry fifty times more efficient than conventional detectors. This design provides long-range radar warning for 200 hours on a single 9 volt battery.

If you drive one hour a day, you won't need to replace SOLO's battery for over six months. (Even if you drive two hours a day, you'll get over three months.)

### No Compromise Performance

With SOLO, you get long range radar warning with no hassles. And

### WHAT THE EXPERTS SAY

*"No other detector manufacturer has anything even close ... Solo moves the state of the art to a higher plane."* BMW Roundel

*"The most user-friendly detector yet ... we fell in love at first beep."* AutoWeek

you never have to worry about SOLO's performance. SOLO maintains all of its radar warning capability over its entire battery life. SOLO's even smart enough to turn itself off if you forget. When it's finally time to replace the battery, SOLO will tell you five hours in advance.

Then just drop in another lithium battery for 200 more hours (or use a standard alkaline to power SOLO for 80 hours). SOLO costs less than three cents per hour of use.

### Experience The Freedom

You'll slip your SOLO into its carrying case and carry it in your shirt pocket. In your car, just clip SOLO to your visor and switch it on.



SOLO's super efficient design never needs a power cord. A 9 volt battery provides 200 hours of power — several months of radar protection for most drivers (at a cost of only three cents an hour).

It's so easy, you'll never go without radar protection again. And now a special offer lets you try SOLO for 30 days at no risk.

### We GUARANTEE Your Satisfaction

SOLO is only available from us, and comes complete with our Digital Key anti-theft system, all mounts and accessories, two batteries, and a one year limited warranty.

Here's our offer. Try SOLO. If for any reason you're not completely satisfied, just return SOLO within 30 days. We'll refund all your money and even pay your return shipping cost. You can't lose.

Once you try self-powered radar protection, nothing else will do. Order today.

Order today and try SOLO  
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# How a middleweight fights heavyweight battles.

The new mid-size Dodge Dakota. Now with V-8 power.

More available payload than Ford and Chevy half-tons.

The battle lines were drawn. And when it was over, the middleweight from Dodge tasted



Dakota's available new V-8 really packs a punch.

victory while some bigger trucks from Ford and Chevy went down to defeat.\*

Choose the powerful punch of a V-8.

Introducing the mid-size Dodge Dakota V-8.

Dodge Dakota 4x2 V-8

Its new eight cylinder muscle is 170 hp strong, 5.2 liters big and cranks out 262 lbs-ft of torque at 2,400 rpm. But if a V-8 would overpower your job, Dakota also offers a choice of 4 cylinder or V-6 engines as well.

The payload of a heavyweight.

With up to 2,550 lbs of available payload, Dakota gets the job done. Ford and Chevy full-size half-tons can't haul as much.\*\*

The body you always wanted.

Take your choice of 6 1/2 or

8 ft cargo beds. Pick a 4x2, a shift-on-the-fly 4x4 or even a Club Cab that seats up to six.

Every one of them offers more front leg-room than any full-size pickup from Ford or Chevy. And bold new styling designed to look good on or off the job.

The agility you always needed.

No full-size pickup can out-manuever Dakota. It fits into places no full-size can. And with special savings on popular



From 4x4 to 4x2 to Club Cab, Dakota's got every body.

options, it fits your pocketbook better too. Just ask your dealer about Advantage Package savings. And about our 7/70 power-train warranty that

helps keep your Dakota physically fit for years to come.†

Welcome home to Dodge.

The middleweight Dakota V-8. Now bringing more truck buyers home to Dodge. So are our hard-working full-size Ram Pickups, including our Dodge Cummins Turbo Diesel. The only turbo diesel there is. So if you're looking for the winning punch, come to Dodge. Come see what we're made of.

\*Competitive claims based on '90 data ('91 competitive data incomplete at time of printing). \*\*Regular cab 4x2 payload comparisons. †See this limited warranty and its restrictions at your dealer. BUY OR LEASE AT YOUR DODGE DEALER. Buckle up for safety.



Advantage: Dodge.



