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Popular Mechanics

SPINE-TINGLING! ACURA'S NSX
plus COMPLETE '91 IMPORT REPORT

HULL DESIGN BREAKTHROUGH

ROCKET SHIP

50-mph All-Aluminum
Jet Passenger Ferry
Shatters Atlantic
Speed Records



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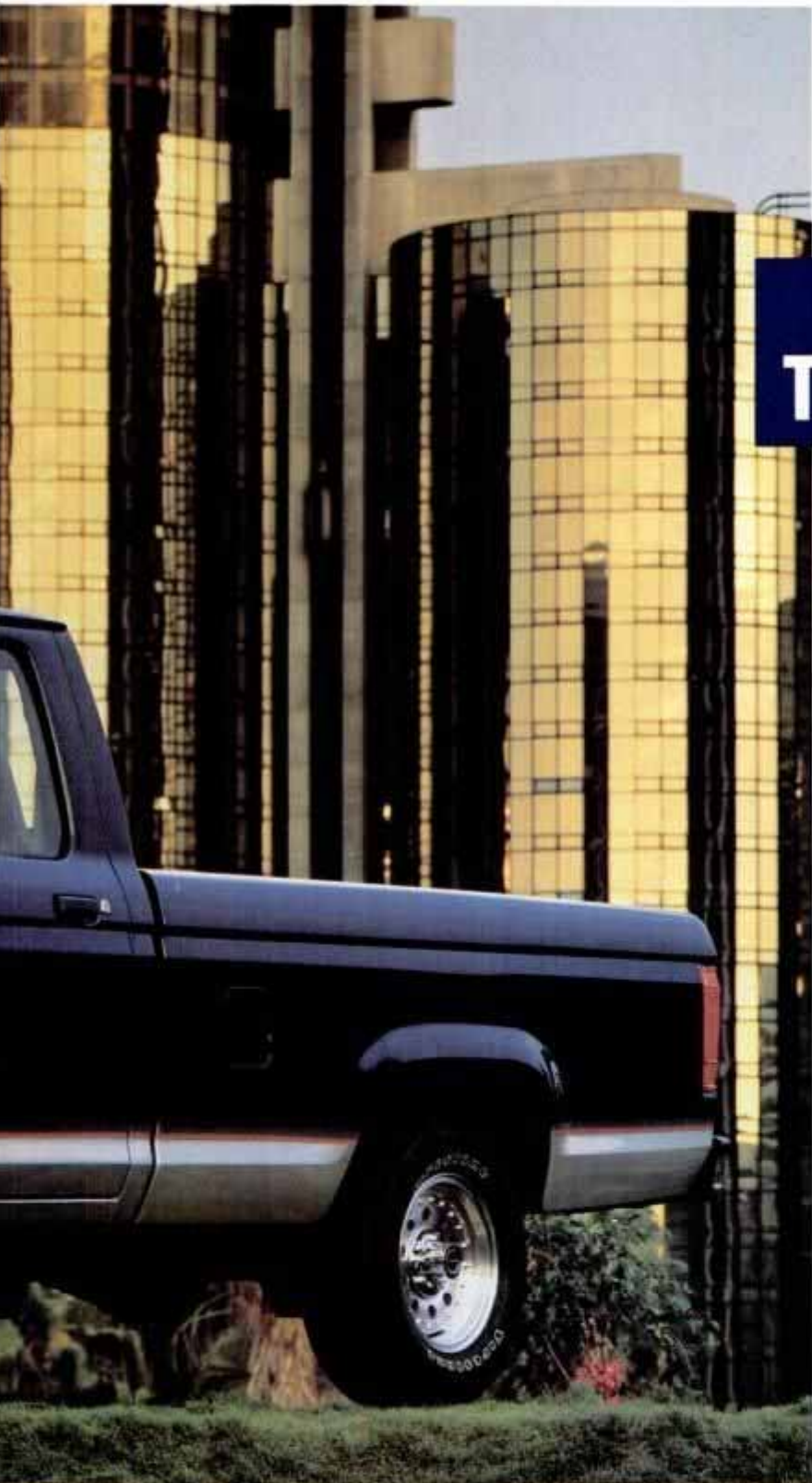
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Popular Mechanics®

DECEMBER 1990
VOLUME 167
NO. 12



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EDITOR'S NOTES

● When we wrote about the project to build a tunnel under the English Channel ("England's French Connection," Sept. 1986), we envisioned the high-speed train being the main link between Great Britain and continental Europe. Now, a company called Hoverspeed has thrown a monkey wrench into those plans. With the introduction of a regular high-speed ferry service between Britain and the Continent, those traveling between the European Community and Britain will have a choice. The ferry is already in service. The Channel Tunnel is on the verge of being completed. Both the tunnel and the ferry ("Fast Ferry," page 31)

utilize breakthrough technology to solve problems and reach objectives. Our Science/Technology Editor, Abe Dane, found the hull design of the ferry especially interesting, combining a cutting-edge ground-effect



