

JANUARY 1989 \$2.50

# Popular Mechanics

COMPLETE BUYERS GUIDE  
1989 PICKUPS

AIR FORCE'S 'INVISIBLE' ATTACK PLANE

## STEALTH FIGHTER

First Look At America's Most Secret Aircraft



Out of the shadows at last, the Lockheed F-117A relies on angled planes of radar-absorbing material to defeat ground- and air-based sensors.

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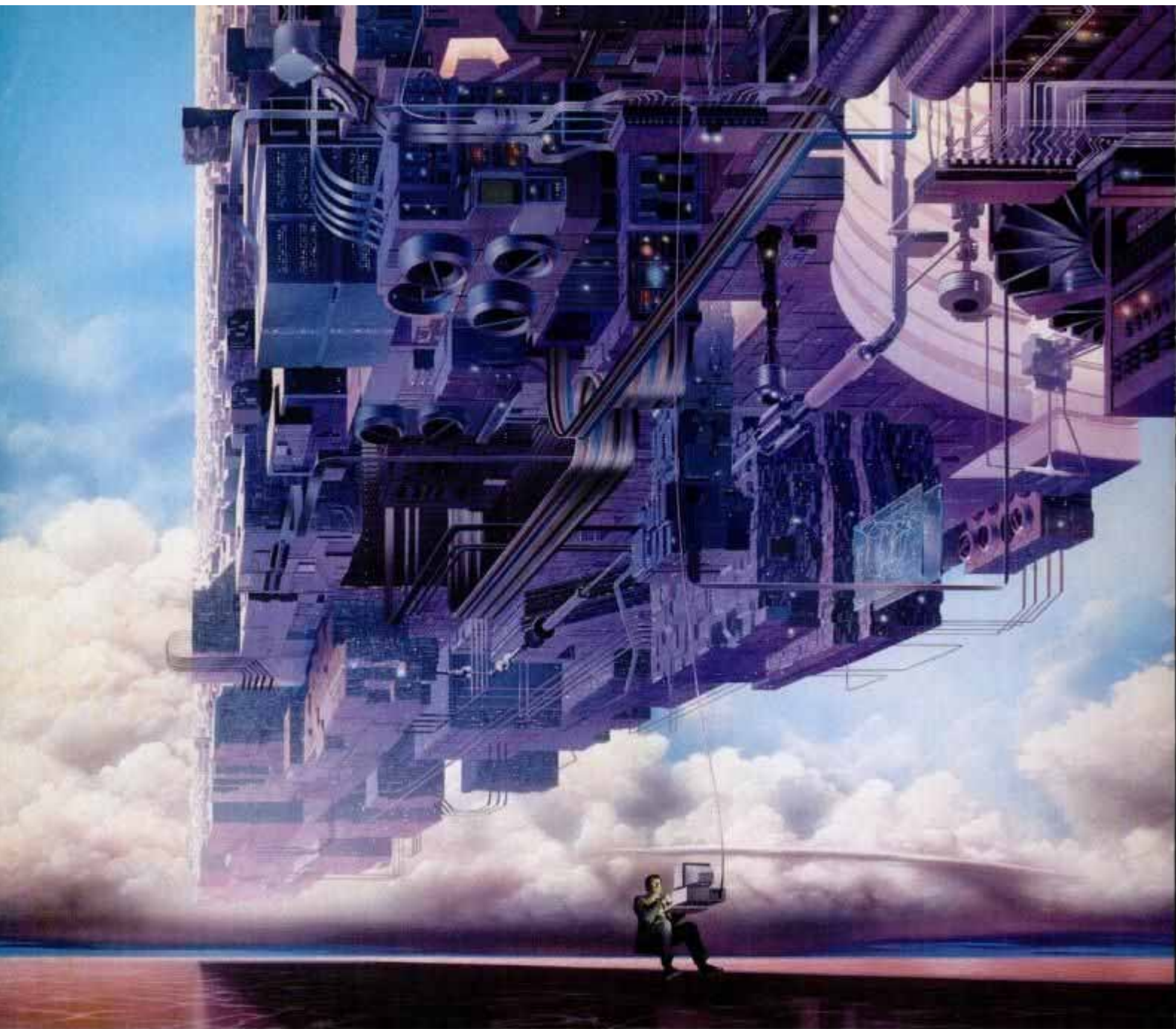
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## 66 COVER STORY

The story of the Air Force's Stealth Fighter has been veiled in secrecy for years, but we now know much about the unique F-117A.  
—PM illustration by Attila Hejja



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# EDITOR'S NOTES

# Popular Mechanics

**I**T HAS BEEN perhaps the best-kept military secret since the atomic bomb. Its "blackness" was almost impenetrable. Even members of Congress had tried to uncover some hard facts on this black program from the Pentagon. To no avail. Indeed, the Air Force's so-called Stealth Fighter program was living up to its reputation. It was invisible. To enemy radar. And to Americans who, for one reason or another, were curious about this mystery weapon in the Air Force's arsenal. There was speculation that, not only was the plane operational but that there was a whole squadron of them based in Tonopah, Nevada. Meanwhile, everyone from toy companies to computer software manufacturers were capitalizing on the interest in the Stealth Fighter. Finally, after years of strict silence on the top-secret program, the Air Force was about to announce details of the Lockheed-built fighter on October 4, just as they had done some months earlier with the B-2 Stealth Bomber. But then, something happened. The press conference was canceled. But just the fact that the Air Force was preparing to release details of the plane confirmed its existence. And since those events took place, people involved with the program have been less reluctant to talk about it. As such, we are able to bring you a comprehensive first



The Stealth Fighter: Already operational at toy stores.

report on America's most secret aircraft—the Stealth Fighter ("Our Most Secret Fighter", page 66). If, by some chance, the Air Force has released its information on the plane by the time I've written this and you get this month's copy of POPULAR MECHANICS, I hope you'll accept the information contained in this month's cover story as what the facts were as of October 24, 1988, and our attempt to bring you the inside story of this fascinating aircraft. . . . The absolute fastest cars we've driven in quite a while. That's really the only way we can describe the new crop of maximum muscle machines coming out of Detroit for '89. Auto Editor Tony Swan and Assistant Auto Editor Mike Allen pushed these modern musclecars to the max to let you know what makes them tick. The tire spinning begins on page 53. . . . You may have noticed the ad in last month's issue (there's another in this issue) for the POPULAR MECHANICS Great American Frontier Adventure To Alaska. If you've ever dreamed of seeing America's last great frontier, this is the way to do it. Our trip offers features you simply won't get with any other tour. Plus, several of our editors will be along with you sharing the adventure. The POPULAR MECHANICS Great Frontier Adventure To Alaska is shaping up as the trip of a lifetime. If you'd like to be a part of it, check the ad in this issue. . . . Once again last year, the top-selling vehicle in America wasn't a car. It was a pickup truck. It seems like everyone drives a pickup these days, from urban cowboys to suburban homeowners with things to haul. If you're in the market, check out "Truckin' '89" beginning on page 85. . . . If there's one power tool you must have in your home shop, it's the do-everything router. Our complete guide to this superversatile tool's many uses begins on page 75. Check it out. . . . 'Til next time.

report on America's most secret aircraft—the Stealth Fighter ("Our Most Secret Fighter", page 66). If, by some chance, the Air Force has released its information on the plane by the time I've written this and you get this month's copy of POPULAR MECHANICS, I hope you'll accept the information contained in this month's cover story as what the facts were as of October 24, 1988, and our attempt to bring you the inside story of this fascinating aircraft.

. . . The absolute fastest

Joe Oldham

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rear wheels. The interiors of all Ford cabs are roomy and comfortable.

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Buckle up — together we can save lives.

Ford's maximum payload exceeds Chevy's for each series — up to 1,000 lbs.

**BIGGER VALUE.**

Fords also come with standard equipment the Chevy C/K doesn't. Features like AM radio with digital clock, cigar lighter and four gauge package.

All big Ford pickups have gas-pressurized shocks, standard — optional only on Chevy K1500. Ford was first with rear Anti-lock brakes, aerodynamic styling, and 4x4 Twin Traction Beam independent front suspension. Automatic locking front hubs are optional on F-150 4x4 models.

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210-hp. 5.8L EFI V-8	Ford 4-Door Crew Cab
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180-hp. 7.3L diesel	<b>EQUIPMENT</b>
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\*Based on calendar year manufacturers' reported retail deliveries through Sept. '88.  
\*\*Based on 1988 New Car And Truck Buyer Study.



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# LETTERS

## Perfect Place To Work

**W**E'VE always considered a rolltop desk as one of the most perfect places to do correspondence and all types of work—writing checks and keeping track of finances, maintaining files on everything from the home mortgage to appliance owner's manuals. It can be set up as a complete office without even taking up a room in the house. My husband recently drew up his own plans (remembering the rolltop you published sometime in the '70s) and built the desk in his spare time. He dimensioned the cubbyholes and pencil trays to leave enough height for his typewriter and to install a flush-mount light above it. I thought you'd like to see how it turned out.

LILLIAN HAHN  
NEW BERLIN, WI

The rolltop you remembered is the turn-of-the-century design that appeared in *PM's* Jan. '76 issue (page 80). It's now included in our "Plans and Ideas" brochure as PL-1736. Other readers who want to get organized can order plans for the desk by sending \$5.95 to *POPULAR MECHANICS*, Box 1014, Radio City Station, New York, NY 10101.



Sept. '88 issue with Vette section includes a pull-out poster.



Rolltop desk built by reader Hahn was inspired by *PM* plan.

### Vette On Your Wall

I wanted you to know that *PM's* special Corvette section ("Happy Birthday, Corvette," page 58, Sept. '88) was superb. A great job.

FRED SCHAAFSMA  
CHIEF ENGINEER  
CHEVROLET MOTOR DIV.  
WARREN, MI

I've been collecting the posters you've been printing in *PM*. The September poster of the Corvette Indy experimental car is fantastic. Is it possible to get large, unfolded copies that would be more suitable for framing?

JOHN SNOBER  
WOODSIDE, NY

We're glad you like the posters. Right now, they're available only in the printed, folded format in the magazine. But we're looking into the possibility of reprinting them in large, 2x3 ft. wall size. If enough

readers want them, we'll do it. Write to Joe Oldham, Editor-In-Chief, if you'd like to see the posters made available unfolded.

### Early Flyers

In "Time Machine," (page 10, Oct. '88), in the "50 Years Ago, October 1938" section, I was fascinated to read about Art Chester, who was called to his reward in a crash some years ago. In the early '30s, Art had his racer based here in Lansing at the Ford Airport.

The old hangar where it was kept is now designated a historical building. Maybe other *PM* readers would like to see the photo I took of Chester's airplane parked just outside of the hangar.

MAX TRINOWSKI  
LANSING, IL

Thanks for sharing with *PM* readers this glimpse back into a fascinating time in the history of aviation.

### Remembering Tucker

Your "Freewheeling" column (page 30, Nov. '88) kicked off with "Tucker: The Man And His Dream" and it sure brought back memories. I was at the Chicago plant the day the first Tucker was shown to prospective dealers. In fact, I still have the badge required. It reads: "Tucker '48—The First Completely New Car In 50 Years." According to my logbook, it was on June 19, 1947 that I flew a prospective Tucker dealer from Pontiac to Chicago.

CARL MONK  
LOUISVILLE, KY

### Listen Up!

Your article on antique radios ("Oldies But Goodies," page 82, Oct. '88) generated over 60 letters in three days! Unfortunately, your article implied that we appraise, buy and sell radios, which we don't. Our membership is interested in preserving the history and apparatus of early radio communications.

JANE W. & WILLIAM E. DENK  
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A moment in aviation history, 50 years ago: Art Chester's plane rolls out.



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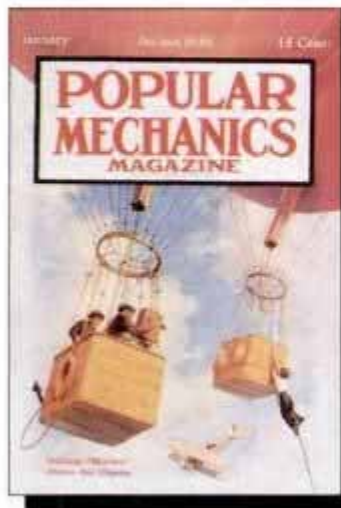
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# TIME MACHINE

## 75 YEARS AGO: JANUARY 1914



### Silent Stunts

The motion-picture industry was barely into its adolescence, but audiences were sophisticated enough to spot a crudely crafted stunt. In our January 1914 cover story we explored the ways filmmakers framed spectacles before the magic of special effects. In one silent thriller, the airborne climax featured an escape from a kidnapper's balloon into a maneuvering biplane. The scene was filmed thousands of feet up, the cameraman's balloon tethered to the villain's.

### Water Walker

The spark of homespun invention has always lit up our pages, and never more brightly than during our early years. Case in point: this life preserver with hinged leaves that let the wearer duckwalk through the deep. The aluminum leaves folded to the calf during a forward stride and deployed outward when the leg swung back. The St. Louis inventor used the contraption to stride waist-deep through the Mississippi as he gunned down unsuspecting waterfowl.



## 50 YEARS AGO: JANUARY 1939



### Flame Tamers

As the nation bounced back from the Depression, a gas-guzzling populace returned Texas to a boom state—sometimes literally, when oil wells blew out. Wild-well damage control was our cover story 50 years ago. Teams of asbestos-clad specialists, operating behind tin heat shields, detonated nitroglycerin to snuff out or divert 40-ft. flame geysers. Meanwhile others set to work with high-pressure dredging equipment and capping manifolds to salvage buried casings.

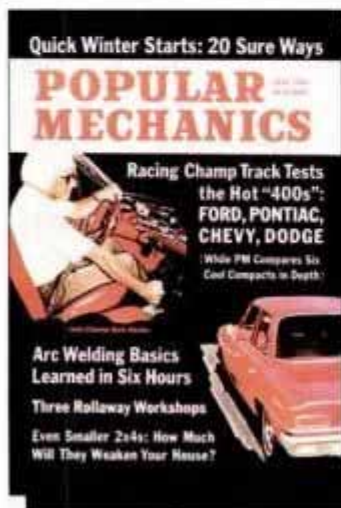
### Bigfoot's Daddy

Monster trucks aren't a recent phenomenon, as evidenced by this '39-vintage stomper that accommodated up to 10 13-in.-wide tires. It was

built for wading through the bayou, rather than steam-rolling its lesser brethren in the gladiatorial arena.



## 25 YEARS AGO: JANUARY 1964



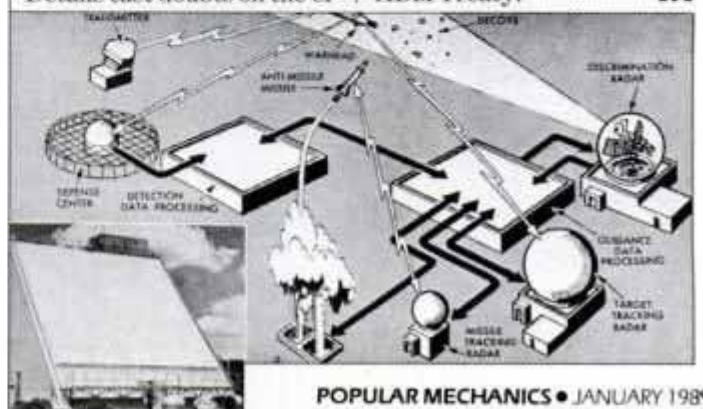
### Four On The Floor

Power-mad auto buyers snapped up Detroit's 1964 offerings, particularly the optional 400-cu.-in. engines. For our January cover story Indy champ Sam Hanks put four hot-engine cars through the paces at Willow Springs Raceway in Rosemond, California. The contestants: Ford Galaxie, Plymouth Sport Fury, Chevrolet Impala Sport Coupe, and Dodge Polara 500. Despite the cars' different transmissions, steering and brakes, the results were surprisingly close.

### SDI, 1960s-Style

Cold Warriors learned that the Soviets installed a new antiballistic missile complex. Details cast doubts on the ef-

fectiveness of the U.S. Nike-Zeus defense system and opened an era of strategic jockeying leading to the 1972 ABM Treaty. **PM**





# VANTAGE

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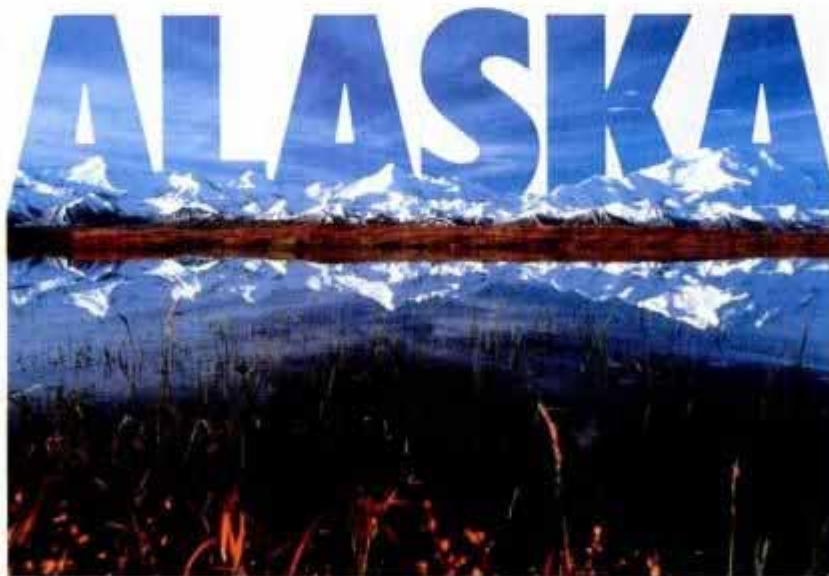
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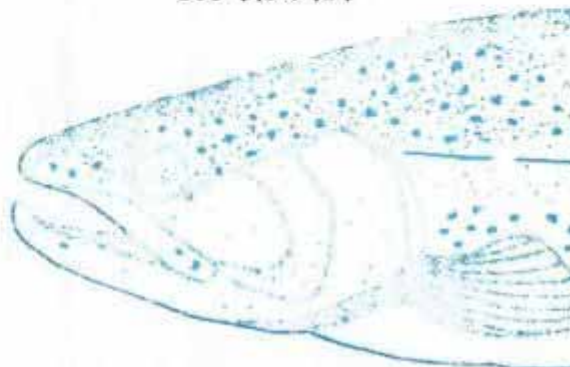
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# TECH UPDATE

## Doctors Are Long-Distance Operators

NEW YORK, NY—A major new avenue in health technology is opening, merging therapy with telecommunications to provide remote medical attention.

Pioneering the trend, the Programmable Implantable Medication System was developed at Johns Hopkins Applied Physics Laboratory. Surgically implanted in the abdomen is a titanium-encased infusion pump packaged with valves, microprocessor, communications coils and a 3-month medication reservoir.

After surgery, the physician uses a radio transmitter to program the pump from outside the body. A patient can also control medication release using his own walkie-talkie-size radio-frequency programming unit. For example, a diabetic could boost insulin output after a carbohydrate-rich meal.

In an emergency, the physician can communicate with the pump using a telephone transceiver that transforms data received from the physician's computer into radio signals.

Addressing different long-distance emergencies, Medphone Corp. has developed a transtelephonic defibrillator. The device consists of a briefcase-size defibrillator

hooked up to telephone equipment in a house, office or hotel.

On experiencing chest pains, the patient or a witness opens the case, automatically dialing the hospital, and alerting a physician. The defibrillator pads double as electrocardiogram (EKG) electrodes and transmit the heartbeat reading to the physician. If electric shock is needed to restore normal

heartbeat, the doctor sends a signal that charges and fires the defibrillator.

Medphone is developing a cellular version as well as other remote-control medical devices.

Telephone therapy may sidestep several problems in health care, including the accelerating costs of hospital care and the frustrating obstacles in providing emergency medical services.

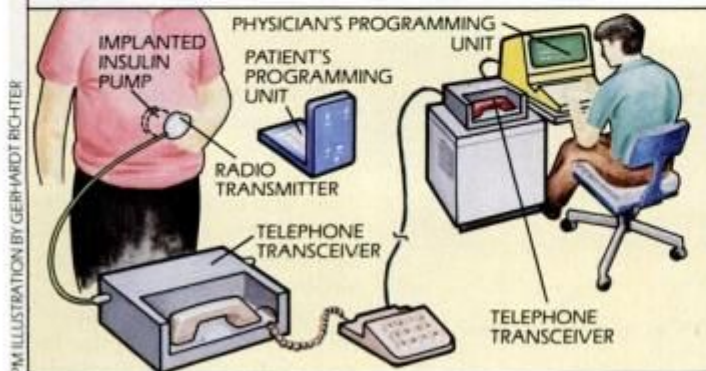
**Palm-size pump, cut away to show microprocessor, with communications coils around perimeter. Central hole receives 3-month injection of medication.**

Editor: Tim Cole  
Assistant Editor: Gregory T. Pope  
Contributors: Tom Benerson, Mike Fillon, William Siuru

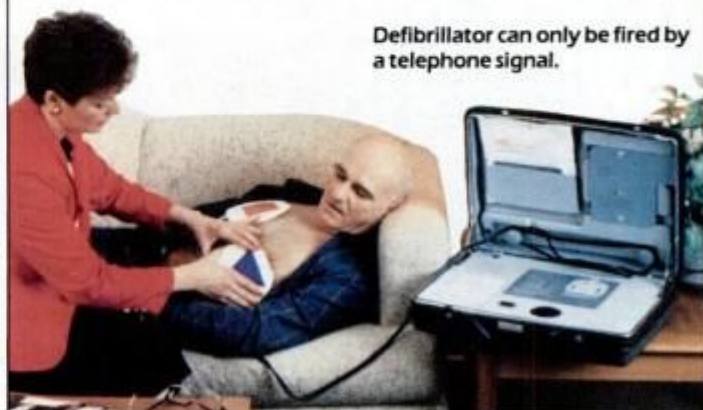
**Defibrillator can only be fired by a telephone signal.**



APL PHOTO



Pump responds to radio signals from patient or remote doctor.



MEDPHONE PHOTO



GENERAL TECHNOLOGY APPLICATIONS PHOTO



## Gumming Up Oil Spills

ST. JOHNS, NEWFOUNDLAND—Ocean trials off the Canadian coast have proven that a chewing gum ingredient is effective in reducing the spreading action of oil spills.

Normally a tacky, rubbery mass, polyisobutylene—the ingredient that gives gum its “chew”—is pulverized under cryogenic conditions into a **Vacuum nozzle removes treated oil from surface waters.**

free-flowing powder called Elastol.

The powder is then blended with solvents that allow it to dissolve in oil.

Once distributed in a spill, the powder creates a solution that, while still liquid, resists dispersion due to the bonding activity of the long, coiled polyisobutylene molecules. Cleanup times for spills have been cut to one-tenth of those for previous efforts.

## Moon Base Made Easy

HOUSTON, TX—Engineers and architects are proposing creative solutions to the problems anticipated in conquering the Moon. Two concepts were unveiled recently at a conference sponsored in part by NASA and the Lunar & Planetary Institute.

A transportation system outlined by Houston engineer David Dannemiller would use electromagnetic forces for landing as well as takeoff.

The Lunar Magnetic Acceleration Device (LMAD) is essentially a 2-way railgun. The bullet-shaped flight vehicle would touch down on a 10-mile rod-shaped magnetic rail, guided by a microwave



LMAD vehicle lifts off rail, propulsion magnets disengaging as drive assembly below car swings outward.

landing system. Magnetic interaction between vehicle and rail would decelerate the craft, and kinetic energy ab-

sorbed during landing could be stored in a superconducting electricity storage ring. The system would eliminate

fuel-storage questions.

Meanwhile, Saudi Arabian architect Yousef Hijazi has suggested using prefab self-erecting structures to house lunar pioneers. Prototypes now accommodate pilgrims to the holy city of Mecca.

The concept calls for a multifloor dwelling to unfold from a cylinder that opens after touchdown on the lunar surface. Self-powered winches would wind in cables to lift each floor, while side panels and columns would swing down from ceilings to provide support. A hydraulic footing mechanism would lend stability, and pumps would suck lunar soil into an inflatable solar-flux shield that would envelope the finished structure.

The dwellings would shelter early inhabitants prior to completion of permanent Moon-base structures.



Modular 4-story lunar shelters unfold from delivery cylinders without heavy machinery or manual labor.

PM ILLUSTRATIONS BY ED VALIGUERSKY



## Four-Way Door Hinges

PASADENA, CA—Jet Propulsion Lab engineers have designed a door that can be opened left or right, top or bottom.

Mounted at each corner of the door frame is a slotted cup that receives a stemmed ball fastened to each door corner.

When one side of the door is pulled, the two connector hinges on that side will pop free, and the door will swing open on the other side. The slots allow the ball to arc out of the cup.



Four-way door, for Space Shuttle, opens regardless of orientation.

PM ILLUSTRATION BY ADOLPH BROTHMAN

## Free-Ranging Leisure Sub

PLYMOUTH, ENGLAND —Design concepts found in military subs have been incorporated into this 2-man civilian submersible, the Marlin S1.

A 50-hp diesel-electric engine gives the sub an 8-knot surface speed, eliminating the need for a support ship. The engine recharges the electric batteries that power subsurface movement.

In addition, a streamlined cowl covers the machinery

that festoons most other submersibles. The Marlin can cover substantial distances underwater by gliding between power spurts.

Inside, the pilot lies face-down on a sloping couch, his viewport angled down. A second crew member sits above at a conning tower.

Relatively inexpensive (at \$200,000), the Marlin could herald the emergence of the personal submersible.



Marlin's nose houses ballast tank.

LONDON PICTURES SERVICE PHOTO

## Cockpit Looks Ahead

NEW YORK, NY—The fast-changing world of cockpit technology continues to spin out innovations for tomorrow's flyers. Newly developed hardware will both dim and enhance a pilot's view.

On the training side, pilots can use glasses developed by Instrument Flight Re-

search to practice flying under instrument conditions while an instructor has an unobstructed view.

The glasses remain clear as long as the pilot is looking at the panel instruments, but cloud over to a preset visibility when the pilot looks out the window. A scud setting randomly varies visibility from zero to the preset range, to simulate broken clouds on a final runway approach.

A military version with an all-plastic visor allows pilots to use the simulator while wearing helmets or eyeing head-up displays.

Meanwhile, McDonnell Douglas recently showed

Console adjusts visual range in bad-weather simulator.



Big Picture simulated by rear projection.

off its Big Picture future-cockpit concept at the Farnborough Air Show.

The idea is to replace the entire instrument panel with a 100-sq.-in. video display spanning the cockpit. Big Picture would allow information from short- and long-range sensors to be presented on a unified range scale instead of on separate monitors.

The sensor data pops up in windows overlaid on a constantly moving map. The pilot can customize the presentation in flight, shifting information around with voice or

touch commands. Instrument information would be relegated to a head-up display on the helmet. Big Picture would likely be twinned with McDonnell's Agile Eye helmet, which features a built-in sighting system that aims weapons.

At the moment, Big Picture remains a flight simulator. Technology hasn't caught up with the need for a screen big and bright enough to counter intense sunlight at high altitudes. The perfection of semiconductors that emit visible-light laser energy may provide the needed push.

MCDONNELL DOUGLAS PHOTO



IFE PHOTO



# TECH UPDATE

## Laser Wind Sounder

HUNTSVILLE, AL—Researchers at Marshall Space Flight Center want to put a laser anemometer in space.

The light detection and ranging (lidar) device would bounce infrared laser light off airborne particles. Analysis of reflected light would determine speed and direction of winds and concentration of suspended particulate matter.

The instrument could be mounted on the polar-orbiting Earth Observation System (EOS) platform, to track global wind circulation, or on the Space Station to focus on the tropics and subtropics.

Wind profiles derived from lidar readings will replace atmospheric data obtained from sounding balloons.

Lidar will be particularly helpful in tracking poorly understood ocean winds.



Lidar uses circular tracking pattern to obtain wind data from ground up to 40,000 ft.

## World's Biggest Printer

TORRANCE, CA—This high-speed paint-jet printer features rolling drums that measure 14 ft. across. Operated by Computer Image Systems, the printer generates huge advertising images from photographic transparencies scanned and digitized by computer.



Megaprinter (below) can print on to material strong enough to be towed behind plane (above).



FBI PHOTO BY BRIAN F. WOLFF

COMPUTER IMAGE SYSTEMS PHOTO

## Mach-2 Business Jet

SAVANNAH, GA—Gulfstream Aerospace is outlining requirements for a supersonic corporate jet to be made available by 2000.

The 100-ft.-long plane would have a deeply swept delta-wing formation with twin-canted vertical stabilizers and forward canards. Wingspan would be 60 ft. It would carry 10 to 12 passengers and a crew of two.

The primary obstacle remains the elimination of sonic

booms while flying over land. Rolls-Royce, which makes the Olympus engines used by Concorde, is experimenting with variable-cycle jet engines. These engines would act as turbofans at takeoff and during subsonic flight, reducing noise and fuel consumption.

At cruise speeds, the engines' bypass outlets would close off and the plane would become a Concorde-type turbojet.



Gulfstream supersonic business jet for transoceanic sprints.

ILLUSTRATION BY JOHN BARTCHELOR

## Looking Inside The Engine

WASHINGTON, DC—Researchers are employing different techniques to explore

the inner workings of engines during combustion.

At Los Alamos National Labs, a research group is using a Cray supercomputer to model fluid dynamics inside a direct-injection stratified-charge (DISC) engine's combustion chamber. The group is trying to determine optimum chamber shape, injector location and design, spark location and other parameters for the experimental engine before a production model is developed.

Meanwhile, Sandia National Labs has fitted a sparkplug with eight fiberoptic lightguides. The fibers lead to a computer that analyzes light from the ignition flame. The sparkplug fits into any unmodified production engine.

Fibers' eyes are in plug housing.



Fuel spray injection in DISC.



Ignition as piston nears top.



Fuel burns fast as piston drops.



LOS ALAMOS COMPUTER IMAGES

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## The High-Tech Revolution in the Home Is Just Starting

Sweeping changes are taking place in our homes, changes brought about by the phenomenal growth of home entertainment electronics. Already available are high resolution TV, TVs with stereo sound, simultaneous multi-channel viewing, projection TV, Camcorders, 8 mm video cassettes, and compact disc players.

And the revolution has spread to the business sector as tens of thousands of companies are purchasing expensive high-tech video equipment used for employee training, data storage, even video conferencing.

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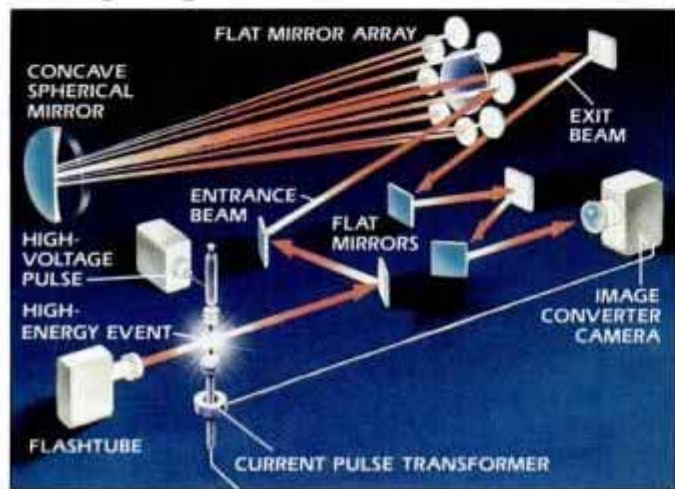
## Camera Sees Back In Time

GAITHERSBURG, MD—By the time a lightning bolt strikes, or an engine component suddenly fails, it's too late to record how it happened. At the National Institute of Standards and Technology, physicist Edward F. Kelley has overcome this with a device that photographs events *after* they occur.

Called an image-preserving optical delay, it works by bouncing the light from the

event to be photographed through a 385-ft.-long maze of mirrors, which holds it up for 390 nanoseconds. Meanwhile, an electric pulse races along a shorter path to trip a camera's high-speed shutter. The pulse beats the image by 290 nanoseconds, allowing time for 10 quick shots of what happened.

The technique is being used to probe electrical insulation failures.



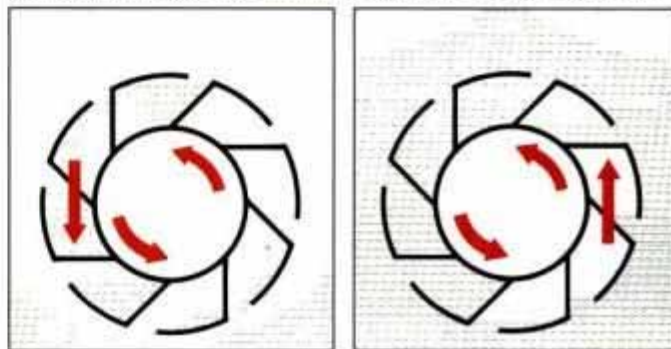
Light bounces among mirrors, while signal shortcuts directly.



Booms rotate as waves move along axis.

## Isolated-Areas Ocean Power

GOTHENBURG, SWEDEN—The latest system to generate electricity from ocean waves uses two floating cylindrical booms. Slanted vanes run across their exterior. Crests washing over the booms fill the upward-opening vanes on one side, and trap air under the downward-facing vanes on the other.



Water weight pulls down.

Air buoyancy pushes up.

## To Dance On Air

NEW YORK, NY—Highly complex and ingeniously simple technologies are helping aircraft turn, dive and climb with more agility and better control.

The complex variety is represented in Agile Eagle, which recently began flight testing. The F-15B is fitted with jet nozzles that direct

(or vector) engine thrust up, down or forward.

Pilot workload is eased by a fly-by-wire system that integrates nozzle operation with that of the plane's retrofitted canards and other control surfaces.

Vectored thrust will increase the F-15's dog-fight performance and, along with other modifications, shorten landings by 72 percent.

NASA has developed a

much simpler device called a leading-edge vortex flap, which promises to help swept-wing aircraft perform

better on takeoff and in tight turns. Whenever a plane flies at a high angle of attack, vortices of turbulence

flow back over the tops of the wings.

These vortices produce lift, but also create drag, slowing the plane. Vortex flaps, angled sharply downward from each wing's leading edge, force a controlled vortex to form there, so it doesn't flow back over the wing.

Confined to the leading edge, the vortex counteracts drag by pulling the wing forward as well as upward.

Tests aboard an F-106B at NASA's Langley Research Center showed the flaps increased maneuverability by 20 percent.



NASA PHOTO



NASA F-106B with leading-edge vortex flaps (above right) and Agile Eagle F-15 demonstrator.

PM ILLUSTRATION BY ADOLPH BROTHMAN

PM ILLUSTRATION BY ED VALIGURSKY

PM ILLUSTRATIONS BY GERHARD RICHTER



# Save Gas, Save Engine with 'POLY'

**GUARANTEED LOWEST PRICE** (see details below)

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

## The Secret is "Poly"

"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer...plus it reduces metal wear, defraying costly overhauls.

## Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

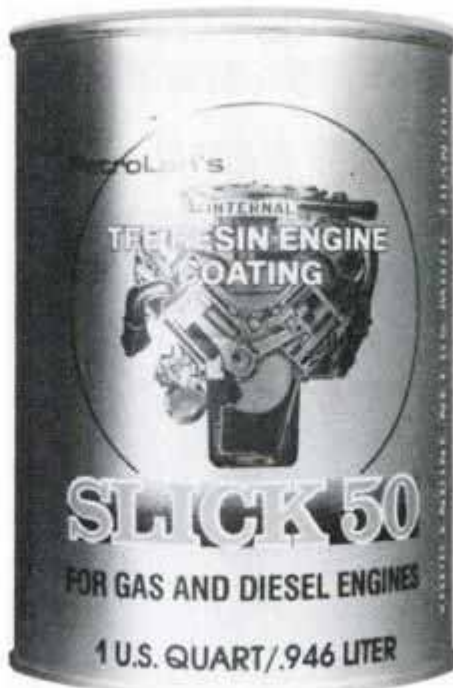
TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test-simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decrease fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WIVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



## It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "Poly" between the parts where it is burnished into the pores of the metal.

## Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

## Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

## 4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine.
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

## Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

## There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund—no questions asked.

## Profit from Selling Slick 50 Yourself

Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

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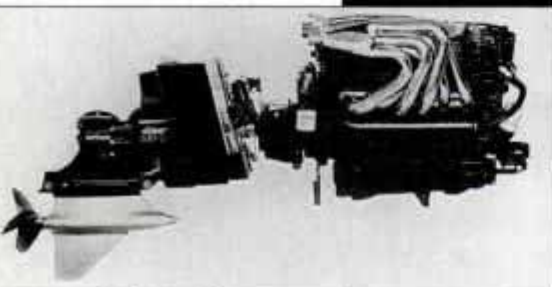


# OUTDOORS

BY JOE SKORUPA

## Fifty Years In The Fast Lane

**T**HE WIZARD OF Wisconsin. That's what Mercury Marine founder E.C. "Carl" Kiekhaefer was called and I can't think of a more apt title. When Kiekhaefer (pronounced Kee-kayfer) died in 1983 I was only in the marine industry for a few years and never got



"Miami Vice" 's Don Johnson (above) set New Orleans-to-St. Louis record using Merc-Lamborghini engines (left), the most powerful production stern drives made.

to meet the legendary entrepreneur. But I couldn't escape hearing tales of his innovative genius and bulldog determination to be the best.

Like many intensely driven men, Kiekhaefer was a colorful character. He was fond, for example, of hanging a competitor's engine over a bonfire at dealer meetings and hosting a ceremony called "melting the enemy." He worked Herculean hours and never took a vacation because, I was told, "he wouldn't know what to do with himself."

He was also a renowned perfectionist, a personality trait that frequently comes with a rough edge. Kiekhaefer had a short fuse when frustrated and was known to fire some of his closest associates. Those who knew him well, and cared enough to put up with an off-with-his-head temper, refused to leave and were often rewarded for their gumption. Others, including some big industry names, left with long-standing chips on their shoulders.

His obsessions, no doubt, drove him beyond the limits

of most men. His accomplishments include 200 patents, 100 marine industry firsts, and a room full of boat and auto-racing trophies.

### Merc's 50th

But Kiekhaefer's greatest achievement was the creation of a giant marine engine company based in a quaint little farm town called Fond du Lac, Wisconsin.

In 1939, the 35-year-old son of a farmer borrowed \$25,000 to buy the physical plant of the defunct Cedarburg Manufacturing Co. His original intent was to build magnetic devices and go into competition, I suppose, with Stearns Magnetic, of Milwaukee, where he'd worked for 10 years and risen to the rank of chief engineer.

To generate cash flow, the new owner salvaged the company's only inventory, 400 faulty Thor outboard engines previously rejected by Montgomery Ward. Kiekhaefer knew very little about outboards, but he repaired the Thor engines well enough that Montgomery Ward bought them back and another catalog firm, Western

Auto, placed a new order.

Within a year, Kiekhaefer was ready to capitalize on the booming demand for outboard motors by introducing his own line, Mercury, at the New York Boat Show in January 1940. Within a year the fledgling outboard company had orders for about 45,000 units.

### Born to run

But the war effort shut down all nonmilitary use of aluminum. When production was resumed Kiekhaefer was

ready to shake the industry with a major development, Mercury's famed 2-cylinder Lightning outboard. Although the 19.92-cu.-in. engine was rated at 10 hp, it not only beat all competitive motors in its class at the 1947 Albany to New York race, but outperformed motors rated twice as powerful.

Kiekhaefer soon followed this triumph with the introduction of the equally famed Thunderbolt, the industry's first 4-inline, 2-cycle engine, in 1949. It was the first stand-



GM's engine of the future, Corvette LT5, is built by Mercury.



ard production outboard to deliver 1 hp per cubic inch.

