

SEPTEMBER 1990 \$1.95

Popular Mechanics

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DEATH VALLEY TO PIKES PEAK
FORD EXPLORER TORTURE TREK

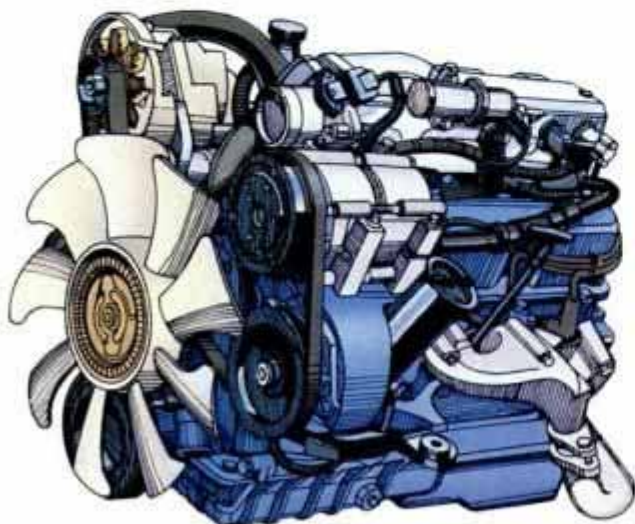
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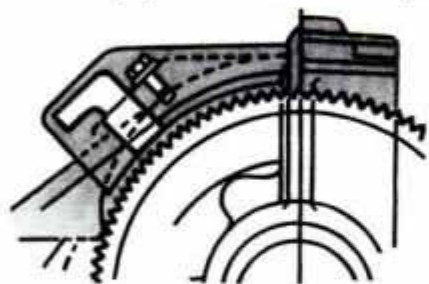
Why Do Ford Trucks For Some Very Technical



Advanced engine technology: Newly developed 4.0L multi-port electronic fuel-injected V-6 governed by Ford's advanced EEC-IV engine control computer.



A Ford exclusive: Electronic pushbutton four-wheel drive system. Shift on-the-fly from 2WD to 4WD-High and back at the touch of a button at any speed. Standard on Ranger 4x4s.



Computer-controlled anti-lock rear brakes for more controlled braking. Functions full-time in the 2WD Ranger and when the 4WD model is in 2-wheel drive.



Buckle up—together we can save lives. Optional light bar shown not for occupant safety.

*1990 Model Year Manufacturers' Reported Retail Deliveries by division vs. 1989.

**Based on an average of consumer-reported problems in a series of surveys of all '81-'89 models designed and built in North America.

Keep Widening The Gap? Reasons.

Another industry exclusive: 2WD Twin I-Beam and 4WD Twin Traction Beam front suspension systems with nitrogen gas shocks for a smooth, controlled ride.



Ford Ranger.
America's most popular compact truck.



The sales gap is growing.*

That's a good indication that our technical expertise is paying off.

But staying ahead of the competition means staying ahead of the times.

So we're going to continue to make

**Ford Trucks.
The Best Never Rest.**

the kinds of advances we've made with Ford Ranger. It already has a technically advanced 4.0L engine and an exclusive pushbutton four-wheel drive system, but we're going to keep working to make Ranger better. The same goes for every truck we make.

Because we're determined to make the best-built,** best-selling American trucks better and better. And watch the sales gap grow wider and wider.



THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS
ARE NOT FORD TOUGH.



91PY-97W-3PB3

ANGLER USES HIS IQ TO FIND GOLD AT THE END OF THE RAINBOW.

You won't let the big ones get away if you use your IQ—the super slim IQ Zoom 700.

This incredibly compact camera offers a full range of automatic features that are simple to operate. So you can reel in all the photos you want with just the push of a button.

The power zoom lens, first introduced by Pentax, lets you choose any focal length between 35mm and 70mm. And the macro setting lets you hook even the tiniest guppy.

The IQ Zoom 700 has many other special features that make picture-taking fun, and easy. Built-in auto-flash, backlight compensation, daylight sync and slow shutter-speed sync assure beautifully exposed photos from sunrise to sunset.

This user-friendly camera even has such unconventional creative features as a multi-exposure mode, and the self-timer lets you catch yourself with your catch, twice, with only one setting.

When you use your IQ you'll fall for picture-taking hook, line and sinker. And that's no fish story!

PENTAX
IQZoom700

© 1990 PENTAX CORP.



Caught with a Woolly Bugger, backlight compensation, and 70mm zoom lens.



Slow shutter speed sync.



Anchor your shot with focus lock.



All pictures taken with the IQ Zoom 700 and Kodak Ektar film.

Popular[®] Mechanics

SEPTEMBER 1990
VOLUME 167
NO. 9



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—PM cover illustration by Jeff Mangiat



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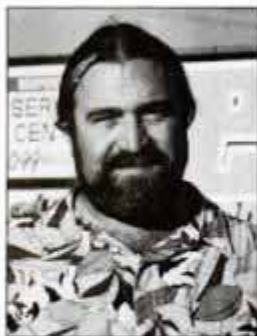
POPULAR MECHANICS (ISSN 0009-4568) is published monthly by The Hearst Corporation, 224 West 57th Street, New York, NY 10019, U.S.A. Subscription prices: United States and possessions, \$15.94 for one year; \$27.94 for two years. Canada and all other countries, add \$16.00 for each year. Second-class postage paid at New York, NY, and additional mailing offices. Authorized second-class mailing in Canada privileges by Canada Post, Windsor, Ont. Send returns to Canadian Direct Mailing Sys. Ltd., 900 Mercer St., Windsor, Ontario N9A 7C2. Registered as second-class matter at the Post Office at Mexico D.F., Mexico, June 20, 1960, © 1990 by The Hearst Corporation. All rights reserved. Printed in U.S.A. POSTMASTER: Send address changes to Popular Mechanics, P.O. Box 7170, Red Oak, IA 51591.

EDITOR'S NOTES

WANT TO KNOW the best and quickest way to find out what kind of mettle a vehicle has? Torture test it. Run the wheels off it. Compress months and years of wear and abuse into a week or a month. Essentially, that's what the auto manufacturers do at their proving grounds. Unfortunately, you have neither the time nor the facilities to torture test a vehicle before you buy it. So you have to rely on us to do it for you. When the new Ford Explorer sport/utility vehicle was announced several months ago, the accompanying hype was tremendous. So we decided to see if the Explorer could, indeed, live up to its press. Last month, it was one of the top-rated vehicles in our 4-door sport/utility comparison test. This month, Boating/Outdoors Editor Joe Skorupa gave it the ultimate off-road test—Death Valley to Pikes Peak. How did the Ford do? Check page 38 to find out. . . . **Hydrogen power** for cars, planes and other transportation vehicles isn't a new idea. But it's suddenly making a strong comeback. We've got the complete story for you on page 21. . . . **Ever since I've been an editor**, I've always wanted to have my magazine's main editorial section positioned right up front, not following 50 pages of columns and advertisements. Publishers always had other ideas. Now I have the pleasure of working with a publisher, Bob Dillingham, who agrees with me. So starting this month, you'll find POPULAR MECHANICS slightly reorganized. Up front, there's just the contents page, letters from you, our retrospective Time Machine page, Tech Update news section, and then—bam! There's the heart of the issue right there. You'll find all your monthly columns right after the main section. So we haven't changed the content of your favorite magazine, just the organization of it. I hope you find PM a quicker and easier read. . . . **I'm very proud** to tell you that, for the seventh year in a row, POPULAR MECHANICS has been honored by the judges of *Graphic Design: USA* for our page designs and illustrations. In addition, Contributing Editor Fred Mackerodt was just presented with an Award of Excellence by the Aviation/Space Writers Association for his article, "Big Bird," that appeared in our March 1989 issue (page 74). Thank you to all the judges for recognizing our editorial excellence. . . . **Last month in this column**, I wrote about ace photog Rich Cox. But I mistakenly ran photos of another ace West Coast shooter, Ron Hussey. Here's what Cox and Hussey really look like. Sorry guys. Till next time.



Skorupa in Death Valley



Ron Hussey



Rich Cox

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Joe Oldham
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WAIT TILL YOU SEE THIS SAW SAW.

Every now and then it happens. A product is introduced that is so superior it quickly becomes the standard by which all others are judged.

The Stanley SHORT CUT™ saw is such a product.

It is, in fact, the fastest cutting saw you can buy for one simple reason.

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Examine them closely. You can see the new aggressive tooth configuration. It is this configuration which gives each tooth three cutting surfaces while most saw blade teeth only have one.

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forward and reverse strokes.

Which means it's a faster cutting saw that saves you time.

Plus, it's short enough to fit neatly into your toolbox.

Of course, the SHORT CUT saw is just one of many that Stanley

offers. In fact, no one offers more types of saws for more uses than Stanley.

So if you want to cut your sawing time in half, try the new Stanley SHORT CUT saw. It's the fastest saw you ever saw saw.



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Published by The Hearst Corporation

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Come on down to Jack Daniel's someday and tour our old time distillery.

"ALL GOODS WORTH PRICE CHARGED," is what Jack Daniel's nephew said in 1907. We're still saying it today.

Mr. Lem Motlow put this slogan on crocks and jugs of his uncle's whiskey. You see, he knew our Jack Daniel's Tennessee Whiskey was made with Tennessee cave spring water and mellowed through hard maple charcoal before aging. Mr. Motlow knew value when he saw it. And still today, though Jack Daniel's is priced above many whiskeys, a sip will prove its worth.

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LETTERS

Warbirds

TOM REILLY should be highly commended for restoring these old planes. The government squandered the opportunity to store away scores of these old warbirds right after World War II. Now, people like Reilly are correcting the government's lack of vision. These old fighters and bombers played a significant role in winning the war, and it seems a shame that we have to depend on the determination and resources of people in the private sector like Mr. Reilly to preserve the glory of the machines that brought us peace.

To your list of air museums you should add the museum in Oshkosh, Wisconsin, that is sponsored by the Experimental Aircraft Association. They have added a wing to the museum that deals exclusively with WWII aircraft. Visitors will see a B-17, a P-38, a Me-109 and other planes.

KIM KLINE
ROLLA, MO

You neglected to include the Yankee Air Museum in Ypsilanti, Michigan, on your list of air museums.

DAVE WALKER
TAYLOR, MI

The June cover photo brought back many vivid memories of the bent-wing Corsairs—especially the checkerboard design of the VMFA-312. The famous Marine squadron commissioned in 1943 still flies the checkerboard design on its F-18 jets.

My own encounter with VMFA-312 was in the spring of 1953 when the squadron came aboard our carrier, USS *Bairoko*, CVE-115, off the east coast of Korea. If memory serves me, the VMFA-312 squadron was the only prop-driven squad-

ron to shoot down a MIG in Korea.

LEE R. WAY
ARLINGTON, TX

In regard to the picture of the F4U-7 Corsair on your June cover, I was in an F4U-5N squadron in 1950, at the time the aircraft were new. I always thought that they were the last of the line of the F4Us, as jets were beginning to take over. I would say that your picture was that of a F4U-1, but the prop appears to have four blades, and the F4U-1s had a 3-bladed prop.

VERNON FEDDERSEN
AMC USN (RET.)
LAKE MARY, FL

The photos and the article on restored WWII aircraft were excellent and nostalgic. However, I'd like to correct two small errors in the story. First, engines on multiengine aircraft are numbered from left to right, as viewed from the pilot's seat. It must have been the No. 3 engine that was missing from the right wing of the B-24 being restored, rather than the No. 2, since No. 2 is inboard on the left wing.



Reader David D. Voeltz altered PM's fireplace mantel project.



Old planes spark memories.

Second, the British Commonwealth countries did call that venerable North American single-engine trainer the Harvard. But here, in its parent country, it was the AT-6 Texan. By whatever name, the AT-6 was an amazingly tough, agile bird that, in the right hands, could give fighters of the day fits in a dogfight—in spite of the speed differentials. This statement will jolt a lot of old fighter pilots who never tangled with an AT-6 in the right hands.

JAMES L. BREWER
GRANT, AL

Classic Buff

What a joy to see the beautiful old cars in the May issue. It makes one sick to think that cars used to be made with style, beauty, and in more comfortable and safer sizes. Today, all the cars look alike. I'm probably not the only person who used to get excited about the new cars coming to the showroom and went out to see them. But I haven't done that since 1977.

REV. LOUIS H. SHOWERS
GOSHEN, IN

Iron Men

Cliff Gromer's article, "A 50-Year-Old Record Falls" (page 24, June '90), states that Tommy Morrison and seven endurance drivers were involved in setting the new record. It's interesting that the existing record was set in 1939 by Ab Jenkins driving solo for 24-hours straight. Ab's car, the Mormon Meteor III, is currently under restoration and will be on display in a Salt Lake City museum in a couple of years.

ORVAL WILSON
SALT LAKE CITY, UT

Mantel Piece

Had to send this picture of a fireplace mantel project featured in your February '89 issue. I decided to use oak instead of the soft wood recommended in the article. Aside from a few modifications to make the mantel fit my unit and please my wife (she does not like dentils), the project was straightforward and simple. Total cost was less than \$100. This was especially satisfying after seeing comparable mantels selling for \$400 to \$600.

I figure the \$300 to \$400 savings will go a long way in renewing my subscription to your fine magazine.

DAVID D. VOELTZ
PIERRE, SD

Despite what these guys think



a leading-edge defense system doesn't have to cost a lot.

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TIME MACHINE

75 YEARS AGO: SEPTEMBER 1915



Music To The Eyes

The precursor to today's laser shows and garish disco lighting effects had its debut in more refined environs—Carnegie Hall. There, a new device called a color organ painted a moving mural of hues that danced and shimmered in time to the music. The effect was produced by a system of tungsten lamps fitted with reflectors and color filters. Keys on an organ console in the orchestra pit varied the display by controlling an elliptical conveyor holding the lamps.

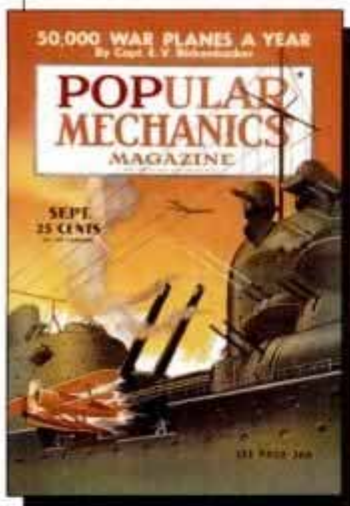
Great Lakes Disaster

Our article was titled simply, "Supreme Tragedy Of The Lakes," and aptly. One moment the vessel *Eastland* was standing at berth, as well-wishers and 2500 pas-

sengers waved. The next, she was lying on her side in Chicago River's murky water. Rescuers were on hand immediately, but more than 800—mostly women and children—drowned.



50 YEARS AGO: SEPTEMBER 1940



New-Wave Battleships

Warship designs that had grown up in peacetime were being subjected to the realities of battle, yielding a windfall of hard experience for naval architects. Their responses were the subject of our cover story. Detailed cutaway drawings showed plans for future dreadnoughts with beefed-up anti-aircraft batteries, bands of armor to deflect enemy torpedoes, and rounded decks and turrets to deflect aerial bombs.

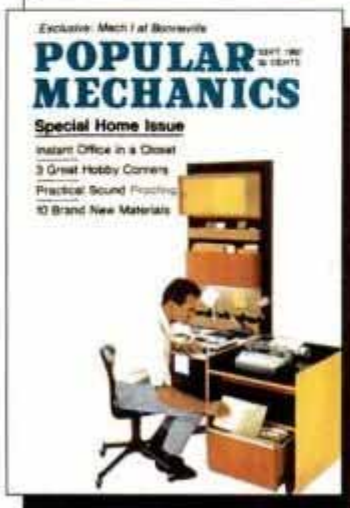
Industry Goes To War

Any doubt of the link between national security and industrial vitality would be dispelled by Capt. E. V.

Rickenbacker's piece on America's need for 50,000 warplanes by 1942. Considering the country had 19,335 planes in 1940 gives some appreciation for the feat.



25 YEARS AGO: SEPTEMBER 1965



Killer Closets

Closets bursting with ideas were the theme of our special home issue for 1965. The light of new ideas from noted industrial designer Franklyn Jacoby brightened these dark and often wasted spaces. Among the concepts: an instant office with a typing stand/foldout writing table, a miniprojection room with all equipment mounted on the back of the closet door, and a hunting and fishing hideaway with spots for tackle, guns, and a fly tying bench.

Battle Of The Skylifters

Twenty-five years before the million-ton An-225's debut at the Paris Air Show (see "Heavy Lifters," page 56, Feb. '90), the Russians stole

the same show with their 250-ton An-22. America's biggest at the time was the 160-ton C-141 Starlifter. The C-5A, our next move in the seesaw struggle for heavy lift supremacy, was still on the drawing board. **PM**



NEW!
From the maker of
PASSPORT



Radar Warning Breakthrough

Digital Signal Processing (DSP) allows the new ESCORT to warn you of traffic radar much sooner than previously possible

When we introduced the original ESCORT, its superheterodyne design revolutionized radar detector performance. Now our all-new ESCORT will revolutionize radar warning again.

Its secret? Digital Signal Processing (DSP), an incredible new computer technology.

DSP Technology

DSP is used by NASA to create detailed space photos from blurry images. It's used by military radar to distinguish enemy aircraft. And now we're using DSP to find radar signals too weak to be detected by conventional means.

How it works

The new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This information is digitized and continuously analyzed by a built-in signal recognition computer. The end result is remarkable.

Breakthrough performance

ESCORT's advanced signal processing provides an incredible increase in sensitivity. Quite simply, this means that the new ESCORT picks up radar signals further away than was ever before possible, even distant instant-on radar.



The heart of ESCORT's DSP circuitry is a custom version of the Motorola DSP 56000. This 20 MHz 24 bit parallel HCMOS processor is capable of 10.25 million instructions per second, and is also used in Steve Jobs' new \$10,000 NeXT computer.

"The new Escort packs ultimate sensitivity into a small package. Nothing else even comes close, and no wonder... No analog device can hope to match this performance."

BMW Roundel, December 1989

Intuitive warning system

This additional range would be of little use without a clear, informative warning system. But ESCORT gives you the full report on radar.

Upon radar contact, ESCORT's alert lamp glows and its variable-pulse audio begins a slow warning. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

The moment of truth

As you get closer, the bar graph lengthens and the audio pulse quickens. You'll understand ESCORT the first time you use it.

Advanced City/Highway circuitry lets you optimize ESCORT for either driving environment. There's also a Dark mode for more discreet operation, a fully adjustable volume control, and a new "AutoMute" that automatically decreases the volume after the initial alert.

No compromise design

We've spared no expense in making ESCORT the best equipped radar detector ever. The precise electronics are secured in a heat-treated aluminum housing, finished in non-glare black. There's a new electronic anti-theft system. And a complete array of accessories.

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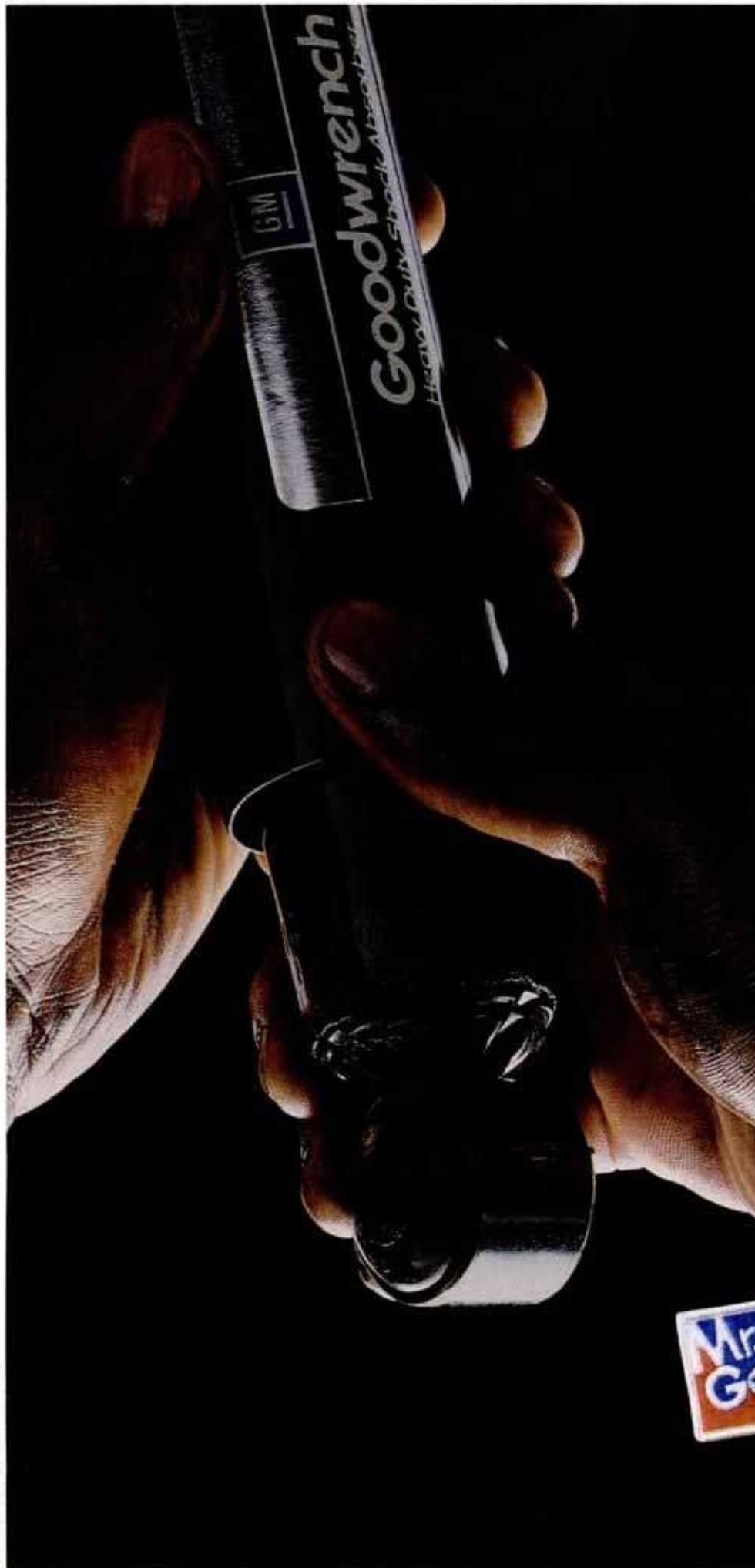
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To help keep your car handling properly, have Mr. Goodwrench check your shocks and/or struts. If they need replacing, he'll have the exact GM Goodwrench Shocks your GM car or truck was designed to use.

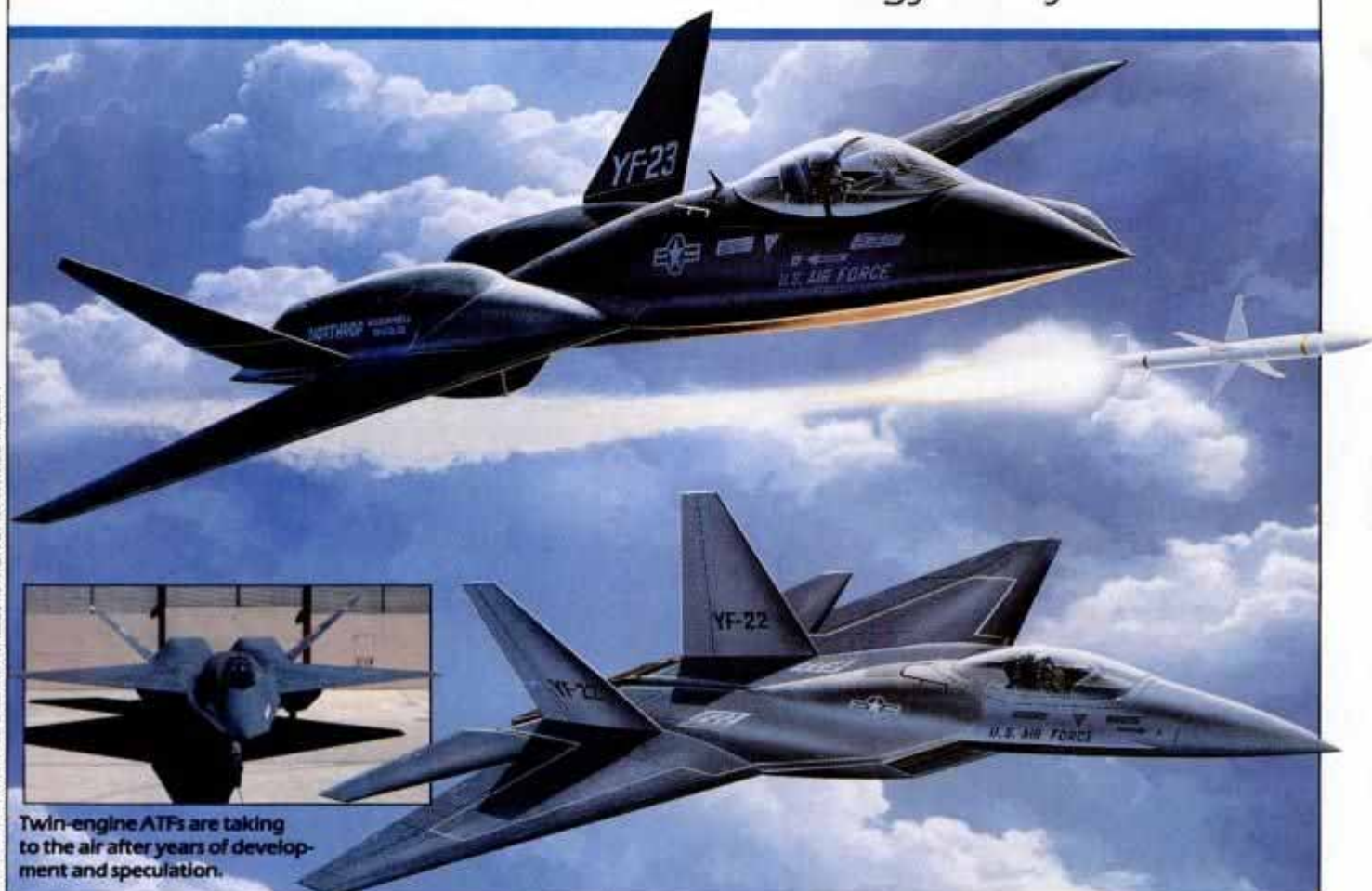
Plus, when you get GM Goodwrench Shocks you get a Lifetime Limited Warranty that's good for as long as you own your GM car or light truck. See Mr. Goodwrench for details, now at over 7,200 General Motors dealerships coast to coast—wherever you see these signs.



Because it's not just a car...
it's your freedom.

TECH UPDATE

News Of Tomorrow's Technology Today



PM PHOTO BY MICHAEL O'LEARY/PM ILLUSTRATION BY MARK MCCANDLISH

Twin-engine ATF's are taking to the air after years of development and speculation.

Advanced Tactical Fighter Rivals Revealed

WASHINGTON, D.C.—The Air Force has unveiled the two designs that will go head to head in the cutthroat competition for the Advanced Tactical Fighter contract—America's bid to dominate the skies into the 21st century.

Renderings of the Lockheed/General Dynamics/Boeing YF-22 and the Northrop/McDonnell Douglas YF-23, released in mid-May, provided the first glimpse of the prototypes. Now, the Northrop-led team has gone one step farther, rolling out its prototype for a photo session. The radically contoured plane, likened to the fictional "Firefox" of the 1980s Clint Eastwood movie, should begin flight testing

shortly. At press time, Lockheed's ATF candidate was scheduled to begin flying in August 1990.

Intended to replace the 1970s vintage F-15 Eagle, both competitors will take advantage of the latest computerized avionics and stealth technology. Detectability is cut further by the planes' ability to supercruise or fly well above the speed of sound without using afterburners. Engine exhaust blasts through thrust-vectoring nozzles that deflect power to aid maneuvering.

Weapons will include current short- and medium-

range air-to-air missiles, carried internally and launched from hydraulic racks. Weaponry may prove irrelevant,

however, in the ATF's first, and possibly toughest, battle before a cost-conscious Congress.

Highlights This Month

- **Seeing-Eye Projectile**—Artillery shell doubles as reconnaissance drone.
- **Concorde: The Next Generation**—Son of SST would do London-to-Tokyo in 6 hours.
- **Hubble Heartbreak**—Misshaped mirrors cloud astronomers' hopes.
- **Hit The Beach**—Sneaky landing craft ducks under the waves.
- **Ricochet Radar**—Beams bounce over the horizon to light up long-range threats.
- **Grounded Wings**—With NASA's help, sailwinged yachts conquer the land.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Steven Shaker, Mike Fillon

First SWATH Cruise Liner

RAUMA, FINLAND—The first of the futuristic cruise vessels predicted in our December '88 cover story, ("Superships," page 69) is now under construction at the Rauma-Repola shipyard in Finland. Called the SSC (Semi-Submersible Craft) *Radisson Diamond*, it will be launched in 1992.

At 410 ft. long and 105 ft. wide, the 18,400-ton ship is dwarfed by the biggest liners, but what it lacks in size, it makes up for in luxury, including a 5-story atrium with glass-enclosed elevators and balconied staterooms.

For stability, the ship employs a radical Small Wa-



Radisson Diamond will carry 354 high-ticket passengers and a crew of 170 at a cruise speed of 12.5 knots.

ter-plane Area Twin Hull (SWATH) design, floating on submerged platoons to mini-

mize wave motion. Passengers wishing a closer view of the water can use a hydrau-

lically lowered aft minimarina for swimming and jet-skiing.



All-Terrain Security Robot

ALBUQUERQUE, NM—To help seal off remote locations, a teleoperated 4-wheel-drive vehicle patrols terrain, while portable sensor arrays watch from fixed points. Sandia National Labs developed the system.

The mobile unit is a Honda ATV modified for remote operation and linked by radio to a control console. Its eyes

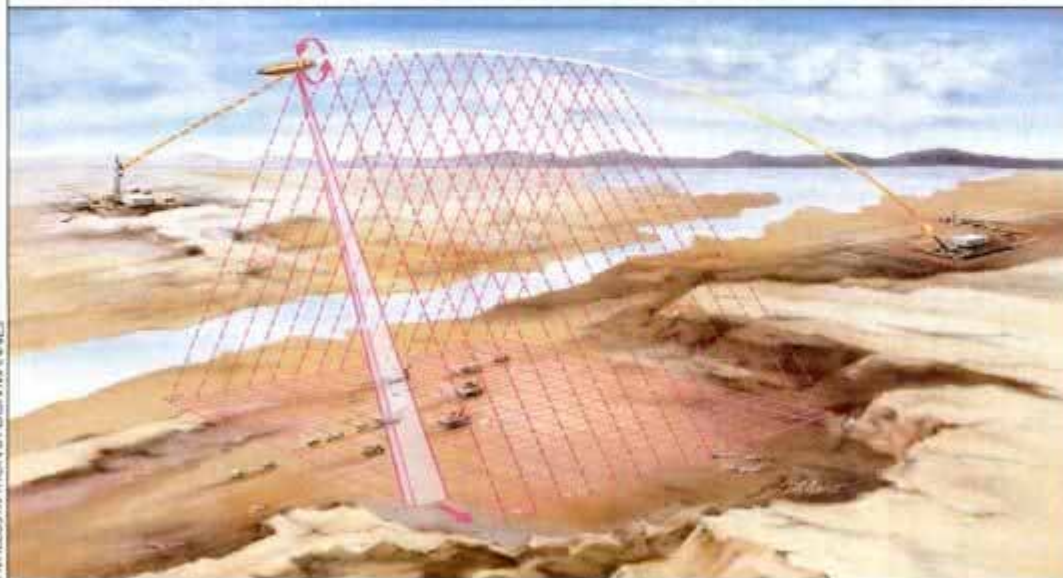
and ears include an infrared motion detector, video camera, ground surveillance radar and four microphones.

Meanwhile, the fixed station uses similar sensors and transmits readings of potential intruders via fiberoptic cables to the control console. There, a host computer analyzes threats before alerting human guards.

Telerobot ATV, with mast-mounted sensors (left), and fixed sensor stations (right) secure sensitive outdoor locales.



Howitzer-Launched Camera Scouts Battlefield



Howitzer shell, a cheap alternative to drones and spy satellites, radios picture to ground station.

LIVERMORE, CA—Also out of Sandia comes a 155mm shell that can relay to a ground station pictures of the terrain it flies over.

Traveling at 1500 ft. per second, while spinning at 130 rpm, the projectile uses a photodiode to pick up light through a small Lucite window in its side.

As the window spins, the photodiode is exposed to a succession of tiny fields of view. An electrical signal, with strength that depends on each field of view's brightness, travels via radio to a ground computer, which assembles a composite picture.

Sandia hopes the shell's simple mechanism will suit it to low-cost target spotting for artillery commanders.

PH ILLUSTRATION BY DION MANNING

RAUMA-REPOLA ILLUSTRATION

SANDIA PHOTOS

On our way to the HDRA/SCORE Class 8 Championship we passed 57,942 cacti, 127,391 snakes and 47 Sunday Drivers.

There's no limit to what winners can achieve when they stick together. And when it's the winners that make up American Thunder, the off-road truck team sponsored by Mobil 1[®] BFGoodrich T/A[®] Radials and Chevrolet, we proved you can really stick it to the competition.

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So don't pass by your opportunity to ride with the winners, or they just might pass you in the process. Ride with Mobil 1, BFGoodrich T/A Radials and Chevrolet and feel the power of American Thunder.



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21st Century Concorde

LONDON, ENGLAND—Joining the spate of supersonic planning in Japan, Germany and the United States, the Concorde team of British Aerospace and Aerospatiale have proposed their own follow-on to the original SST.

Carrying 300 passengers, it would be 50 percent longer and have four engines, but would gain little speed, topping out at Mach 2.2. Its size would demand 25- to 30-percent better aerodynamics, leading designers to a modified delta-arrow wing and canards.

A range of 5500 nautical miles would open up routes like London to Tokyo, reducing flight times from 13 to 6 hours. First flight should be around the year 2005.



Advanced Supersonic Transport (AST)—Concorde's long-range offspring—could take off in 2005.

BRITISH AEROSPACE ILLUSTRATION



NASA PHOTO

NASA's New Space-Talk Link

HUNTSVILLE, AL—From now on, scientist-astronauts working on the Shuttle's Spacelab missions will answer to a new control center here at Marshall Space Flight Center. Flight crews will continue to communicate with Mission Control in Houston. Spacelab is the research module carried "Roger, Huntsville." For the first time, astronauts will talk to controllers outside of Houston.

in the Shuttle's cargo bay.

Spacelab Missions Operations Control will monitor and guide science activities in 15 upcoming Shuttle launches, ranging from SDI's Starlab mission to microgravity experiments lined up through 1995.

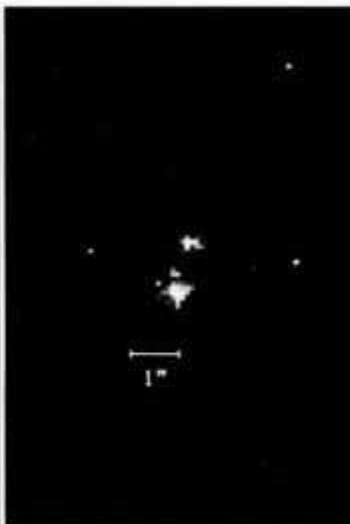
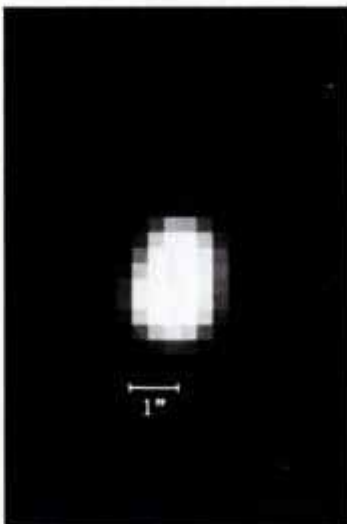
The first Huntsville-controlled mission scheduled is the delayed Astro-1, an ultraviolet/X-ray astronomy mission on board *Columbia*.

Hubble Hobbled

GREENBELT, MD—Shortly before discovering a major flaw in the mirrors of the Hubble Space Telescope, ground controllers here were encouraged by the return of a surprisingly sharp image of a star in the constellation Carina. Although taken with the scope's Wide Field Planetary Camera (WFPC), one of the instruments most severely affected by the defective mirror, the image was 50 percent better than a similar shot taken from the ground. It was not until controllers attempted to bring the image into sharper focus that they

discovered the grim reality—a textbook case of spherical aberration will make it impossible for the telescope to fulfill many expectations.

However, NASA insists that all is not lost. Plans to have Shuttle astronauts add three new instruments, including a replacement WFPC, were already well-advanced. If scientists on the ground can determine the exact extent of the defect, it will be a relatively simple matter to correct. Look for a detailed analysis of the trouble with Hubble in next month's Science column.



Despite aberration, the Hubble image (right) is far clearer than the image from a ground-based observatory (left).

CARNEGIE INSTITUTE PHOTO; NASA PHOTO



Submersible Landing Craft

GRIMSBY, ENGLAND—Storming the beach will be an operation of stealth, rather than brute force, in a landing craft designed by Seaforth International.

The S-60 carries 60 troops and 2½ tons of equipment from a mothership, then submerges and propels itself at 4 knots into the surf zone. A hatch on the top bow swings open, becoming a ramp to the shore for attacking troops. After personnel and equipment finish off-loading, the submersible sinks out of sight until the landing party recalls it using a portable sonar transponder.

The vessel could also serve as a covert mobile station to monitor submarine incursion into territorial waters.

Submersible S-60s convey special forces and equipment in a stealthy amphibious assault.

Tilt-Wing Turboprop

NAGOYA, JAPAN—A concept first aired in the 1960s is materializing in the form of a 16-passenger, tilt-wing turboprop. Fort Worth-based DMAV, Inc., is designing the craft for Japan's Ishida Corporation, which plans to build a fleet of 100 tilt-wings to shuttle between Japanese airports.

Although the TW-68 would use helicopter landing pads, it wouldn't be as effi-

cient in hover mode as, say, the V-22 tilt-rotor. It would perform more like an airplane in cruise mode, during which top speed would be 400 mph. A flying-boat hull would also permit seaplane operations. First flight of a prototype is slated for 1993.

Small enough to land on an offshore oil-rig helicopter pad, the TW-68 could also touch down on water. Note fan in T-tail to aid hover mode.



Superlaser Breakthrough

SCHENECTADY, NY—A high-precision, solid-state laser now puts out a record 1000 watts of power, an achievement that will revolutionize the machining of ultratough aircraft metals.

Developed at a General Electric research center, the device is powered by a slab of lasing material, rather than a gas. Carbon dioxide lasers, used regularly for high-power applications, deliver beams at too wide a wave-

GE engineer Angel Ortiz Jr. directs operation of 1000W laser through a ½-in.-sheet of nickel-based superalloy.

length for precision cutting. Other solid-state lasers zap with tighter beams, but perform poorly at power levels above 50 watts, due to heat distortion. A new cooling system is the key to the 1000W laser's abilities.

GE plans to use the laser in robotic machining systems, drilling air-cooling passages through the combustion chambers of jet engines. Pulses of laser energy snake through a fiberoptic cable to a moving drillhead, which can cut a hole through a ½-in. sheet of metal five times a second.

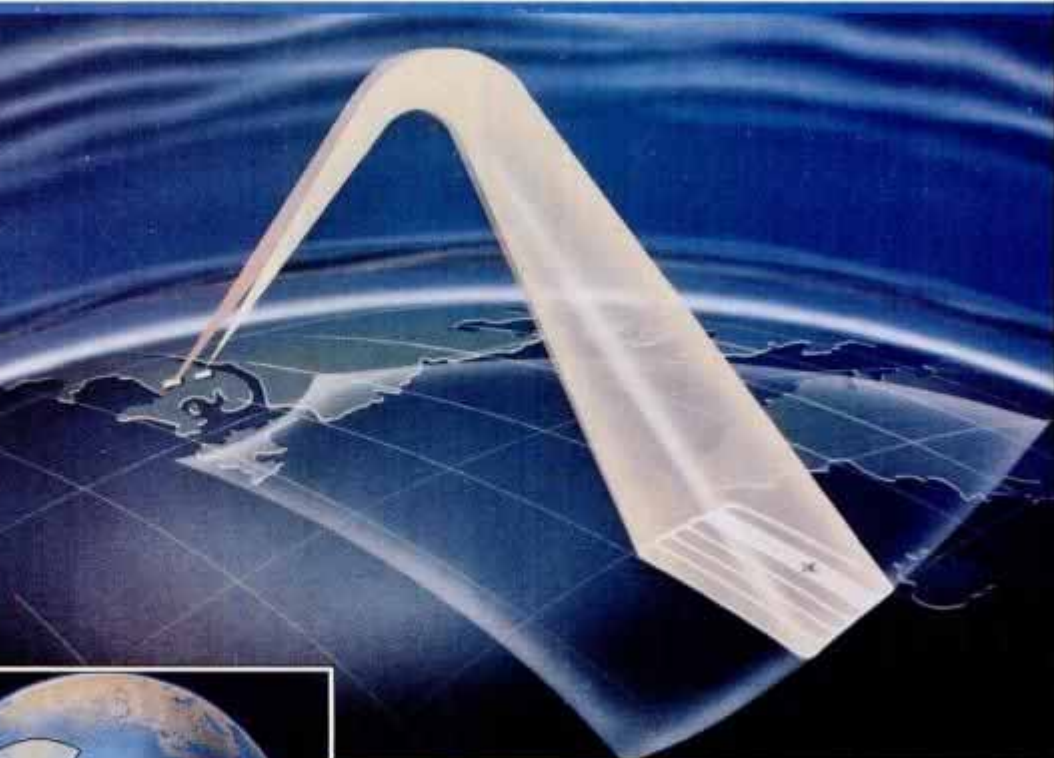
New Long-Range Radars

BANGOR, ME—Now operational is the first of four planned Over-The-Horizon Backscatter (OTH-B) radar installations, recently turned over to the USAF's Tactical Air Command by General Electric.

Operators can view air traffic in a semicircular swath from Greenland to eastern Cuba and as far out as 1800 nautical miles into the Atlantic. The system covers more than 4.5 million square miles—around 3 percent of the Earth's surface.

OTH-B radar antennas bounce high-frequency signals off the ionosphere to extend their surveillance around the planet's curvature. Unlike conventional radar, however, OTH-B's acuity can drop if atmospheric conditions are unfavorable.

By 1995, three other OTH-B sites, in the Pacific Northwest, Minnesota and Alaska—along with a string of conventional radar sites across northern Canada—will form an early-warning



New radar (above) bounces off the ionosphere to surface. Four sites (far left) will cover North America. Each of three Maine antennas (left) is 3600 ft. long.

borne drug smugglers, which could allow some funding of the control center's operations to come from the Defense Department's antidrug coffers. The Maine installation's Caribbean coverage will overlap with that of a Virginia-based U.S. Navy relocatable OTH-B unit tracking sea vessels.

air-surveillance shield around the United States.