# REPLACING YOUR CATALYTIC CONVERTER

BY JIM PIECHOCKI

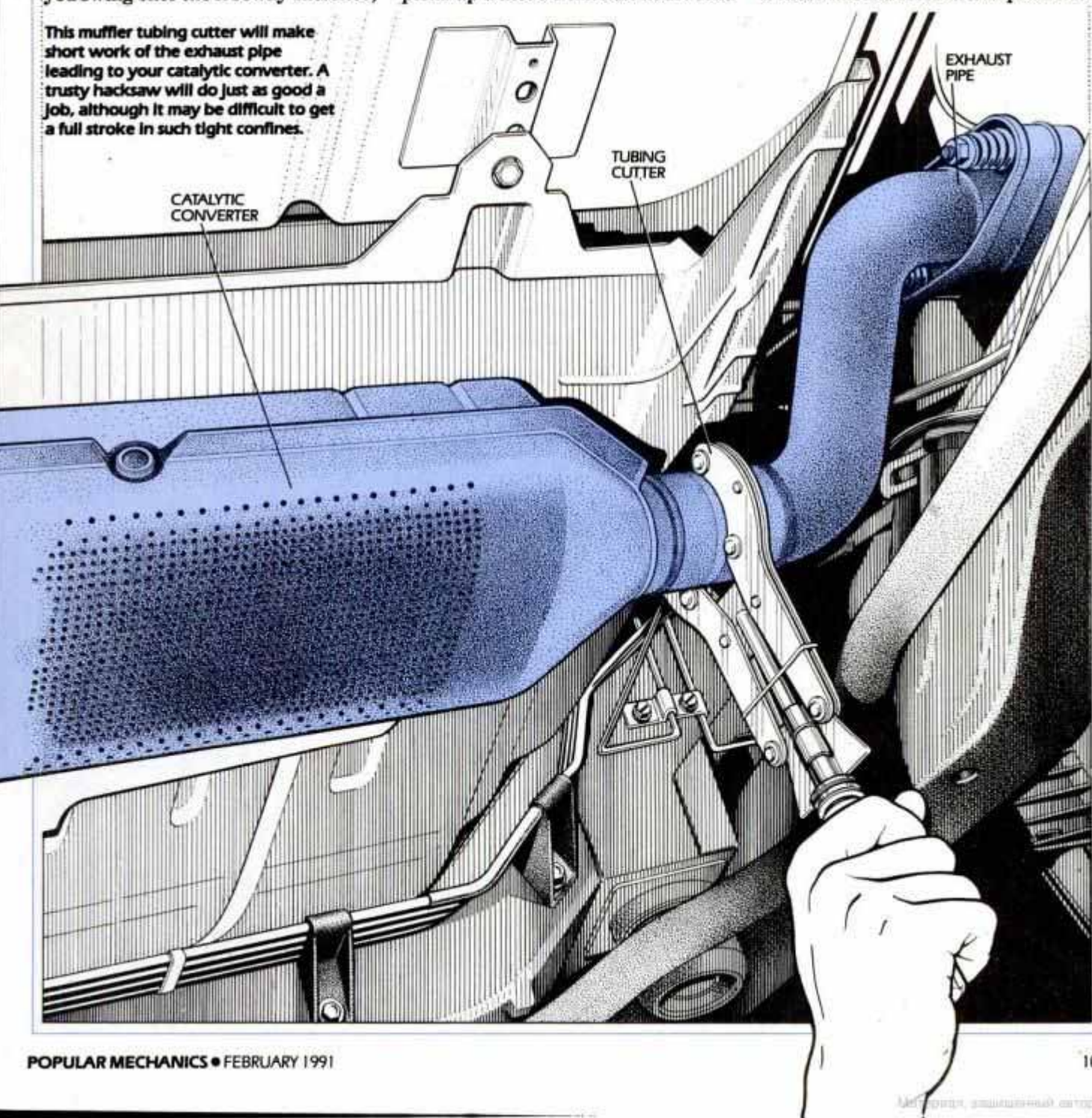
● You've fought your way through boulevard traffic for what seems like long enough for the next payment on your sled to become overdue. At last, you swing onto the freeway entrance,

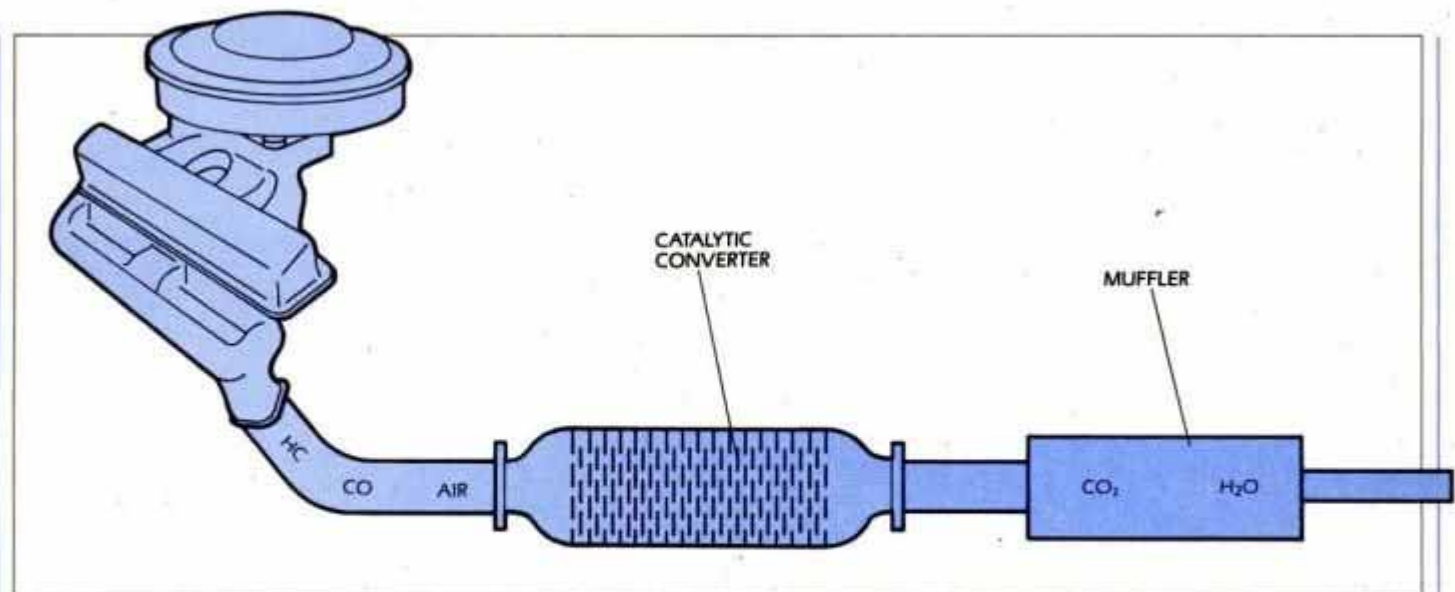
with the wind blowing in your hair. Hmm . . . not very twisty here. So, you do what any red-blooded vehicle owner would—leadfoot the accelerator pedal and brace yourself for the welcome surge of speed that seemed so easy last week. Instead, your car picks up a mere 1 mile an hour. And