Dane on board the Hoverspeed Great Britain with Stephen Quigley of In-Cat Designs, Great Britain builder.

theory with a gigantic catamaran shape. I think you'll find his report interesting even if you never intend to cross the English Channel. . . . This issue also contains our third and final report on the new '91 cars. You'll remember that our first report on early bloomers appeared in the April issue. The balance of what's new from Detroit dominated our October issue. Now here's everything you wanted to know about '91 imported cars. Automotive Editor Tony Swan again went the extra mile in researching our import report. In fact, he went several extra miles—per hour over the speed limit on at least one occasion while gathering material for this issue. Swan's not talking, but



Swan: guilty with an explanation.

we hear he talked his way out of a 130-in-a-55 stop in Arizona while wringing out a new Acura NSX. His plea? Guilty with an explanation. . . . Soon, fear of flying may be a thing of the past. New accident avoidance systems may, mercifully, bring an end to a rash of aviation accidents that have cost too much in human terms in recent years. Read "Happy Landings" starting on page 41 for the whole story. Till next time.


Joe Oldham

Popular Mechanics

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LETTERS

Power To The People

Thank you for the article "The Hydrogen Age." We have to replace fossil fuels within not too many decades. Broadly, we have two alternatives: the nuclear-electric future and the solar-hydrogen future. I am convinced that the solar-hydrogen route is better, for reasons of cost, environment and control of nuclear weapons. But nuclear-electric still has its believers, including notably your major competitor, *Popular Science*. We have to get the word out that solar-hydrogen is a truly practical, here-and-now choice. Thank you for your efforts.

JOHN B. HODGES
BLACKSBURG, VA

Popular Science? Are those guys still around?

Clearly as the fuel driving our solar system, and very likely our universe, hydrogen is most likely to be the fuel to solve our energy problems here on Earth. As your article indirectly pointed out, the only way we could electrolyze water without using other fuels to produce needed energy in quantities larger than could be reclaimed by burning the hydrogen produced would be through the use of solar energy. I was, however, stunned by the problem of needing that much solar electrical generation. The statement made was: "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." A 244-mile-diameter array? That's over 46,000 sq.



miles or nearly 40 percent of the state of New Mexico. What do those people have against people who live in New Mexico? Seen in another way, that array would constitute more than 1.3 percent of the entire United States! For every 10 ft. x 10-ft. area in this country, we would need, on average, a PV cell of 12 x 16 in.! How about using this as a springboard to look at PV cell technology?

BARTON W. HENDRIX
DENAIR, CA

It was bound to happen sooner or later, right? The first, and who knows maybe the final, oil war in the Middle East. Are we doomed to spill our children's guts on battlefield after battlefield until we inevitably run out of oil, or blast ourselves into eternity by going nuclear?

There are alternate technologies available to us that might just help pull us out of our rut forever and allow us to wave bye-bye to the OPEC nations and our dependency on them. One technology with a great deal of promise is the production of hydrogen gas from ordinary water via solar-electric hydrolysis. The source of this power is eternal—just pure

sunlight and water, forever!

Hydrogen is no more or less dangerous than many fuels in use today, but some people are scared of it. It's important to inform the public that hydrogen production by this method has absolutely nothing to do with hydrogen bombs or hydrogen fusion. With careful handling, hydrogen gas is no more difficult to manage than propane, and in many ways safer when vented properly.

In my humble opinion, this technology may be our best if not totally perfect solution to many of our problems. I cannot tolerate the idea that we, like junkies, are doomed endlessly to kill off each other for a poisonous black fix. If the public generally were to learn of the benefits of freeing ourselves from OPEC control over our oil supplies, not to mention all the other advantages, maybe they would support changing our ways and insist that we prepare for a safer and saner future.

JOHN MURRAY
VANCOUVER, CANADA

Highway Patrol

Let's get real! The only reason anyone would spend \$250 to \$400 for a radar detector is so they could break the speed limit with impunity. Holy cow! No one unintentionally finds himself driving at 80 mph. Can we expect an arti-

cle comparing burglar tools in the future? PAUL TENSER
SPRINGVILLE, NY

I cannot help but be intrigued by your "Sign Of The Times" article from your Aug. 1915 issue in *Time Machine*. The sign urged motorists to voluntarily drive within a 30-mile-per-hour speed limit so that speed cops would not be needed to enforce the same. You concluded the piece by wondering what became of the idea of an honor system regarding speeding, then on the facing page ran a full page ad for a radar detector. I believe if you have not answered your own question, you have certainly provided a clue.