In addition to its strategic role spotting long-range bombers, the East Coast

OTH-B antennas will aid intelligence gathering in the northern Atlantic, and will guide rescue missions. It will also help interdiction of air-

Landlubber's Sailwing

IVANPAUGH DRY LAKE, NV—The concept that propelled *Stars and Stripes* to victory in last year's America's Cup is now boosting the performance of land vehicles.

Art and Philip Rothrock, a father-and-son team from Portland, Oregon, built a land yacht with a vertically mounted rigid wing, instead of a sail. At the World Cup Regatta held last April, 40 miles northwest of Las Vegas, the Rothrock's yacht vied closely with a sail-driven New Zealand vehicle at 90-mph speeds before finishing second.

Though also built of

strong, lightweight composite materials, the Rothrock's wing differed from Dennis Conner's effort. The wing's profile derived from data on low-velocity airfoil design out of the Subsonic Aerodynamics Branch of NASA's Langley Research Center. The wing also featured trailing-edge flaps engineered for aircraft use in low-velocity climb and cruise conditions. The Rothrocks employed flaps to gain starting momentum and to adjust for changes in wind speed.



Stainless-steel body and composite wing rocketed the Rothrock land yacht across Nevada desert at 90 miles per hour.



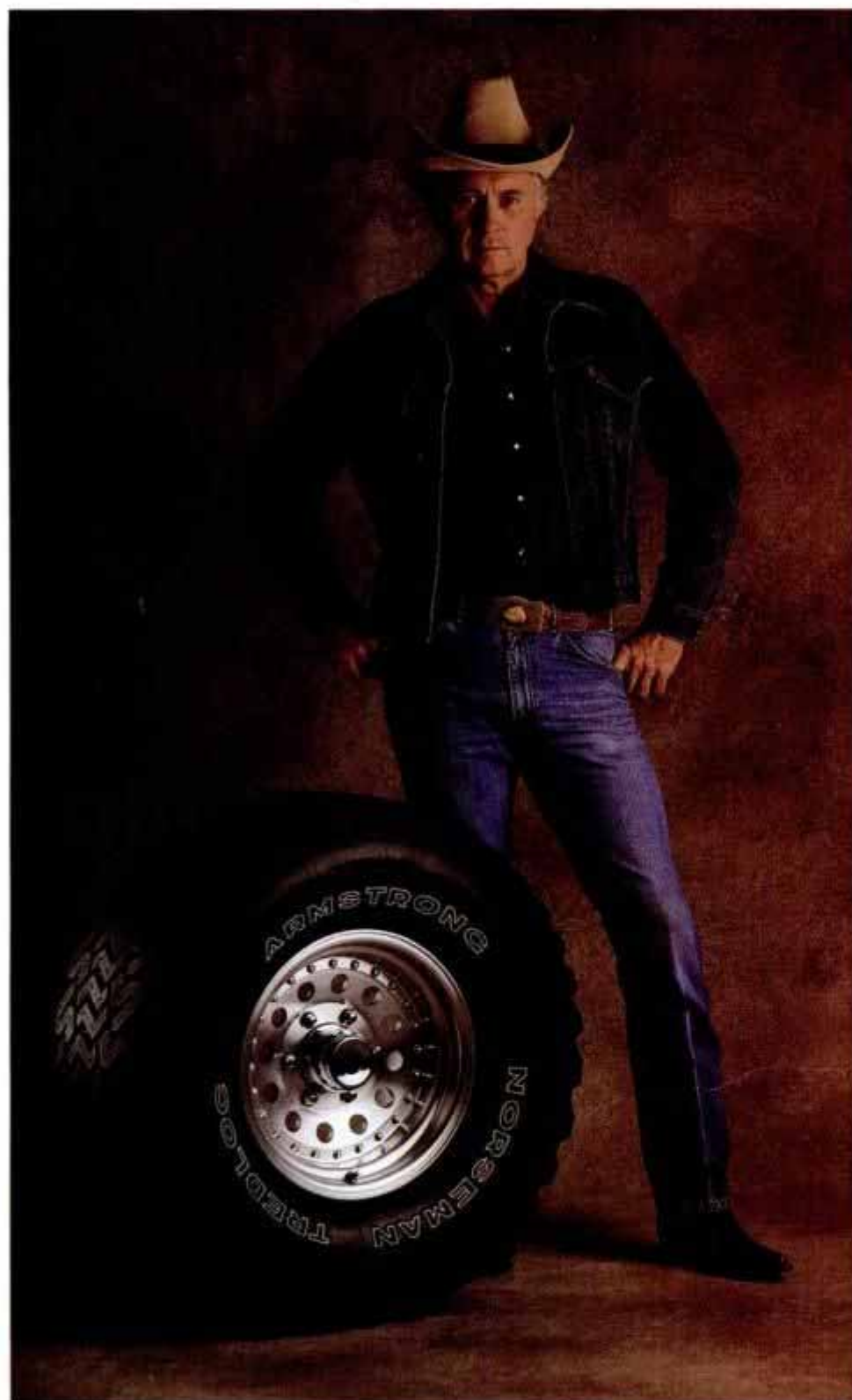
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|----------------------------------|----------|---------------------------------------|----------|-------------------------------------|----------|
| Acura Integra GS..... | \$16,685 | Ford Escort GT..... | \$10,588 | Oldsmobile 98 Regency Brougham..... | \$21,595 |
| Acura Legend Coupe LS | 30,690 | Ford Tempo LX..... | 11,422 | Peugeot 405 Mi16..... | 21,990 |
| Alfa Romeo Veloce | 20,950 | Ford Mustang GT..... | 14,803 | Plymouth Laser RS | 12,675 |
| Audi 80 Quattro | 22,800 | Ford Taurus LX..... | 16,180 | Pontiac Sunbird GT..... | 12,444 |
| Audi 100 | 26,900 | Ford Probe GT..... | 15,543 | Pontiac Grand Am SE..... | 15,194 |
| Audi Quattro V-8 | 47,450 | Ford Thunderbird Super Coupe | 20,390 | Pontiac Firebird Trans Am GTA..... | 23,320 |
| Bentley Mulsanne S | 133,200 | Ford LTD Country Squire | 17,921 | Pontiac 6000 S/E..... | 16,909 |
| BMW 325is | 28,950 | Honda Accord EX..... | 16,595 | Pontiac Bonneville SSE..... | 23,994 |
| BMW 535i | 43,600 | Honda Civic..... | 10,920 | Pontiac Grand Prix SE..... | 17,684 |
| BMW 750iL..... | 70,000 | Jaguar XJ-6 Vanden Plas..... | 48,000 | Porsche 944 | 41,900 |
| Buick Skylark Custom LE..... | 13,145 | Lamborghini Countach..... | 145,000 | Porsche 911 Targa..... | 59,900 |
| Buick Regal Limited | 15,860 | Lexus LS 400..... | 35,000 | Porsche 928..... | 74,545 |
| Buick LeSabre Estate Wagon..... | 17,940 | Lincoln Town Car | 27,986 | Rolls-Royce Corniche II | 215,800 |
| Buick Electra Park Avenue..... | 21,750 | Lincoln Mark VII LSC..... | 29,468 | Saab 900 | 17,515 |
| Buick Reatta | 28,335 | Lotus Esprit..... | 71,500 | Saab 9000 CD | 32,995 |
| Cadillac DeVille | 27,540 | Mercedes-Benz 190E | 31,600 | Sterling 827SL..... | 29,975 |
| Cadillac Allante..... | 50,900 | Mercedes-Benz 300CE..... | 55,700 | Subaru Legacy LS | 14,699 |
| Chevrolet Beretta GT..... | 12,500 | Mercedes-Benz 500SL..... | 83,500 | Subaru XT-6..... | 17,111 |
| Chevrolet Camaro IROC-Z..... | 15,360 | Mercury Topaz LS | 12,360 | Suzuki Swift GS..... | 9,264 |
| Chevrolet Lumina | 14,240 | Mercury Sable LS..... | 16,067 | Toyota Camry LE | 14,658 |
| Chevrolet Caprice Brougham | 16,325 | Mercury Cougar XR-7..... | 20,213 | Toyota Cressida | 21,498 |
| Chevrolet Corvette ZR-1..... | 58,995 | Mitsubishi Galant GSX..... | 17,171 | Toyota Corolla LE..... | 11,703 |
| Chevrolet Geo Metro | 8,465 | Mitsubishi Eclipse GSX..... | 17,260 | Toyota Celica GT-S..... | 17,258 |
| Chrysler LeBaron..... | 15,995 | Nissan Stanza GXE | 14,775 | Toyota Supra Turbo | 25,200 |
| Chrysler Fifth Avenue | 20,860 | Nissan Axxess SE | 16,749 | Volkswagen GTI..... | 10,800 |
| Dodge Daytona ES Turbo..... | 13,700 | Nissan Maxima SE..... | 18,749 | Volkswagen Jetta GLI..... | 14,555 |
| Dodge Colt Vista..... | 13,906 | Nissan 300ZX Turbo..... | 33,000 | Volkswagen Corrado..... | 17,990 |
| Eagle Premier ES..... | 17,845 | Oldsmobile Cutlass Calais SL..... | 14,015 | Volkswagen Passat GL..... | 14,770 |
| Eagle Talon TSi Turbo..... | 15,613 | Oldsmobile Cutlass Supreme Intl. | 17,995 | Volvo 240-DL..... | 18,450 |
| Ferrari Testarossa..... | 150,600 | Oldsmobile 88 Royale | 15,995 | Volvo 780..... | 38,735 |

Source: Automotive News 12/18/89, "Pricing the '90 Models"



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Norseman® Tredloc®. Because Things Are Tough All Over.



The great outdoors isn't so great when you're in it up to your wheel wells. But since you're not about to change where you go, think about changing how you go. With Armstrong Norseman Tredloc Radials.

Instead of the usual criss-crossed layers of steel belts, Norsemans are wrapped with two continuous woven belts of DuPont Kevlar®. It's a process so unique, it's patented. Kevlar's lightweight, but pound-for-pound, it's five times stronger than steel—so you begin to get a pretty good idea about where the "strong" in Armstrong comes from.

Those Kevlar belts also let the tread flex more easily—so it contours itself to whatever off-road surface you subject it to. And, with low-inflation performance that's equally awesome, it's no mystery why *Off-Road Magazine** calls the Norseman Tredloc one of the best year-round, off-road tires on the market.

Hard to believe a tire so good at riding out tough times can feel so good on the road, but Norseman handling and steering response are nothing short of



excellent. Its bigger "footprint" comes from that woven belt construction to allow the entire tread to stay flat on the road.

No matter what you're driving, there's an Armstrong Norseman tread pattern and size to fit most 4WD and 2WD light trucks, vans and RV's.

So check it out now. Because when things are tough all over, your ride doesn't have to be.





THE HYDROGEN AGE

As oil dwindles and environmental dangers mount, hydrogen is emerging as a likely candidate to be our power source of the future.

BY ABE DANE,
Science/Technology Editor

AT ONE END of a 3-mile corridor of pavement in the Mojave Desert, a dartlike plane the size of a small jetliner is readied for flight. With only minutes until ignition, a potent slurry of super-cooled hydrogen rushes into its fuel tanks. And two pilots monitor an endlessly rehearsed sequence of events that is gradually bringing the craft to life.

The tanks fill. The plane settles on its landing gear, burdened by a load of hydrogen three times its weight. Packing three times the power per pound of Jet-A kerosene, the hydrogen will combust in a row of rectangular ramjet/scramjet engine modules under the rear of the radically swept delta wing. The resulting thrust will propel the plane to 25,000 mph, and fling it into orbit.

The year is 1997. The National Aerospace Plane, the X-30, is on the flight line for the first time. In itself, it is an achievement on the order of the *Apollo* spacecraft. But it also represents a whole family of technologies with the potential to work profound changes on our daily lives.

The tie that binds these technologies together is hydrogen. Today,



Early Lockheed concepts for future freighters provided large fuel storage spaces for lightweight, high-power hydrogen.

even as work goes forward on propulsion systems and new materials for the X-30, quieter advances are being made toward the development of an infrastructure that would bring the fuel of spaceflight home, ending our dependency on dirty and dwindling fossil fuels.

Future fuel

At the heart of hydrogen's promise lie two key qualities. First, supplies of it are virtually limitless. Since it is a primary constituent of water, an economical method of extracting it is the only thing needed to produce literal oceans of energy. Second, burning hydrogen does no harm to the environment. It simply returns the gas to the form of water.

Hydrogen is also a uniquely flexible

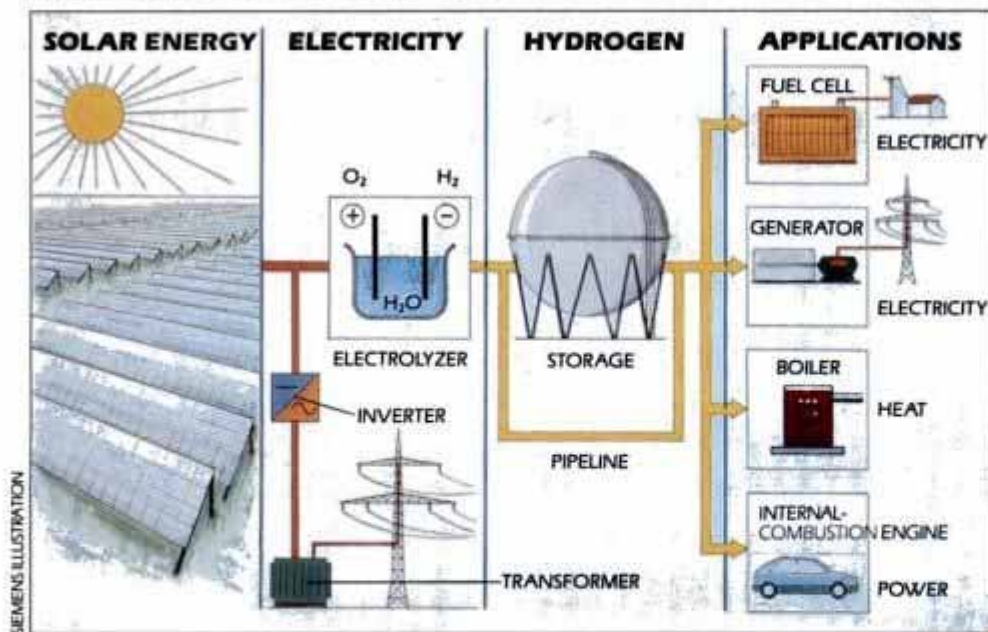
medium for the storage and distribution of energy. It is easily converted into electricity through the use of a fuel cell, and electricity can be turned back into hydrogen by electrolyzing water. Transmitted through pipelines similar to those used for natural gas, it can carry energy from large, remote powerplants to individual homes and factories as electricity now does—but with far greater efficiency. And unlike electricity, hydrogen can be kept in tanks to fuel vehicles, or to store power for periods of peak demand.

In the words of Peter Hoffman, editor and publisher of *The Hydrogen Letter*: "Hydrogen is the fuel at the end of the line when everything else has been depleted, found unworkable or environmentally objectionable."

Stumbling blocks

To most people, the word hydrogen immediately conjures up the specter of the *Hindenburg* dirigible, exploding over the New Jersey countryside. Yet, a more objective analysis reveals that hydrogen is no more dangerous than other flammable materials used as fuels, and even has some significant safety advantages. Ironically, a case in point is the *Hindenburg* incident itself. Although it exploded hundreds of feet off the ground, 62 of the air-

THE HYDROGEN AGE



Scheme for a future energy economy uses electricity from solar panels to electrolyze water into hydrogen for storage and pipeline transmission, and then for a diverse range of applications.

ship's 97 passengers survived, partly because the lightweight gas rose clear of the craft as it burned, and was consumed in a relatively brief explosion. Kerosene jet fuel would have clung to the wreckage and burned furiously for a long time, likely killing everyone in the vicinity. Still, the *Hindenburg* remains a real obstacle to hydrogen's acceptance among the general public.

From a practical point of view, however, the real problems have to do with engineering and economics. For decades, hydrogen has presented researchers with a tantalizing combina-

tion of promise and impracticality. Efforts to use it as an aviation fuel, where its light weight would be especially useful, stretch back to the 1950s, when the Air Force ran one engine of a B-57 Canberra bomber on the fuel in preparation for a proposed effort to run a supersonic version of the U-2 spyplane on hydrogen. The project was scrapped not for technical reasons, but because of the prohibitive cost of outfitting airports around the world with hydrogen fueling stations. "It's a beautiful fuel for turbines," says Willis Hawkins, a retired

Lockheed engineer who worked on the program.

Subsequent projects have amply demonstrated the feasibility of using hydrogen to power aircraft, home appliances, cars and everything in between. But these uses haven't caught on for reasons similar to those that killed the ill-fated U-2 project.

Accelerating progress

Before the impasse can be overcome, more efficient ways must be found to produce hydrogen, handle it and burn it. Research has been sporadic. Over the years, however, knowhow has accumulated in diverse and seemingly unrelated fields which, when taken together, adds up to a considerably brighter outlook for hydrogen. Examples include:

- Steady improvements in the cost and efficiency of amorphous silicon photovoltaic cells, which could power electrolyzers that split water into hydrogen and oxygen. An exhaustive study completed last year at Princeton University predicts that around the year 2000, it will be economical to convert solar energy into hydrogen.

- New storage mediums based on superactivated carbon that can hold 7- to 8-percent hydrogen by weight—more than twice as much fuel per pound as earlier hydrides. These would allow for storage systems safe and light enough for cars.

Hydrogen Today: Clean Car Power

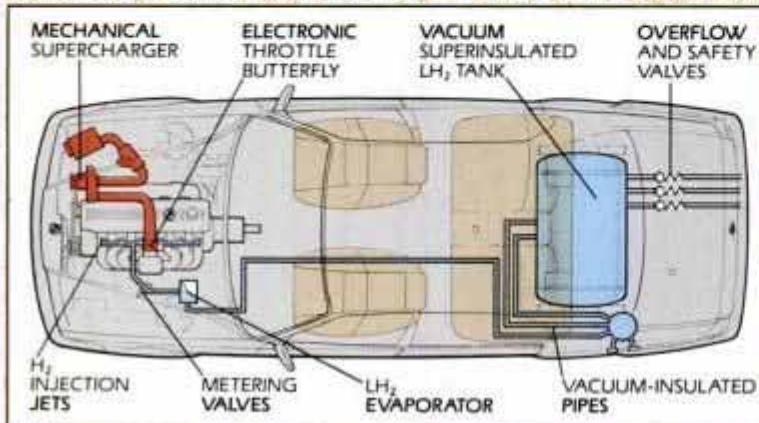
ALTHOUGH alternative fuels, such as methanol, have grabbed a lot of attention for their ability to cut emissions; nothing has been found that would eliminate automotive pollution entirely. Nothing, that is, except for hydrogen.

Several experimental vehicles are now on the road, representing a variety of approaches to hydrogen's engineering challenges. Because of acute pollution and energy security worries, the Germans have

produced the most advanced cars. BMW has focused on using liquid hydrogen stored in vacuum superinsulated tanks. (See "Hydrogen-Powered BMW," page 61, Nov. '89.) Although complex and expensive, a liquid hydrogen system is the best current compromise between weight and range. Mercedes has used metallic hydride storage media, which are completely safe, but need to be very heavy to store large amounts of fuel.

Although not as technologically sophisti-

cated as the German programs, a car conversion project recently begun at Riverside Community College in California is the most significant U.S. effort, because it has the support of the South Coast Air Quality Management District. Representing some of the most heavily polluted areas in the country, the district has taken the lead in developing antipollution technologies that are likely to be adopted elsewhere as pollution problems spread. —A.D.



BMW's hydrogen-powered car is the most advanced one currently on the road. It carries fuel in high-density, liquefied form to extend range.

PH ILLUSTRATION BY FRED WOLFF

BMW PHOTO

■ More powerful fuel cells that convert hydrogen and oxygen into electricity at very high levels of efficiency. These can now produce four to five times as much power for their size as was possible two years ago. Power-to-weight ratios are now near the point where they could be used to run electric airplanes and helicopters with tremendous range.

These and other technologies now developing could form the foundation of an overall energy economy in which hydrogen would replace fossil fuels and electricity as the basic energy currency.

Turning sunlight into hydrogen

According to a study by Joan H. Ogden and Robert H. Williams of Princeton University, electricity from a 244-mile-diameter array of photovoltaic cells in New Mexico could electrolyze water into enough hydrogen (and oxygen) to satisfy the energy needs of the entire U.S.

Based on the predictable advance of photovoltaic technology, Ogden and Williams calculate that by the year 2000, amorphous silicon PV cells with efficiencies between 12 and 18 percent should be available at 20 to 40 cents per peak watt. Figuring in other costs (land, electrolyzers, financing and so on), that translates into hydrogen costs between \$1.19 and \$1.83 for the energy equivalent of a gallon of gasoline. In Germany, where gas already costs more than that, a large solar hydrogen plant is now near completion.

Hydrogen to go

Once hydrogen becomes available at a reasonable cost, one of the first large markets for it is likely to be transportation. Converting even a small proportion of the cars in polluted areas to hydrogen could cut smog substantially, and at less cost than new mass-transit systems. (See "Hydrogen Today: Clean Car Power" on page 22.)

But using hydrogen to power a car puts you face to face with a giant problem: How to carry enough of it. Because hydrogen contains only about one-third the energy of gasoline per unit of volume, you theoretically have to carry three times as much to go the same distance.

The Modification Assisted Cold Storage System (MACS) being researched by James A. Schwarz of Syracuse University may be the answer here. MACS takes advantage of the porous structure of activated carbon, which gives it about 2000 sq. meters of interior surface area per gram. Dr. Schwarz exposes the carbon to a dilute mix of oxygen and nitrogen at



controlled temperatures and pressures, causing the carbon to oxidize slightly, or calcinate. The chemistry is not fully understood, but somehow calcination allows hydrogen to bond with the carbon surfaces in molecules
(Please turn to page 92)

Hydrogen on the wing (from top): The first aircraft to burn hydrogen was an Air Force B-57 converted by NASA in 1956. It wasn't until 1988 that the Russians produced their converted Tu-154. Now on the drawing board is an Airbus with a hump for hydrogen. X-30-derived spacecraft may begin orbiting payloads early in the next century.

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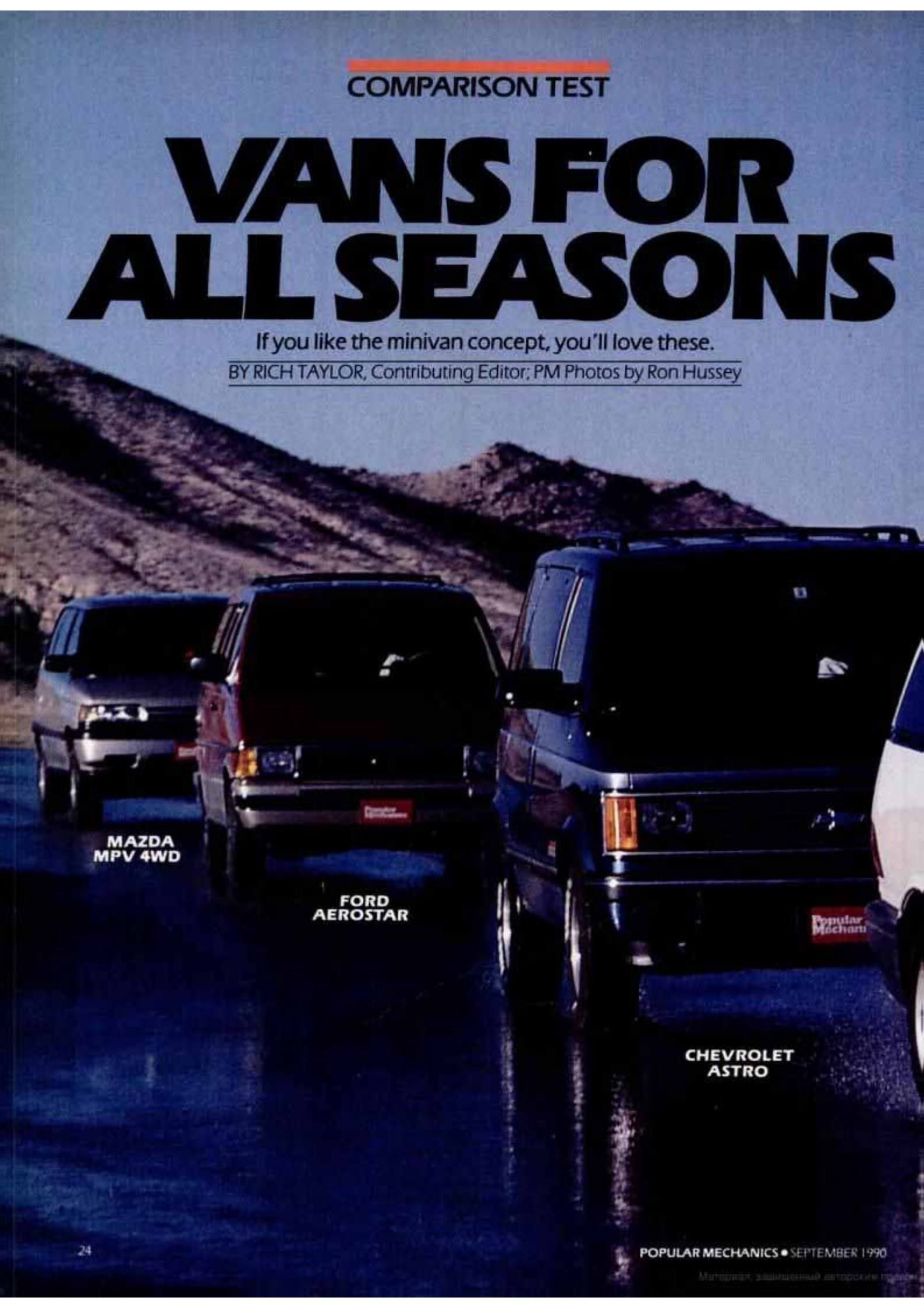
MCDONNELL DOUGLAS ILLUSTRATION

COMPARISON TEST

VANS FOR ALL SEASONS

If you like the minivan concept, you'll love these.

BY RICH TAYLOR, Contributing Editor; PM Photos by Ron Hussey



MAZDA
MPV 4WD

FORD
AEROSTAR

CHEVROLET
ASTRO

A MINIVAN equipped with all-wheel drive has to be the most versatile vehicle on American highways. You can carry seven passengers, haul a half-ton of almost anything, tow a boat up a slippery launching ramp or arrive at a posh affair looking stylish and smart. And you're more likely to arrive safely, no matter what the weather, thanks to the added traction gained by driving all four wheels.

There are two types of all-wheel-drive systems, with one important difference between them. Most pickups and sport/utility vehicles use a simple 4-wheel-drive system, with a transfer case connecting the front and rear differentials. These systems are designed for occasional use at low speeds on slippery surfaces.

The all-wheel-drive systems in our test vans are like those used in cars like the Audi Quattro or Mitsubishi Eclipse/Eagle Talon. Not only is

there a differential in each axle to allow the wheels to turn at different speeds, there's also a center differential that allows the various drive-shafts to rotate at different speeds. This means you can drive four wheels all the time, even on dry pavement, without undue drivetrain wear.

There are six all-wheel-drive minivans on the market. We assembled all six for instrumented testing, including a wet track evaluation, plus a general wringing-out in real-world conditions, that ranged from mountain roads partially covered with melting snow to sun-baked freeways.

As you'd expect, all have capabilities lacking in their 2-wheel counterparts. But that's where equality ends.

Toyota Previa LE All-Trac

For all seasons, our general favorite is Toyota's brand-new Previa. There's a lot to like here. The Previa's appear-

ance is striking—not as radical as GM's rakish new GM200 vans, but clearly on the cutting edge of contemporary design. It also encloses a warehouse of useful interior space. And as we've come to expect, Toyota's fit/finish work is flawless.

The Previa's chassis and drivetrain are just as clever as the bodywork. The new 2.4-liter dohc 16-valve Four is canted over on its side at 75° and mounted amidships under the floor. This has many benefits, including excellent weight distribution and a low center of gravity. The engine is protected by a skidplate, and service functions—coolant reservoir, oil check, drivebelts—are under the hood. Unorthodox, but it works.

From the center differential—viscous-coupled, limited-slip—drive-shafts go fore and aft to differentials driving halfshafts that transmit power to the independently suspended wheels. There are MacPherson struts



**TOYOTA
PREVIA**

VANS FOR ALL SEASONS



MAZDA MPV 4WD



VOLKSWAGEN VANAGON SYNCRO

in front and a 4-link setup with a Panhard rod at the rear. The result is transient response as good as anything in this class. Add 4-wheel anti-lock vented disc brakes (optional), and it gets top marks for stopping.

The interior gets mixed reviews. Most successful is the triple-curved dash that groups minor controls into a projecting center console. The dash-top fusebox is also neat. Less attractive are the oval speedometer and beanhole cutouts in the steering wheel. The Previa has seven comfortable seats. The rearmost fold flat against the sides for cargo loading. Materials are top quality, there's a top-line sound system and upscale touches everywhere.

All in all, the Previa is a terrific combination of style, safety, comfort, function and fun. Although the engine lacks the launching power of some of the other V6s, the Previa is, for our money, the state-of-the-art minivan.

Mazda MPV 4WD

Think of the MPV as a more conventional alternative to the Previa. The

styling isn't quite as striking, the engine lives under the hood, and the interior leans more toward traditional ideas of comfort and convenience. It's also a good deal more snug.

But on the Mazda's scorecard, add the plus of performance that's just this side of exhilarating. And this truck is as easy to drive as any compact sedan.

The MPV handles well, and the 150-hp V6 gives it a lot more punch in all speed ranges. All controls are easy to operate, with the notable exception of the worst column shifter since the 1949 Kaiser.

The MPV's interior ergonomics are better than the Previa's, with a padded steering wheel, white-on-black gauges and very good bucket seats.

The Mazda falls down a bit on interior volume. But in every other respect, this minivan is excellent—solidly engineered and solidly built.

Ford Aerostar

When the Aerostar 4wd was introduced, it looked like something from "Star Wars." But just as R2D2 has

given way to "Teenage Mutant Ninja Turtles," the Aerostar has been surpassed by the Previa and MPV (as well as the non-4wd GM vans).

But that's not to say the Aerostar doesn't have a lot to offer. Thanks to its big 4.0-liter V6, the Aerostar has gobs of smooth midrange torque. And it feels firmly planted on the road and very easy to drive.

Ford quality is truly world-class these days. The Aerostar is well-finished and refined and seems durable. The all-wheel-drive system functions without fuss, all the controls are easy to find and operate, and seating is first-rate, one of the reasons this van emerged as a consensus pick for best bet to drive in a coast-to-coast run.

If you plan to run up a lot of hard miles, haul heavy loads or hitch up a trailer, the 4wd Aerostar should be high on your list, maybe even ahead of the more carlike Previa and MPV.

Chevrolet Astro/ GMC Safari

The Astro—and identical twin, Safari—is a perfectly competent all-wheel-

SPECIFICATIONS AND DIMENSIONS

| MANUFACTURER/ MODEL | BASE PRICE/ PRICE AS TESTED | ENGINE/ DISPLACEMENT (ci/cc) | ENGINE HP, NET/ TORQUE (ft.-lb.) | ENGINE/ DRIVE LAYOUT | TRANS- MISSION TYPE | WHEEL- BASE (in.) | LENGTH OVERALL (in.) | WIDTH OVERALL (in.) | TRACK FRONT/REAR (in.) | CURB WEIGHT (lb.) |
|--|-----------------------------------|------------------------------------|--|----------------------------|---------------------------|-------------------------|----------------------------|---------------------------|------------------------------|-------------------------|
| Chevrolet Astro All-Wheel Drive | \$18,300/ \$22,517 | V6 OHV 262/4301 | 150 @ 4000 rpm/ 230 @ 2400 rpm | front/ 4wd | 4-speed auto | 110.0 | 177.0 | 77.0 | 65.1/65.1 | 3700 |
| Ford Aerostar | \$15,408/ \$22,480 | V6 OHV 245/4015 | 155 @ 4200 rpm/ 215 @ 2400 rpm | front/ 4wd | 4-speed auto | 118.9 | 174.9 | 71.7 | 61.5/60.0 | 3600 |
| GMC Safari SLT | \$18,513/ \$22,272 | V6 OHV 262/4301 | 150 @ 4000 rpm/ 230 @ 2400 rpm | front/ 4wd | 4-speed auto | 110.0 | 177.0 | 77.0 | 65.1/65.1 | 3700 |
| Mazda MPV 4WD | \$19,394/ \$21,512 | V6 SOHC 180/2954 | 150 @ 5000 rpm/ 165 @ 4000 rpm | front/ 4wd | 4-speed auto | 110.4 | 175.8 | 71.9 | 60.0/60.6 | 4050 |
| Toyota Previa LE All-Trac | \$21,308/ \$25,687 | I4 DOHC 149/2438 | 138 @ 5000 rpm/ 154 @ 4000 rpm | mid/ 4wd | 4-speed auto | 112.8 | 187.0 | 70.9 | 61.6/61.2 | 3780 |
| Volkswagen Vanagon Syncro | \$17,605/ \$19,375 | F4 OHV 129/2109 | 90 @ 4800 rpm/ 117 @ 3200 rpm | rear/ 4wd | 4-speed manual | 96.9 | 179.9 | 72.6 | 62.4/61.8 | 3950 |



1. Times from a steady-state 40 to 70 mph. 2. Best speed achieved while weaving through seven cones placed in line, 100 ft. apart. Speeds provide index of transient response.



FORD AEROSTAR



TOYOTA PREVIA

drive minivan. It has good power, a smooth drive system, adequate handling and ABS brakes. But the basic concept, nevertheless, is somewhat flawed.

For starters, the Astro's old-fashioned short-nose design cramps driver and passenger footspace around the engine box. It also puts most of the weight on the front wheels, which doesn't do much for handling. The unloaded rear axle bangs and jumps over even minor bumps, thanks to stiff spring rates, and the split rear doors limit rear vision.

Chevy's 4.3-liter V6 has plenty of torque, but it's rougher and noisier than the other V6s in this group, and runs out of breath at relatively low rpm, which holds it back at the test track.

On the bright side, GM's drive system is flawless, and the engine performs well in normal everyday driving. And despite its so-so test



GMC SAFARI

numbers, the Chevy Astro handles quite well in the real world.

The Astro's interior is nicely finished, but in 7-passenger trim, there's no luggage room behind the rearmost seats, and limited legroom elsewhere. The 5-passenger model is far more useful.

VW Vanagon Syncro

VW's rear-engined Syncro is, frankly, not in the same league with the other vehicles in this test. It's beautifully finished, inside and out, and the interior is more versatile. In fact, you get a fold-out table, swiveling seats and a mattress above the engine compartment—all standard.

So what's wrong with the Syncro? Basically, old age.

With only 90 hp, the engine is anemic. Merging onto a freeway is a distressing experience. Acceleration is further hampered by an antique shifter that has to reach from the driver's compartment all the way back to the rear-mounted engine.

Styling is subjective. But let's face it, the VW bus design goes back umpteen years and isn't getting any better looking. We could go on, but why beat a dead horse? A Vanagon replacement is on the way for 1992.

PM

TEST RESULTS

| STEERING TYPE/TURNS LOCK-TO-LOCK | BRAKE SYSTEM FRONT/REAR | FUEL ECONOMY (MPG EPA city/PM test) | ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph) | PASSING ¹ ACCELERATION 40-70 MPH (sec.) | BRAKING 60-0 MPH (ft.) | 700-FT. ² SLALOM (mph) | 200-FT. ³ SKIDPAD (G) | EPA CARGO VOLUME (cu. ft.) | MAXIMUM TOW RATING (lb.) |
|----------------------------------|--|-------------------------------------|--|--|------------------------|-----------------------------------|----------------------------------|----------------------------|--------------------------|
| Power recirc. ball/ 2.8 | F: 11.9-in. vented disc, ABS/ R: 9.5-in. drum, ABS | 16/ 14.1 | 12.4 19.09 @ 70.06 | 10.9 | 135 | 57.5 | .71 | 151.8 | 6000 |
| Power rack & pinion/ 4.0 | F: 10.3-in. vented disc/ R: 10.0-in. drum, ABS | 16/ 17.0 | 10.6 18.42 @ 74.07 | 10.3 | 162 | 56.6 | .72 | 140.4 | 5000 |
| Power recirc. ball/ 2.8 | F: 11.9-in. vented disc, ABS/ R: 9.5-in. drum, ABS | 16/ 16.0 | 12.3 18.91 @ 72.78 | 11.0 | 140 | 57.4 | .71 | 151.8 | 6000 |
| Power rack & pinion/ 3.9 | F: 10.1-in. vented disc/ R: 10.2-in. drum, ABS | 16/ 19.3 | 11.0 19.34 @ 71.56 | 11.1 | 131 | 58.3 | .78 | 110.0 | 4500 |
| Power rack & pinion/ 3.5 | F: 10.9-in. vented disc, ABS/ R: 11.4-in. vented disc, ABS | 16/ 17.0 | 11.0 20.59 @ 66.37 | 11.9 | 128 | 59.6 | .75 | 157.8 | 3500 |
| Power rack & pinion/ 3.8 | F: 10.9-in. vented disc/ R: 9.9-in. drum | 16/ 18.2 | 17.3 21.89 @ 61.74 | 20.1 | 127 | 54.5 | .73 | 99.7 | NA |



FORD AEROSTAR



CHEVROLET ASTRO



VOLKSWAGEN VANAGON

3. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best clockwise and counterclockwise.

INTRODUCING EXPLORER. NOBODY'S EVER TAKEN FOUR- WHEEL DRIVE THIS FAR.



FORD FOUND A NEW ROUTE TO THE GREAT OUTDOORS.

Compact sport utility vehicles seemed like a passport to any territory you wanted to explore.

No route was too rough, no campsite too far off the road.

One problem: Some vehicles didn't give you much room to stretch in, much less explore in.

THE 1991 EXPLORER. DESIGNED FROM THE GROUND UP.

The new, long wheelbase made all the difference. It means doors can be wide, easy to enter. But, the real news is behind those doors. You'll find plenty of headroom, legroom, real room for adventure.

You'll find a big, deep cargo area too. Pack all the gear you need, and then some.

Space isn't taken by the spare tire; it's mounted below the cargo area.



For longer or bulky supplies, just fold down the rear split-bench seats. The rear access is also versatile; open just the window or the entire liftgate.

ENGINEERED TO TAKE IT, WHEREVER YOU TAKE IT.

The four-wheel drive Explorer has Twin-Traction Beam front suspension for independent wheel action. The frame's ladder-type construction utilizes heavy gauge side rails and 5 crossmembers. P235 OWL all-terrain tires are available.

GO EXPLORING IN REAL COMFORT.

Discover all that's available in Explorer Sport. There are power windows, door locks, remote mirrors; a tilt-up open-air roof and sport bucket seats with leather seating surfaces are available. Sound good? Wait until you hear the available Ford JBL audio system.



EXPLORE NEW ROADS AT THE TOUCH OF A BUTTON.

With all other 4x4 compact utility vehicles, shifting to 4WD means struggling with a clumsy, floor-mounted shift that uses up passenger room and elbow grease. Instead, Explorer has Ford's exclusive Touch Drive system. With the push of a dash-mounted

4x4

button, you shift from 2- to 4-wheel drive high, and back again, on the fly.

The powerful, energetic engine is a fuel-injected 4.0L V-6. Power front disc brakes are standard, as is the rear anti-lock brake system.

Properly equipped, 2-door Explorer can tow 5,400 lbs.

AN IDEAL 4-WHEEL DRIVE VEHICLE... WITH 2-WHEEL DRIVE.

If you don't often encounter conditions that call for 4WD, 2WD only models are available, as are 2- and 4-door models.

The 4-door Explorer has been named "Four Wheeler of the Year" by Four Wheeler magazine. Competing against some of the newest vehicles in its class, foreign and domestic, Explorer ranked #1 in on-road ride and drive, exterior styling, and overall interior excellence.

Discover the 1991 Ford Explorer. You'll see... Nobody's ever taken four-wheel drive this far.

BEST-BUILT AMERICAN CARS AND TRUCKS.

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

Buckle up — together we can save lives.

EXPLORER



Have you driven a Ford... lately?

UPGRADING YOUR FACTORY SYSTEM

You bought the factory car audio system but now you want more. Here are the options.

BY LAWRENCE B. JOHNSON



IN THOSE FIRST exhilarating miles, when the tires still shine, the paint glistens, the upholstery has that new-car smell and you think the sound system sounds like Carnegie Hall—all is right with the world. But soon, something is amiss and you can't put your finger on it.

It's the sound system. The tunes just don't measure up to the rest of the car. This is the package that came with the keys, and it was fine for a while. But you've heard better.

Not to despair. Factory autosound systems were created to be improved upon—upgraded, as the aftermarket mavens like to put it—and there are a million and one ways to go about it. You could do radical surgery, but it usually makes more sense to take it a step at a time. There's often no better place to start your upgrading than with the immediately offending component: speakers.

With some splendid exceptions,

factory system speakers tend to be limited in their performance. They may be plentiful enough, say, a pair in the front doors and another pair in the rear doors, deck or walls. But their high-frequency response may end around 10,000 Hertz, even though your hearing and the range of many recordings extend to nearly twice that. As for bass response, are we still having a serious discussion?

Extend your range

Some very rewarding improvements can be made by simply replacing the factory drivers with real hi-fi speakers. No cutting on the deck or doors is likely to be required, nor is too much labor and only modest expense. For instance, most full-size and midsize cars would accommodate a 6 × 9-in., 2-way speaker such as Alpine's model 6205 (\$130 per pair list) in the rear area and its companion 6204 (\$90 per pair list) up front.

With the 6205's combination bass driver and cone-type tweeter, you suddenly have a rated frequency response out to 21,000 Hz and *down* to 45 Hz. Speakers of this design and quality are typically quite power-efficient, which means they should deliver a good, full sound from the amplifier power built into the head unit (cassette receiver or otherwise) that came with your car system. The 4 × 6-in. 6204 affords less bass extension, but should provide the detailed mid-range and highs needed for good frontal stereo imaging.

Once the upgrade bug strikes, and you begin to see and hear what can be done with sound in a car, chances are you'll soon be ready for the next step: a higher-quality head unit and probably some outboard power. But let's put the muscle move on hold and concentrate first on getting a solid cassette receiver. If you choose one with preamp outputs, such as Kenwood's



Among the products you can use to upgrade an existing system are the Blaupunkt BMA5350B amplifier (opposite) listing for \$900, JVC's CD changer "Commander" (above) listing for \$250, the SAS T62 Bazooka subwoofer (top) listing for \$219, and the Eclipse EQ5-1000 digital sound processor (right) listing for \$1000.

KRC-555 (\$499), it will be easier to add power amps later without junking that receiver. Like other cassette receivers, the KRC-555 can be purchased with a slide-out chassis to minimize the chance of theft.