the driver behind you is frantically gesturing toward your tailpipe.

Red-faced, you hop out and see sparks dancing out of your tailpipe. No, you're not a victim of a demonically possessed exhaust system. Your car has fallen prey to a malfunction of a most-misunderstood component of

This muffler tubing cutter will make short work of the exhaust pipe leading to your catalytic converter. A trusty hacksaw will do just as good a job, although it may be difficult to get a full stroke in such tight confines.





Some catalytic converters use excess air in the exhaust stream to oxidize excess pollutants.

your emissions control system: a clogged catalytic converter.

## Catalytic converter operation

A bubble of metal located after your engine's exhaust manifold, the catalytic converter is designed to reduce hydrocarbon (HC) and carbon monoxide (CO) emissions into carbon dioxide and water vapor. The converter also purges oxides of nitrogen ( $\text{NO}_x$ ) vapors from the exhaust. It is called catalytic because precious-metal catalysts inside the converter react with these toxic gases on the large surface area of an ingenious honeycomb coated with less than a gram of the catalytic material.

Most vehicles made after 1980 use this so-called monolithic converter. If your car is pre-1980 vintage, it's more likely you'll have a pellet-type converter. Pellet converters contain thousands of tiny grains of ceramic reactants that produce a similar result.

A catalytic converter is a tiny combustion chamber. Your vehicle's air management valve adds fresh air to the exhaust gases inside the chamber, heating the converter's insides to speed up the catalytic reaction. Additionally, the engine management computer only lets air into the converter when the engine is heated. A fuel-rich mixture from a cold engine can cause the converter to overheat, and after a period of time, melt down. So can the excess

hydrocarbons from a poorly running, misfiring engine.

This leaves goopy chunks of partially melted matrix inside the converter. They rattle around the inside of the converter and eventually clog the exhaust flow. A worst-case scenario can blow out your head pipe after the converter is completely blocked.

Catalytic converters are also sensitive to what some mechanics call lead poisoning. Exhaust from leaded gasoline gunks up the honeycombed monolith by coating the precious-metal catalysts with metallic lead, rendering it dysfunctional. This will leave your converter with serious intestinal blockage as well.

A final cause behind cranky converters is nature itself—rust can eat away the converter casing. While the device can still operate, the unpro-

tected elements are so superheated that one vehicle owner lost his entire lawn in a fire that was caused by his converter.

You might conclude that the main beneficiary of emissions controls isn't the environment—it's your mechanic's pocketbook.

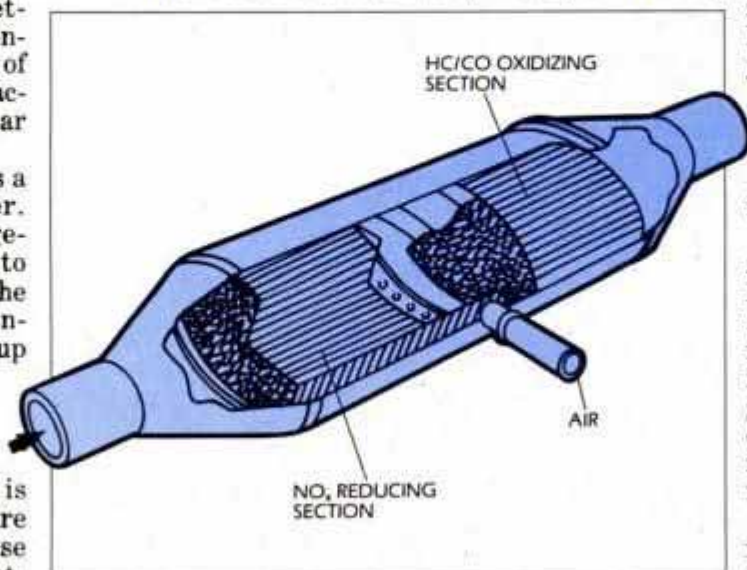
## Getting to the bottom of it

Yet, it's not necessary to fork out the \$300 to \$500 most service departments charge for converter replacement. Replacing your own converter is almost as easy as installing a new muffler. But, no surprise, there are a few caveats before you begin.