Among the innovations pioneered by Mercury, and spearheaded by Kiekhaefer, were the 1-piece driveshaft housing and streamlined engine cowl (1939), remote throttle and shift control system (1949), key-switch operation of electric starter and choke (1954), jet-prop exhaust system and single-lever control unit (1957), a standard-production 6-cylinder outboard that exceeded 100 mph (1957), hydraulic power trim (1966) and more than 100 others.

In 1961, Kiekhaefer sold Mercury Marine to the Brunswick Corp., a conglomerate based in Chicago that has become one of the country's largest companies. The company, the Wizard from Wisconsin started with \$25,000 in 1939, was now worth \$33 million. Kiekhaefer, who became Brunswick's largest stockholder and vice president, continued to be Mercury's driving force for the rest of the decade.

MerCruiser sterndrive engines, Kiekhaefer's biggest blockbuster, were launched in 1962 and began to set a standard for high-performance offshore applications that it has never relinquished, although Volvo and former Mercury engineer Jim Wynne developed the technology two years earlier.

In 1969 Kiekhaefer resigned from Mercury and Brunswick to form his own company, Kiekhaefer Aeromarine, where he continued to be a fierce competitor. *Powerboat* magazine estimates that Kiekhaefer engines, under his own name or MerCruiser's, won 450 of 643 offshore racing events from the inception of sterndrive power in 1962 to the time of the great man's death in 1983.

### Merc Then And Now

The first Mercury outboard (below) rushed out in 1940 to fill the need for booming demand, incorporated a number of design innovations later adopted by the entire outboard industry, including a rubber rotor water pump, enclosed lower shaft housing, and a reed-valve induction system. Merc's latest top-of-the-line outboard (far right) is the V6 200 XRi, with electronic fuel injection (EFI). This system uses an electronic control unit that delivers fuel to the engine based on input from sensors monitoring rpm, throttle position, manifold pressure and engine temperature.—J.S.



### High-performance legacy

Competitiveness and product innovation are still very much a part of Mercury Marine. Last year MerCruiser celebrated its agreement with Lamborghini Motors by equipping two 630-hp V12s with Super Speedmaster Stern Drives and setting a new record (recently broken) in a race from New Orleans to St. Louis. These propulsion units are the most powerful production sterndrives on the market.

Recently, Merc formed a division that would have pleased its founder—Mercury Powerboats, which will market fishing boat packages (boat, motor and trailer units) in 1990.

And the future holds an even more dramatic development. Two years ago GM selected Mercury as exclusive manufacturer of its engine of the future, the 5.7-liter, 350-cu.-in. Corvette LT5. Mercury was selected because of its high-performance background, aluminum-block expertise and ultraprecise machining capabilities.

The LT5 will power the hot new Corvette ZR1, which will be the fastest production car in the world when it hits the pavement in a couple of months. It is the first all-aluminum 4-cam, 4-valve-per-cylinder V8 engine built in the U.S. for nonracing applications. It combines demon speed with durability, lightweight, small size and fuel economy.

This description, of course, is a perfect recipe for a hot sterndrive engine and Mercury may have a marinized version ready for the 1990 model year. No doubt the LT5 engine will do for boating what it's done for Corvette—leave everybody else in the prop wake. Carl Kiekhaefer would be proud. **PM**

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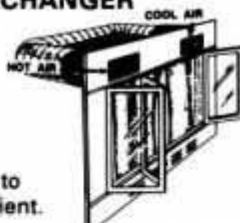
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In fact, three years ago, Baron (that's him, next to the front left tire) completely thrashed the bed of another brand of truck with his tail. In less than 10 minutes.

That's when the gator farm bought their first Nissan. And you might be interested to know it's only this year they're replacing it.

With the Hardbody SE you see here.

Of course, a double-walled, seamless bed isn't the only thing that makes a Nissan tough.

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# CAR CLINIC

BY MORT SCHULTZ

## Hot Spot

**W**ASHED my car on one of those hot days we had last summer and failed to be quick enough to get the soap off the windows before it dried. This caused spots on the glass. I've tried one glass cleaner after another, but the spots won't come off. The soap I used is specifically for washing cars and is made by a well-known company. Do you have any suggestions?

ROBERT BOCCIOLATT  
WATERTOWN, NY

*It's probably not the soap's fault. I don't know of any ingredient used in a soap made for car finishes that would eat into glass without also eating into the painted surface. On the other hand, minerals in water when subjected to the*

*sun can dry and cause crusty spots that are tenacious enough to resist window cleaners. These spots can probably be removed by scraping them, carefully, with a razor blade. The residue that remains can then be washed off.*

*As a last resort, the windows could be polished with any of several commercial preparations intended to remove minor scratches. You might try this yourself, or sublet the job to an automotive glass shop.*

### Trench Warfare

Hairline cracks in the vinyl roof of my 1978 Oldsmobile Delta 88 are beginning to join and form lengthy gullies. I have called several shops only to be told that there's

nothing that can be done to save the roof. I find this hard to believe. Is there any way to repair a vinyl roof?

MICHAEL BERNARD  
MT. PLEASANT, MI

*No! Cracks in a vinyl roof are similar to cracks that form in a concrete driveway. But unlike concrete, cracks in vinyl can't be patched.*

*Once the process begins, you may be able to stop its progress, but you can't repair the damage that's already taken place.*

*The root of the problem is the inevitable hardening caused by the plasticizers, which are volatile, evaporating out of the vinyl. You can delay that process, however, with any of several products sold for vinyl-top care. The important thing is to apply it regularly, to retard the loss of the plasticizers.*

*Vinyl interiors crack for the same reason, but here you probably should stick to a more universal product, like Armor-All or Son Of A Gun, which won't leave your clothes stained the same shade as your interior. They'll do a pretty good job of preserving your vinyl roof as well, although being clear, they won't be much help restoring the faded color.*

### Tar Seeks Oil Foil

There is a persistent oil leak around the valve cover of my 1984 CJ-7 Jeep 258-cu.-in. inline 6-cylinder engine. The dealer replaced the gasket using both a silicone gasket sealer and a cork-composition gasket, and torqued the cover to specs. The cover isn't warped and the head is like new. But no matter what's done, the cover starts to leak oil a short time after repairs are made. Another difficulty I'm facing is that I'm now stationed in Spain

(the vehicle is here with me), and the nearest Jeep dealer is some distance away. The leak, however, started when I was in the States. At that time, the dealer told me there was nothing more he could do. Shall I give up?

BRIAN PARKS  
U.S. NAVY, FPON NEW YORK

*Not yet. Back in 1986, what was then AMC/Jeep/Renault issued I-Sheet 1668. I-Sheet stands for Instruction Sheet, which is what the company called its technical service bulletins. It announced a re-designed valve cover for the 258-cu.-in. engine in 1981-86 vehicles. The part number for the cover and hardware, which you can now obtain from a Chrysler/Jeep dealer, is 8983 503 343.*

*The new cover has a pre-cured RTV seal and is secured to the cylinder head with special bolts and retaining nuts. The Jeep dealer in Spain should be able to get the kit and Instruction Sheet needed to install the cover. If not, you'll have to wait until you and the Jeep ship back home. The Instruction Sheet is needed. Among other procedures, it describes drilling and tapping three new holes in the cylinder head. If the job is done without referring to instructions, the repair may not be successful.*

### A Tough Act To Follow

I'd like to add to the answer you gave Frank Ferrer in the October '88 "Car Clinic" (page 22). His 1987 Ford Taurus GL 4-cylinder engine keeps losing coolant, and there are no apparent leaks. Your suggestions, of course, were quite valid, but my experience with the same problem was caused by a defect that had nothing to do with

*(Please turn to page 28)*

### Stuck On Tape

You don't have to rely on someone using an electronic air-leak detector who might charge you as much as \$100.

Instead, try using duct tape to seal potential leaks one at a time, road testing between each taping to see if the air leak has been zippered.

For example, when checking the windshield, start by taping the upper edge. Take the car for a ride. If the noise is no longer apparent, you'll know that



you have to remove the molding to reseal the area. But if the noise continues, tape and test the left or right edge next, then the other side and finally the base. Don't forget that a space between a body side molding and a door or fender can also produce an air whistle. So tape each molding in turn and test.





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### CAR CLINIC (Continued from page 26)

Ford's head-gasket problem you reported on. This tip, therefore, might help Frank and others with the same condition avert an involved engine repair:

The 4-cylinder engine in my daughter's '87 Mustang drove me daffy looking for an elusive coolant leak. After months of searching, I found a pinhole in a heater hose, which was leaking only under pressure without leaving a trace of coolant on the garage floor. The dripping coolant was falling right onto the hot exhaust manifold and was evaporating instantly.

RAYJ. SALEK  
BRIDGEWATER, NJ

*Thanks for the tip, Ray. Heater hoses should always be inspected closely when there is a loss of coolant even if no coolant shows itself on the floor. That's why I'm printing your letter—to remind DIYers reading "Car Clinic" to do so. But in Frank's case, he wrote that the cooling system in his Taurus was microscopically checked by the dealer. As part of the examination, the system is put under pressure with a cooling system pressure tester. Therefore, a leaky heater hose will usually show itself.*

### Poor Pawl

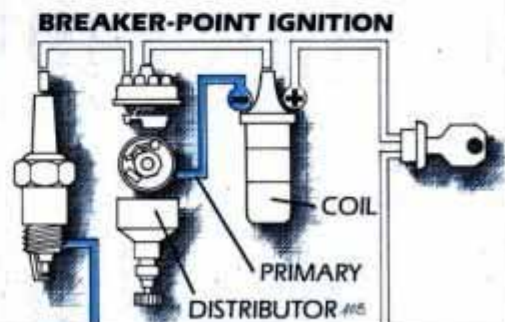
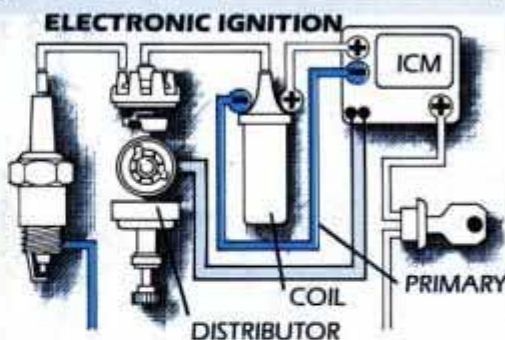
The automatic transmission of our 1984 Chrysler Fifth Avenue is extremely

### Taking Sides

In the days of distributors that had breaker points, you knew when it came to replacing the ignition coil that the primary circuit wire coming from the distributor had to be attached to the negative side of the coil. So you traced that wire, which ran straight from the distributor to the coil.

With electronic ignition systems, the negative side of the coil is still ultimately connected to the distributor, but by way of the ignition control module (ICM). You can't tell by tracing the wire, because it doesn't go directly to the distributor. Sensor wires, usually two or three or more cabled together (see illustration) now make the connection. Maybe that's why there have been so many cases of reverse ignition polarity. Reverse polarity is when the primary circuit ground wire and primary circuit positive wire get switched at the ignition coil, resulting in hard starting, high-speed miss and sparkplugs that dish out ground electrodes prematurely.

Don't remove the old coil until you've matched it to the new coil.







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hard to shift out of PARK when we park it nose-up in our driveway, which is a steep incline. Our mechanic doesn't know what to do. Can you help?

SID MORTON  
CAMDEN, NJ

*This is a heavy car. When that weight comes to bear on the parking mechanism in the transmission, it takes muscle to pull the transmission out of PARK. That's why the procedure recommended by Chrysler to park the car on an incline should be followed with this car or any vehicle with an automatic trans, as it's not a situation unique to Chryslers. Before removing your foot from the brake, set the parking brake securely and then shift into PARK—in that order.*

However, there are 1987 and older Chrysler-made vehicles equipped with front-wheel-drive (fwd) automatic transmissions that are experiencing the same condition you are having with your rear-wheel-drive (rwd) Fifth Avenue.

To resolve the problem in fwd vehicles, Chrysler issued technical service bulletin (TSB) 21-14-87, titled "High Pullout Effort From Park" when parked on a steep grade. This TSB gives a clue as to what could be going

on with your rear-wheel-drive car.

*The TSB cites the cause of the condition in fwd automatic transmissions as "improper park rod bullet hardness" and also the possibility that the force needed to shift these fwd transmissions has resulted in a bent control lever. A bent control lever makes it even harder to shift out of PARK.*

*As with fwd transaxles, a part of the parking mechanism in your transmission (the parking pawl to be exact) may not be up to the task. Therefore, you and others experiencing this problem with rwd transmissions should have a new parking pawl installed if the Chrysler-recommended parking procedure doesn't work—either that or park in the street.*

*The parking pawl for your automatic transmission now being sold in the parts departments of Chrysler dealers is a stouter unit than the one originally installed. In replacing the pawl, you should make sure the control rod lever hasn't been bent. If it is, replace that too.*

FM

### DO YOU HAVE A CAR PROBLEM?

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

### SERVICE TIPS

■ Nissan 1986½-88 pickups and 1987-88 Pathfinders and vans which are sluggish on acceleration or demonstrate a rough or erratic idle, requiring you to keep your foot on the throttle pedal to keep the engine running, should be examined, according to TSB 88-077. The fuel injectors may need to be replaced.

■ With cold weather here, owners of 1983-88 Buick Skyhawks, 1985-87 Somersets and 1986-87 Skylarks may once again be faced with the Isuzu 5-speed manual transmission clashing its gears. TSB 88-7-4 has the solution. Drain the fluid presently in the transmission and refill it with *synchromesh* transmission fluid. That's STF—not ATF (automatic transmission fluid), which may cause severe synchronizer damage.

■ The way to get rid of a high-pitched buzzing noise from the exhaust system of your Toyota Corolla if it's equipped with the 4A-F engine and was manufactured before 2/88 is to install a new exhaust system center pipe. The new pipe has a mini-muffler wrapped around it to deaden the noise. The part number is 17420-16320, or 17420-16330 for California.

■ New rear disc-brake rotors (part No. E80Y-1125-A) and pads (part No. E80Y-2200-B) may be needed to get rid of a shudder from the rear when applying the brakes between 25 and 40 mph on '88 Continentals. TSB 88-18-4 says so.



# OLD HOUSE RESTORATION

BY BOB VILA

## Restoration Glass

**W**HEN you buy an old house, you inherit its remodeled past—good or bad. Many times, old window glass has been replaced in the name of energy efficiency. In harder times, a past owner may have even sold a stained-glass window or two to raise needed cash.

I don't need to tell you how a modern window frame can create havoc with the facade of an old house. Modern glass, especially when it is used to replace etched, carved or leaded glass, can have the same effect.

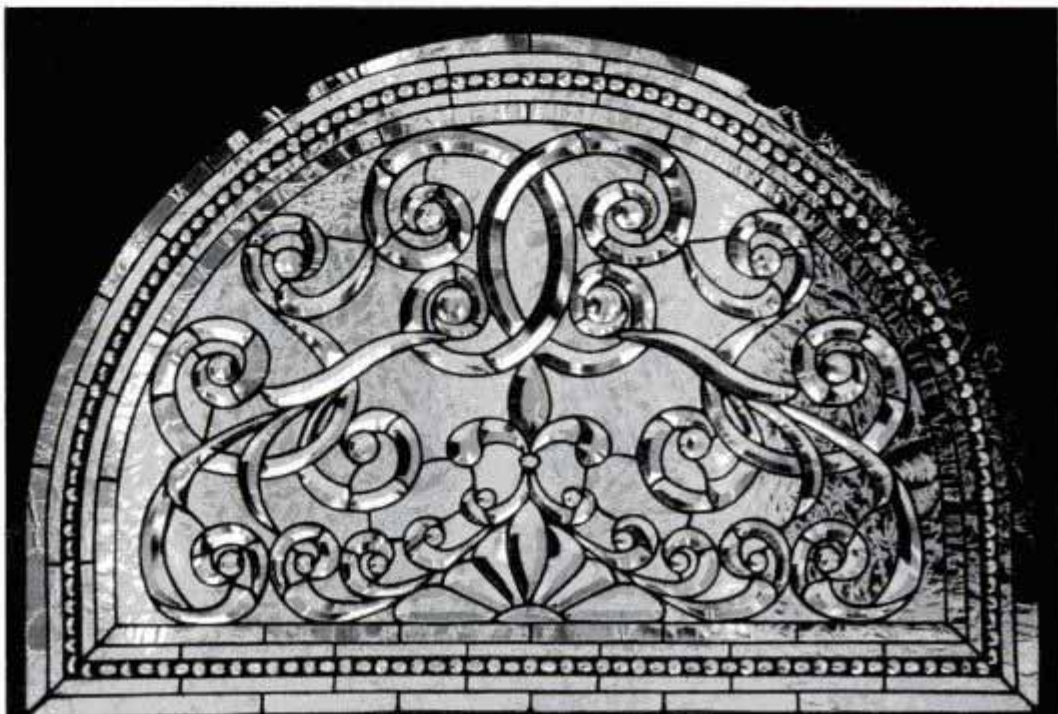
Several different kinds of glass were used in period homes. And, you can still find most of it being replicated by craftspeople today. Of course, since much of this glass is handmade like it was years ago, it doesn't come cheap. Expect to pay a premium for the skill, time and patience required.

### Leaded glass

Understanding what types of glass were used years ago will help you decide what to choose for your old house. Perhaps the glass old-house owners are most familiar with is antique sheet glass. Basically, this is the single-paned, slightly textured and wavy material—with maybe an occasional bubble or two—found so often in old, double-hung wood windows. Manufactured predominantly for the restoration business today, these clear glass panes are sold either by the sheet or cut to size.

Leaded glass, either clear or colored, is another popular old-house choice. The techniques used to make these windows today are largely the same as they were 100

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



Glass panels, like this exquisite example, can sometimes be purchased at antique shops or salvage yards. They can also be duplicated by contemporary craftspeople using a number of different techniques.

years ago. Beveled panes in various shapes and sizes are simply joined with lead cane.

Although some simple, geometric lead-paned windows were used in Colonial homes, there weren't many craftsmen skilled in this trade then. So, this glass was an expensive decorative seen only in finer homes.

Leaded windows, both stained and clear, were very popular during the Victorian era. Designs tended to be flowery in an abstract, balanced way. Window patterns were more linear or geometric, made up of circles and lines, in the Art Deco era. The realistic, free-form style the Art Nouveau period is famous for was also reflected in its glass, with flowing, long-stemmed floral designs.

### Etched glass

Etched glass, where a design is defined by either frosted or clear glass, is another deco-

orative favorite. There are generally two ways to do this: acid etching or sandblasting. Although you may be able to find someone who still uses acid, sandblasting is the more common way glass is etched today. It's interesting to know how both techniques work.

When acid etching glass, the entire surface is covered with wax. The desired pattern is then carved out of the wax, and when acid is poured over the surface, only the exposed glass becomes etched. The waxed area remains untouched. Acid etching is a very smooth, surface technique. If you rubbed your finger across a panel that had been made this way, you'd barely feel any depth to the pattern surface.

A rubber or vinyl stencil is generally used when sandblasting glass. For a frosted pattern on a clear field, the design is cut from the rubber

and removed. To create a clear pattern on a frosted field, the opposite procedure is done: Rubber covers the glass where the pattern is desired while the remaining glass is sandblasted, creating a frosted background.

Sandblasting can add some depth to the glass—how much depends on the coarseness of the sand. When fine sand, like talcum, is used, you'll see a slight granular effect on the glass.

But if coarser sand is used, a rougher, more obvious texture results.

There's another, modern way to reproduce the look of original old etched glass. Called photostenciling, it's essentially a sandblasting technique that, as its name implies, stencils glass photographically. Working from black and white artwork, the design is developed on the glass with a liquid stencil. (When it dries, it's light sen-



sitive). A film with the stencil pattern is then placed over the glass. When it's developed, certain areas will darken. When these dark sections are washed off the glass, the remaining exposed surface is sandblasted, leaving behind a design. It's possible to produce incredibly intricate patterns—like the old Victorian designs—more economically this way instead of hand-stenciling.

### Cut glass

Sandblasting glass for longer periods erodes even more glass, producing a 3-dimensional or carved effect. This is similar to wheel carving techniques, where a design is cut into the glass using a copper wheel. The resulting sculptured surface has shimmer to it.

Brilliant-style cutting, where designs are handcut with stone, was used around the turn of the century. Many Victorian homes had frosted-glass door panels, cut to different depths, that sparkled like jewels. The glass is ground with a stone wheel, then polished with a cork wheel and pumice. Finally, felt and jewelers' rouge bring the cuts to a sparkle. Brilliant cutting usually looks bolder than copper wheeling.

There are a couple more types of period glass that should be mentioned here: glue-chip glass and bull's-eye glass. As its name implies, glue-chip glass is actually made using animal-hide glue spread on the surface of the glass. As the glue dries, it grabs the glass and chips it. When it's finally washed off, you're left with a frost-like, fern pattern. The best way I can describe it is "icy." Glue-chip glass windows were generally used where people didn't want a lot of visibility through the panes.

Finally, bull's-eye glass was one of

the earliest, types of glass used in late 17th and early 18th century homes. Many of the early Cape Cod houses had bull's-eye glass in the transoms and sidelights. Bull's-eye glass was considered scrap and was used where folks didn't necessarily want to see out but still wanted to let in some light. It's thicker than regular glass and has a swirly or circular pattern.

### Period glass today

As you may have guessed, finding craftspeople who can replicate period windows isn't going to be easy. A list of some suppliers follows and you may

have some luck looking in the *Yellow Pages* under stained or leaded glass.

Many glass studios have a supply of stock designs on hand. Or they will do custom work in their specialty, whether it's leaded, etched or carved glass.

Surprisingly, much of this work can be done through the mail. Some craftsmen can replicate a panel by looking at the remaining broken piece of glass. If you're trying to match an etched or carved panel, a rubbing can be taken of the existing panel. Just rub a soft pencil on a piece of tracing paper held against the glass. Crayon also works well on brilliant-style cut glass. **PM**

### Source List

Following is a list of some suppliers of old-house glass:

- S.A. Bendheim Co., Inc., 122 Hudson St., New York, NY 10013, (212) 226-6370
- Blenko Glass Co., P.O. Box 67, Milton, WV 25541, (304) 743-9081
- Chatham Glass Co., P.O. Box 522, N. Chatham, MA 02650, (617) 945-5547
- Ferguson's Cut Glass Works, 4292 Pearl Rd., Cleveland, OH 44109, (216) 459-2929
- Glass Arts, 30 Penniman Rd., Boston, MA 02134, (617) 782-7760
- Golden Age Glassworks, 339 Bellvale Rd., Warwick, NY 10990, (914) 986-1487
- Great Panes Glassworks, Inc., 2861 Walnut St., Denver, CO 80205, (303) 294-0927
- Kardell Studios, Inc., 904 Westminster St., N.W., Washington, DC 20001, (202) 462-4433
- Kraatz Russell Glass, Grist Mill Hill, RFD 1, Box 320C, Canaan, NH 03741, (603) 523-4289
- Pocahontas Hardware & Glass, Box 127, Pocahontas, IL 62275, (618) 669-2880
- J. Ring Glass Studio, 2724 University Ave., S.E., Minneapolis, MN 55414, (612) 379-0920
- Salamandra Glass Ltd., 133 Market St., Portsmouth, NH 03801, (603) 431-4511
- Sunflower Glass Studio, Box 99, Route 523, Sergeantsville, NJ 08557, (609) 397-1535
- Venturilla Studios, 32 Union Sq. E., Rm. 1110, New York, NY 10003, (212) 228-4252
- Williams Art Glass Studios, Inc., 22 N. Washington (M-24), Oxford, MI 48051, (313) 628-1111

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# INSIDE DETROIT

BY JIM DUNNE

## New Beak For The Sunbird

**L**OOK for this front end to show up on the new Sunbird GT models next year as Pontiac completes its facelift program for the sporty subcompact. The bulk of the Sunbird line received a major facelift for 1988, but the angular front-end styling of the GT was left unchanged. That made the GT look as if it was designed by a committee. The front end of the car had angular corners, while the rear of the car was more rounded in appearance.

Next year, it all comes together with curves in front to match those in the rear. Also note that the headlights will be lower in height.

The change is not as radical as it may appear. Pontiac will use the same hood that the LE model uses now. Only the lower parts of the front end will be changed to the new style.

### Seville Under Wraps

Cadillac is testing prototypes of its newly styled 1990 Se-



After one year out of step with the rest of its family, Sunbird GT gets a new nose for the 1990 model year.

ville, but the luxury carmaker is a bit shy about what its plans really are. The prototype Seville shown here has disguises that cover the roof, rear end, taillights and part of the front end. But there's no mistaking that trademark Cadillac grille.

Cadillac insiders admit they made a mistake in downsizing their cars during the early 1980s, and are de-

termined to make up for that as new models are introduced. However, it seems the division is locked into front-wheel drive. The Seville will continue with this drivetrain layout through the foreseeable future.



1990 Seville will ride on GM-10 (Pontiac Grand Prix) platform.

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### Econoline Van

A new grille and body shape is in store for the 1991 Ford full-size van, but don't look

for major changes in the chassis or drivetrain. Ford will go to a plastic grille and a more rounded shape for the front of the Econoline/Club Wagon as seen below. Changes in this model are typical of cooling system tests. The grille, front fenders and hood are taken from the 1991 design and tacked onto the 1989 body and chassis. With this setup, Ford can examine the design for any flaws in airflow that may hinder engine cooling. Later, as prototype van bodies and windows are crafted, completed vans will be put in the test schedules.

### V10 And Beyond

Chrysler will not stop its power development with the V10 engine it is planning for its big vans, Ramchargers and motor home/school bus chassis. The V10s will be ready for production within a year.

The new engine is essentially Chrysler's 360-cu.-in. V8 with two extra cylinders, and a displacement of about 450 cu. in., which is competitive with the biggest Fords and Chevys.

Shortly after the V10 makes its appearance, Chrysler will have a 4-valve version of the engine. It won't be in the ZR1 Corvette power range, but look for it to be smoother, with horsepower approaching 300.

### S10 Blazer 4-Door

Chevy has fully styled prototypes of its 1991 S10 Blazer 4-door on the road performing full test schedules. And from



Full-size Ford vans get aero nose job in '90.



the appearance of the first of these sport/utility vehicles, there won't be much in the way of styling innovation aside from the extra two doors to make life easier for rear-seat passengers. Grilles are slightly altered from today's style, but the sheetmetal appears to be lifted directly from the 1989 version.

However, the chassis holds at least one major change. The wheelbase has been stretched at least 6 in. to make more room for rear door entry, and wheels are fancier with a rugged, sporty motif.

Chevy (and GMC with the S15 Jimmy) will have two 4-door utility vehicles when the new Blazer is introduced. The big GMC Suburban was one of the originals, and continues to be a favorite among 4-wheel-drive buyers.

### Eagle Talon

Chrysler's new Jeep/Eagle division will have its own version of the sporty coupe being produced by Diamond Star Corp. It will be called the Talon, a reference to its Eagle marketing umbrella. Talon will have a 4-wheel-drive chassis based on the sporty car Mitsubishi calls Eclipse and Plymouth will call Laser. Look for this model to be sold in low numbers because of its sticker—which should be in the \$16,000 range—and the crowd of competitors in the mid-price sporty car market.

### Sun Block

That all-purpose van (APV) Chevy and Pontiac will introduce next year will be full of innovative features. Plastic body panels over a steel space frame is one of those features. That's similar to the construction of the Fiero, and should keep weight down, in addition to eliminating body corrosion.

Latest reports say that the APVs will also have solar-reactive glass in the windows—the glass will automatically react to sunlight and become darker, thus cutting down on radiant heat in the passenger compartment.

With the wide expanse of glass used in the APV, the solar glass is a near necessity. In addition, the darkened glass gives a different, more customized appearance to the vehicle.

### GM's 2-Stroke Talent Hunt

GM is looking for engineers who know about 2-cycle engines. That's the same kind used for outboards, lawnmowers and snowblowers. The company has been running advertisements in newspapers calling for experts in 2-cycle technology which means GM is cranking up a project that may eventually produce a 2-cycle engine for its cars, something both Chrysler and Ford are actively pursuing.

Recent developments in 2-cycle tech-

nology—premixing of the air/fuel charge and oil injection—make the rebirth of an automotive powerplant of this type possible, owing to cleaner operating potential.

The attraction of a 2-cycle engine lies in its smaller size, lighter weight and higher output potential, the latter because a 2-cycle produces a power stroke twice as often as a 4-cycle engine.

### Saturn Screamer

Shortly after the Saturn cars are introduced in mid-1990, a high-performance engine will be offered in selected models. Saturn is working on a dohc 4-valve

version of its unique 1.9-liter 4-cylinder engine.

The expected 30- to 40-percent boost in output, plus a wider operating range, will give the Saturn the power it needs to compete with subcompact import coupes like Prelude and Mitsubishi's new Eclipse.

The new Saturn engine will be all-aluminum, cast by a lost foam process, the first automobile engine to be made completely with this technique. The high-output version differs from the standard 1.9-liter Four mainly in the design of the head, combustion chamber and valvetrain. **PM**

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BY TIM COLE

## The New Nuclear Technology

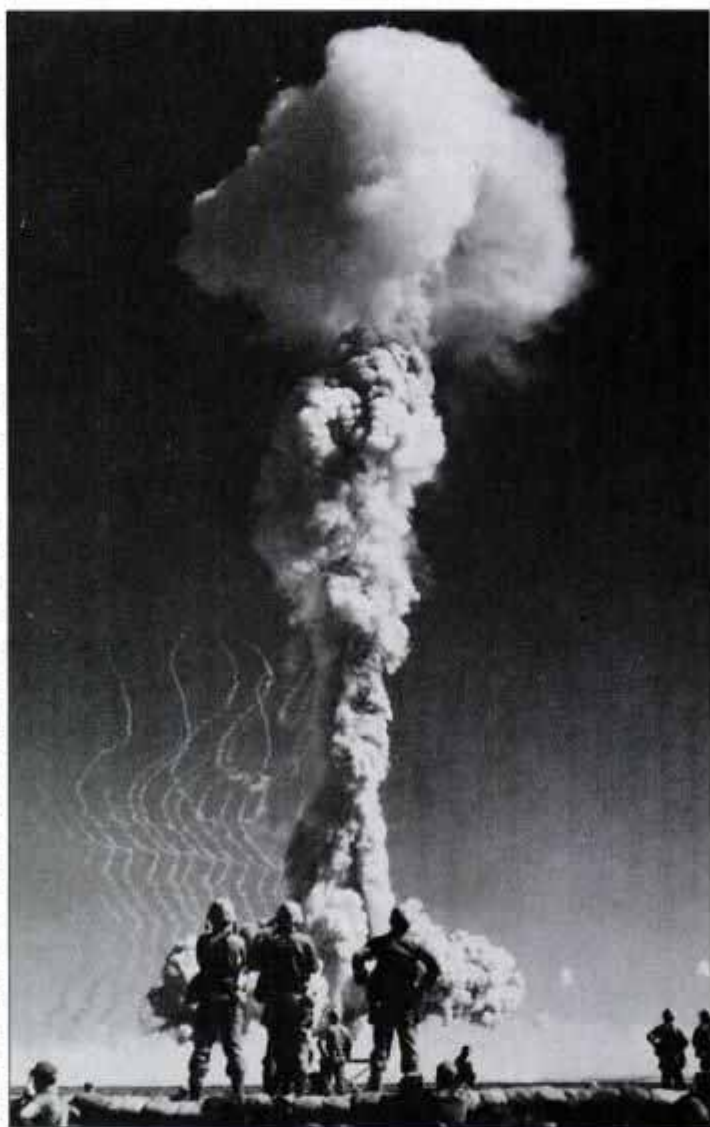
**W**ITH any luck for this beleaguered planet, the recently ratified treaty between the U.S. and the U.S.S.R. to limit intermediate-range nuclear missiles signals a dramatic shift in the technology of terror that has gripped the nuclear age. Heretofore, scientists in national labs and academic centers have worked to create lighter, more powerful, swifter weapons of destruction. Multiple independently targeted reentry vehicles are an example, as are death-dealing neutron warheads.

But INF has ushered forth a new technology that has far more wholesome prospects: The technology of disarmament.

Army Brig. Gen. Roland Lajoie, director of the On-Site Inspection Agency, said in a recent interview with *Defense News* that Soviet and American inspectors would be using portable X-ray equipment to disclose the contents of trucks and containers coming out of American and Soviet defense plants. The Soviets are reportedly using a Cesium-137 device, along with induction metering systems, at the Hercules Aerospace Co. in Utah, and Americans have taken an infrared imager to the U.S.S.R.'s Votkinsk Machine Building Plant.

New seismological techniques are yielding more precise information about the magnitude of Soviet and American nuclear explosions. The American side uses a system called *Corrtex*. A cable is placed in a hole adjacent to the nuclear charge and *Corrtex* hardware measures the size of the blast based on the time it takes to crush the cable.

The Soviets prefer a system of off-lying seismic stations to measure blast



U.S. Army soldiers watch a mid-'50s atom test (as seen in "War and Peace in the Nuclear Age" on PBS).

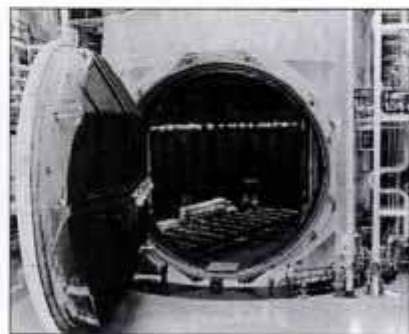
effects. News agencies have reported that results from recent blast tests show that seismic measurements work as well—and sometimes even better—than *Corrtex*.

These disarmament verification methods are another chapter (dare we say the last one?) in the history of the Cold War. To obtain a clearer view of nuclear deterrence and nuclear disarmament, Public Broadcasting Stations around the country will be broadcasting a 13-week series called "War and Peace in the Nuclear Age." Producers Zvi Dor-Ner and Elizabeth Deane take viewers around the world to study the political, emotional and scientific effects of the nuclear arms buildup—from Robert Oppenheimer's Manhattan Project, to President Eisenhower's tremendous fleet of B-47 strategic bombers, to today's intricate and hard-won disarmament treaty. It's a balanced and skillfully wrought report covering nuclear technologies and nuclear tensions as the human species faces the possibility of its own annihilation.

"War and Peace in the Nuclear Age" will sharpen perspectives—for proponents of both nuclear deterrence and a nuclear ban—as this fearful era continues. **PM**

### Space Station: On Again?

Last summer, Congress made a reluctant, 11th-hour appropriation for America's stepping stone in low-Earth orbit. Many space scientists contend that unmanned launchers would yield more data for less money, an argument tempered by the recent successful Shuttle launch. Where does the Station stand? Somewhere in the purgatory of Executive budgetmaking and Congressional appropriation. But don't count it out. Recent experiments to simulate the Station's heat load and temperature environment indicate critical development work for our much-needed future space infrastructure.



Space Station heat-load simulation in Johnson Space Center vacuum chamber.

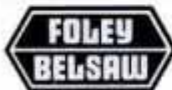


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# FREEWHEELING

BY TONY SWAN

## Driving The Futurebird

**A**LTHOUGH concept cars have been whipping our automotive lust centers into frenzy for decades, it's rare when one actually lives up to the promise of its sexy exterior. Many of the showmobiles suggesting the shapes of cars to come have been capable of nothing more than the most rudimentary level of self-propulsion, and all too often those seductive surfaces have clothed little more than air.

However, as competition intensifies, this tradition seems to be changing. Instead of merely indicating the shapes and systems of future automotive generations, more and more show cars are also able to demonstrate performance.

An excellent example of this trend is Pontiac's Banshee, a fully operational prototype that debuted as part of GM's traveling display—the so-called Rogerama show—last year. This is one car that delivers on its implicit promise and to prove it, Pontiac invited us out to Portland International Raceway for a little test drive.

Slipping into the Banshee's clever cutaway driver's seat, there isn't much question that this car is not of today. Although the steering wheel's hub-mounted controls are consistent with current Pontiac practice, the rearview TV monitor and ETAK navigation system clearly belong to the future, albeit the barely distant future. The steering hub also demonstrates how Pontiac intends to reconcile air bags with hub-mounted controls.

The Banshee's Head-Up Display (HUD) isn't really Buck Rogers stuff anymore—HUDs are already appearing on production cars from GM and Nissan—but other aspects of the car's instru-



Banshee fiberglass work was handled by Cars and Concepts in Michigan, and is intended to suggest possibilities for future Firebirds. Coefficient of drag ( $C_d$ ) is rated at 0.30. Basic chassis layout is front engine, rear drive and suspension componentry is borrowed from Corvette.

mentation are intriguing indeed. Included under this heading are the electronic compass, the acceleration timer (for 0 to 60 and quarter-miles) and the G-Analyst meter, replete with pop-up dot-matrix display.

The car's front-mounted, 4.0-liter, dohc, 32-valve port-injected V8 engine is a particularly interesting part of the story. It's a monoblock—heads and block are all one big aluminum alloy chunk—and it's already history after a production run of three copies. GM had plans for this powerplant at one point, but

it has since become a museum piece.

It doesn't feel like a museum piece, though. Torque is plentiful, giving the Banshee pilot a massive push in the back when the throttle is depressed, and growling as only V8 engines do.

The Banshee's fighter plane-style plexiglass canopy looks sexy, but it's a heat-gatherer and full of optical distortion, something that's initially disconcerting, especially when scenery moves toward the driver at higher rates of speed. The car's steering, which involves ca-

bles and pulleys, also takes some getting used to.

Nevertheless, the Banshee gives its occupants the feel of a racing machine, with flat cornering and excellent adhesion, thanks in no small measure to massive low-profile tires on alloy wheels. The latter were machined up from billet stock, an impressive piece of work that must have cost plenty.