The Kenwood, which features an AM/FM tuner with an autoreverse cassette player in a slide-out chassis, also serves as a good example on a couple of other counts. Its rated power of 10 watts a channel is probably twice what you got with your car. But a word of warning about power ratings. They are not standardized in autosound, and there's a tendency among manufacturers to play with numbers. Advertisements, particularly those paid for by retailers, often talk about maximum or peak power output which can be a very impressive 50 or 60 watts and which the amp might be able to sustain for, say, several milliseconds.

Depending on your budget and ex-

pectations, you might not go the receiver route at all, but head straight for a cassette tuner (with no built-in amp) or CD tuner or even a hybrid of the two. Without the built-in power afforded by a receiver, all your system power will spring from outboard amps tucked away in the trunk or stashed under the seats. This is where car-fi starts to get serious and heady.

CDs in the trunk

For the moment, let's bypass tape and look at CD tuners, which are quickly becoming more affordable. Sony's recently introduced CDX-6020, at \$450, features 4-times oversampling in the CD section and autotuning in the AM and FM modes. You can have both tape and CDs on the road by linking your tape head unit to a CD changer secured in the trunk or hatch area. Several companies offer combinations of CD changers and cassette tuners/controllers. As an add-on

to an existing system, the CD changer would be accessed via a handheld remote commander wired into the cassette tuner. For example, JVC's XL-MK1200 12-disc CD changer (\$729) can be patched into your system and operated via its matching KS-RM12 controller (\$250).

To savor the full dynamic range and clarity of CDs on wheels, you need some hefty system power, speakers that can handle it, and reinforcement of subwoofers on the extra bass. You're best off starting with speakers, and letting those choices determine how many and what kind of amplifiers you'll need.

For optimum stereo staging, as well as maximum accuracy and power handling, something like Boston Acoustics' model 761—a set of separate 6½-in. midranges and 1-in. tweeters listing for \$240—can be used in front. The midrange drivers go into

UPGRADING YOUR FACTORY SYSTEM

the doors, with the tweeters in the dash locations where factory speakers are usually found. For rear-area fill, it's not a bad idea to stick with matched speakers. In this case, Boston Acoustics' model 751 component array listing for \$230 per pair. The 751 consists of a pair of 5¼-in. midranges and 1-in. tweeters.

Better bass

In the unmincing words of one veteran car-fi installer: "What this business is really all about is creating deep bass." To cross the line from pretty good sound to supersonic sensations, you need a subwoofer or two. You don't need to make room for an 8-, 10- or 12-in. woofer in the passenger compartment, because the ear generally cannot discern the origin of deep bass frequencies. The subs can be mounted in the trunk, if you have one, or enclosed in custom-made boxes in the hatch area of sportier cars. All that matters is the transmission of those low frequencies into the listening area.

That can be accomplished by venting the subs through the back seat or even through a rear deck re-covered with an acoustically porous material. Even among autosound hobbyists, who measure power by the kilowatt, the cardinal rule is to preserve the vehicle's stock appearance. A really trick sound system is, above all, one you can't see.

Among the more cost-effective bass solutions, especially for cramped spaces, is the SAS Bazooka T62 subwoofer (\$219 per pair list). The Bazooka T62, named for its appearance and potent report, delivers bass down to a low 39 Hz, while demanding comparatively little of an amplifier. Some installers prefer the more defined sound and greater power handling capacity of a conventional cone subwoofer, such as the Infinity RSDS 12 (listing for \$225 each).

How many amps?

With all this sonic firepower in place, how about a spark to set it off? Amplifiers can be as simple or as complex a subject as you care to make them.

Many installers like to use a minimum of two amps, one dedicated to the subwoofer and one to the stereo satellite speakers.

Some amplifiers can be used in either stereo or mono, an option that gives you a lot of flexibility if you want to build a car audio system over time. The Altec Lansing ALA-552 (\$300) offers 50 watts per channel in the stereo mode. The ALA-552 can also be bridged to operate at 100 watts in mono—perfect for the omnidirectional bass thundering from a subwoofer. Amplifiers from several different

work with variable cutoff frequencies across the spectrum.

Not all factory-installed systems readily lend themselves to upgrades. Some, such as the Delco Bose and the Ford JBL factory systems, are quite good to begin with, but incompatible with most aftermarket components. Denon has come up with an answer to such puzzles in its Car Audio Modular Interface (CAMI) series, a system of interlocking modules that Denon says will allow you to connect any in-dash unit, factory or aftermarket, to any amplifier. The DCL-420 4-channel

level interface controller, for example, offers individual control of the input and output levels for each component linked to the amplifier.

Alpine is taking another upgrade approach. Its CD Shuttle Link is a module that connects between a factory cassette receiver and a car compact disc changer. Due to the varying methodologies used by the car companies, there are 14 different Shuttle Links with 60 applications. Prices vary for each, but most are under \$100.

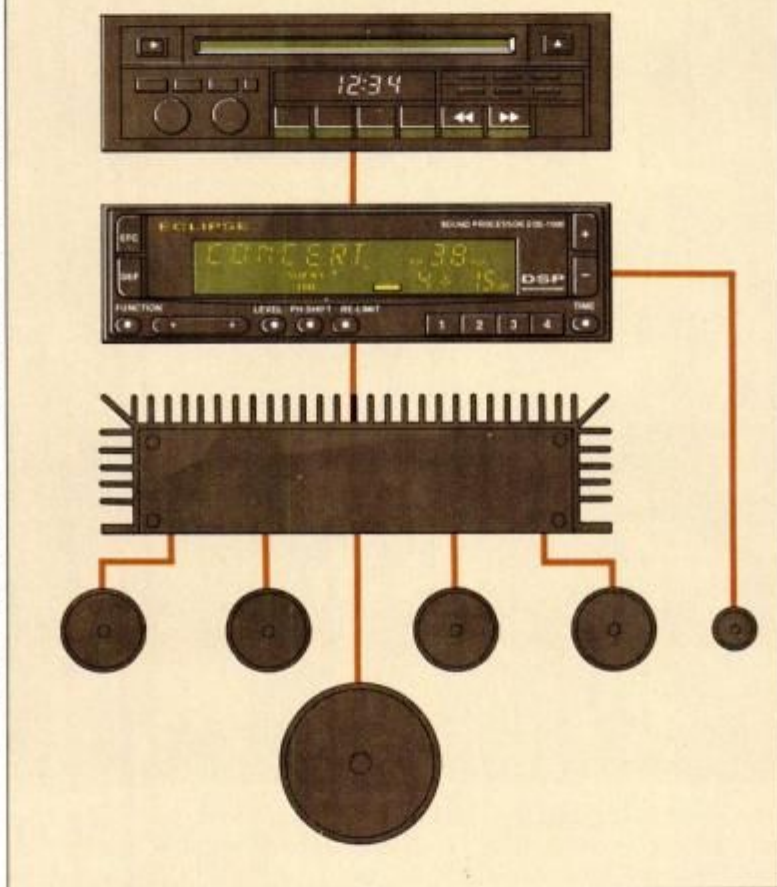
Add surround-sound effects

The boldest breakthrough lately is the auto adaptation of surround sound through digital signal processing (DSP). One of the first units to feature DSP is the Fujitsu Ten/Eclipse EQS-1000 (\$1000). This magical little black box, which can be tucked away beneath the dash, uses a 24-bit chip that makes 13 million computations per second—enough computer power

to duplicate the acoustical character of a concert hall, jazz club, arena or cathedral—including the early and late reflected sound and decay time.

Or you can create your own acoustical environment by altering delay times and the subwoofer level. The EQS-1000 does require both a subwoofer and a center-channel speaker (for which a 10-watt amp is built in), plus two pairs of speakers. Other companies, like Technics and Pioneer, promise DSP surround components later this year. Technics says its system will be built into a head unit, probably a cassette tuner. **PM**

SOUND SHAPING FOR THE CAR



The Eclipse EQS-1000 (center) is a digital sound processor that replicates the acoustics of different environments. The system—connected between CD tuner and amplifier—requires two pairs of speakers, a subwoofer and a center-channel speaker. The center-channel speaker (right) is powered separately by the EQS-1000's 10-watt amplifier.

manufacturers have this capability.

Some high-power fiends also like to use a separate mono-mode amplifier for each stereo channel. The power ratings for each amplifier should be matched, of course.

Another approach to amplifiers is to use just one amplifier with a single massive power supply for the entire system. Blaupunkt's BMA 5350B (\$900) is typical of that class. Rated at 50 watts into each of four channels (bridgeable to 100 watts by two channels), the BMA 5350B also includes 150 watts for subwoofer service, as well as an integrated crossover net-

TRUCKS

DREAM HAULERS

Although the pickup truck has resisted change for decades, new ideas are on the near horizon.

BY CLIFF GROMER



DODGE
LITTLE RED
TRUCK

MAYBE IT WAS all the California truck crazies who started it—elevating the lowly pickup truck into a cult/lifestyle thing. Maybe it was Detroit market research that tapped in on pickups becoming a first-vehicle choice among a growing number of buyers.

Whatever it was, Detroit and the import truck designers have gone back to the drawing board

on pickups. Their concept designs take a fresh and futuristic look at what was once a pure workhorse. One look at the trucks pictured here and you know they're not destined to groan under a load of gravel.

These dream haulers focus on personal use and recreation. And, like their concept car brethren, automakers use them to gauge public reaction to overall look as well as specific features.

Pickups are more popular than ever, with the biggest growth in personal use. Compact trucks have a big image advantage over economy cars carrying similar

price tags. Where the car says: "I'm driving this because it's all I can afford," the truck comes across with a more positive sporty, macho image: "I'm driving this because I'm hip."

Dodge LRT

Dodge had a popular hit in '78 with its Li'l Red Truck—a vehicle now in demand by collectors. It had a macho truck image and good performance from a converter-free 360-cu.-in. V8. The Mopar folks are trying to recapture some of that magic with their LRT (Little Red Truck) convertible based on the V8-powered Dakota.

NISSAN GOBI



The unique front-end treatment is designed to look tough and aggressive. According to the designers, the grille, pontoon fenders with flush aero lamps and integral bumper are supposed to emulate a Peterbilt look.

The top and bed are special features on this 4x4. The convertible top uses retractable metal panels which stow behind the bucket seats. They are moved by electric motors, similar to the old Ford retractable hardtop. The track mechanism for the system is

housed in the sport bar, which also supports off-road lights.

The bed tilts like a dump truck, and a winch/conveyor track allows easy loading/unloading of an ATV. The package is rounded out by 17-in. wheels similar to those used on the '89 Dodge Viper R/T concept car.

Nissan Gobi

If you think entry-level trucks tend to be plain and bland, the Gobi will quickly change your mind. Nissan designers looked to the Bell helicopter for inspiration, and the chopper influence is quite evident in the pod-shaped cab and asymmetrical interior. Controls and instruments are grouped toward the driver, while the passen-

ger benefits from a spacious loungelike area.

Nissan adds a bit of wit to the already-amusing overall shape by labeling outside storage compartments: "Things," "Stuff" and "Odds and Ends." Many cars and trucks are already equipped with a removable radio, but the Gobi goes one better by giving you a removable glovebox. Out back there's a functional bed that uses folding corrugated side panels for easy loading and unloading. The Gobi may not fly, but unlike some airlines, the truck at least gets you and your luggage to the same destination at the same time.

Isuzu Costa

Isuzu adds a new twist—or slide—to its sporty Costa 4x4-seater prototype. Push a button and a motor-driv-

ISUZU COSTA



PM PHOTO BY BRUCE CRABAG PHOTO

CHEVROLET XT-2



en sliding deck moves forward to cover the rear seats, effectively silencing back-seat drivers or just adding a sportier appearance. The vehicle also explores the use of plastic body panels as a definite coming trend to pickups in general. Powerplant is a 2.6-liter Four cranking out 120 hp and 146 ft.-lb. of torque.

Chevrolet/PPG XT-2

Shades of El Camino—an IROC Camaro pickup. But the El C. never performed like the XT-2—even with a 454-cu.-in. V8. What we have here is serious V6 power in race trim producing 360 horses for quarter-mile acceleration in about 13 seconds flat and a 0-to-60 mph time of 6 seconds.

Not surprisingly, the function of the XT-2 goes beyond most concept trucks as it will see active service as a pace vehicle for the CART PPG Indy Car World Series. To handle the task, the pace truck was built from the ground up and is based on a tube frame with integral rollbars—necessary rollover protection at racing speeds.

The huge sloping windshield, which also serves as the hood, is the largest piece of windshield glass ever made by PPG and lifts on gas struts like a hatch. With the windshield raised, the top of the instrument panel also lifts up for access to the engine. The rear drivetrain is accessible through a removable bed floor.

The 4.5-liter 90° V6 traces its lineage to a Trans-Am racing-type powerplant, and uses Chevy high-

FORD SURF



performance Bow Tie components, including the block and cylinder heads.

A special clear-coated PPG 3-step paint job with blue mica chips over a red base gives the smooth flanks an electric blue color in the sun that changes to purple in low light.

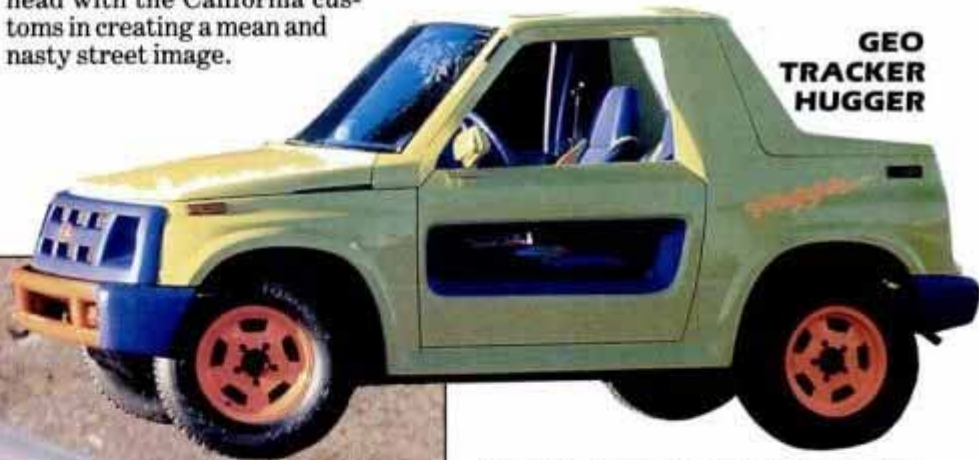
Surf And Street

Ford fields two concept trucks—the Surf, a no-roof, no-tailgate version of its new Explorer 4x4, and the Street, an exercise that goes head-to-head with the California customs in creating a mean and nasty street image.

The Surf is promoted as a leisure vehicle—a fun way to get to the beach. Big 15-in. wheels help traction in the loose stuff and add to a macho look. Flared fenders control water and sand spray, while special wheel discs keep hubs grit-free. It's all topped off with one of Ford's uninhibited paint jobs.

Based on a full-size F-150 model, the Street gets its don't-mess-with-me Hulk Hogan stance from a low profile and big 16-in. wheels. Roof height is chopped 3½ in. The truck is lowered 4 in. in front and 3 in. at the rear. Then

GEO TRACKER HUGGER



the suspension was set up to create a nose-down, "bad" attitude.

The California influence is also evident in the shaved door handles, frenched antenna and quad exhausts molded into the rocker panels. Ford doesn't have anything special under the hood to back up the menacing look, but that may soon change.

GEO Tracker Hugger

The Hugger exercise on the Geo Tracker convertible is definitely not for introverts. Its screaming zonker fluorescent paint job could easily be a landing beacon for UFOs.

The designers went for a fun, rugged look here in creating a really basic



DREAM HAULERS



recreational vehicle like the original Jeep. They muscled up the front end with a fiberglass version of the full-size CK pickup grille and tube bumpers. The Tracker designers also achieved an open-air look by eliminating the top, chucking the rear seats, hardware and carpeting, making for a 2-seat minipickup.

A companion design—Hugger II—is a less radical exercise with possible production in mind. This version retains the Tracker's top hardware and uses a canvas top that's Velcroed in position, making it possible to easily remove the entire top or just the front half portion. The canvas rear section zippers out.

GMC Mahalo And Transcend

Not one to be left out of the concept truck crowd, GMC has cooked up two



offerings—the Mahalo, a convertible based on the '91 compact Sonoma extended-cab pickup, and the Sierra-based Transcend. Designed to fit right in with the California truck scene, the Mahalo's "sea spray" 3-color paint scheme is a real head turner. If you

can't get to the beach, just stand by the truck and smell the salt air.

The extended-cab version is unusual in the custom truck arena, but the designers felt it gave a convertible more styling potential with the top up than the smaller version. The look here is more coupelike, rather than a regular cab covered in vinyl.

The macho look is achieved by a lowered ride height and 16-in. wheels with fat tires. Full ground effects, tonneau cover and rear spoiler help integrate the entire package.

The Transcend is geared more toward luxury and advanced features, based on the division's full-size pickup. The show-stopping feature here is a remote-controlled retractable hardtop. Push a button on the remote, and motors whir, making the roof do a disappearing act behind the seats.

If you're in the habit of misplacing your car keys, the Transcend is just for you. A keyless ignition system and a remote entry system activated by the same transmitter make keys and door handles obsolete.

Like the Mahalo, the suspension is lowered for a more aggressive stance and better handling, while a feature-packed console sports everything from a CD player to just about every power accessory known to man. **FM**





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Castrol's higher viscosity helps sustain a protective film between metal surfaces while providing maximum



protection against viscosity and thermal breakdown. (For geographic areas where temperatures are consistently below 20° F, Castrol also offers 10W/40, 10W/30 and 5W/30.)

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**CASTROL GTX 20W/50.
ENGINEERED FOR TODAY'S SMALLER CARS.**

ADVENTURE

DEATH VALLEY TO PIKES PEAK

We bang out 1300 rugged miles from desert sand and rock to high-mountain mud and snow in the new Ford Explorer.



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

IT'S HIGH NOON in Death Valley. I'm inching up a steep, rocky cliff and learning the true meaning of "serious off-roading." At daybreak, I was told by a park ranger that the trail to Echo Canyon goes through the Funeral Mountains and into Nevada. The ranger's exact words were: "It goes through, but it's not for everyone. It's a good trail up to Inyo Mine. After that, it's serious off-roading. And I mean serious."

Give me a break. Who could be more serious than copilot Rich Cox and I? We're driving the new Ford Explorer. We've got a winch, tools, spare parts, camping gear, maps, supplies and food for a week. Serious off-roading is our middle name.

Four hours later, we're only half-way to Nevada and threatening to impale the Explorer on jagged bedrock. A series of steps climbs to a 5000-ft.-high pass. We build ramps of loose boulders to create elevated tracks up the steep ledges. One uncontrolled

slide and the Explorer bottoms out hard. Perhaps permanently.

Everything hinges on the next few moves. The trail is definitely serious. But so are we. Finally, success. We lurch to the top and look back at the lowest point in the country. Then, to our relief, it's a speedy bounce down a dry wash into sandy Nevada.

A tough way to start a 6-day, 1300-mile adventure? Nah. Just a typical PM torture test.

No Trip Tik

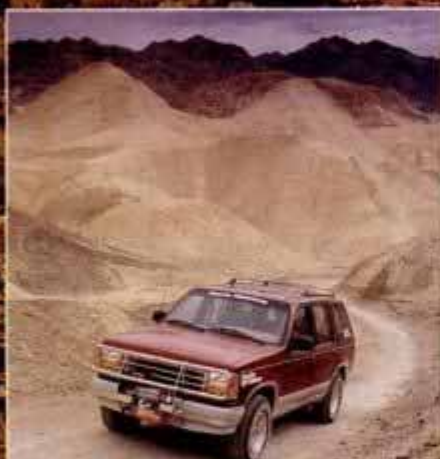
My idea was simple. Drive from Death Valley in California, to Pikes Peak in Colorado. Do it in a stock 4x4 sport/utility vehicle and drive at least 60 percent on dirt roads.

I asked the local chapter of Triple-A for an off-road Trip Tik, but the clerk said, "Uh, we don't do that." Most people, I was told, prefer interstate highways to the boondocks. I can't imagine why.

Since I couldn't get a Trip Tik, I



DEATH VALLEY TO PIKES PEAK



EXPLORER'S ROUTE

This page: Creeping down a ledge near Zion National Park (above), a clean start in Death Valley (inset above), Totem Pole Rock near Moab (below right) and a flat in Nevada (far right). Opposite page: Fresh snow near Telluride (top left), a serious trail in California (bottom left), Utah's Onion Creek (inset bottom left) and at Pikes Peak (far right).

PH ILLUSTRATION BY TOM FREEMAN

DEATH VALLEY
(LOWEST POINT
IN U.S.A.)

START

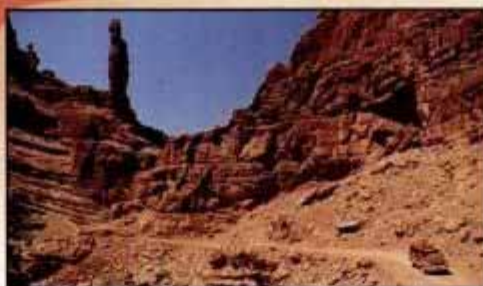
CALIFORNIA

LAS VEGAS

NEVADA

LAKE MEAD

ARIZONA



ZION
NATIONAL
PARK

LAKE POWELL

UTAH

MOAB



contacted the National Forest Service, the Bureau of Land Management and the U.S. Geodesic Survey. Each produces excellent maps showing dirt roads and trails.

My vehicle of choice was the new 4-door Ford Explorer, replacement for the Bronco II. This roomy, compact sport/ute was powered by a hefty 4.0-liter V6 and equipped with rear-wheel ABS and Firestone P235/75R15 All-Terrain tires. Three items on the spec sheet bode well for torture testing: 1. on-demand 4wd that's engaged by the touch of an on-dash button, 2. a long 111.9-in. wheelbase for smoothing out bumps, and 3. an immense cargo area. The moment of truth came in May.

No nukes

Location: Badwater Basin, a natural blast furnace located at minus 282-ft. below sea level. Time: 8 am. We head for the mountains before the temperature can reach 102° F, as it did yester-

day. A *serious* climb brings us to the Nevada border around noon. A couple of hours later, we're on U.S.-95. Total driving time to this point: 6 hours. Distance: 76 miles.

A quick lesson from the outback: Plans made in New York City don't always make sense in the bush. My original route shows us bypassing Vegas to the north by driving through a nuclear test site and an Air Force gunnery range. Wisely, we go south.

A few miles east of Vegas, we find a well-maintained dirt road that connects with a rugged, twisty trail beneath crackling powerlines. This dusty washboard takes us through the Paiute Indian Reservation.

A short sprint on I-15 puts us on a trail that winds through scenic Virgin Canyon. We reach paved roads as darkness descends. The first night is spent in Mesquite, a truck-stop town near the Arizona border.

Surprise of the day? Picked up a

nail and got a flat tire. How did a nail get in the middle of the desert? Driving time and distance: 12 hours and 240 miles.

Mud and snow

They flag me down at Kolub Reservoir. Two retirees covered in mud. "Can POPULAR MECHANICS help us out?" Apparently, our decals are working. How can I refuse a request like that? No fools these.

It's midday on a 7000-ft.-high mesa that skirts Zion National Park. Earlier, we passed through the northwest corner of cactus-studded Arizona. Now we're in Utah mountain country. A couple of days ago, a storm blanketed the passes and peaks with snow.

"We're afraid to move any farther, or the van might drop in the ditch," say Paul Devenport and Doyle Warnock, of nearby St. George. Their van is stuck on a side road in coffee-colored mud like potter's clay—slick on



BLACK CANYON OF THE GUNNISON

CONTINENTAL DIVIDE

PIKES PEAK FINISH

COLORADO SPRINGS

TELLURIDE

COLORADO



the surface, gumbo underneath.

Time to test the new XD9000 Warn winch (\$785). In about a minute, it easily pulls the van onto safe footing.

"You better back out of here, it's pretty bad," the grateful Utahans suggest. "Don't worry about me," I tell them, "I'll do a K-turn." Seconds later, I'm in the ditch. Always happens when you play Samaritan. But serious off-roading is my middle name, and I drive myself out. Eventually. Give credit to the Explorer's excellent on-demand 4wd system and the Firestone tires, which have proven themselves on mud, rock, sand, snow and superhighways.

The first thing we do after reaching Cedar City is wash off a hundred pounds of mud. Then we head into the Escalante Desert. Our goal is to reach Richfield for the night, but nightfall inspires other ideas. We find a motel in a town called Beaver.

Up to this point, about 80 percent of the route is on dirt roads, but the closer we get to Colorado, the harder it is to find lowland trails. Mountain routes are snowed in. The off-road percentage drops to about 50 percent, although we still spend 90 percent of our time off pavement.

From Beaver, we go through two mountain passes and descend a long high-altitude plateau to Green River. We're forced to travel more frontage and powerline roads than we'd prefer, but some are scenic and take us through tunnels cut in solid rock.

After a night in Green River, we go through a section of Utah's Canyonlands and into Moab. From here, we climb the twisty Onion Creek Trail to a snowy pass in the La Sal Mountains at 8500 ft. On the way down, we cross

DEATH VALLEY TO PIKES PEAK



After a serious bath, the Explorer looks right at home in front of the plush Broadmoor.

into Colorado, and finish the day in Telluride.

From Telluride, we drive through the Gunnison wilderness area. We cross the Continental Divide in a

fierce snowstorm at Monarch Pass, elevation 11,300 ft. The last road night is spent in Salida. The next day, we search out as many off-road miles as possible, but most lead to snow-coun-

try. It's a stunning drive from Canon City through historic Cripple Creek and into the outskirts of Colorado Springs.

Peak experience

The Pikes Peak toll road closes at 3 pm and we just make it. But it's snowing again. It's been snowing every day for a week and the road to the summit is only partially plowed. We're disappointed that our 1300-mile adventure winds up 10 miles short, but what the hell. After 749 jolting off-road miles and 76 hours behind the wheel, we feel we've accomplished what we set out to do. We drive as far as we can and celebrate in the snow.

Our celebration continues in a luxury suite at the Broadmoor Hotel, one of the plushest hotels in the country. It costs a fortune and we're blowing our budget, but Rich and I feel we've earned it after six days of pounding washboard roads, inhaling dust, sliding through mud and snow, eating on the run and sleeping in cheap motels. Waiting for us in the suite are four bottles of champagne, courtesy of Warn Industries.

Our first toast is to the magnificence of the land we've just traveled. It's a privilege to be able to enjoy the splendor of this awesome terrain.

Our second toast is to the Ford Explorer. The top-of-the-line Eddie Bauer model (base price \$21,315) enabled us to make the rugged adventure in sophisticated style. Adjustable-support bucket seats, a sunroof, a JBL audio system, power locks and windows, and cruise control are a partial list of standout features. Sleek styling—inside and out—and superb handling made the miles flow by comfortably.

Off-road, the soft suspension and 6-in. clearance of the transfer case demanded extra-special driving care. This was especially true over boulders. Essentially, the Explorer is a compromise vehicle: carlike ride coupled with serious off-road features. How serious? It handled 1300 of the toughest miles I've ever driven without a breakdown. Highway gas mileage was an impressive 22.1 mpg. Off-road, it was 17.7 mpg.

I'd change a number of things if I were to do this trip again. For example, I'd start in June, after the snowmelt, so I could explore the high-mountain trails. Also, I'd allow myself more time to slow down and appreciate the scenery.

But the one thing I wouldn't change is the vehicle. The Explorer took everything an epic off-road adventure could dish out, and did it effortlessly. I can't say the same for the driver. **FM**

Rules Of The Off-Road: Tread Lightly

I USED so many maps during my Death Valley to Pikes Peak adventure that the Explorer began to look like Maps 'R' Us. And I needed every one. The route wound through five states and included everything from super-highways to dirt roads to unmaintained trails. But one path I consistently followed was laid down by the U.S. Forest Service. It's called Tread Lightly.

About 750,000 sport/utes are sold annually. Statistics show that 90 percent never leave the road. My torture test in a stock vehicle proved that they can if they want to. Off-roading is a terrific way to experience places that few people ever see.

If you try it, and I hope you do, familiarize yourself first with the goals of the Tread Lightly program:

- Travel only where motorized vehicles are permitted. Use existing roads. Never blaze a new trail.
- Respect the rights of outdoorsmen to enjoy activities undisturbed.
- Educate yourself by obtaining maps and regulations from public agencies. Comply with signs and learn the low-impact rules of the off-road.
- Avoid tearing up soft trails. Damage done in the wet season deteriorates.
- Drive responsibly to protect the environment for future generations.

To find out more about Tread Lightly, write to the U.S. Forest Service Intermountain Region, Federal Building, 324 25th St., Ogden, UT 84401, or call (801) 625-5170.

For route planning, I suggest writing to the National Map Distribution Center, U.S. Geological Survey, P.O. Box 25286, Federal Center, Denver, CO 80225, or call (303) 236-7477.



Other sources of maps are the Forest Service and Bureau of Land Management. In regions managed by these agencies, an office is always located in the state capital.

The pleasure of off-roading is derived from the thrill of meeting a challenge. Our biggest challenge is to preserve the environment for the future. As we succeed, it will give us our biggest thrill. —J.S.

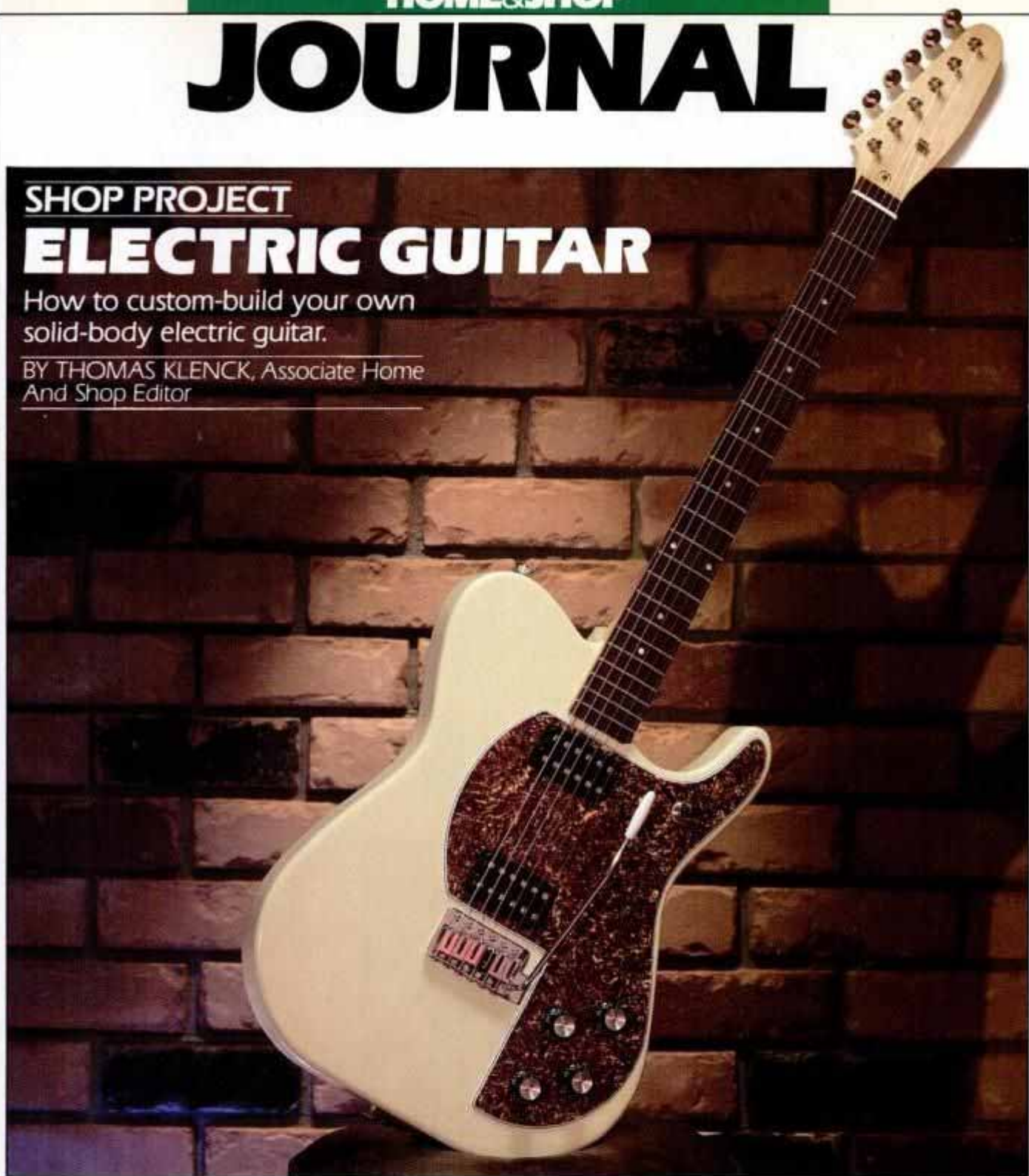
JOURNAL

SHOP PROJECT

ELECTRIC GUITAR

How to custom-build your own solid-body electric guitar.

BY THOMAS KLENCK, Associate Home And Shop Editor



IT CAN SCREAM with ear shattering intensity or whisper gentle melodies, sear the air with a torrent of winding scales or dominate the space with massive, organlike chords. It's shaped the sound of popular music for the past 40 years—from jazz and country to rock and folk. And, there are few people today who haven't at one time or another played—or yearned to play—the electric guitar.

The guitar we built is based on the classic Fender Telecaster. However, we've made a few changes, such as

adding two powerful double-coil pickups with independent volume and tone controls, a 3-way toggle switch for pickup selection, a tremolo bridge and a custom pickguard.

Guitar hardware is available at most well-stocked music stores. We bought all of our components from two sources: WD Music Products, Inc., 261 Suburban Ave., Unit I, Deer Park, NY 11729; and Woodworkers Dream, 510 Sycamore St., Nazareth, PA 18064. (See Materials List and drawing on pages 44 and 45.) If you

choose components other than those specified, have them before you start construction so that any necessary design changes can be made.

Although the guitar is simple to construct, start with a full-size drawing from which you can transfer design details to your work. The neck requires special care to ensure that it's straight and that the frets are installed accurately.

Lead photo: Alex Layman
Step-by-step photos: Thomas Klenck
Technical art: Eugene Thompson

Making The Neck

Our guitar features a maple neck with a rosewood fingerboard. The neck is secured to the body with four screws and contains a box-type truss rod that can be used to straighten the neck, should it bend under the load exerted by the strings.

Select straight-grained maple for the neck, thick enough to be planed to a perfectly flat, $\frac{3}{4}$ -in.-thick board. After truing and thicknessing the neck stock, use a router with fence to cut the truss rod channel along the centerline. Check that the truss rod fits snugly and that the top of the rod is flush with the surface. Then, lay out the neck shape and band saw to the outside of the line (Photo 1). Mark the nut position on the neck.

Plane the fingerboard stock flat and to a thickness of $\frac{1}{4}$ in. Keep the cutter sharp and finely set, and use a bench hook to hold the stock in place (Photo 2). Scribe the centerline, edges, body end and nut position on the fingerboard. Cut off the excess at the nut end about 1 in. beyond the nut position and band saw to the outside of the remaining perimeter lines.

Apply slow-setting epoxy to the sides of the truss rod, set it in the channel and wipe away excess epoxy. Then, apply ordinary carpenter's glue to the neck surface and clamp the fin-

gerboard in place with the nut positions on the fingerboard and neck aligned (Photo 3). Let the glue dry overnight.

Plane the neck sides to the scribed lines on the fingerboard. Smooth the edges around the head and lay out the line for cutting the head to a thickness of $\frac{1}{2}$ in., as shown in the drawing on page 45. Band saw to the line using a block taped under the neck for support (Photo 4). Use a drum sander to smooth the curve from the fingerboard to the head, and sand the head face. Trim the body end of the neck to length and round the corners to a $\frac{1}{4}$ -in. radius. Check that the fingerboard is flat by laying it facedown on a cast-iron jointer or table saw top.

Use a vernier or dial caliper to accurately lay out the fret spacing. It's best to lay out the spacing between several frets first, as shown in the fret detail. This reduces the chance of an accumulated error that can occur if each fret is spaced consecutively. Lightly scribe each fret location across the fingerboard centerline. The fret slots must be .020 in. wide. Some fine dovetail saws are appropriate, but be sure to check the kerf with a feeler gauge. The small Blitz saw (available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013) will do the job.



1 After routing the channel for the truss rod in $\frac{3}{4}$ -in.-thick maple, lay out neck outline and band saw to outside of line.



2 Use a sharp, finely set hand plane to joint and thickness fingerboard to $\frac{1}{4}$ in. Long bench hook holds work in place.



3 After installing truss rod in channel with epoxy, glue fingerboard to neck with carpenter's glue. Let glue dry overnight.



4 Shape head setback on band saw to bring head thickness to $\frac{1}{2}$ in. Smooth sawn face with drum sander and by hand.

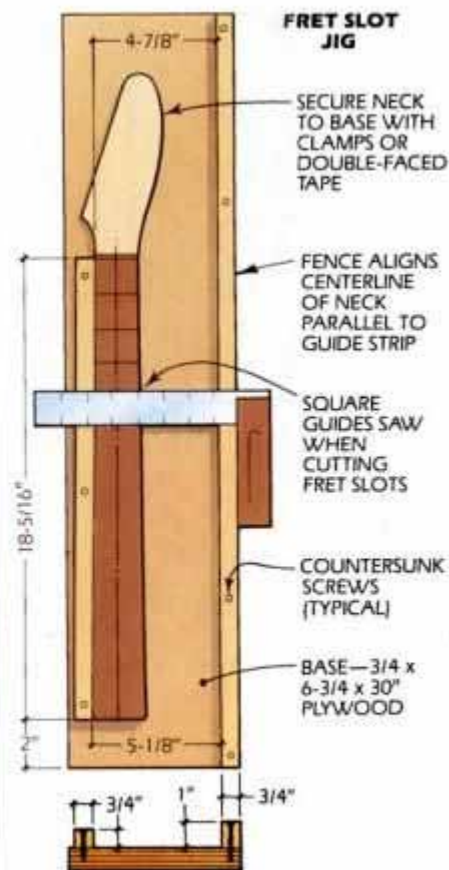
MATERIALS LIST— ELECTRIC GUITAR

| Key | No. | Size and description (use) |
|-----|-----|---|
| A | 1 | $1\frac{1}{2} \times 1\frac{1}{2} \times 16'$ basswood (body) |
| B | 1 | $\frac{1}{2} \times 4 \times 25\frac{1}{2}'$ maple (neck) |
| C | 1 | $\frac{1}{2} \times 2\frac{1}{2} \times 19'$ rosewood (fingerboard No. 14FB18A**) |
| D | 1 | $\frac{1}{4} \times \frac{7}{16} \times \frac{3}{4}'$ maple (access block) |
| E | 1 | tremolo assembly (No. STRB**) |
| F | 2 | pickup (No. WPU 11 BL*) |
| G | 4 | potentiometer (No. WD 500*) |
| H | 2 | .022 μ F capacitor (No. .022 CAP*) |
| I | 2 | tone knob (No. KB 130 T*) |
| J | 2 | volume knob (No. KB 130 V*) |
| K | 1 | 3-way toggle switch (No. WDE 7*) |
| L | 1 | truss rod (No. 13BAR**) |
| M | 1 | nut (No. BNF*) |
| N | 1 | 6-in.-line tuning machines (No. SD 9105 MN*) |
| O | 1 | 9 x 15 $\frac{1}{2}'$ pickguard blank (No. GB-705*) |
| P | 17 | pickguard screw (No. PGFC*) |
| Q | 2 | strap button (No. EPB 2 C*) |
| R | 1 | neck plate (No. NBS 3 C*) |
| S | 4 | neck plate screw (No. FNC*) |
| T | 8 | $\frac{7}{16}$ "-dia. pearl dot (No. 13D08**) |
| U | 1 | $\frac{1}{2}$ " jack (No. WDE 12*) |
| V | 1 | jack plate (No. JCS 3 C*) |
| W | 60' | fret wire (No. 13FWF020**) |
| X | 1 | string retainer (No. RG 11 C*) |
| Y | 1 | set strings |
| Z | 1 | tremolo cover plate (No. STB-3606*) |

Misc: 120- and 220-grit sandpaper, 400- and 600-grit wet/dry sandpaper, clear spray lacquer, Martin-Senour Peanut Beige Spray Enamel No. 7872 and Gray Primer No. 7865, polishing compound, tung oil, epoxy, glue.

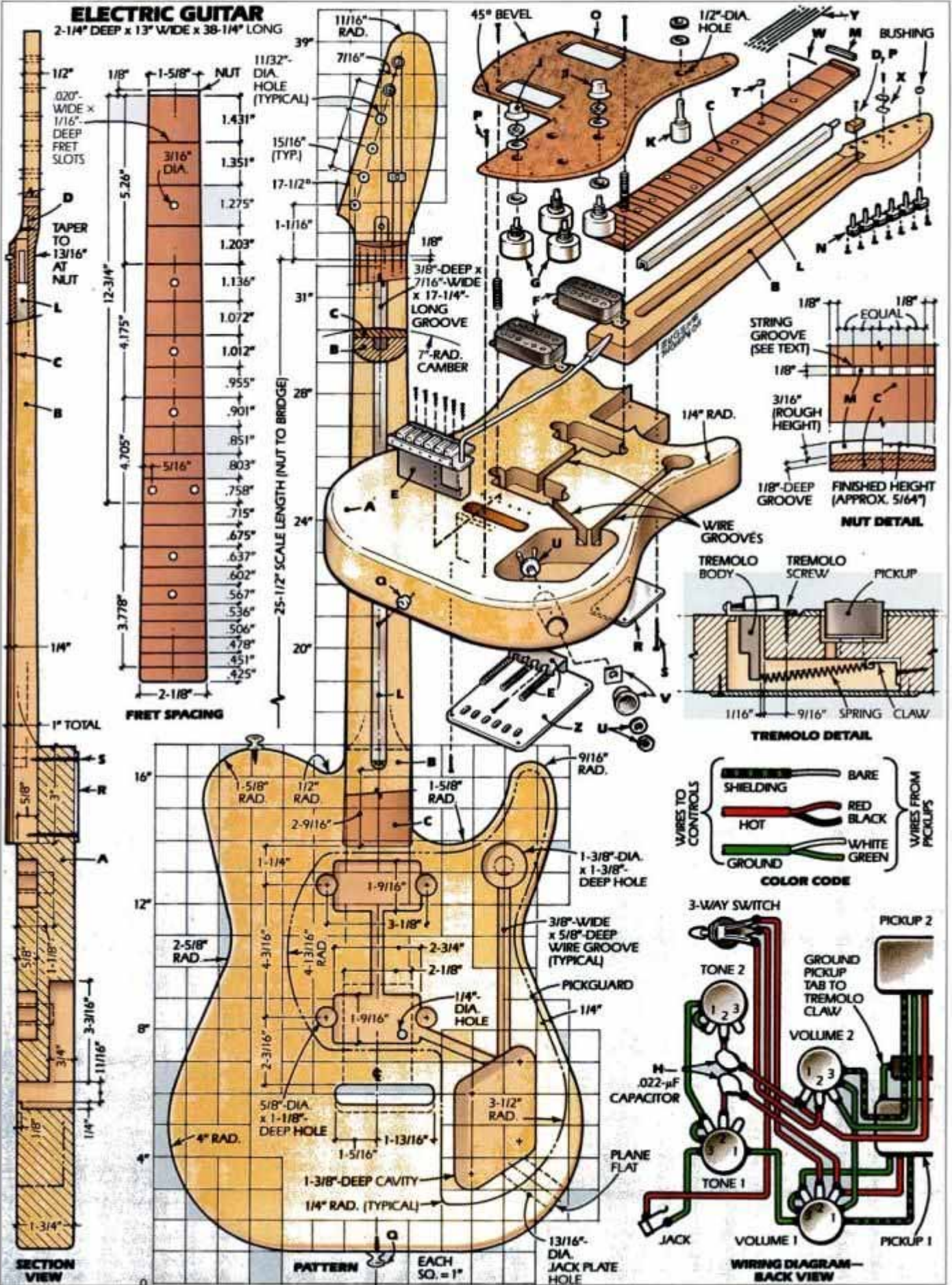
* Stock Nos. from WD Music Products, Inc., 261 Suburban Ave., Unit 1, Deer Park, NY 11729. Tremolo, pickup, potentiometer, switch, tuning machines, strap button, jack, jack plate and string retainer come with necessary fasteners.