As always, use proper ramps or jackstands to lift the vehicle high enough for access to its underpinnings. Don't improvise, unless you feel capable of bench-pressing a ton or so. You'll be working directly underneath the parts you're wrenching on, so use some sort of eye protection to prevent flakes of rust from finding their inevitable and painful way into your eyes.

Be sure your vehicle has sat, engine off, for at least 2 hours before you begin. Since the converter is a miniature combustion chamber, it runs hotter than your engine. Even if your engine is cold, the heat-hungry demons inside your converter may still be cavorting.

There are no published generic diagnostics for a blown converter. Most service mechanics simply test-drive the vehicle and feel the engine



Other designs inject a volume of fresh air into the converter to permit oxides of nitrogen ( $\text{NO}_x$ ) to be reduced in a separate chamber.

lug. You can also tap the converter with a rubber mallet. Loose monolithic elements will rattle inside the housing. This tells you that the precious metals have flaked off the honeycomb and are threatening to invade your tailpipe.

A brief examination of the converter housing will also reveal corrosion and scoring caused by road damage. Rarely, an off-road odyssey may have even scraped open the metal shell and exposed the monolith.

A simple rustout or scrape of the converter's outer skin may not seem immediately perilous, but there are sound reasons to avoid leaving the converter's inner shell exposed to the elements. First off, it leaves the inner shell exposed to road salt, air and other potentially damaging foreign substances or objects. Second, the loss of insulation will make the converter take longer to warm up to its effective operating temperature, spewing excess pollutants all the while it's slowly digesting the parts of itself that have warmed up. Third, converters run *hot*—hotter than the rest of the exhaust system because the reactions inside the converter are producing even more heat than the manifold is pumping in.

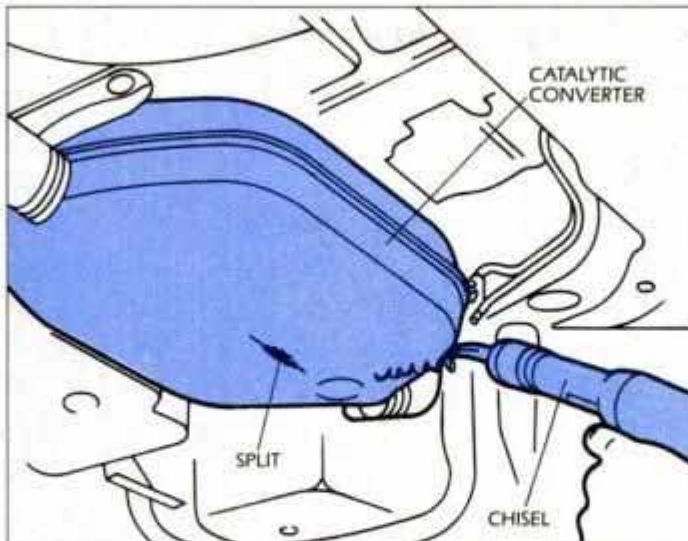
Fortunately, many converters can be reskinned by simply chiseling off the old outer skin and insulation, and crimping on a new outer shell from the dealership.

For the same reason, it's really important to replace or repair any metal heat shields in the area of the converter, whether they are intended to protect the interior and floor of your own vehicle or to keep heat from melting the pavement beneath the converter when you park.

## Is this trip really necessary?

A loyal, obsessive Saturday Mechanic disciple, you of course want to check your plugged converter against the numbers. You simply need a vacuum gauge, which measures your engine's health in inches of mercury.

Attach the vacuum gauge anywhere you can find unmettered vacuum on the intake



In some cases, it's possible to repair a damaged outer shell by chiseling off the casing and crimping on a new one.

manifold or throttle plate. On GM/BOC (Buick, Oldsmobile and Cadillac) vehicles, the air-conditioning and cruise-control ports are ideal. Look for a vacuum fitting that springs from the manifold itself, or from the carb or throttle body well below the throttle plates. Tee in before any gadgets in the line, as they may restrict the vacuum flow—you want pure unadulterated manifold vacuum.

For most cars, a normal reading with the engine idling is about 17 to 19 in. of mercury. A converter problem, or for that matter any exhaust restriction, will reduce this when the engine revs up.

Once you have attached the gauge, increase the engine speed beyond 2500 rpm. Mechanics vary on this figure. Some like to rev it beyond 3000. A normal, unblocked exhaust system

will read within 3 pounds of idle. A clogged system will show a reading that's well below this and often sputter and miss.

For example, if your engine shows 18 in. of mercury at 1500 rpm, revving it up should create 15 in. at 2200 to 2500 rpm. If the vacuum meter reads below 15 in., you may have a blocked exhaust system caused by a malfunctioning converter.

For an even more positive diagnosis, there are exhaust pressure gauges that screw into the exhaust manifold at the fitting for the O<sub>2</sub> sensor.