Pontiac presents this car as a suggestion of things to come for its Firebird line. Now which of the suggestions do you suppose are possible? **PM**



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Orch. (CBS Masterworks) 369843</p> <p><b>Bob James</b>—The Scartati Dialogues (CBS Masterworks) 369835</p> <p><b>John Williams</b>—The Baroque Album (CBS Masterworks) 369769</p> <p><b>Stryper</b>—In God We Trust (Enigma) 370361</p> | <p><b>Richard Marx</b> (EMI-Manhattan) 369611</p> <p><b>Claude Bolling</b>—Piano Bolling's Greatest Hits (CBS) 369751</p> <p><b>George Howard</b>—Reflections (MCA) 369314</p> <p><b>Bobby McFerrin</b>—Simple Pleasures (EMI-Manhattan) 369306</p> <p><b>Murray Perahia, Piano</b>—Schubert: Sonata, Op. Posth., D. 959 Schumann Sonata, Op. 22 (CBS Masterworks) 369207</p> <p><b>Prince</b>—Love Sexy (Paisley Park) 369124</p> <p><b>Simon &amp; Garfunkel</b>—Greatest Hits (Columbia) 219477</p> <p><b>Placido Domingo</b>—A Love Until the End of Time (CBS) 365262</p> <p><b>Michael Jackson</b>—Bad (Epic) 362079</p> <p><b>Hank Williams, Jr.</b>—Wild Streak (Warner Bros./Curb) 370320</p> | <p><b>Chicago 19*</b> (Reprise) 368829</p> <p><b>REO Speedwagon</b>—Greatest Hits (Epic) 367672</p> <p><b>Michael Tilson Thomas</b>—Beethoven: Symphony No. 3 (CBS Master) 367441</p> <p><b>Brahms</b>—Double Concerto, Isaac Stern, Yo-Yo Ma, Abbado, Chicago Sym. 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(CBS Masterworks) 368274</p> <p><b>Vladimir Feltsman</b>—American "Live" Debut (CBS Master) 365254-365251</p> <p><b>James Taylor</b>—Never Die Young (Columbia) 365189</p> <p><b>Foreigner</b>—Inside Information (Atlantic) 364018</p> <p><b>Pretenders</b>—The Singles (Sire) 362541</p> <p><b>Andres Segovia Collection, Vol. 1 Music By Bach</b> (MCA Classics) 362293</p> <p><b>Neil Diamond</b>—Hot August Night II (Columbia) 362277</p> <p><b>Cheap Trick</b>—Lap Of Luxury (Epic) 368050</p> | <p><b>Daryl Hall &amp; John Oates</b>—...ooh yeah! 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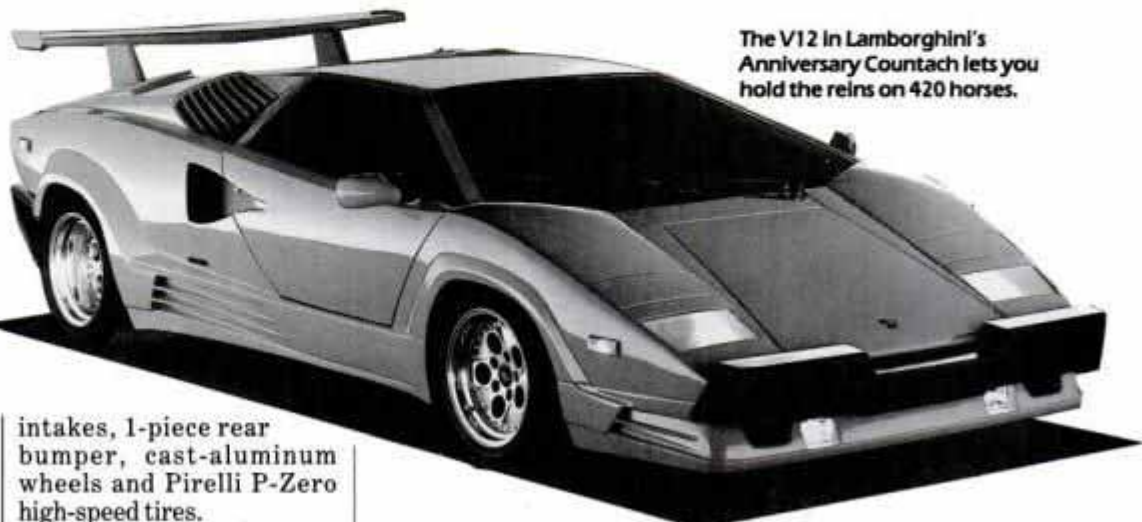
# IMPORTS

BY BILL HARTFORD

## Pouring On The Power

**N**OT TOO LONG ago, one horse was all you needed to get you to town lickety-split. Now, as any modern man knows, 1 horsepower—550 ft.-lb. per second or 745.7 watts—is entirely inadequate for powering even a pony car. In fact, to recast the saying for '89: "You can't be too thin, too rich, or have too much horsepower under your hood."

This will be a record year for cylinder proliferation and horsepower production. Whatever the car, the more hp the better. Even a basic (and brilliant) transportation module like the Honda Civic has had a horsepower jump in recent years from 76 to 108. That, from a 1.5- or 1.6-liter Four, means the difference between just slogging along, and stepping out with a margin of safety in the tight spots—not to mention with some self-esteem.



The V12 in Lamborghini's Anniversary Countach lets you hold the reins on 420 horses.

intakes, 1-piece rear bumper, cast-aluminum wheels and Pirelli P-Zero high-speed tires.

### Tough Torque

But let's get real. Even among models produced for the masses—select tens of thousands of them, anyway—12 cylinders is the hot setup. Reaching for the ultimate in a high-performance passenger car, several automakers have gone, or are go-

ing, the 5-liter Twelve is that three-quarters of its torque is doing the job while the engine is turning at a gentle 2000 rpm.

### Mighty Mercedes

Caught coasting as BMW captured the imagination of performance-minded buyers with its 750iL, Mercedes-Benz is readying its early '90s S-Class sedan with a voluminous 6-liter 48-valve V12 that cranks up 355 hp. With four camshafts and discrete fuel-injection and ignition systems for each bank of cylinders, the Mercedes-Benz motor should give the S-Class sedan a performance advantage over the V12s of Jaguar and BMW. And the new Mercedes is also expected to offer the absolute state

of the art, with electronics calling all the shots.

### Audi Gets Even

While Audi's powerful and familiar Five continues as prime mover in the 100/200 and 80/90 cars, by midyear there will be an Audi V8. This 150-mph flagship, the first of the fast-lane V8s from abroad—to be joined by Toyota's Lexus (see preview report, page 70) and Nissan's Infiniti—will mount a 3.6-liter, twin-cam, 32-valve motor that's rated at 250 hp. Power will go to all four wheels to give the Audi V8 an advantage over its rear-wheel-drive competition. But, whatever the drivetrain layout, cars engineered to hit 150 mph are the very best of the breed. **PM**



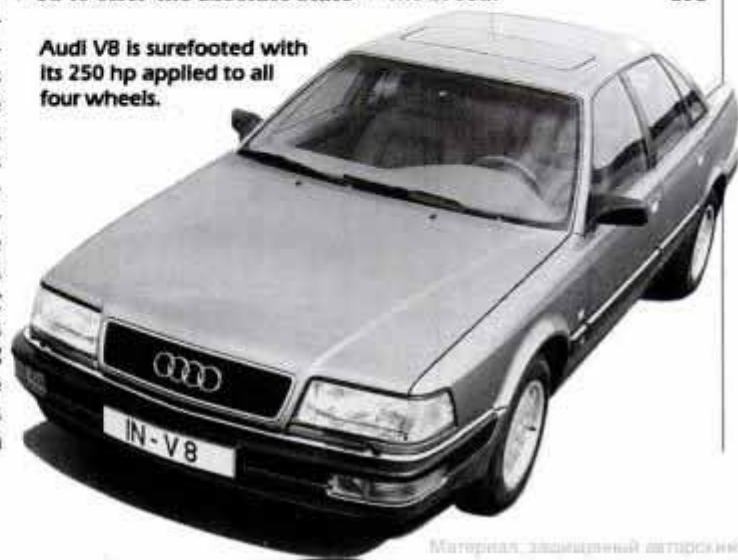
BMW 8-Series (to replace 635CSi) gets the same V12 as the 750iL.

### Firing On All Twelve

At the wheel of a car that represents much more than just transportation, the 12-cylinder Anniversary Countach, you can go from a standing start halfway to 100 mph in the time a traffic light is yellow. The V12 is a 5.2-liter, 4-cam, 48-valve powerhouse that does its thing from a midships position in the limited-edition Lambo. Only 200 of the scissor-door exotics will be made, and will be distinguishable by new air dam, side skirts, high-capacity air

ing, the 12-cylinder route. BMW recently joined Jaguar in offering a V12 in its exquisite 750iL sedan. Acceleration is as if by magic in this car. You don't hear or feel the balanced Twelve taking you beyond the legal threshold in less than 7 seconds. This engine will soon be here in another 150-mph BMW, the new 8-Series, replacement for the now classic-looking 635CSi. Horsepower is 296 at 5200 rpm and torque hits 332 lb.-ft. at 4100 rpm—fine numbers by themselves, but what is so astounding with

Audi V8 is surefooted with its 250 hp applied to all four wheels.





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BY STEPHEN A. BOOTH

## Instant Pictures Through Electronics

**I**T IS ESTIMATED that an original Kodak box camera that sold for \$25 back in 1888 is worth \$2000 or more on the collectors' market today. If collecting's your thing, you'd best run right out and snatch up Canon's new RC-250 Still-Video Camera. It's the first filmless, all-electronic camera for amateurs, and it goes on sale this month for about \$800. In a century or so, it might share the Kodak's status as the first of its kind to make an esoteric technology available to millions.

It seems we've been writing about filmless electronic photography in this space for the past four years. We've been through the rumor and the prototype stages. Then, in September 1986 ("Electronics," page 56) we reported on the first still-video camera for professionals—Canon's RC-701 and associated peripherals. You might remember that the camera itself cost \$2600. The playback deck for its 2-in. magnetic disk cost another \$2700, and a snapshot printer \$7750. You might also remember that Canon promised to deliver a consumer version of the still-video camera in about two years.

The company's done just that, in time for the 150th anniversary of photography. Although only two working models were available in the U.S. before the launch, we spent a week getting a hands-on acquaintance with the new filmless snapshotter. Before we report on the outcome, let's review just how still-video works.

Similar to a VCR or camcorder, still-video cameras such as the RC-250 store images on a magnetic medium,



Canon's RC-250 Still-Video Camera records pictures on a magnetic disk instead of film. It costs \$800.

instead of film. This means there is no chemical image processing involved. The magnetic material, just like tape, plays back directly to a TV monitor, and can be erased and reused.

The magnetic medium in this case is a 2-in.-dia. disk, housed in a hard plastic shell similar to that of a 3½-in. computer floppy. Whereas videotape records moving images, the video floppy records freeze-frame stills—up to 50 of them. As with camcorders, the image registers on a charge-coupled device (CCD) pickup chip, which transmits the visual information to the disk as a standard, NTSC television signal with 3:4 height-to-width proportions.

The disk itself spins at 1800 rpm while the recording head travels across it, inscribing video information on a 0.1mm-wide (1/1000-in.) track. Because the information is stored in the NTSC video format, the disk can hold either 50 images in the NTSC field mode, or 25 in the higher-resolution full-frame mode (two interlaced NTSC fields).

The RC-250 records in the field mode only—as most consumer still-video cameras

are likely to do. Ironically, the pictures recorded by the RC-250 are in some ways better than those taken with earlier, full-frame pro models. This is because the RC-250 is the first still-video camera to use the new High Band recording format.

High Band is similar to the higher-resolution systems used for videotape—Super VHS, for example—in that it yields more lines of horizontal resolution and less noise in the picture than the conventional formats. In operation, it's similar too. High Band still-video records the luminance (black-and-white brightness) portion of the video signal at a higher carri-



Compactly styled RC-250 has sports housing (right).

er frequency than earlier still-video cameras (9 megahertz compared to 7 megahertz), and over a greater bandwidth (2.0 compared to 1.5 megahertz).

Though in theory, High Band recording can yield up to 500 lines of horizontal resolution, the actual count will vary from camera to camera, according to the capabilities of the image-pickup chip and other factors. The RC-250, for example, uses a ½-in. CCD with a relatively modest 200,000 pixels, to record, horizontal resolution of 300 lines—about the same as a live TV broadcast. In playback, the RC-250 is capable of reproducing up to 400 lines if, for example, it were playing a disk recorded in another, higher-resolution machine.

That ability to play back disks—in the camera—makes the binocular-shaped, 18-ounce RC-250 unique among still-video cameras: Others require a separate playback deck to output the disk's signal to a TV or video printer. A simple RCA cable links the RC-250 to your TV, for an electronic slide show.

The camera itself runs on a built-in rechargeable battery (good for 500 exposures) that also powers the built-in flash. Inasmuch as the RC-250 has a relatively low ISO film speed equivalent of 100, the flash fires automatically





whenever needed. The camera's capable of shooting up to three frames per second, depending on the aperture and shutter speed that the camera's automatic exposure program has selected. Those shutter speeds range from  $\frac{1}{30}$  to  $\frac{1}{500}$  second; apertures range from  $f/2.8$  to  $f/22$ . The fixed-focus, 11mm lens keeps everything in focus from 3 ft. to infinity. In the selectable macro mode, objects as close as 1 ft. are in focus.

If the RC-250's 11mm lens seems short (and somewhat fish-eyed) by photographic standards, remember—this is video! The focal plane on which the image registers is a CCD chip much smaller than a frame of 35mm film. To equate video focal lengths to photographic-lens terms, multiply by 4 for  $\frac{3}{4}$ -in. CCDs, and by 5.33 for  $\frac{1}{2}$ -in. ones. Using this formula, the RC-250 has the equivalent focal length of 60mm.

In addition to the basic \$800 package that includes the RC-250, battery charger, AC adapter and all cables, there's an optional kit (\$200) that includes a water-resistant housing and sports finder, an action grip to which a 1.33-power teleconverter attaches (for the equivalent of an 80mm lens), a macrophotography frame and stand, and a sports bag to transport it all.

At this time, Canon offers no provision for making hard-copy prints from the RC-250. At least, there's no high-quality printer priced for household budgets. And while still-video images look quite good on a TV video monitor, they lose their eye appeal when reproduced on low-resolution, thermal-paper printers—even in the small snapshot size. It is, however, possible to get still-video prints if you shell out \$2500 for the printer Canon sells to newsgathering organizations. Just two years ago, Canon's entry-level printer cost \$7750.

Eventually, commercial photoprocessors will be making reasonably good and affordable still-video prints alongside of those shot on film. Until then, it's probably best to enjoy still-video as video—for a convenient electronic slide show on your TV.

## It's A Plane . . . .

There has been no end to the speculation over America's future tactical aircraft, the so-called Stealth Fighter. In fact, speculation for the most part is all there has been—what with the Pentagon keeping mum about the ace-in-the-hole it might or might not have.

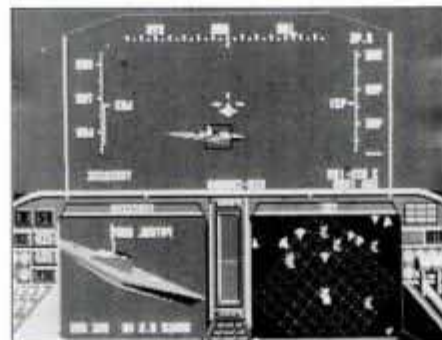
Just like the Stealth bomber before it, warbird watchers have been trying to divine the fighter's appearance and capabilities, much the way the six blind men tried to describe the elephant. Even POPULAR MECHANICS, in this issue, takes a more-than-educated guess at the warbird's feathers and fangs ("Our Most Secret Fighter," page 66).

One vision of the Stealth Fighter hails from MicroProse, the highly acclaimed publisher of computer flight simulators and other action software. And you can fly that vision for \$69.95—plus the cost of an IBM-compatible computer.

MicroProse has even given the Stealth Fighter a name—the F-19 (even though it is now officially the F-117A). On a recent mission to our offices, company president "Wild Bill" Stealey—a former fighter pilot—put MicroProse's Stealth Fighter through its paces.

The simulation is a tour de force of 3D-like graphics and combat aviation. The manual for the simulation weighs in at 210 pages alone—and its chock-full of Stealth Fighter specifications that MicroProse believes are very close to the real thing.

When you're at the controls of the MicroProse simulator, its avionics and other displays bombard you with a constantly updated stream of information on your armaments, orientation, radar profile, disposition of enemy targets and maneuvers—all the stuff that real pilots have to digest as they advance at



F-19 Stealth Fighter computer flight simulator presents compelling 3D-like graphics and continuous head-up displays.

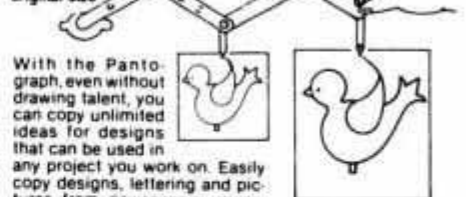


mach speeds and careen through high-G turns. Meanwhile, the view through your windshield changes with nearly 3D realism as you whiz past terrain at lightning speed. This realism results from five years of work in polygonal graphics by MicroProse.

Regardless of whether the Stealth Fighter according to MicroProse is close to the real thing, it's certainly a fascinating plane to fly. Maybe the Pentagon will even learn a trick or two! **PM**

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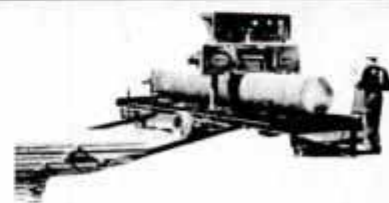
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# Brain—With Some Brawn

BY FRANK VIZARD, Contributing Editor

**I** NEED a new brain," said the streetwise shopper to the store salesman.

"Does your brain have a radio?" asked the salesman, himself a veteran of the streets but still needing some clarification.

"Yeah," said the shopper. "And listen, I need more power for my brain. Like 50 volts."

"No problem," said the salesman.

The foregoing is actually a conversation overheard in a hi-fi store. What the customer wishes to buy is an audio receiver with output power of 50 watts—not volts—per channel. As you can see, hi-fi retailers sometimes have to speak in tongues.

While it is possible to build an audio system around a separate amplifier and tuner, most people opt to buy a receiver—a simpler and less expensive approach. Receivers are truly brains in the sense that they combine the functions of a control amplifier, power amplifier and an AM/FM radio in one package. Now that's the classic definition. The truth is that today's receivers are much smarter than you'd expect. They're not only smart, they're also solid performers as well.

An exceptional cranial capacity is to be expected of high-wattage, high-priced receivers. Lots of brainpower, though, is now evident in some moderately powered receivers in the less expensive 50-watts-per-channel range. Less expensive



Sansui's RZ-3000 is one of the new breed of modestly powered receivers with high-end features.

doesn't mean inadequate, as 50 watts a side is sufficient for most listening situations.

A prime example of a good brain in this class is Sansui's RZ-3000 receiver (\$370). In addition to the substantial power that 50 watts per channel provides, the RZ-3000 offers a level of performance and flexibility that makes it stand out from the crowd. Frequency response is listed at 20 to 20,000 Hz with a very low 0.09 percent total harmonic distortion (THD). The difference or distortion between the signal recorded on the disc or tape being played and the sound that you hear is measured as THD. Ideally, there should be as little difference between the two as possible.

The RZ-3000's other specifications are equally impressive and, unlike many other receivers in this price category, the RZ-3000 has video inputs that allow you to connect a video cassette recorder or other video source to your audio system.

While being able to switch between phonograph, compact disc, video, AM and FM radio stations, and two tape sources makes the RZ-3000 a

flexible machine, it offers still more. One unusual feature for a receiver in this price range is a variable loudness control. When playing music at low volume levels, midrange frequencies are more prominent to the ear than bass and treble notes. Engaging the loudness control gives the bass and treble notes more emphasis. Many receivers have a simple ON/OFF button for loudness control. The RZ-3000, however, uses a rotary dial that affords more precise adjustments.

The RZ-3000 is a radio lover's dream in that up to 30 presets are available for 1-touch station location. You can program each preset using either the station's call letters or its frequency, but not both (the RZ-3000 permits only four characters per preset). So, if you find it easier to remember more-familiar call letters than station frequencies, you might find the RZ-3000's programming capabilities a perfect solution. Tuning, as well as source switching, can be done via a 20-key remote control. Even the rotary volume knob is motorized for remote operation, making the RZ-

3000 one of the best receivers around for the money.

## D-I-Y HI-FI

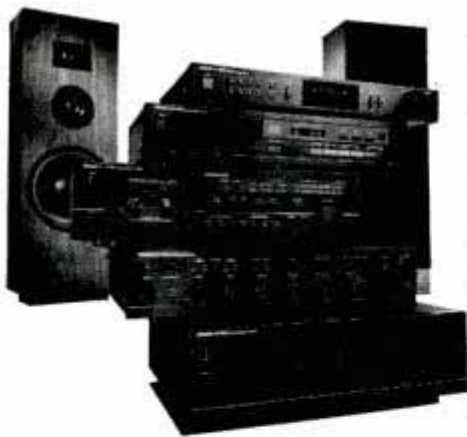
It's sometimes said that electronic audio components have become too complicated for hobbyists to build themselves. The Heath Co., a subsidiary of Zenith, disagrees.

The Heathkit catalog features a line of high performance, hi-fi components that will make do-it-yourselfers salivate. Three of the components are available in kit form: an AM/FM stereo tuner, a 100-watts-per-channel power amplifier, and a pre-amplifier.

Although all three bear the Heath brand name, they're actually designed and produced for Heath by Harman Kardon, one of the most respected names in audio. This means that "kit" doesn't mean "no frills." The AJ-3520 tuner, for example, boasts 16 station presets while the AA-2500 power amp offers frequency response of 20- to 20,000 Hz, with THD a low 0.06 percent.

Each kit comes with a detailed construction manual. The tuner kit lists for \$229, the amp for \$449, and the





Audiophile manufacturer Harman Kardon designed the new hi-fi kits for Heath.

preamp for \$349. They're also available fully assembled—add \$50 each for the amp and preamp, \$20 more for the tuner. As you can see, you don't necessarily build from kits to save a lot of money. It's more for the satisfaction—and bragging rights—that you've done it yourself.

If you do, Heath offers two fully assembled source units to match your tuner and amps. The Harman Kardon-designed CD player and cassette deck cost \$349 each. Additionally, there are two JBL-designed loudspeaker systems, priced at \$399 and \$159 a pair. Heath's toll-free number is (800) 253-0570.

### Riding The Beam

For some years autoreverse in an automotive cassette/receiver has been both a convenience and a curse. As a convenience the benefits are obvious. There's nothing more tiresome than having to eject a cassette, flip it over and reinsert it just to hear Side B—particularly if you're doing it 1-handed with double nickels on the speedometer.

The downside of convenience has been a lack of performance on either Side A and/or Side B of the cassette. The problem is azimuth adjustment. Azimuth is defined as the angle of the gap in the playback head in relation to the direction of tape travel. The azimuth must be a perfect 90° to insure proper high-frequency response.

For the longest time, autosound manufacturers couldn't have it both ways. When the audio tape changed direction, the alignment of the playback heads in relation to the tape changed as well. On the other hand, autoreverse sold cassette receivers. So, no one cared. Azimuth could be a small town in the Duchy of Abalonia. Manufacturers did their best, generally optimizing azimuth for one tape direction or trying align the azimuth so it was perpendicular for both directions. Neither solution proved ideal. Even a slight deviation in azimuth causes a drop off in high frequency re-

sponse. Cymbals that should sound shimmering and metallic, for example, just sound hissy.

Clarion and a number of other cassette/receiver makers are now using an automatic azimuth adjustment system that properly aligns the playback heads with the tape no matter which direction the tape is moving in. Cassette/receivers with automatic azimuth adjustment have internal mechanisms preset for both tape directions. When the tape changes direction, a lever triggers the appropriate preset so that the tape playback head is properly aligned.

Automatic azimuth adjustment is becoming more widespread as a feature in car cassette/receivers and it is certainly a welcome development. Autoreverse is a great feature to have, particularly if it means there's no loss in performance.

### Winter Warnings

We've all gotten into the habit of being able to listen to music all year round and in just about any environment. Winter, however, presents certain hazards for Walkman-type personal stereos and for car cassette/receivers. The big problem is cold.

When a tape player is too cold, you might experience what is called "wow." This displeasing sound is caused by sluggish drive belts and contact points affected by viscous oil in the recorder. This effect can be avoided in a car cassette/receiver by letting the car's heating system go to work for a few minutes before you attempt to play any tapes. Outside, just wear your personal stereo under your jacket. Your body heat will keep the machine operating efficiently.

Coming in from the cold also presents some problems. You've probably noticed that eyeglasses often fog up when the wearer enters a warm, humid room after being in the cold outdoors. The same thing can happen to the playback heads of a tape deck, thus impairing the machine's ability to operate. Fortunately, this problem isn't all that serious. All that you have to do is let the machine adjust to the ambient temperature for a few minutes. Just for the record, I advise against speeding up the process by putting the machine over a stove or radiator.

Cassette tapes themselves are rarely problematical in cold weather. Most cassettes can operate perfectly in temperatures as low as 0° F. Extreme cold can make the carrier film of the magnetic tape become a bit stiffer, thus raising the torque needed to transport the tape.

Listening to hot tunes when it's cold outside or skiing to hot jazz on a wintry slope is great fun.

A few simple precautions are all that is necessary to make your car or personal tape deck run properly. **PM**

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## Long-Term Test

### **OLDSMOBILE CALAIS**

Quad 4 quality.

### **MAZDA 626 4WS TURBO**

They don't make 'em like this anymore.

### **BUICK REGAL CUSTOM**

Redeems itself in the long run.

**A**S THE 1988 model year drew to a close, we reduced our long-term test fleet by a factor of 50 percent, as three veterans, the Olds Calais Quad 4, Mazda 626 and Buick Regal, quite literally went to meet their makers.

The remaining trio—Dodge Caravan, Ford Festiva LX and Renault Medallion—are also updated here.

#### **Olds Calais Quad 4**

If dependability is the basic currency of consumer satisfaction in automobiles, our Olds Calais is on the gold standard. Over 10 months and 11,498 miles, it's performed flawlessly, with never a hiccup, balk or a single minute of down time.

The only problem we've had with the car—failure of the windshield washers—is one of those irritations that wouldn't even be mentioned if there were *real* problems. Aside from that, the shocks seem to be getting a bit tired

and the cloth upholstery seems a little more worn than one year of normal use would seem to warrant.

But the heart of our Calais International Series coupe—the Quad 4 16-valve twin-cam engine—left our care as fresh as the day we took delivery. Fuel economy over the course of our evaluation has ranged from as low as 21.5 mpg, to a bit over 30, and the overall average was 25.7—not great, but certainly not bad, either. There were some negative observations in the logbook concerning engine noise, but these were offset by praise for the Quad 4's spirited performance.

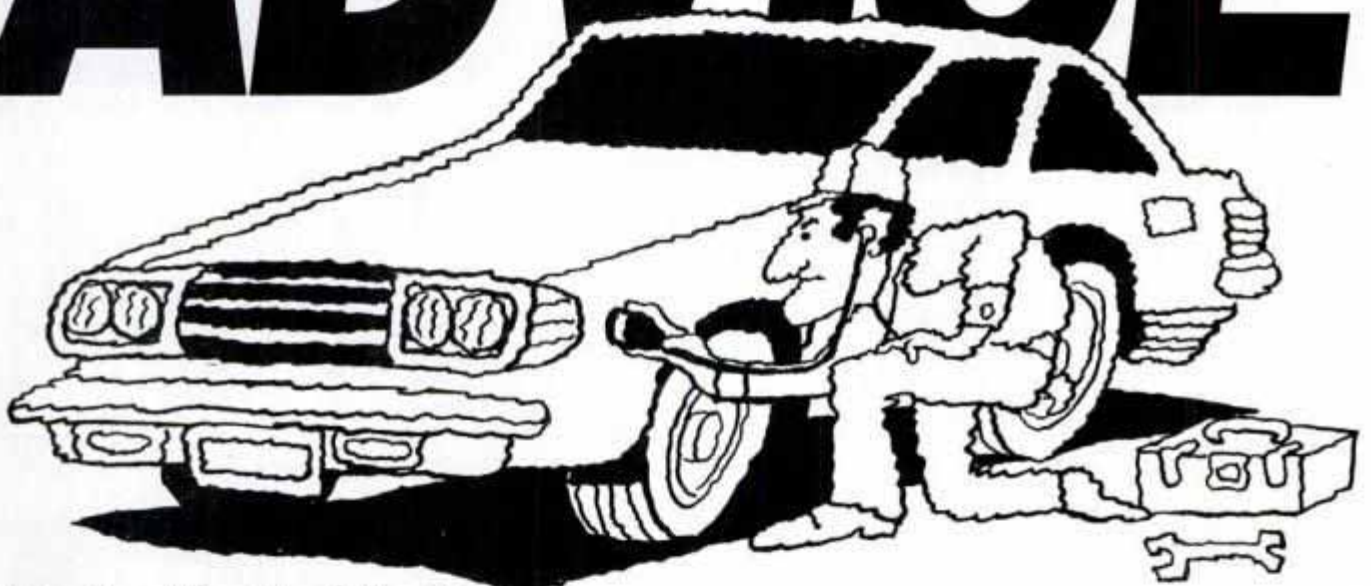
*(Please turn to page 50)*



Go-power of 626 Turbo drew plaudits, 4ws helped in parking lots.



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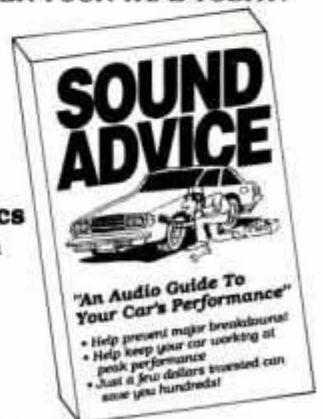
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We logged a couple of idiosyncrasies that become annoying over the long haul, not only in this car but in its GM stablemates—Pontiac Grand Am and Buick Somerset—as well. One is the absence of a detent to keep the passenger-side seatback from pitching forward under hard braking. Then there's the absence of coin storage, which is a hassle for commuters who travel on toll roads. And finally, we regularly wondered why GM thinks it's a good idea to render the glove-box-mounted trunk release inoperable without the ignition switched on.

However, these quirks have nothing to do with why we brought the Calais to New York City. We wanted to see how GM's new Quad 4 would stand up to one of the least hospitable urban automotive environments in the country. And it's hard to imagine a car performing much better than this one did.—*Tony Swan*

### Mazda 626 4WS Turbo

Our 626 reached the end of its evaluation with 12,435 miles on the clock, although a year's worth of mileage doesn't seem to have aged this car's spirit even slightly. It still runs down the road like it's being chased by a process server, delivering a somewhat disappointing 22.8 mpg in the process. City commuting drops the mileage to nearer 20, but that's not unusual for a 12-mile trip that often takes an hour. On the open road, the 626 does much better, regularly logging mpg in the high '20s and even low '30s.

Oil consumption has been less than a quart between our frequent changes (usually between 2000 and 3000 miles), and Detect oil analysis hasn't revealed any nasties in the crankcase.

The 626's clean, near-monochrome styling makes a good impression even among those who have to ask what kind of car it is. Several drivers have commented on its excellent high-speed manners, even without being aware of the car's 4-wheel-steering system. This isn't surprising, since the distinction between Mazdas with conventional steering systems and our own 626 is difficult to perceive. About the only area of marked contrast is when it's time to wedge the car into some tight parking spot, but this doesn't really seem like enough to justify the system's expense, and Mazda has had trouble getting buyers to bite on 4ws so far.

There have been a few problems. We can't blame Mazda for the tire and

alloy rim that were eaten by a pothole late one night, although it is impressive that the alignment remained true. One particularly steamy August road trip with a car full of people left the air conditioner ducts with a recurrent case of mildew, giving the ventilation system a more or less permanent case of bad breath.

Last year, when Mazda announced its 4ws option, everybody wondered why this system was limited to the 626 Turbo, which is auto transmission only, rather than the sportier MX-6. Well, Mazda has apparently been listening, because for 1989 the 4-wheel-steering option has been moved to the sporty MX-6 coupe, making our 626 Turbo sedan something of a collector's item.—*Mike Allen*

### Buick Regal Custom

The Regal's last hurrah was a spirited end run from Long Island, through the Catskill Mountains, to Lime Rock, Connecticut, to the International Motor Press Assn.'s annual



After early hiccups, Buick Regal delivered trouble-free driving.

test-driving day. On the way back, as we wheeled on board the Cross-Sound ferry, the Buick was cookin' fine, but this driver went to full recline and reflected on 5172 miles of city, country and interstate driving.

Last summer, the car, with its slick coupe styling, got lots of attention. By the end of '88, however, its good looks would be taken for granted. Also taken for granted by the time we headed for Lime Rock was the Regal's ability to quickly and smoothly take us anywhere we wanted to go. Our faith in solid-state electronics was restored after a one-in-a-million blowout of the ignition coil assembly that left us stranded, having to hail a tow truck to get us to a Buick dealer, in 96° heat ("Long-Term Test," page 118, Sept. '88). At the time of the tow, with the front end being lifted toward the stars, we weren't very receptive to the truck driver's exclamation: "Great looking car!" The part replacement, made under warranty overnight, put us back on the road to continue logging miles on what we

judged, in the long run, to be a very capable car.

The 2.8-liter V6 with EFI teamed with the 4-speed automatic gave us all we needed off the line and let us sit back in 25-mpg economy and comfort on long hauls. When we had to serpentine, the suspension, steering and Goodyear Eagle GT+4 radials let us quickly bob left and right without any surprises.

The Regal did develop a few idiosyncrasies that we learned to live with, not finding the time to schedule a dealer service department correction, or to "get out and get under" ourselves—like the headlight switch that required a hard jab every time you wanted to turn on the lights, or the passenger-side power window that would occasionally stop, dead in its tracks, midway up or down. With a little help from its friends, it would continue its travel.

All in all, the Regal became a car we felt good about living with—not *loving* exactly, but living with. At 3000

pounds, it's a middleweight with a solid stance—there's nothing tinny about it. It's Detroit iron properly forged: lightened with a dash of alloys, designed with seats that make sense (seductive to drivers who know how well the imports take care of this department), engineered for proper performance and patriotic fuel economy and styled with staying power, to still be satisfying after the last car payment is made.

—*Bill Hartford*

### Dodge Caravan SE

Our Caravan has had incredible abuse heaped on it over the course of the summer racing season, moving the entire PM Racing pit setup to and from tracks, moving furniture on weekends between races and doing occasional duty as 7-passenger transportation.

Even with enough of an overload to nearly bottom the springs, it remains unfussy to drive on the turnpike or in traffic. Mileage under these loads plummets to 16 or so, but remains 20 to 22 in traffic carrying only one or two commuters.

At 18,000 miles, it has required only normal maintenance, and promises to remain as reliable in the future. The interior *is* beginning to look a little moth-eaten, mostly as a result of being loaded hurriedly after 24-hour endurance races by guys who hadn't been to bed for two days.

—*Mike Allen*



## Ford Festiva LX

Thanks to heavy new-car introduction schedules over the summer, our Festiva has only 3459 miles on its odometer at this writing, barely 1000 more than our initial report. To be candid, one of the reasons for this is that staffers tend to opt for bigger cars when it's time to hit the open road. Although this Korean-built mini makes the most of interior volume, it's not the sort of car one packs a family into with a week of touring in mind.

Nevertheless, we still see this jaunty little box as an ideal urbocar, quick enough in traffic, cheap to run and eminently parkable.

Although we still have no debilitating problems to report, Ford did issue a Technical Service Bulletin on this car, addressing the part-throttle stumble that's drawn complaints from our car's drivers already. Ford's fix includes running ignition timing up a bit and dialing back on EGR, neither of which seemed to produce any noticeable difference in our car's behavior. —Tony Swan

## Eagle Medallion

Chrysler Corp.'s rebadged Renault is a perplexing car. When it's running well, it's actually a terrific small sedan. It's roomy, has a big trunk, has more than enough power for its weight, has a smooth ride and responsive handling. The trouble with our Eagle Medallion test car is that so many things have gone wrong with it that some of the good feeling we've had for the car is also gone.

Right now, the car has just over 10,000 miles on the odometer. Recently, the car's battery went dead for the second time. No explanation. Nothing was left on. The car was just dead in the morning. Like the first time, a jump and a checkout revealed no harm to the battery's cells. So far, we haven't determined the cause of these blackouts.

Since our last report, the front brakes have completely worn out. The car is at our local dealer right now having the rotors machined and the pads replaced. Yes, we drive the car hard, but not new-brakes-in-just-10,000-miles hard.

Also, the automatic transmission quit downshifting (even if shifted down manually!), the horn quit and so did one of the turn signals.

Between the dead battery episodes, no brakes and a transmission that won't shift properly—all in 10,000 miles—this test car isn't exactly helping to build a stellar track record for Chrysler's new Jeep-Eagle brand. —Joe Oldham

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# MOTOWN MUSCLE



ZR1 dash is identical to standard Vette. LTS engine—4 cams, 32 valves, 375 hp.



## Corvette ZR1

Engine	5.7L dohc 32-valve V8
Hp. net	375 @ 6000 rpm
Torque, lb.-ft.	370 @ 4800 rpm
Transmission	6-speed manual
Curb weight	3425 lbs.
Brakes	Vented disc, ABS
Tires, f-r	275/40ZR-17, 315/35ZR-17

### Performance

0-60 mph	4.3 sec. (est.)
0-100 mph-0	14 sec. (est.)

We sample Detroit's newest power players.

BY TONY SWAN, Auto Editor,  
& MIKE ALLEN, Asst. Auto Editor

**T**HERE ARE THOSE who still yearn for the days when Detroit was the world reservoir of horsepower of the massive V8 variety, viewing everything that's come along since as a compromise.

We don't buy this theory. Backed by a growing arsenal of high-tech powerplants, Detroit is back in the

power game. We offer these mini-tests of the Motor City's hottest newcomers for 1989 as proof.

### The Vette that would be king

For the sake of perspective, let's begin by observing that there have been previous limited-edition Corvettes capable of matching the performance of this one. Even without the benefit of aluminum-alloy castings, four valves per cylinder and one of the most sophisticated induction systems on the planet, the small-block Chevy V8 has always been a bountiful horse-

power source. Chevrolet has sold street-going editions rated at 375 hp (gross), as well as big-block engines capable of well over 425 hp, and it's not difficult to extract 600 hp from a race-prepared small block today.

However, that word race is the key to then versus now. The red-hot limited editions of yesteryear were essentially racing machines—crude, noisy and about as much fun to drive on the street as dump trucks. The ZR1 Corvette, for all its potency, is civilized and luxurious, as capable of pampering its occupants as it is of flattening them against their seatbacks.



## MOTOWN MUSCLE



### Ford Thunderbird SC

Engine	3.8L supercharged ohv V6
Hp, net	215 @ 4000 rpm
Torque, lb.-ft.	315 @ 2600 rpm
Transmission	5-speed manual
Curb weight	3701 lbs.
Brakes	vented disc, ABS
Tires	225/60VR-16

#### Performance

0-60 mph	8.4 sec.
1/4-mile	16.7 sec. @ 85.2 mph



Like its exterior, T-Bird's dash is all new. Supercharged 3.8 V6 makes 215 hp.

Although the ZR1's LT5 engine design started with Chevy's venerable V8, it's about as new as new ever gets in the powertrain business. The block and heads are cast aluminum, with Nikasil-treated aluminum wet liners and cast-iron reinforcements for the bearing cradles. Cylinder bores are a tad smaller than the standard cast-iron small block (99.0 mm compared to 101.6 mm) and the stroke is slightly longer (93.0 mm versus 88.4 mm), yielding a total volume that is 6 cc smaller than the tried and true, at 5727 cc.

Developed by Lotus, the LT5 shows the benefit of extensive racing experience in its valvetrain and combustion chamber design. The chain-driven cams—two per cylinder bank—operate self-adjusting hydraulic bucket tappets, and the valves open into shallow combustion chambers floored by dish-topped pistons that yield a whopping 11.3:1 compression ratio.

The intake system is perhaps the most interesting engineering aspect of the entire engine, utilizing three throttle valves, one small and two large, and 16 intake runners, one to each intake valve. In addition to these, half of the inlet runners are equipped with their own valves which open only under certain combinations of rpm and throttle position, as when

the driver stands on the gas.

Aside from installing massive rear-end rubber to handle the extra power—315/35ZR-17—the ZR1 engineering team didn't have to change much from the standard Corvette setup. The slick new 6-speed ZF gearbox is available on all members of the Corvette family, as are the massive front brakes—13-in. vented rotors with dual calipers, a key element, along with the standard ABS, in Chevy's mind-bending 0-to-100-to-0 expectations. We have also heard Corvette engineers talking about 12.86-second/116-mph quarter-mile runs.

We can neither confirm nor deny these or other performance expectations, since official test cars won't be available for awhile. But based on informal drives in prototypes, we expect mind-bending to the max.—T.S.

### Ford Thunderbird SC—the Super Coupe

Like Chevrolet, Ford is making a statement here. Though the company can easily extract this kind of power from its excellent 5.0-liter V8, that engine belongs to yesterday and Ford is acutely conscious of tomorrow.

In addition to being perceived as a design leader, Ford wants engineering recognition as well. Which is how the intercooled, supercharged 3.8-li-

ter V6 came to be the heart of the latest T-Bird.

The new engine is basically the same as the basic 3.8 that's standard equipment for the T-Bird/Mercury Cougar line, with the addition of a Roots-type supercharger and a lot of bottom end shoring-up. Although the supercharger sops up horsepower, its response time is much quicker than the 2.3-liter turbo it replaces and its torque output is impressive.

And as the data panel indicates, there's enough to get the job done. The supercharged 'Bird isn't particularly fast, but it's quick—more than quick enough to satisfy most personal luxury-coupe shoppers.

While its substantial mass does resist directional changes, the Super Coupe is surprisingly agile and positive in its handling capabilities. The power rack-and-pinion steering is precise, and the basic handling trait seems to be somewhere between neutral and mild understeer, with no nasty changes in character.