** Stock Nos. from Woodworkers Dream, 510 Sycamore St., Nazareth, PA 18064.



ELECTRIC GUITAR

2-1/4" DEEP x 13" WIDE x 38-1/4" LONG





5 After laying out fret spacing, saw fret slots perpendicular to fingerboard centerline. Saw kerf must be .020 in. wide.

Use the fret slot jig (page 44) to ensure that the slots will be perpendicular to the neck centerline. Line up the square with each fret location to guide the saw and cut the slots about $\frac{3}{32}$ in. deep (Photo 5). If the saw binds, apply a little paraffin to the blade.

Plane the fingerboard top to a 7-in.-rad. camber. Use a template as a guide (Photo 6) and periodically check that the board remains flat along its length. Sand with 120-grit paper and a long, straight sanding block.

Mark the pearl dot positions and use a drill press to bore holes just deep enough for the dots to protrude above the surface. Secure with fast-setting epoxy and sand flush, finishing with 220-grit paper.

Prepare to install the frets by ensuring that the fret slots are slightly deeper than the tang of the fret wire. It's a good idea to practice fretting on a scrap block of maple—when you're confident, you can move onto the actual neck. Cut the first fret about $\frac{1}{4}$ in. longer than the slot. Use pliers to bend it to a tighter curve than the fingerboard camber. Place the ends over the slot and tap them gently but firm-



6 While hand planing the fingerboard camber, use a 7-in.-rad. template to gauge the arc. Then, sand the board smooth.



8 Use Surform tool to shape neck back near head and body joint. Finish between with spokeshave and sand smooth.

ly into the slot. Then, seat the rest of the fret by gently tapping across the fret, working from side to side (Photo 7). If the ends pop out, you're probably tapping the center too hard.

After the frets are installed, cut the ends flush and file to a 45° bevel. Shape the back of the neck by band sawing the taper that goes from 1 in. at the body joint to $\frac{13}{16}$ in. at the nut. Use files and Surform tools to shape the neck at each end (Photo 8) and spokeshave the area in between.



7 Install frets by first bending to tighter curve than board. Hammer ends in place and then tap from side to side to seat fret.



9 Carefully lay out spacing of holes for tuning machines and bore on drill press. Use backing board to eliminate tearout.

ly into the slot. Then, seat the rest of the fret by gently tapping across the fret, working from side to side (Photo 7). If the ends pop out, you're probably tapping the center too hard.

Then finish by hand sanding the neck. Saw the sides of the nut slot to the correct depth and add a saw kerf in between. Then, use a chisel to break away the waste, and clean out the slot with a file. Glue the nut blank in place with a dab of epoxy, file the ends flush and trim the height to the rough dimension shown in the nut detail. Lay out the tuning machine holes and bore them with a drill press (Photo 9). Then, shape and install the truss rod cover block at the head.

Making The Body

Glue together 2-in.-thick basswood to create the 13 × 16-in. body blank, and then thickness to 1 $\frac{1}{4}$ in. Lay out the body shape and mark the centerlines on the front and back. Band saw to the outline and smooth with a drum sander and by hand sanding (Photo 10).

The cavities for the pickups, controls, tremolo and neck joint are all made by using templates to guide a plunge router equipped with a guide bushing. To rout the neck cavity, use a $\frac{1}{4}$ -in.-dia. straight bit and $\frac{1}{2}$ -in.-dia. guide bushing. Cut a template to the shape of the cavity, but $\frac{1}{8}$ in. larger on each side to compensate for the bit offset from the guide bushing. Mark the centerline on the template so it can be aligned on the guitar. Make a trial

neck joint in scrap stock to ensure that the template is correct.

Begin the pickup cavities by boring the $\frac{5}{8}$ -in.-dia. holes, as shown. Then, using the $\frac{1}{4}$ -in. bit, $\frac{1}{2}$ -in. guide bushing and appropriate template, rout the cavities $\frac{3}{8}$ in. deep. Follow by routing the control cavity, boring the hole for the 3-way switch, and routing the wire channels.

Lay out the tremolo slot and remove most of the waste with a drill press and $\frac{1}{2}$ -in. drill bit. Then, with a long, $\frac{1}{2}$ -in.-dia. straight bit, $\frac{3}{4}$ -in. guide bushing and appropriate template, rout the tremolo slot that extends through the body (Photo 11). Next, use the same template, bit and bushing on the back of the body to rout the slot undercut shown on the

tremolo installation detail. This time, however, set the template $\frac{1}{4}$ in. closer to the guitar bottom and stop the cut $\frac{1}{8}$ in. from the front face, as shown. Complete the tremolo cavity by routing the recess in the guitar back that contains the tremolo springs and claw.

Use the neck plate (R) as a template for boring the screw holes through the body at the neck joint. Then, clamp the neck in place, check that it's aligned properly, and transfer the hole locations to the neck (Photo 12).

Round the edges of the body with a $\frac{1}{4}$ -in.-rad. rounding-over bit. Plane a slight flat at the jack hole location as shown and bore the jack hole to meet the control cavity. Then, bore the hole through the bridge pickup cavity for the ground-to-tremolo claw.



10 After laying out body shape and centerlines on 1 1/4-in.-thick basswood, saw to the outside of the line on the band saw.



11 Plunge router with guide bushing follows plywood templates for cutting all body cavities. Shown is the tremolo slot.



12 After boring screwholes through body, align and clamp neck in place and transfer pilot hole locations to neck.

Pickguard And Wiring

First, make an exact template of the pickguard from 1/4-in. plywood and include all cutouts for pickups and controls. This template not only acts as a guide for shaping the pickguard, but serves as a temporary assembly board for the wiring.

Use double-faced tape to secure the template to the back of the pickguard blank (Photo 13) and rough saw the shape on the band saw. Then, use a chamfering bit with ball-bearing pilot mounted in a router table to trim the pickguard edge (Photo 14). Use a straight bit with pilot to cut the pickup holes after boring a starter hole with a drill bit. Bore the holes for the pickup mounting screws and controls, making sure to hold the pickguard firmly, as it has a tendency to lift as the bit exits the material (Photo 15). Countersink all pickguard mounting screw holes.

Place the controls and pickups in their positions on the pickguard template for wiring. Use ordinary 20-gauge hookup wire, from electronic supply stores, for connections. First, wire the hot leg of the jack to the center terminal of the 3-way switch. Be sure to use enough wire so the jack can be inserted in the jack hole during assembly. Connect the ground side of

the jack to the bottom of the nearest pot (potentiometer).

Next, connect each side of the 3-way switch to the center tab of a volume pot. In this way, the hot side of the circuit can be routed to either or both volume controls through the 3-way switch.

Each double-coil pickup has four colored wires and a bare shield wire. Attaching the wires, as shown in the color-code detail, connects the two coils of each pickup in parallel for a bright sound. For a somewhat deeper sound with a slight increase in power, you can wire the coils of each pickup in series by connecting the white and

red wires to each other, and using the black and green for the hot and ground. The shield wire always goes to ground. Be aware that other pickups may have different color codings. Check manufacturer's instructions.

When soldering the pickup wires to the volume pots, also solder the capacitors that connect the volume pots with the tone pots (Photo 16). Complete the wiring by connecting all grounds and soldering a grounding wire to the bridge pickup tab that will eventually be connected to the tremolo claw. Remove the wired components and install them on the pickguard (Photo 17).



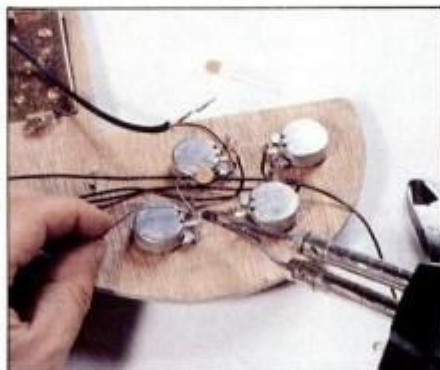
13 Use double-faced tape to attach pickguard template to pickguard blank. Then, band saw blank roughly to shape.



14 Mount router in router table and use chamfering bit with pilot to bevel edges of pickguard. Work against bit rotation.



15 After cutting pickup holes, use drill press to bore control holes, pickup screw holes and pickguard mounting holes.



16 Install all of the electrical components in pickguard template and use a soldering gun or small iron to complete wiring.



17 Mount the completely wired assembly in the pickguard. Pickup screws and springs allow adjustment of pickup height.

Finishing

We finished the guitar body with an acrylic enamel paint and primer that's available in spray cans at auto parts stores (see Materials List on page 44). Be sure to follow all product warnings, provide adequate ventilation, and wear a respirator when using spray paints. If possible, do the job outside.

After sanding the body with 220-grit paper, apply 10 coats of the primer. Allow to dry for one week, and then sand with 400-grit wet/dry paper using water for lubrication and a piece of rigid foam as a sanding block.

Have three cans of the color coat on hand and apply light coats until the last can is empty (Photo 18). After one week, wet sand with 400-grit paper until all surface imperfections have been eliminated (Photo 19). Follow with 600-grit paper and then use auto body polishing compound, following the directions on the can.

Finish the neck by first masking the fingerboard and then applying about 10 coats of clear spray lacquer that's available at hardware and paint

stores. Then, join the neck to the body. Install the tremolo so that the tremolo body is free to pivot on the mounting screws and doesn't touch the slot sides. Tighten the screws only until they contact the unit, and install the springs and claw.

Tap in place the jack plate and square washer. Install the jack and fit the pickguard to the body. Thread the grounding wire to the claw and secure it behind a claw screw. Turn each pot shaft clockwise all the way and press

on the knobs with the No. 10 facing up (Photo 20). Install the tuning machines and the string retainer as shown (Photo 21).

Use a large file to dress the frets to the same height. Carefully move the file along the frets until a small flat spot appears at the top of each fret (Photo 22). Then, mask the rosewood between the frets and use 400- and 600-grit paper to round and smooth the fret tops. Finish by applying a light coat of tung oil to the rosewood.



18 After priming guitar body, apply finish coats. Be sure to have adequate ventilation and observe manufacturer's precautions.



19 Wet sand final finish with 400- and then 600-grit paper to remove all imperfections. Then use polishing compound.



20 Install tremolo unit and wired pickguard assembly. Rotate controls clockwise and install knobs with No. 10 facing up.



21 After fitting tuning machines, screw string retainer in place. This holds high strings down to bear tightly on nut.



22 Lay a large file along the fingerboard and move it carefully along the length to level all frets to the same height.

Guitar Setup

Lay out the string spacing at the nut, as shown in the nut detail. Use a triangular file to cut the string slots for the three lower, heavy strings, and the fretting saw for the remaining high-string slots. Cut the slots just deep enough to hold the strings in place. Then, install a set of strings and bring them roughly to pitch. Be sure to pass the two highest strings under the string retainer. Strings are generally classified by gauge and sets are often referred to by the diameter of the lightest string. We installed extra-light gauge strings where the high string was .009 in. in diameter.

Beginning with the lowest string, carefully deepen the nut string slot until the string just clears the first

fret when it's pressed down at the second fret. The exact position is a matter of personal preference. If the slot is too deep, the open string will rattle on the first fret. If too shallow, the string will be difficult to fret.

Adjust the depth of all string slots and then trim the top of the nut to just below the top of the heavier strings. Make sure that the slots are angled back so the strings are clearly contacting at the foremost edge.

Next, check the fingerboard for straightness with the strings at full tension. A very slight forward bend is acceptable, as it provides room for the strings to vibrate. Check by holding down a string at the first and last fret while measuring the distance between the string and 12th fret. There

should be a gap of no more than $\frac{1}{64}$ in. If necessary, carefully tighten the truss rod to reduce the gap and straighten the neck. At the bridge, adjust each string saddle so that the strings are at a comfortable playing height and don't rattle.

The individual bridge saddles can also be moved forward or backward to adjust the intonation along the entire fingerboard. To adjust the intonation, first sound a harmonic tone at the 12th fret by gently touching the string over the 12th fret while plucking the string. Then, press down the string at the 12th fret and sound the string. If the fretted tone is higher than the harmonic tone, move the saddle backward. If the fretted tone is lower, move the saddle forward. **PM**

**SHOP
TECHNIQUES**

**FAST
REFINISHING**

TEXT AND PHOTOS
BY FRANK CANOVATCHEL

HALF OF THE FUN in finding a great piece of country furniture is anticipating how fantastic it will look after it's been stripped and refinished. And, nothing is quite so satisfying as being able to do the entire job yourself. The finishing products available today not only make the job fast and easy, but offer endless possibilities for achieving the exact look that you're after.

For this project, we found a charming country cabinet with a dark paint finish. Our goal was to remove the paint and refinish the piece in a way that combined the warm, well-used appearance of Early American country furniture, with the look of a natural-wood finish.

If you want more information on the chemical stripper, stains and tung oil that we used for this project, contact ZAR, United Gilsonite Laboratories, Box 70, Scranton, PA 18501. And before starting any finishing job, make sure that you have the right protective equipment on hand, such as rubber gloves, goggles and a respirator.

Step 1—Stripping

The first step in a typical refinishing job is to remove the old finish with a chemical stripper. Be sure to read the label on the can to determine whether the stripper requires a neutralizing agent, such as water or mineral spir-



its. To speed up the stripping process, we used paint remover that doesn't require a neutralizing agent.

Before you apply the stripper, carefully examine the workpiece. If carpentry repairs are necessary, it's often best to do these after the old finish has been removed. Small repairs, such as renailling loose trim, can be done before you start stripping.

Remove all hardware, such as hinges and latches, and set these aside with the original screws. If possible, plan to reuse the original hardware to maintain the character of your piece. If the components are



Furniture stripping begins with these basic ingredients: rubber gloves, goggles, dust mask, bristle brush, putty knife, paint remover and, of course, a piece of furniture.



1 Apply stripper with brush in single strokes—avoid brushing back and forth. Work on horizontal surfaces if possible.



2 After about 15 minutes, scrape off old finish with wide-blade putty knife. If paint remains, repeat stripping process.



3 Use 2-part bleach, available at paint stores, to remove stains and discolorations apparent after stripping.

heavily caked with paint, soak them overnight in paint remover. After the hardware has been thoroughly cleaned, lightly oil any components that have moving parts. We decided not to strip the interior of our cabinet because the small compartments made it difficult work. If you're refinishing a similar piece, and you wish to remove the paint on the inside, first check to see if the shelves can be taken out to make the job easier.

Apply the paint and varnish remover with single strokes going in one direction—don't brush the liquid back and forth (Photo 1). Try to adjust the workpiece so that you're always applying stripper to a horizontal plane. In this way, the chemical will stay put and soften the finish quicker.

After about 15 minutes, scrape away the old finish with a wide putty knife. Scrape with the grain. If the finish is particularly heavy, you may need to repeat the process (Photo 2).

Step 2—Coloring the wood

If areas of the wood appear stained or discolored after the finish has been completely removed, apply a commercial, 2-part bleach that's available

in paint stores (Photo 3). Follow the directions on the label carefully.

After bleaching, and when the wood is completely dry, smooth the surfaces with 80- and then 120-grit sandpaper (Photo 4). If you use an orbital sander, follow by hand sanding with the grain. Be sure to wear a respirator for this job. Brush or vacuum away all dust and wipe the wood with a tack cloth.

After thoroughly sanding the outside, we cleaned the inside with a turpentine-dampened rag in preparation for painting. Then, we applied two coats of an oil-based Country Blue paint to all interior surfaces and the back of the door (Photo 5).

We used Colonial Pine stain to color the wood on the outside of the cabinet. This is a pigmented oil stain that must be stirred to keep the pigment in suspension and ensure uniform color. Apply the stain with a rag or bristle brush. Let the stain stand for about 10 minutes and then wipe away with a lint-free cloth. The longer the stain is left to stand, the darker the color. A second coat can also be added to darken the color.

To get the popular whitewashed

country look, we thinned the stain slightly with turpentine to impart a lighter, warmer tone to the wood. Then we applied a tinted-white stain, called Country White, without thinning and let it remain on the wood for about 20 minutes. After the excess is wiped away, some of the white remains in the crevices and corners of the piece (Photo 6).

Step 3—Final finish

There's no faster or easier way to a successful natural-wood finish than with tung oil. Tung oil stands up well to daily use and resists moisture and most stains. Best of all, it dries to a traditional, hand-rubbed finish with little effort.

Apply the tung oil by pouring a liberal amount on a lint-free rag and then rubbing it into the surface (Photo 7). Let the finish dry for at least 12 hours. For extra protection, add one or two additional coats, buffing between each coat with 4/0 steel wool. For the final touch, apply a coat of paste wax with a rag or extra-fine steel wool pad. Then buff with a clean fiber bristle brush and follow with a soft, lint-free rag (Photos 8 and 9).

PM



4 After the bleached wood is dry, finish sand all surfaces with 120-grit paper. Since bleach is in wood, be sure to wear respirator.



5 Because the interior was difficult to strip, we chose to paint it blue after wiping surfaces with a turpentine-dampened rag.



6 After applying thinned pine stain to color wood, white stain is applied and then wiped off to give whitewashed look.



7 When the stain has dried for 24 hours, apply the tung-oil finish with a rag. Apply a second coat after buffing with steel wool.



8 Additional surface protection and luster is achieved with a thin coat of paste wax. Apply with a rag or extra-fine steel wool pad.



9 After the wax has dried for a few minutes, buff the entire surface with a soft, clean, lint-free cloth to produce a satin luster.



TOOL TECHNIQUES

PLATE JOINER BASICS

How to make the most of
the newest power tool.

TEXT AND PHOTOS BY
ROSARIO CAPOTOSTO,
Contributing Editor

MOST WOODWORKERS would agree that the bulk of wood-working is simply a matter of joining

pieces of wood together in a neat, strong and efficient manner. And in case you haven't looked up from chopping dovetails lately, there's a new tool for getting the job done that's catching on with pros and amateurs alike—the plate joiner.

The plate joiner is essentially a small, plunge-cutting circular saw. It's designed to quickly and accurately cut matching slots in pieces that are to be joined. Oval-shaped wooden plates (often called biscuits) are glued into the slots to join the pieces.

The plates are made of die-cut beech, with the grain oriented diagonally to resist breaking in the completed joint. The plates are compressed so that they're slightly thinner than the slot.

When they come in contact with water-based glue, they quickly swell,

locking the joint together. This means that you can usually remove your clamps sooner than with conventional joints so that they're free for the next assembly.

Unlike dowel joinery, which requires precisely aligned holes, plate joinery permits as much as $\frac{3}{32}$ -in. lateral alignment of the parts immediately after assembly. Any slight misalignment of the slots is then easily compensated for.

Although relatively new to most small workshops, plate joinery was developed in the mid-'50s by Swiss cabinetmaker Herman Steiner, who subsequently marketed the Steiner Lamello plate-joiner system throughout Europe. Low-cost plate joiners have recently made this method affordable for all small shops and home woodworkers.

About The Tool

Several manufacturers offer plate joiners including Elu, Freud, Kaiser, Lamello, Porter-Cable and Vitruex. Although all of these machines have some design differences, the basic components are similar and they're all designed to accommodate standard plate sizes. Two popular models are the Freud JS100 (Photo 1) and the Porter-Cable 555 (Photo 2). Both of these have a spring-loaded base that keeps the blade safely retracted until it's plunged into the work. An adjustable stop sets the depth of cut to match one of three plate sizes: Small, No. 0; Medium, No. 10 and Large, No. 20 (Photo 3).

The faceplate of the typical plate joiner, the part that is held up against the workpiece, contains a pair of spurs to prevent the tool from shifting as the cut is made (Photo 4). Joiners also have a fence for registering the tool against the surface of the work. The Lamello Top plate joiner, for example, has a completely adjustable fence that can be pivoted to suit any bevel angle from 0° to 90°. Other tools, such as the P-C and Freud tools shown, have nonpivoting fences that only handle the more common 45° and 90° operations.



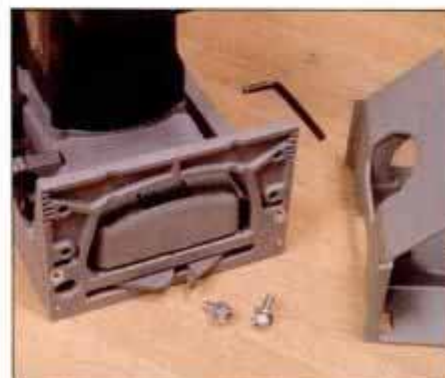
1 The Freud JS100 tool shows standard plate joiner configuration. Blade is gear-driven and motor has slide switch.



2 The upright handle and trigger-type on/off switch make the belt-driven Porter-Cable 555 plate joiner unique.



3 Adjustable depth-of-cut stop has three positions to suit the three plate sizes. Knurled knob permits fine-tuning.



4 With fence removed, faceplate and blade are visible. Spring-loaded spurs on faceplate grip stock and prevent shifting.

Basic Plate Joinery

The speed and effectiveness of the plate joiner are due to the ease at which it can accurately register the plate slots so the mating pieces will align properly. The basic procedure for using a plate joiner involves referencing both the base of the tool and the work against a flat surface, such as your worktable. In this case, the joiner fence is not used and the worktable top must be flat and clean for best results. Aligning the tool horizontally is accomplished with the index mark on the faceplate.

First, align both pieces as they are

to be joined and mark the center of the plate joint slot on each piece (Photo 5). Then, with both the plate joiner and the workpiece resting on the worktable, align the index mark of the plate joiner with the mark on the first piece. Turn on the motor and quickly advance and retract the blade to make the cut (Photo 6). Then, repeat the process on the other piece and apply glue to the slots. Insert the plate in one slot (Photo 7), and join the pieces. Before clamping, check that the registration marks on the pieces are aligned and shift the components if necessary.

Note that the index mark on the faceplate aids in aligning the slot with the end or edge of the stock, while the actual surface of the worktable registers the slot across the thickness of the stock. When using the joiner in this manner, be sure that the worktable is clean and flat, and place the finish side of the wood down for the best alignment.

While the most direct way to apply glue is to simply squirt a little along the slot and push it in with a thin stick, this method isn't very efficient. And, with fast-setting glue and many slots to fill, it can be frustrating. The best



5 The first step in making a plate joint is to align mating pieces and mark the center of the plate joint slot on both pieces.



6 Align index mark on joiner faceplate with centerline of joint. Turn on power and push forward to make the slot.



7 Apply glue to the slots and to the surfaces to be butted. Insert plate in one slot, join the second piece and clamp.



8 To position slot at center of thin stock, such as 1/2-in. plywood panel, install fence at correct distance from blade.



9 This mitered edgebanding uses two plate sizes: No. 10 plate for the narrow miter and No. 20 along the panel edges.



10 Edge mitering is done by setting the fence for 45°. Most tools register against the inside of the joint as shown here.

tool for this job is the specifically designed Lamello glue bottle. This has a narrow nozzle with holes on the sides for distributing glue in the slot. However, you can improvise a simpler and cheaper substitute by using a slim-nozzle hair-coloring applicator available at cosmetic counters. Simply increase the hole size to $3/32$ in. to handle the thicker glue, and use a wax-coated toothpick as a stopper.

Because the plate joiner blade is centered $7/16$ in. from the plane of its base, it registers a slot that's centered $7/16$ in. from one face of the stock. Although this puts the slot slightly off center in $3/4$ - or $13/16$ -in.-thick lumber, the asymmetrical slot has little effect on the joint. Just be sure that the working face of each component to be joined is placed down on the worktable before the cut is made. When the stock is especially thick or extra strength is required, you can simply cut two parallel slots, each $7/16$ in. in from the stock faces.

For precisely centering the slot in thin stock, or when the size of the work prohibits using a worktable as a reference surface, you can use the adjustable joiner fence. To use the fence for basic edge-to-edge operations, such as applying a solid-wood banding around a plywood panel, first adjust the fence so the slot will be positioned appropriately across the stock thickness. Then, mark the slot positions on the mating pieces. Hold the fence firmly against the face of the work with the faceplate against the stock edge. Align the index mark and make the plunge cut (Photo 8). When making the corresponding slots in the adjoining stock, make sure that the fence is held against the same working face to ensure good alignment.

Always use the largest plate permissible for the joint being made and adjust the depth slightly deeper than one-half of the plate width. Bear in

mind that the actual slot is longer than the plate that's suited for it. This places limitations on the width of stock used for both regular face frames and mitered frames. A No. 20 plate, for example, will require at least a 3-in.-wide surface for the slot to be completely contained. The small No. 0 plate needs about $2\frac{1}{4}$ in. Using mitered frame joints allows slightly narrower stock, as the angled joint face is longer than the stock width. Often, two size plates are necessary in one assembly (Photo 9).

To cut slots for an edge-miter joint, set the fence in the 45°-miter position

and make the cuts. Most joiners, such as the Freud unit shown, register the cut against the inside work surface (Photo 10). The Porter-Cable fence (visible in Photo 8) registers against the outside surface. This system ensures that the outside of the joint will be aligned regardless of variation in stock thickness.

In addition to joining stock edge to edge, the plate joiner excels at edge-to-face joints typical in shelf and cabinet construction. And because there's no traditional joinery involved, each component can be cut to its exact size for assembly.



11 To join shelf to case side, first clamp shelf to side panel at shelf location. Then mark joint centers on both panels.



12 With base of tool held flat against cabinet side, align index mark with slot centers and cut all slots in shelf edge.



13 To cut corresponding slots in cabinet side, hold tool upright against shelf edge and align index mark with centers.



14 After all slots have been made, apply glue, insert plates and assemble. Check for accurate alignment before clamping.



15 When edge gluing lumber, reference slots from best side of stock. Place slots 2 in. from end, and 4 to 12 in. in between.

To join the edge of a shelf to a case side, first mark the shelf location on the side component. Position the shelf edge at this mark, align the side edges of both pieces and secure the components with a clamp so they don't shift. Then, mark the slot locations on the panels (Photo 11). With the fence removed, rest the joiner on the side component and cut the slots in the end of the shelf (Photo 12). To cut the corresponding slots in the side component, place the base of the joiner against the shelf edge, align the centered index mark with the slot locations and cut the slots in the side



16 Offset joints can be made by supporting the tool on a spacer block to locate the slot. L-block holds work in place.

(Photo 13). After all of the cuts have been made, apply glue to the slots, install the plates and assemble the components (Photo 14).

Like doweling, plate joinery is an excellent way to align and strengthen glued-up panels (Photo 15). For good alignment, determine the best side of each board and make these the reference faces for all slots. In this way, any variation in thickness from one board to the next will be apparent only on the poorer side of the assembled panel. Place slots 2 in. from the ends of the boards and 4 to 12 in. apart in between.



17 Here, two plates are installed at each corner of mitered frame for extra strength. Band clamp holds pieces until glue sets.

Offset joints, such as the leg-to-apron joint of a table, are easily made by using a spacer block under the joiner base, and resting the stock directly on the worktable (Photo 16). An L-shaped block clamped behind the workpiece takes the thrust of the plunge cut and allows you to use both hands on the joiner.

Plate-joined mitered frames are easier to assemble than dowel-joined frames because the components can be shifted for the best alignment. Use a band clamp wrapped around the perimeter of the frame to hold the pieces until the glue sets (Photo 17).

Special Plates

While most joiner manufacturers only offer the standard wooden plates, the Lamello system increases the versatility of any joining machine with several special-purpose products.

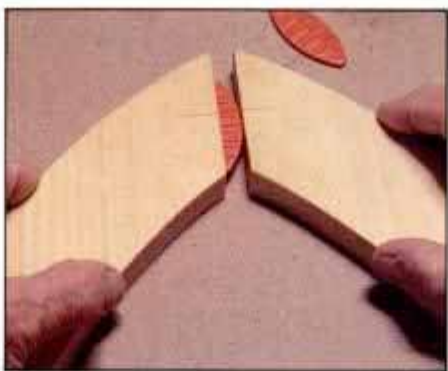
When it's impossible to apply clamping pressure, the K20 adhesive plate may solve the problem. It's made of plastic and has barbed cross ribs that grip the sides of the slot (Photo 18). Although no glue is necessary, ordinary wood glue can be used.

The C20 joining plate is made of translucent polypropylene and is used to join solid-surfacing materials, such as Corian and Avonite (Photo 19). This plate is primarily used to align and stabilize the joint, and glue is not normally required.

For knockdown (KD) shelving and similar applications, Lamello offers a 2-part aluminum plate that fits into No. 20 slots. It's glued in place with a 2-part adhesive (Photo 20).

The Lamello Duplex is a sleek, detachable cabinet hinge that's available in a left- or righthanded version, in brass, nicked-steel or black finish (Photo 21).

For information on Lamello products, contact Colonial Saw, 100 Pembroke St., Kingston, MA 02364.



18 Lamello K20 plastic plate holds components securely with or without glue. Use it where clamping is impossible.



19 For aligning and stabilizing solid-surfacing materials, the plastic, translucent Lamello C20 plate is available.



20 The Lamello aluminum KD fitting is inserted into No. 20-size slots. Fitting at top is shown on panel surface for clarity.



21 Lamello hinges are flush mounted in recesses milled with plate joiner. Hinge halves are detachable for easy installation.

Jigs And Fixtures

Although the portability of the plate joiner is a desirable feature, handling small stock or performing repetitive work is better done on a stationary machine. The shopmade joiner stand shown is designed to convert the Freud joiner into a versatile stationary tool. With a few modifications, the idea could be adapted to any joiner.

The stand consists of a wood base with blocks that support the tool upside down. Shape the rear support block to fit the motor housing and hold the tool level. The small curved piece on the front support block fits inside the joiner handle. To lock the tool to the stand, a crosspiece is tightened over the motor section with two wingnuts. A slide-in block with finger holes tightly wedges the handle in place. To attach the plywood table with the flathead screws as shown, you'll need to drill four holes through the joiner fence. Two cleats under the plywood reinforce the table. Note that the Freud joiner requires two $\frac{3}{4}$ -in.-rad. cutouts, as shown, to provide clearance for the fence-height adjustment knobs.

To use the stand, blocks can be clamped to the platform to align the stock and ensure accurate repetitive

cuts (Photo 22). The joiner can handle edges beveled to any angle with the addition of the simple bevel platform shown in the drawing. Just construct the platform at the desired angle and use protruding nail points, as shown, to hold it in position on the joiner stand auxiliary table (Photo 23).

When the joiner isn't in the stand, a

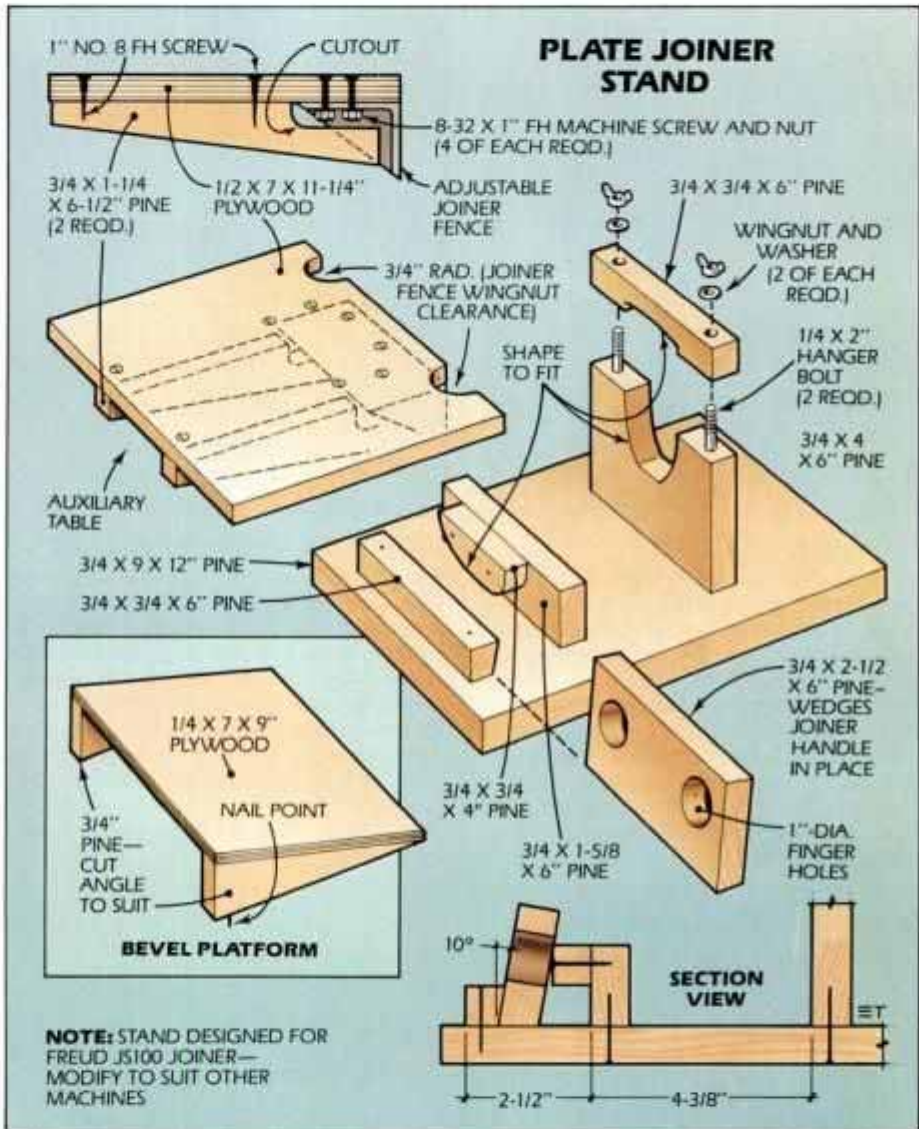
similar bevel platform makes joining edge miters other than 45° easy (Photo 24). And, holding narrow pieces is facilitated by using a joiner platform that has blocks that position the tool and the stock. Two nail points protruding about $\frac{3}{32}$ in. from the platform base serve to hold the work while the cut is made (Photo 25). **PM**



22 Bench-mounted joiner is ideal for small parts and repetitive jobs. Here, guideblock uniformly registers stock for miter joint.



23 With appropriate shopmade bevel platform in place on joiner stand table, slots are cut for miter joints of any angle.



24 Bevel platform can also be used with handheld plate joiner for bevels other than 45°. Clamp stock to prevent shifting.



25 Platform jig consistently positions joiner and stock. A pair of projecting nail points in the base anchor workpiece.

PM ILLUSTRATION BY EUGENE THOMPSON

NEW PRODUCTS

HOME ECONOMICS

New products that save time, money and space.

BY ROY BERENDSOHN,
Assistant Home and Shop Editor



Building Blocks

You can build a glass block wall without mortar with this grid system. Glass blocks are wrapped with foam tape (included) and set into the snap-together aluminum grid, which comes in bronze, silver, gold or white finish. Use it to build walls and windows. A kit equipped with rubber boots in place of foam tape can be used for floors. It costs \$17-\$23 per square foot at building material suppliers. For more information, write to Pittsburgh-Corning, 800 Presque Isle Dr., Pittsburgh, PA 15239.



No-Rust Water Heater

This gas-fired water heater has a blow-molded polybutylene plastic tank that's guaranteed not to leak. Its manufacturer says it's 35 percent more efficient than conventional water heaters, due in part to 2 in. of polyurethane tank insulation. Other features include an intermittent ignition that eliminates a pilot light, and sensors that shut off the heater if the flue is blocked. It costs about \$700 at home centers. Write to Marathon Water Heater Co., 3107 Sibley Memorial Hwy., Eagan, MN 55121.

Grilled

To install one of these wood grilles in your floor, just stain and finish it, then drop it in place. You don't even have to use nails or screws to fasten it. They are available in red or white oak in several styles and dimensions from 2 1/4 in. wide x 12 in. long, to 6 in. wide x 14 in. long. The model shown is 4 in. wide x 14 in. long and costs from \$35 to \$40 at flooring suppliers. Custom sizes in other hardwoods are also available. The grilles can also be used for wall vents. For more information, contact Wood Ventures, Grass Valley, CA 95945.



Cover Up

Protect your roof or change its color with these water-based coatings. Clear Shingle Seal (below right) can be applied to new and existing asphalt or fiberglass shingles. It waterproofs and prevents fungal growth. Premium Roof Pro is a white reflective coating designed to seal the roof and keep it cooler. It can be colored with any latex tint. A gallon of Shingle Seal costs about \$19, and a gallon of Premium Roof Pro is \$23 at home centers and roofing suppliers. For information, write Macklanburg-Duncan, P.O. Box 25188, Oklahoma City, OK 73125-0188.



Create Space

A standard kitchen or bathroom drawer can be converted to a pull-out counter or table with this hide-away slide kit. The kit is also useful for tight-space applications, like on boats. It's designed to be installed on drawers up to 24 in. wide and on counters from

20 1/2 in. to 32 in. deep. Made of bright zinc-plated steel, it can support up to 176 pounds and adjusts to ensure smooth action, its distributor says. It costs about \$125 (not including the cost of the countertop or the drawer face) from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374.

Quick Dry

Spray this indoor/outdoor enamel on wood, metal or masonry and the object is ready to handle in 10 minutes, according to its manufacturer. It's also available as a 10-minute primer, so that, from bare wood or metal, the object is completely finished in less than a half-hour. It comes in clear, metallic gold and aluminum, flat black and white, and 14 gloss colors. A 12-ounce can costs about \$2 at hardware stores. Write to DAP, P.O. Box 277, Dayton, OH 45401.



Surrounded

Install a tile surround over almost any surface, even old tile, with this kit. The kit includes a flexible plastic membrane that is spread over an adhesive you apply on the wall. The tile adhesive is applied over the membrane, and guidelines on the mem-

brane help you position the tiles. The kit also includes: adhesives, a chalkline, trowel, nails, tile cutter, tile nippers, grout, grout float, sponge and caulk. The kit costs \$325 at home centers. For more information, contact The Noble Co., 614 Monroe St., Grand Haven, MI 49417.

Pure And Simple

This whole-house water filter with a see-through tank is designed to be installed without soldering. It installs on plastic, copper or galvanized pipe and the necessary solderless fittings (1/2-in.-dia. reducers and compression fittings) are included. A built-in valve lets you bypass the filter, such as when watering the lawn, and a relief button releases pressure for filter changing. It costs about \$50 at home centers and hardware stores. Write to Omnifilter Corp., 2500 165th St., Hammond, IN 46320.



Carpet Backers

Made from 100-percent recycled newspaper, this carpet underlayment is designed to be laid over concrete. It comes as a 4-ft. x 4-ft. panel, 1/2 in. thick. The panel's back is kerfed every 4 in., forming a grid to relieve the stresses that cause fiber-based underlayment to cup when placed over concrete. Also, it's treated to resist fungal growth and termites. It's fastened with subfloor adhesive. A sheet costs about \$9 at most lumberyards. For more information, write to Homasote Co., P.O. Box 7240, West Trenton, NJ 08628-0240.

PM



Solar Hot Water

This roof-mounted solar water heater hooks to an existing gas or electric water heater. It has no moving parts, and does not require outside power. It works on any pitched roof and is most effective on roofs pitched from 20° to 60°. It weighs about 160 pounds and measures 4 in. thick x 4 ft. wide x 10 ft. long. It's warranted for 10 years and costs about \$2200 from Sage Advance Corp., 1001 Bertelsen Rd., Eugene, OR 97402.



Hot Water

Designed to fit into white, contemporary kitchens, this sink-mounted hot water dispenser delivers 60 cups of 190° F cooking water per hour. Made of white ABS plastic, it fits through the hole used by a spray nozzle. Its insulated 1/2-gallon tank is thermostatically controlled. It costs about \$180 at home centers. For more information, contact NuTone, Dept. PM, P.O. Box 1580, Cincinnati, OH 45227-1599.

APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Installing Gasket

I have a portable Montgomery Ward dishwasher model No. UC0979-80A, serial No. SBK58468. I took off the old tub gasket, but I can't get the new one on, and I was hoping you could help me by explaining how to do this.

ROBERT RULE
COLUMBUS, OH

First, order the tub gasket, the gasket wire and the gasket clips from Montgomery Ward's national parts sales center, (800) 323-1965 (see below for part numbers).

Unplug the dishwasher. Open the door and remove the bottom dish rack. Remove the outer door panel, which is held with Phillips head screws along the inner door panel.

Push the gasket wire into the gasket's groove, so each end of the wire is inserted in the hole at the end of the gasket. With the door open, place the gasket on the tub's front lip, with the wire facing the rear of the tub.

Hold the gasket in place and close the door slightly. Reach between the outer door panel and the tub's front lip. Hold the gasket and wire tightly against the tub's lip while closing the door. Next, snap the two metal gasket clips over the gasket's top lip and through the gasket's cutouts. The long end of the clips face the rear of the tub. You may need a flat-blade screwdriver to push down the clips completely. The clips hold the wire in place, as well as lock down the gasket to the lip of the tub.

Once the gasket is secured, install the outer door panel, and test run the machine. The gasket is part No. S000401.801, clips are part No. 848AO42HO1 and the wire is part No. C000505132.