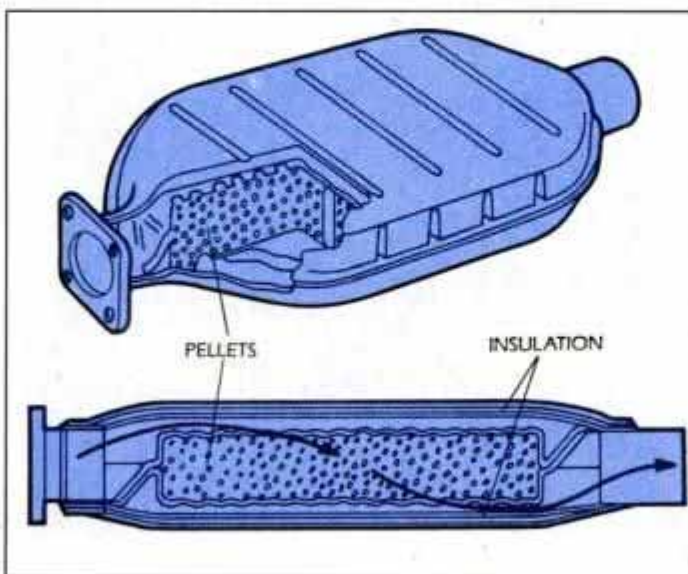
At any rate, you've decided the problem has to be the converter. The next step is to replace the converter. A basic enough procedure, there are, nevertheless, a few key details to master.

## Removing and replacing your converter

Most catalytic converters are attached to the exhaust system by a set of clamps and flanges. There is both a converter inlet and an outlet attachment. The first step is to remove these clamps. This is where the fun begins, particularly in cold weather regions.

Four-figure temps and salt-fed rust can eat away boltheads and wreak havoc on vulnerable flanges. To detach corroded bolts, you might try a torch to heat and loosen them. Don't be afraid to heat the fittings cherry red. Those of you without a torch will have to resort to more conventional measures, like nut splitters, penetrating oil and a few well-chosen phrases. Plan on replacing all of the hardware from the beginning—it's rare that you can get much of it apart in any shape to be reused. You'll make better headway when the replacement is already waiting on the bench, and you're not trying to rescue some old chewed-up bolt.

Many domestic vehicle converters are actually welded to the exhaust system. In this case, you can use a pipe cutter or hacksaw to remove the inlet and outlet points. Cut just inside the welds so your installation is not hampered by excess traces of the old converter.



This pellet-type converter, a design that's giving way to honeycomb types, uses ceramic pellets coated with catalyst metals.

You must also detach the air hose that runs from your manifold to the converter. Typically, a clamp or flange subassembly is all you need to remove. Think hard about replacing at least a few feet of this hose, while you're in the neighborhood.

## Confirming the worst

There is a final check before you finally bolt up the expensive new pieces. Clamp a length of pipe to the system inlet and outlets, bridging the converter's place in the

exhaust system. Reattach the vacuum gauge, and rev it up. You should see the vacuum settle at an appropriate value, well above the one with the slagged converter corking things up.

But do not—and we mean it—do not drive the vehicle yet. The Environmental Protection Agency requires that all post-1979 vehicles on the road possess a functioning catalytic converter. Squirrels, pine trees and asthmatic emissions checkers will haunt you for eternity if you do not comply with this simple regulation.

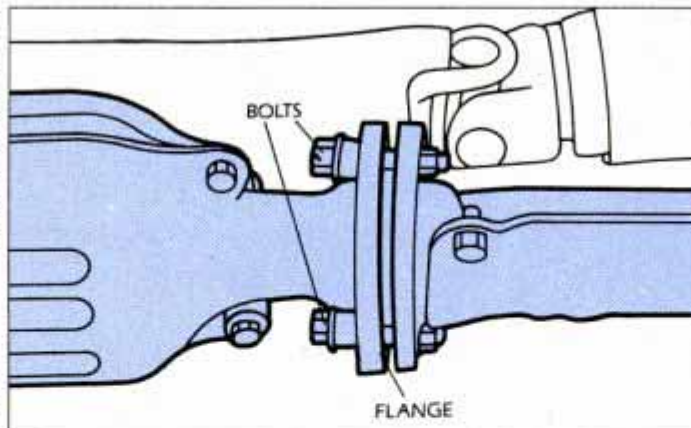
Now, it's time to replace the converter. Simply repeat the removal steps in reverse. Mechanics are mixed on their preference for the exact steps. Suffice to say that the new converter must be securely attached at both inlet and outlet ports, and the manifold air hose must be clamped in place.

Start by assembling all the flanges and slip-joints loosely, with all the hardware started and gaskets in place, but without tightening anything even finger tight. Make sure everything is hanging straight and level, with plenty of clearance—exhaust systems move around a lot.

Be sure any slip fittings telescope at least 2 in. into each other, and clamp the center of the overlap. Try buttering up the hardware with some antiseize compound as well. You *might* need to disassemble this stuff at some point a year or three down the pike—when the remaining exhaust system corrodes away, for example, which it will do sooner or later. The antiseize compound will make your life much simpler when that day arrives.

## Aftermarket converters

A visit to your dealership parts department will reveal that a new catalytic converter can cost you as much



Separating corroded fasteners is the toughest part of converter replacement. Have fresh replacements on hand.

as \$300—each, if you're unfortunate enough to have two. Yet there are a number of very good aftermarket converter kits available. Priced at \$125 to \$150, these kits include a so-called universal catalytic converter and a conversion kit. You *must* purchase the right kit for your vehicle. You'll find these converters along with plenty of good advice as to what other parts you will need, at the local auto parts store.