Considering the ratio of contact patch to total vehicle mass, the Super Coupe's braking performance is nothing short of astounding. ABS, standard equipment on the Super Coupe and Cougar XR-7, helps, although it doesn't necessarily produce shorter stopping distances on dry pavement. But, even though the T-Bird was the





### Ford Taurus SHO

Engine	3.0L dohc 24-valve V6
Hp, net	220 @ 6000 rpm
Torque, lb.-ft.	200 @ 4800 rpm
Transmission	5-speed manual
Curb weight	3078 lbs.
Brakes	Vented disc
Tires	215/65VR-15

#### Performance

0-60 mph	7.0 sec.
1/4-mile	15.7 sec. @ 92.9 mph



SHO package includes outstanding bucket seats. SHO V6 features dual intake tract.

PM PHOTOS BY G. PHOTO

heaviest car in this group, it turned in the best braking performance.

All in all, we'd have to say this big 'Bird's performance is just as impressive as its new exterior. And that's saying something.—T.S.

### Ford Taurus SHO—the new Q-ship

If you're the kind of driver who enjoys having serious performance in a demure wrapper, you're gonna love this one. Although Ford's Taurus has

been a major success, it's never been noted for its ability to wrinkle pavement—until now. Wrapped up in that understated exterior is a potent new 3.0-liter port-injected 24-valve twin-cam V6 that zooms this modest family sedan into a very fancy performer.

The SHO (Super High Output) V6 comes to Ford from Yamaha, and even though its displacement is about the same as Ford's pushrod Vulcan V6 it's an all-new engine. The block is thin-wall cast iron with aluminum cylinder heads and cast-aluminum oil pan. There are two chain-driven cams per cylinder bank, and the valves—four per cylinder—are operated by direct-acting bucket-style tappets. To compensate for the low-end sluggishness common to many multivalve engines, the Yamaha V6 uses a dual intake system feeding Siamesed



Stock Shadow interior gets Shelby seats and wheel. Shelby-ized engine makes 175 hp.

### Dodge Shelby CSX

Engine	2.5L turbocharged L4
Hp, net	175 @ 5200 rpm
Torque, lb.-ft.	200 @ 2400 rpm
Transmission	5-speed manual
Curb weight	2515 lbs.
Brakes, f/r	Vented disc/drum
Tires	225/50VR-15

#### Performance

0-60 mph	8.2 sec.
1/4-mile	16.3 sec. @ 85.8 mph

PM PHOTOS BY G. PHOTO



## MOTOWN MUSCLE



### Olds Cutlass Calais H.O.

Engine	2.3L dohc 16-valve L4
Hp, net	185 @ 6200 rpm
Torque, lb.-ft.	160 @ 5200 rpm
Transmission	5-speed manual
Curb weight	2740 lbs.
Brakes, f/r	vented disc/drum
Tires	205/55R-16

#### Performance

0-60 mph	7.2 sec.
1/4-mile	16.1 sec. @ 87.3 mph

Deck spoiler distinguishes H.O. Calais. New cylinder head helps bump hp to 185.

ports. Compression ratio is a relatively modest 9.8:1, while output is a not-so-modest 220 hp at 6200 rpm, better than the supercharged Thunderbird.

What this does for Taurus go-power is about the same as what happens to Clark Kent when he ducks into a

phone booth. Suddenly the mild-mannered Taurus is capable of running with just about anything in the BMW stable, right up to 140 mph.

This is about as much power as anyone's bolted into a front-drive car, and Ford worked hard to make the SHO's

handling match its speed. Roll stiffness has been increased, shock damping is firmer and there's a little more tire contact patch.

We'd have to grade the effort in this department as a midrange B. While the SHO-mobile is thoroughly predictable, it won't be hurried through corners and isn't really as crisp in transient response as we'd like in a car with this kind of potential. Braking, too, could be better, although we think this could be improved by changing pad material. The rotors are big enough, and vented up front.

Ford is concerned that Taurus SHO sales may be limited by the nonavailability of an automatic transaxle—the only gearbox offered is Ford's excellent 5-speed. This could be true, but we're more inclined to think that once the word gets out about this car, the sales limits will be dictated by availability. This one's our candidate for sleeper of the year.—T.S.



### Pontiac Grand Prix Turbo

Engine	3.1L turbocharged ohv V6
Hp, net	205 @ 4800 rpm
Torque, lb.-ft.	220 @ 3200 rpm
Transmission	4-speed automatic
Curb weight	3450 lbs.
Brakes, f/r	Vented disc/disc, ABS
Tires	245/50ZR-16

#### Performance

0-60 mph	7.2 sec.
1/4-mile	16.1 sec. @ 86.2 mph

Sporty SE interior reflects Grand Prix's new potential. V6 turbo makes 205 hp.

PHOTOS BY TIM M'KINNEY

PHOTOS BY TIM M'KINNEY





Anniversary Trans Am dash has familiar look, but 245-hp Grand National V6 is new.

### Pontiac Trans Am Turbo

Engine	3.8L turbocharged ohv V6
Hp, net	245 @ 4400 rpm
Torque, lb.-ft.	340 @ 2800 rpm
Transmission	4-speed automatic
Curb weight	3486 lbs.
Brakes	Vented disc
Tires	245/50ZR-16

#### Performance

0-60 mph	5.9 sec.
1/4-mile	14.0 sec. @ 98.72 mph

### Dodge Shelby CSX— love it or hate it

There aren't any real secrets to what Shelby & Co. have done to yet another K-car clone. Start by turbocharging its 2.5-liter Four to within an inch of its life—12 psi and 175 horsepower's worth. (To be fair, the Garrett Variable Nozzle Turbo does do an admirable job of reducing turbo lag, pretending it's a small turbo at low rpm and a bigger turbo at speed.)

Continue the program by lowering and stiffening the suspension. Add some aero stuff, and *voilà*—instant pocket rocket.

The real secret is that Shelby makes it work, though this is a very one-dimensional vehicle, and a questionable choice for your only car.

But you might if you lived in, say, California, where roads are mostly devoid of potholes and frost heaves.

Carroll Shelby lives in California, near smooth, twisty canyon roads, which is where the CSX suspension really shines. It has all the sophistication of a go-kart, but the damping, spring and antiroll bar rates keep the fat Goodyears working hard.

Those Goodyears, incidentally, are mounted on composite plastic wheels. They're super light, but only time will tell how they hold up to curb rash.

The icebox-white paint complements the air dam, skirts and spoiler, but the police will peg this baby as a bandit from six lanes away. Even so, we vote it most fun/dollar.—M.A.

### Olds Calais H.O.— cutting-edge Cutlass

When the guys from Lansing tell us "these are not your father's Oldsmobiles," here's the Olds that springs to mind. With 150 hp on tap, the Olds Calais Quad 4 was satisfying. Bumped to 185, it climbs into the realm of potent.

This is the first of many power upgrades we expect to see for this engine. In this application, the increase was achieved by bumping compression from 9.5:1 to 10.0:1 and increasing the diameters of both the intake and exhaust valves. Olds also cast new intake runners, opened up the exhaust a bit and adjusted valve timing, all pretty much standard hot-rod practice, or would be if Olds hadn't done it with an all-new head casting.

To get the H.O. Calais (the hottest-up Quad 4 is also available in the Pontiac Grand Am), you must order the Olds International Series package, which includes stiffer everything and spiffy 16-in. cast-alloy wheels. *Note:* the H.O. won't be available until later in the model year.—T.S.

### Pontiac McLaren Turbo Grand Prix— boutique musclecar

Pontiac, GM's excitement division, enlisted ASC/McLaren for development of the limited-edition Turbo GP. They started by stroking the boat-anchor 2.8-liter pushrod V6 8 mm, upping the displacement 300 cc. Then they turbocharged and intercooled it until the horsepower curve had the slope of an Alpine mountain range, peaking at 205 hp at 5200 rpm. To make it live, the nodular-iron crankshaft and rod castings are specially hardened before assembly.

You'll have no option about the transmission—only the 4-speed auto is available. Also standard is the Y99 suspension package, and 16x8 rims with 245/50 ZR-rated tires. This combination corners with considerable understeer, which is what you'd expect from a front-drive car. But it's a controllable understeer, devoid of most torque steer and nibbling, and there's a fair amount of road feel through the high-effort rack-and-pinion power steering. Aero add-ons complement the flared fenders, and you must make sure that your insurance agent never looks at your car or you'll wind up in the assigned risk

(Please turn to page 116)





Landmark photo gear includes George Eastman's 1888 Kodak camera (left) and its characteristic round prints. Man holding camera in snapshot is Eastman, in 1890. Leica's Model A (above), circa 1923, was the first still camera to use the downsize 35mm film, available in color with the 1936 introduction of Kodachrome. Photographs are now easier to take thanks to automatic focusing and exposure control, first combined in 1979 in Canon's Sure Shot (opposite, top). The company's new RC-250 still-video camera (opposite, center) takes pictures on magnetic disks instead of film.





# PORTRAITS

As photography celebrates its 150th anniversary this year, the ageless beauty of film will witness the birth of electronic imaging.

BY STEPHEN A. BOOTH  
Electronics/Photography Editor

**T**HE TELEGRAPH was still a click in Samuel Morse's mind when Her Majesty's Steamship *Queen*—itself a marvel of technological progress—raced to New York with news of Frenchman Louis Daguerre's magical "photogenic drawings." Those early photographs, announced in Paris in January 1839, challenged once and forever the monopoly of the artist's pen and brush. When the first *daguerreotypes* were displayed in September of that year, Morse—himself an artist and inventor—reported that they were not merely "copies of Nature, but portions of Nature herself."

Since its inception 150 years ago, the camera has wit-



nessed millions of birthdays and anniversaries. Now, it's photography's turn to celebrate—and with good cause. The technology deserves a place beside the printing press as an instrument of social change.

Before the camera's arrival, the ability to record history or portray events graphically was a costly and time-consuming endeavor, with only the wealthy and powerful seeing the results. But the image-making revolution sparked by Daguerre simplified the transcription and dissemination of visual information, and technological innovations such as George Eastman's Kodak camera put the tools to do so in the hands of Everyman.

With today's computer-assisted point-and-shoot cameras, a person can take superb pictures without having any photographic know-how whatsoever. It is what the historian John Kouwenhoven called "the democratization of vision."

As photography extended our vision, it also changed the way we look at ourselves. In contrast to the posed, artificial and often fanciful presentations of art, the camera captures candid, unpretentious snapshots of life as it is. And while it made us culturally richer, photography has had an economic impact too, adding to our material prosperity.

Where once a wealthy nobleman might have kept a handful of artists in rent money, photography today

employs hundreds of thousands around the world. It's a \$20 billion industry in the United States alone, where some 9 million cameras were purchased last year. At the same time, Americans took more than 15 billion pictures—about one-third of the world's total. Photofinishing itself

the first practical photographic process, the first known photograph is actually the doing of one Nicéphore Niépce, another Frenchman. His 1826 *heliographs* (sun-writings), along with experiments in light-sensitive materials by 18th century researchers, formed the basis of

Daguerre's work. But the origins of photography date back even farther, to the Renaissance and possibly the Middle Ages, in the form of two optical drawing aids for artists—the *camera lucida* and *camera obscura*.

These devices focused a prism or lens on a distant subject, then projected the reflection on a flat surface, enabling the artist to copy the details on a piece of tracing paper. The concept of photography was born when artist-inventors such as Daguerre and Britain's William Talbot began to wonder whether the reflected image could be transferred to paper automatically—detail for detail—instead of being traced approximately by the artist's selective hand.

Photography as we know it today evolved from the contributions—literally positive and negative—of both men. Daguerre's photographs, recorded on a silver-coated copper plate, yielded excellent but one-of-a-kind positive images that could not be reproduced. Talbot's process used silver-coated paper to create a negative image—light and dark tones reversed—within the camera. The "negative" could be

transferred to a second sheet of sensitized paper to yield a positive or correct-reading image, making multiple copies possible.

Compared to Niépce's heliographs, which required nearly a whole day's exposure in sunlight to register an image, both Daguerre and Talbot got exposure time down to a then-remarkable 30 minutes or less.

Even so, street scenes depicted in early photographs are eerily devoid of people—or even horses. Moving subjects simply traveled past the camera faster than the light-sensitive plates or paper could register them. Even posed subjects literally had to sit still for their portraits: The stiff, stuffed-shirt appearance of many early subjects might have less to do with their personalities than their discomfort with the head and body braces re-

xxxviii Advertisements

THE

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PHOTOGRAPHY REDUCED TO THREE MOTIONS.

1. Pull the Cord. 2. Turn the Key. 3. Press the Button.

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Size of Camera, 2 1/2 x 2 1/2 x 4 1/2 inches.  
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Price includes hand-sewed, soft leather Carrying Case, with shoulder strap and film for 100 exposures.

PRICE

For Developing, Printing and Mounting 100 Pictures, including special 100 film for reloading Cameras... \$10.00  
Special for reloading only... 1.00

THE EASTMAN DRY PLATE AND FILM CO.,  
11 Oxford Street, London? Rochester, N. Y.

The 1948 Polaroid camera yielded instant prints in less than 1 minute.



Ad for the 1888 Kodak stressed its "You press the button, we do the rest" simplicity.

is a \$4 billion business in the United States. If all the labs were a single company, it would rank 94th on the *Fortune 500* list.

### Light-writing

As with many technological breakthroughs, more than one individual deserves the credit for bringing photography from dream to reality. And as is so often the case, the rapid advancements in the field were the doing of kitchen chemists and backyard inventors.

The term photography itself derives from the Greek words *photos* (light) and *graphos* (writing). Though Daguerre is credited with developing



quired to restrict movement during the excruciatingly long exposures.

It did not take long, though, for advances in cameras, lenses and recording materials to extend the practicality of photography. By the 1850s, exposure-making was nearly instantaneous—in daylight—thanks to a new light-sensitive material called wet collodion, discovered by the British sculptor F. Scott Archer.

Quick exposure doesn't mean that photomaking was easy: A heavy glass plate had to be sensitized in liquid chemicals then exposed in the camera while still wet—all of this in the dark. Next, the exposed plate had to be developed immediately. For photographers in the field, this meant having to haul a darkroom full of heavy materials on the road.

It was under such burdensome conditions that Matthew Brady, America's first photojournalist, captured his compellingly graphic images of the Civil War.

### American Ingenuity

It took a young bank clerk named George Eastman—another basement tinkerer who'd been bitten by the photo bug—to really put photography on the move.

By 1879, working in his mother's kitchen in Rochester, New York, Eastman had simplified the wet-collodion process with "dry" plates—that is, presensitized glass plates that could be stored for spontaneous loading and exposure, then developed at leisure. Still, the plates were heavy and delicate glass, and had to be exposed one at a time. Eastman didn't believe a pack-horse should be a necessary photo accessory.

His next product, introduced in 1885 and a revolution in itself, was a dry, lightweight, multi-exposure roll of chemically sensitized paper. Since cameras of the day were equipped to



MINOLTA MAXXUM: PM PHOTO BY BRIAN KOSOFF

Cameras have kept getting easier to use over the years. The 1952 Asahiflex (right) was the first practical single-lens-reflex 35mm camera with through-the-lens viewing. Minolta's 1985 Maxxum brought autofocus to SLRs.



shoot only plates, Eastman had to conceive a new design: Enter the Kodak roll-film camera of 1888.

The name Kodak, meant to be pronounced easily in any language, reflects the hands-on simplicity of the camera. All the user had to do was pull a string to cock the shutter, turn a key to advance the film, point the lens at the subject, and press a button to shoot the picture.

### "You press the button . . ."

The Kodak measured about 3.5 in. square  $\times$  6.5 in. long and weighed less than 2 pounds. It cost \$25—nearly twice the price of a man's suit then—and came loaded with 100 exposures. When the roll was exhausted, the owner mailed the entire camera and \$10 to the factory. Return mail

brought a treasure of 2 $\frac{1}{4}$ -in.-dia. circular prints and a camera reloaded with another 100 rounds. The Kodak lived up to its advertising slogan of "You press the button, we do the rest."

By 1900, Eastman had replaced light-sensitive paper rolls with film as we know it today. And, he had introduced the Brownie camera—at \$1. Though intended for kids, the Brownie's simplicity and low price opened the world of photography to the masses, becoming the first true "volks-camera." Meanwhile, the graphically superior film-based recording medium put photography on the fast track to technological improvement.

### The better mousetrap

One great idea spawns another, and Eastman's continuous-roll film inspired Thomas Alva Edison to invent the kinoscope, or motion-picture camera.

"Movie" film—at 1.5 in. or 35mm wide—was narrower than that used in still cameras. In 1912, a Missourian named Guy Smith envisioned a small, still camera that would use 35mm film pierced at the edges by sprocket holes—the film-advance method still used today. The next year, the first working prototype of the 35mm Leica

(Please turn to page 114)



BRADY: THE GRANGER COLLECTION

Matthew Brady (inset), America's first photojournalist, recorded Lincoln and Civil War.



# FIREBREATHERS

Totally awesome tunnel boats with candy colors and stiletto hulls look California cool while running 70-mph hot.



BY JOE SKORUPA, Boating/Outdoors Editor; PM Photos by Rich Cox

**T**HE DESERT SUN climbs over the dusty, boulder-studded mountains like a fireball threatening to set Southern California ablaze. In a few hours it will be 102° along the shore of Lake Elsinore, but right now the feeling is decidedly cool—California cool.

Four West Coast warriors—high-performance tunnel boats with twin slots running the length of their hulls—are lined up on the ramp ready to launch. The first boat, a 20-footer equipped with a 200-hp Suzuki Exante outboard, is dropped in the water and ready to go. I take it out for the first high-speed run of the day.

Mist still hangs over the middle of the lake and the ripple-free surface is as smooth as glass. I cruise to the start of the designated high-speed zone and press the pedal to the metal. Engine torque surges through the steering column and the speedo begins to climb.

At 50-percent trim the gauges read 5000 rpm and 62 mph. I push the trim higher and the rpm gauge hits the redline mark, 5600. The speedo reads 69 mph. At maximum trim, the engine revs past the redline and the speedo flickers at 71 mph. To avoid over-revving and overheating, I back off the trim.

But for an instant, with the wind ripping at my face and the hull bouncing on the water from chine to chine, I could feel the exhilarating adrenaline rush of the high-speed boat racer and almost understand the philosophy many of them live by—life begins at 70 mph.

For this head-to-head comparison test, the PM test team brought together four of the West Coast's hottest custom boat builders. Over three days, two at Lake Perris and one at Lake Elsinore, we subjected the fleet of supersleek, 20-ft. tunnel boats to a battery of tests. The boats, which have an unlimited hp rating and are



**PM**  
**COMPARISON**  
**TEST**



Fleet of hot-rod tunnel boats blisters Lake Perris (left to right): 20 Caribbean Tunnel, Avenger 203 Outboard, Baker RST and Eliminator 20 SS Tunnel. Cooling down between runs (below) are the Baker and Caribbean, both equipped with Suzuki's V6 Exante outboard.





## FIREBREATHERS

capable of speeds in excess of 90 mph, were equipped with Suzuki's high-tech 164-cu.-in., oil-injected outboard engine. We ranked the boats according to their ability to handle well at full throttle and to turn heads at idle speed. Here's what we found.

### Avenger 203 Outboard

You can have it all—speed, comfort and sexy good looks. The Avenger decisively beat the fleet in acceleration time and cockpit stowage space. It was second in top-end speed, total cockpit area and fit and finish.

It also tied for first in hull construction, due to a full-length wooden stringer system, flotation in tunnel pods and molded-in splash well.

In categories where the winner finished lower than second, performance-course time (third) and foredeck stowage space (fourth), it wasn't far from the leaders.

One of the test team's biggest surprises was how well tunnels handled the performance course—full-throttle left, right and 180° turns plus two short sprints. Instead of sliding, as we expected of essentially flat-bottomed hulls, the winner behaved with precision and carved turns tight enough to pin us against the gunwales.

The Avenger was equally sure-footed on top-end runs, where it al-



BAKER RST

lowed the driver to go to maximum trim without any hint of instability.

Beyond high performance, the Avenger has a cockpit that easily accommodates seven passengers and the fleet's only flat deck. The others have decks that rise and fall with the contours of the tunnel slots. Features of note are cavitation plates on transom, built-in ski locker, and gel coat with five colors and a fade (shading that goes from dark to light).

The only nits to pick are a ski pylon that rattled annoyingly and a throttle control jammed against the driver's seat. Both problems are correctable

and don't diminish the winner's achievement as a superb pleasure craft with a high-speed heart.

### 20 Caribbean Tunnel

With first-place finishes in top-end speed and performance-course times and second in hole-shot, the Caribbean was a driver's favorite. Its blistering top-end of 61.5 mph decisively smoked the other boats.

The Caribbean finished well in hull construction (tied for first) because of a full-length wooden stringer system and drag-reducing profile.

Although the brilliant gel coat,

#### TEST PARAMETERS

Each boat was propped and tuned by technicians from Suzuki. Speed and timing figures are the result of averaging four test runs for each boat with two adults aboard and matched fuel loads. Performance course began from a dead stop and included full-throttle sprints and 90° and 180° turns.



OVERALL RANKING/MAKE/MODEL	1. AVENGER 203 OUTBOARD	2. 20 CARIBBEAN TUNNEL
LOA/Beam/Weight/Fuel Capacity	20'1"/89"/1250 lb./28 gal.	20'83"/1200 lb./32 gal.
Top End (mph)/Ranking	60.88/2, aggressive and stable at speed	61.5/1, leaves the water steaming
Acceleration 0-40 mph (sec.)/Ranking	6.81/1, leaps on plane at touch of throttle	7.73/2, spirited and responsive
Performance Course (sec.)/Ranking	22.95/3, not far from the leader	22.49/1, standout cornering and handling
Cockpit Space (sq. ft.)/Ranking	43.26/2, loads of legroom, spacious	36.67/4, adequate but smallest in fleet
Cockpit, Foredeck Stowage (cu. ft.)/Ranking	29.01, 71.37/2, lots in cockpit where it counts	9.22, 73.30/4, missed opportunities in cockpit
Hull Construction/Ranking	Stringer system and flotation in pods/1 (tied)	Good stringer system and flotation/1 (tied)
Fit and Finish/Ranking	Fleet's only flat cockpit deck/2	Ski pylon, battery access cause problems/3 (tied)
Price As Tested (including Suzuki engine)	\$19,000	\$18,000
Address	Cee Bee Mfg., Avenger Boats, 11511 Bellinger St., Lynwood, CA 90262, (213) 537-0073	Hardin Marine, 1655 S. Claudina, Anaheim, CA 92805, (714) 535-3640



Each hull in the test featured a similar twin-slot, mod-V configuration.

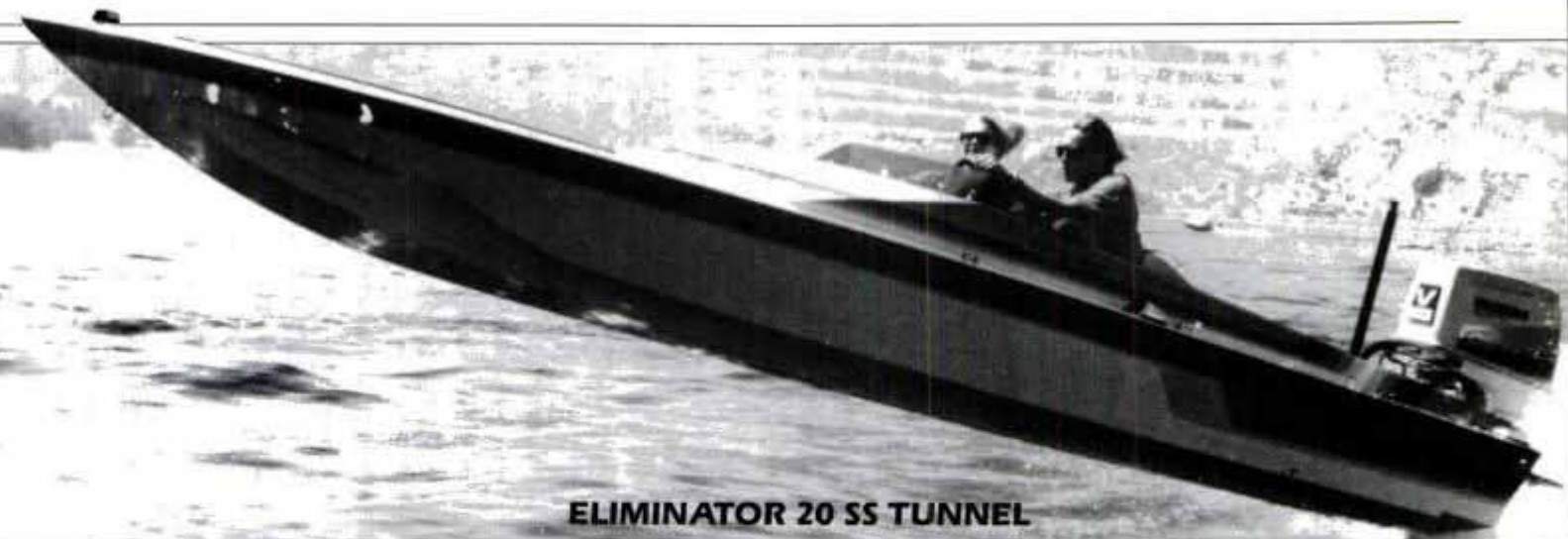


Instruments are angled to driver and easy to read, but throttle is tight against seat.



Left-side wheel features foot pedal and 3-position transmission shifter.





## ELIMINATOR 20 SS TUNNEL

which features six colors and a fade, and rich upholstery demonstrate superior craftsmanship, certain details could be improved. The Caribbean had the fleet's smallest cockpit, tightest seating and skimpiest cockpit stowage space, although it features an immense area below the foredeck. (So do the others.)

Fit and finish suffered because it required serious screwdriver work to reach the battery (a hinge and a latch would help) and the seats, although nicely upholstered, were narrow and low backed. Also, the Caribbean would benefit by having a venturi-

type windscreen to prevent rogue waves from coming over the low bow. One driver was temporarily blinded this way during testing.

Among the many outstanding features were lefthand steering with foot throttle (enabling driver to keep both hands on wheel), four handy side pockets in the cockpit, a lever to open the fuel fill, and a competition-type steering wheel position indicator.

### Eliminator 20 SS Tunnel

Voted best dressed by the test team, the Eliminator led the fleet in fit and

finish and total cockpit space. It was second in total foredeck stowage space and overcame back-of-pack rankings in hole-shot and top-end speed to finish a strong second on the performance course.

It features such outstanding design elements as roomy, high-backed seats, left-side mounted steering wheel with foot throttle, two cockpit stowage pockets, and a large forward ski locker.

In addition, it was the only boat in the fleet to feature bronze anodized cleats, courtesy handles and instru-

*(Please turn to page 99)*



#### 3. ELIMINATOR 20 SS TUNNEL

20'6"/96"/1400 lb./40 gal.  
57.63/4, nose tends to float at speed  
8.25/4, heavy hull may have held it back  
22.91/2, handles sharpest turns at full throttle  
43.76/1, well laid out and roomy  
15.05, 77.95/3, side pockets help out cockpit  
No stringers or flotation, some foredeck flexing/3  
Best dressed with swim steps, metal trim/1  
\$20,000

Eliminator Boats, 10795 San Sevaine, Mira Loma, CA 91752, (714) 681-1222

#### 4. BAKER RST

20'1"/86"/1270 lb./32 gal.  
59.0/3, no misbehavior or instability  
7.97/3, good, but requires deep negative trim  
24.05/4, off pace due to excessive cavitation  
38.75/3, room to stretch legs  
20.95, 81.56/1, huge foredeck compartment  
No stringers but has flotation/2  
Some glitches, but better than most/3 (tied)  
\$18,750

Baker Boats, 1230 N. Grove, Unit B, Anaheim, CA 92806, (714) 666-1030

### SPEAKING OF POWER

All test boats were equipped with Suzuki's punchy 200-hp Exante V6 outboard, which features Comlink, the industry's first talking motor. Although this voice-communicated system, which replaces familiar engine warnings, received a lot of attention when it was introduced earlier this year, other outstanding features include oil injection, loop charging, an over-rev limiter, dual water intakes, I.C. ignition and a long list of the bells and whistles that high-tech Suzuki engines are noted for. We found the 164-cu.-in. outboards, which cost approximately \$9500, to be highly responsive and reliable performers during our three days of testing. Suzuki America is based in Brea, California.



Low windscreen and bronze anodized aluminum trim are standout features.



Speaker for Comlink is mounted near wheel for best sound transmission.



# OUR MOST SECRET FIGHTER



The wraps are slowly coming off one of the best kept military secrets of all time—the Air Force's Stealth Fighter.

BY NICK NICHOLS; PM Illustration by Attila Hejja

Ellington eased back on his stick and punched up full afterburners. The Frisbee's engines could only give him Mach 1.3, but this was the place to use all the power he had. Now the Frisbee was vulnerable. No longer lost in the ground clutter, her engines radiating their maximum signature, the Stealth aircraft was broadcasting her presence.

His right thumb toggled the launch-enable switch, and his forefinger squeezed the trigger twice. The Sidewinders left the aircraft half a second apart. Both missiles angled for the Mainstay's starboard wing. Thirty feet away from the target, laser proximity fuses detonated, filling the air with lethal fragments.

*Both of the Mainstay's right-side engines exploded, the wing came off, and the Soviet aircraft began cart-wheeling violently downward, lost seconds later in the clouds. It all worked, the F-19 really did surprise them.*

**I**N THIS EXCERPT from the techno-thriller *Red Storm Rising*, author Tom Clancy graphically profiles the mission scenario of a Stealth Fighter at work. But how much of Clancy's prose is fact and how much is merely a flight of literary fancy?

As this issue of POPULAR MECHANICS went to press, official spokesmen for both the Air Force and Lockheed Corp. (alleged developer of the so-called F-19 Stealth Fighter) issued a terse denial of the existence of the





America's supersecret F-117A Stealth Fighter closes in on a target and fires a Maverick air-to-ground missile.

supersecret jet—their wording was, not surprisingly, identical: “We have no knowledge of such a program.” However, Defense Secretary Frank C. Carlucci registered a tacit admission of the craft’s existence when he recently told a gathering of test pilots, “Not since the Manhattan Project have we seen a program cloaked in such secrecy . . .” This achievement in defense security is all the more remarkable when one considers that many thousands of Lockheed employees (as well as those of numerous subcontractors) and Air Force personnel have been involved in this hush-hush program since its inception nearly 15 years ago.

This airtight veil of secrecy came very close to being lifted on October 4, 1988, as Senator Chic Hecht of Nevada prepared for an afternoon media briefing in which

he planned to release certain technical details along with an illustration of the heretofore ethereal bird. The morning edition of *The Washington Times* scooped the Republican lawmaker by publishing contents of a Pentagon-generated draft press release. For reasons which remain unclear, a chagrined Hecht was collared by the Pentagon at the last minute and firmly advised to cancel his news conference. Hecht complied, and the Stealth Fighter slipped back into the murky depths of clandestine Special Access, or “black,” programs.

In spite of DOD’s 11th-hour about-face, Hecht insisted that his aborted news conference was predicated on Pentagon assurances that release of program details was imminent, serving to confirm that the aircraft existed. According to an October 10 editorial in the highly



## OUR MOST SECRET FIGHTER

respected—and customarily conservative—*Aviation Week & Space Technology*: “The Air Force’s abrupt about-face last week on plans to unveil the Lockheed Stealth Fighter and the ensuing public relations scramble to stuff the cat back in the bag left no doubt as to the aircraft’s existence.”

So we began our own quest for the elusive Stealth Fighter. More than a tale of technological intrigue, the story of Stealth turns out to be one of the great mysteries of our time.

### Shades of gray

Where national security is concerned, there is a fine line between investigative reporting and espionage, and the public’s right to know must occasionally be tempered by the Pentagon’s right to privacy on certain sensitive issues.

But the Stealth Fighter project—originally hatched by Lockheed’s top-secret “Skunk Works” in 1974—could hardly be said to reflect the state of the art in low-observables design and materials, so the well-worn “national security” defense for continued confidentiality becomes rather dubious.

As one Pentagon source expressed it: “The [Stealth] fighter is over a decade old and represents first-generation technology. We’re now well into development of second- and perhaps third-generation Stealth with the B-2 (Stealth Bomber), ATF (Advanced Tactical Fighter) and ATA (Advanced Tactical Aircraft). And it really doesn’t make much sense to let people see the B-2, which is, in fact, a more sophisticated airplane, while keeping the fighter under wraps.”

An additional motivation for disclosure may have been Pentagon concern that a class-action suit being pursued by Skunk Works employees over industrial health hazards threatens to compromise the Stealth program in any case. By taking the wraps off now, Defense Department officials would short-circuit any unauthorized disclosure, thereby rendering the project “gray” and allowing them to control exactly what details were revealed.

According to Tim Weiner, a *Philadelphia Inquirer* reporter whose coverage of black programs earned him a Pulitzer Prize, “The decision to go public was apparently politically motivated. Jimmy Carter unsuccessfully ran the same gambit in 1980 by publicizing his support of Stealth technology and the ATB program. Some commentators criticized Carter for jeopardizing national security for political ends. This time around, it was the Dems who cried foul, and forced

the Pentagon to back off.

“On the other hand,” Weiner posited, “once a black program has been defrocked, the military has to start answering a lot of uncomfortable questions about cost and performance.”

### A wraith materialized

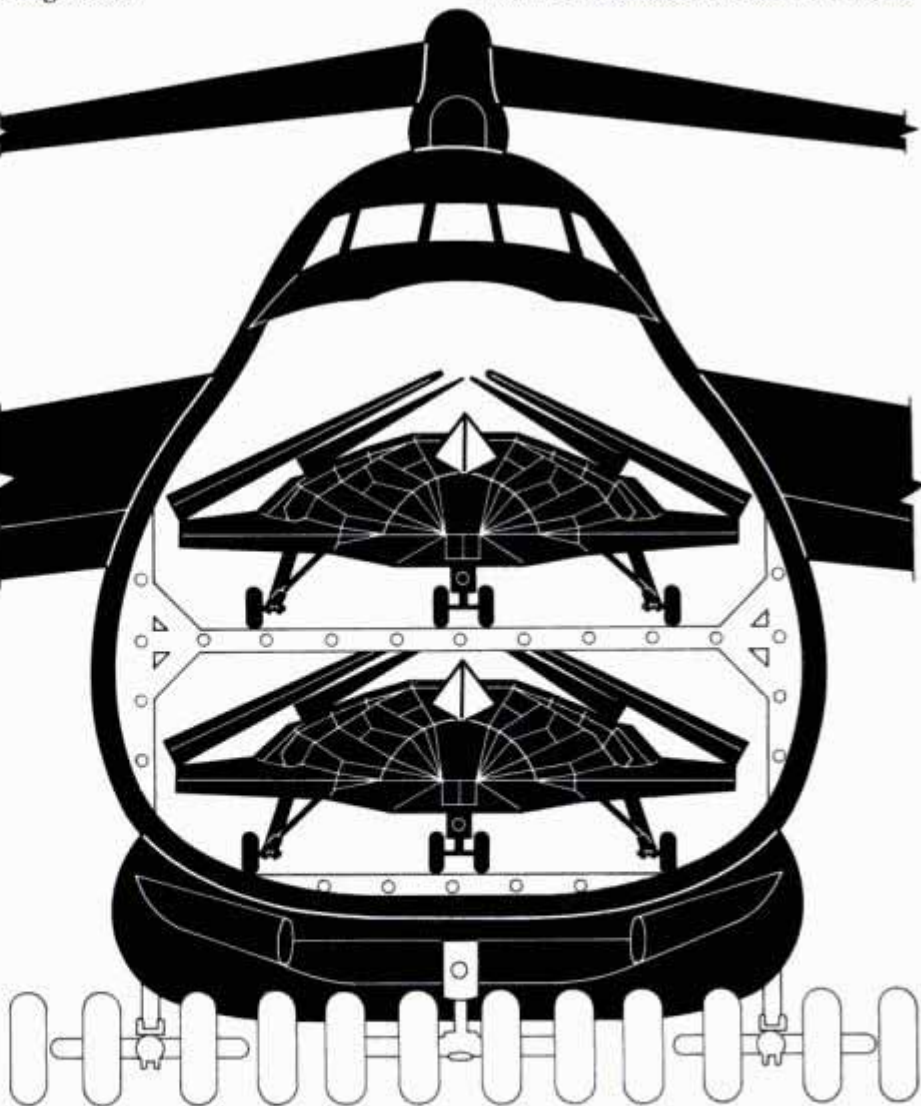
Whatever the reason for this abrupt retreat into the protective cocoon of silence, the Pentagon had definitely gotten our attention. We were fascinated by the sketchy details revealed in the text of the premature press release. Could these particulars be verified? We intended to find out.

The leaked document indicated that the formal Air Force nomenclature for the aircraft, long thought to be F-19, is, in fact, F-117A. The price per copy was quoted at approximately \$60 million, and perhaps most interestingly, the F-117A was described as being “boxy” and “angular” in conformation as opposed to the sleek, curvaceous artists’ impressions that have cropped up in the pages of numerous magazines.

We easily validated the F-117A designation with several unrelated sources whose high-level positions in the aerospace industry prevent disclosure of their identities.

One persistent mystery these clues helped to solve is that of the number of F-117As produced to date or still “in the pipeline.” Based on close scrutiny of Lockheed’s annual reports, Wall Street analysts had previously tagged the Stealth Fighter as a \$4 billion program. As this figure does not include the various prototype birds built under the XST (experimental, stealth, tactical) research initiative, a bit of arithmetic reveals a total run of approximately 67 production units, or one wing of operational aircraft.

This number is also borne out by an analysis of the production period. Startup was authorized sometime during 1981, and according to noted aerospace author and Stealth expert Bill Gunston, who claims to have been made privy to much highly classified Stealth-related data from Lockheed, “The production line is now closed. Lockheed delivered the last bird more



One mission scenario: Palletized F-117As and stores are deployed aboard C-5B Galaxies.



than a year ago." A 6-year production period would equate to an annual yield of about a dozen units. For purposes of comparison, the SR-71 Blackbird—larger and more complex than the F-117A—was produced by the same company at a rate of eight units per year.

Some sources have said that a wing of F-117As is already operational in a high-security section of Nellis Air Force Base near Tonopah, Nevada, and that one of the Stealth Fighters crashed in the California desert about two years ago while on a training mission. This all appears to be true. After the crash, an incredible security blanket was placed on the whole incident. No media were allowed anywhere near the crash site and few details were given other than there had, in fact, been a crash.

In October, several pilots from Nellis, who have apparently flown the plane, attended the Air Force Assn.'s national convention in Washington, D.C., and reportedly spoke fairly freely to associates about the aircraft's handling characteristics. Thus, a Nellis base for the F-117A looks more correct as time passes. But at least a portion of the F-117A fighter wing may not be quartered there.

"I have it on good authority," offers the U.K.-based Gunston, "that the Stealth Fighter has been seen flying here in England!" Other Stealth spotters have placed the aircraft over Eielson Air Force Base outside of Fairbanks, Alaska.