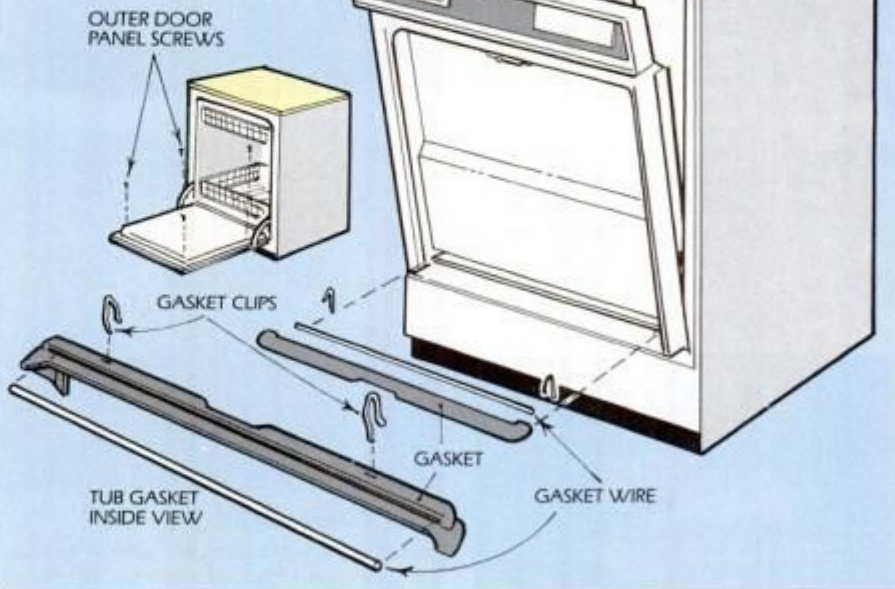
Piping Up

When my Kenmore dishwasher model No. 587-70110, serial No. 1176355-0182, is filling with water, the water pipes make a noise. When I turn on the sink's hot water faucet, it stops. Can you explain how to fix it?

ROBERT ST. PIERRE
OKLAHOMA CITY, OK

It sounds as if the water volume and pressure going through the flow

When replacing dishwasher tub gasket, remember to insert gasket wire. Long end of gasket clips face the rear of the tub.



washer in the water fill valve may be setting up a harmonic vibration. By opening the faucet, you change the water flow and pressure, and thus, quiet the noise.

Sometimes you can fix this by simply closing down on the dishwasher water supply line valve. The line usually goes from the hot water line under the sink to the dishwasher fill valve. By cranking down the valve wheel, say a quarter-turn, you may be able to tune out the noise and still get enough water into the dishwasher. If this doesn't work, you may need to replace the water fill valve.

Timer Wanted

I need a clock timer for my GE stove. Can you tell me where I might find one? The timer is part No. C21-K3, serial No. 8765254.

COURTNEY PURVIS
SANDSTON, VA

The clock timer for your 1953 range (GE part No. WT53X14) is no longer available. But there is a GE company in Iowa that rebuilds clock timers.

Although they don't have a replacement timer for your range, they may take your clock timer apart, find out what's wrong with it, swap a few new parts from other timers, and get it working again. This would cost about \$40, plus shipping.

Send a note and your timer to Attn.: Repair and Exchange, General Electric, 1803 Radiant Rd., Car-

roll, IA 51401. Include range's brand name, model number, and your name, address and phone number.

Oven Too Hot

I have a Sears Kenmore oven model No. 278.4018812, serial No. 9013134, that's between 50° and 75° F hotter than the digital readout says it is. Sears repair service replaced the sensor and the main module control board. This did not solve the problem. Sears then contacted the manufacturer and was told this was normal operation. Is there a solution?

JACKIE CLIFFORD
CALIFORNIA, MD

Your oven uses an electronic range control that accurately maintains oven temperatures. There is no internal calibration adjustment to bring down the oven temperature. Instead, a resistor can be added in series with the sensor circuit to make the range control think the oven is hotter than it is, thus lowering the temperature.

By changing the resistor's value, you can change the oven temperature from 25° to 45° F. This procedure is explained in Sears service flash No. 22-510, which the Sears service technician should check.

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

MAINTAINING AN ASPHALT DRIVEWAY

BY ROSARIO CAPOTOSTO,
Contributing Editor
PM Illustrations
by George Retseck

YOUR DRIVEWAY, like your house, can easily become an eyesore if you neglect it. But it doesn't take much effort or money to keep an asphalt driveway in top shape and looking good. Also, routine driveway maintenance will keep small problems from becoming big ones and postpone the major expense of replacement.

All a driveway needs is periodic attention, like filling cracks and potholes and applying a couple of coats of sealer. We've listed specific information about the products we used in our driveway maintenance job at the end of this article.

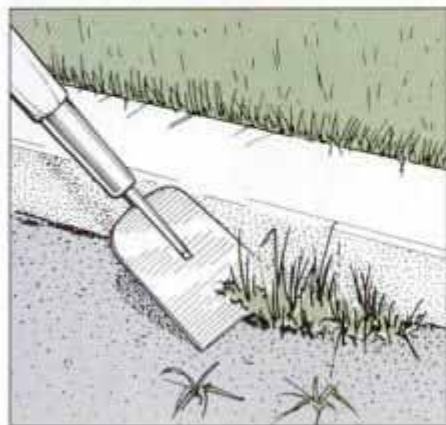
If your driveway was installed by a good paving contractor, it's about 4 in. thick and was well-rolled on a substantial subbase. If so, it has probably stood up well and all it may need is occasional sealing for cosmetic purposes.

If, however, your driveway was installed by an unscrupulous paver, and is only an inch or so thick, then it's probably already falling apart. Sealing and patching will help its appearance, but they only postpone its inevitable deterioration.

Several forces act against even the best driveways, and here's what typically happens. Temperature cycles, especially freezing and thawing, cause the driveway to expand and contract over time. Although flexible, a driveway has a limit to how many



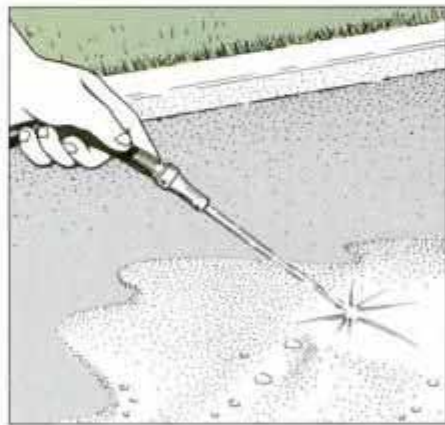
Sealing a driveway extends its life and improves its appearance. It's important to prepare it for sealing. Clean it, patch its potholes and fill its cracks, then apply sealer.



1 Remove clumps of grass and weeds using an ice scraper or a shovel. Also, scrape off hardened clumps of grease and dirt.



2 Clean oil and grease stains with driveway cleaner and scrub brush. Or use a solution of warm water and household detergent.



3 To remove cleaner and residue, thoroughly rinse off the scrubbed areas using a garden hose with a spray nozzle.



4 To prepare small holes for filling with patching compound, clean out crumbling pavement and dirt using a stiff wire brush.

expansion/contraction cycles it can take. Eventually, small cracks open in its surface and water seeps through to the subbase. Periodic wettings compact and settle the soil, creating a sizable void under the pavement. Ultimately, the weight of an automobile will crush through that spot, causing a pothole.

Or, water trapped in cracks below the surface turns to ice during a freeze. Water expands when frozen and enlarges the cracks. Gas, grease



5 Loose debris can be removed from narrow holes and wide cracks using a crevice nozzle and a wet/dry shop vac.

and oil drippings act as solvents and damage the pavement by dissolving the asphalt, particularly during hot weather.

Surface preparation

It's important to prepare your driveway's surface before sealing it. Like any coating, sealer bonds better when applied over a clean surface. Also, patches and repairs last longer if they are made first, then protected by two coats of sealer.



6 Mound patching compound in holes using a small trowel. Patch should be about 1/2 in. higher than the surrounding surface.

Begin by using a shovel or ice scraper to scrape off lumps of grease and dirt. Pull grass or weeds out of cracks, trying to remove their roots as well. Otherwise, scrape them off flush to the surface. Use a knife or trowel to dig out the roots and dirt, and enlarge the hole to receive patching material.

Use a stiff broom to sweep clean the driveway and check for areas where grease, oil or gas drippings have marred and softened the surface. Scrub these spots with a driveway

SCATTER.





7 Tamp down patch even with rest of driveway using a small piece of 2x4. Pack down patch as tightly as possible.

cleaning solution or with warm water and household detergent. Use a stiff scrub brush and spray rinse the area with a garden hose.

Patching

Small holes and depressions are repaired with asphalt driveway patching compound. This pastelike material contains small aggregate (gravel). For a small hole, chip out all broken blacktop material around the edges to about 2 in. deep. Brush out or



8 Complete packing of dish-shaped pot-holes by placing a board facedown and pounding on it with a heavy hammer.

vacuum loose material and fill the hole with compound to about 1/2 in. higher than the surrounding pavement. Use the end of a short length of 2 x 4 as a tamp to compact the compound until it's level with the pavement.

If the hole is shallow and dish-shaped, complete the packing by placing a board facedown on the compound and hitting its face with a heavy hammer. Finish the repair by tapering the compound to a feather edge with a trowel.



9 Smooth patching compound with a trowel and work it to a feather edge. This compound is ideal for repairs against curbs.

The relatively fine consistency of the patching compound makes it easy to level, but since the feather edge is worked over the surrounding pavement, it's important that the pavement surrounding the hole be cleaned thoroughly to ensure the compound will adhere to it.

Cracks

Blacktop driveway crack filler comes in a cartridge and is used for cracks up to 1/4 in. wide. Brush or vacuum loose

BRAIN.



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The Rubbermaid® Work Space™ System is the brains behind any successful workshop organization. An assortment of hooks, holders and bins snap into the Work Space™ strip, which easily mounts onto a wall or peghole panel. Makes everything easy to sort. Easy to find. Why not give some thought to one?



Don't you wish everything was made like Rubbermaid?



10 Driveway crack filler is used on cracks up to ¼ in. wide. Fill deep cracks with sand before applying filler.

material out of the crack, then lay in a continuous bead of filler. Allow it to set for about 10 minutes, then stroke over it with a putty knife to level and firm the bead to the crack's edges. If the crack is more than ½ in. deep, it should first be packed with sand to within ¼ in. of the surface.

Potholes

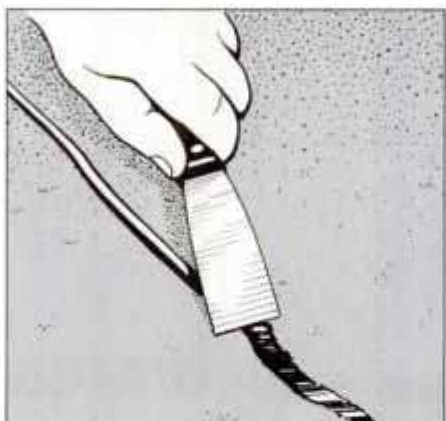
A large pothole in the driveway is repaired with cold-mix, an asphalt-based filler that has larger aggregate than driveway patching compound. Typically, it comes in a 60- to 70-pound bag.

Use a cold chisel and hammer to chop out crumbling pavement until the pothole is rimmed with a clean, firm edge. If possible, undercut the hole slightly to lock the patch in place. Dig down until you get to a solid surface and remove loose debris from the hole's bottom. Shovel the mix into the hole, mounding it so it's about ½ in. higher than the surrounding surface. Compact the mound by tamping with a block of 2 × 4.

You can also pack the cold-mix by placing a scrap piece of plywood over



13 Cold patch must be thoroughly packed down. One method is to place plywood on patch and drive a car onto the plywood.



11 Let filler set for about 10 minutes, then smooth and compact it with a putty knife. Apply a second bead if necessary.

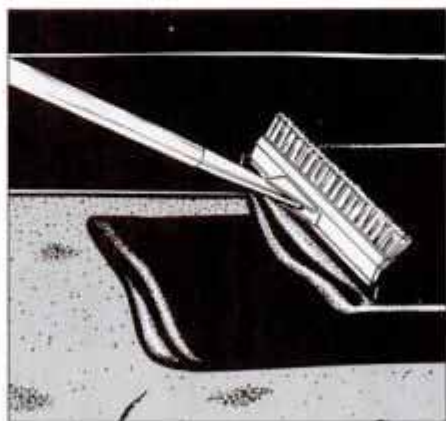
the mound and driving back and forth over it with the front wheel of your car. Deep potholes should be filled and tamped in layers. Add some mix, tamp, then add more mix and tamp.

Sealing

A coat of waterproof blacktop sealer, applied every two or three years, will protect the driveway from the sun, rain and snow, and will improve its appearance.

The sealer comes in 5-gallon cans and usually needs only to be stirred before use. Read the product label to determine how much area it will cover. Usually this ranges between 200 and 300 sq. ft., depending on the porosity of the surface. Apply the sealer with a long-handled applicator that has a squeegee blade on one side and a brush on the other. Roller applicators are also available.

First, pour enough sealer from the can to work a 3- or 4-ft.-wide strip across the driveway. Using the squeegee side of the applicator, spread the sealer across the driveway, working it into all tiny cracks and crevices. When the strip has been



14 Apply two coats of sealer with squeegee/brush or a roller applicator. Spread the sealer first with the squeegee blade.



12 Remove loose pavement around large potholes by chopping it out with a cold chisel and a hammer. Trowel in cold patch.

covered, flip over to the brush side and use it to level the coating and smooth ridges left by the squeegee. Work the brush at right angles to the path worked by the squeegee.

Don't leave puddles of sealer and don't spread it too thin. It's best to apply two coats. Read the label to determine how long to allow the sealer to dry before recoating.

Supplies

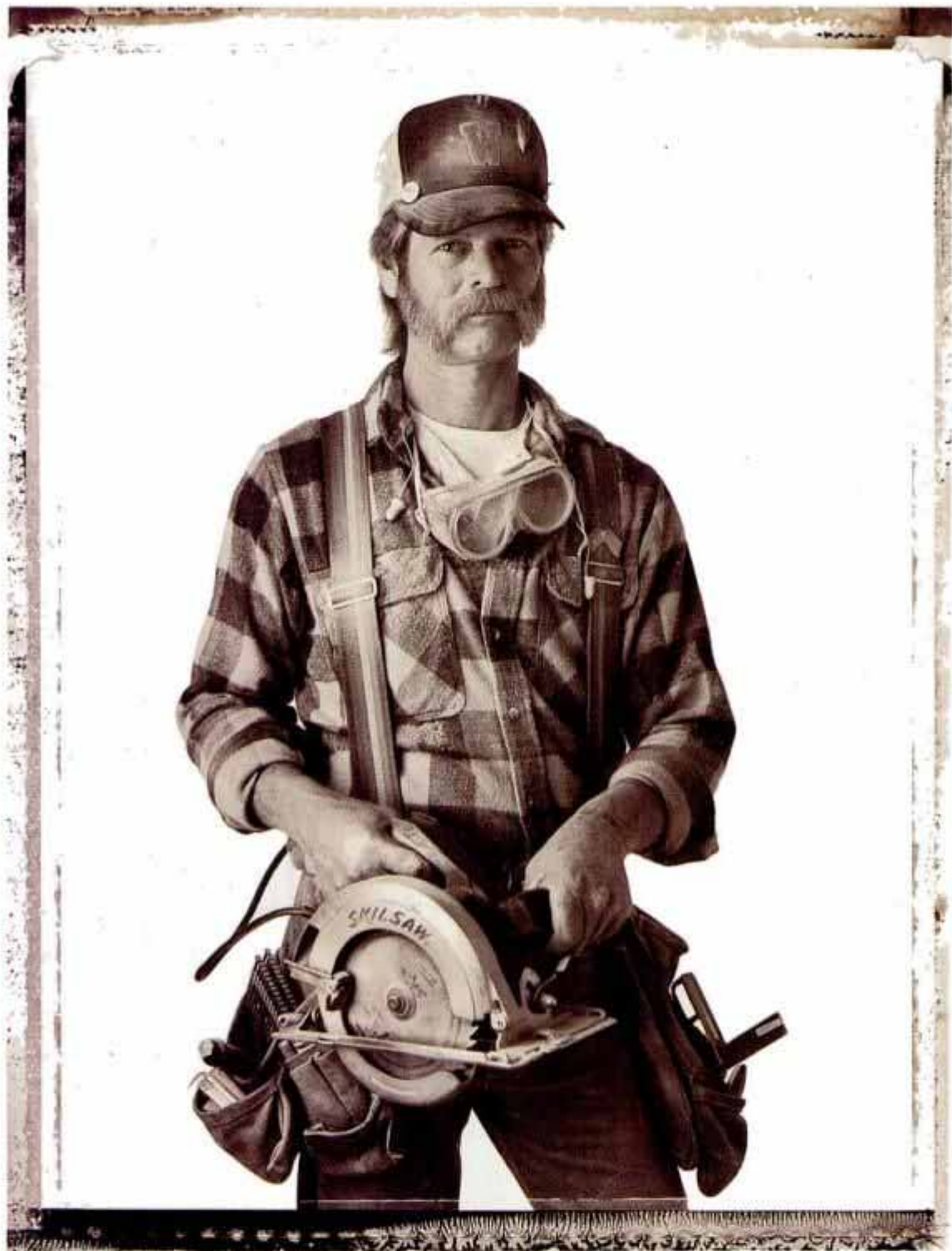
Sears sells a variety of driveway maintenance products at its retail stores: driveway/garage floor cleaner, 1-quart, item No. 45504, about \$4; patch compound, 1-gallon, item No. 45465, about \$6; crack filler, 10.5-ounce cartridge, item No. 38091, about \$2; Sears' Best Easy-To-Stir sealer/filler, 5-gallon, item No. 45477, about \$12; squeegee/brush applicator, item No. 12778, about \$6. Write to Sears, Dept. 703-PM, BSC 40-16, Sears Tower, Chicago, IL 60684.

Sakrete cold patch comes in 66-pound bags, about \$7 in hardware stores. For more information, write to Sakrete, P.O. Box 17087, Cincinnati, OH 45217.

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15 After sealer is evenly spread, brush at right angle to direction taken with squeegee. Work the sealer into the surface.



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HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Furnace Payback

Could you tell me how to calculate the payback on a gas furnace, based on the sticker efficiency rating and the cost of gas per therm? This would help me in comparison shopping for a new furnace.

JOEL SLOCUM
WELLESLEY, MA

The most accurate way to calculate the payback between two new gas furnaces is, first, to do a heat balance on your house. That is, you should determine the heat loss per hour (in BTU/HR) in order to find the amount of heat necessary to maintain the desired temperature.

This analysis is quite difficult for the layman because the house's wall construction, floor square footage, exposure, window type and area, insulation and so on must be considered.

A more practical way is to have a heating contractor give you an estimate of the heat loss. Also, you will need to call your local utility for the cost of gas per therm. A therm is a unit of heat equivalent to 100,000 BTU.

New gas heating appliances dis-

play a bright-yellow energyguide sticker. In the example shown, the heat loss figures are the top horizontal line and the cost per therm of gas is the vertical left column.

For example, assume furnace X costs \$1100 installed and the high-efficiency furnace costs \$1500. If you pay 40 cents per therm, and the heat loss of your home is about 55,000 BTU/HR, the cost to heat your home for one year using furnace X is \$605 and for the high-efficiency furnace, \$441. The cost savings per year for using the more efficient furnace is \$164. It would take 2.44 years for the fuel savings to pay for the cost difference between the furnaces.

Furnace Filter

We need a replacement filter for our Lennox Pulse furnace. Its manual clearly states not to use throwaway filters, but the local heating service companies cannot supply me with the correct filter. When I called Lennox, its people told me to keep trying local heating service dealers, because they couldn't sell me a filter directly.

A local dealer suggested I use a

throwaway filter. Are these acceptable? If not, where can I get a Scotfoam filter recommended by Lennox?

JOYCE HIXSON
BARTLETT, IL

The Scotfoam filter has lower air-flow resistance than throwaway fiberglass filters. This enables the furnace to operate at peak efficiency. I talked with the people at Lennox, and I'm forwarding your letter to Bill Drake, manager, Service and Product Application, Lennox Industries, Inc., P.O. Box 799900, Dallas, TX 75379-9900. He'll make arrangements for you to get the correct filter.

Will Precooler Work?

Would it be cost-effective to build a precooler for a residential central air-conditioning system? The system would cool the freon before it enters the air conditioner by running the copper tubing through a water tank.

MIKE BEENE
DALLAS, TX

The system you propose is basically a water-cooled condenser in series with the air conditioner's air-cooled condenser. While this will improve the system's overall efficiency, it probably would not be cost-effective. Water-cooled compressors are no longer used for residential cooling, though older models are still in use.

Cool Heat Pump

I recently moved into a condominium with a heat pump for central heating. When the unit is operating, I feel cool air coming from the register, although the house is warm. Is something wrong with the heat pump?

JEFFREY BECKER
COLUMBIA, MD

The heat pump is working correctly. It heats air to about 90° F, which feels cool because it is lower than body temperature, but is warm enough to heat the room. The air discharged from an oil- or gas-fired furnace is about 110° to 130° F. To compensate for the lower temperature, heat pumps require a high airflow rate, and may create a drafty feeling. **PM**

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

ENERGYGUIDE—BRAND X

80,000 BTUH INPUT STANDARD FURNACE

COMPARATIVE NATIONAL AVERAGE YEARLY COST (\$) INFORMATION

CAPACITY: 80,000 BTU/HR

MODEL NO:

EFFICIENCY RATING

LEAST THIS MODEL MOST

51.00 65.0% 81.10

| COST PER THERM OF NAT. GAS | BTU/HR HEAT LOSS OF HOME (1,000s) | | | | | | |
|----------------------------|-----------------------------------|-----|-----|-----|-----|-----|-----|
| | 25 | 30 | 35 | 40 | 45 | 50 | 55 |
| \$.10 | 87 | 108 | 120 | 137 | 154 | 170 | 187 |
| \$.20 | 152 | 181 | 210 | 239 | 266 | 297 | 326 |
| \$.30 | 217 | 258 | 300 | 341 | 383 | 424 | 465 |
| \$.40 | 282 | 336 | 390 | 443 | 497 | 551 | 605 |
| \$.50 | 347 | 413 | 480 | 546 | 612 | 678 | 774 |
| \$.60 | 413 | 491 | 569 | 648 | 726 | 805 | 883 |

80,000 BTUH INPUT HIGH EFFICIENCY RECUPERATIVE FURNACE

COMPARATIVE NATIONAL AVERAGE YEARLY COST (\$) INFORMATION

CAPACITY: 80,000 BTU/HR

MODEL NO:

EFFICIENCY RATING

LEAST THIS MODEL MOST

54.00 85.0% 88.20

| COST PER THERM OF NAT. GAS | BTU/HR HEAT LOSS OF HOME (1,000s) | | | | | | | |
|----------------------------|-----------------------------------|-----|-----|-----|-----|-----|-----|-----|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| \$.10 | 90 | 103 | 116 | 129 | 141 | 154 | 167 | 180 |
| \$.20 | 154 | 175 | 197 | 219 | 241 | 263 | 285 | 307 |
| \$.30 | 217 | 248 | 279 | 310 | 311 | 372 | 403 | 434 |
| \$.40 | 291 | 321 | 361 | 401 | 441 | 481 | 521 | 561 |
| \$.50 | 344 | 393 | 442 | 491 | 540 | 589 | 638 | 687 |
| \$.60 | 407 | 466 | 524 | 582 | 640 | 698 | 756 | 814 |

REMOVING WALLPAPER

BY GENE & KATIE HAMILTON
PM Illustrations
by George Retseck

REMOVING WALLPAPER is a messy job, but somebody's got to do it, and that somebody will probably be you. Finding someone to do it is almost more difficult than doing it yourself. Professional paperhangers often don't want to do it and when they do, they charge you a premium rate.

Fortunately, this job is more messy than it is difficult. It's a good example of the kind of grunt work homeowners can do themselves. The job requires little skill and few tools, just scraping and patience. With the advent of improved wallpaper removing tools, teamed with time-proven methods, the job is easier than ever.

Different papers, different problems

Not all wallcoverings are created equal, meaning that some are more difficult to strip than others. The easiest papers to remove are the "strippable" wallpapers. They can be removed without tearing and without being loosened by water or steam.

Slightly more difficult to remove are old, untreated and uncoated wallpapers. They simply need to be wetted and scraped loose.

The most difficult to remove are the papers with vinyl coatings (washable wallpapers) or those with laminated surfaces of woven fabric or foils. Wallpaper that's been painted falls in this category. These papers are difficult to strip because water doesn't penetrate their surface as readily as with uncoated paper.

Stripping on drywall/plaster

Painted plaster is the easiest surface from which to strip wallpaper. Unpainted drywall is the most difficult.

Before you start, check to see what type of wall you have. Your stripping method depends on the type of paper and what's beneath it.

Most newer houses have drywall, and most houses over 50 years old have plastered interiors. Plaster is rock-hard and smooth. Drywall is softer than plaster and easily punctured. Its paper facing has a slight "tooth" that becomes more apparent after you've gained some experience



distinguishing drywall from plaster.

You might see rows of small bumps or dents where wall compound covers the nails holding drywall to the framing. Another telltale sign of drywall is a long but shallow lump where the compound covers the tape that hides the seam between sheets. But be careful here, because the tape may conceal a crack in a plastered surface, not a drywall seam.

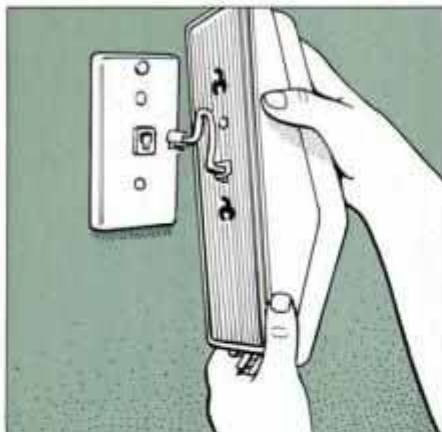
If after looking for these signs you still can't tell which wall material you have, take a look at the material you find behind the faceplate for a light switch or outlet (you have to remove these faceplates to strip the wallpaper anyway).

Drywall is thin and a uniform thickness, usually $\frac{1}{2}$ to $\frac{5}{8}$ in., and is attached directly to the studs. Plaster varies in thickness and is applied over wood, gypsum or metal lath that's at-

tached to the studs. The electrical box will fit through a hole cut into the drywall. Since plaster is applied to a wall and not installed as a sheet, you'll find it has been troweled right up to the box.

It's important to check what wall material you're working on in the part of the house you'll be stripping. In an older house, the wall material may vary. If you're stripping wallpaper from a relatively recent addition to an older house, chances are the addition has drywall, while the rest of the house has plaster. Also, the plaster may have been removed in rooms that have been extensively remodeled.

Paint seals plaster and drywall, and makes removing wallpaper easier. Removing wallpaper from unpainted or unsized (sizing is a solution applied before papering that further seals the wall surface) drywall is hard, because



1 Begin the job by turning off the electricity to the room and removing the telephone, electric outlet and switch plates.

the glue used to attach the paper penetrates the drywall's face and forms a strong bond. You have to use water to soften the glue that holds the wallpaper, but this also softens the drywall paper facing. Be careful not to tear the paper face of the drywall as you remove the wallcovering.

Preparing the area

First, prepare the room. Remove phones, pictures, lightweight furnishings, and move the heavier furniture and area rugs to the room's center (Fig. 1). Cover remaining objects and the floor with dropcloths. Although old bed sheets will do in a pinch, wet globs of wallpaper could soak right through them and damage the floor or furnishing beneath. Water-resistant plastic or canvas dropcloths are better and prove to be a good investment for future projects. Plastic sheeting and combination paper/plastic dropcloths are another alternative. Although somewhat slippery to work on, these coverings can be disposed of at the end of the project. Next, turn off the electricity



2 Tape the dropcloth to the baseboard molding and unfold it into the room. Use masking tape at least 1 1/2 in. wide.

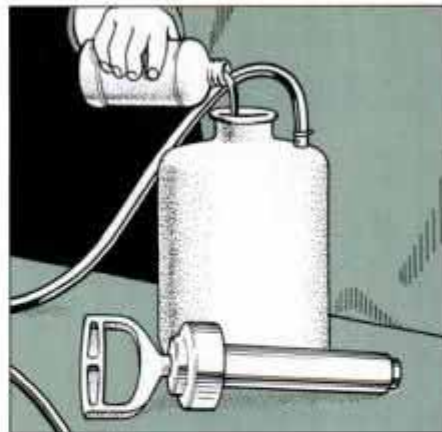
and then remove any remaining faceplates.

To stop soggy wallpaper from hitting the floor, tape the dropcloth to the baseboard with masking tape at least 1 1/2 in. wide (Fig. 2). Tape the dropcloth's edge to the baseboard and unfold it into the room.

Stripping without steam

Old-fashioned wallpaper comes off the wall easily if you get enough moisture behind it. It's held up with wheat paste adhesive, a substance easily softened by water. These porous papers absorb water, hastening the decomposition of the paste.

Stripping the paper is even easier if you mix some wallpaper remover in the water. The remover, sold at paint and hardware stores, has wetting agents that penetrate the paper and soften the paste. Some strippers also have enzymes that attack the wheat paste and dissolve it. Mix the remover in a pail or directly in a garden sprayer (Fig. 3). The sprayer should be clean and free of pesticide residue. Start applying the remover at the wall's top



3 Use a garden sprayer to soak uncoated wallpaper. Fill sprayer with a solution of wallpaper remover and warm water.

and work down. Work on 6-ft.-wide areas, soaking the area with the solution (Fig. 4).

Another effective way of applying the remover is with a sponge mop or a paint roller (Fig. 5). A hand sprayer is effective for spraying hard-to-reach areas (Fig. 6), such as the thin strip of wallpaper between a window casing and a kitchen cabinet.

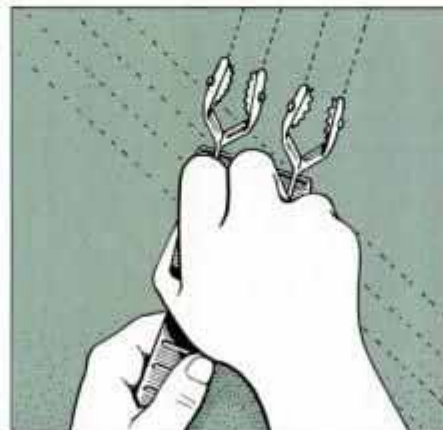
The paper will darken as it absorbs water. Apply only as much solution as the paper can absorb. Excess solution just runs down the wall and onto the floor. Let the solution soak in, then resoak it.

Let the solution do the work. You'll have to rewet the paper several times during a 1/2-hour period. A lot of water is needed to saturate it and soften the glue. Prepare another section while the first is soaking.

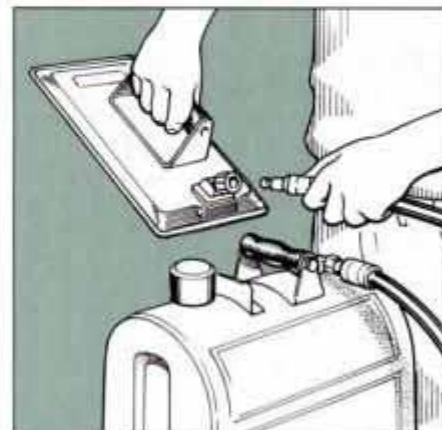
Test that the wall is ready to strip. If you can easily run a scraper from the baseboard molding to the ceiling, the wall is ready (Fig. 7). Let the paper fall on the dropcloth. For plaster walls, use a broadknife scraper or wallpaper razor scraper. On drywall,



7 The soaked paper should strip off the wall easily. If it doesn't, resoak. Use a wide, dull scraper to remove large pieces.



8 Perforate painted or waterproof wallpaper to prepare it for steaming. Holes allow the steam to penetrate the paper.



9 Plug a steamer's hose into the tank and into the steam plate before letting it heat up. Parts are too hot to do this afterward.



4 Spray remover from the top of the wall down. Soak the paper during a 15- to 20-minute period, then soak a second area.

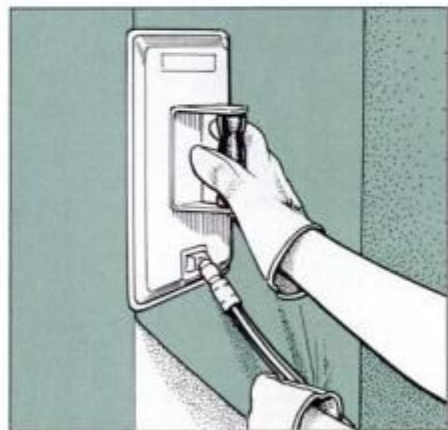
use a putty knife with a dull edge to avoid gouging its paper face.

Preparing for steam stripping

Vinyl, foil-faced and other moisture-resistant wallpapers are designed to be cleaned. The challenge, then, is to get moisture behind their water-resistant face to soften the glue. Wallpaper remover is not as effective on coated papers as uncoated. The solution is to steam the paper loose, then scrape it off the wall.

You have to prepare these papers before steaming them. The easiest way to get steam or water behind a coated wallcovering is to score the surface to allow moisture to penetrate. A good tool for this is the Paper Tiger by Zinsser (William Zinsser, 39 Belmont Dr., Somerset, NJ 08875, Dept. PM). This gadget (about \$10 at paint stores) has small wheels with sharp spurs on them that make holes in the wallcovering (Fig. 8). Its cutting depth is adjustable, so, with care, you can use it on drywall.

Painted wallpaper may be difficult



10 Start steaming the wallpaper along a seam. Hold the steam plate on the wall for 10 to 20 seconds or until the glue softens.



5 A floor mop can spread wallpaper remover. Soak the paper, but avoid letting the solution run onto the floor.

to score. With several coats of paint, it can take on an almost canvaslike quality. Begin at the top of the wall, concentrating on an area that you can comfortably reach, and work down. Score the paper thoroughly, crisscrossing the surface. Time and effort invested at this stage results in a cleaner strip because the steam better penetrates the paper. If the paper is old and there are several painted layers, most of the layers can be scraped off with a razor scraper. This is harder work than steaming off the individual layers, but it's much faster than trying to steam down through the individual layers.

Steam stripping

For about \$20 a day, you can rent a wallpaper steamer. This tool has a small electric boiler tank that holds about 1.5 gallons of water. It plugs into a standard 15-amp household outlet, but draws a lot of current, so use a heavy-duty extension cord rated to carry that amperage. The boiler connects to a perforated steam plate with a hose. When the tool starts produc-



11 Hold steam plate over perforated areas. Use a razor scraper or flat knife to scrape softened paper off the wall.



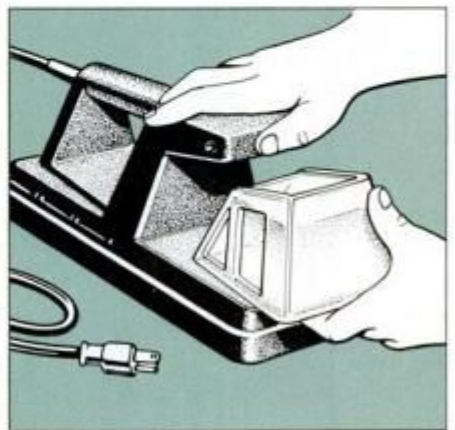
6 Apply the remover with a hand sprayer on hard-to-reach areas, such as a strip of paper between cabinet and window trim.

ing steam, press its plate against the wall to loosen the paper.

First, snap the steamer's hose onto the tank and to the steam plate while the parts are cool and easy to handle (Fig. 9). Remove the heavy steel stopper covering the tank's fill hole and insert a funnel. These tanks are hard to fill without a funnel because the fill hole isn't very large. Fill the tank with tap water (don't use wallpaper remover). Let the steamer heat up for about 10 minutes. Fill the tank again when it's half empty, so you won't have a long wait for the water to boil.

Wear heavy work gloves, old clothing and especially an old pair of shoes or work boots. Stepping around all day in piles of soggy wallpaper will quickly ruin a pair of sneakers. Most importantly, avoid touching the hot hose or steam plate. You can't turn off the steam without shutting down the boiler, so rest the steam plate on a heavy towel when you change areas or want to take a break.

Hold the steam plate at the top of a wall and follow a wallpaper seam (Fig. 10). When the seam is loose, work



12 You may consider buying Black & Decker's Steamworks, instead of renting. Tool combines water tank and steam plate.

onto the perforated area. Gently pull a corner of paper toward you when it starts to come loose. Move the steamer ahead as you pull the paper off the wall. If the paper does not readily come off, steam the area more thoroughly. Allow the steam time to penetrate. If you rush the process, you'll have to scrape off a lot of small pieces.

Even when you are patient, however, the wallcovering may separate from its backing. Give the remaining paper a second shot of steam, and pull it or scrape it off.

The procedure is basically the same for painted wallpaper (Fig. 11). Work a small area to allow the steam longer to penetrate. If you uncover another wallpaper layer, attack it as you did the previous one.

If, as you progress, the steamer seems to be working less efficiently than it should, check that the tank isn't low on water or that the steam plate hasn't been clogged with bits of paper. Lightly scrape off any paper stuck to the steam plate using a broadknife.

If you are removing the paper from several rooms, or you need the steam-



13 Let Steamworks heat up, and use it as you would a rented steamer. Tool weighs about the same as steam plate and hose.

er for a couple of days, consider buying Black & Decker's Steamworks (Fig. 12). It costs about \$50 at hardware stores and home centers.

It's used the same as the rented steamer, but we found it less cumbersome, even though it weighs about the same. Plug it into a 3-prong outlet or extension cord, fill its tank with water, and a minute later, it's ready to use. Its steam plate area is smaller



14 Pry up one corner of the strippable wallpaper using a putty knife or scraper. Slowly peel the paper off the wall.

than the rented steamer, but there's no hot hose to worry about (Fig. 13).

Removing wallpaper from a ceiling

This is the worst wallpaper stripping job, because of the additional challenge of working overhead. Set up a pair of stepladders, spanned by a short section of scaffold or painter's adjustable plank (either may be available at

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15 Wash glue residue and bits of paper off the wall using a solution of TSP and warm water, or use a household detergent.

your rental center). Working on the planking or scaffolding will save you countless trips up and down a ladder.

Observe several precautions when stripping the ceiling. First, wear goggles to keep pieces of wet paper, condensing steam or drops of wallpaper remover out of your eyes. Also, watch your step—it's easy to step off your scaffold when looking overhead. Keep the scaffolding clear of slippery bits of



16 To complete the job, fold up debris in disposable dropcloth and throw it out. Let the walls dry before painting them.

paper, and work with it aligned in the direction you are stripping. You can insert a pole into the Paper Tiger so you can score the paper from floor level or the scaffold.

Strippable wallcoverings

Strippable wallpapers simply peel off the wall when gently pulled from a corner (Fig. 14). At a seam, lift the corner of the paper with a putty knife

or scraper and pull toward you. Carefully remove the adhesive left on the wall with a fresh blade in a razor scraper. Since the paste is dry and hard, most of the heavy residue can be scraped off. Then wash the walls with warm water and detergent.

Cleanup

Once the paper is off the walls, most of your work is done. After each wall is stripped, and still moist, wash off remaining paste and paper bits. Use a large sponge soaked in a warm solution of TSP (trisodium phosphate) and water (Fig. 15). If phosphate-based detergents are banned in your area, use a powerful household cleaner, like Spic 'n' Span, instead.

Remove the masking tape and dropcloth from the baseboard. Pick up the four corners of the dropcloth to keep the water from running out (Fig. 16). If the dropcloth is disposable, simply tie or tape the cloth around the debris as if it were a giant garbage bag and throw it out. Otherwise, scrape the debris into a trash bag and rinse off the dropcloth with a garden hose. **FM**

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TOOL TEST

**NEW
RANDOM
ORBIT
SANDER**

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO,
Contributing Editor

NOW THAT Porter-Cable has introduced an electric random orbit sander, high-speed, swirl-free sanding is available to the home shop woodworker. Formerly, these sanders were air-powered and limited to shops that used air tools. I tried this tool and liked it.

The sander isn't meant to replace pad or belt sanders, but to complement them. It's versatile enough to be used for woodworking, for metal finishing, for auto bodywork or for paint and finish removal.

The 3.7-amp sander's 5-in.-dia. pad accepts adhesive-backed abrasive discs. Its pad speed is 6000 orbits per minute, ideal for fast stock removal and efficient for smooth sanding with fine-grit paper. Weighing 5.5 pounds, the nicely balanced tool has most of its weight over the pad.

Also, being a disc sander with random orbit, it can sand into a corner against a vertical surface, such as a shelf support, without marring it. Belt sanders can't reach into these corners, and vibrating sanders have a tendency to bounce against the vertical surface, marring it.

Unlike conventional disc sanders, this one is easy to use. To prevent a conventional rotary orbit disc sander from gouging and bouncing over the surface, you have to hold it so only a third of its disc touches the work. At best, its rotary motion produces a crossgrain swirl pattern. With this sander, however, hold the pad flat on the surface and move it in long, overlapping strokes. Its random orbit prevents it from bouncing. You can gouge the wood only if you tip the sander or hold it in one spot.

The sander's performance was quite satisfactory in a variety of tests. I quickly removed several coats of varnish from a flat piece of mahogany. Starting with 80-grit sandpaper, I progressed through 100-, 120- and



Porter-Cable's random orbit sander has a low profile that allows close-quarter sanding.

220-grit papers. The wood was left smooth, level and ready for finishing. Even under close inspection, no swirl marks were visible.

A contour pad is available as an accessory (model No. 13701, \$15). Equipped with the pad, the sander nicely smoothed the long and graceful curves of a cabriole leg.

Another nice feature is that its random orbit lets you sand flush wood members where grain direction

meets at right angles, like where a door's rail and stile meet. You don't have to stop at the joint to avoid cross-grain sanding marks.

Powered by a double-insulated motor, the Model 7334 Random Orbit Sander comes with an assortment of Stikit papers. It costs about \$205 at hardware stores and home centers. For more information, write to Porter-Cable Corp., P.O. Box 2468, Jackson, TN 38302-2468. **PM**



1 Slide switch forward to turn on power. Release it to turn off sander. Lock on power by pushing front of switch down.



2 Abrasive discs are easily installed. Simply peel off their backing paper and stick them onto the padded disc.



3 Sander proved to be versatile. Here it's used to remove a finish by sanding varnish coats off a mahogany surface.



4 The accessory contour pad has slightly more flexible backing. Sander equipped with pad smooths a cabriole table leg.



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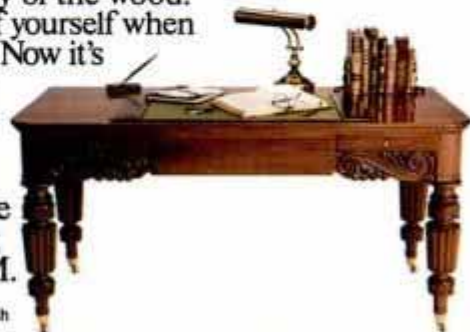
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Energy: The Long and the Short of it.

Quick Fixes

WHAT CAN YOU DO NOW, without spending a lot of money, to make your home more energy efficient this year? Here are some quick fixes:

- Buy efficient light bulbs—The compact fluorescent bulbs available today use 75% less energy than regular bulbs. That's why they each eliminate 500 pounds of air pollutants. They more than pay for themselves in lower bills, and last up to six years. Check lighting specialty stores in your area to see what's on the market, or write to the Alliance to Save Energy (see information at the end of this article).
- Weather-strip your doors and windows—Your local hardware store should have an array of door- and window-sealing materials. Unless you have snug-fitting double-pane or storm windows, weatherstrip them and add temporary, low-cost coverings. The cheapest interior storms are the clear film type you fasten to the inside of the window frame.
- Look for the biggest air leaks—Two notorious energy wasters are attic entrances and fireplaces. If you have an attic hatch or door entrance, do a good weatherstripping job on it. If you have a fireplace, try to adjust the damper for a tighter fit. If it won't close tightly, stuff a strip of insulation around the damper edge (but remove it when you build a fire!).
- Service your heating and cooling equipment—Clean or replace furnace air filters regularly—at least twice a year. Window air conditioner filters should be cleaned at least once a year. Furnaces, boilers, heat pumps, and central air equipment should be professionally serviced at least once a year.