DAVID R. DENNY
JOHNSON CITY, TN

Rack 'Em Up

I am the owner of a company named *Wooden Luxuries*. We do custom kitchens, baths, specialized furniture and so on. Even with my 12 years of experience, your pool table project (page 74, Dec. '89) was a challenge. Although the plan called for mahogany, I built my table out of cherry wood. And with the exception of how I routed the edges using different bits, it is identical to yours. I hope to see more projects like this one in the future.

DOUGLAS T. STEWART
ASHEVILLE, NC



Reader Doug Stewart's finished product.

Popular Mechanics

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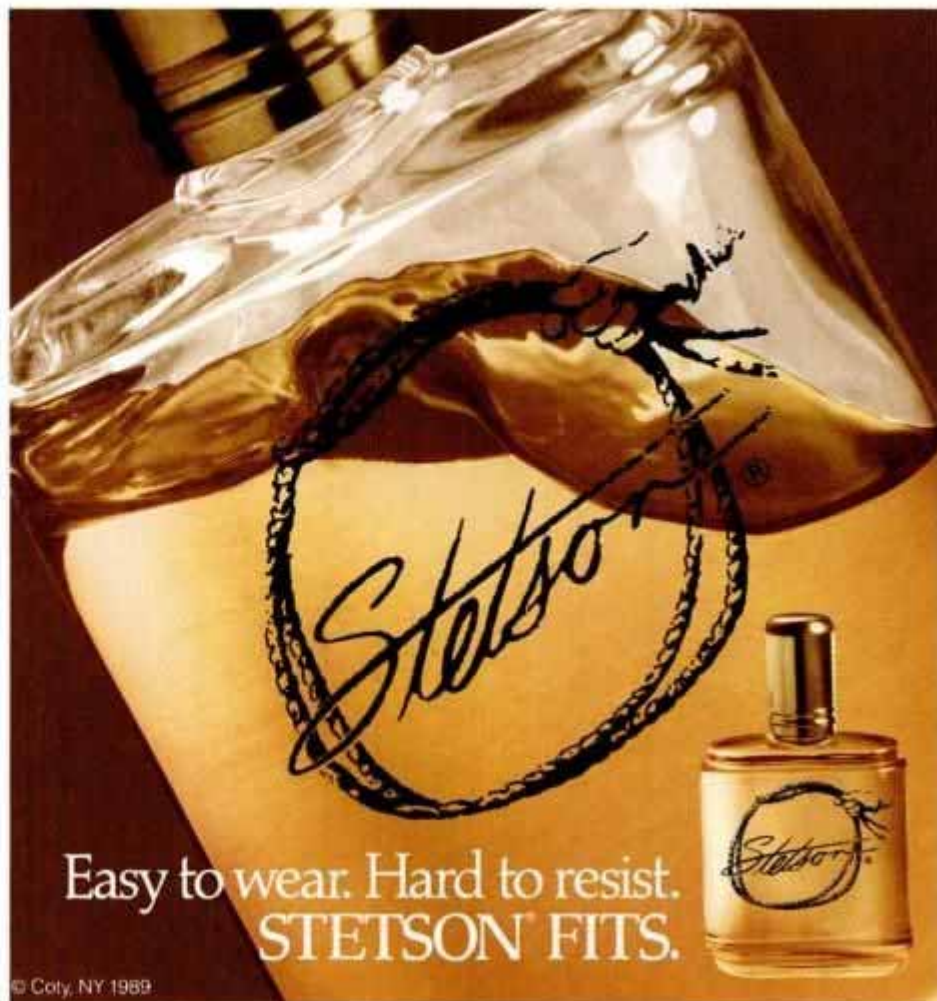
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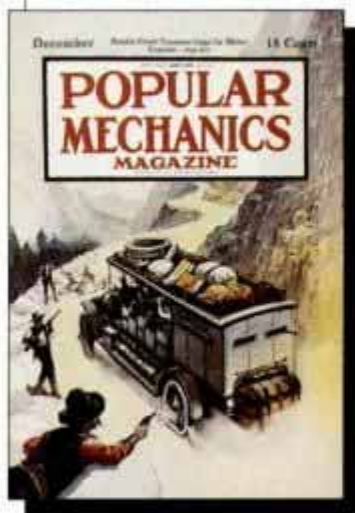
Over \$1500 less.