### What it looks like

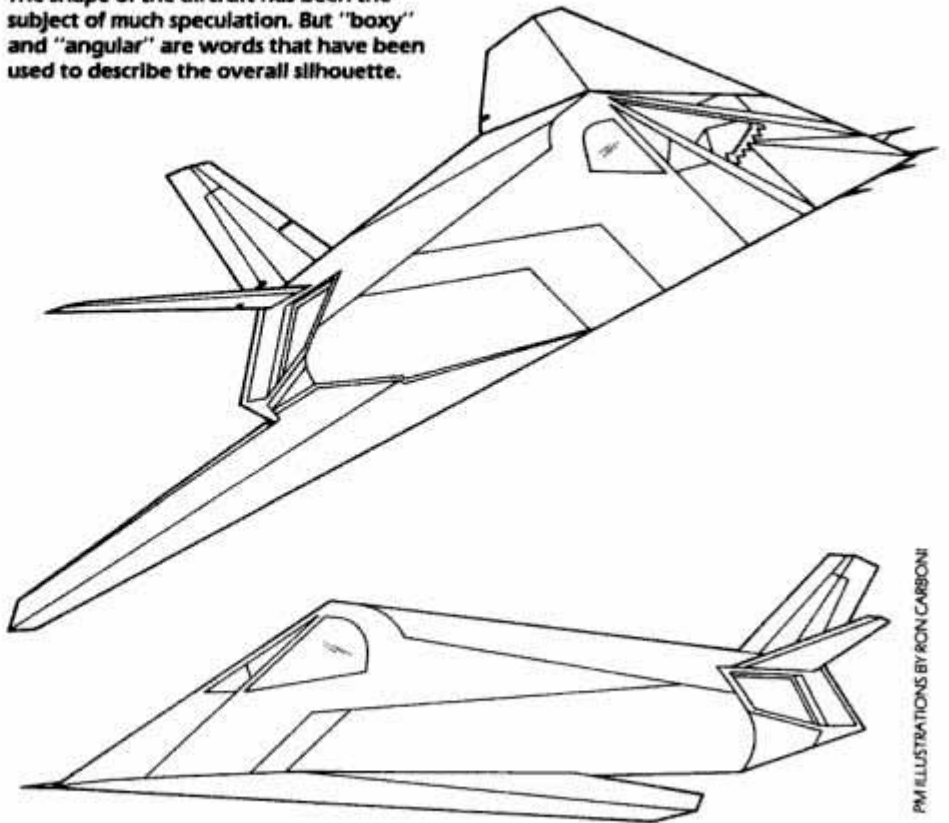
Bill Sweetman, technical editor for the trade journal *Jane's Defense Weekly* and author of *Stealth Aircraft: Secrets Of Future Airpower*, has taken a particular interest in the F-117A's physical characteristics.

According to Sweetman, the F-117A is a very unconventional-looking aircraft. "Over the years, I've recorded the impressions of a number of eye-witnesses, but they've been something akin to the blind men and the elephant: Everyone 'sees' something different," he mused. "One report likened the F-117A—when viewed from directly above—to a pair of pine cones placed end to end, one a little larger than the other, while others have noted a remarkable similarity between the Stealth Fighter's planform and that of the Space Shuttle. Now, these two disparate accounts would hardly conjure up images of a highly sophisticated airplane, but they are both, in fact, very accurate.

"The reference to 'boxy' and 'angu-

## F-117A Stealth Fighter

The shape of the aircraft has been the subject of much speculation. But "boxy" and "angular" are words that have been used to describe the overall silhouette.



PM ILLUSTRATIONS BY RON CARBONI

lar,' as it appears in *The Washington Times* article, is very difficult for most people to conceive. It doesn't fit their concept of a 'modern' design. But, in fact, it corresponds very closely to a detailed description I extracted from an individual who definitely knows what he's talking about."

The angular shapes referred to are elongated RAM (radar-absorbent material) tiles fitted all over the fuselage in an arrangement called faceting. Their angles are carefully calculated to scatter radar waves away from the aircraft, preventing them from returning to the source. There are a number of very effective RAM products currently available in tile form, like Plessey's LA1 material, which weighs a scant 0.6 lbs./sq. ft.

This "all-aspect" stealthiness is a prerequisite for a strike aircraft with a deep-penetration mission. In this scenario, the application of low-observable attributes must take into account the position of the aircraft in relation to all potential enemy search radars—whether airborne, land-based or bistatic.

While radar-defeating facets may be the F-117A's most prominent feature, the aircraft has other unconventional aspects that make it one of the most intriguing airplanes of all time. The single cockpit is set well forward with a canopy that blends in with sur-

rounding hexagons. The provisional length is somewhere between 55 and 60 ft., with a 32-ft. wingspan. We have it on good authority that the F-117A's General Electric F-404 high-bypass powerplant produces 12,000 pounds of thrust, hurling this 40,000-pound airplane along at a speed of Mach 1 plus.

Sweetman surmises that the Stealth Fighter enjoys a combat radius of nearly 800 nautical miles, nearly twice the range of the F/A-18 Hornet, which is comparable in size, weight and engine type to the F-117A.

He draws this conclusion based on several accounts that the F-117A was considered—and rejected—for a role in America's 1986 retaliatory strike against Libya. For instance, deploying the aircraft to a base in Sicily, and sending it to Libya and back, would make 800 nautical miles a reasonable figure.

The F-117A's extended range is, says Sweetman, a byproduct of the aircraft's unusual design. Since the Stealth requirement calls for everything from engines to ordnance stores to be internally arranged, the somewhat massive fuselage offers a good deal of surplus internal volume for fuel cells.

To these facts Bill Gunston adds, "In a mid-altitude strike-reconnais-

*(Please turn to page 118)*





# LEXUS TECH

Toyota plans a sci-fi assault on the luxury-car market.

BY LEN FRANK, West Coast Editor

**I**N THE PAST, Toyota has had a whole range of models called Crown and Corona, but now, when the company is readying a car that really does crown the corporation, those superlatives are used up. What to do? Understate and add elegance.

There will be two distinct Lexus sedans. The entry-level car—ES 250—is based on the Camry, and should be a comfortable if not terribly exciting car to drive.

The senior Lexus—LS 400—is Toyota's new flagship, the car that's expected to help expand Toyota's reputation for high technology.

The LS 400 is a front-engine, rear-

drive, unit-bodied 4-door sedan, about the same size, class, general shape and configuration as a Mercedes-Benz 300E or BMW 5-series.

Like its German competitors, the Lexus has all-independent suspension, 4-wheel disc brakes, ABS, a driver's-side air bag, a 4-speed auto-

Lexus LS 400 will be new division flagship.







the torque curve that sets this engine apart. The Lexus V8 makes 260 lb.-ft. at 4400 rpm, with at least 90 percent available from 1300 to 5600 rpm.

The automatic transmission has electronic controls that reduce engine torque during shifting to smooth the transition from gear to gear, a feature Lexus will share with the new Cressida. The hydraulic clutch pressures are also electronically controlled—a first—which allows shifts at full throttle to be smooth and part-throttle shifts to be all but unnoticeable, without allowing undue slippage.

Another feature of this transmission is an electronic feedback loop designed to provide smooth shifts for the life of the car by varying clutch pressure.

The LS 400 has double wishbones at all four corners, à la Supra, but developed specifically for this car. Coil springs are standard, but an optional air suspension has been developed with electronic control of both the air spring rate and shock damping. Provision has been made for electronic control (through air-pressure variations and shock valving) of pitch, bounce, dive, squat, roll and ride height. Sensing is done at each wheel, independently. There is also a provision for cockpit adjustability.

The rack-and-pinion steering has speed-sensitive variable assist. Goodyear has developed a special Eagle (205/65R15) tire claimed to be quiet, smooth-riding, with low rolling resistance and high cornering ability.

Toyota has paid special attention to the normal process of deterioration. The feedback loop in the transmission and close tolerance control in the engine have already been noted, but there is also anti-aging control of the rate at which the various materials in the interior fade, corrosion-resistant steels, special paint finishes—anti-chipping paint on the underbody,

*(Please turn to page 97)*

matic transmission, and electronic fuel injection. And after those easy comparatives, the LS 400 is its own car, advanced and unique.



4.0-liter 4-cam V8 makes 250 hp at 5600 rpm.

The engine is a 4.0-liter light alloy V8 with two cams per bank. The valves—four per cylinder—are set into a very compact, modified pent-roof combustion chamber with central plug and 10.0:1 compression. The pan is used as a block girdle, to stiffen the main bearing webs, and the pistons run in cast-iron wet liners. The intake cams are driven by a single Aramid fiber-reinforced toothed belt with the exhaust cams driven off the intakes by Toyota's clever scissors gears.

Although tuned intake runners aren't really new, Toyota has achieved exceptional results here, particularly in midrange torque. Peak output is 250 hp at 5600 rpm, but it's



The ES 250 will be the Lexus entry-level model. Sleek new skin covers Camry mechanicals.





# VIDEOPHONES

A quarter-century after its unveiling, the videophone has found a home. Your home.

BY FRANK VIZARD  
Contributing Editor

**F**LASH GORDON confronted the villainous Ming the Merciless via videophone in the 1930s' serials bearing his name. Thirty years later, visitors flocked to New York to see AT&T's "Picturephone" at the 1964 World's Fair. In the quarter-century since the fair, the videophone concept has been introduced in fictional settings ranging from the "The Jetsons" cartoons to the "Star Trek" television series. The videophone is a machine firmly embedded in the American psyche.

While we've always seen the videophone in our mind's eye, it has been frustratingly elusive to develop in reality. Indeed, the product Americans imagine—a voice phone displaying a

full-motion video image—is still some years away. In the meantime, we can see a black-and-white still image of ourselves that is transmitted over existing telephone lines in under 10 seconds—and costs no more than a conventional phone call. No special wiring is required. The videophone connects to the modular phone jack in your wall, and your telephone in turn jacks into the videophone. You'll need an electrical outlet nearby, to power the videophone's TV and electronics.

Mitsubishi and Sony are the first companies to offer consumers a working videophone. Panasonic and other brands are likely to be on the market in the near future, thanks to a technological standard recently set by Ja-





# COME OF AGE

pan's Telecommunications Technical Committee (TTC). To test the standard and the products themselves, POPULAR MECHANICS examined the first two videophones on the market, Mitsubishi's Visitel LU-500 (\$400) and Sony's PCT-15 (\$500).

## How they work

The videophones coming on the market today all use the same operating principle to transmit an image. Your picture is taken by a tiny black-and-white camera mounted in the videophone adjacent to the display screen—where your image is frozen. An analog-to-digital (A/D) converter changes each pixel, or picture element, into a numerical representation

of various shades of gray. This digital information is stored in a DRAM (dynamic random-access memory). When you press the SEND button on the videophone, a second microprocessor routes the digital data stored in the DRAM through a modem designed for videophones.

At this point, the digital data is converted to an audible tone whose frequency is 1748 Hertz. As the tone passes through the telephone lines, the modem varies the amplitude of the tone to correspond to the varying levels of gray in the original picture. During transmission, you'll see your image slowly disappear from the screen, starting at the top and working toward the bottom. Transmission

is completed when your still image vanishes from the screen.

During reception, this process is simply reversed—except that the incoming still image you see on your screen has been stored on a DRAM in your videophone, making it cruder than a live camera image.

The TTC standard dictates that a videophone must be able to transmit a minimum of 16 shades of gray. In practice, videophone makers are likely to exceed that minimum. The degree to which each manufacturer exceeds it is one factor that will distinguish one videophone from another. The more shades of gray repre-

You can send and receive black-and-white still pictures through conventional telephones and voice lines with videophones such as Sony's \$500 PCT-15 (left) and Mitsubishi's \$400 Visitel LU-500 (below).



VIDEOPHONE PHOTOS BY HING/NORTON.  
FLASH GORDON/MIING THE MERCILESS. ORIGINAL STUDIO STILLS HAND-COLORED BY LARRY SULLIVAN.



## VIDEOPHONES COME OF AGE

sented, the better the picture will be.

Shades of gray, however, are not the only apparent difference between videophones. An examination of the Mitsubishi and Sony models revealed differences in picture tubes, picture size and external outputs.

### Mitsubishi Visitel LU-500

Mitsubishi's videophone is the model with the longest track record since it is basically derived from an expensive technology introduced to business users in 1986. While designed around the 16 shades of gray minimum-standard set by the TTC, Mitsubishi uses what the company calls "contouring" circuitry to achieve a 32-level effect. Contouring circuitry aside, the LU-500 offers few features.

Picture size is 3¼ in. high × 2½ in. wide, a display meant to accommodate the vertical proportions of faces. To the right of the 4½-in.-diagonal display screen and hidden by a sliding door is the video camera. Opening the sliding door automatically turns on the videophone.

User controls on the LU-500 are minimal. Two buttons on the far left control eight brightness levels, so that you can adjust the picture in relation to the light levels in the room. The VIEW/POSE button, in the middle, lets you see a live picture of yourself and the three images you're able to store in the machine's memory. You can transmit any one of these by pressing the SEND button on the far right. Transmission time is 5½ seconds. The three images in memory are stored on a first in-first out basis. The whole package measures 6¼ × 6¾ × 7 in. in size.

### Sony PCT-15

While Mitsubishi's videophone is cube-like in shape, Sony's PCT-15 has a taller, more rectangular aspect, measuring roughly 6 × 11 × 6 in. in size. The display screen is about the same size as Mitsubishi's but its height-width proportions are reversed. The video camera is also positioned differently, being above the display screen.

The Sony PCT-15 is also different in more fundamental ways. Key among these is a second mode of picture-transmission style. Mitsubishi's vertically oriented picture conforms to the TTC standard. The Sony PCT-15 transmits and receives the same vertically oriented picture in what Sony calls the "quick" mode.

Gray masking bars on each side of the horizontal display screen frame the content of the "quick" picture. Transmission time is 6.5 seconds.

What Sony calls the "normal" mode of transmission fills the display screen with a horizontally aligned picture. The larger picture can be transmitted in 10 seconds. In either mode, the PCT-15 is able to offer a sharper picture than its Mitsubishi counterpart because it uses 64 levels of gray to create the image.

Choosing between the "normal" and "quick" modes is as easy as pushing a button positioned directly below the display screen. A second button allows you to call up from the machine's memory either the last picture received or transmitted. The Sony PCT-15 doesn't have the 3-picture memory contained in the Mitsubishi.

Additional PCT-15 controls are found below a strip of LEDs indicating operating conditions. These controls include the POWER and SEND buttons. There's also a MONITOR and a FREEZE button to let you alternate between a live picture and a still frame. A camera-brightness control is located on the right side.

The PCT-15 also features three external RCA jacks located in the rear just above the telephone, line input and power jacks. The PRINTER OUT RCA jack allows you to connect the unit to a video printer so that an image can be printed as hard copy. You can also use this output to connect the videophone to a TV or monitor so images can be viewed by a group of people.

The other two RCA jacks let you use the PCT-15 in conjunction with a tape recorder. Images received by the videophone can be recorded on standard audio cassettes for playback

later. Unfortunately, this capability does not make the PCT-15 completely compatible with telephone answering machines. The videophone picture cannot be recorded on tape machines with automatic gain control (such as telephone answering devices and portable recorders) as this defeats the tape recorder's ability to record varying levels of gray. Tape decks such as those in stereo systems must be used.

### Hands-on results

We found the live picture of Sony's PCT-15 superior to that of Mitsubishi's. The LU-500's picture was often accompanied by a solarized, halo-like pattern in the background which, while not affecting the main subject of the image, gave the whole picture a psychedelic feeling.

On the other hand, the live picture you'll monitor on the Sony is not what the party on the receiving end will see. The image stored in the DRAM—visible as the "freeze" picture—is closer to the transmitted image. With both machines, the DRAM picture is coarser and grainier than the live-camera image. Accordingly, neither videophone proved itself practical as a medium for the transmission of printed data. Most printed material took on a mosaic appearance that was rarely legible.

Installation of both videophones is very simple. Points are awarded to Mitsubishi, though, for its attempt to minimize the amount of wiring.

### Future features

Although the Mitsubishi and Sony videophones are the first on the market, they won't be the last. Panasonic, for instance, already plans to offer a 3-model lineup. The WG-R2 (\$400) is a stand-alone unit with a 4½-in. screen, while the KX-TV10 (\$500) combines a 4-in. screen with a telephone handset and speakerphone feature. A third Panasonic videophone incorporates a telephone answering machine that can double as a doorbell answering system when connected to a remote video camera. Visitors can leave a verbal and visual message.

Future models will likely include such features as video inputs for transmitting pictures from a VCR or camcorder. Additional video output jacks would let you route the transmitted image to an optional, accessory video printer, to obtain videophone snapshots. A computer tie-in is yet another possibility. In time, a telephone without video capability might be as hard to find as a rotary-dial phone. But rest assured that an outside party can't use it to spy on you. **PM**



Multifunction telephone is built into Panasonic's \$500 KX-TV10 videophone.



# Mastering The ROUTER

A woodworker's guide to the superversatile router.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor

**O**F ALL THE PORTABLE power tools found in a typical woodworking shop, the router is arguably the most versatile. When fitted with any one of the hundreds of bits available, the router's capabilities are almost endless. Some of the more common uses include cut-

ting cabinet joints such as the dado, rabbet and mortise-and-tenon; trimming plastic laminate; shaping decorative edges; milling moldings and carving signs and plaques.

A wide range of router accessories and attachments are available for turning table legs, cutting machine threads in wood, routing precise dovetails, cutting frame-and-panel doors, and forming letters and numbers. The router can also be mounted upside down in a worktable for use as a small shaper.

Since a router can perform so many different tasks, it's often considered a sophisticated tool by the uninitiated, and therefore, novice woodworkers have traditionally shied away from it. In truth, however, a router is no more difficult to operate than any other portable power tool. In fact, in some ways it's easier and safer than most power tools. All you need is a basic understanding of how the router works and a little practice.





## Getting Started

**A** ROUTER is really a very simple tool. It consists of a high-speed motor fitted into a base. A split-collet chuck secures the bit, and depth of cut is adjusted by raising or lowering the motor in the base. Most routers have a simple toggle ON/OFF switch while others have a more convenient trigger switch.

Routers come in various sizes with respect to power and are rated according to chuck capacity and horsepower—typically ranging from ½ hp to 3 hp. Most routers have a ¼-in. chuck. Larger routers accept bits with ½-in.-dia. shanks. For general woodworking, a 1-hp router with a ¼-in. chuck is adequate. However, if you're using a router primarily as a shaper in a router table, then consider a 3-hp router with a ½-in. chuck.

When changing a router bit, always unplug the tool and—in most cases—remove the base. Some routers come with two wrenches. One is used to hold the motor's shaft from turning and the other wrench loosens or tightens the chuck. Other routers have a convenient shaft-lock button. When depressed, the button keeps the shaft

from turning so that only one wrench is needed to remove a bit. After installing a bit, check to be sure it's held securely before starting the router.



Here's a good, general-purpose router: The Porter-Cable model No. 100. Wingnut locks the base on motor to set the depth of cut.



Some routers require two wrenches for bit changes. Place one wrench on the shaft and tighten chuck with the other wrench.



This Sears router has two convenient features: a stand-up, flat-top housing and a shaft-lock button for 1-wrench bit changes.

## Guided Cuts

**H**ERE are a few simple ways to guide a router to make perfectly straight cuts. The easiest way is to nail or clamp a straightedged board to the workpiece. Then, simply guide the router along the straightedge. To position a straightedge guide, measure from the outside edge of the router's base to the edge of the bit.

To control cuts along the edge of a board, use a piloted bit. Router bits come with a solid pilot or a ball-bearing pilot. While ball-bearing piloted bits cost more, they perform better than solid pilot bits. The pilot rolls against the uncut portion of the workpiece edge to control the cutter.

When you need to rout several identical pieces or a very exact, unique shape, try using a template guide bushing. The guide bushing attaches to the router's base and is used in conjunction with a straight bit and template. Cut the template from ¼-in. hardboard or plywood. Nail or clamp the template to the workpiece and guide the router so that the bushing rides against the template edge. The bit extends below the bushing to cut the work to match the template.

Another accessory that's available for most routers is an edge guide. The adjustable guide fits onto two steel rods that clamp to the router's base. Advance the router with the guide bearing against the workpiece edge.



Guide router against straightedged board that's nailed to workpiece. Allow guide to overhang work to support router at start.



For precise control of edge shaping, use a ball-bearing piloted bit. Bearing rolls along uncut portion of edge to control the cutter.



Guide bushing protrudes from subbase and rides against ¼-in. plywood template. Bit extends below bushing to shape the work.



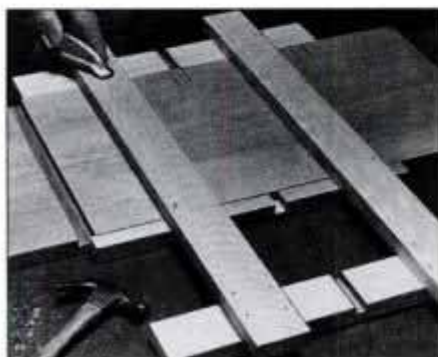
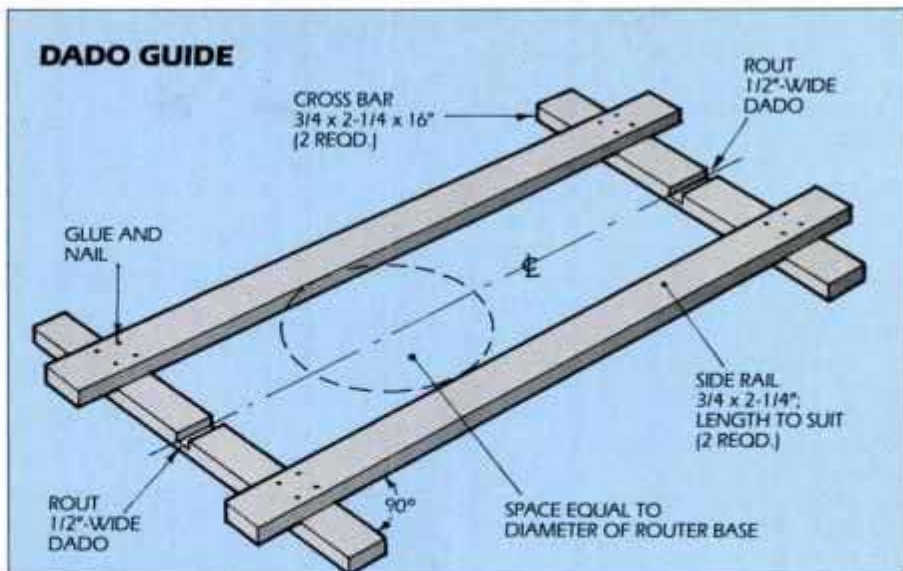
Edge guide accessory mounts on two steel rods that clamp to the router's base. Guide rides against work's edge to control cutter.



## Dado-Cutting Guide

**A** ROUTER is an ideal tool for cutting dado joints. Therefore, we designed this easy-to-make jig that will save set-up time and ensure accurate dados. The jig consists of two long side rails connected by shorter cross bars. Cut the parts from  $\frac{3}{4}$ -in.-thick straight, warp-free boards. Nail and glue the jig together. Be sure that the space between the rails equals the diameter of the router's subbase.

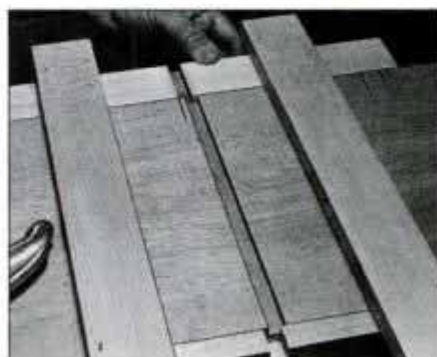
Most dado joints are  $\frac{3}{4}$  in. wide. However,  $\frac{3}{4}$ -in. plywood and particleboard isn't always  $\frac{3}{4}$  in. thick—it's often less which results in loose, sloppy joints if the dado is cut with a  $\frac{3}{4}$ -in.-dia. bit. Therefore, the jig is designed for use with a  $\frac{1}{2}$ -in. straight bit. This way, two passes are made to rout the exact width of the mating piece.



Mark two lines on workpiece to show outside edges of dado. Then, align edge of  $\frac{1}{2}$ -in. channel in cross bar with one of the lines.



Clamp or tack-nail the jig and workpiece to the bench and make the first pass. Scrap strip is in place to prevent splintering as bit exits.



Reposition jig to align the  $\frac{1}{2}$ -in. channel in cross bar with the second line of the dado. Secure jig and rout final pass to form dado.

## Ball-Bearing Pilots

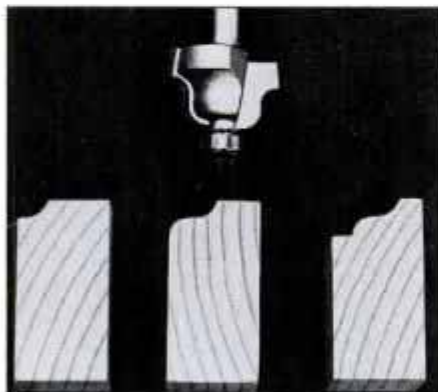
**R**OUTER bits come in a wide variety of sizes, styles and shapes. They're available in both high-speed steel (HSS) and with long-lasting carbide tips. While carbide-tipped bits cost more, they hold an edge much longer than HSS bits.

As mentioned earlier, piloted edge-shaping bits come with either solid—integral—pilots or ball-bearing pilots. When using a solid pilot bit,

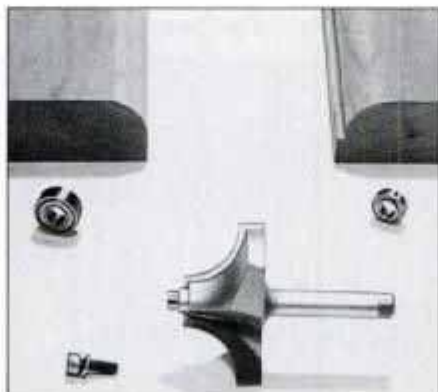
advance the router slowly to prevent friction burns that result from an overheated pilot. Ball-bearing pilots will very seldom burn an edge. However, be aware that they can burn the work if the bearing freezes up. Clean the bearing frequently with thinner and keep it lubricated. This is especially important when trimming plastic laminate. Contact cement and laminate shavings tend to clog and

stall a bearing quite easily.

Some bits, known as arbor-type bits, feature interchangeable cutters. They consist of a shaft, or arbor, fitted with a ball-bearing pilot and locknut. The arbor accepts any of several cutters. Simply place the cutter and bearing on the arbor and tighten the locknut. Usually sold in kit form, arbor-type bits provide an economical way to start a router bit collection.



These three profiles were all cut using the ball-bearing piloted bit shown. Variations are made by adjusting the depth of cut.



Rounding-over bit becomes two bits by changing pilot. Use larger pilot (left) for rounding over, smaller pilot for bead cut.



To trim overhanging plastic laminate, use a carbide-tipped flush-trimming bit. Be sure to keep the ball-bearing clean and lubricated.



## Circle-Cutting Guide

**I**F YOU USE a router just to make straight cuts, it will still be an indispensable tool. However, to increase its versatility make our simple circle-cutting guide.

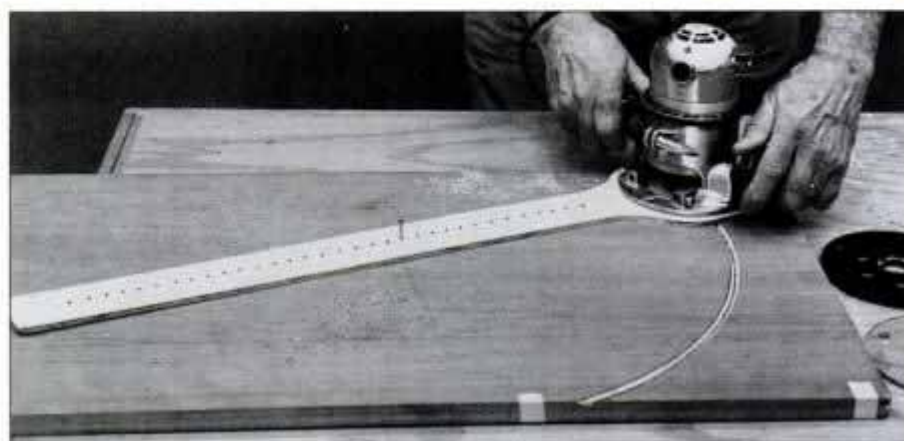
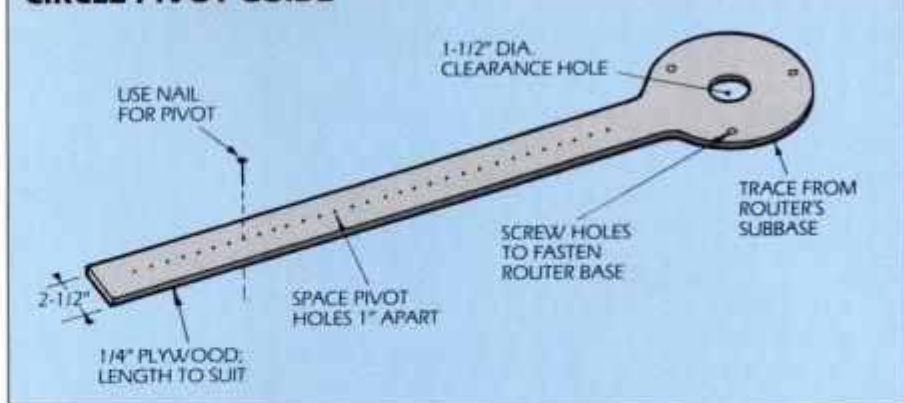
Cut the guide as shown from 1/4-in. plywood or hardboard. The length of the guide is optional, but 3 ft. long is adequate for most work. Cut the circular end of the guide to match the router's subbase. Then, bore pivot holes in the arm spaced 1 in. apart.

To use the guide, first remove the router's plastic subbase and screw the guide directly to the router's base. Use the same screws used to hold the subbase to the base. Then, measure the desired radius and drive a nail through the appropriate hole in the arm.

The nail acts as the pivot point. Start the router and slowly swing the tool into the workpiece. Be certain to keep the work surface clean and free of obstructions to allow the guide arm to slide smoothly. The guide can be used to rout complete circles or any portion of a circle.

As with all other routing procedures, make deep cuts in several passes. Lower the bit slightly after each pass. Use the guide to make circular grooves or cut through the workpiece entirely to form a perfectly round or round-top piece.

### CIRCLE PIVOT GUIDE



Rout circles and arcs with shopmade circle-cutting guide. Guide pivots on a nail driven through a hole in the arm. Note that router's subbase is removed before guide is attached.

## Problem Solvers

**S**HOWN here are a few problems that can occur when routing. Let's talk briefly of how to avoid them. Using a dull bit is a sure way to burn the work. And remember, a high-speed steel bit becomes dull much more quickly than a carbide-tipped bit—especially when routing hardwood and particleboard. For clean, smooth cuts, use only sharp bits.

Splintering can occur when a bit exits the workpiece edge at the end of a cut, or when routing plywood. To prevent tearing the workpiece edge, clamp a wood scrap board to the work. This way, any splintering will occur on the scrap board, not the workpiece.

When plywood is routed across the grain, the veneer often splinters. To avoid this, scribe both sides of the line of cut with a utility knife before routing. This allows the veneer to break off cleanly at the knife cuts without splintering.

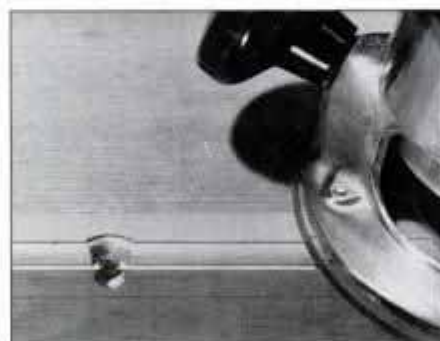
Counterbored screwholes, missing knots and other voids must be filled before routing with a piloted bit. Remember, the pilot rides along the edge. Should it fall into a hole, the bit will gouge the work, as shown.



A dull bit (left) will burn the work and put undue strain on the router's motor. Carbide-tipped bit (right) stays sharper longer.



To prevent splintering when bit exits a cross-grain edge, clamp a scrap board to the edge. This way the scrap splinters, not the work.



Bit's pilot follows the edge and any imperfections, such as this counterbored screw hole. Fill all holes and voids before routing.



Cross-grain routing can splinter the veneer of some plywood. To prevent this, scribe the cut's borders with a knife before routing.



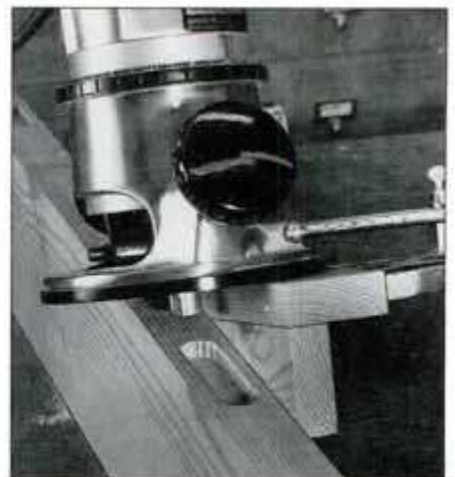
## Quick Tips And Techniques

**R**EMEMBER the importance of feed direction—the direction that a router is moved around a workpiece. The general rule is to always rout against the rotation of the bit. The bit rotates clockwise, therefore, move the router counterclockwise, as shown. This way, the bit spins into the work and pulls the router against the edge. This is the safest, most effective technique, but it does cause splintering occasionally. However, like most rules, there are exceptions.

Sometimes, the router can be fed *with* the rotation of the bit. Caution must be exercised, since the router can run along the edge. Routing with the bit's rotation is useful when trimming veneer, very hard, thin wood or other materials that splinter easily.



For best control and safest working conditions, advance router against rotation of bit. This means counterclockwise, as shown.



A router is excellent for cutting mortises. Attach an L-shaped wood fence to edge guide for extra support and greater control.



Here's a safe, easy way to rout decorative moldings. Shape the edge of a wide board and then rip the narrow molding from it.



Plunge routers are especially useful for cutting stopped dados and slots, as shown. Router is mounted on a spring-loaded base.



With the depth stop set, plunge the router down into the work. Then, advance the router slowly. Note use of straightedge.

## Jigs And Templates

**T**HERE are various aids, accessories, jigs and templates—both shopmade and store-bought—that can increase a router's capabilities.

Some of the most popular accessories available are dovetail templates. These allow you to cut precise-fitting dovetail joints quickly and accurately with a router. Some dovetail templates cut traditional, through-dovetail joints that mirror a handcut joint. Note that the template shown cuts half-blind dovetails. The router is fitted with a dovetail bit and a guide bushing. Clamp the mating workpieces in the template at a right angle. Then, cut the tails and mating sockets at the same time. The joint shown was cut in about a minute.

A router will never replace a planer, but for small surfacing jobs, make the simple planing jig shown. Bore a 1½-in.-dia. hole in the center of a board that's about 6 in. wide × 36 in. long. Remove the router's subbase, insert a ¼-in. straight bit, and screw the router to the board. Clamp the workpiece between two rails. Then, span the rails with the router/board assembly, as shown. Lower the bit gradually to smooth the work.



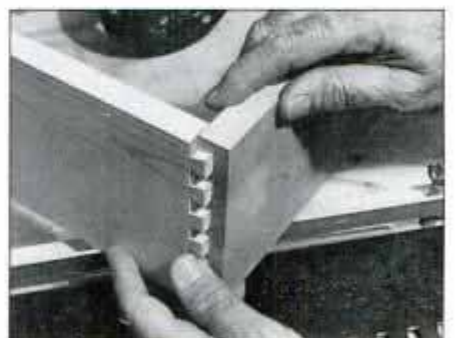
Guide bushing rides along a hardboard template to cut a groove for rolltop desk. Another tough job made easy with a router.



This simple setup turns a router into a surface planer. Router is attached to board that spans the workpiece on two wood rails.



Template allows router to cut tricky half-blind dovetail joints. Router is equipped with guide bushing and dovetail bit.



The router template cuts both the tails and mating sockets simultaneously. The half-blind dovetail joint locks together tightly.







# EASY DOES IT

Our cozy armchair has soft cushions and an adjustable back. Build it and relax.

BY ROSARIO CAPOTOSTO, Contributing Editor

**A**FTER a hard day in the workshop there's little that beats settling down into a soft, cushioned armchair. And, if you've made the chair yourself, it's twice the pleasure. Here's your chance to make your chair and sit in it, too. Our design is based on Mission-style furniture that was commonly produced in the early 20th century.

In contrast to the real thing, we've lightened the proportions to give the chair a more contemporary look and replaced Mission's typical dark oak with warm, easy-to-work pine. Complete with foam cushions covered with white duck fabric, it's destined to become the favorite chair in any woodworker's household.

The chair is made of  $\frac{3}{4}$ -in.-thick stock, with the exception of the framing around the spindles. The  $1\frac{1}{8}$ -in.-thick

stock that you'll need for these pieces is called  $\frac{5}{4}$  stock.

Aside from pine's good looks and workability, we chose it because it's easily available and relatively inexpensive. Although our chair may look like it's made from clear stock, we used ordinary No. 2 common pine and simply worked around the knots.

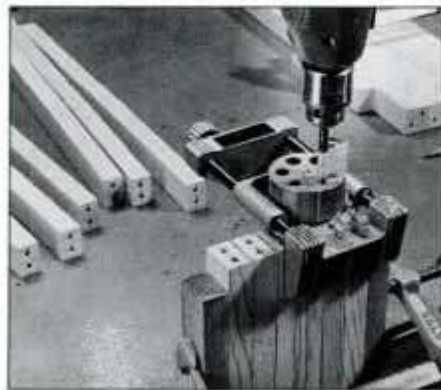
If possible, bring your tape measure and materials list along when you buy the wood and choose boards that will produce the least waste. Then, lay out all the chair components on your lumber so that the knots are avoided and cut each piece oversize.

Color photo: J.R. Rost  
Black-and-white photos: Rosario Capotosto  
Technical art: Eugene Thompson  
Photo stylist: Gabe Herrick

## Start With The Sides

**B**EGIN the side frames by ripping the  $\frac{5}{4}$  frame stock to about  $\frac{1}{16}$  in. oversize, planing the sawn edges to exact width and crosscutting the pieces to length. Then, rip and smooth the  $\frac{3}{4} \times 1\frac{1}{8}$ -in. spindles the same way.

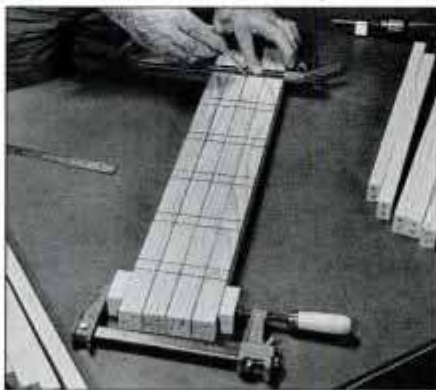
The frames are assembled with dowel-reinforced butt joints—use a doweling jig to ensure straight, accurately placed holes.



**1** Use a doweling jig to bore holes in side pieces. Ganging pieces together helps jig alignment and speeds up work.

Since there's so little surface area on the ends of the spindles, it makes sense to gang them together in groups of six when boring the dowel holes (Photo 1). Bore the end holes in the  $1\frac{1}{8}$ -in.-square horizontal frame members the same way.

While the horizontal frame members are clamped together, carefully lay out the spindle positions with a square (Photo 2). Then, separate the



**2** To space spindles accurately, clamp horizontal frame members squarely together when marking spindle locations.

four pieces and use your doweling jig to bore the holes for joining the spindles to the frame (Photo 3).

It's best to sand the frame components before they're assembled. After the dowel holes have been bored in the horizontal frame members and spindles, lay similar pieces together on a flat board and sand them in groups to avoid rounding the corners excessively (Photo 4).



**3** Align doweling jig at each spindle location and bore  $\frac{1}{4}$ -in.-dia.  $\times$   $\frac{1}{16}$ -in.-deep holes. Tape on bit indicates boring depth.



# EASY DOES IT

Next, prepare to assemble the side frames by applying glue sparingly to the holes in the horizontal members and spindles for one frame.

Insert the dowels into the spindle ends, join the spindles to the horizontal members and clamp (Photo 5).

Check the assembly for square by measuring the diagonals and then re-

peat the procedure for the other side frame.