To this end, aftermarket manufacturers publish catalogs that recommend connector pipes for attaching their products to your vehicle. A lifetime warranty applies to many aftermarket converters.

## Go for the cause—not just the symptom

Auto companies design catalytic con-

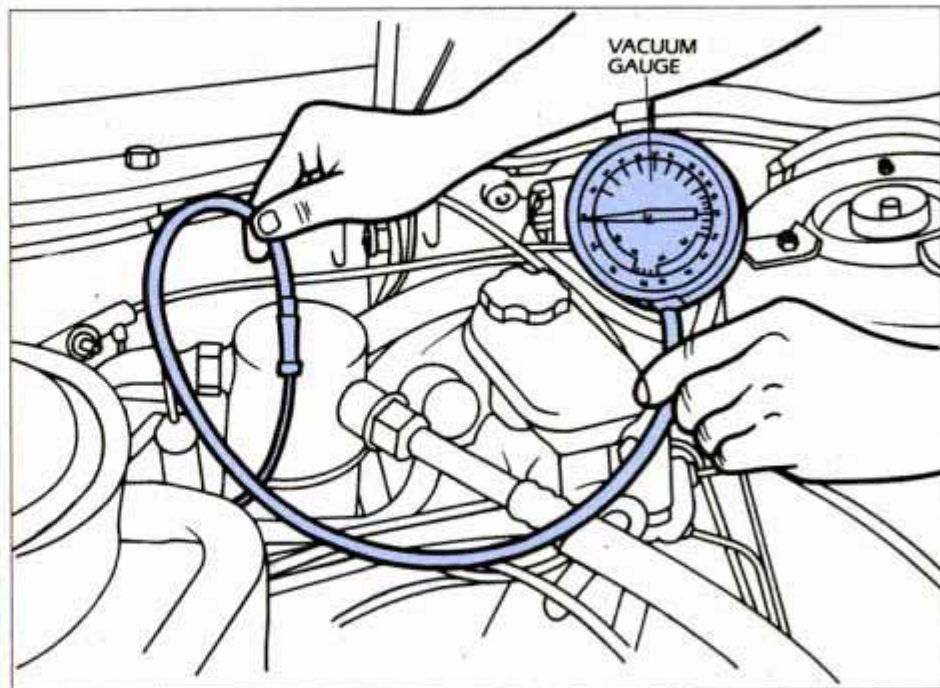
verters to last the lifetime of the vehicle. Emissions testing labs, such as GM's Milford Proving Grounds, batter converter prototypes with months of all-weather tests that evoke secure nods of approval from engineering management.

When your catalytic converter goes bad, the reason is usually that your engine is not functioning properly. Don't be a Saturday mechanic who installs a new converter, only to discover his car or truck lugging after a few months of city driving. To

prevent future converter damage, it is essential that you discover why your engine is malfunctioning.

## Waste not, want not

At some point in time, catalytic converters will consume virtually all of the worldwide production of rhodium, one of the catalysts. Fortunately, rhodium, platinum and other scarce elements are pretty easy to reclaim from the slag in your converter. Many salvage lots will even *give* you a few bucks for your old converter, because they sell them in bulk to someplace that melts them down and re-refines them for the few grams of precious metals in them. At worst, take the hulk down to a muffler shop and see if they mind you throwing it onto the pile of converters that they send off to be recycled. **PM**



A plugged converter will show up on a vacuum gauge as abnormal vacuum readings, indicating that there's backpressure in the system.

# DEMYSTIFYING ETHANOL

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY BRUCE KING

● Alcohol and boating *do* mix. If you're talking gasoline and ethyl alcohol, they mix well indeed. In fact, gas mixed with 10-percent ethanol burns with reduced carbon monoxide emissions, increases octane ratings and results in less residue or deposits on internal engine components. It also burns cooler than gasoline and, perhaps most importantly, it's the only renewable alternative fuel.

But why is ethanol, typically made from fermented corn and available since the late 1970s, so slow in catching on? In part, the answer is due to messages like this, which appeared on a fuel-system warning label printed by the National Marine Manufacturers Association (NMMA) until last December: "The use of alcohol-modified fuels can cause deterioration of the fuel system."

## Fact and fiction

Someone once said: "Never play cards with a man named Doc. Never eat at a place called Mom's. And never bring up the subject of ethanol at a party of gearheads." (Actually, I changed the third admonition, which was too spicy

for a family magazine anyway.) Gearheads are the original know-it-alls, and one thing they know for sure is that marine engines shouldn't run on ethanol-blended fuels. They cite several reasons. Let's look at them.

● *Ethanol absorbs water—a real problem in the marine environment.* Yes, ethanol and all alcohols absorb water. If your fuel system is exposed to water intrusion, you could be in big trouble—with or without ethanol fuel. But what about natural condensation? Ethanol will absorb it, and this is an advantage. It actually dries out your system.

The only problem with water arises when you let the boat sit for weeks at a time. Ethanol may do something in these circumstances called phase separation. Basically, this means that it separates into a gasoline-rich portion and a water-rich portion. When this happens, there's a chance that your fuel system will deliver the water-rich portion to your carburetor. The solution? When you give your boat a major holiday, drain the fuel tank.