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TIME MACHINE

75 YEARS AGO: DECEMBER 1915

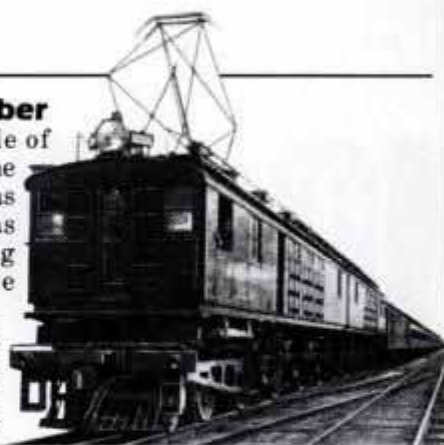


Stage Fright

The 20th century was taming the wild, wild West, but bad guys still stalked the mountains of Colorado. To counter their depredations, one motorized stagecoach operator outfitted his vehicle with a wire-mesh cage for mail and passenger's valuables. The time and effort needed to break into the cage, he reasoned, would deter robbery. In case the stage ran into real desperadoes, however, he advised supplanting the cage with a steel pillbox housing several well-armed gunmen.

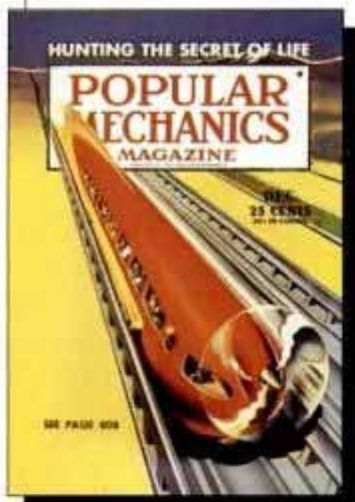
Mountain Climber

In another example of technology taming the West, electricity was overtaking steam as the driving force along the railroads of the Rockies. Steep inclines tended to tax steam engines, which often choked passengers with sulfurous fumes. So the Chicago, Milwaukee and St. Paul Railway electrified a 440-mile route through Montana and marshaled 42 of the world's biggest electric loco-



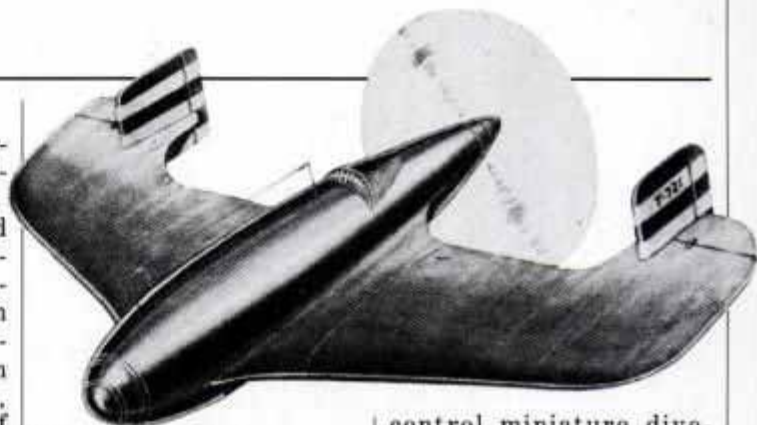
motives. The trains, which used the new technique of regenerative braking, soaked up 3000-volts DC from nearby hydroelectric plants.

50 YEARS AGO: DECEMBER 1940



Prop Tracks

Before the birth of the Interstate Highway system, railroads offered dead-straight rights of way that inspired visions of transportation utopia. Our cover story proposed replacing tracks with 6-lane highways. Prop-driven vehicles would race down the inner lanes at 200 mph, balanced on a single line of rubber wheels. Meanwhile, serpentine, articulated freight trucks would dominate the middle lanes. The outer lanes would be reserved for passenger cars.



Kamikaze Robots

Although television was an infant science, teleoperated weapons were already on the drawing board. Two Chicago engineers outlined a remote-

control miniature dive-bomber that sought out its target with the aid of a TV camera. Flocks of the drones, shepherded by a control plane, could carry out carpet-bombing missions.

25 YEARS AGO: DECEMBER 1965



Do-It-Yourself Xmas

Ho-ho-ho home-shop projects were our theme. We gave you plans for moving yard displays animated by pulleys, connecting rods and small direct-drive motors. Toy ideas included spring-driven boxing puppets, sure to be a knockout with the boys, and a doll's house based on your own home. To bring our plans to life you clipped patterns from the magazine, soaked them in vegetable oil, mounted them on slides and projected the images onto plywood.



Surface Effects

The '60s saw the evolution of the hovercraft from nautical novelty to workhorse of the English Channel. In 1965, California commuters experienced the United States' first commercial air-cushion service. A 60-mph British

model churned across the San Francisco Bay right up onto the runways of Oakland International Airport. Meanwhile, naval architects were developing second-generation craft, from 2-man sport models to 500-passenger behemoths. **PM**

CLIMBER ZOOMS UP MOUNTAIN JUST BY USING HIS IQ.

You won't need backpacks or hiking boots to accomplish this feat, as long as you're smart enough to take along 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 concentrate on enjoying the scenery instead of worrying about how to capture it.