Cultivate Healthy Energy Habits

Here are some simple tips for lowering energy costs day by day:

- If your refrigerator has a "power saver" or "energy miser" switch, turn it on.
- Lower the temperature setting on your water heater to 120 degrees, or the lowest setting that meets your hot water needs.
- Adjust your thermostat (lower in winter or higher in summer) at night and when you are away from the house.
- Wash clothes in cold water whenever possible.
- In summer, keep windows shaded during the day. Use fans instead of air conditioning on moderate days.

- In winter, keep shades drawn on north-facing windows. Open them during the day on southern-exposure windows.

Battle the Elements

Insulate, Insulate, Insulate

The Attic is the place to start insulating. Field studies have shown that most attics in the U.S. have too little insulation. How much insulation should you add? The Department of Energy recommends that the "R-value" (heat-retaining value) of attic insulation be at least R-30. That's about 9 inches of mineral fiber "batts" or 10-14 inches of loose fill or "blown" insulation, depending on the material. R-values up to R-49 are



A Message from Senator Wirth

The collapse of the Berlin Wall and the changing nature of our national security have once again focused attention on issues the Alliance to Save Energy has been pioneering for more than a decade. We believe energy efficiency is good energy policy, good environmental policy, and good economic policy.

Environmental concerns have emerged at the top of the public agenda. From oil spills to the vanishing rain forests, from ground water pollution to global warming, the environment is in trouble. With energy efficiency, we have the opportunity, indeed the responsibility, to reduce harmful emissions and save energy. Right in our own homes, we can make a difference.

Saving energy does not require that we be cold in the winter and warm in the summer. Instead, reducing our energy bills can be accomplished with new technology that helps eliminate pollution and save money. The compact fluorescent light bulbs in my house save 75 percent of the energy used by regular bulbs. If we all used them we could eliminate more than 100 million tons of greenhouse gases.

This special section is full of practical ideas to help you save energy in your home. I hope you will undertake these simple steps—our research shows that you can save \$25 on a \$100 heating bill. And the energy you save today will help protect the environment we pass on to our children and grandchildren.

Senator Timothy E. Wirth
Chairman of the Alliance to Save Energy



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justified in the coldest states. Contact the Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) for more specifics (*see references at end*).

The Walls It is harder to add insulation to the typical wall than the typical attic. Check behind electric outlet plates to see if you have wall insulation. Unless you have none or live in cold climates, adding wall insulation may not be cost-effective.

If you decide to add wall insulation, you have three main options: 1) Fill the wall cavities (spaces between the wall studs) by blowing in insulation through temporary holes. 2) Add insulation to the exterior, under the siding. Best time to do this is when you are re-siding the house. 3) Add insulation to the interior wall surface. This option reduces your floor area and requires retrimming around doors and windows. Contact CAREIRS for more specifics.

The Foundation Most existing homes are not insulated around the foundation. Yet recent national laboratory research shows that the energy savings potential from insulating foundations is big. The problem is—how to do it. Foundations vary a lot, from full basements to crawl spaces and slabs; many homes have a mix.

There are three ways to insulate a basement: 1) adding foam board or other water-resistant material to the exterior; 2) adding insulation to the interior basement wall; or 3) filling concrete block walls with foam or other materials. Ask an insulation contractor for the cheapest and most appropriate solution for your house.

Prior to finishing any basement, or installing insulation that covers the walls, it is a good idea to perform a radon test. If any problems are found, it is easier and cheaper to solve radon problems before the energy retrofit. Contact your local health department for information on radon testing and control.

Crawl space walls should be insulated similarly to basement walls. Slab edges also should be insulated. Because foundation insulation is a new science, make sure any contractors you use have direct experience with your type of foundation.

Stop Air Leaks

Energy researchers and retrofitters have found that most homes waste a lot of energy through air leaks. One of the tools they've come up with to control air leakage is called a "blower door." It's a powerful fan/door assembly that fits in a doorway. The operator measures the air leakage with instruments connected to the fan, and then tracks down the big air leaks made obvious by the air movement. A skilled operator can seal up most of the big leaks in a couple of hours and bring the air leakage down to a reasonable level. Many utilities and weatherization agencies are starting to use blower doors. The catch—they're not available yet in many areas. Ask your utility or state energy agency if blower door tests are available in your area.

With or without a blower door, to seal the most likely air leakage sites (beside the attic hatches and fireplaces mentioned earlier): caulk around window and door frames, pipe penetrations in ceilings, and behind baseboard moldings where the wall meets the floor. Put plastic gaskets under the cover plates for electrical outlets. If you have an unfinished basement, caulk the joints where the wood framing meets the concrete foundation.

Check Your Windows—Should They Be Replaced?

The window has long been an architect's delight and a major energy loser. On average, homes lose 25% of their heat through windows. But now there is good news for consumers—new, high-tech windows insulate up to four times better than standard models.

These windows have special, transparent coatings known as low-emissivity or "low-e." They let visible light through but stop heat radiation, keeping heat inside in winter and outside in summer. Low-e coatings and related window insulation features are gaining rapid acceptance among window-makers, builders, and window contractors.

Recent engineering studies show that these advanced windows are cost-effective for much of the U.S. So always ask for low-e windows when buying a new home or replacing your old windows.



Maximize Big Energy Users

Heating and Cooling Systems

If you need to replace a furnace, heat pump, or air conditioner, or are looking at a new home, use the following guidelines for efficiency.

| APPLIANCE | HIGH EFFICIENCY | BEST EFFICIENCY |
|------------------------------|-----------------|-----------------|
| Furnace AFUE* (Oil or Gas) | 80% | 90%+ |
| Heat Pump HSPF† | 7.0 | 9.0 |
| Window Air Conditioner SEER‡ | 9.0 | 10.0+ |
| Central Air Unit SEER‡ | 10.0 | 12.0+ |

*AFUE—Annual Fuel Utilization Efficiency; a measure of the relative seasonal efficiency of a boiler or furnace. †HSPF—Heating Seasonal Performance Factor; measures heat pump efficiency in its heating phase. ‡SEER—Seasonal Energy Efficiency Ratio; measures the cooling energy efficiency of a heat pump or air conditioner.

Before replacing an older furnace or boiler, consider retrofitting it with a high-efficiency burner. It can boost efficiency at a much lower cost than buying a whole new unit. Other retrofit options: automatic vent dampers, electronic ignition devices to replace pilots, and better controls. Consult your area heating contractors to find those who are skilled in these options.

One option that can reduce your heating and cooling costs is a set-back thermostat, sold in most hardware stores. They let you program your home's temperature to meet your comfort needs. Note: set-back thermostats are not normally usable for heat pumps.

Other things to check for in your heating and cooling systems:

- If you have air ducts, and they run through unheated spaces, make sure that they are insulated. Seal any obvious air leaks with duct tape.
- If your equipment is located in a utility closet, make sure the closet is air-sealed from any unheated attic, basement, or garage spaces.

Hot Water

Your water heater is one of the biggest energy users in the house. Simple hot water saving options include:

- Wrap it—Hot water heater insulation blankets can cost as little as \$10, and pay for themselves quickly.
- Slow the flow—Low-flow shower heads are now widely available for less than \$10, using less than half the water of standard models while delivering a brisk shower. Flow-reducing faucet aerators also reduce waste at the sink.
- Pipe insulation—Hardware stores

carry simple, slip-on pipe insulation. Place this material over the first several feet of hot water pipe coming out of the heater.

Appliances

Good news for consumers came in the National Appliance Efficiency and Conservation Act of 1987, which set new efficiency standards for major appliances like furnaces, air conditioners, and

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refrigerators. These standards take effect beginning in 1990, so new models will be less expensive to operate as the standards phase in.

But in the meantime, and even after the standards are in place, some appliances will always be more efficient than others. Read the yellow "Energy Guide" tags on appliances in the showroom. If you want a guide to the most efficient appliances, write to the American Council for an Energy Efficient Economy at 1001 Connecticut Ave. N.W., Suite 535, Washington, D.C. 20036



Buyer's Guide

What to Look For in a New Home

Many builders today are energy conscious. Ask them about the energy features of the home you are looking at, using this general checklist:

- What are the R-values of the ceilings

and walls? Is the foundation insulated?

- What has the builder done to control air leakage in the home? Is an air-sealing housewrap used?
- Are the windows double-paned? Do they have low-e coatings?
- How efficient are the heating and cooling systems? Use the table in the heating and cooling section for guidelines.

Energy Savings: Where to Start and How to Finance

You must be the judge of whether you install energy measures yourself or hire a professional. Major appliances that require serious plumbing, electrical, or duct work should be done by professionals. Insulation, weather-stripping, and similar work can often be done by the homeowner. Some of the best sources for professional help are:

- Utilities—Many utilities offer energy audits and other efficiency services.

Some offer contractor referrals, rebates, and other incentives for energy-efficient equipment. Call your electricity and gas suppliers to see what they have available.

- Insulation contractors—They can install ceiling, wall, floor, and other insulation. Contact local contractors to compare skills and prices.
- Heating and cooling contractors—Their expertise lies with furnaces, air conditioners, water heaters, ductwork, and related equipment. Some have arrangements that let you pay through your utility bill. Some manufacturers offer rebates (through contractors) for efficient models.
- State energy offices—Many state agencies have information, loan programs, and other services that can help you get started.

Lack of money stops many a well-intentioned energy retrofitter. While many of the steps suggested here are



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It takes something special to become the top name in metal protection. Like the special formula that gives our metal paint more rust-fighting ingredients than other paints. To seal out moisture. Keep its rich color. And make metal last longer.

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*TEFLON® Resin is DuPont's registered trademark. © 1990, Rust-Oleum Corporation, U.S.A.



inexpensive, some, like furnaces or wall insulation, can add up to thousands of dollars. Consult your utility and state energy offices. They may have incentive or financing programs. Home improvement loans or the increasingly popular home equity loans are further options.

Financing Through Your Mortgage

One promising financing method is called the Energy Efficiency Mortgage. Offered by some mortgage lenders when you are buying a house, this program gives you two options: 1) for a home that is already energy efficient, it eases the qualifying rules; and 2) if the home needs energy work, it lets you pay for the improvements in the mortgage.

This program is available at the option of local lenders. One national lender that offers it is GMAC Mortgage. Call James Berryman at 1-800-GMAC-123, or write to GMAC Mortgage Corporation, 8360 Old York Road, Elkins Park, PA 19117-1590.

Get Involved and Receive a Free Energy Efficient Light Bulb!

Join The Alliance to Save Energy through this supplement and you'll receive a free energy-efficient compact fluorescent light bulb and a Consumer's Guide to Efficient Lighting as part of your membership introduction. Your membership dues will allow The Alliance to Save

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We are a non-profit coalition of business, government and consumer leaders, dedicated to increasing the efficiency of energy use. We conduct important research, educate the public and engage in public advocacy.

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For More Information

On all energy-efficiency topics: Call CAREIRS at 1-800-523-2929 or 1-800-233-3071, or write CAREIRS at P.O. Box 8900, Silver Spring, MD 20907.

On efficient appliances: Write the American Council for an Energy Efficient Economy at 1001 Connecticut Ave. N.W., Suite 535, Washington, D.C. 20036.



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For large jobs, Rust-Oleum Wood Saver Trim Paint puts the same formula to work protecting your eaves, porch railings, doors and windows. Everywhere trim is vulnerable to the damaging effects of water and direct sunlight.

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efficiency electric heat pump keeps the air in your home cleaner because there are no fumes. Which means you can build a tighter, better insulated house, with less heat loss and a more consistent temperature overall. If you plan to build or remodel, contact your electric utility for more information on energy efficient heat pumps. You'll find any time's a good time to install an electric heat pump.

Electricity.  A better world is in your power.

IMPORTS

BY RICK TITUS, West Coast Editor



Mercury Capri—Practically Sporty

THE ALL-NEW Mercury Capri is not a fine-edged, sharply balanced, high-energy thoroughbred. What it is is a well-rounded, solid-handling, smartly powered, surprisingly practical 2+2 sportster designed around comfort and reliability.

The single biggest challenge in designing a 2+2 sports roadster is to build in enough of the essential sports element while preserving enough car for day-to-day use. From the sports side, the recipe requires 4-wheel independent suspension, front and rear antiroll bars, and 4-wheel disc brakes. Capri has them.

The engine should have the response of dual-overhead camshafts and four valves per cylinder. And the transmission should have five close-ratio forward speeds and a light, precise touch. Capri has those.

The look should be European, with a low, steeply raked nose and a shape for splitting the wind. And the cockpit should resemble a jet fighter. The Capri has at least most of that.

But the feel—this is sacred territory—the feel should be light, clean, crisp and instantaneous. And the Capri isn't quite that.

From the more practical car side—a roomy passenger compartment—the Capri measures up better.

The soft top should be easy to use and the rest of the car should be cheap to maintain and simple to own. The Capri gets top marks on this score.

The new Capri is the final outcome of an international design and manufacturing effort on the part of Ford

Motor Co. Capri's shape was designed in Italy by Ghia Studios, a Ford subsidiary. Its driveline is from Mazda in Japan. Engineering was handled by Ford in the U.S., and final assembly by Ford of Australia.

There are two trim levels for the front-wheel-drive Capri, which includes a base model fitted with a 1.6-liter, dohc, 16-valve 4-cylinder equipped with multiport electronic fuel injection. Producing 100 horsepower, the standard engine is no neck-snapper, but pulls smoothly and with little fuss through its 5-speed manual transmission.

The up-market XR2 uses the same powertrain, but with the addition of a turbocharger and an air-to-air intercooler. This bumps the power output to 132 hp, putting the XR2 very close to the neck-snapper category.

The XR2 also has a performance suspension tweak, fog lamps, rear spoiler and alloy wheels. It's also fitted with air conditioning, cruise control, power door locks and cassette player as standard equipment.

Though the XR2 comes with a 5-speed transaxle only, the base model can be ordered with an electronically controlled 4-speed automatic.

An all-steel 1-piece hardtop, painted in body color, is offered as an option and includes a rear window defogger, glass quarter windows, molded headliner and a dome lamp with individual map lights. Weighing just 75 pounds, it comes with its own stand and cover for easy storage.

The Capri's convertible top can be operated by one person and tucks away out of sight under a steel trim panel at the rear of the cockpit.

The small but functional rear seat can accommodate adults for short distances, and with its seat back folded down, longer items can be loaded in through the trunk into the cockpit.

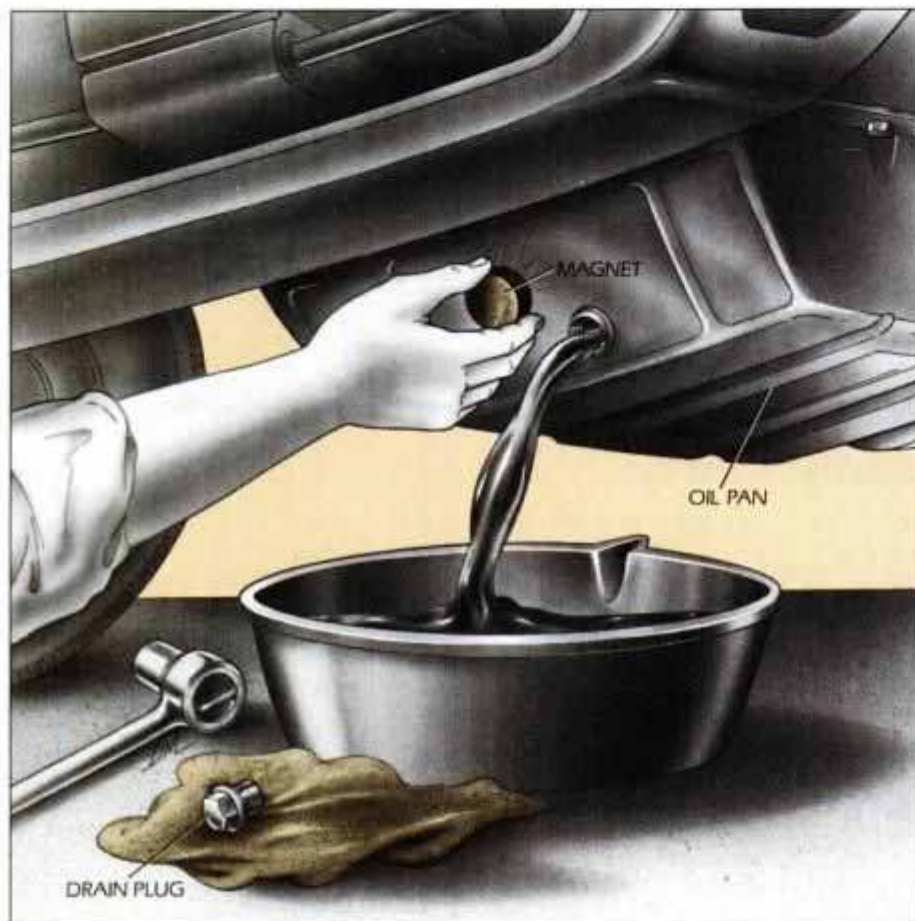
The new Capri enters an already competitive and very vertical niche market. Yet its odds for success are quite good, given its attractive base price of just under \$13,000 and surprising level of functionality. It's not a sports car—but it does offer sports car fun, with the added attraction of real car practicality. **FM**



Capri's optional hardtop has glass side windows and a rear window defogger.

CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PM ILLUSTRATION BY DON MANNES

A Magnetic Personality

ON ALL MY CARS, I stick a strong magnet on the oil pan next to the drain plug. I got the idea from an old outboard motor. After I warm up the engine, I remove the magnet and then drain the oil. On my old outboard, there were always filings stuck to the magnetic drain plug.

If it is of any value, why don't manufacturers make the drain plug of some magnetic material?

PAUL LAQUIDERA
NATICK, MA

It's a pretty good idea, Paul, and some manufacturers do include a magnet on the drain plug of the transmission.

However, there's not that much in the way of magnetic material floating around in the crankcase of a modern engine—most of the particulates are either carbon, silicates, brass or chromium. You could either do what

you're doing, which is to remove the magnet from the pan just prior to popping the drain plug, or you could stick it to the end of the filter, and remove it once the filter is removed.

Any auto parts store ought to be able to sell you a magnetic drain plug for your transmission. Be aware that automatic transmissions also don't make much ferrous junk, either. The mud that collects in the bottom of the pan is mostly friction material from the clutches.

Manual transmissions are another story. There's usually a good supply of chips and shavings in the bottom of the pan. But sticking a magnet to the thick cast-iron case won't do much good—the magnet won't have enough power to attract particles through the thickness of the case. This ploy works on engine oil pans because the magnetic field penetrates the thinner sheetmetal pan.

I don't recommend epoxying a magnet to your present plug. If the glue fails, and the magnet winds up in the works, you'll be sorry.

Hopped-Out Bunny

My 1982 Volkswagen diesel pickup has about 130,000 miles on it and sees a lot of high speed and mileage (around 500 miles a week). It uses about 2 quarts of oil a week, which seems like a lot to me. It doesn't appear to be burning the oil—there is only blue exhaust smoke when you mash the accelerator hard. And it doesn't leak oil onto the ground. Is this much oil consumption excessive, or is it piston ring time?

Also, because so much new oil is being put in every week, is a complete oil change necessary? Or could I change just the filter?

RON MASTERS
PALM BAY, FL

After 130,000 miles, how can you complain? And contrary to how it seems to you, a blue smoke cloud on hard acceleration is nothing else but worn-out rings.

As for your second question: No, just because oil is disappearing, you shouldn't use that as an excuse not to change the oil. Oil should be changed for several reasons. First, the oil and the additives become exhausted. In your case, no problem—it's not staying around that long. But the other reason is to drain out all the sludge and particulates that don't get caught in the filter. Particulates like iron filings and chromium from the cylinder walls and rings, and brass from the valve guides, as well as silicates (sand) from airborne dirt. That goop doesn't burn—it stays inside your motor until you drain it.

Clutching At Straws

I own a 1986 Chrysler LeBaron GTS, with 8000 miles on it. When the motor is running and I work the clutch, it has a scraping sound and a rough feeling. (The clutch is worked by a cable.) When the motor is not running, there is no problem. Could this lead to something serious?

JOE CELMER
TACOMA, WA

(Please turn to page 84)

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Quaker State's limited guarantee covers lubricated parts in engines of every single imported and domestic car or light truck sold in the United States. It even covers the deductible on any extended warranty you might have purchased from your new-car dealer. Enrollment is absolutely free.

See a copy of lubrication limited warranty and enrollment details at participating service centers.

Complete details and enrollment forms for the Quaker State 250,000-mile or ten-year guarantee are available at

participating Quaker State service centers. These include many new-car dealers, automotive service centers and fast lubes nationwide.

To participate in the guarantee program, enroll your new car at a participating service center within six months or 6,000 miles of purchase. Use only Quaker State Motor Oil, and have your oil and filter changed at a service center according to manufacturer's instructions for severe driving conditions but not to exceed 4,000 miles or four months between changes. Save your receipts.

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The Big Q is One Tough Motor Oil.

Service Bulletins On Call

KEEPING TRACK OF Technical Service Bulletins around the office here has always been a pain in the neck. There's about a foot of paper every month, all of which has to be inserted into the appropriate files.

A few months ago, I received one of Alldata Corporation's System 3 CD-ROM TSB database systems for evaluation. The CD-ROM format uses a disk based on audio CDs, but contains digitally stored data. The amount of data that a single CD-ROM can store is staggering—the five CD-ROMS shown here have TSBs on virtually every vehicle sold in the U.S. market since 1978. Searching through the data for a TSB takes only a few seconds, as opposed to flipping through mounds of paper.

In addition, the CD-ROMs contain service manuals, wiring diagrams, parts and time guides, and vacuum hose routing diagrams. Graphics, like line drawings or charts, are keyed to the text, and can be displayed on-screen alongside the words. Included in the computer's CPU box is a high-speed thermal printer. There are quarterly updates to the database.

The information is culled from

a number of sources, from the manufacturers, *Motor* publications and others. And, unlike the swelling pile of paper gracing the cabinet in my office, it's already organized.

It's but a matter of a few seconds to use the computer's mouse to pick a particular make, model and year of vehicle from Alldata's menu. It then will let you browse through the TSBs by symptom, and it even keeps track of which TSBs you've already looked at. Or you can read through the shop manual, wiring or vacuum hose charts,

parts list or mechanic's time guide.

Of course, this gadget wasn't intended just for overworked journalists. It's sold to independent repair shops and dealerships to help them improve the speed and accuracy of their automotive repairs. With the complexity of modern cars, there's no substitute for accurate, up-to-date info about fuel-injection systems, recalls or TSBs. An Alldata-equipped shop mechanic has at least a fighting chance of having what he needs to know.

Dealerships are supposed to have all this information on file for the mechanics to use. But it's pretty easy to lose track of a little bit of the flood of paper TSBs. And of course, it's all too easy to remember something passing through a few months ago, but not exactly whether it applies to some particular customer's car or not.

Now a car owner can find a shop with an Alldata machine and search for any TSBs that might apply to their vehicle. And a smart shop owner will automatically check for TSBs on every vehicle that passes through, potentially saving a lot of head-scratching. Alldata can be reached at (800) 829-8727.



Install A Genie® Garage Door Opener, And We Guarantee It Will Screw Up Your Door.

A close-up photograph of a white Genie garage door opener motor unit. The unit is rectangular and has the word "GENIE" printed in large, bold, red letters on its side. The unit is shown from a low angle, highlighting its three-dimensional shape.

GENIE®

It's already serious, Joe. You've got a bad throwout bearing—or worse. Get this car into the shop. You'll have to pull the transmission and assess the damages, as the worn TO bearing may already have trashed the pressure plate.

Topless

I have a Camaro with an aftermarket custom convertible top. I've been looking for a replacement for six months. Nobody has ever heard of the company. Can you help?

PAUL SHAPIRO
OCEANSIDE, NY

I don't have any information about the specific manufacturer you mention in your letter.

But any time I've ever needed a new top or cloth sunroof, I've just gone down to an automotive trim shop. Using the old top as a pattern, they have been able to cut and sew a new top from scratch. This also means you can specify almost any color or fabric you want. They probably can install it as well, if you don't want to tackle it yourself. It's a complex task, especially if you've never done it before. The price should be surprisingly reasonable.

Bagging It

I want to have a car that would be safe in a car crash. I would like to have air bags installed in my Toyota Land Cruiser.

Do you know of anyone who installs air bags as an aftermarket product? If not, do you think that this will ever happen?

CAROL DUPLANTIS
VALDOSTA, GA

I don't know of any such systems available on the aftermarket.

Air bag systems are awfully complex. The engineering of the car has to be correct, and I sincerely doubt that an aftermarket universal system could be effective. It could, in fact, be downright dangerous if not properly engineered with the vehicle in question in mind, or if improperly installed.

And if you wear the seatbelts already installed in your vehicle, the incremental improvements in safety are minimal. **PM**

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

■ 1989-90 Geo Prizm owners may have some difficulty installing front license plates, as the front fascia isn't drilled at the factory. The dealer should have taken care of this, but if you move to a state that requires front plates, you may need to drill a $1\frac{5}{32}$ -in. hole into the dimples provided. A standard license plate nut can then be used. TSB 90-05-10

■ 1988 and later Ford truck owners who use their vehicles in excessively dusty conditions may find that the plastic idler pulley on the serpentine accessory belt wears rapidly. Formerly, the entire idler assembly had to be replaced, but now there is a replacement plastic pulley available separately. TSB 89-14-19 warns, however, that the idler pulley bolt on the 5.0L, 5.7L and 7.5L engines has lefthand threads, and the 4.9L uses righthand threads. Turning this bolt too far the wrong way may damage the threads. It also warns not to allow the arm to spring back to the stop while removing the belt, to prevent damage to the casting.

■ Misadjusted brake-light/cruise-control switches may result in brake drag in Chevrolet products. Pull the brake pedal rearward against the stops. If you can hear clicks, the switch is out of adjustment. This will also automatically readjust the switch. TSB 88-74-5 warns against trimming the brake cylinder pushrod or shimming the master cylinder to prevent drag.

And Screw It Down.

Because Genie has the first complete line of Screw Drive garage door openers for Do-It-Yourselfers, Genie Screw Drive openers have always set the standard for reliability, security and convenience. But until now, they were only available professionally installed.

Now, thanks to our innovations in screw and rail engineering, Genie Screw Drive units can be easily transported and installed at home.

All our Do-It-Yourself Screw Drive openers come with the features you want most:

- **Durability.** The solid steel screw has the strength needed for years of trouble-free operation under any condition.

- **Easy Installation.** Fewer parts to assemble using a fully illustrated guide and easy-to-follow instructions.

- **Clean, Quiet and Simple.** Genie Direct Screw Drive means quieter operation and no chains to stretch or reset.

- **Security.** Solid steel screw provides a positive security lock versus slack chain drive systems.

- **Safe.** UL listed with standard features such as automatic safety reverse if the door meets an obstruction or fails to close within 21 seconds of activation and compatibility with our exclusive Genie Safe-T-Beam™ non-contact reversing system.

- **Unbeatable Warranty.** Every Genie Screw Drive garage door opener is covered by our exclusive Genie Pro-Tech™ Limited

Warranty, the best in the industry. And our products are backed by the largest dealer network in the business.

Genie Screw Drive openers. Take one home. Put it up. It won't let you down—until you want it to.

For the name of a nearby Genie dealer, call 1-800-87-GENIE.

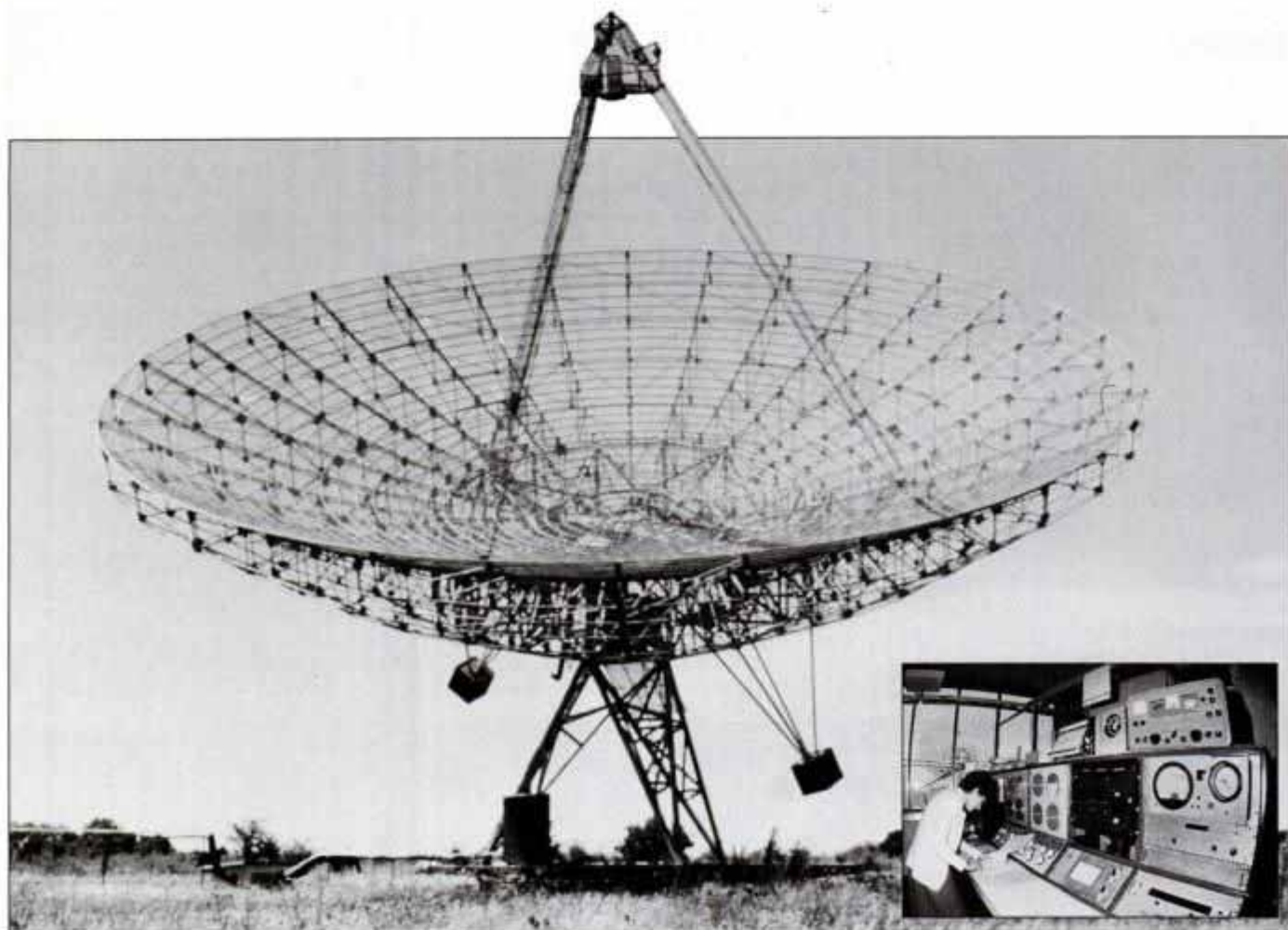
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SCIENCE

BY ABE DANE, Science/Technology Editor



PLANETARY SOCIETY PHOTOS

The Hunt For Aliens Heats Up

THIS SUMMER when two refrigerator-sized boxes crammed with electronics were held up by Argentine customs officers, professor Raul Colomb had a bit of explaining to do. You see, he had to assure them, the machinery was intended for nothing more sinister than finding aliens from outer space.

The whole thing was very much on the level, however. The equipment was on its way from Harvard University. Part of the Megachannel Extraterrestrial Assay II (META II), it was to be installed in the second of two instruments custom-built under the direction of physicist Paul Horowitz. With processing muscle on par with a supercomputer, they are among the most advanced devices ever contrived for the purpose of finding interplanetary radio transmissions from extraterrestrial life forms. These messages, which many scientists suspect are now buried amidst the cosmic background noise bombarding our

planet every day, are the most likely way for us to find out if there is intelligent life elsewhere in the Universe.

META II was bound for the Argentine Institute for Radioastronomy, 15 miles southeast of Buenos Aires. Hooked up to a 98-ft.-dia. radiotelescope dish there, it will participate in the first-ever systematic scan of the Southern sky for a beacon from another world. Symbolically, the search will begin this month, on Columbus Day.

A similar search of the northern half of the sky has been under way at the 84-ft. Harvard/Smithsonian Astrophysical Observatory's Oak Ridge radiotelescope in Harvard, Massachusetts, since 1985.

The wizard of Ozma

The two META installations represent the most thoroughgoing approach yet to a quest that began 30 years ago. For three months during the summer of 1960, astronomer

Frank Drake used a new 85-ft. dish at Green Bank, West Virginia, to tune in emissions from Tau Ceti and Epsilon Eridani, two nearby Sunlike stars. Although the effort, known as Project Ozma, found no signs of life, Drake's thinking caught on. In essence, the premise was that with about a billion-trillion stars in the known Universe, most of them much older than our own, there's bound to be someone somewhere trying to get a message out. On that assumption, about 50 Search For Extraterrestrial Intelligence (SETI) scans have been carried out with radiotelescopes since Project Ozma.

SETI tech

These efforts have been paced largely by advances in the electronic technology needed to tune in and analyze signals over a wide range of frequencies, while searching a large area of sky. Comparison between META I and its predecessor at the Harvard Observatory provides some idea of the progress that has been made.

Designed in 1981, the earlier device, known as Sentinel, was powerful, but could only monitor one very narrow band at a time. Thus, researchers had to try to guess not only where the aliens were, but precisely what frequency they would be transmitting on.

That's not as impossible as it sounds. SETI researchers reason that aliens wishing to make their presence known to an unfamiliar culture would likely base their choice of frequency on some universal constant, such as the radio frequency emitted by hydrogen—the most common element in the Universe. But trying to predict alien logic, along with the vagaries of interstellar radio-transmission, is uncertain at best, so an engineer working on the program came up with the idea of wiring together numerous Sentinel processors in parallel to produce META, a spectrum analyzer capable of monitoring more than 8 million narrow frequency bands at once. Although META would still require operators to guess the aliens' frequency, it would at least increase the margin for error, and thus greatly decrease the risk of missing a signal purely by chance.

In 1983, Horowitz's team received funding to build META from the Pasadena-based Planetary Society, which had also backed Sentinel. The system, comprising 25,000 chips, 500,000 hand-soldered connections and 150 processors—each comparable in power to a VAX microcomputer—was completed by September 1985. A few weeks later, the ceremonial switch was thrown by Steven Spielberg, a major META supporter, and the first continuous SETI search was on.

As advanced as it is, however, META is not likely to remain at the forefront of SETI technology for long. NASA has planned a far more ambitious effort to use the world's largest radiotelescope, located at Arecibo, Puerto Rico, to scan all the Sunlike stars in the Southern sky at a much broader range of frequencies than META can. A parallel effort coordinated by the Jet Propulsion Laboratory will make briefer checks of every star within 1000 light years of Earth, using smaller radiotelescope dishes. At present, it is uncertain whether the \$100-million program will be fully funded by Congress, but even if it isn't, NASA plans to begin SETI searching on some level within the next couple of years.

Meanwhile, META's search continues, and we must prepare ourselves for the possibility that sometime, maybe tomorrow, maybe 50 years from now, we will tune in a distant signal telling us that we are not alone. **PM**

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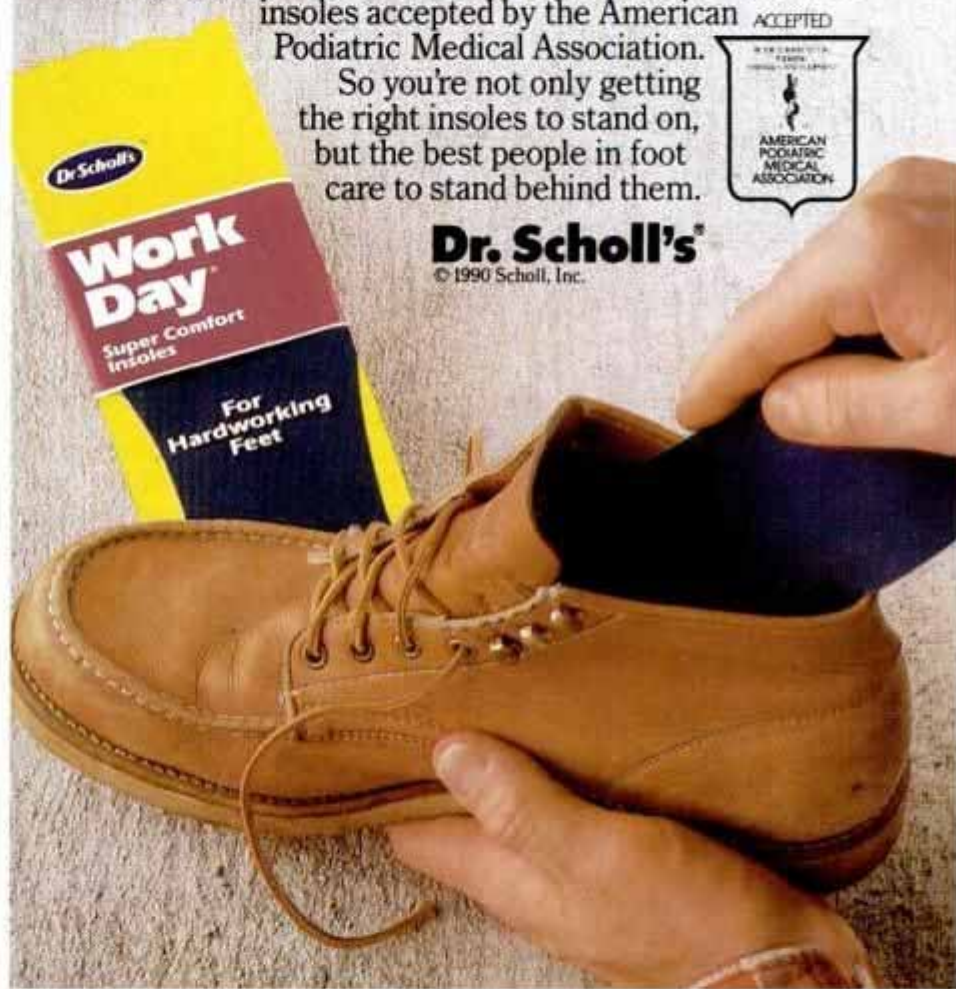
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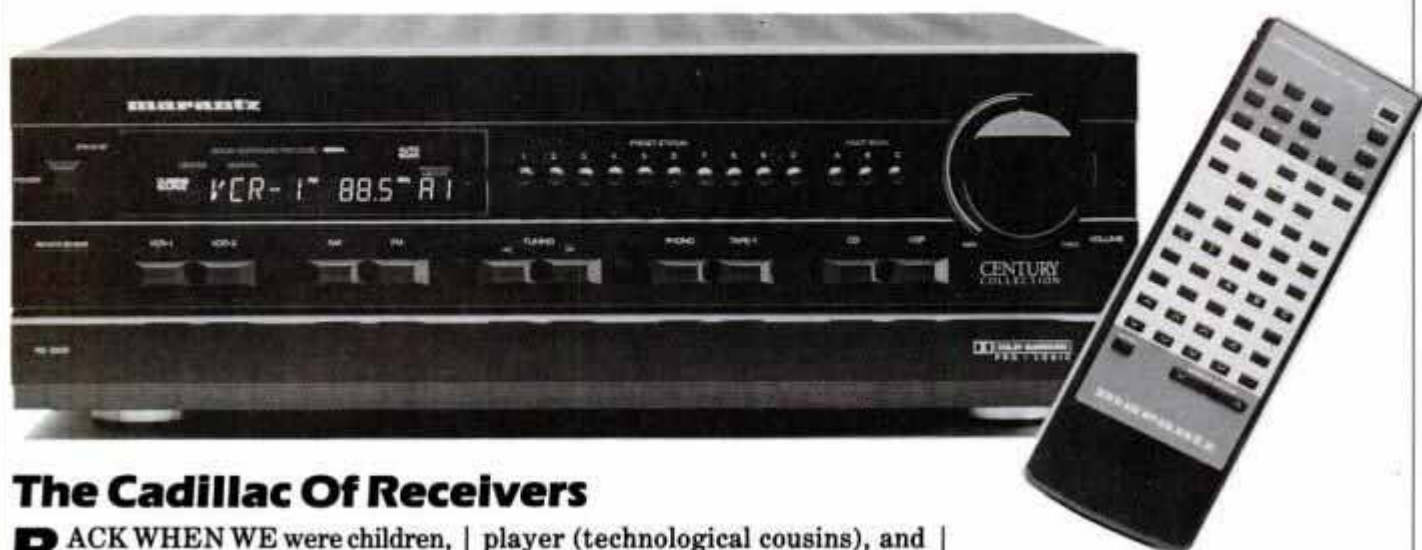
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ELECTRONICS

BY FRANK VIZARD, Electronics Editor



The Cadillac Of Receivers

BACK WHEN WE were children, the Cadillac automobile was the epitome of grace and power. Those old Cadillacs, with their graceful designs and powerful engines, come to mind as you operate the Marantz RS 3559 audio/video receiver.

The Marantz RS 3559 is what good hi-fi design is all about. Unlike the plethora of audio/video receivers offered by much of the competition, the Marantz RS 3559 exudes a sculpted simplicity that implies powerful sophistication. By contrast, the competition is enamored of a multitude of flashing lights and large rotary knobs that suggest a ham operator's license is required of the owner.

What did Marantz do different? According to company insiders, Marantz employed the services of a graphic designer rather than an industrial designer, as is more commonly the practice. The result is a positioning statement by Marantz that says: "Art + science."

Art meets science

The art is plainly visible. The RS 3559 is available in matte black or brushed gold with optional lacquered rosewood side panels. The faceplate is simplicity itself.

Your eye is immediately caught by the 10 large, sculpted function controls paired off in what amounts to an electronic "buddy" system. The two videocassette recorder inputs are grouped together, as are the AM and FM buttons, the up/down tuning controls, the compact disc and videodisc

player (technological cousins), and lastly, the phonograph and audio tape buttons (paired, perhaps, because of their veteran status).

Above the input controls are an easy-to-read display and a line of round preset buttons which, when used in conjunction with the three multiscan buttons on the far right, can store up to 30 radio stations in memory for instant recall. The rotary volume control is backlit so you can tell at a glance where you are on the loudness scale.

The lower third of the faceplate is actually a flip-down door that opens to reveal a somewhat cluttered array of auxiliary controls. The clutter is of little consequence, though, since most of the important features can be accessed with the 64-key remote.