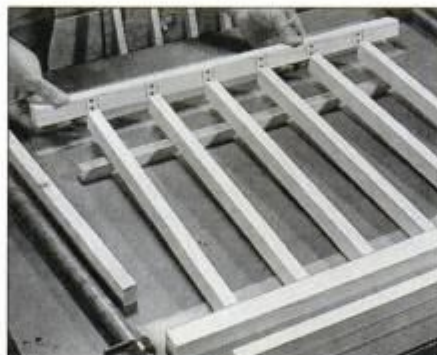
After the glue has set, use dowel centers inserted in the ends of the horizontal members to mark the hole locations on the vertical frame members (Photo 6). Then apply glue sparingly and join the vertical members to the frame assembly.

While the glue is drying, cut the base pieces and feet to exact size and sand. Glue and nail the feet to the bases with 4d finishing nails. Then, clamp the bases to the frames and bore and countersink the screw pilot holes (Photo 7).

Secure the bases with 1½-in. No. 10 fh screws.



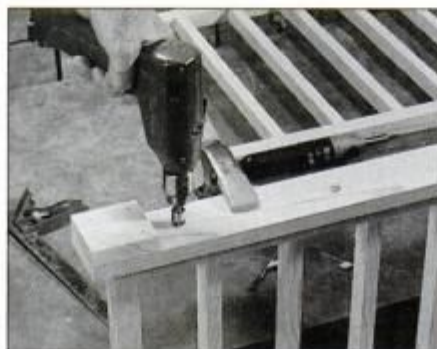
**4** Place side frame pieces on flat board and clamp for gang sanding. Wood strips between stock and clamps protect stock.



**5** Apply glue to dowel holes, assemble spindles to horizontal pieces and clamp. Check for square by measuring diagonals.



**6** Use dowel centers for locating dowel holes in vertical frame pieces. Stock clamped to frame ensures alignment.



**7** After assembling the base and feet, clamp the base to the frame, and bore and countersink screw pilot holes. Then, secure.

## MATERIALS LIST—EASY CHAIR

Key	No.	Size and description (use)
A	4	1½ x 1½ x 27¼" side horizontal (pine)
B	12	¾ x 1½ x 17¼" spindle (pine)
C	4	1½ x 1½ x 20" side upright (pine)
D	2	¾ x 4 x 33" arm (pine)
E	2	¾ x 3 x 32" base (pine)
F	4	¾ x 3 x 3" foot (pine)
G*	2	¾ x 2¼ x 28½" frame side (pine)
H*	2	¾ x 2¾ x 24" frame front (pine)
I	1	¾ x 2¼ x 22½" crossmember (pine)
J	1	¾ x 2¼ x 22½" crossmember (pine)
K	2	¾ x 2¼ x 31" seat frame side (pine)
L	1	¾ x 3 x 19½" seat frame front (pine)
M	2	¾ x 2¼ x 19½" seat frame inner/rear (pine)
N	1	¾ x 20¼ x 21" seat (plywood)
O	2	¾ x 2½ x 22" back frame side (pine)
P	4	¾ x 2½ x 15½" crossmember (pine)
Q	2	¾ x 1½ x 24" base cross tie (pine)
R	1	¾"-dia. x 24½" steel rod
S	1	5½ x 24 x 25" bottom cushion (foam)
T	1	25¼ x 56¾" top, front, bottom fabric
U	2	6¼ x 26¼" side boxing
V	2	4¾ x 25¼" back boxing
W	1	24" zipper
X	1	4 x 21 x 22" back cushion (foam)
Y	1	23¼ x 47¼" front, top, back fabric
Z	2	5¼ x 22¼" side boxing
AA	2	3¾ x 23¼" bottom boxing
BB	1	22" zipper
CC	2	2½ x 1½" butt hinge
DD†	¼"	¼"-dia. x 1" dowel
EE†	¼"	¼"-dia. x 1½" dowel
FF	1½"	No. 10 fh screw
GG	2"	finishing nail
HH	1¼"	finishing nail

Misc: glue, sandpaper, Deftoil Danish Oil Finish, Deft Satin Finish.

\* Overall dimension  
† As required

## Making The Arms

**E**ACH arm features angled slots that hold the ends of the 7/16-in.-dia. steel rod. As the rod is moved from one slot to the next, the back angle changes.

First, cut the stock for the arms to 4 in. wide and to exact length. Then, lay out the three ½-in.-dia. hole positions on each arm as shown in the drawing. Center the holes just slightly more than ¼ in. from the stock face. Use a brad-point drill with a doweling jig or

drill press and bore the holes 1¾ in. deep (Photo 8).

Then install a V-groove bit in your router. Clamp the stock to your worktable and secure a stop along the edge of the arm to limit router travel. A straight strip clamped squarely across the stock is used to guide the router.

Adjust the guide and bit depth so the cut will be tangent to the hole and rout the forward edge of each hole (Photo 9).



**8** The angled slots are started by boring ½-in.-dia. holes near face of arm stock. Use a brad-point drill bit for the best results.



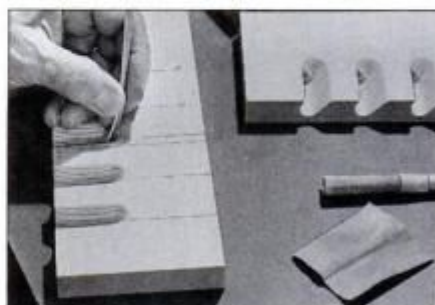
**9** V-groove bit routs slope on forward edge of slots. Clamp strip squarely to guide router. Strip at edge limits router travel.

Finish by carefully sanding with an emery board and a dowel wrapped with sandpaper (Photo 10).

After the slots are finished, lay out the taper along the outside edge of each arm.

Saw the taper leaving approximately 1/16 in. and then trim to the line with a hand plane.

Temporarily clamp each arm to the top of each frame. Secure with 1½-in. No. 10 screws driven from the underside of the top frame members.

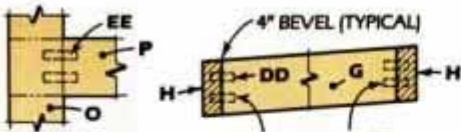


**10** Finish angled slots by hand sanding. Emery board and dowel wrapped with sandpaper helps working in tight space.



# EASY CHAIR

30" WIDE X 33" DEEP X 38-7/8" HIGH



DETAIL 1



DETAIL 2



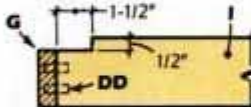
DETAIL 3

4° BEVEL (TYPICAL)

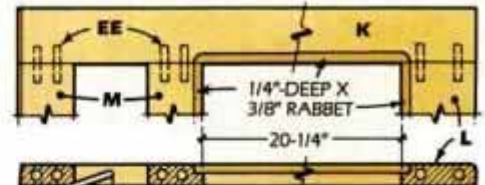


BORE DOWEL HOLES PERPENDICULAR TO ENDS OF SIDE-G

DETAIL 4

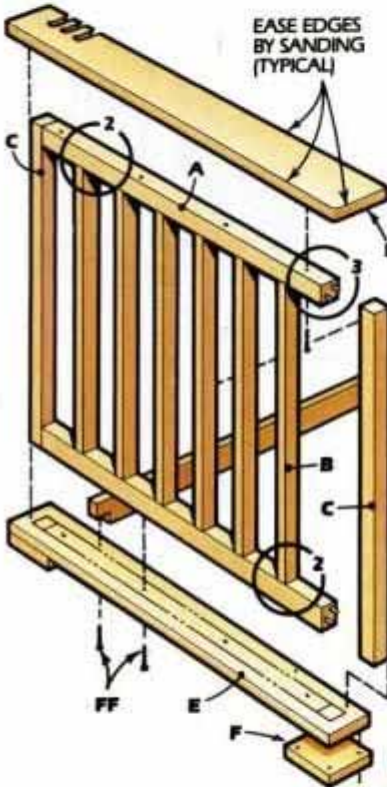
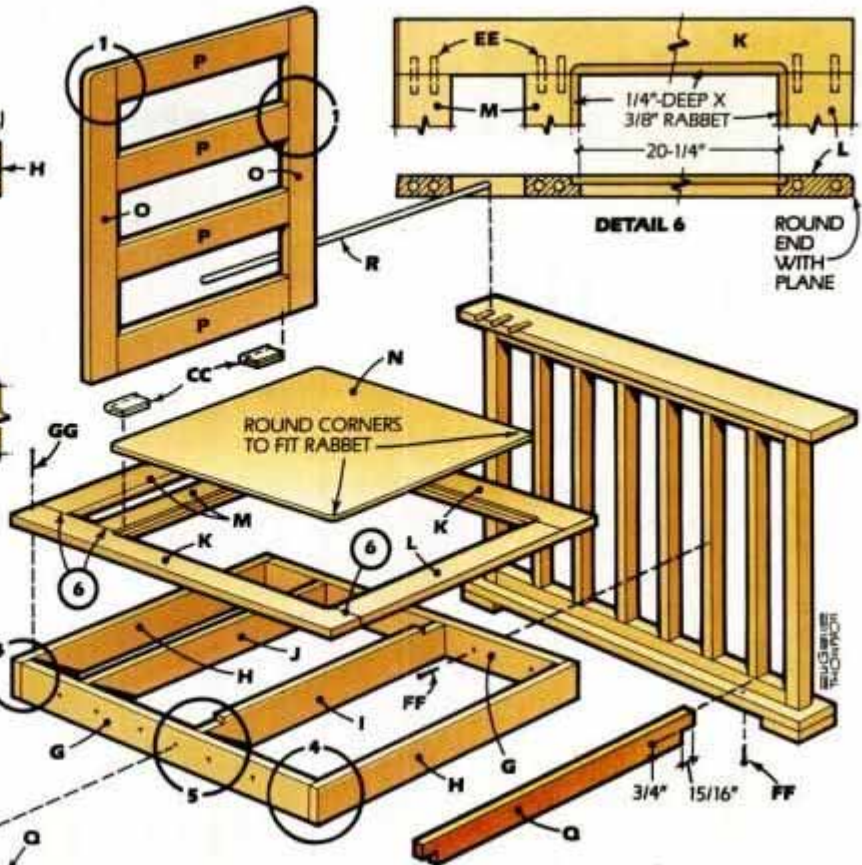


DETAIL 5

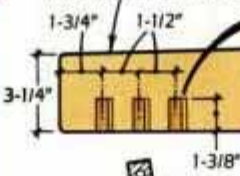


DETAIL 6

ROUND END WITH PLANE

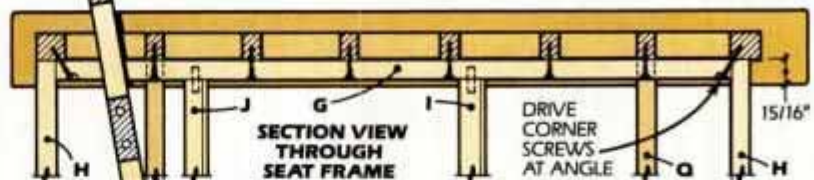


TAPER OUTSIDE EDGE

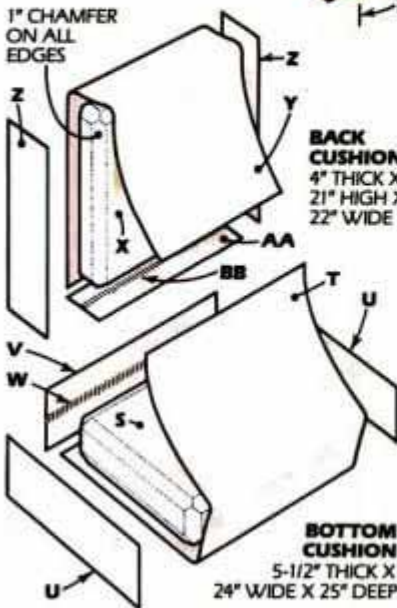


- 1 BORE 1/2"-DIA. FLAT-BOTTOM HOLE
- 2 ROUT SLANT WITH 3/4"-DIA. V-GROOVE BIT
- 3 ROUND EDGES BY SANDING

TOP VIEW ARM-D

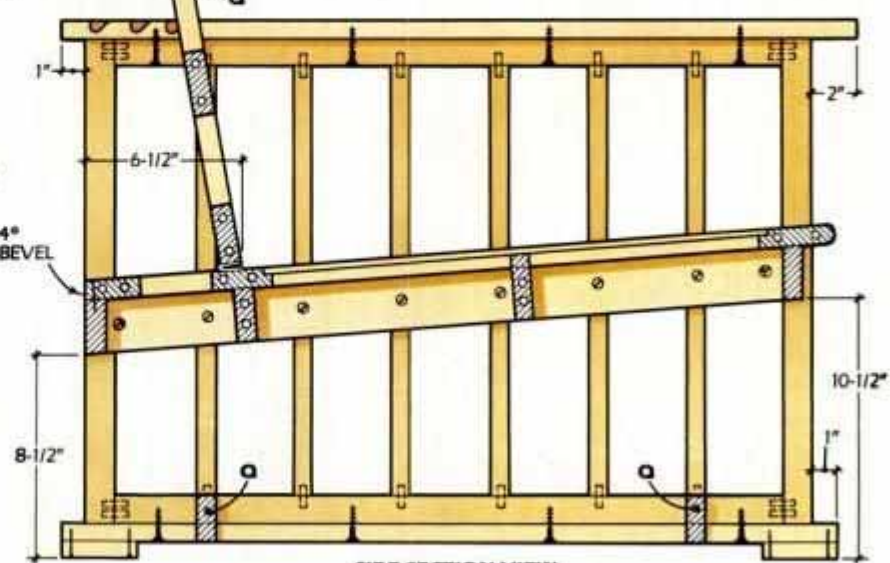


SECTION VIEW THROUGH SEAT FRAME



BACK CUSHION  
4" THICK X  
21" HIGH X  
22" WIDE

BOTTOM CUSHION  
5-1/2" THICK X  
24" WIDE X 25" DEEP



SIDE SECTION VIEW



## EASY DOES IT



**11** Use doweling jig at end of mitered sides of box frame. Simple shopmade jig guides bit for matching holes in stock face.

### Seat And Back Frame

**T**HE SEAT support structure is composed of a box frame that will be attached to the sides and a top frame that holds a plywood panel.

First, rip the box frame side components to width. Lay out the 4° miters on the ends and trim the stock to length.

The front and rear box frame components are then ripped to width at a 4° bevel and cut to length. Prepare the crossmembers by cutting to size, notching the ends of crossmember (Part I), and boring the dowel holes as shown in the drawing.

Bore dowel holes in the ends of the side pieces. The doweling jig ensures that these holes will be perpendicular to the mitered-end surfaces. Then, bore corresponding holes in the front and rear pieces and bore the holes in the sides to receive the crossmembers.

A simple shopmade guide insures straight and accurate holes when boring into the stock face (Photo 11). Assemble the box frame and clamp until the glue sets.

Construct the seat and back frame by cutting the pieces to size and join-



**12** After seat frame is assembled, use a 3/8-in. rabbeting bit to rout the 1/4-in.-deep rabbet that holds the plywood seat.



**13** Clamp seat box frame to side and bore and countersink pilot holes. Holes at each end are bored at an angle to reach frame.



**14** Use scrap stock clamped to box frame for supporting seat assembly when aligning other side. Secure with screws.



**15** Secure hinges to back first. Then, insert rod and place back in position. Carefully mark hinge screw locations on seat frame.

ing with dowels as shown in the drawing. Install a 3/8-in. rabbeting bit in your router and set the depth of cut to 1/4 in. Then, rout the recess in the seat frame that holds the plywood panel (Photo 12). Cut the plywood seat to size and round the corners as shown in the drawing.

Lay a chair side on your worktable and place the box frame in position. Bore and countersink screw pilot holes, secure the frame and then attach the other side (Photos 13 & 14). Note that the front and rear of the frame is secured by screws driven at

an angle. Then install the cross ties between the bases.

Place the seat frame in position and check for fit. Then, attach the hinges to the back of the frame. Insert the steel rod in the slots and position the back so it leans squarely against the rod. Mark the hinge positions on the seat frame and bore the screwholes (Photo 15). Unscrew the box frame from the sides and secure the seat frame to the box frame with 6d finishing nails. Set the nails and fill.

Finish sand the entire chair and gently round all harsh corners.

### Cushions And Finish

**W**E FINISHED our chair with clear Deftoil Danish Oil Finish to give the wood a warm glow and enhance the beauty of the grain. This type of penetrating oil soaks deep into the wood and contains urethane resins which harden upon drying to help protect the typically soft surface of the pine.

The finish is brushed on heavily and the excess is wiped off after about a half hour. A second coat is applied after the first has dried for 1 hour. This finish is easy to use because dust and brush marks are eliminated.

Although the penetrating oil finish stands up well on its own, extra protection can be achieved by applying a final top coat of Deft Satin Finish.

The cushions are made from foam blocks covered with almond-colored duck fabric. Since the foam is generally available in thicknesses of up to 4 in., you'll have to add a 1 1/2-in.-thick



**16** Two coats of Danish Oil Finish are applied for a clear durable finish. For extra protection, apply a last coat of varnish.

piece when making the seat cushion. Use a spray adhesive suitable for use on foam to join the pieces.

You can usually have the foam cut to the required sizes by your supplier. If you're going to cut it yourself, an electric carving knife or serrated bread knife will do the job. Don't forget to chamfer the corners of the foam as shown on the drawing.

The fabric sizes in the materials list allow 3/8 in. on each edge for the seams. The sewing is done inside out starting with the installation of the zippers.

Then attach the side boxing strips followed by the large pieces that cover the cushion faces. Pull the covers inside out through the zipper opening and insert the foam. **PM**



# TRUCKIN' '89



FORD RANGER

PM PHOTO BY BILL ASHE

New technology and features lead the way as the new pickups hit the highways.

BY BRUCE W. SMITH

**W**HEN IS A pickup truck not a pickup truck? Just about all the time, judging by the tastes of today's buyers. While some still see this class of vehicles as the same family of humble haulers we've known for decades, many others see a new alternative to the automobile—a sort of sports car with a cargo bed in back. And because of this new perception, the offerings of the manufacturers battling for shares of this huge and profitable market reflect a range of equipment and capabilities that's nothing short of seductive.

Whether your taste runs to Baja bashing or boulevard profiling, the

industry is doing its best to make you happy. In the pages that follow, we detail just how each manufacturer plans to do this for 1989.

## Chrysler Corp.

Chrysler's Dodge Truck Division, hunting for a healthier share of the over-8500-pound-GVW market,

opens another skirmish in Detroit's ongoing powertrain wars with the addition of a 5.9-liter, 160-hp Cummins turbodiesel as an option in selected 2- and 4-wheel-drive Ram 250 and 350 pickups, plus chassis-cab models. The engine, which produces a remarkable 400 lb.-ft. of torque at 1700 rpm, isn't new—Cummins has used it to power



CHEVROLET K1500 SPORTSIDE



# AMERICA'S HAVING A CHANGE OF HEART



Let's get it together — buckle up.

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# POWERFUL



**THE ADVANCED FULL-SIZE CHEVY.  
MORE STANDARD HALF-TON POWER  
AND PAYLOAD THAN FORD. MORE  
TWO-SIDED GALVANIZED STEEL THAN  
FORD. MORE CAB ROOM THAN FORD.**

Nobody got off easy this year. The weather, food prices and feed prices all turned nasty.

Now you've got another year of uncertainty to face. More than ever, you need a good truck to lean on.

For example, farmers need dependable power. The fuel-injected Vortec V6 starts sharp every morning and delivers 15 more standard horsepower in the Chevy\* half-ton than Ford's

old-fashioned in-line six.

And the Chevy hauls more too. It has a bigger standard half-ton payload than Ford.

Inside, there's more leg and shoulder room than Ford. And that means comfort over long hours of work.

Right now's a good time to look into a new Chevy full-size pickup. And look into new Preferred Equipment Groups that can save you up to \$1,800.\*

Test drive a Chevy. If you were considering a Ford, you're going to have a powerful change of heart.

\*Based on Manufacturer's Suggested Retail Prices for option packages versus options purchased separately. Comparisons based on data available at time of publishing. © 1988 General Motors Corporation. All Rights Reserved.

THE *Heartbeat* OF AMERICA  TODAY'S CHEVY TRUCK™

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**JEEP COMANCHE SPORTTRUCK**

In the Jeep/Eagle quarters, advancements in stopping technology in the sport/utility line haven't filtered down to the Comanche pickups yet, but they still boast the most powerful 6-cylinder engine in the light-duty truck market. Jeep's 177-hp Power Tech Six, an electronically fuel-injected 4.0-liter

various trucks up to 35,000-pounds GVWR since entering production in 1984. But its availability in this application lends a fresh dimension to Dodge's pickup powertrain picture.

The Cummins turbodiesel produces the best torque, fuel economy and performance figures (it is said to pull Ram pickups to sub-12 second 0-to-60 times) in its diesel class and should be a boon to those who do heavy-duty towing, especially at high altitudes. Though typical naturally aspirated diesels lose about 30 percent of their power at 10,000 ft., the Cummins engine only loses about 5 percent. Diesel-powered Dodges come equipped with a fully synchronized Getrag 5-speed, the first 5-speed manual offered in a heavy-duty Dodge truck.

Dodge's venerable 5.9-liter V8, the largest gasoline engine offered in the division's light-duty trucks, succumbs to modern technology, getting throttle-body electronic fuel injection, roller-tip rockers, a new cam and other valvetrain improvements that increase its output to 190 hp—an 11-percent gain over last year's carbureted version. Buyers concerned with mpg will now be able to order Dodge's 3.9-liter V6 in ½-ton 4x4s (W150), or compromise by opting for the 140-hp 5.2-liter V8.

Fuel-injected pep comes to the mid-

size 2- and 4-wheel-drive Dakotas via an EFI-fed 2.5-liter inline-Four that replaces the carbureted 2.2-liter engine. The 4-wheel-drive Dakota Sport and Dakota chassis-cab models will offer Dodge's mildly refined 3.9-liter V6 as their standard powerplant.

However, if real tire-smokin' performance is the No. 1 objective, the Carroll Shelby Dakota has it: 175 horsepower from a massaged version



**TOYOTA SR5 4X4**

of Dodge's 5.2-liter V8 stuffed under the hood. Look for 0-to-60 times under 9.5 seconds.

Gas shocks and rear-wheel antilock brakes (ABS) make their way underneath the new Dodge trucks, as does the optional 4-speed automatic (except 1-tons) that previewed in the Dakota series late last year.

inline-Six, is the standard engine in the 2-wheel-drive shortbed Comanche Eliminator package and an option for the 121-hp 2.5-liter inline-Four used in all other models.

The Eliminator is Jeep's top-of-the-line pickup, aimed squarely at the sport-truck buyers. It's outfitted with leather-wrapped sport steering wheel, power steering, bucket seats, upgraded interior trim, special paint and graphics, P225/70R-15 Eagle GT+4 tires, aluminum wheels and a 5-speed manual transmission. As with other model Comanches, an optional 4-speed automatic is available that affords drivers with power or comfort modes, depending on preferences and conditions.

Jeep also keeps up the pace with the other manufacturers in offering special equipment groupings like the Off-Road Package and Big Ton, a payload option that increases hauling capacity to 2205 pounds. New Jeep owners will also find Chrysler's 7-year/70,000-mile powertrain protection and 7-year/100,000-mile corrosion warranty of even greater long-term value.

### **Ford**

For 1989 the focus of Ford product planners turns away from the world's No. 1 selling vehicle, the famed F-Se-



**CHEVROLET S-10 BAJA**



**MAZDA B7600 4X4**



ries full-size pickup, and focuses on the nation's top-selling compact pickup—the Ford Ranger and its sport/utility counterpart, the Bronco II. Both get new front bodywork to make them look like their big brothers, while under the Ranger's hood sits a unique 2.3-liter Twin Plug EFI inline 4-cylinder. Adding an extra plug per cylinder boosts horsepower by 16 percent, bringing the base engine to 104 hp at 4750 rpm and simultaneously increasing EPA fuel economy ratings. The Ranger's old 2.0-liter inline-Four has been dropped from the line for the 1989 model year.

In addition to styling changes, Rangers benefit from ABS brakes in the rear, larger front discs, a 17-gal. fuel tank, steering column-mounted automatic shifters and an all-new instrument panel and dash.

Full-size F-Series pickups with a GVWR of more than 8500 pounds will have the old 3-speed C-6 automatic replaced by an all-new, electronically controlled 4-speed (E4OD) version. The transmission's shift points and torque converter clutch are controlled by computer.

## General Motors

With a new generation of successful high-tech trucks—the full-size K-series of Chevrolet and GMC—only one year into production, 1989 looms as a year of minor refinements for GM's truck group.

The sporty look developed by Chevrolet and GMC for their '88 Sportside 4x4s has been passed on to 1989 Fleetside models, which get a blackout grille, dual side mirrors and front air dam.

On a more technical side, the K3500 1-ton 4x4s get the benefit of Borg-Warner 1370 transfer cases, making it possible for dual rear wheels to be ordered directly from the factory and, as a result, for the GVWR to be brought up to 10,000 pounds. The new transfer case incorporates an electrically actuated synchronizer that smoothes shifting in and out of 4-wheel drive. Engine choices still remain the same on the full-size pickups, with no fewer than five fuel-injected powerplants available: 160-hp 4.3-liter V6, 175-hp 5.0-liter V8, 210-hp 5.7-liter V8, 230-hp 7.4-liter V8 and 143-hp 6.2-liter diesel.

S-10/15 compact buyers will find braking far improved from past years, as antilock rear brakes make their debut in all models, 2wd and 4wd alike. Performance improves too, with the highly successful 4.3-liter V6 offered across the board as an option

NISSAN HARDBODY W-10



for GM's old-tech 125-hp 2.8-liter 60° V6. Pickups and sport/utility vehicles equipped with the base engine have had drivetrain noise significantly reduced from last year's models, thanks to GM's New Process 231 transfer case that incorporates redesigned gears.

Chevrolet's ability to niche market—to go after specific customer groups—results in a new cosmetic option package called the Baja S-10. It's a real head turner, with oversize tires, special wheels, lots of lights, bed-mounted spare tire, tailgate net and "prerunner" graphics. For those more attuned to paved roads, the Cameo S-10 pickup returns with its ground-effects fascia and low-slung, road-racer look. Both packages can be ordered with the 160-hp 4.3-liter Vortec V6.

## The Imports

Japanese manufacturers continue to struggle against the one-two punch of a 25-percent duty and increasingly tough competition from U.S. compact models.

Toyota is striking back with a major cosmetic and mechanical makeover of its entire pickup line. The wholesale revision includes extensive use of 1-piece body panels from nose to bed, in addition to reworked suspension com-

ponentry and ergonomically redesigned interiors.

Externally the new trucks feature a front grille that integrates the bumper with the lower valence panel. The new trucks have lost their crisp body edges in favor of aerodynamically rounded curves and the lower edges of the side body panels are indented slightly, providing more protection from rocks and other debris. Single-piece interior bed sides and a 1-piece floor eliminate all those panels and seams characteristic of pre-'89 generations. Underneath, Toyota makes extensive use of PVC undercoatings and 1-piece inner fenders to keep areas of potential corrosion to an absolute minimum.

Toyota's new-generation pickups also debut a shift-on-the-fly 4-wheel-drive system, the first import manufacturer to provide such a feature. Toyota's Automatic Disconnecting Differential (ADD) system, called "4WDemand" in the States, is a standard feature on top-of-the-line SR5 V6 4x4s and an option on several lower trim level models.

There's no longer a turbocharged 4-cylinder in the new Toyota line, dropped in favor of the pickup-engineered dohc V6 introduced last year. The V6 rates at a very lusty 150 hp at 4800 rpm and reaches a peak torque of

DODGE DAKOTA LE







MITSUBISHI SPX MACROCAB



FORD F150

180 lb.-ft. at 3400. The 3.0-liter V6 is now an option in both 2wd and 4wd pickups.

Toyota has made a number of suspension upgrades to the new trucks, particularly at the rear, where leaf springs have been extended by 4 in. and gas shocks have been revalved. Trapezoid-style spring shackles also help increase rigidity while reducing the leaf-spring torsion that gave previous Toyota trucks their characteristic choppy ride. In addition, top-of-the-line 2wd SR5 models receive resin collars in the upper arm bushings of

the double wishbone-type front suspension to further enhance ride quality. Torsion bars are also larger on all models, improving on- and off-road handling and performance.

Toyota's engine and suspension changes bring towing capacity up to 3500 pounds on 4-speed automatic-equipped V6s and 5000 pounds on the 1-ton models.

Cab interiors on the new Toyotas reflect the general industry push toward producing pickups with car-like qualities. The doors are larger, cabs wider, gauges bolder and controls

easier to reach. The new 1-piece stamped doors create an additional 3 in. of elbow room. Xtracabs benefit from a 9-in. stretch, and there are jump seats and a raised rear roof to accommodate rear-seat passengers. Split-bench seats, which are becoming an industry standard in pickups, find their way into the new Toyotas, as do sportier, more adjustable bucket seats on the high-line models.

Corrosion resistance was another design priority in the new Toyota pickups, which incorporate two different types of rust-resistant metal in

## Truck Tech: The Hardware Wars Heat Up

**A**LTHOUGH every manufacturer in the truck trade has long since learned that stripes, alloy wheels and aggressive tires will go a long way toward moving a prospective owner into the ranks of the converted, it's also becoming plain that having a competitive edge in today's market takes more than flash. As a result, all truckmakers are racing to score engineering victories, as well as cosmetic coups, a trend that's vividly mirrored in technical developments for the 1989 model year. A few of the major highlights follow.

### Ford

It's no secret that the blue-oval boys are battling other manufacturers for engine superiority. And the new Ford Ranger's powerplant is a key to what's coming—Distributorless Ignition Systems (DIS).

The Ranger's 2.3-liter Dual-Plug engine uses a pulse wheel on the front of the crankshaft in place of a conventional distributor. As the crankshaft spins, the pulse wheel rotates through a Hall Effect (magnetic field) sensor, transmitting an electrical signal to both the DIS module mounted on the lower intake manifold and to the electronic engine control (EEC-IV) computer under the dash. In turn, a spark signal is sent to each sparkplug's coil tower (simultaneously to each pair in the Ranger engine), ensuring very precise spark timing because of the elimination of timing belts and distributor drive system.

In an effort to gain better control of fuel burn rates in each cylinder, Ford redesigned the head to accept twin sparkplugs. The extra plugs are located on the intake side of the engine, directly opposite the original set.

But the biggest performance and fuel-economy gains were the result of computer-

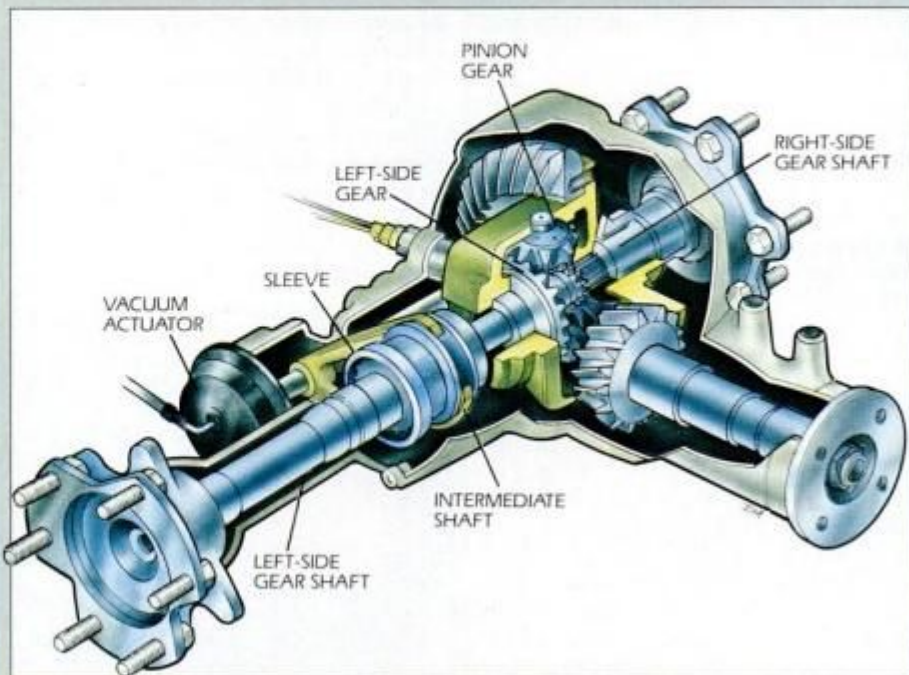
designing the intake manifold runners and the cylinder head to reduce restrictions, increase the mixture swirl and provide balanced flow to each cylinder.

The free-flowing engine, with its twin plugs and distributorless ignition, gains 16 percent more horsepower (up to 104) and 3 percent more torque compared to its single-plug predecessor.

The new engine also incorporates smaller main bearings and roller finger followers, the

latter a design change planned for other Ford engines. Both changes reduce parasitic friction within the engine.

Ford's EEC-IV on-board computer system also controls its new E4OD automatic transmission on light-duty trucks and vans with a gross vehicle weight rating (GVWR) over 8500 pounds, replacing the revered C-6. This electronically controlled automatic (a milestone for Ford Light Truck) receives commands directly from the engine control computer, which processes input from engine, transmission and the vehicle itself to deter-



Toyota's new Automatic Disconnecting Differential permits changing 2wd to 4wd on the fly.





DODGE RAM 50



ISUZU PICKUP

the majority of the body construction: Galvannealed steel sheet and Excelite-treated panels. The latter is used for outer panels such as doors, sides, fenders and hood, where the ability to withstand the elements as well as provide a good paint base are prime concerns. Excelite consists of two zinc-iron (Zn-Fe) alloys, electrically deposited onto the basic sheet steel. Galvannealed steel uses just one layer of Zn-Fe alloy electrobonded to the base metal sheet.

Isuzu, though much less aggressive than Toyota, does have a few new

wrinkles for its 1989 models. There's a new trim level, called the XS, bringing the total to three, and a Spacecab model in the baseline S-series. The XS trim is a mid-level version that slots between high line and base models to provide a more well-appointed feeling in Isuzu's medium price range light-duty pickups.

Along with the new trim level and Spacecab additions come bolder graphics and more colors, plus 31x10.50R tires and sporty wheels with the 4wd short-wheelbase special-edition red body. This flashy

package also includes bright yellow bumpers and bed-mounted light bar. With the larger diameter tires comes 4.55:1 rear-end gearing, something others have not yet offered.

Except for the foregoing, Isuzu seems content to keep things simple and stay away from the horsepower wars. Two sohc inline-Fours, the 96-hp 2.3-liter (found only in the 2wd Regular Cab) and its 120-hp 2.6-liter big brother, continue to power the entire lineup.

Mazda is another manufacturer making very little change to its '89

mine the best shift points for performance and consistent shift feel. The E4OD's low gear is lower than the old C-6 (2.71 versus 2.46) and it provides a 0.71:1 overdrive for better open-road economy.

## Toyota

Toyota, the leading import truck manufacturer, was the first to offer a compact 4x4 pickup (1979) and now, a decade later, is the first to offer a shift-on-the-fly 4wd system for 4-wheel-drive imports.

According to Bill Porento, Toyota's national

technical services manager, the Automatic-Disconnecting Differential (ADD) system (4WDemand for U.S. marketing purposes) uses a vacuum actuator attached to the outside of the front differential housing, to move a splined sliding sleeve, located inside the housing, couples the front axles, differential and front driveshaft together. Automatic locking front hubs contribute to the overall ease of operation.

Toyota's shift-on-the-fly is relatively simple: When the driver shifts from 2Hi to 4Hi a switch inside the transfer case signals two

vacuum switching valves (VSV), mounted on the passenger-side inner fender, to apply vacuum to one side of the actuator and vent atmospheric pressure to the other.

The resulting pressure imbalance pushes the shift fork and attached collar over the left side gear shaft, engaging the shaft and front differential, transmitting driving force to both front wheels.

Disengaging 4-wheel drive reverses the pressure imbalance inside the actuator. Vacuum to activate the system comes from the engine's intake manifold. A 4wd indicator light is activated by the shift fork, confirming actual engagement.

Only top-of-the-line SR5 V6s will receive 4WDemand as standard equipment. Lower level SR5 4x4s may be able to get it as an added feature, which is expected to be about a \$750 option.

Though Ford and Toyota dominate the light-truck technology news for 1989 a number of other developments are noteworthy:

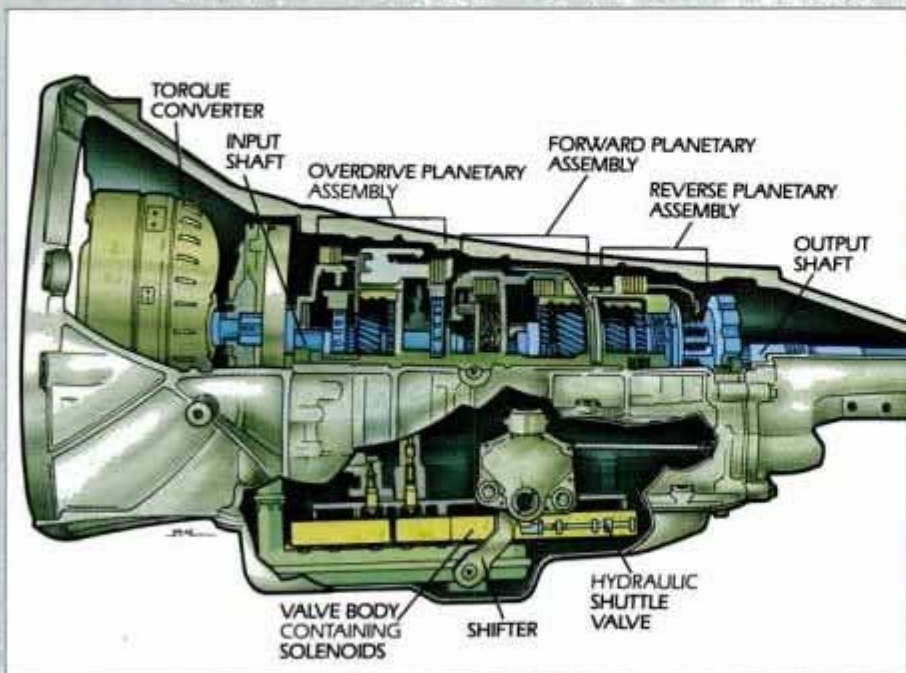
- 4-wheel antilock brakes (ABS) on Jeep Cherokee and Wagoneer models equipped with the 4.0-liter inline Six.

- Rear ABS standard on GM S-trucks, sport/utility vehicles and Astro/Safari vans, as well as Ford Ranger and Bronco II, and the Dodge Dakota.

- Electronic Fuel Injection (EFI), added first to Dodge 5.9-liter engines, is now standard on all domestic Dodge truck engines and all but a few imports.

- 5.9-liter (360-cu.-in.) inline-Six Cummins turbodiesel added to ¾- and 1-ton pickups, producing 160 hp at 2500 rpm and 400 lb.-ft. of torque at 1700 rpm.

- 160-hp 4.3-liter 90° V6 added as an option to GM S-truck models—Dodge adds 3.9-liter V6 to 4x4 ½-ton W150s.—B.W.S.



Ford's E4OD electronically controlled 4-speed automatic is operated by engine computer.



# TRUCKIN' '89

lineup. However, Mazda 4x4s will be getting a healthy improvement in performance with the introduction of a new engine, the G6—a 3-valve 2.6-liter 4-cylinder powerplant that replaces the engine used in the earlier models. The engine will probably find its way into the 2-wheel-drive trucks late in the year. The 3.0-liter V6 used in the new MPV van will not surface in the pickups, at least not in model year 1989. Neither will a 4-speed automatic in the 4x4s.

As for **Mitsubishi**, the changes from '88 models are subtle. The '89 Macro-cabs provide an inch more legroom to front-seat passengers plus another cubic foot of behind-the-seat storage, while Mighty Max Macro-cabs get a split 60/40 bench seat and an optional 4-speed automatic. And while performance in the '89 Mitsubishis may feel stronger, the change doesn't stem from major engine improvements. Rear-end gearing has been changed from 3.909 to 4.222. The lower gears help the 2.6-liter, 109-hp 4-banger move out a little quicker than previous models.