The power zoom lens, first introduced by Pentax, lets you choose any focal length between 35mm and 70mm, plus a macro setting for close, detailed images.

The IQ Zoom 700 has many other features that lift picture-taking to new heights. Built-in auto flash, backlight compensation, daylight sync and slow-shutter speed sync assure beautifully exposed photos from dawn to dark, outdoors or in.

The pushbutton ease of this camera even has such unconventional features as a multi-exposure mode, and the self-timer lets you capture yourself as King of the Hill, twice, with only one setting.

See how easy it is to reach the peak of picture-taking? Just be smart enough to use your IQ.



Zooming reaches its peak at 70mm



King of the Hill at 35mm



Roped in by macro mode.



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

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IQZoom700

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how much power is
left in this battery?**



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little bit?*



This much?



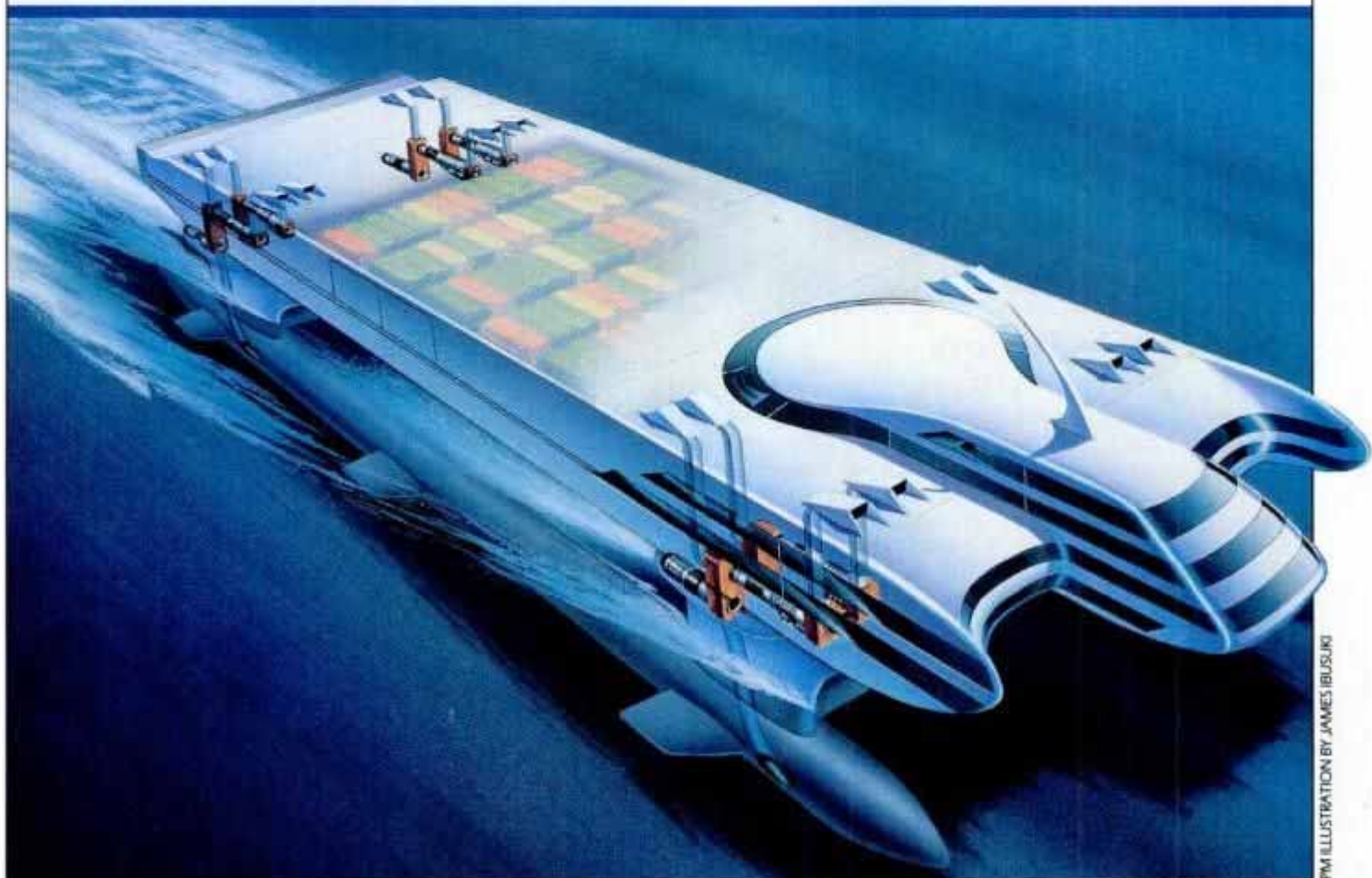
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TECH UPDATE

News Of Tomorrow's Technology Today



P/M ILLUSTRATION BY JAMES IBIJUNG

Japan's Jumbo Jet-Freighter Of The Future

TOKYO, JAPAN—Japan's principal shipbuilders have joined forces with government researchers to create a high-speed superfreighter that will leave existing cargo ships in its wake.