The RS 3559 works best as the anchor for a home theater system. This receiver has five amplifiers packed into its chassis. The main front stereo channels are conservatively rated at 125 watts per channel. Two rear channels get 20 watts, while a separate center channel is powered by 20 watts.

The astute video fan already will have guessed that the RS 3559 offers Dolby Pro Logic surround sound for a theaterlike experience. Dolby Pro Logic employs a fifth center channel for anchoring on-screen dialogue. The RS 3559 does offer a phantom center-channel setting in case a fifth speaker isn't available.

While Dolby Pro Logic is the preferred method of surround-sound de-

livery, there's also a simulated mode, as well as adjustable hall and stadium settings for non-Dolby encoded material.

The RS 3559 is also notable in that it runs extremely cool for a receiver with this much amplifier power. Marantz uses what the company calls a "thermal tunnel" cooling technique that employs a tiny fan that sends air over the heat sinks of the amplifiers and out through a rear vent. Remarkably, the fan is inaudible and has no effect on what is a very clean-sounding receiver that performs extremely well.

Surround Headphones

The surround-sound capabilities of the RS 3559 also afforded us the opportunity of evaluating a new type of headphone described as being capable of offering surround sound. Made by Memtek and listing for \$100, the VHS-100 headphones work with a small black box to which the rear channel speaker wires are connected.

The VHS-100 uses two headphone jacks. One plugs into your receiver, while the second plugs into the black box. Each earpiece contains two speakers, one for the main stereo image and one for the rear channel fill.

In evaluating the VHS-100, we used "Empire Of The Sun" as our test laserdisc. The sound offered by the VHS-100 is certainly not comparable to the impact of surround sound as

(Please turn to page 93)

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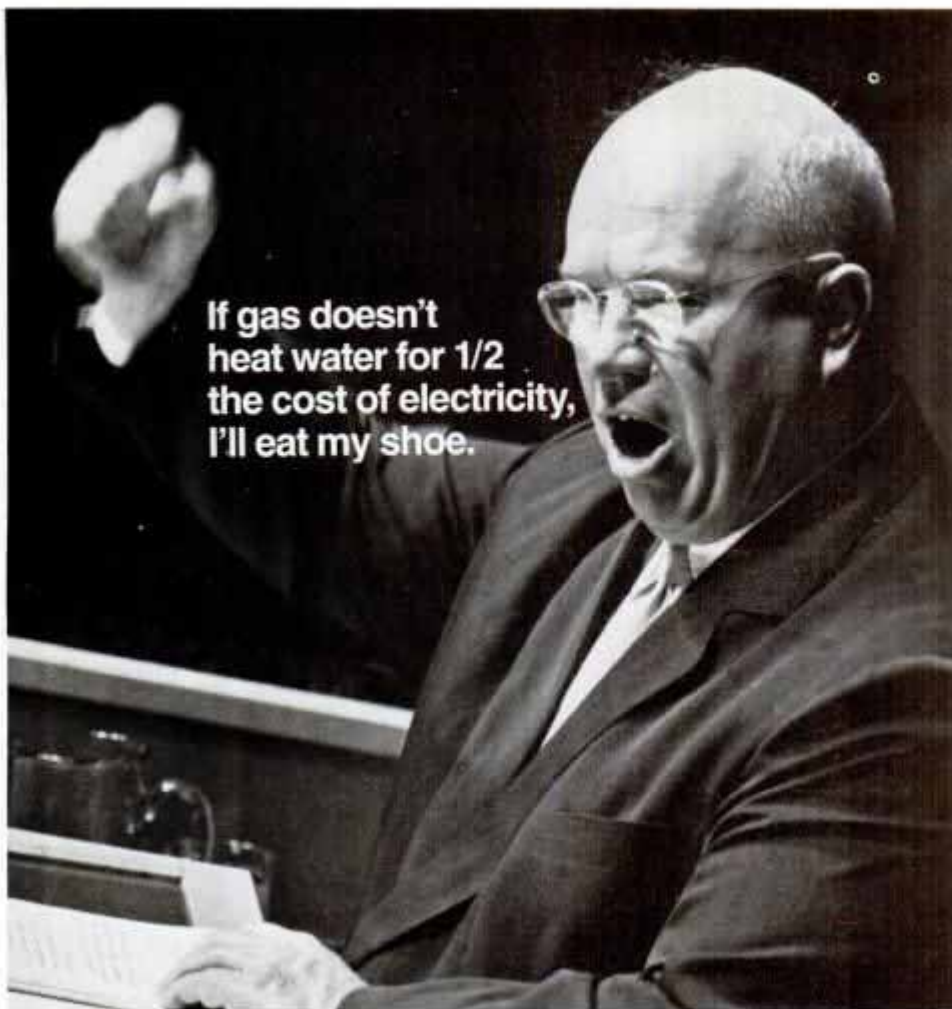
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If gas doesn't heat water for 1/2 the cost of electricity, I'll eat my shoe.

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THE HYDROGEN AGE

(Continued from page 23)

characterized by carboxylic (COOH) groups. To augment the effect, the carbon is dipped in a nickel nitrate solution in a process like that used to make catalytic converters for cars.

As with hydrides, charging and discharging the MACS material is a matter of altering temperatures and pressures. When hydrogen pressure is increased and temperature lowered, the gas is absorbed into the carbon. When temps rise and pressure is relieved, hydrogen is released.

Flying on hydrogen

As the technology for fueling cars with hydrogen matures, interest has also revived in the use of lightweight gas to power aircraft, which many believe to be the application that offers the greatest long-term potential. The most recent evidence of this belief was an agreement signed by the Soviet Union and West Germany's Deutsche Airbus at this year's Hannover Air Show, calling for the joint development of hydrogen propulsion technology for civilian aircraft.

Airbus had announced at the last Paris Air Show plans to convert one of its planes to liquid hydrogen. Tupolev

had already converted the right outboard engine of a Tu-154 trijet to liquid hydrogen, and had flown it in 1988. The companies now plan to undertake a joint feasibility study, then to develop a new aircraft for testing, followed by certification and trial operations in regularly scheduled short-range service. With an initial refueling depot in Hamburg and an operational radius of 500 nautical miles, the plane would be capable of round trips to such cities as Milan, Budapest, Warsaw, Stockholm, Oslo, Edinburgh and Paris.

In the U.S., Lockheed has shown the most interest among airframe manufacturers in investigating hydrogen power. In the 1970s, it proposed several configurations for aircraft that could use hydrogen for fuel. Most research has been in the area of giant freighters with greater payload and range than is now possible.

Hydrogen for electricity

Although it can be burned like gasoline in modified internal-combustion engines, hydrogen also offers another option that gives a far better yield. Used with a fuel cell-powered electric motor, hydrogen can produce motive force with efficiencies well over 50 percent. After years of refinement,

auto internal-combustion engines run at only about 17-percent efficiency.

Fuel cells convert hydrogen and oxygen into electricity and water, essentially reversing the electrolysis process that turns water into hydrogen. Like a storage battery, they consist of stacks of electrodes interleaved with layers of electrolyte. Hydrogen and oxygen are supplied through pores or capillaries in alternate electrodes. Hydrogen ions produced by reactions on one electrode pass through the electrolyte and react with oxygen atoms on the other. The result is an electric current through whatever is hooked up to the electrodes.

The process can be up to 90-percent efficient, but until recently, fuel cells were so big that they were only practical for large vehicles and stationary use. Over the past few years, however, improved designs, and a new solid polymer electrolyte manufactured by Dow Chemical, have made it possible to increase energy densities by at least a factor of four.

Fuel cells manufactured by Ballard Technologies of British Columbia have used the new electrolyte membrane to achieve power outputs as high as 5000 amps per square foot. Thus, where fuel cells were previously thought too bulky for use in buses, the new SPFCs are light and powerful enough to propel aircraft. Another advantage of fuel cells is that they can run on methanol, which could be distributed through the present gasoline infrastructure, and thus ease the transition to hydrogen.

A battle of technologies

The transition from fossil fuels to hydrogen will very likely conform to a pattern that has been played many times before. According to David Scott, professor of mechanical engineering at the University of Toronto, what fuel prevails in a given application depends on the quality of the technology that uses it, not on the intrinsic merits of the fuel itself. As an example, he cites the switch from steam to diesel locomotives after World War II. Diesel won out over coal not because it was cheaper or more readily available, but because diesel electric locomotives came along that were better than steam engines.

According to Scott, what is happening now is a change in technology similar to the introduction of the diesel locomotive. As was the case then, the transition will take decades. Equipment has to be replaced and a new infrastructure built. But advances made in the past few years are stepping up the quietly brewing battle between the technology of hydrogen and the technology of fossil fuel. **PM**

heard through standard speakers. In short, the VHS-100 did not make us say: "Wow!" The development of surround-sound headphones strikes us as a dubious achievement since headphone listening is essentially a "surround" experience by definition.

Camera Tube

What may at first look like a camcorder is actually a point-and-shoot camera made by Canon called the Photura. In an effort to introduce what Canon claims is a more sophisticated lens into the point-and-shoot camera category, the company found itself limited to what would be considered a large lens for this type of camera. The result is a camera you can operate with one hand.

A cue perhaps was taken from camcorders, and the resulting design is essentially a lens barrel with controls mounted on the rear and side. The size of the barrel allows Canon to offer a big zoom capability out to 105mm. This is the equivalent of a 3X zoom lens in camcorder terminology.

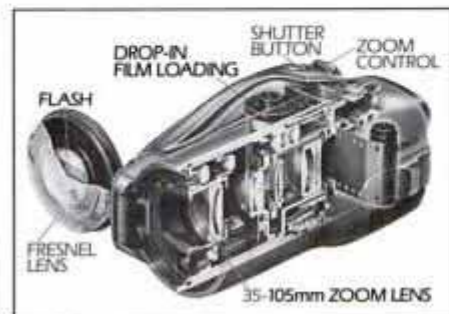
Linked to the zoom lens is the flash, which is cleverly positioned on the inside of the lens cap. A fresnel lens in front of the flash zooms in and out in synchronicity with the zoom lens. This way the light from the flash can be concentrated or diffused as required.

Another neat feature of the Photura is the drop-in loading of the film cartridge. Just drop the film into the slot at the top of the camera, close it up, and the camera does the rest.

The Photura offers a lot of additional features as well. For instance, there's both a straight-on viewfinder and a right-angle viewfinder for real low-angle shooting.

The camera also uses an automatic 3-point focusing system that qualifies as a fuzzy logic circuit when it needs to guess which object in the frame is the subject of the picture. This circuitry prevents out-of-focus pictures from occurring.

The Photura measures $3 \frac{15}{16} \times 2 \frac{7}{8} \times 6 \frac{1}{8}$ in. and weighs 21.3 ounces. List price is about \$500. **PM**



Cutaway illustration shows main features of Canon's new Photura 35mm camera.

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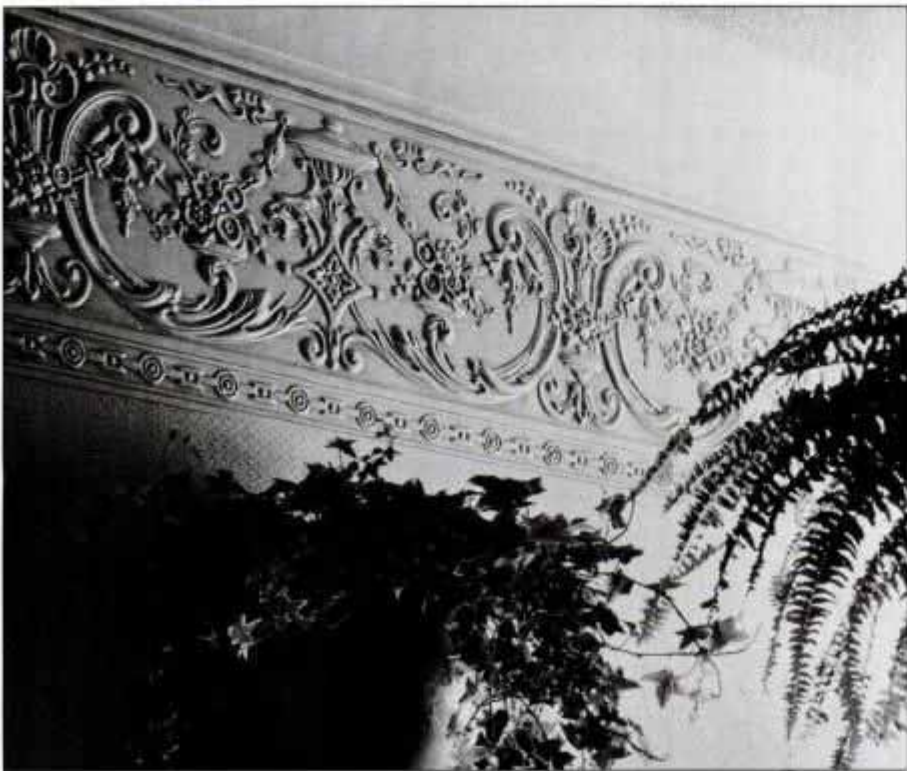
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OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



BENTLEY BROTHERS PHOTO

Embossed Wallcoverings

RECREATING THE sculpted beauty of yesterday's elegant embossed wallcoverings isn't difficult to do. Especially since two popular historical examples, Lincrusta and Anaglypta, are still manufactured.

Both are made almost the same way they were over 100 years ago, when they were used to provide texture and relief to walls, wainscots and ceilings. The variety of finishing techniques possible make Lincrusta and Anaglypta good choices for those looking for that special touch to authentically complement their period decor.

A brief look at the history of these embossed wallcoverings is a good place to start. Once you understand the differences, along with tips for successful hanging and finishing, you'll be in a good position to choose what's right for your old house.

All in the family

Lincrusta was invented in England, in 1877, by Frederick Walton. It's in-

teresting to note that Walton's father had invented linoleum 14 years earlier. So the similarities between the two products are no coincidence. Lincrusta can be considered a thinner, lighter version of linoleum which is, of course, embossed. It contains many of the same ingredients as linoleum, including linseed oil. One of the major differences between the two is the elimination of cork. Without it, the finer texture and embossed detail of Lincrusta are possible.

This heavy, 1/4-in.- to 1/2-in.-thick wallcovering is quite durable and impervious to water. Since the material actually gets harder with time, it's not unusual to find original old Lincrusta still functioning. (Unfortunately, the many layers of paint usually applied to the wallcovering over the years often eliminate its solid relief.) Historically, the tough nature of Lincrusta made it ideal for dining areas, stair-halls and wainscots.

For all of its good points, Lincrusta did have a few drawbacks. It was relatively expensive and difficult to hang on ceilings.

Embossed wallcoverings, like this Lincrusta frieze, can add dramatic flair to just about any room's decor.

About 10 years later, Anaglypta (now called Anaglypta SupaDurable) was created as a product that circumvented Lincrusta's shortcomings. Made from paper and cotton pulp, Anaglypta was flexible and resistant to wear. Although it wasn't as durable as Lincrusta, Anaglypta, with its hollow relief, was less expensive. The combination of its two main ingredients adds up to a strong, deep embossed design. It was the ideal material for friezes and ceilings, where its application often imitated more expensive plasterwork.

In the 1960s, a high-quality embossed wallcovering made from two sheets of bonded paper became available. Called Anaglypta Original, this lightweight paper is the modern cousin of Lincrusta and today's Anaglypta SupaDurable.

Finishing techniques

Unlike the wallcoverings we're most familiar with, Lincrusta and the different forms of Anaglypta are considered *white goods* and, as such, are meant to be painted. In their original state, they are most often an off-white color. There are several ways to finish the material, allowing you to create a look that's uniquely your own.

Perhaps the most popular way to treat embossed wallcoverings is to paint them a solid color. The detail stands out quite nicely, allowing the relief of the embossing to shine through. The main thing to remember is that you must use an oil-based paint for Lincrusta. The product has a linseed-oil base, so a latex paint won't adhere to it properly. When painting the paper-based Anaglypta SupaDurable and Anaglypta Original, the first coat must be a latex.

Another way to add some variety to these papers is to paint them with one color, then antique them with a thin stain. This is a popular way that was originally used many years ago to finish friezes and wainscot panels. After the light basecoat dries, it's painted over with a darker stain. The stain is wiped off, releasing an *antiquing* effect. Anytime you use a wood stain,

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

you must finish with a varnish coat to keep it from rubbing off.

Another old way to finish embossed wallcoverings is called rag rolling. After the basecoat is applied to the paper and allowed to dry, a second coat of a contrasting stain is applied to the first. While it's still wet, a rag that's been soaked in mineral spirits and wrung out is literally rolled in an irregular pattern down the paper. This gives the wallcovering a rag-rolled effect. Again, follow with a varnish coat to keep the stain intact.

It was also popular years ago to make these papers look like leather. This look is achieved by painting the paper with a background color, like burnt orange, then brushing on an oil-based wood stain that's quickly wiped off and followed with a varnish coat. The key to a successful job here is finding the base color that will simulate the type of leather you want. It may take some experimenting to find the right combination of base color and stain. It's best to practice on several scraps of paper that have been applied to cardboard until you find the results you're looking for.

Although it's relatively easy for many do-it-yourselfers to apply a special finish to small sections of embossed wallcoverings, like wainscots

and friezes, treating an entire wall is a different story. Since you must work in sections, it takes some skill to finish the wall so that it looks like one surface, not something done in pieces.

Hanging tips

As you can imagine, the thickness and weight of Lincrusta make it hard to manipulate and hang. If it's bent, it will break, especially in cold weather. Because of its thickness, it is an ideal wallcovering for concealing bad plaster. The material will hide all the hairline cracks and other imperfections of old walls.

Lincrusta is highly absorbent and, if it's not allowed to absorb enough water before it's hung, it will change its shape on the wall. Most experts recommend a good ½-hour soaking time, which entails sponging warm water on the back of the material, then allowing it to sit for 30 minutes before hanging. (As an added bonus, this soaking will make the Lincrusta more flexible.) If you don't allow enough soaking time, the material is likely to stretch on the wall, causing severe problems.

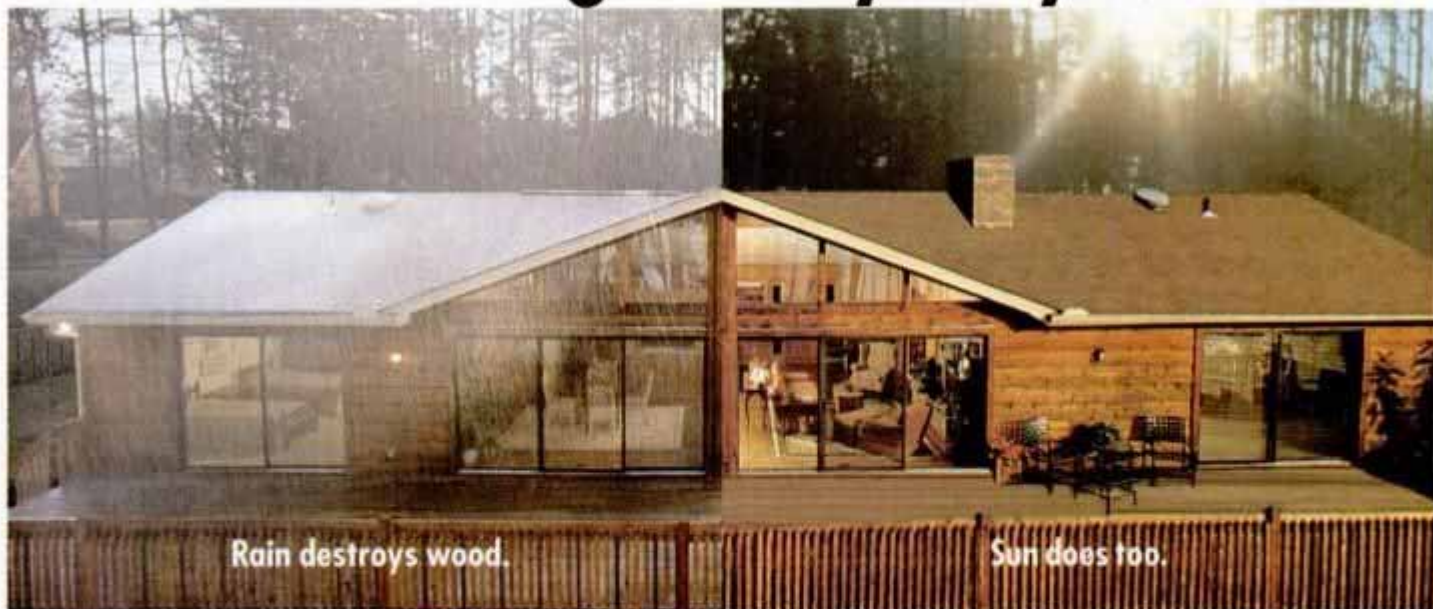
Anaglypta Original and Anaglypta SupaDurable also have an added soaking time, though it's not as long as that of Lincrusta, and involves

paste, not water. Letting the paste sit on the back of each sheet for at least 10 minutes is generally a sufficient amount of time to allow the paper to react to the moisture and reach its fully expanded width. If you don't do this, the material is likely to expand on the wall, causing major problems.

Although all three papers can be successfully hung by do-it-yourselfers, some are easier to work with than others. Lincrusta is probably the most time-consuming and difficult to install—the degree of difficulty depends on the pattern and installation location. Since the Anaglypta Original is much harder to hang than the SupaDurable, if you've never hung an embossed paper before, it's best to learn with the latter.

Finding embossed wallcoverings is relatively easy today. If your local wallpaper store doesn't carry them, two of the manufacturer's (Crown Berger Europe Limited, Darwen, Lancashire, England) authorized U.S. distributors can lead you to a dealer in your area. For more information and a list of local suppliers, contact: Bentley Brothers, 918 Baxter Ave., Louisville, KY 40204, (800) 824-4777; or Classic Ceilings, 902 E. Commonwealth, Fullerton, CA 92631, (800) 992-8700. **PM**

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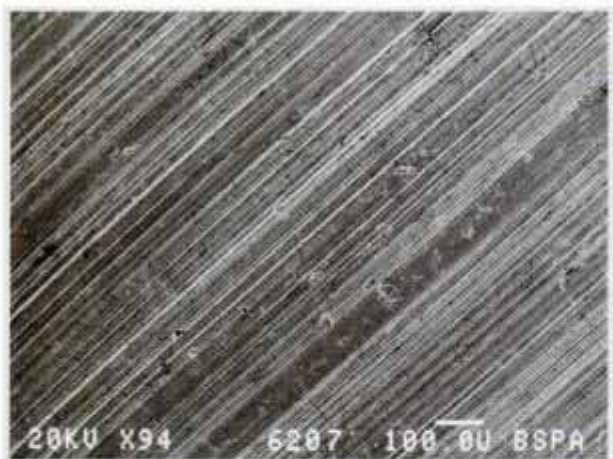
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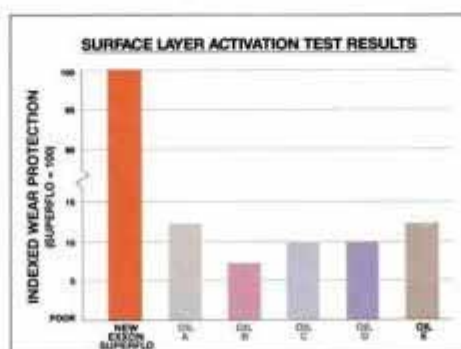


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AUDIO

BY FRANK VIZARD, Electronics Editor

A New Angle On Speakers

WHILE THE electronics end of home audio systems have improved by leaps and bounds over the past few years, speakers remain basically the same. Yes, there have been some notable improvements in sound quality, thanks to the use of better materials. However, the basic design of speakers has not changed. This doesn't mean that there isn't any tinkering.

Most popularly priced speakers utilize one of two basic approaches. Acoustic suspension speakers were invented by Harry Olsen of RCA and first commercialized by Acoustic Research (AR) in 1954. In an acoustic suspension speaker, the box behind the woofer cone is sealed. The springiness of the trapped air inside the box is the major contributor to the woofer's motion. By using this design, good bass can be extracted from relatively small enclosures. While sound quality is generally very good, some critics say acoustic suspension speakers lack a real bass punch.

Bass reflex speakers, on the other hand, were popularized in the 1930s. Bass reflex describes a speaker that has a port or vent in the cabinet. While bass reflex speakers can offer

more kick at the bottom end, they can also sound boomy.

Now, MB Quart, a German loudspeaker maker, is offering a speaker that is neither opened nor closed. The key element in MB Quart's Moving Control System (MCS) is positioned to the right of the tweeter in the accompanying photograph (right). At first glance, it looks like a port or vent with a grille cover across its mouth.

What MB Quart attempts to do here is produce a lot of cone movement in the woofer for deeper bass. There are two tubes behind the vent. The larger tube makes the speaker act like a bass reflex speaker, while the smaller tempers the tendency toward distortion by providing the woofer with extra air. The extra air allows the woofer to move more quickly and accurately. The smaller tube is tuned to frequencies as low as 10 Hertz, so it only affects the reproduction of low bass notes. The idea is to capture the best characteristics of both an acoustic suspension speaker and a bass reflex speaker.

A big sound

To some degree, MB Quart appears to have succeeded. Comparing pre-MCS models to MB Quart's new line, the MCS speakers seemed to add a sense of spaciousness and height to music. But this effect was more pronounced with airy classical music than it was with rock-and-roll.

MCS also seemed more effective with the larger MB Quart speakers. The benefits of MCS in bookshelf-sized speakers were not very apparent. The added bass response attributed to MCS did not compensate for the small size of the woofer.

In downtown Brooklyn, meanwhile, Ohm Acoustics continues to experiment with sound distribution. Ohm's new line of FRS speakers differs from conventional speakers in the positioning of the tweeters. The FRS tweeter is mounted into one corner of the speaker cabinet and fires upward at a 45° angle. Treble notes, therefore, reflect off ceiling to your ears.

By adopting this tweeter/woofer configuration, Ohm is attempting to



widen the "sweet spot" where the right and left channels meet to create the stereo effect. The effect, says Ohm, is comparable to the difference between a floodlight and a spotlight.

Ohm is also introducing its own home theater audio system. The anchor is a subwoofer/center-channel speaker that also doubles as a video monitor stand. Different models are available, depending upon the size of the video monitor you plan to use. Satellite speakers, 7 in. tall, are available for front and rear channels. Cost ranges between \$850 and \$1200. **PM**



Ohm's tweeters fire upward.

Sinead O'Connor:
I Do Not Want What
I Haven't Got 33512

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Unbroken, Vol. 2
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(Capitol) 64305

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(RCA) 01112

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Time (RCA) 01027

Jane Child
(Warner Bros.) 60204

Rod Stewart's: Greatest
Hits (Warner Bros.) 33779

The Glenn Miller Orch.:
In The Digital Mood
(GRP) 43293

Great Love Songs Of The
'50s & '60s, Vol. 1
(Laurie) 20768

Lionel Richie: The Com-
poser (Motown) 24700

k.d. lang: Absolute Torch
And Twang (Sire) 60257

Kathy Mattea:
Willow In The Wind
(Mercury) 60075

Whitesnake: Slip Of The
Tongue (Geffen) 01147

The Cure: Disintegration
(Elektra) 01109

Hank Williams, Jr.: Lone
Wolf (Warner Bros.) 64311

Quincy Jones:
Back On The Block
(Warner Bros.) 64116

Mötley Crüe: Dr.
Fetters (Elektra) 33928

Restless Heart: Fast
Movin' Train (RCA) 10802

Cher: Heart Of Stone
(Geffen) 42874

Stanley Jordan: Cornu-
copia (Blue Note) 73847

Kentucky Headhunters:
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(Mercury) 24740

Lad Zepplin IV (Runes)
(Atlantic) 12014

Dion & The Belmonts:
The Wanderer (18 Hits)
(Laurie) 00999

D.J. Jazzy Jeff & The
Fresh Prince: And In
This Corner (Jive) 01020

Duke Ellington w/Erich
Kunzel & Cincinnati
Orch.: Orchestral Works
(MCA) 53780

Scorpions: Best Of
Rockers 'N' Ballads
(Mercury) 63492

The Moody Blues:
Greatest Hits
(Threshold) 34284

Elvis Presley: 18 Number
One Hits (RCA) 72190

Eric Clapton: Journey-
man (Warner Bros.) 53940

Skid Row (Atlantic) 01038

Alice Cooper: Greatest
Hits (Warner Bros.) 70296

Norrington: Beethoven,
Symph. No. 9
(Angel) 00467

Def Leppard: Hysteria
(Mercury) 00927

Earl Thomas Conley:
Greatest Hits, Vol. 2
(RCA) 53713

Allman Brothers: Eat A
Peach (Polydor) 63353

Billy Idol: Charmed Life
(Chrysalis) 62264

Taylor Dayne: Can't
Fight Fate (Arista) 01114

Peter Murphy: Deep
(RCA) 44638

Enuff Z' Nuff
(ATCO) 64257

Keith Whitley: I Wonder
Do You Think Of Me
(RCA) 33768

Horowitz At Home
(DG) 25211

Chicago: Greatest Hits
1982-1989 (Reprise) 63363

Gun: Taking On The
World (A&M) 82473

Fine Young Cannibals:
The Raw And The
Cooked (I.R.S.) 01068

Roxette: Look Sharp!
(EMI) 01106

Tanya Tucker: Greatest
Hits (Capitol) 53968

Kitaro: The Kojiki
(Record Of Ancient
Matters) (Geffen) 43758

Alabama: Greatest
Hits (RCA) 20247

Phil Collins: No
Jacket Required
(Atlantic) 20771

Don Henley:
The End Of The
Innocence
(Geffen) 01064

Dirty Dancing/
Sdtk (RCA) 82522

Original Sdtk: The
Fabulous Baker
Boys (GRP) 44637

Milli Vanilli: Girl
You Know It's True
(Arista) 01048

Guns N' Roses:
Appetite For
Destruction
(Geffen) 70348

Sawyer Brown:
The Boys Are Back
(Capitol) 44657

Linda Ronstadt: Cry Like
A Rainstorm, How Like
The Wind (Elektra) 52221

Richard Marx: Repeat
Offender (EMI) 01118

Bruce Hornsby & The
Range: A Night On The
Town (RCA) 83689

Great Hits Of Eddie
Rabbitt (RCA) 73786

Bobby Brown: Dancel...
ya know it! (MCA) 73660

Beat Of The Doobie
Brothers
(Warner Bros.) 43738

Big Band Bash
(21 Swing Era Classics)
(Compos) 10458

Dan Seals: On Arrival
(Capitol) 63634

The Church: Gold After-
noon Fix (Arista) 71667

Tears For Fears:
The Seeds Of Love
(Fontana) 33653

Bon Jovi: New Jersey
(Mercury) 00516

Aerosmith: Pump
(Geffen) 63678

Technronic: Pump Up
The Jam-The Album
(SBK) 34781

Tommy Page: Paintings
In My Mind (Sire) 60184

Lisa Stansfield: Affection
(Arista) 34198

James Gayaway: Greatest
Hits (RCA) 73233

Madonna: Like A Prayer
(Sire) 01029

Dolly Parton,
Linda Ronstadt,
Emmylou Harris: Trio
(Warner Bros.) 14804

They Might Be Giants:
Flood (Elektra) 14772

Slaughter: Stick It To Ya
(Chrysalis) 42308

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Controversy
(Geffen) 00839

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OUTDOORS

BY JOE SKORUPA, Boating/Outdoors Editor



Great Gadgets And Gizmos

IT LOOKS LIKE an aired-out hydroplane just seconds before kiting skyward and back flipping into a somersaulting crash. But it's supposed to look this way as it thunders across the water in perfect control. This is Zytiron, a high-speed hydrofoil. It's designed to ride high to clear waves. Yet it maintains three points of contact below the surface. Currently, Zytiron is a 5-ft.-long, radio-controlled model, but it will soon be a 29-ft., 200-mph firebreather.

Breakthrough product design, like Zytiron, is a rare commodity. There's no shortage of ideas. The problem is that they rarely work, at least outside highly controlled conditions. For me, the only sure-fire way to prove a new product works is to give it to Bubba. You know Bubba. He's the guy who won't read owner's manuals and accidentally leaves everything out in the rain. He finds every limitation, exceeds every tolerance, plays with a piece of high-tech equipment like a kid and, basically, enjoys the hell out of it. If it passes the Bubba test, well, now we're onto something.

Starting small

Zytiron is named after a medieval terror of the sea. While the full-blown beast isn't ready for Bubba yet, the model deserves attention.

The boat was designed by Kenneth

E. Cook, of Lake Worth, Florida. Cook employs three hydrofoils—two forward, which are set on wings, and one aft near the prop. These hydrofoils are designed to operate at supercavitating speeds (above 60 mph) and go *through* the water. Standard hydroplanes also have three points of contact, but the forward two skip on the water's surface and the hull rides on a slip-stream of air.

The most interesting elements of Zytiron's design are three shock-mounted pivot points that act as a self-stabilizing suspension system. They're located in each wing and near the midpoint of the fuselage.

The wings pivot independently for side-to-side stabilization. The midsection pivots to stabilize the speedster front to rear. In addition to the shock-absorber movement, all pivot points can be manually controlled. This enables the craft to adjust the hull-to-water distance, for wave clearance, and to change the angle of attack for control of pitch.

This space-age water toy was designed by Cook to be a prototype for a full-size race boat. Until he gets the 29-footer built, Cook is making available kits of the 5-ft. model. The unpainted hull is made of carbon fiber, epoxy, urethane foam and Kevlar. Each kit includes an 80-cu.-in. to 90-cu.-in. engine, Lexan canopy, radio

and all hardware. These high-quality, limited-production models aren't cheap and aren't for inexperienced model builders. Current price begins at \$2500. Write to Cook at Hydrofoils, Inc., P.O. Box 6006, Lake Worth, FL 33466, or call (407) 964-6399.

Bike suspender

If you're a fanatic, a bike is a marvel of high-tech, high-speed wizardry. If you're not, a bike is something simpler. Materials have changed. Gear and brake systems have evolved. But, basically, a bike is still a bike.

Enter the Allsoft *Soft Ride*. As one rider observed, the *Soft Ride* looks like a bicycle seat cantilevered on the end of a giant moose tongue. What it does is act like a shock absorbing system to smooth out bumps and reduce body fatigue.

The moose tongue (support beam) component of the *Soft Ride* consists of two S-shaped, foam-filled fiberglass pieces separated by a layer of rubber-composite material. The S-sections move in slightly different ways as the beam moves up and down. The composite layer absorbs energy created by the shearing motion. By damping some of the motion, the beam acts less like a springboard and more like a suspension system.

The front, frame-mounted end of the beam is fastened to a strut system that spreads the load created by the

(Please turn to page 104)

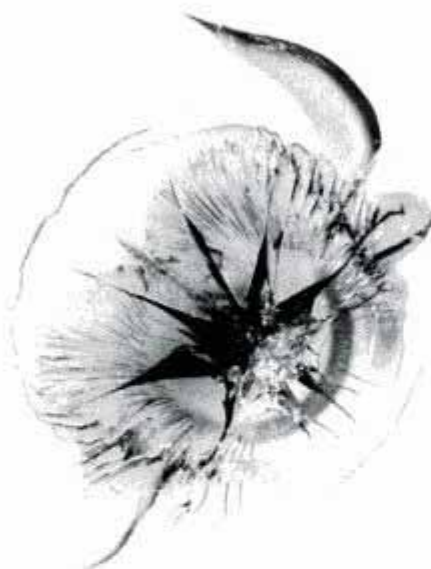
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cantilevered seat. Once mounted, the normal seat post becomes irrelevant. The entire unit adds only about 18 ounces to the bike.

Benefits of the Soft Ride are twofold: 1. reducing rider stress by effortlessly gobbling up bumps on rough terrain and, 2. allowing the rider to devote all attention and energy to propul-

sion. The Soft Ride system is offered in two models, the Pro (125 pounds per inch spring rate) and the Combi (90 pounds per inch spring rate). Both add-on units have a suggested retail of \$189. Weekend warriors interested in the Soft Ride can write to Allsop at 4201 Meridian, Bellingham, WA 98227, or call (800) 426-4303.

Shooting stars

Target shooting enters the space age with two devices that use beams of infrared light instead of bullets.

The first is the **Quick Skill** target shooting system from Daisy, which takes a unique approach to target shooting. Instead of creating a light-transmitting gun, Daisy developed infrared-transmitting bullets. This method enables firearms owners to practice handling their own pistols by replacing live ammo with battery-powered cartridges. They're available in .38, .357, .44 and .45 calibers.

When struck by a firing pin, the special cartridge fires a bullet of infrared light at a special receiver placed up to 20 ft. away. The target flashes red when a hit is scored. An audio response can also be selected.

Quick Skill battery-powered targets cost about \$40. Cartridges, which come six in a box, cost about \$60. Batteries are replaceable in both components. Write to Daisy Manufacturing Co., P.O. Box 220, Rogers, AR 72756, or call (501) 636-1200.

The second infrared targeting system is for shotguns and simulates clay pigeon shooting. Developed by **Laser Sporting**, from England, it uses standard over and under 12-gauge bore shotguns modified to shoot infrared pulses. These pulses spread at the same rate as standard shells.

Special clays are launched from conventional traps. Hits are reflected back to the shooter and running tallies are posted electronically on a digital scoreboard. Sound simulation creates bangs and hits. Up to five shooters can take aim at a single clay.

While the system isn't overly com-



Where's the seat post? It's not needed with the Allsop Soft Ride.

plex, it requires highly specialized electronic equipment. Consequently, it's expensive. Prices range from \$20,000 to \$30,000, depending on the number of guns per unit. Currently, there are 70 operating sites in Great Britain. The first in the United States is scheduled to open in New Orleans. Write to Laser Sporting Leisure U.S.A., P.O. Box 323, Georges Mills, NH 03751, or call (603) 763-3066.

Back to bikes

Mountain bikes have been on a roll for the past decade, and now, with the introduction of a 3-spoke composite wheel from **Specialized**, they'll be moving ahead faster. The triple-spoke wheel, developed jointly with DuPont's Advanced Composites Division, is designed to achieve superior aerodynamics at cycling speeds of 25 mph to 35 mph. Wind tunnel tests by DuPont show that compared to conventional 36-spoke wheels, the Specialized wheel can save about 10 minutes in a 100-mile time trial.

The wheel's main body is made of carbon fiber, Kevlar and glass fibers. The rim is made of aluminum. It weighs about 2.6 pounds. The price is expected to reduce as demand increases, but right now, it's around \$750. Contact Specialized at 15130 Concord Circle, Morgan Hill, CA 95037, or call (408) 779-6229.

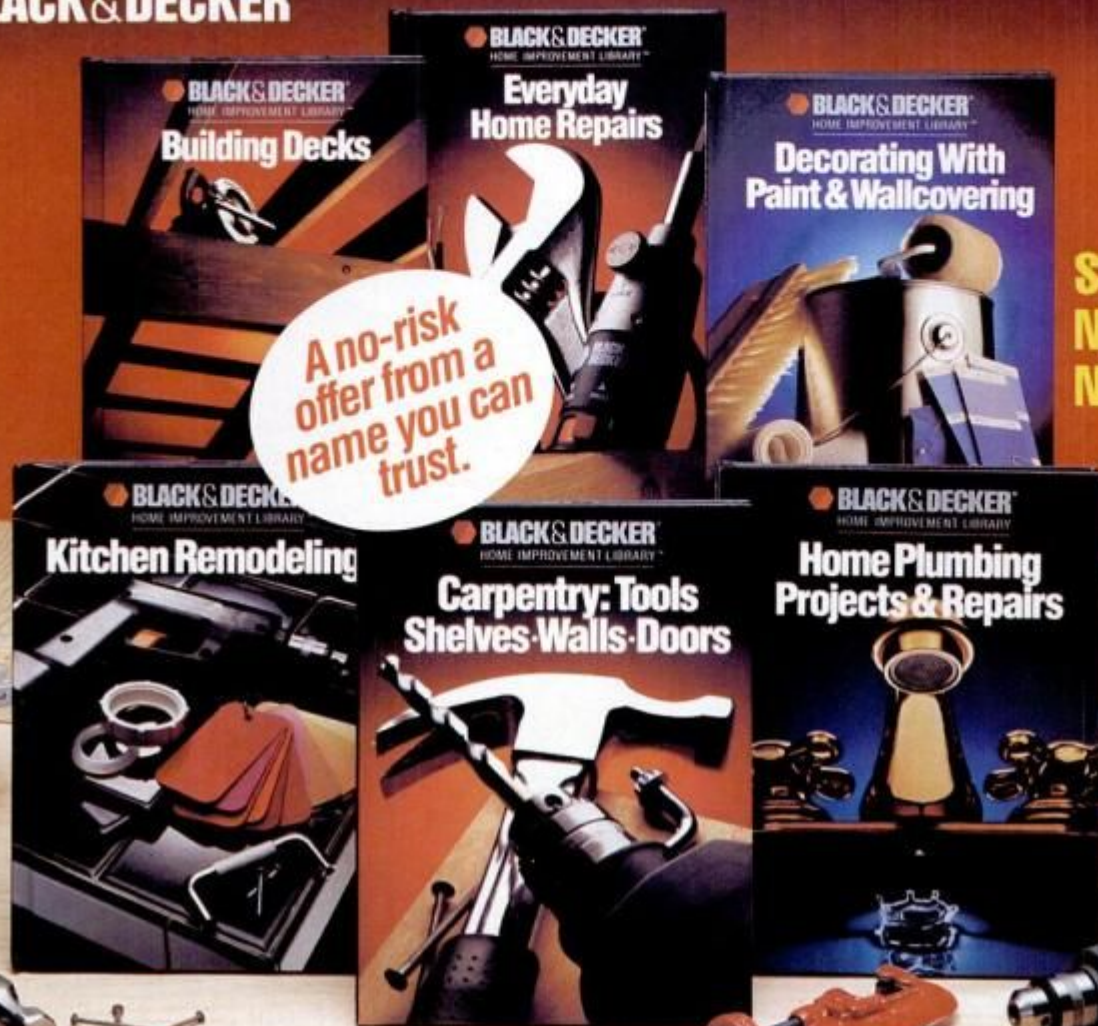
Finally, one of the oldest continuously produced models in boating, the **Grumman** aluminum canoe, gets an upgrade. Canoe paddlers can now harness the wind with the introduction of a new add-on sail kit. The 34-sq.-ft. sail is designed to draw the wind in at the canoe's low center of gravity. The mast is aluminum, the boom is fiberglass and the leeboard is mahogany. The rudder employs a rope tiller system. Minimal drilling is required. Price is \$750. Write Grumman Boats, P.O. Box 549, Marathon, NY 13803, or call (607) 849-3211.

The innovative products noted above are all ready for the infamous Bubba test.

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DRIVE REPORT

BY TONY SWAN, Automotive Editor



Acura's NSX Challenges The Elite

THANKS TO A string of successes dating back to the stratified charge Civic, we've been conditioned to bring a set of high expectations to every new vehicle introduction staged by the Honda Motor Co. And when the car is one that's generated as much anticipation as the new mid-engined Acura NSX sports car, those expectations are high indeed.