Last, but certainly not least in consumer's minds, is **Nissan**, which makes the Hardbody nickname offi-



cial for its E-Series pickups. The nickname was coined for the new-generation pickups last year by the designers at Nissan's La Jolla, California, center.

Nissan's intermediate XE trim level has been replaced by the availability of special-order option groupings like the Power Plus Package that includes limited-slip rear differential, fender flares, big tires, special

wheels, power windows and door locks, and a sunroof. Similarly, the flashy SE Sport Package, a trial option introduced last year, is back. With limited-slip differential, 145-hp 3.0-liter V6, 31x10.50R tires, fog lights, bed-mounted light bar/cooler carrier, bed-mounted spare tire, pop-up sunroof and driver-adjustable shocks, it's a young off-roader's dream truck. **PM**

## 1989 PICKUP TRUCK PRICES\*

### DOMESTICS

#### CHEVROLET

##### S-10

2wd Pickup	\$7474
2wd Extended Cab	9435
4x4 Pickup	11,275
4x4 Extended Cab	12,085

##### C-K/Series

2wd Pickup	10,543
2wd Extended Cab	11,467
4x4 Pickup	12,676
4x4 Extended Cab	13,691

#### DODGE

##### Ram 50

2wd Pickup	\$7664
2wd Extended Cab	8680
4x4 Pickup	10,485
4x4 Extended Cab	11,620

##### Dakota

2wd Pickup	7469
4x4 Pickup	10,502

##### Ram

2wd Pickup	9208
4x4 Pickup	12,898
2wd Diesel	14,400
4x4 Diesel	15,985

#### FORD

##### Ranger

2wd Pickup	\$8518**
2wd SuperCab	9786**
4x4 Pickup	10,966**
4x4 SuperCab	12,120**

##### F-Series

2wd Pickup	10,267
2wd SuperCab	12,027
4x4 Pickup	12,399
4x4 SuperCab	11,767

#### GMC

##### S-15

2wd Pickup	\$7527
2wd Club Coupe	9491
4x4 Pickup	11,331
4x4 Club Coupe	12,141

##### C-K/Series

2wd Pickup	10,395
2wd Club Coupe	11,527
4x4 Pickup	12,425
4x4 Club Coupe	13,751

#### JEEP

##### Comanche

2wd Pickup	\$7646
4x4 Pickup	10,609

### IMPORTS

#### ISUZU

2wd Pickup	\$7590**
2wd SpaceCab	11,947**
4x4 Pickup	10,453**
4x4 SpaceCab	14,161**

#### MAZDA

2wd Pickup	\$7775**
2wd CabPlus	9114**
4x4 Pickup	10,505**
4x4 CabPlus	11,947**

#### MITSUBISHI

2wd Pickup	\$7599
2wd MacroCab	10,179
4x4 Pickup	10,559
4x4 MacroCab	13,019

#### NISSAN

2wd Pickup	\$7549
2wd King Cab	8549
4x4 Pickup	9999
4x4 King Cab	10,999

#### TOYOTA

2wd Pickup	\$7998
2wd Xtracab	9648
4x4 Pickup	11,138
4x4 Xtracab	12,388

\* Prices in effect Nov. 1, 1988 \*\* Estimated price





## ACTIVE TERRAIN TAMER

**I**T WASN'T so long ago that pickup trucks were regarded as strictly utilitarian. They were good for all sorts of odd jobs, or, with 4-wheel drive, excursions into the outback for fishing, hunting or just plain getting away from it all.

But one look at today's traffic mix makes it plain that this basic perception has changed dramatically. Pickups have staged a major invasion of the lifestyle market in recent years, and sales have boomed. Over half the vehicles sold by the Ford Motor Co. in 1988 came from the company's truck division, and light-duty trucks (including sport/utility vehicles) will account for about one-third of all U.S. vehicle sales in 1989.

As GMC's advertising asserts, "It's not just a truck anymore."

For all its popularity, though, the pickup has taken a back seat in technological development. While passenger cars rush into the next decade

GMC's A/R 400 with active suspension shows the future of off-roading.

BY BARRY BRAZIER

with ABS, 4-wheel steering, cockpit-adjustable shock absorbers and viscous-coupled 4-wheel-drive systems that automatically adjust front/rear torque split to traction conditions, the pickup remains mired in the recent past. Although 4-wheel drive is available with most of today's pickups, the rest of the hardware is limited to the familiar. ABS is currently limited to rear-wheel applications.

However, this technological poor-cousin syndrome is fading rapidly at GMC Truck. Thanks to the formation of GM's Advanced Vehicle Engineering group, plus the hard-earned experience of racing and the miracle of the

microchip, sophisticated new suspension systems are on the horizon for a new generation of multipurpose vehicles that will combine Cadillac ride with the capability of handling the toughest off-road conditions imaginable. The vehicle shown here—the GMC Sierra A/R (for Active Ride) 400—is the second development prototype en route to a true production version.

The first project from this engineering group was the Blazer XT-1, a concept vehicle equipped with 4-wheel steering, 4-wheel drive and several advanced systems ("4x4s Move Uptown," page 82, Sept. '87) that helped to shape the A/R 400 project. The heart of the Active Ride system was developed by GM's recently acquired Group Lotus, Ltd., and Moog, Inc. It's similar to the active suspension under development for the Corvette of the early 1990s, with one important difference: The Corvette system, as pre-



# Add.

## Comanche Option Group Discount 2WD ALN

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- Manual 5-Speed Overdrive Transmission
- Intermittent Wipers

- Pioneer Trim Package, silver styled steel wheels, and P215/75R15 outline white letter tires

## Comanche Option Group Discount 4WD ALN

- 4.0 Litre Power-Tech Six
- Manual 5-Speed Overdrive Transmission
- Pioneer Trim Package, silver styled steel wheels, and P215/75R15 outline white letter tires

- Intermittent Wipers
- Dual Remote Mirrors
- Gauge Group

## Comanche Option Group Discount 2WD ALM

- Pioneer Trim Package including silver styled steel wheels and P205 black sidewall tires

- Intermittent Wipers
- Dual Mirrors

## Comanche Option Group Discount 4WD ALM

- Pioneer Trim Package including silver styled steel wheels and P205 black sidewall tires
- Dual Mirrors

- Intermittent Wipers

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## GMC SIERRA A/R 400 ACTIVE SUSPENSION SYSTEM

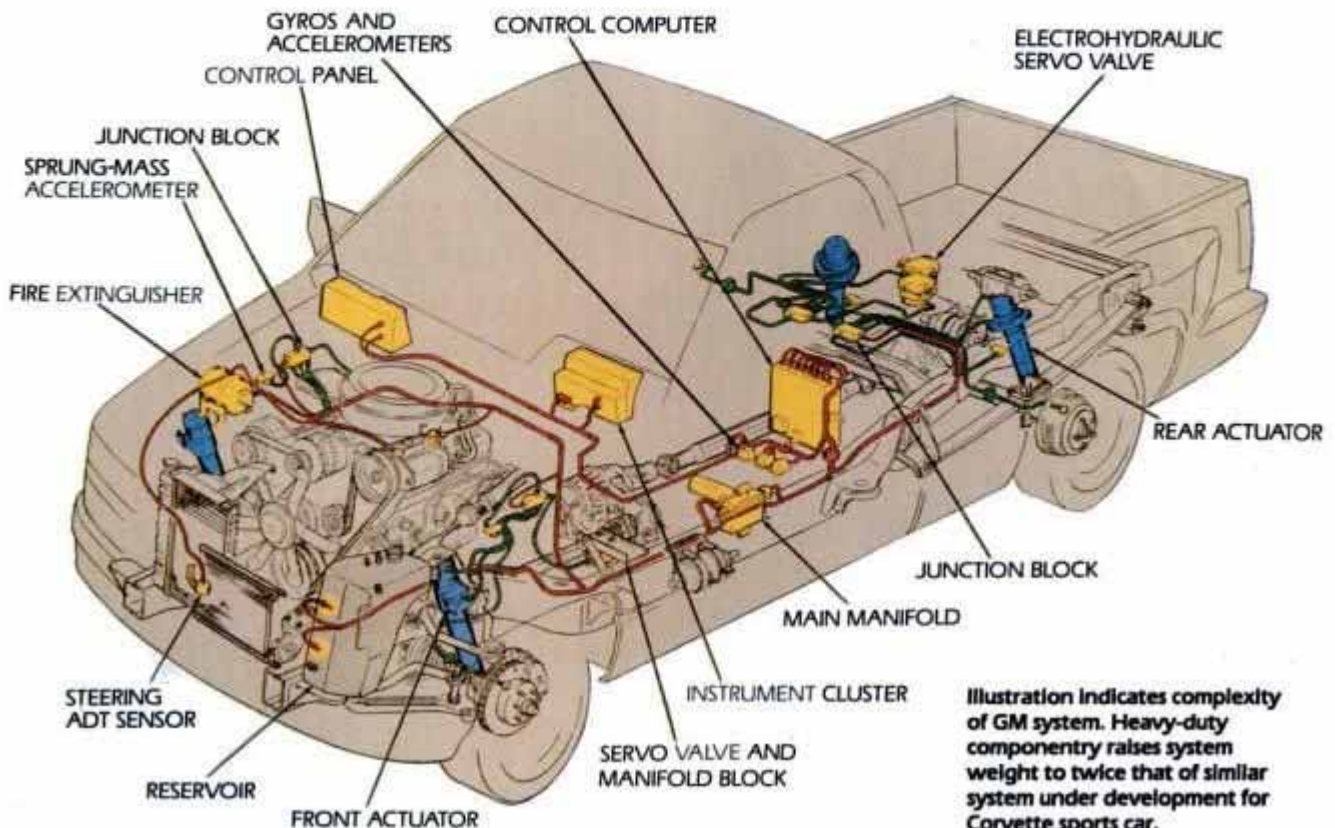


Illustration indicates complexity of GM system. Heavy-duty componentry raises system weight to twice that of similar system under development for Corvette sports car.

viewed in the Corvette Indy concept car ("Corvette Indy," page 66, Sept. '88) is much less bulky.

The dynamics of a sports car are obviously much different from a truck, as are the load requirements. A stock GMC Sierra chassis represents a different set of operating parameters.

Active suspension replaces the usual springs and shocks (considered a passive system) with computer software, motion sensors, fluid pumps, valves, servos and four hydraulic actuators. The system is called active because of its ability to adjust to load demands and terrain variations. Since the A/R 400's range of operation

takes in a much wider variety of both load and terrain, its version of the active system weighs 425 pounds, more than twice the weight of the systems proposed for the Lotus and Corvette sports cars.

Aggravating the weight problem is the system's demands on engine output. The A/R 400 employs enormous actuators fed by a Cessna aircraft pump capable of maintaining 4 gallons of fluid at pressures varying between 1900 and 3000 psi, and at full load the pump siphons off as much as 40 hp.

Nevertheless, the system's performance is impressive, producing dramatic effects on ride quality and

driver control. The basic problem presented by conventional suspension systems on bumpy surfaces is the inability of shocks and springs to keep the wheels in constant contact with the ground, which results in traction losses. The A/R system addresses this problem with wheel sensors that can vary system pressure every 7 milliseconds, if needed, commanding hydraulic valves to pump oil into—or bleed oil from—one or all of the system's actuators.

The system's sensors are capable of determining whether any or all of the vehicle's wheels are actually in contact with the ground, then adjusting system pressure to prevent bottoming regardless of impact. A/R 400 also automatically adjusts itself to deliver a soft ride for highway travel, and simultaneously maintains vehicle attitude and ride height.

When can you order your Active Ride truck or sport/utility vehicle? Unfortunately, not for awhile yet. The bulk and cost of the system's components requires another evolutionary step before production becomes feasible. But it is clearly an idea whose time has come, and the coming of that time is not far off. **PM**



GM engineers used an aircraft hydraulic pump to sustain system's high pressurization.



Beefy hydraulic actuators are capable of response times in the 7-millisecond range.







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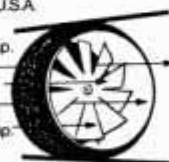
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**MASTERING THE ROUTER** (Continued from page 79)

**Basic Bits**

**S**HOWN below is a small sampling of the hundreds of router bits available. The 16 bits shown represent a good starter collection for the home workshop. Note that the bits are either high-speed steel or carbide tipped. Some bits have pilots—ball-bearing or solid—while others, like the first three shown, have no pilots at all.

When routing always wear eye protection and unplug the router when changing bits. When inserting a bit, push its shank into the collet as far as possible, then withdraw it 1/8 in. to clear any fillet on the bit. After tightening the collet, check to be sure that the bit is held securely.

Store router bits carefully, as you would a fine saw blade, to prevent damage to the cutting edges. An effective storage rack is a simple board with several 1/4-in.-dia. holes bored in it. Place a bit, shank first, in each hole and store them in a dry, dust-free place. Spray the bits with a light coat of oil to deter rust.

To get the best performance and

longest life from a router bit, keep it sharp and clean. High-speed bits can be hand-sharpened in the shop with an aluminum oxide sharpening stone. However, carbide-tipped bits should be sent to a professional sharpening service.

To ensure smooth operation, clean bits frequently of all wood resin and pitch, contact cement and caked-on wood dust. This is especially important with ball-bearing piloted bits. Soak dirty bits overnight in turpentine or kerosene. To remove contact cement, try lacquer thinner. Then, wipe the bits clean with a soft cloth and spray on a coat of oil.

Router bits can be purchased at hardware stores and home centers. Sears (either mail order or retail store) is also a good source for router bits. Some specialized bits can be difficult to find or very expensive. In such cases, mail-order woodworking catalogs offer an easy and often affordable way to get router bits. Look for our story on router bits and where to get them in an upcoming issue. **PM**



Here are some common router bits starting with (left to right): 1/4-in. straight, 1/4-in. straight, dovetail, rabbet with solid pilot, V-groove and 45° chamfering bit with solid pilot.



First four bits shown above have ball-bearing pilots. They are: Roman ogee, slotting, flush trimming bit and bevel trimming bit. The last bit shown is a high-speed steel veining bit.



This set of bits includes (left to right): solid piloted beading bit, rounding over with ball-bearing pilot, core box and two cove bits. One cove has a solid pilot, the other a ball-bearing pilot.



## FIREBREATHERS

(Continued from page 65)

ment trim, plus a venturi-style wind-screen and swim steps.

However, the test team was less pleased with an uneven cockpit deck, absence of stringer system and slight flexing of the foredeck at speed. The positioning of the ski pylon, standard equipment, caused two separate problems: It prevented the bench seat from opening fully and stopped the engine from reaching a full-tilt angle.

The Eliminator demonstrated a light nose at full throttle and didn't run as securely as other boats at maximum trim, but it was the best cornering boat in the fleet.

## Baker RST

The Baker RST was among the fleet's best performers, scoring well in all ranked categories and finishing back of pack in only one. Top-end speed was a solid 59 mph and acceleration time was a swift 7.97 seconds.

Total stowage space is one of the boat's most impressive features. It was first in foredeck stowage and second in cockpit stowage for a whopping total of 102.51 cu. ft.

Features of special note include swim steps with a grab ladder, two cockpit stowage pockets, hydraulic jack plate for adjusting the engine's vertical transom position, and a gel coat of six colors and a fade.

Certain hull elements were outstanding, such as complex molded contours, sculpted foredeck, roomy cockpit-seating layout and flotation in the tunnel pods. But the cockpit deck, like most of the others, is uneven and it doesn't have a stringer system.

Either the jack plate or the transom angle is to blame for the problem we encountered on the performance course. The boat, which required the deepest negative trim in the fleet, resisted all efforts to reduce power-draining cavitation that resulted when the boat banked into the hard 180° turn. However, at full throttle the Baker was ultrastable and showed no signs of instability. It is a dynamic, straightahead scorcher.

The test team was extremely impressed with this unique class of competitively priced, semicustom boats and believe each of their builders could teach the national boatmakers lessons in quality: fiberglass, gel coat and upholstery workmanship.

I only had one opportunity to take a tunnel for a solo pedal-to-the-metal, 70-mph dash on flat water, but there's no feeling like it and I'd gladly swap a high-speed run in a classic, deep-V muscleboat for any tunnel boat in our test fleet.

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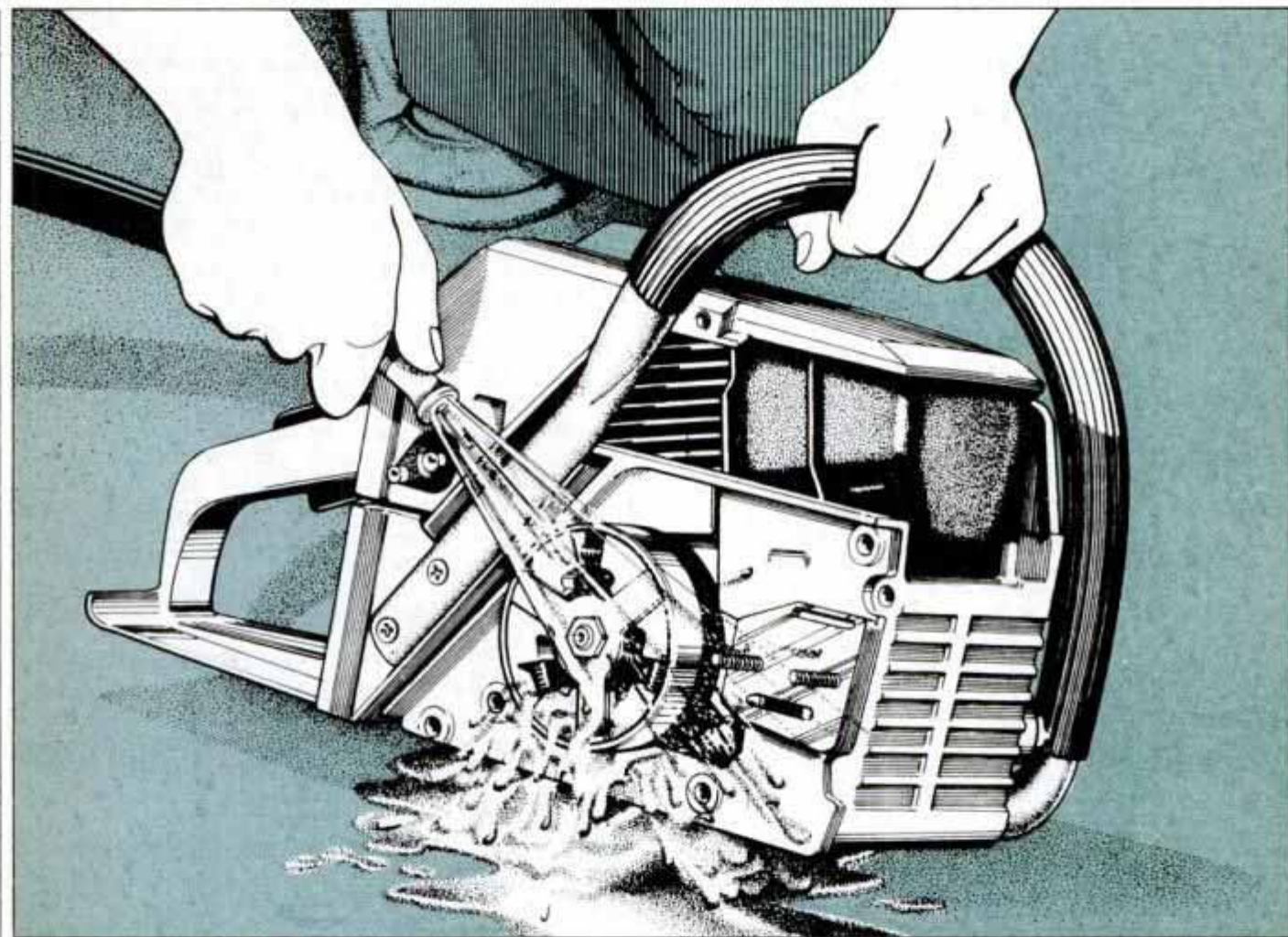
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# How To Maintain Your CHAIN SAW

BY STEVEN WILLSON, Home And Shop Editor; PM Illustrations by George Retseck



**T**HERE was a time when chain saws were the province of professional loggers, tree surgeons and landscape architects. But over the past 10 to 15 years, millions have been sold to average consumers who quickly appreciated the usefulness of these tools. Not only are they indispensable for cutting firewood, but they are also the tool of choice for routine tree pruning and cleaning up storm-damaged limbs. Like any piece of power equipment, however, these saws must be well-maintained to work properly and safely. So, to help

you get your saw in shape for spring cleanup, we contacted the experts at Solo to outline some basic maintenance procedures.

### First things first

All chain saws are basically similar. They are comprised of a small 2-cycle engine with a long, round-nose bar attached to the side. The cutting chain slides along a groove in the bar and is driven by a sprocket that comes off the engine crankshaft. Depending on the particular saw, the tool may come equipped with a chain brake, auto-

matic chain oiler and other features.

Because of these differences, your first task is to carefully read your owner's manual. This booklet will explain your saw's special features as well as setting forth a concise troubleshooting guide that will help you diagnose poor performance problems. Also keep in mind that even though this story deals only with chain saws, most of the techniques apply to any small 2-cycle engine, including those found on string trimmers, leaf blowers, garden sprayers and even some lawnmowers and snowblowers.





**1** Remove sparkplug and clean thoroughly. Check for correct gap with gauge and adjust if necessary. Replace plug yearly.

## Sparkplug

Begin by draining the oil and gas fuel mixture from the fuel tank or by running the engine until the tank is dry. If your saw has been sitting for a couple of months, it's a good idea to flush the empty tank with a little fresh gas to remove any oil sediment.

Next, remove the sparkplug and check its electrodes for dirt, oil and corrosion. A fouled plug indicates several possible problems: improper carburetor adjustments, the wrong gas-to-oil fuel mixture and, in some cases, excessive flooding when starting the engine.

We'll talk about carburetor adjustments later, but the other two problems are easy to correct. Simply follow the manufacturer's fuel mixture requirements as well as the directions for proper starting technique.

If your plug is fouled, clean it thoroughly with emery paper and shake out or blow away any debris. It's also a good idea to wash the plug in gas, using an old toothbrush. After the plug is dry, closely inspect the center and curved electrode for pitting. If either is pitted or rounded over, file both until they are smooth and flat, then gap the plug to match manufacturer's specifications (Fig. 1). Frequent users should install a new plug every 100 hours of engine use. A ball-park figure for occasional users is to replace the plug every year.

## Air filter

Your engine will only run well, if the proper amount of fuel and air are mixed in the carburetor. Because of this, it's essential that you keep your air filter clean at all times.

To check your air filter, begin by brushing away dirt and debris from around the filter cover (Fig. 2). Then

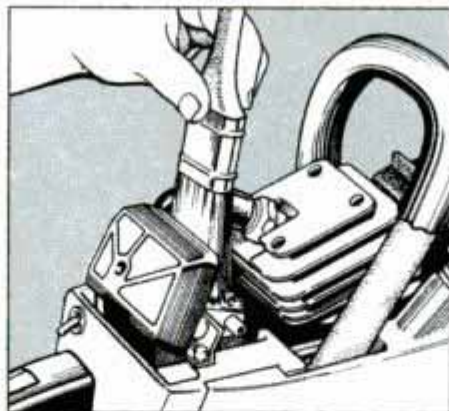
press the **CHOKE** button to close off the carburetor port. This will prevent any debris from falling into the carburetor when you remove the filter. (Note: On some saws, the choke is simply a flapper built into the carburetor cover. Once the cover is removed, the carburetor port is exposed. On such saws, be extremely careful when removing the cover to avoid debris falling into the port.) Remove the filter cover, take it out and brush clean (Fig. 3).

Wash the filter according to manufacturer's recommendations. I use soap and water and blow dry the filter with compressed air.

However, some manufacturers suggest other solvents. No matter what your situation, replace the filter if it is torn or still dirty after several attempts at cleaning it.

## Fuel filter

The fuel filter is designed to keep debris from entering the fuel line and fouling the carburetor. On most saws it's located at the end of the fuel line, inside the fuel tank. To inspect this filter, fish it out of the tank using a wire coat hanger with a loop bent in the end (Fig. 4). Guide the wire into the fuel tank using a flashlight and hook it over the plastic fuel line. Gently pull

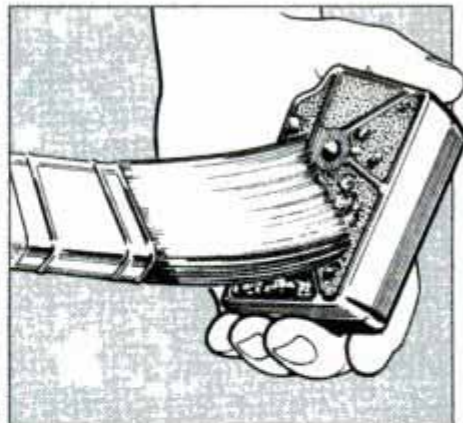


**2** Remove dust and dirt from around the carburetor and air filter. Use either a stiff paint brush or a shop vacuum to do the job.

the line until the filter pops out of the hole. If you pull too hard, you run the risk of tearing the fuel line.

Once the filter is out, check to see if it is clogged with any debris. If it is, pull the filter off the end of the line and wash it with gas and a toothbrush, or blow it out with compressed air. If neither cleans the filter completely, get a new one.

Reinstall the filter on the end of the line and then push everything back into the fuel tank.



**3** Remove the air filter and, again, brush off the debris. Then wash the filter with soap and water, rinse clean and let it dry.

Make sure the filter goes to the bottom of the tank, otherwise, you won't utilize the complete fuel capacity.

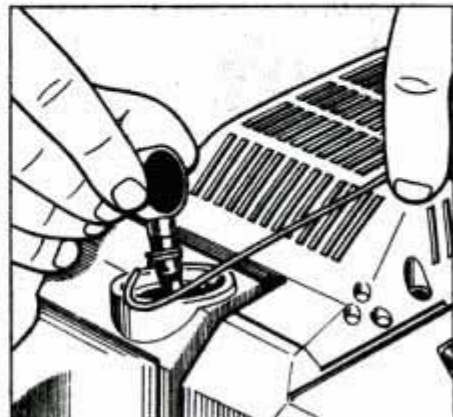
## Pull cord starter

At least once a year it's a good idea to remove the starter housing assembly, even if the pull cord has been working well (Fig. 5). This gives you the chance to thoroughly clean the vent slots and check for worn parts that may need replacement. If your pull cord is broken, then follow the manufacturer's directions on how to replace it—different saws require different techniques and tools. If the starter itself is broken, take the saw to your dealer for repair.

## Muffler and spark arrestor

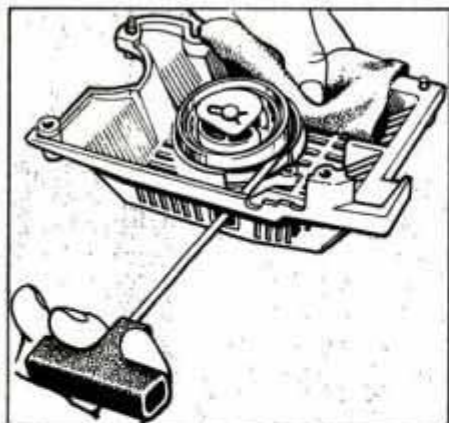
The muffler has two basic purposes: to quiet engine sound *and* to direct harmful exhaust gases away from the user. If it is loose and/or corroded, it will fail to do both jobs. So, it's a good idea to inspect it periodically.

To do this job, you first have to remove the covering panel that pre-



**4** Remove fuel tank cap and fish out fuel pickup line with a bent coat hanger. Make sure line's filter is clean. If not, replace it.



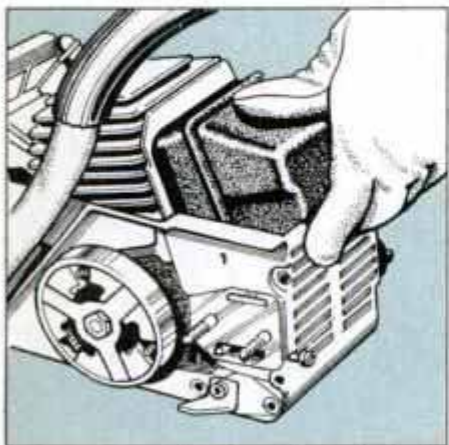


**5** Remove the starter housing assembly and brush debris from entire unit, particularly air vents. Inspect all parts for wear.

vents you from touching the very hot muffler during operation. This is usually part of the chain sprocket housing. Then wiggle the muffler to make sure it's tight (Fig. 6). If it isn't, tighten the bolts to the torque specifications given in your owner's manual. If the muffler is corroded, replace it.

Depending on the age and make of your saw, it may or may not come equipped with a spark arrestor. This device is simply a fine metal screen that prevents red-hot exhaust particles from leaving the muffler and possibly causing a fire. These days you can't cut on most public lands unless your saw has an arrestor.

On our saw, this screen was located just below the exhaust deflector fins. By unscrewing the fin plate (Fig. 7), the arrestor could be lifted out and washed with soapy water and a toothbrush. Compressed air also works well to clean this screen. Because the arrestor is exposed to such intense heat, holes are frequently burned in the screen. When this happens, the

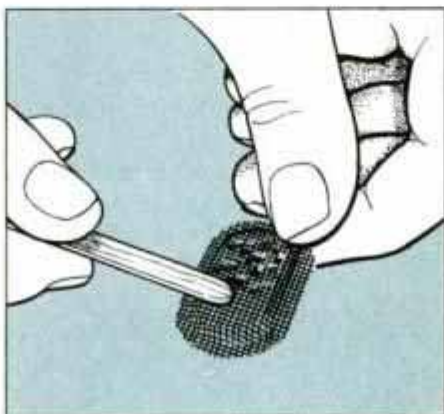


**6** Grasp the muffler assembly and wiggle to make sure it's not loose. Also, check for rust. If muffler is damaged, replace it.

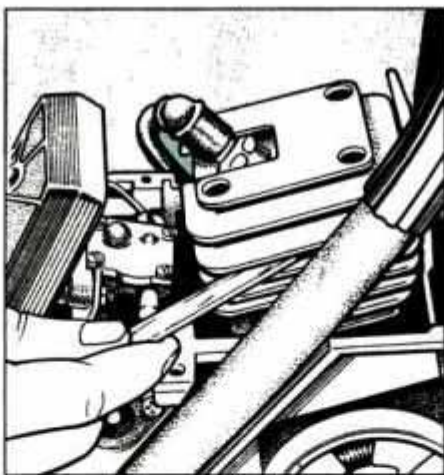
arrestor should be replaced. In any case, you should inspect the arrestor everytime you use the saw to make sure it's in good shape.

On some saws, particularly older ones, this arrestor can be screwed to the inside of the muffler. In such cases the muffler has to be disassembled to reach it. Consult your owner's manual for the more involved procedure.

Now that the muffler and engine fins are exposed, brush away and vacuum up any debris (Fig. 8). Be espe-



**7** Remove sparkplug arrestor screen and remove debris with a brush. For stubborn spots, scrape with small wood stick.

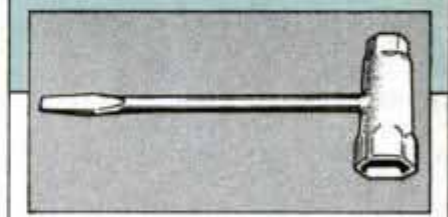
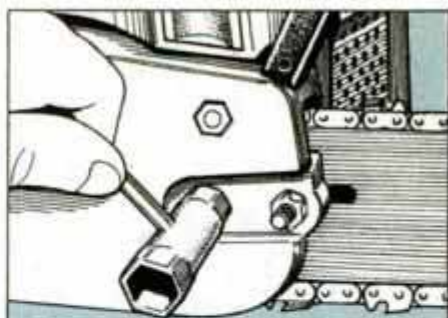


**8** Thoroughly clean the engine fins with a thin wood stick, followed by a stiff paint brush. Be sure to vacuum up all the debris.

cially careful to remove the debris from around the engine cooling fins. Because these saws are air cooled, such debris reduces the airflow around the engine and can cause overheating and damage.

### Chain bar

To free up the chain bar—and the chain for that matter—first loosen the chain tensioning screw at the front of the saw. Then remove the sprocket housing on the side of the saw using

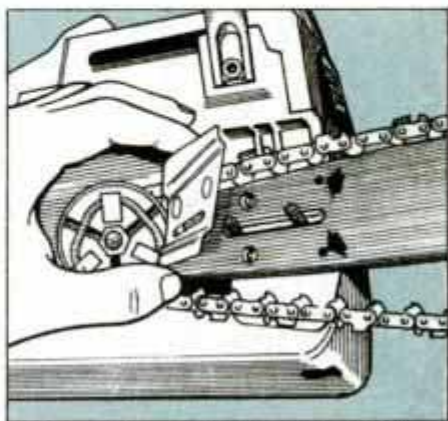


**9** Remove the nuts that hold the chain bar and sprocket housing using a socket wrench or tool (inset) supplied with saw.

either a socket wrench or the combination tool usually sold with the saw (Fig. 9). Once the chain is loose and the cover is off, lift the chain from the bar groove, and set it to one side. Then remove the bar (Fig. 10).

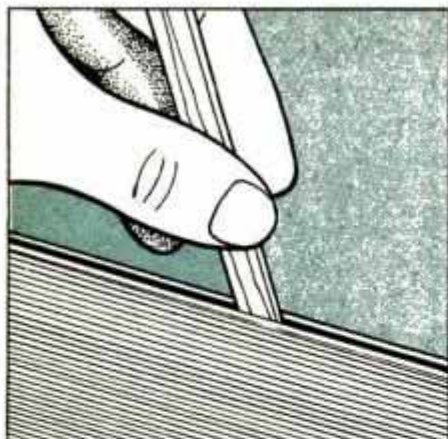
Thoroughly clean the debris from around the drive sprocket and clutch assembly. Compressed air works well for this. But if the wood chips and dust are caked on, a liberal dose of cleaner/lubricant—like WD-40—and a stiff toothbrush will do the trick. Wipe the saw dry with a rag and complete a visual check of the sprocket assembly. If you detect any worn parts, have them replaced.

Next, clamp the chain bar in a vise—preferably one with protected jaws—and remove any dirt and debris from the bar groove. You can use a piece of scrap wood for this job, shaving the end until it slides easily in the



**10** Once the sprocket housing is off, remove the outer bar plate. Then lift chain off sprocket and remove chain bar.





**11** Using a thin wood stick, clean the oil-soaked debris from chain groove on the bar. Use a small nail for stubborn spots.

groove (Fig. 11). Remember that the bar does wear unevenly—more stress is exerted on the cutting side. Because of this, manufacturers suggest that you turn the bar over before every heavy work session to equalize the wear.

Once the groove is free of debris, clean the oil holes on the side of the bar. These holes allow the chain oil to flow along the chain groove. If they are clogged, the oil won't be able to do its job and both the chain and bar will be short lived.

Next, inspect the groove rails for wear. Over time, the movement of the chain will create small, metal burrs along these rails. File these surfaces flat and smooth. If the bar groove is distorted or bent, it's time to replace the bar.

## Chain

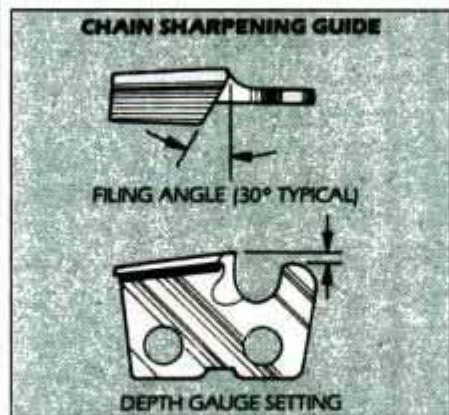
After giving the chain a thorough cleaning with solvent and a toothbrush, reinstall the bar, chain and sprocket housing. Then tighten the



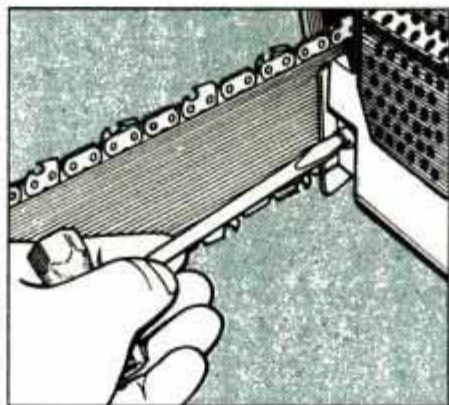
**12** Reinstall the bar, chain, plate and housing, then tighten chain. Sharpen teeth with a combination file guide.

chain tensioning screw until the chain is nearly tight. This will keep the chain stable as you sharpen it.

The sharpening techniques required will depend on the type of



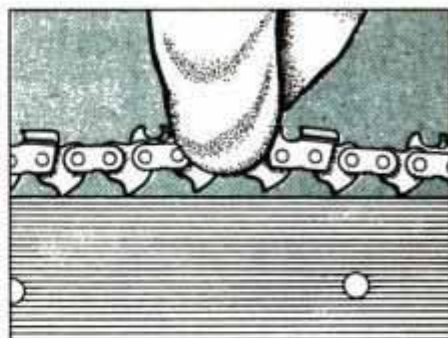
**13** Sharpening angles vary depending on type of chain and manufacturer. The filing angle above is a general guideline.



**14** Once the chain is sharpened, adjust tensioning screw with saw tool to match manufacturer's recommended tolerance.

chain that's on your saw. Consult your owner's manual for specific directions. However, most saws are sold with what is called a standard chain. This is comprised of cutting teeth joined by drive links that run in the bar groove. The cutting teeth have a top plate, side plate and depth gauge (sometimes called a raker). You must sharpen all three of these surfaces whenever the chain is dull.

Many people use a special round file for the top and side plates and a separate flat file for the depth gauge. (The manufacturer stipulates which files to use.) But a better idea—especially for the novice sharpener—is to use a combination filing guide like the one we show in Fig. 12. This tool files all three surfaces at once, maintaining the proper angle and the proper distance between the top of the teeth and the top of the depth gauge (Fig. 13).



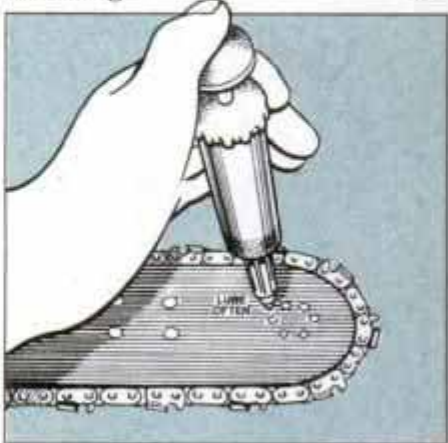
**15** The bottom of a properly adjusted chain should just clear the top edge of the bar. Always adjust the chain when it is cool.

The trick in sharpening is to file all the teeth the same way. Start by finding any tooth that has a chip or nick and file until that fault is removed. Keep track of the number of file strokes required. Then proceed to file all the remaining teeth, using the same stroke and the same number of strokes. If your chain is in particularly rough shape, have it sharpened professionally or buy a new one.

Once the chain is sharp, readjust the chain tension to manufacturer's specifications (Figs. 14 & 15), lubricate the front chain sprocket on the guide bar (Fig. 16), and reinstall the sparkplug. Fill the chain oil reservoir, add the proper fuel mixture to the fuel tank, and give the cord a pull. Your saw should start right up.

If it doesn't, or it runs rough or the chain moves even when the saw is idling, then you'll have to adjust the carburetor. Because carburetor adjustments vary depending on the saw, be sure to carefully read your owner's manual. As a general rule of thumb, you'll have to adjust both the low- and high-speed mixture needles first, followed by the idle screw once the saw is running.