The Techno-Superliner is expected to be 330 ft. long, and carry more than 1000 tons of cargo at 50 knots.

Two versions are under consideration. Mitsubishi and Mitsui are examining a surface-effect variant, essentially a big hovercraft. Meanwhile, Kawasaki, IHI, NKK, Sumitomo and Hitachi are looking into a small-waterplane-area twin-hull (SWATH) design to lift the hull above 6-ft. waves.

To meet its performance

goals, the cargo ship will run on 25,000-hp gas-turbine powerplants featuring ceramics and other advanced materials. The engines, four per ship, should boast 60 percent thermal efficiency and need a third the maintenance of conventional engines.

At full throttle, the Superliner's speed will be 2½ times the average speed of conventional container vessels. That pace will allow the ship to make the Tokyo-to-Taiwan run, normally a 3-day trip, in less than 24 hours. Travel time to the U.S. would be cut to three days.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Alexander Bagley,
Stephanie Denmark, Mike Fillon,
Oliver Fultz

The researchers aim to turn the project over to a shipbuilder in 1993 and have a working Superliner by 2000.

Four gas-turbine-powered waterjets propel SWATH version of Japan's Techno-Superliner to 50 knots.

Highlights This Month

- **Splash Landing**—Jet-powered seabird may be the mightiest plane yet.
- **Person To Person**—Satellites and handheld phones link any two points on Earth.
- **Electric Dreams**—NASA has an eye on the ion engine.
- **Sky Surfers**—Hypersonic planes ride their own shockwaves for better lift.
- **Space Regatta**—Solar wind carries interplanetary sailcraft to Mars.
- **Now You See Me**—Magellan Venus probe stops playing hard to get.

PM ILLUSTRATION BY EED VALCOURSKY



Shockwave Surfers

COLLEGE PARK, MD—A future hypersonic aircraft may surf on the shockwave produced by its blistering passage through the air.

On such a vehicle, called a waverider, the shockwave clings to the leading edge, confining the high-pressure

zone behind it to the plane's underside. The waverider thus enjoys a lift-to-drag ratio 10 times that projected for conventional hypersonic planes.

Under a NASA design program, Ohio State engineers have developed specs

for several waverider vehicles, including a hypersonic-engine testbed and a Mach-6 business or spy jet.

Meanwhile, University of Maryland researchers propose a Mars mission using a waverider that carries out an aerogravity assist flying upside down through Venus's atmosphere. The wave-

Waveriders include Ohio State's Stingray business jet (left and right) and unmanned hypersonic engine testbed (center).

rider's high lift-to-drag value would work in reverse, pulling the craft down into the atmosphere, so that when it slingshots off toward Mars, it gains the maximum boost from Venus's momentum.

Tilt-Prop Alternative

LONG BEACH, CA—A hybrid aircraft with tilting props mounted midwing may offer a low-cost, high-performance alternative to the V-22 Osprey tilt-rotor. The Patriot, under development at American Aircraft Corp., will dash at more than 435 knots and have an operational ceiling near 45,000 ft.

Engines lie above the rear

fuselage, not at the wingtips as on the Osprey. Their position reduces wing-loading, which adds to maneuverability and gives the aircraft a stall speed of between 30 and 60 knots. The props themselves are far simpler than the V-22's, sacrificing hover-mode maneuverability for light weight and economy. A

ducted fan in the aircraft's nose provides extra stability in vertical flight.

AAC has designed three variants: an ordnance-laden gunship, a troop-lift version and a commuter shuttle. The company revealed a nonflying prototype at last summer's Dayton Air Show.

Patriot can carry up to 48 troops or pack massive firepower, arrayed around 360°, for shock assault.



X marks the spot where chip-etching X-rays emerge.

Cheap X-Rays

ITHACA, NY—Instead of dropping megabucks for particle accelerators (see [Tech Update, page 19, June '90](#)), electronics firms could make chip-etching X-rays much more cheaply, say Cornell University physicists.

They've crossed two magnesium wires between electrodes on a pulsed power generator. Pulses packing 500,000 amps vaporize the wires. Where the wires cross, radiation erupts, including X-rays suitable to write ultrafine circuits.