● *Ethanol will damage the engine's hoses and seals.* Older engines were

designed to use leaded gasolines, and the composition of these fuels was far different than what we use today.

Since the widespread introduction of current fuels—ethanol, methanol (methyl or wood alcohol that's typically manufactured from natural gas), unleaded and reformulated gasolines—manufacturers have adapted to the changing times. At first, the rubber and plastic components of the fuel system showed rapid deterioration, but they've since been replaced.

Today, no marine or automotive builder warns in the owner's manual against using ethanol. If your engine is approaching 10 years old, you may have a problem, but all newer engines can accommodate ethanol and other alternative fuels.

● *Ethanol fouls fuel-injection systems and fuel filters.* There has never been a problem with fuel injectors, because ethanol burns 100 percent and leaves no residue. Also, since 1985, all ethanol blends contain detergent packages designed to improve fuel-injector performance.

On older engines, ethanol can loosen contaminants deposited by previous gasoline fills and these particles can collect in the fuel filter. The solution? Change the fuel filter once your fuel system burns itself clean.

## Fuels of the future

Alternative fuels are here to stay. The twin concerns of cleaner air and reducing foreign oil dependency are unstoppable forces. Ethanol is clearly a major player. In fact, it appears in nearly 10 percent of all gasoline sold today. Even the NMMA, whose initial concern was with fuel system components installed by boat builders, rather than engine builders, has dropped its objections.

But why do we hear so much more about methanol, a highly corrosive oxygenate, and methyl tertiary butyl ether (MTBE) than ethanol and ethyl tertiary butyl ether (ETBE)?

Pure methanol, which requires a cosolvent and is limited to 5-percent blends when used in consumer engines, has proven itself in high-performance Indy cars for years. Racers use methanol because it burns cleaner

(Please turn to page 114)



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## BOATING (Continued from page 113)

and cooler than gasoline.

Detroit is comfortable with methanol. Oil companies prefer it, of course, because methanol is a product that comes out of the petroleum industry. In fact, swiftly perfecting MTBE was a top priority for the oil companies. Full development and application of ETBE at oil refineries is still a year or two away.

### Beyond technology

If the world were a simple place, competing technologies would be thrown into the marketplace and their fates would be decided by buyers. This isn't going to happen with future fuels.

Ethanol and all other nonpetroleum additives and oxygenates face a difficult road to acceptance due to the vested interest and power of the oil industry.

To be fair, the oil industry has a legitimate concern regarding the role of the American farmer. Is it in the nation's best interest to divert the effort of farmers from food production to fuel production?

It's no secret that the U.S. maintains an annual surplus of corn supplies, most recently estimated at 5 billion bushels. This occurs even though more than a fourth of all corn-producing land is in the government set-aside program. So, it appears that the nation has more than enough resources to produce food and fuel.

Furthermore, corn used for ethanol isn't entirely lost as a food source. Only the starch portion of the kernel is used. What remains is all of the protein, vitamins, minerals and fiber.

Right now, with the problems of the Mideast foremost on everyone's mind, dependency on foreign oil is of paramount concern. Increased use of ethanol wouldn't solve the dependency problem, but it will be a significant step in the right direction.

This isn't the case with methanol. Although methanol blends burn cleaner and are designed to have higher octane ratings than gasoline that hasn't been reformulated, it won't help solve the nation's foreign oil addiction. U.S. oil fields contain resources to produce large amounts of methanol, but not nearly enough. Like barrels of crude oil, ethanol will ultimately be a net import product.

For more information on ethanol and other issues regarding modern fuels, write to Downstream Alternatives, P.O. Box 190, Bremen, IN 46506; or call (800) 542-FUEL.

If the whole purpose of reformulating fuels is an attempt to do the right thing for the future, doesn't it make sense to use a renewable energy



source, such as ethanol, that our farmers can grow? Fuel for thought.

## Zebras Are Coming

If you haven't already heard about the zebra mussel, you soon will. It's spreading through U.S. waters at an alarming rate. Imported from abroad, the tiny scourge was transplanted in 1988 in Lake St. Clair, near Detroit, by a tanker expelling ballast water. Apparently, the illegal immigrant hitched a ride.

Unfortunately for Lake St. Clair, and now Lake Erie, the zebra mussel has few natural predators to stem its explosive growth. This is where the trouble lies. Each adult can produce as many as 30,000 larvae annually. Concentrations of 700,000 mussels per square meter have already been discovered.

Problems with zebra mussel infestation, now only in its infancy, have already been severe. Municipal water systems have been clogged, marina dock pilings have been damaged and recreational shorelines have become dangerous due to the addition of a layer of sharp shells.

Boaters haven't been spared, either. One boat was pulled from Lake Erie recently with more than 30 pounds of zebra mussels attached. Even more sinister, the pests are so small that they can infiltrate a boat's water-intake system and grow inside the engine. The potential for serious engine damage is vast.