FM

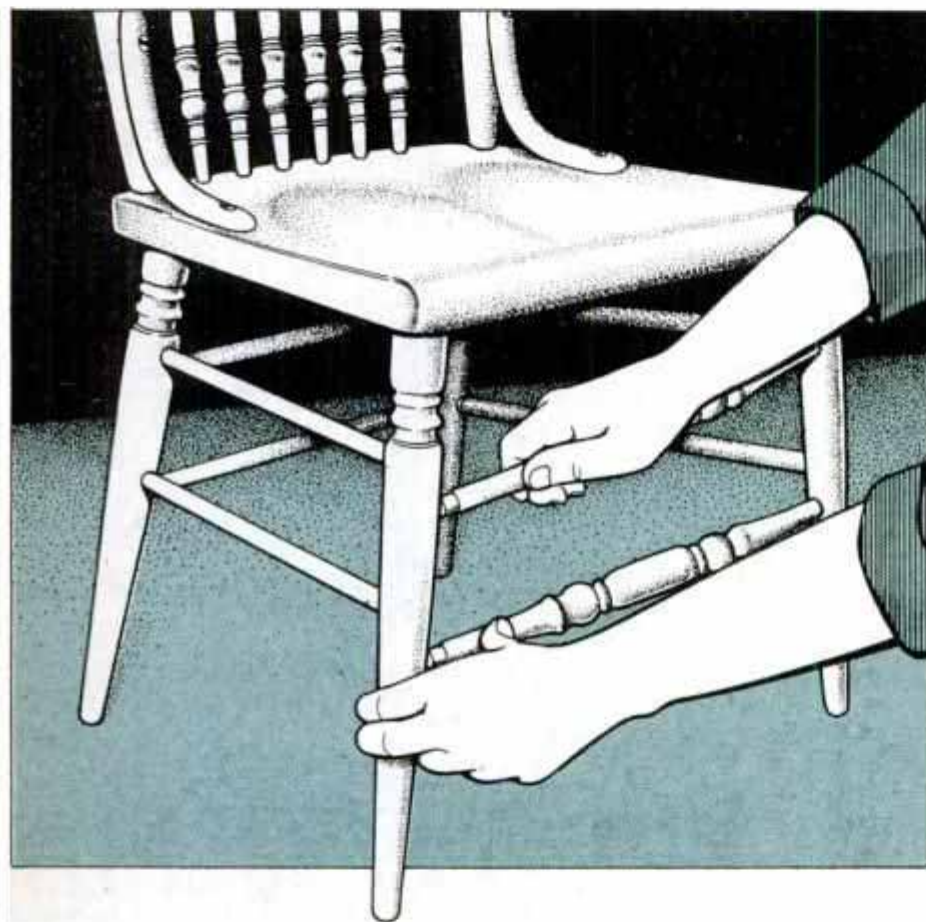


**16** Using a grease gun—available from your dealer—lubricate roller at nose of chain bar with automotive grease.



# How To Fix A Loose SPINDLE CHAIR

BY THOMAS KLENCK, Associate Home And Shop Editor  
PM Illustrations by George Retseck



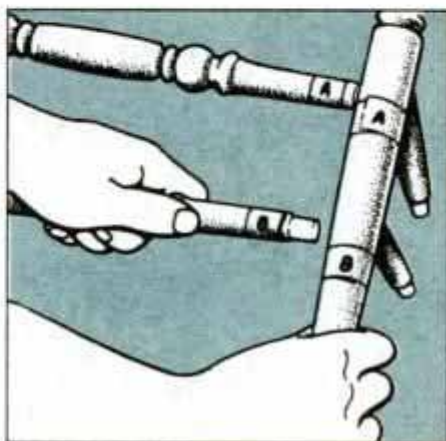
**I**F YOUR chairs are greeting you with a range of squeaks and groans every time you sit down, perhaps they're trying to tell you something. Traditional spindle chairs—whether they be family heirlooms or garage-sale bargains—are all subject to the same problems. Years of hard use will eventually loosen the best-fitted joint and when one joint goes, it's just a matter of time before the rest follow.

Unlike most furniture, chairs endure extraordinary stresses in relation to their weight and size. They must resist the twisting and turning of normal use and the racking that results from an uneven floor or leaning back in the chair.

In addition, the joints swell and contract with seasonal changes in humidity. This can destroy the glue lines and eventually compress the rung tenons to the point where they no longer fit. Paint-stripping procedures can also dissolve the glue leaving you with well-fitting components that are no longer secured together.

Historically, a periodic regluing was considered a fact of life. And, a complete disassembly and regluing remains the surest way to keep your chairs in service for years to come.

As a convenient alternative to gluing, loose joints can be periodically treated with Chair-Loc—a preparation that causes the rung tenons to swell and thereby become locked into



**1** After labeling adjacent components, tap loose joints apart and separate legs from seat. Good joints can be left intact.

the socket. This can be applied by forcing the fluid into existing joints or in place of glue when reassembling. Chair-Loc is available from Chair-Loc Co., Box 45, Lakehurst, NJ 08773 and costs \$3.50 postpaid for 3 ounces.

## Starting repairs

Spindle chairs are either built with rear legs that also serve as back posts, or with back posts that are mortised into the seat and are independent of the leg structure. Because most problems are located in the base, a chair with an independent back is easier to repair. If your chair has 1-piece rear legs and back posts, the rear legs are usually screwed to the seat. In this case you may have to disassemble part or all of the back to work on the legs and rungs.

First, apply masking tape near each joint and label the components so they won't be mixed up during reassembly (Fig. 1). Tap apart all loose joints. If some joints are wobbly, but don't respond to a gentle tapping, secure the rung in a vice and knock the joint apart. Wrap a cloth around the spindle to prevent marring (Fig. 2). If a joint refuses to come apart, it's best to leave it intact.

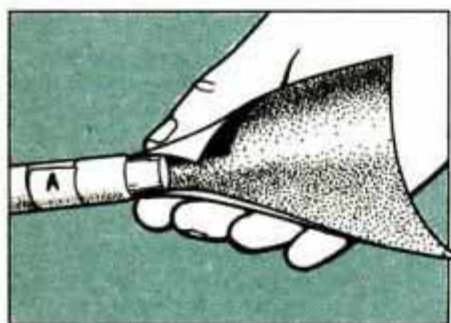
Use 80-grit sandpaper to remove





**2** If joint is loose but won't easily come apart, place rung in vise and knock joint apart. Cloth protects leg from marring.

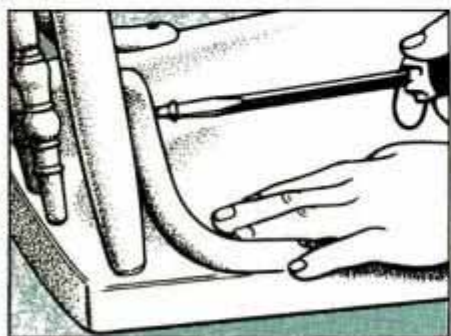
old glue from the tenon ends of the spindles (Fig. 3). A sharp knife with a straight cutting edge or sandpaper wrapped around a dowel does a good job of cleaning the holes. Be careful to remove only the glue so as not to create an excessively loose joint.



**3** Use sandpaper to carefully remove old glue from rung tenons. Avoid excess sanding. Use a sharp knife to clean out holes.

### Checking the back

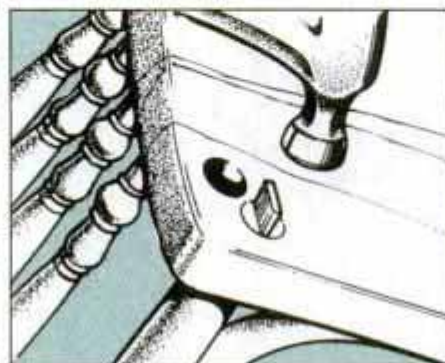
Chair back-to-seat joints are commonly reinforced with a bent-wood brace on each side (Fig. 4). Check to make sure that the screwholes are not stripped. If necessary, use heavier gauge screws when reassembling.



**4** Backs are often reinforced with bent braces. Remove screws to free back posts. Check that screwholes aren't stripped.

Chairs with independent back uprights are usually secured to the seat with wedged-tenon joints. Remove the wedges from the upright tenon ends by pushing them out with a flat-tipped screwdriver. Cut new hardwood wedges—slightly larger than the old ones.

Check that the splat is securely attached to the uprights and remove and prepare for regluing if necessary.



**5** After applying glue to back post holes, insert posts and attach bent braces. Drive wedges in place and then trim them flush.

### Reassembly

First, dry fit the joints and test each for a snug fit. It's best to prepare shims ahead of time for any loose joints. Use a sharp hand plane to cut a shaving from a 1/4-in.-wide board. Wrap the shaving around each loose tenon and cut to size with scissors.

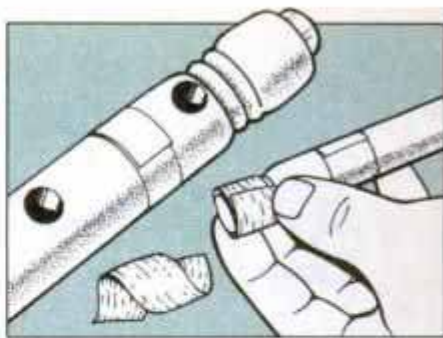
Apply glue to the back post holes



**6** Apply glue to tenons and holes and assemble front right leg and rungs. Then, join rear left leg and rungs in the same way.

and wedges and assemble the back to the seat. Drive the new wedges into the slotted ends of the posts and then trim the wedges flush (Fig. 5).

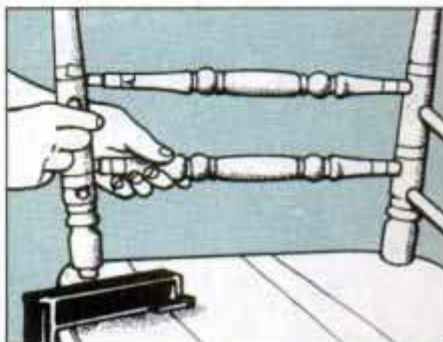
Apply glue to all rung holes in the right front leg and install the rungs (Fig. 6). Assemble the rear left leg and rungs. Apply glue to the leg holes in the seat, rung holes on the other legs, and rung tenons. Partially insert the legs into the seat holes while lin-



**7** Where joint fit is loose, coat tenon with glue and wrap with shaving cut with a hand plane. Apply glue and insert in hole.

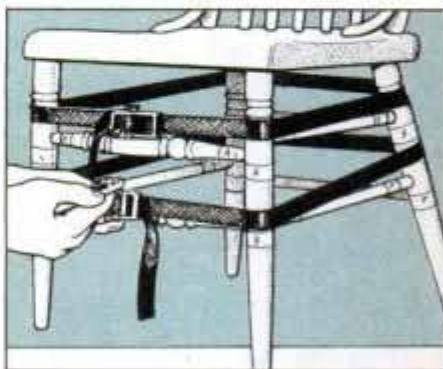
ing up and joining the rungs (Fig. 8). Tap the joints tight and clean away excess glue with a damp cloth.

Place the leg structure upright on a flat surface and adjust it so it's square and each leg is in contact with the surface. Install band clamps around the legs and let the glue set (Fig. 9).



**8** After joining front right leg to seat, insert other legs while lining up and joining rungs. Then, tap joints tight.

If your chair has rear legs that also serve as back supports, assemble the back first. Screw it to the seat, but don't completely tighten the screws. Then, assemble the two front legs and rungs to the seat. Gently spread the front and rear assemblies apart to insert the side rungs, tap all joints, home and tighten the screws.



**9** Make sure frame is square and legs are level. Then, use band clamps to hold structure in position while glue sets.



# Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

## Noisy Water Heater

About six months ago I replaced my electric water heater with a State model No. SRV40NR74 JW, gas-fired unit. Shortly after the installation, I began hearing strange banging noises in the house.

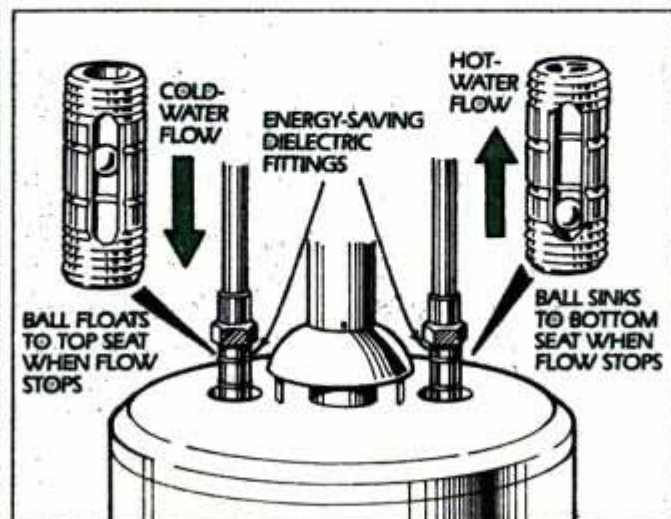
I traced the noise to the water heater where banging could be heard whenever the unit came on. If a large quantity of hot water was being used, the sound eventually stopped. I am concerned that the noise may represent a problem with the heater and may indicate premature failure. Would you comment?

RONALD VOGT  
WHITEHOUSE STATION, NJ

According to the manufacturer, your model water heater is equipped with energy-saving dielectric fittings that connect both the cold- and hot-water pipes to the heater. For the past two to three years, these fittings have been offered as optional equipment. They minimize heat loss that's the result of convection within the water lines when the heater is not supplying hot water.

The energy-saving dielectric fittings have ball valves. When hot water is being drawn, the water pressure moves the balls off their seats allowing water to enter the tank and leave. When the water flow stops, the cold-water ball floats up to restrict heat loss via the cold-water line and the hot-water ball sinks sealing the heat in the tank from the water in the hot-water pipe. This, according to the manufacturer, results in an energy saving of about 12 percent.

Check the water pressure in your house. If it fluctuates or is high (greater than 60 psi), it can cause the balls in the fittings to vibrate resulting in noise. Also, the fittings were redesigned a few years ago and it's possible that you have the old design. In any case, the noise is not harmful and will not cause premature failure. However, if you find the noise annoy-



Energy-saving dielectric fittings minimize heat loss through convection. Ball valves in fittings may vibrate and make noise.

ing, the simple solution is to remove the energy-saving fittings and replace them with the ordinary type.

## Adding A Tank

I installed a new pump and captive tank in my well-water supply system. My old glass-lined tank is still in good condition. Can I connect the old tank to the new system? FRED STUMPF  
EAST QUOGUE, NY

Yes, you can. However, a few words of explanation are necessary. A tank performs two functions. First, it acts as a reservoir from which water can be drawn without having the pump run continuously. Second, it maintains an air cushion that is compressed as the tank is filled. The compressed air is what pushes the water out of the faucet.

Your new captive tank has a fixed membrane that separates the air from the water and prevents the air from dissolving into the water. Your old tank lacks this membrane and works by maintaining a pocket of air over the water. Because the air is in contact with the water, it will, over time, dissolve into the water and the tank will need to be recharged. This may be necessary every 8 to 12 months depending on water usage.

By connecting the old tank and new system, the amount being held for drawing from the tap will be in-

creased and your pump will start less frequently.

## Moldy Mirrors

My decorative glass mirror tiles have developed dark, mold-like, ugly growths in the back-side reflective films. The tiles are the inexpensive type with stick-on tapes.

I intend to replace the damaged tiles and wonder whether first painting the tile backs or applying silicone caulking would keep the problem from recurring.

K. TABA  
KANEHOE, HI

The dark blotchy areas on your mirror tiles are not the result of mold buildup, but rather the tarnishing (oxidation) of the silver backing. Mirrors are made by covering large pieces of plate glass with a film of silver and then a coat of paint to protect the silver from scratches and tarnishing. These large mirrors are then cut into the desired sizes. The cutting not only fractures the glass, but affects the paint bond at the cut line. Minute amounts of the silver film are then exposed to the air where the silver can tarnish. Therefore, additional paint could help if you pay particular attention to the tile edges.

Proper handling of the mirror is also important. If when being installed the backing is scratched—even if the scratch is tiny and doesn't penetrate the silver, that area will eventually tarnish.

I don't recommend silicone caulking for your mirror tiles. This has a solvent that will attack the mirror backing.

You should use an asphalt-base adhesive (mirror mastic) or foam adhesive tape, both of which are available at hardware stores. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.



# Appliance Clinic

BY STEVE TOTH, Contributing Editor

## Thermostat Trouble

I have a G.E. oven model No. JD12A1WH, serial No. LAD10557. When I set the temperature dial for 400° F, the oven thermometer reads only 350° F. If I turn the temperature up to 450° F the thermometer reads 425° F. Is there something wrong with the thermostat?

HERBERT BOYER  
LARGO, FL

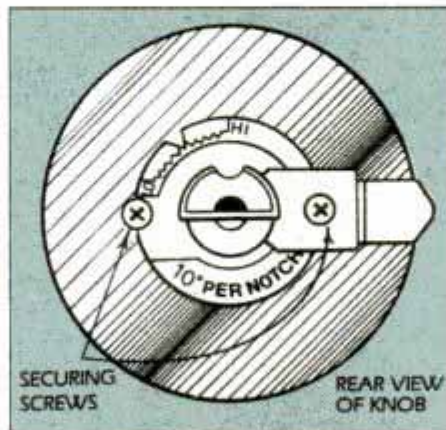
*It's not uncommon for a thermostat to drift from its factory setting after a few years. Usually, it can be adjusted but you'll need a good mercury oven thermometer available at any large hardware store. Place the thermometer in the center of the middle rack of the oven. Shut the door, turn the selector switch to BAKE, and adjust the temperature dial to 400° F. Record the temperature when the indicator light goes off and when the indicator light comes on to get the high and low readings for this dial setting.*

*Record high and low readings for three more cycles and calculate the average temperature. It should fall between 390° F and 430° F. If it's outside this range, then pull the thermostat knob off the shaft without turning the shaft. On the back of the knob you'll see the adjustment mechanism. Each notch will change the oven temperature by 10° F. Loosen the two screws on the knob back, adjust the dial one notch in the desired direction, retighten the screws and replace the knob. Then, recheck the oven temperature. It may take several tries to get the temperature setting within range. If the thermostat continues to drift, then replace it.*

## Enthusiastic Burners

I have Jenn-Air model 88370, serial No. 3703810, drop-in range. This unit has cartridge-type burners that can be replaced with accessories such as a griddle or barbecue grill. The trouble is that when the left rear burner is turned on, the left front one comes on too—at high temperature. It happens when the cartridges are switched and also with the barbecue grill installed. Any ideas?

FRANK R. SHERMAN  
SUDBURY, MA



G.E. oven thermostat can be adjusted by removing dial and loosening screws on back. Shift one notch, tighten screws and retest.

*If your range has the original cartridges, one of the infinite switches that controls the top burner may be stuck in the closed position. Also, the contacts inside the switch may be shorted together. The problem switch might not be the one you're turning, but another one in the system. This shorted switch would allow the current to pass through the blower line to the burner element causing it to heat up.*

*To determine which switch is at fault, have your appliance repairman disconnect the power to the range. Then, gain access to the top burner switch. Check each switch individually with an ohmmeter or continuity tester to see which contacts are closed when the switch is in the OFF position.*

*A good switch—when turned to the OFF position—should have an open circuit between contacts L-1 and H-1 and also between L-2 and H-2. Once you find the bad switch, replace it with a new infinite switch Jenn-Air part No. 700009-4.*

*If this problem began after you installed a new cartridge, then you could have the wrong cartridge for your model range. This would cause both elements to heat up when the front element switch is turned on.*

*If you need help in locating a Jenn-Air service agency, or want to know where to buy parts, call Jenn-Air's customer relations department at (317) 545-2271.*

## Fluctuating Blower

The blower on our new Sears Kenmore Electric dryer fluctuates as the clothes dry. The unit is model No. 110.8688010, serial No. M80102533. The Sears serviceman told us that this problem is the result of a more powerful blower design. Have you ever heard of this happening before and will it damage our dryer or overload the motor?

RICHARD M. NISKI  
SAN DIEGO, CA

*I contacted Sears and they said that this condition can occur when there is a small, lightweight load in the dryer.*

*It can also occur where there is a short or nonexistent exhaust vent system. The clothes will plaster themselves to the exhaust outlet causing a reduction in airflow.*

*To correct this, Sears suggests putting a few lint-free towels in the dryer along with light loads. The towels should keep the other items from clinging to the outlet.*

*When this condition exists, there will be some increased wattage drawn by the motor, but not enough to affect operation or harm the motor in any way.*

## Needs Parts

I have a LaMachine model No. 354, serial No. 150179. I've been told that the Moulinex Co. has been sold or gone out of business and parts are not available. Can you help?

TIM BROWN  
BURLINGTON, IA

*The Regal Co. bought the French company, Moulinex, and parts for your LaMachine are available from any Regal Ware authorized service center.*

*You can also order parts from the factory by writing to Regal Ware, Inc., 2820 Crusader Circle, Virginia Beach, VA 23456, or by calling the company at (804) 468-3500.*

*If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.*



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John D.  
Age 18



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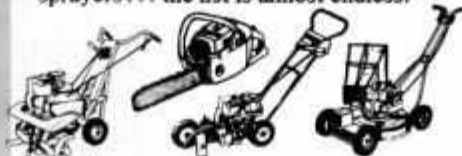
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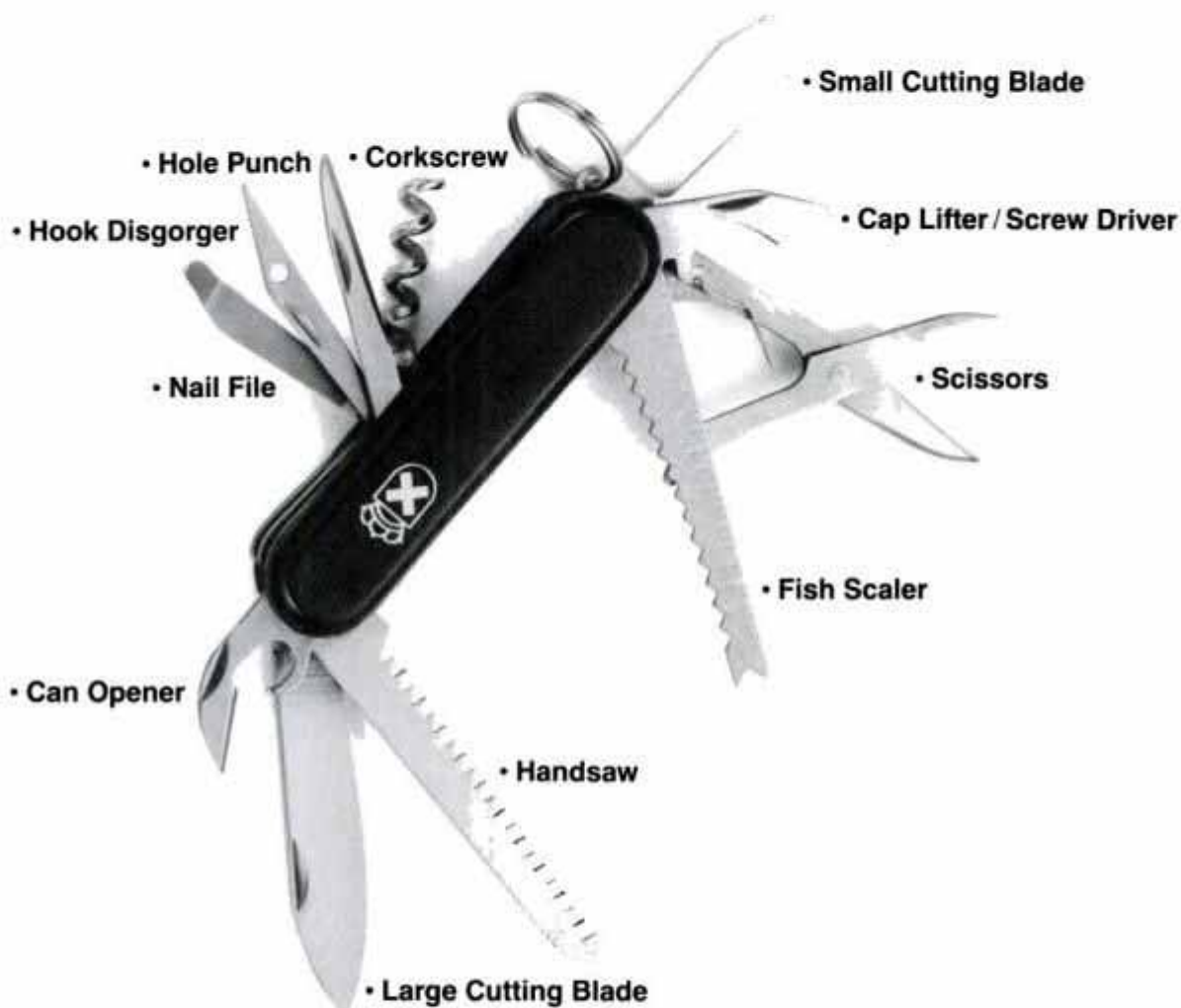




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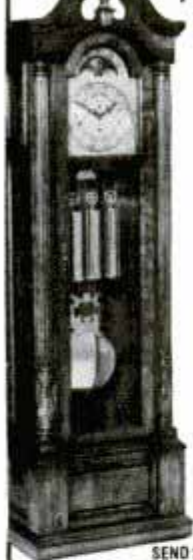
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(for Leitz Camera) was built by Oskar Barnack, chief of the German optical company's experimental department.

The Leica Model A made its debut in 1923 and revolutionized photography. Its superior optics and mechanics permitted fine detail on a small negative. Its quality, compact size and versatile operation found favor with working journalists and weekend photographers alike.

The next advance in 35mm was the single-lens-reflex (SLR) camera, with its characteristic protrusion above the viewfinder. That protrusion houses a pentaprism of mirrors that displays in the viewfinder exactly what the lens sees—enabling the photographer to focus and compose through the lens. "Rangefinder" cameras such as the Leica lacked this feature. Although an SLR called the Duflex was manufactured in Hungary after World War II, the first practical and widely available SLR was the Asahiflex of 1952. Its manufacturer, Asahi Optical Co., is more widely known by the appropriate brand-name Pentax.

## Music to the eyes

Improvements in film and other areas kept pace with the 35mm hardware. The first flashbulb popped around 1925, and electronic flash was in the works at the Massachusetts Institute of Technology by 1940. Portable, artificial illumination was a must for on-the-go photography, as films at the time were still quite slow.

They were also black-and-white. Although color photography was possible as early as the 1890s, it wasn't commercially feasible or physically practical until the advent of Eastman-Kodak's Kodachrome transparency film, in 1936. Kodacolor print film followed in 1942.

The innovative Kodachrome was the work of two kitchen chemists—musicians Leopold Mannes and Leopold Godowsky Jr. Legend has it the classicists whistled in the dark to time the exposure of their slide film. It must have been a long aria, as the first Kodachrome had an ISO-speed equivalent below 10.

Today, it's available in the ISO-200 speed, and other slide films reach ISO-1600. Color print films run as fast as ISO-3200, and Kodak's remarkable T-Max P3200 black-and-white film can banish the darkness by registering images at a hyperfast ISO-25,000. Speed of a different sort is available in the instant films from Polaroid.

Instantly developed pictures were available from while-you-wait street photographers in the late 19th century, but the novelty process was too

impractical for general use. It remained impractical until the 1940s, when Edwin Land designed a film pack with its own jelly-like processing chemicals sealed in. His Polaroid camera, introduced in 1948, delivered black-and-white prints in 1-minute flat. Color arrived in 1963, and today Polaroid offers a wide variety of instant films, including transparencies.

## The electronic age

Ironically, as films become sharper and faster, the electronics technology that helps cameras take better pictures is ushering in the era of filmless photography. This month, 150 years after Daguerre's historic announcement, Canon will begin selling a camera that records images on a magnetic disc instead of film (see "Electronics," page 42).

Electronics has changed the nature of photography over the past decade or so, usually for the better. Smart circuitry created the first point-and-shoot SLR, Canon's AE-1, in 1976. Focusing, along with everything else, was automated by 1979 in the Canon AF35M Sure Shot—a compact 35mm rangefinder that used infrared light to measure subject distance and focus the integral lens.

By 1985, Minolta's Maxxum line of SLRs and lenses made focusing simultaneous with pressing the shutter release. Still-video cameras such as Canon's new RC-250 will use magnetically sensitive materials instead of light-sensitive chemical film to capture an image.

This means no film processing is necessary. Instead of projecting slides, we'll simply display our video stills on a color TV. Electronic snapshot prints will be an option in the future—today's video prints are still pretty crude by photographic standards. In fact, still video has a way to go before it can measure up to photos in image quality. The equivalent film speed of electronic imaging is now limited to about ISO-200. Detail-bearing picture elements measure only in the hundreds of thousands—compared to the 2.6 million pixels present on a snapshot-size print.

It's obvious that still-video imaging is just in its infancy, and if the history of photography is any indication, the advancements will come rapidly. Meanwhile, conventional photographic technology is still in the growth stage—with no sign of slowing down. In the years to come, the two technologies will likely coexist, and continue amazing us. As George Eastman once said, "The man who thinks he has done everything he can do has merely stopped thinking." **PM**



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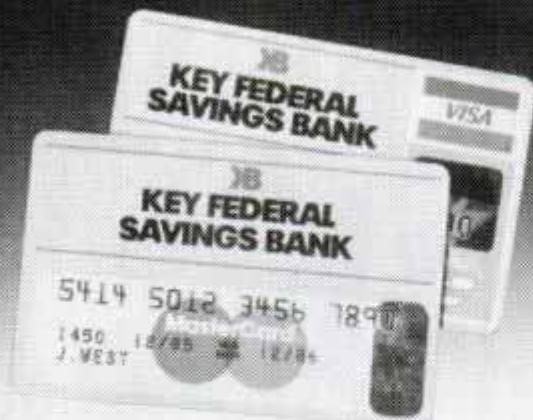
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## MOTOWN MUSCLE

(Continued from page 57)

pool. You should also avoid letting him see the head-up display technology stolen directly from an F-16. The glowing, green digital speedometer reflects off the windshield, so you'll know exactly how much too fast you're going when the state police car zooms up behind you.

At nearly 3500 pounds, 205 hp doesn't make the Turbo GP much of a threat to the street-racer crowd. But it's definitely got more suds than the normally aspirated car. We always felt Grand Prixes needed more tire and more horsepower. The McLaren Turbo has 'em both.—M.A.

## Pontiac Trans Am Turbo—the prime mover

In The Beginning, there was Buick Grand National, the quickest, hairiest production car this side of the oil crisis. But then B-O-C decided that Buick wasn't the performance car company at GM.

However, it seems there were a few GN motors left after '88 model-year production was finished. And Pontiac wanted a fast car for its Indy Pace Car program, which just happens to come the same year as the 20th anniversary of the Trans Am. Think about it—GN 3.8 V6 turbo muscle in a vehicle with nearly 200 pounds less weight, a lower C.G. and *much* smaller frontal area.

With the improved front-to-rear weight bias and F41 suspension calibration, the Turbo pulled a solid .86 G on the skidpad. And beyond sheer adhesion, the Trans Am Turbo is wonderfully controllable to drive at the limit, something that's traditionally difficult for fast, front-heavy cars.

But the real story is acceleration. Without the opportunity for a lengthy dragstrip session, 14 flat in the quarter was the best we could do (!). The 100-mph trap speeds were also something of a disappointment, as the car seemed to stop pulling at about 90 or so. Here is a car that has definitely been geared for E.T. over top end.

But in the short run, this one's a real kick in the pants. Just put the gear selector in DRIVE, hold the brake with your left foot, floor the throttle. As the tach passes 2000, let off the brake. There's no major drama, just the Christmas tree getting very small in the rearview, very rapidly.

Unlike the supercars of the pre-OPEC era, the TTA is a balanced machine, with brakes and handling to match its awesome power. The ZR1 Corvette may be the King of the Hill, but the Trans Am Turbo rates as a crown prince.—M.A.



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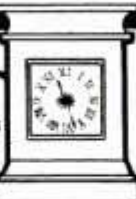


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## OUR MOST SECRET FIGHTER (Continued from page 69)

sance airplane like this, you'd want to cram fuel in every nook and cranny possible. Even so, I'm absolutely certain that an air-to-air refueling capability was a primary design requirement."

Technicians at Wright Patterson AFB are said to have developed the aircraft's reinforced carbon-fiber skin. Lear-Siegler supplied the digital fly-by-wire controls. Theorists point to a special pop-down weapons platform for the aircraft's mission-specific stores. It's possible the weapons bay was designed around the High-Speed Anti-Radiation Missile (HARM), which would permit installation of smaller weapons as well.

One of the biggest misconceptions concerning the F-117A's physical profile involves its tail structure. Some illustrations depict twin inward-canted tails, while others dispense with them altogether, suggesting that they would be supplanted by thrust-vectoring nozzles.

"As a first-generation type," ventured Sweetman, "the F-117A would definitely have some sort of tail or tails. I'm told that the plane definitely has two tails, and that at one point or another during the prototype phase, Lockheed tried mounting them both ways—that is, canted inward and outward—and settled on the latter."

## Flight characteristics

The F-117A is not a fighter in the strictest sense, a fact which has led many reporters astray. It is not designed to engage in air-to-air combat with enemy fighters in the classic manner. Rather, the F-117A is a subsonic medium-altitude air-to-surface strike aircraft. The F-117A, therefore, has no requirement for high maneuverability or air-to-air armament. But despite a very benign flight profile, and a lower priority placed on jinking through terrain, certain aerodynamic design tradeoffs have been made to obtain the optimum in Stealth attributes—both physical and electronic. What this means is that the F-117A is a relatively unstable aircraft, requiring sophisticated on-board computers to effect constant and exceedingly subtle flight corrections.

According to a recent report in *Time* magazine, F-117A pilots commented that this symbiotic relationship between human pilot and computerized copilot doesn't always yield the best of both worlds. The computers haven't consistently functioned as advertised, and as a result, "the plane sometimes 'gets away' from the pilot, who has to take over manually—and

earn his wings all over again." In fact, because of its rather spooky handling characteristics, the aircraft has earned the nickname "Wobbly Goblin" from pilots.

In spite of these stories, Bill Sweetman cocks an eyebrow and cryptically offers, "I've been told that it flies better than you might think." Gunston, too, remarked, "Based on my information, anyone who believed the *Time* magazine account would be misled. It should be well within the compass of any ordinary squadron pilot to fly it."

## Mission specifics

Some accounts of the F-117A's mission profile involves deployment of the aircraft to a forward base on special pallets aboard C-5B Galaxy transports. In this scenario, the F-117A's wings and tails would either fold up like aircraft carrier planes of old, or actually be removed.

The Stealth Strike-Fighter's most likely primary targets are high-value types which would therefore be well-protected: subterranean command posts, surface-to-air missile sites, hardened aircraft shelters and so on. Many pundits have speculated that the AGM-65 Maverick family of guided air-launched missiles would be the obvious weapon of choice, but Sweetman disagrees. "I'd put my money on the BLU-109/B warhead mounted on the Paveway III laser-guided penetration bomb."

Currently in the Air Force inventory, the BLU-109 is a 2000-pounder designed to penetrate 6 ft. of reinforced concrete before detonating. "By using unclassified DOD literature, one can trace exactly what type and how many of a given weapon system are being supplied to any known Air Force unit. Strangely, there are no records available on the distribution of the BLU-109/B. You figure it out."

## Smoke and mirrors

Educated assumptions laced with unassailable facts bring us this advanced first look at America's most secret fighter. It's likely that new aircraft like the ATB and the ATF will supplant this first-generation effort at invisibility from radar. And loitering antiradiation missiles like Tacit Rainbow—in concert with conventional aircraft—are no doubt capable of achieving the F-117A's results against high-value targets. In fact, it's just possible that the much-vaunted Stealth Fighter, the mystery plane of the 20th century, may soon become a museum piece.

FM



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I've acquired a quite respectable art collection including Picasso's, Le Peinte et San Modele which was owned by the Shah of Iran, Picassos "Bull fight" which I acquired from defunct Phillipine strong man Ferdinand Marcos and Rembrandts St. Jerome in Dark Chambers from a Dutch museum. I have many other pieces, however if you are an art connoisseur you can appreciate these pieces significance. I have also purchased some quite impressive status symbols such as a solid gold Rolex Presidential watch and a solid 14K gold brief case which was number 48 of 50 which the Zero Haliburten company manufactured for it's 50th anniversary.

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(Continued from preceding page)

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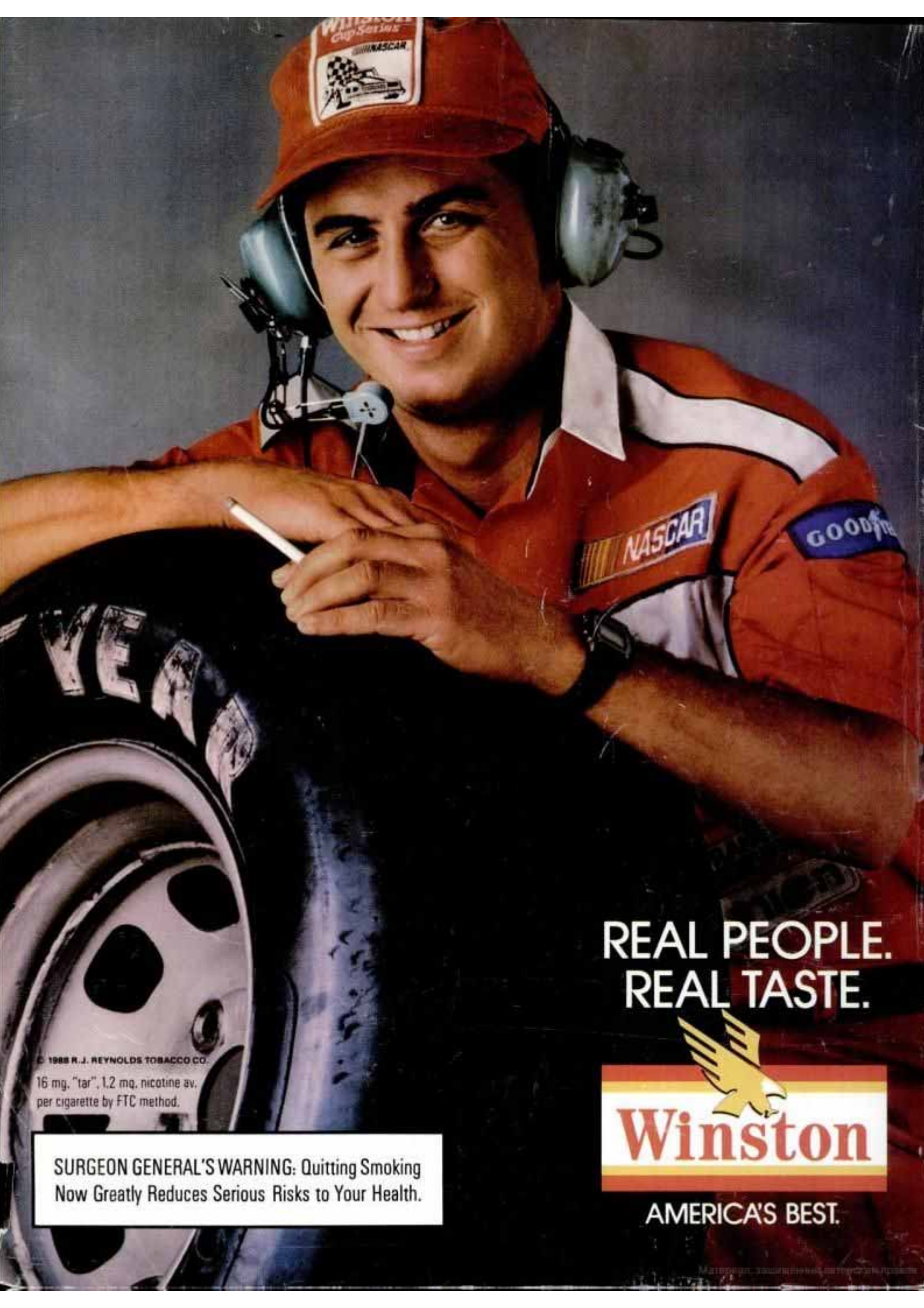
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