But after returning from our first hands-on encounter, we're inclined to think our expectations weren't quite high enough. We expected all-around excellence. What we experienced was a car that seems certain to become a milestone in sports car design.

VTEC V6 engine

The success or failure of any sports car begins with its engine. Honda has long distinguished itself in this area, particularly with its recent domination of Formula One racing. The NSX 3.0-liter dohc 24-valve VTEC V6 can be regarded as a brilliant distillation of Honda's racing knowhow—compe-

tion potent without any of the quirks or harshness that afflict some performance engines.

Construction is all aluminum, with different alloys for block and heads. Honda chose a 90° layout, partly for packaging considerations, with a strongly oversquare short-stroke design—90-mm bore, 78-mm stroke. Combustion chambers are classic Honda pentroof, and, a reminder of Honda's racing heritage, the connecting rods are titanium.

With the exception of the titanium con rods, so far we're talking mere state of the art. But there's more. The VTEC V6 employs a modified version of the Variable Volume Induction System used in the Legend V6, a dual-intake setup designed to improve low-end response and boost high-rpm hp.

The port fuel injection is also similar to the Legend V6, and each of the platinum-tipped spark plugs is topped by its own ignition coil, another reminder of Formula One.

Finally, there's VTEC, for Variable Valve Timing and Lift Electronic Control System. Variable valve timing is achieved by extra cam lobes—three lobes for a set of valves, rather than two. The third lobe, dormant at low-speed, kicks in when the system's computer signals a spool valve to deliver more oil pressure to the triple



NSX combines race car handling with supple ride quality.

rocker arms, locking them together and bringing the third lobe into play to produce more lift and duration.

The VTEC effect is imperceptible, but its potency is undeniable with prodigious horsepower for this displacement: 270 hp at 7100 rpm. And it's as smooth as an electric motor.

Chassis

The most remarkable thing about the underpinnings of the NSX is how straightforward they are. No variable spring rates. No cockpit-adjustable shocks. No rear-wheel steering.

The layout is essentially racing car practice adapted for comfort as well as superb handling: upper and lower control arms front and rear, coil springs, gas shocks and antiroll bars at both ends. The rear suspension has an extra lateral link, and the front control arms mount to a compliance pivot designed to control toe change.

Like every other structural element in the car, the suspension consists of aluminum castings and forgings, bolted to aluminum subframes. Honda set out to achieve high rigidity and low weight (3010 pounds), which pays off with world-class handling.

Braking, bolstered by a 4-channel antilock system, is absolutely first-rate. Honda uses big 11.1-in. rotors at both ends of the car, and the pad material was developed for hard use.

The basic transmission is a 5-speed, and a 4-speed automatic is optional. Both transaxles are equipped with limited slip, plus a new traction control system activated by the brake system sensors (there's also an ON/OFF switch on the dashboard). Steering is variable ratio rack and pinion, with a slick new variable-assist power rack for automatic models.

The wheels—15 in. front, 16 in. rear—are forged aluminum alloy mated to specially developed Yokohama A022 tires (205/50ZR-15 front, 225/50ZR-16 rear).

The car

Clad in aluminum body panels, the NSX has the general look of a miniature IMSA GTP prototype car, with a short nose, distinct passenger canopy and longish tail. The look was inspired partly by some current Ferraris, and, according to its designers, partly by the F-16 fighter. Coefficient of drag (Cd) is 0.32 and lift coefficient is 0.05.

We have yet to see how the car behaves at top speed—160 mph—but it's a model of stability in the 130-mph range, and remarkably quiet.

Honda chose the canopy design to optimize visibility, which is exemplary. And the interior, upholstered in leather, is what we've come to expect

of Honda—everything well-placed, with plenty of leg- and headroom. About the only criticism is that computer gear behind the rightside fire-wall intrudes on the passenger foot-space.

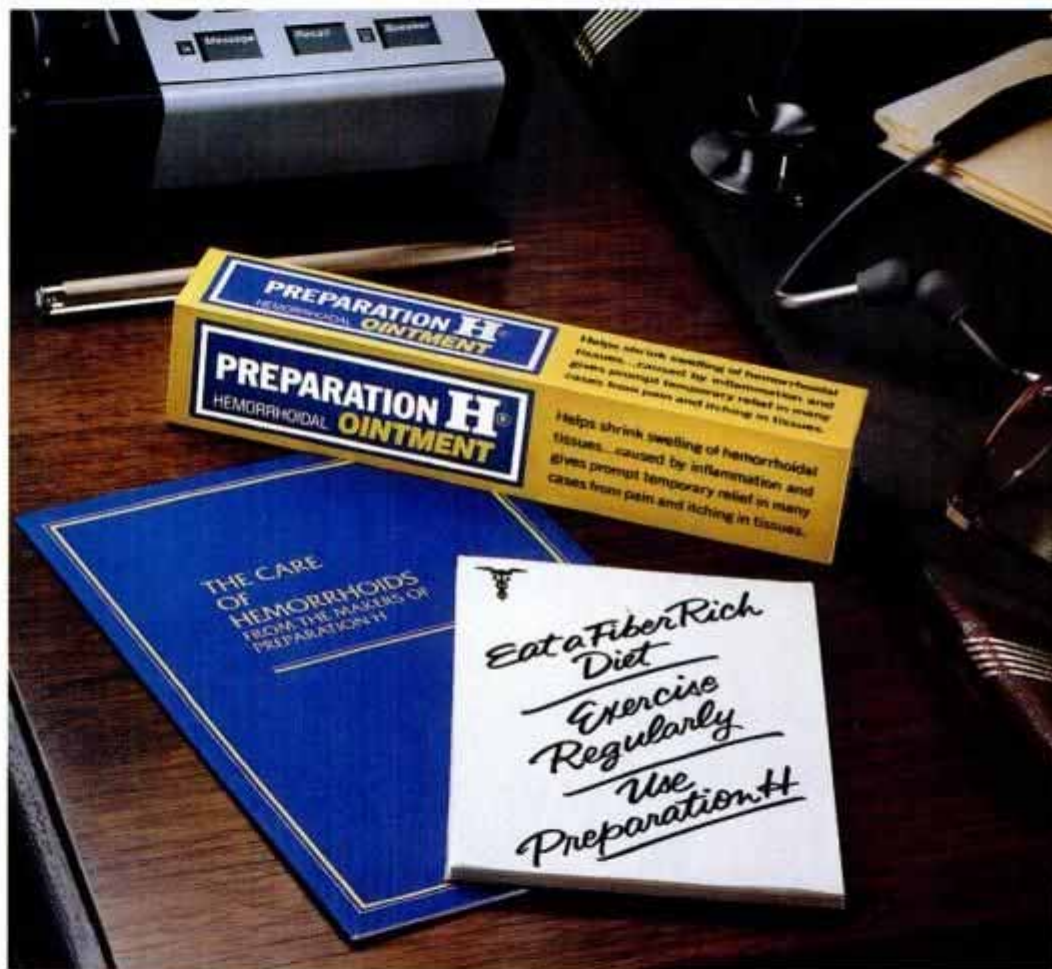
NSX at speed

A day with the NSX at Laguna Seca Raceway, near Monterey, California, and a day on nearby highways left an impression of near perfection with everyone who drove this superb sports car. Honda assembled a few competitive cars—a Nissan 300ZX Turbo, Ferrari 328 and Corvette convertible

—for comparison, and the consensus was that there was no comparison.

Of course, we intend to explore the issue of comparisons more extensively in a later issue. But for now, we see the NSX as one of those rare cars that improves the capabilities of anyone who straps it on.

There are cars in this price range that are faster, and equally capable at their limits—the ZR-1 Corvette, for example. But we can't think of one that combines civilized driving with race car performance more effectively. In that sense, the Acura NSX stands alone. **PM**



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*We're talking about the 1989/1990 J.D. Power and Associates Light Duty Truck Customer Satisfaction With Product Quality & Dealer ServiceSM Surveys ('88/'89 models). **We're also talking comparisons of comparable regular cab 4x2 models, here. Please buckle up for safety. And thanks for reading the fine print.

REPAIRING PLASTIC BODY PANELS

BY JOHN DECKER

YOU'RE BACKING OUT of the garage one morning after a late night at the bowling alley. Your mind is on that last 7-10 split, while your right foot eases on the throttle. But after a few feet, all motion to the rear ceases. Hmmm. What gives?

Uh-oh. Number-two son's MX bike has managed to move itself across the garage and directly into your flight path. ("Honest, Dad—I left it in the bike rack!") And the steel handlebars have punched a hole right through the side of your car's fender.

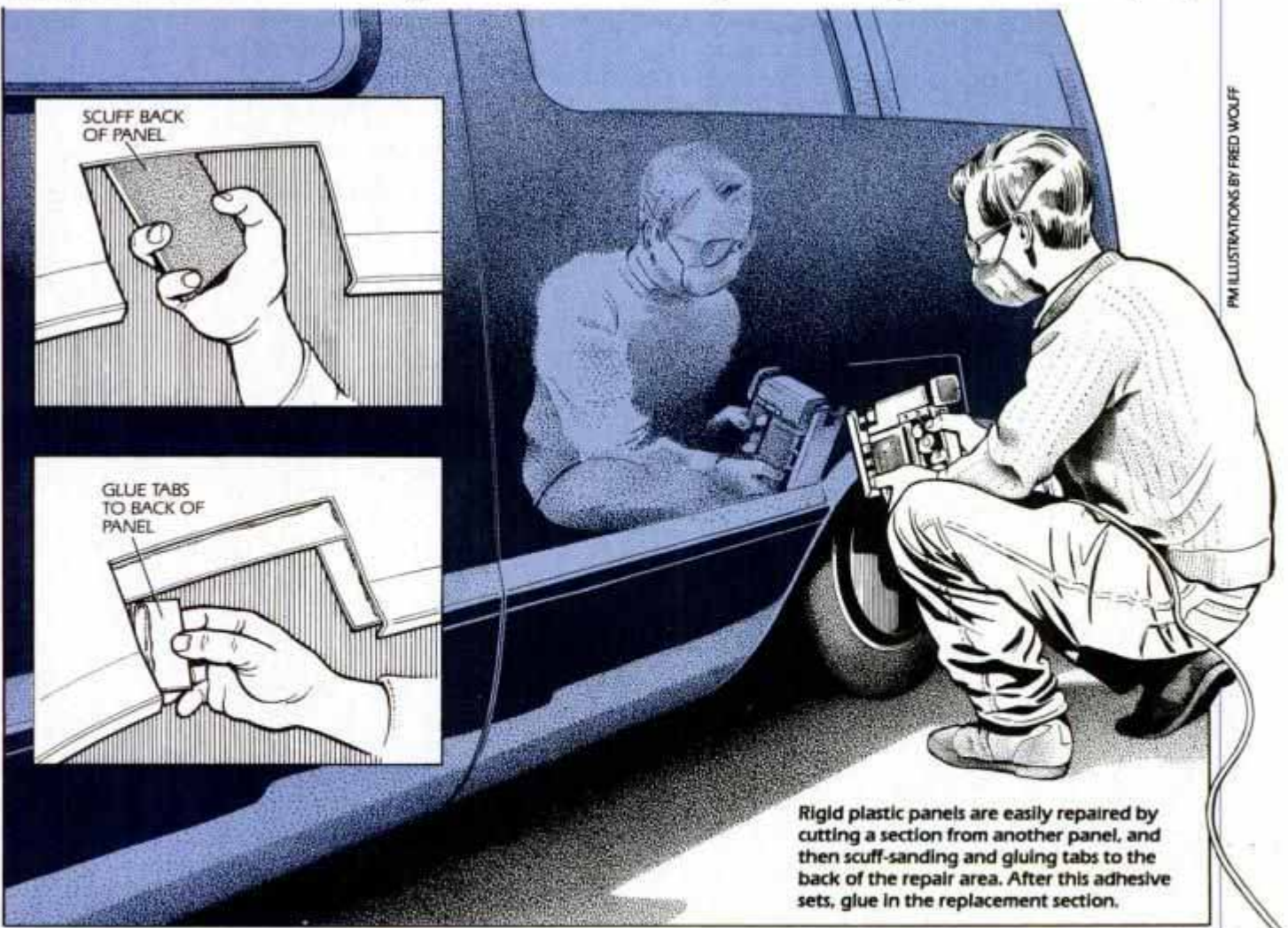
Hole? Not a dent, but a nasty ragged hole in the metal. Wait, it's not metal—it's *plastic*! There are lots of little fibers hanging out of the hole, and there's no evidence of the panel being bent—just the hole.

You already know how to repair a hole in a metal fender—screwing, riveting or, better yet, welding a patch over the hole, carefully dollying and hammering the metal back to its original contour. Add a little filler, and number-two son won't have to remain grounded until he starts college. But

plastic? How do you weld that?

If this seems like a scenario from "Back To The Future," look again. There are plenty of at least partially plastic cars out there. The aerodynamic noses on cars like the Chevy Beretta, Toyota Celica and GEO Storm are made of flexible plastic. In fact, it's getting harder and harder to find a modern car that doesn't have flexible plastic panels, at least for the front and rear fascias or bumpers.

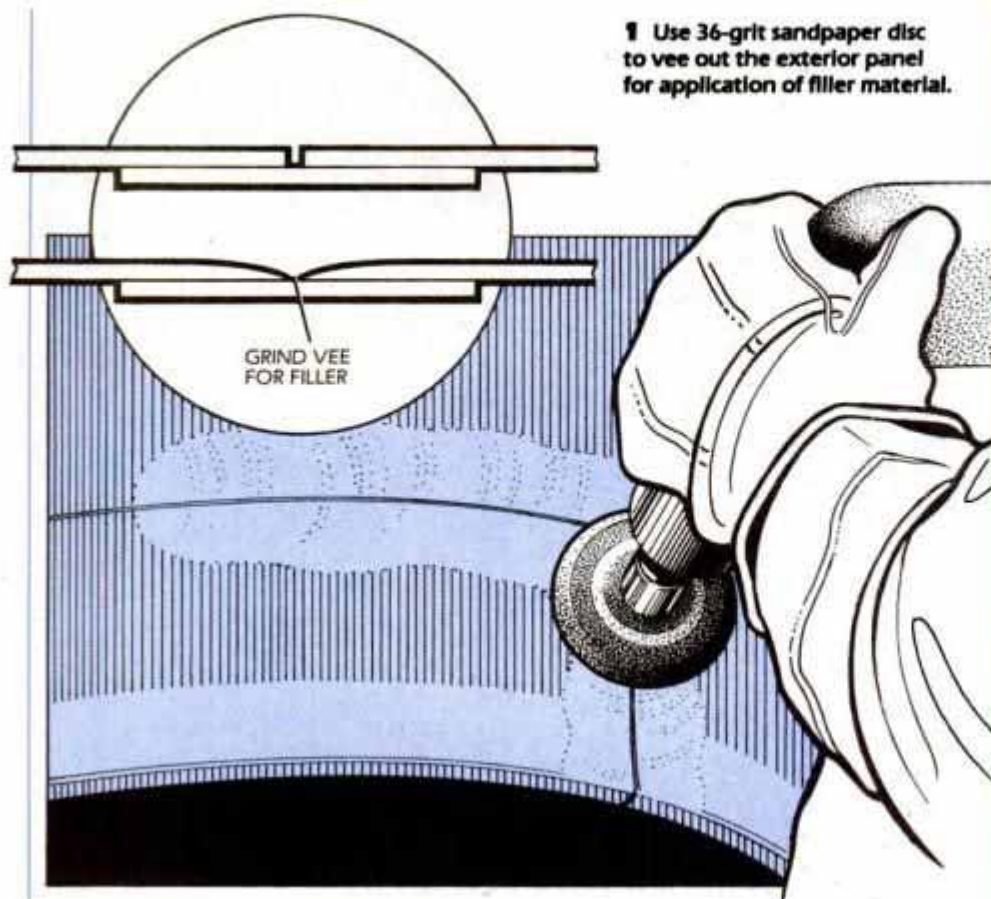
You'll find rigid plastic makes up the tailgate on late-model Jeep Wag-



PH ILLUSTRATIONS BY FRED WOLFF

Rigid plastic panels are easily repaired by cutting a section from another panel, and then scuff-sanding and gluing tabs to the back of the repair area. After this adhesive sets, glue in the replacement section.

1 Use 36-grit sandpaper disc to vee out the exterior panel for application of filler material.



oneers and on both the hood and tailgate of the Ford Aerostar.

There are also several totally plastic-bodied cars out there. General Motors' GM200 minivan (Chevy Lumina APV, Pontiac Trans Sport and Olds Silhouette) has an entire body made of rigid plastic panels. The panels are glued to a steel cage welded up from

sheetmetal stampings, and the whole structure provides strength that is equal to that of a similar all-steel design. Remember the Fiero? It used both rigid and flexible panels, although they weren't structural parts of the car, but were merely bolted-on. In theory, you could drive a Fiero around without its skin, something

that's not true of the newer plastic-bodied minivans.

The repair techniques are the same whether the panel is structural or not—although you might consider how good a job you're doing in light of whether the panel represents merely a cosmetic face or is an integral part of the car's structure.

So how do you fix plastic body parts? Throw away your hammer and dolly. You can't beat this stuff back into shape. But thanks to several new products, repairing both rigid and flexible plastic parts is fairly easy. And figuring out where the plastic body parts are on your car is no more difficult than grabbing a magnet from your refrigerator. If it doesn't stick to the car, you've found plastic.

Rigid plastic repairs

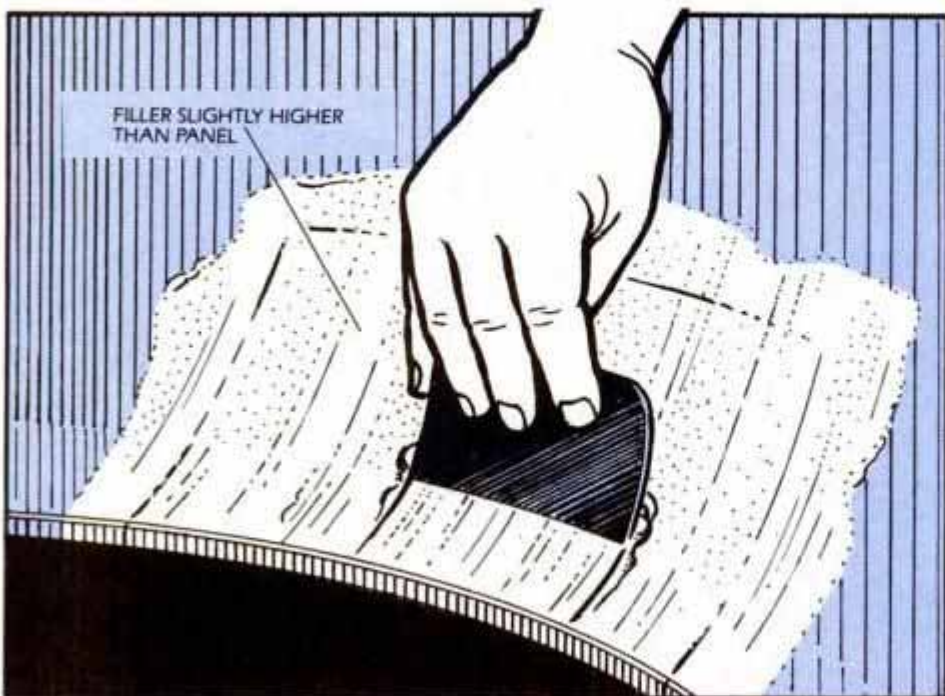
Rigid plastic body panels are hardly a new idea. The 1953 Corvette was made of fiberglass, and Corvette bodybuilding didn't change much until 1984 when Chevrolet switched the Corvette to a new plastic material that's called sheet molding compound (SMC). Now, SMC is the plastic of choice when carmakers build rigid plastic body panels.

Like fiberglass, SMC is impregnated with glass fibers for structural strength. However, fiberglass is laid or sprayed into a mold and cured by a catalyst additive. Fiberglass repair is a completely different topic. We're not going to discuss fiberglass repair here at all, as the techniques and materials are completely different.

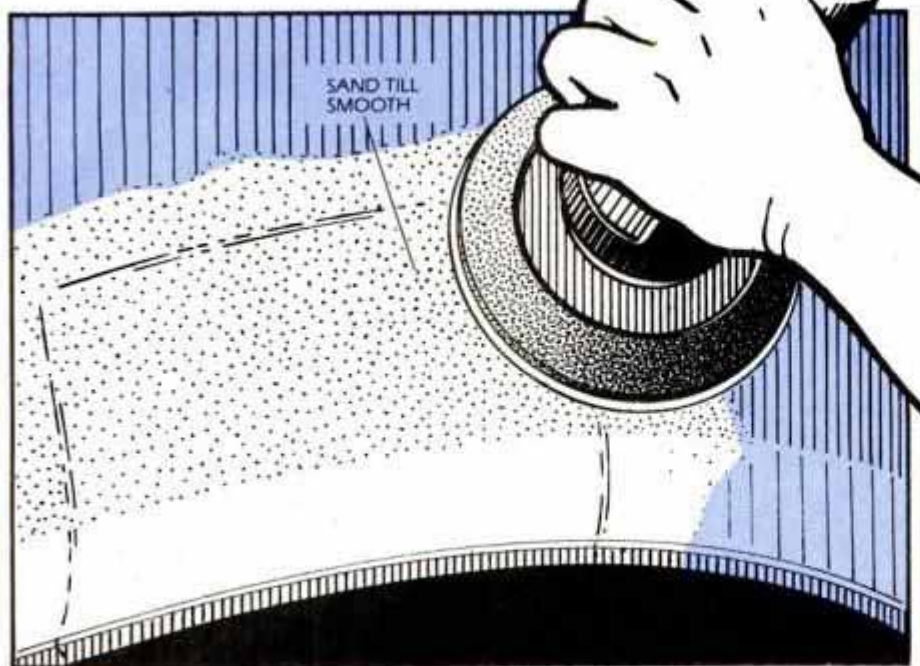
Sheet molding compound, on the other hand, is made up of two preformed, partially cured plastic sheets. Glass fibers and resins are sandwiched in between, and the whole affair is pressed into shape in male and female molds before the SMC is heat cured. The result is a plastic body panel that's quicker to make, smooth on both sides, and dimensionally accurate. More importantly, the side that shows has a better surface finish than fiberglass.

In an accident, an SMC panel retains its shape—until it's hit hard enough to gouge, rip, tear or crack. Then the undamaged portion of the panel will spring back into shape by itself.

Devcon makes an epoxy filler designed for consumer use. It's good for repairing minor gouges and scratches in both SMC plastic and fiberglass. It's available at auto parts stores. To use it, grind out the damaged area with a coarse sanding disc, then scrub



2 Spread the filler material slightly higher than the surrounding plastic panel. Allow the filler to cure completely before sanding.



3 Block-sand filler for proper contours, and feather-edge back into the original panel. Then use plastic primer and finish-paint the area to match.

the area with Plexus cleaner or lacquer thinner. Next, mix equal parts of A and B until it reaches a uniform gray color.

Fill the damaged area so it's slightly higher than the surrounding body. The filler hardens in about a half-hour. Once hard, sand the area with 180-grit paper to level the repair and achieve a smooth contour. If there are any pinholes, mix more filler and apply a skim coat. When dry, resand the filler and feather-edge the paint with 240-grit paper, followed by 320-grit paper, until the repair is perfectly smooth.

You can't use lacquer- or enamel-based primers/surfacers to prime SMC repairs—or any plastic repairs, for that matter—because the solvents will cause the repair to bleed through. Then, after it's painted, the area will have what body men call a bulls-eye.

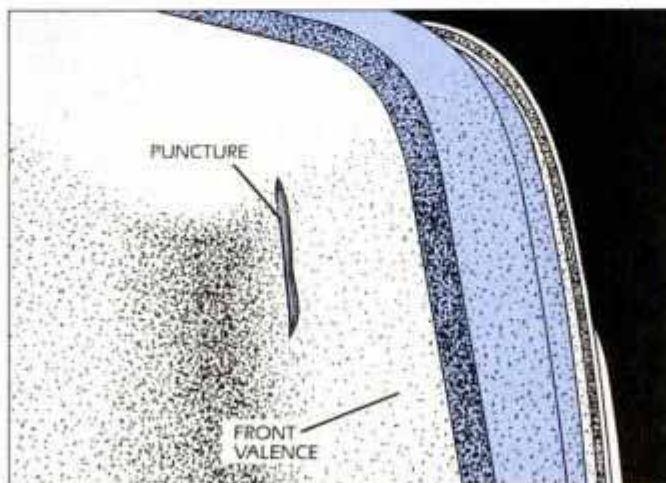
To get around this problem, Devcon's Plexus primer is specifically formulated for plastic parts. It comes in a 5-ounce aerosol can. To cover the area sufficiently, apply several thin coats, allowing the primer to dry for 5 to 10 minutes between coats. Finish-paint the area to match, using the paint manufacturer's recommendations for painting plastic parts.

For more serious damage, you'll want to use 3M's Rigid

Parts Repair system. This is the stuff that body shops use and it should be available at auto parts and paint stores where professional body and paint supplies are sold. In spite of the For Professional Use Only tag on the box, the counter staff should be happy to sell you some, and also will be able to answer any questions you might have.

Be sure to follow the manufacturer's recommendations about wearing particle masks and respirators, and proper ventilation of your shop area.

The 3M system, in addition to having a filler that's similar to Devcon's, also has an adhesive. It can be used for gluing broken SMC panels back together again using a scrap of SMC as a backup patch. You can also use the ad-



4 This scrape may need to be reinforced from the back if the flexible plastic panel has torn all the way through.

hesive to section new pieces in place, after damaged pieces are cut away (see lead illustration on page 109).

Where do you get the new piece? You can always buy a replacement panel from the dealer. A cheaper alternative is to go to the local salvage lot with a cordless sabre saw. A little searching and some luck should turn up an identical, undamaged panel, or at least a panel that doesn't have damage in the area you need to make your repairs.

To section a new piece in place, remove any inner panels and move any wiring out of the way. Cut away the damaged portion with a sabre saw, then cut the new piece so it fits into the hole. Use the old panel to fashion bonding strips. They should be at least 3 in. wide, follow the original body contour as closely as possible and run the entire length of the repair. (It's okay to use multiple pieces.)

Clean the inside of the car's panel, the bonding strips and the new piece with 3M General Purpose Adhesive Cleaner. Next, scuff-sand all bonding surfaces with 80-grit sandpaper, then clean scuffed areas with lacquer thinner (top inset to lead illustration).

Mix equal parts of A and B of the 3M adhesive, then glue the bonding strips to the hole in the body. The strips should form flanges to hold the repair piece. Allow the adhesive to cure for 30 minutes, then remove the clamps. Apply adhesive to the scuffed portion of the repair piece and glue it onto the body. Use clamps to locate the panel properly.

After the adhesive has hardened, remove the clamps, then grind out V-notches at the repair seams using a 36-grit disc (Fig. 1). The V should taper back from the seam about 1½ in. to provide enough surface area for the filler to adhere adequately.

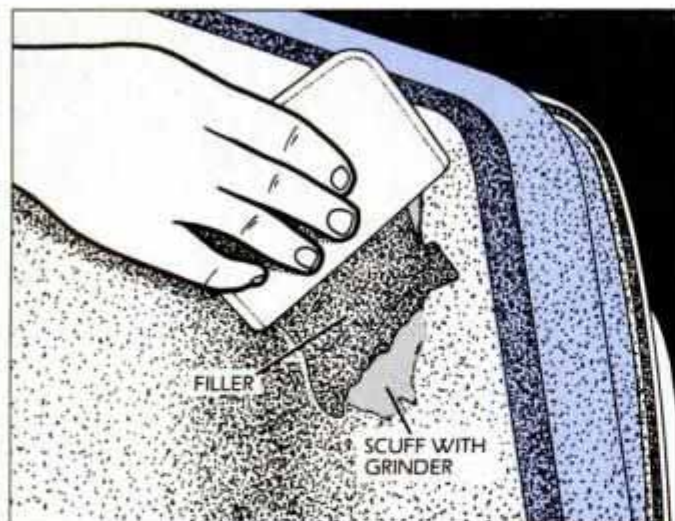
The 3M filler is applied in the same manner as Devcon's filler (Figs. 2 and 3). After the filler is applied, sanded and feathered, use plastic primer, then paint to match.

Flexible plastic repair

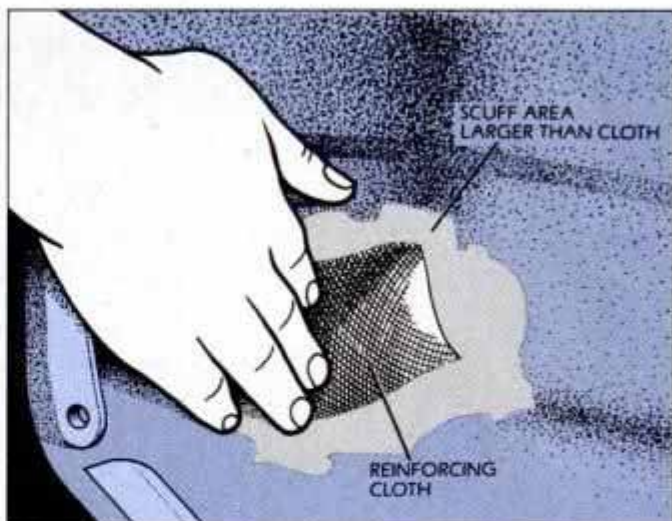
For years, repairing flexible plastic fascias, spoilers and skirts has been incredibly easy, but horribly expensive. That's because the only choice has been to throw away the old piece and bolt

on a new one.

That's changed recently



5 If the damage is superficial, simply clean, scuff-sand and fill with the appropriate flexible panel filler material.



6 If the damage penetrates, then cut a piece of fiberglass cloth to use as a reinforcement. Scuff-sand the area.

with the introduction of flexible plastic repair materials. Both Devcon and 3M have systems that make invisible repairs to splits, gouges and tears without compromising the part's flexibility.

Like Devcon's Plexus rigid plastic repair system, the Plexus flexible system consists of an epoxy filler. The main difference is that this filler remains pliable after it has cured. The same is true of the 3M filler.

With both systems, you simply grind out and fill minor gouges (Figs. 4 and 5). For splits and tears, remove the part and add a fiberglass reinforcing patch to the back. But before we start, there's something you need to know about flexible plastic.

Most flexible plastic parts are based on polyurethane. But some are based on polyolefin. It's important to know which one you're working with because the filler won't adhere to polyolefin unless an adhesion promoter is used.

How can you tell one poly from another? Grind it with a high-speed (at least 3600 rpm) 36-grit disc. Polyurethane will grind cleanly, with no melting or smearing. Polyolefin, on the other hand, melts and smears as it's ground.

Devcon doesn't make an adhesion promoter, but 3M does. Keep this in mind when you find plastic that melts when you grind. To repair a cut or split with the Devcon system, start by removing the part, or at least getting easy access to both sides of the damaged area. It's hard on your back and knees, so you may find it ultimately much easier to remove the part.

Clean both sides with soap and water, then clean the damaged area on

both sides with Plexus cleaner.

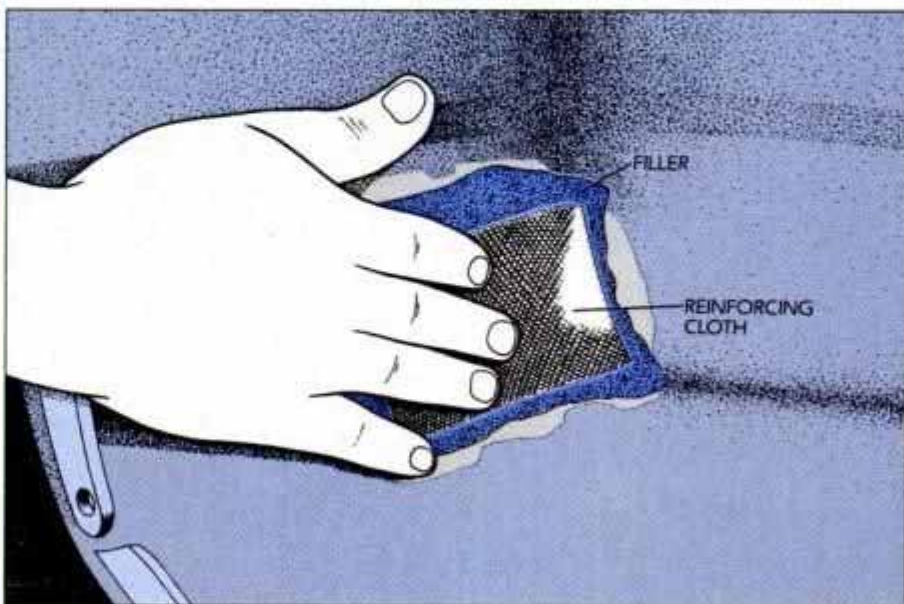
Grind the back side with a 36-grit disc, then cut a fiberglass patch to fit over the area (Fig. 6). Mix equal parts of A and B of the flexible filler, and coat the scuffed area, then apply the fiberglass patch (Fig. 7). Spread more filler over the patch and smooth out any wrinkles or bubbles.

After the backside patch has cured for about 30 minutes, use a 36-grit disc to grind a V in the front of the part. Mix more filler, then spread it over the damaged area so it is slightly higher than the undamaged surface (refer back to Fig. 4).

After 30-minutes curing time, sand the area with 180-grit sandpaper to establish the proper contour. Then use an oscillating sander or a rubber

block with 240-grit sandpaper to feather the edges and remove scratches. If there are any pinholes, apply a skim coat of filler and resand after it has cured. Before priming the area with Plexus primer, wet-sand with a rubber block and 320-grit or 400-grit sandpaper.

The procedures for using the 3M system are essentially the same. However, you'll have to use a spray gun to apply 3M's primer, called flexible parts coating. And if you're working on polyolefin, you'll have to spray adhesion promoter over the area being repaired every time you sand or grind the part. After priming, paint the area to match, using the paint manufacturer's instructions for painting plastic. **PM**



7 Lay on the flexible filler, press the fiberglass patch into it, and then cover immediately with a little more filler. Allow the area to cure for 30 minutes.

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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Cadillac Style, Circa 1992

CADILLAC WILL completely redo the styling of its 1992 full-size sedan, but maintain the conservative, luxury appearance that has made Brougham a favorite among big-ticket buyers for decades.

In addition to the exterior changes, partially revealed in this view of a prototype on test at one of GM's proving grounds, the Brougham will have Cadillac's new North Star 4.9-liter aluminum V8 engine and continue with rear-wheel drive.

Antilock brakes and traction control will be standard features as well. While dimensions of this model are still a closely held secret at Cadillac, you can bet the Brougham will continue as its biggest, heaviest sedan.

Mark VIII

Lincoln's popular prestige coupe is getting a redesign for late 1991 introduction. This early prototype gives a hint of the front end styling changes to come.

The sheetmetal and front end details of this car are bolted onto a standard Ford Thunderbird body, a short-cut automakers use to test cooling efficiency of the new grille openings.

Look for the introduction of Ford's



Next-generation Ford Taurus will be more angular.

top modular engine, a dohc version of its new V8, in the Mark VIII.

Tomorrow's Taurus

A leaner, more sharply defined appearance is in store for the 1993 Taurus, as Ford designers pull back from their recent aero styling binge.

This is the SHO version of the Taurus, equipped with the advanced dohc V6 from Yamaha. Ford may have its own new V6 ready for this car, an engine adapted from the 1991 Town Car's modular V8.

Mild revisions in styling are also planned for other models in the Taurus family—the station wagon and Mercury Sable.

Trabant Turmoil

In East Germany, reunification with West Germany is looked upon as a benefit for the most part. But not all workers are happy. The Trabant plant employees are concerned because the demand for their archaic 2-stroke car has dropped sharply.

East Germans are on a buying binge, picking up used cars from the West at lower prices, rather than staying in line for a Trabant delivery. Even

the addition of a conventional VW 4-cylinder engine may not be enough to save the Trabant assembly line.

Workers there are looking toward long layoffs starting this fall. The crunch could last until a new factory can be built, where workers will build a new, Western-designed car.

Viper Go-Ahead

Chrysler has given the green light to production of the 2-seat Viper sports



Wide headlights, laid-back grille distinguish '92 Mark VIII.

convertible. That means it should be in showrooms within three years.

Unique among Viper features is the V10 engine. Chrysler claims it will be based on a production engine, but will be built of cast aluminum (more expensive), instead of cast iron.

Look for displacement in the 440-cu.-in. range and 450 ft.-lb. of torque (Chevy's ZR-1 puts out 385). If you want a Viper, line up now. First production run will be only 200 to 500.

New Ford V8

Starting in the 1992 model year, Ford

(Please turn to page 118)



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DETROIT SPY REPORT

(Continued from page 117)

will install its new 4.6-liter modular V8 engine in the Crown Victoria and Grand Marquis lines. As a replacement for the current 5.0-liter V8, the engine represents a major advance in powerplant technology for Ford high-production cars.

The term modular means that the basic spacing for cylinders can be used in a number of engine types, making it possible to build V8, V6 and even 4-cylinder engines on similar manufacturing lines. Costs can be cut, and the ability to change from one type of engine to another on the same line becomes possible.

In the Crown Victoria and Grand Marquis, the new V8 will feature a single overhead cam valve system, aluminum cylinder heads and accessory mounts cast right into the engine block. Output is said to be in the 200-plus horsepower range at 4600 rpm.

Import Or Homemade?

That distinction is becoming increasingly blurred as Ford/Mazda, Chrysler/Mitsubishi and GM/Toyota hookups expand. Look for more to take place, especially involving European firms like Fiat and Volkswagen that already have experience in dealing with Eastern Europe.

American firms are moving aggressively in competing on the international market. New countries of interest are Thailand, for its low-cost auto parts, and Russia, for its raw materials and potential home market.

Wage Slaves

Earlier this year, the Czechoslovakia automaker Skoda found itself in an embarrassing position. Its assembly line shut down because inmates from a nearby prison quit and went home.

It seems that with a new democratic political regime, the political prisoners were set free. So they halted production of Skodas, Czechoslovakia's top-selling car line.

"Many countries use prisoners for outside work," a Skoda executive explained. "We pay the prison for its services and it fills the need we have for laborers."

Conveniently, the prison is right next door to the Skoda plant, located about 60 kilometers outside Prague.

Safer Cars?

Yes, progress has been made in making new cars safer. A study by Mercedes indicates that in the period from 1974 to 1987 there has been a 50-percent reduction in the injury rate for car accidents in Germany. Virtually all of this reduction results from better, safer cars.

FM



Scene from "Dateline 1961, Berlin"

“ August 13, 1961, Berlin. As dawn broke over the beleaguered city, it was suddenly clear that the nightmare had begun. The East German army was severing Berlin in two. ”

The Eagle and the Bear: Dateline 1961, Berlin
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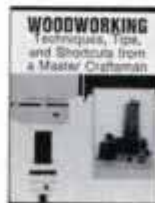
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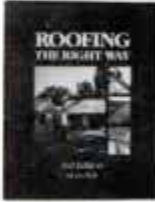
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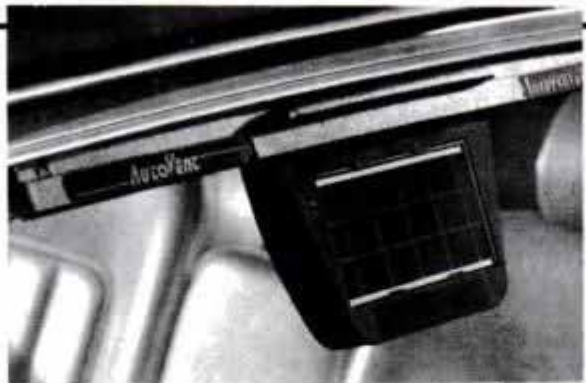
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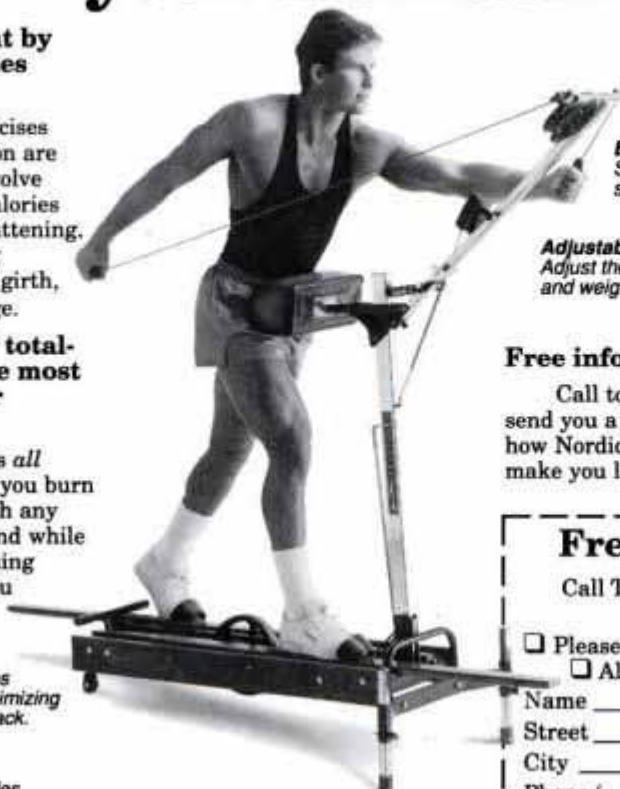
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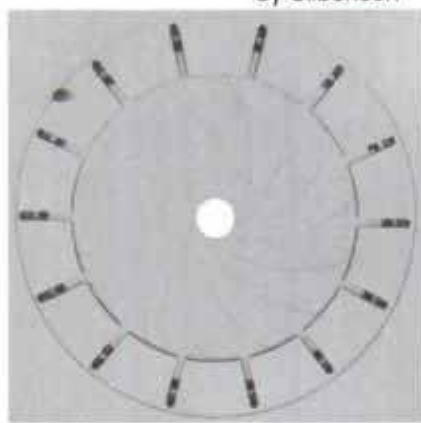
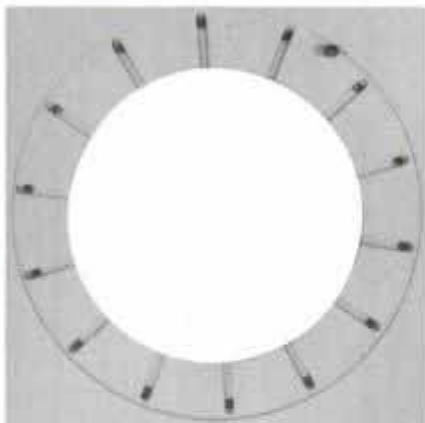
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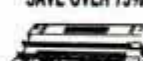
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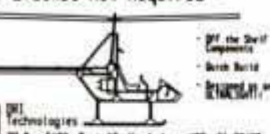
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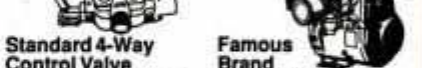
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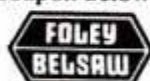
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