What can you do? Unless scientists discover a way to eliminate zebra mussels within the next couple of years, boaters on the Great Lakes and the surrounding waters will have to learn to live with the flourishing organisms. Here are some tips:

- To protect your hull, use an anti-fouling bottom paint from Interlux or other marine coating company. Apply a new coat each year.
- Wash the hull with a strong spraying or rubbing action each time the boat is pulled from the water. This will prevent larvae from building up below the waterline and halt the spread of mussels to new areas.
- Tilt outboard motors out of the water when not in use. Check and clean props, shafts, trim tabs, transducers and lower gearboxes weekly, if boat is left in water.

The entire Great Lakes ecosystem is threatened by an imported invader. For more information, write to the Zebra Mussel Information Clearing House, State University of New York, Brockport, NY 14420; or call (716) 395-2638. We can do something, but the time to act is now. **PM**

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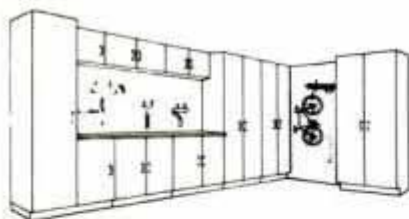
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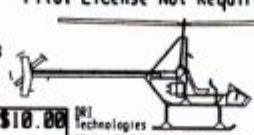
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(Continued on next page)

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(Continued from preceding page)

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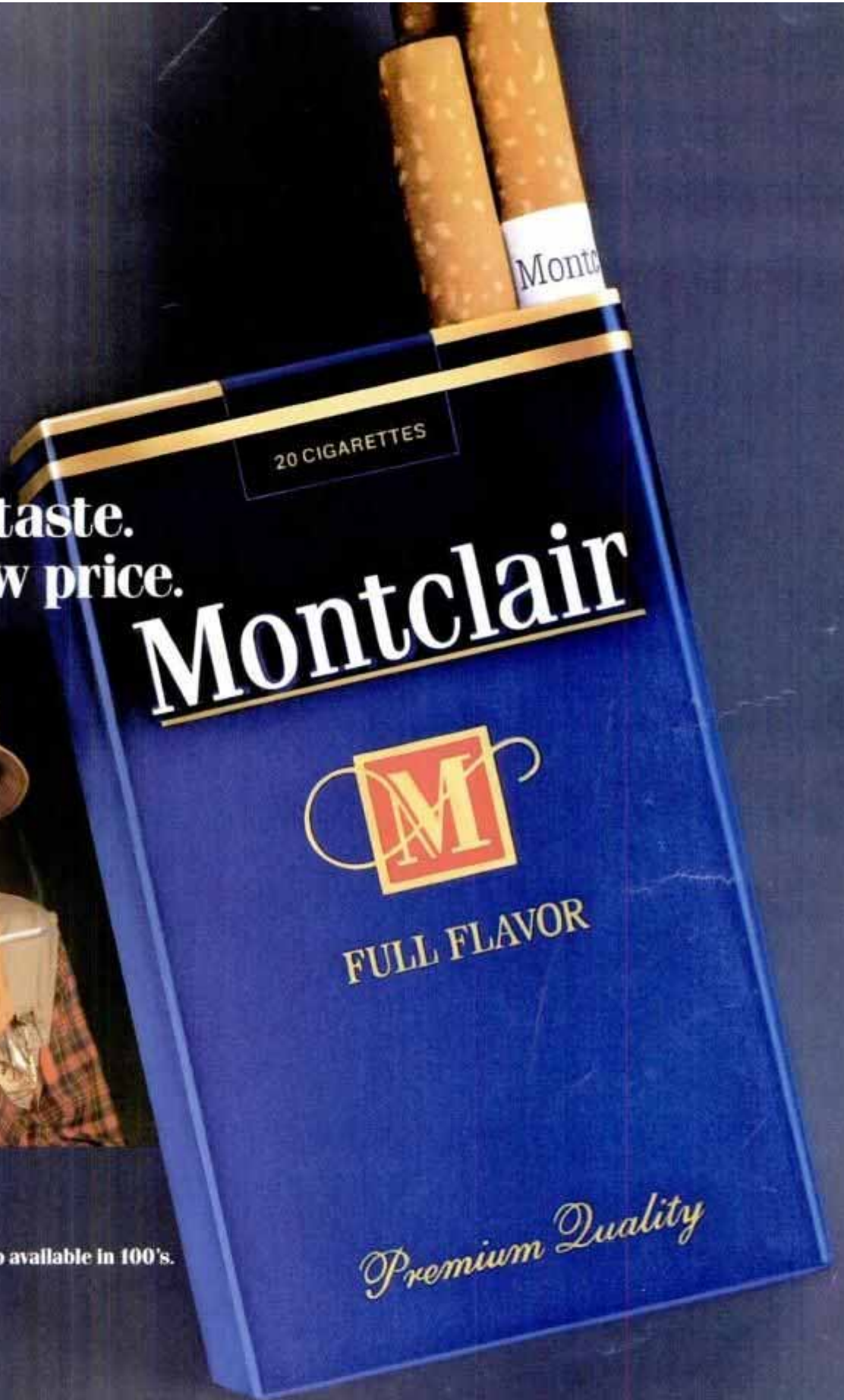
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