PM ILLUSTRATION BY DEAN ELLIS



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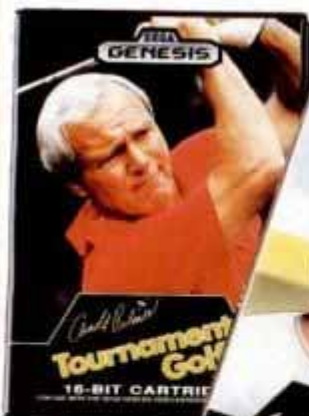
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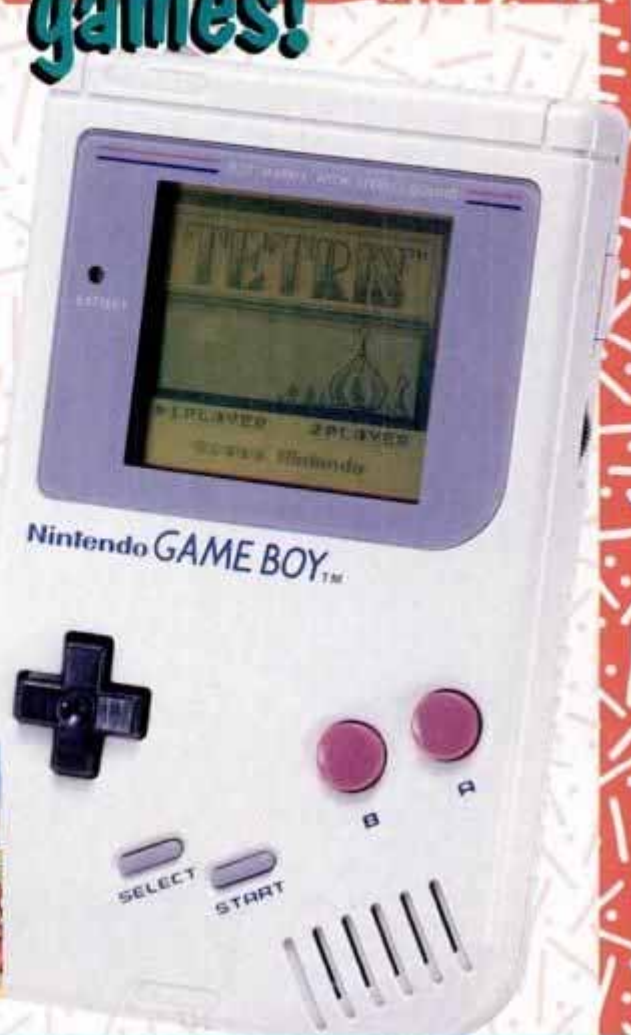
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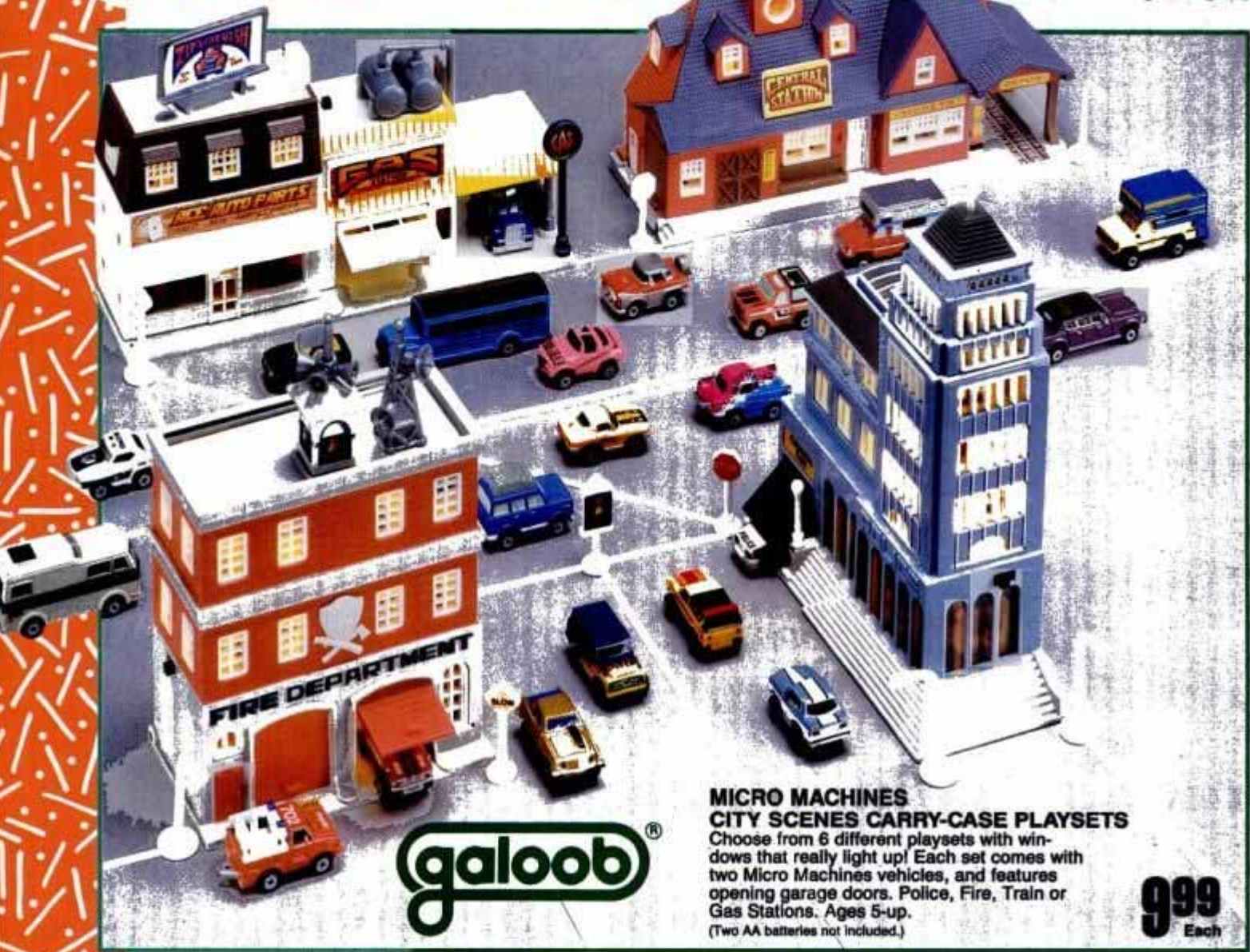
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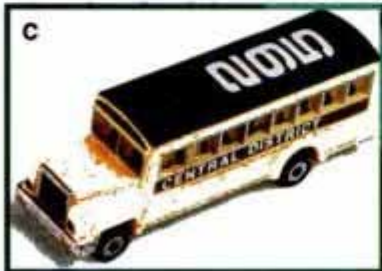
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TRIVIAL PURSUIT 1980'S MASTER GAME

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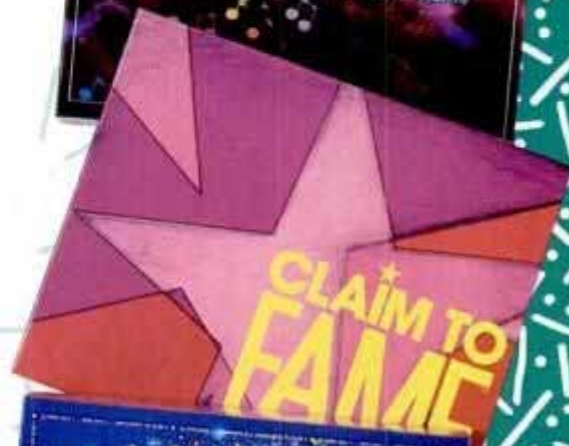
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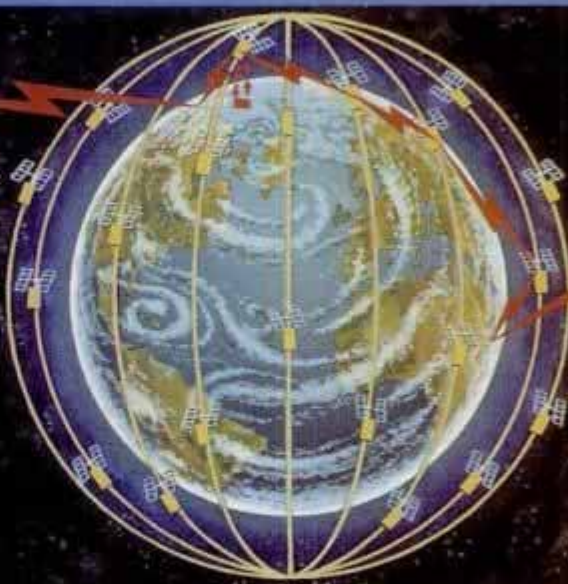


Manufactured in Hong Kong

Global Remote Phone Service

SCHAUMBURG, IL—The most ambitious use of the coming generation of low-cost, lightweight satellites yet proposed is a worldwide telecommunications system organized by Motorola. The network, called Iridium, would allow callers to communicate from anywhere, without knowing the location of the dialed party.

Seventy-seven satellites, each weighing only 700 pounds, would circle the globe pole-to-pole in low Earth orbit, ensuring that every point on the planet would be in line of sight with a spacecraft. Each satellite would project a 350-mile-dia.



coverage "cell" that sweeps across the surface as the spacecraft orbits.

Motorola hopes to begin

launching the satellites on expendable rockets in 1992, possibly using *Pegasus*-winged boosters.

Iridium lightsat takes call from remote handset, checks billing via ground station, and relays call via sister satellites.

PM ILLUSTRATION BY PAT RUGGERO

Ion-Thruster Space Engines

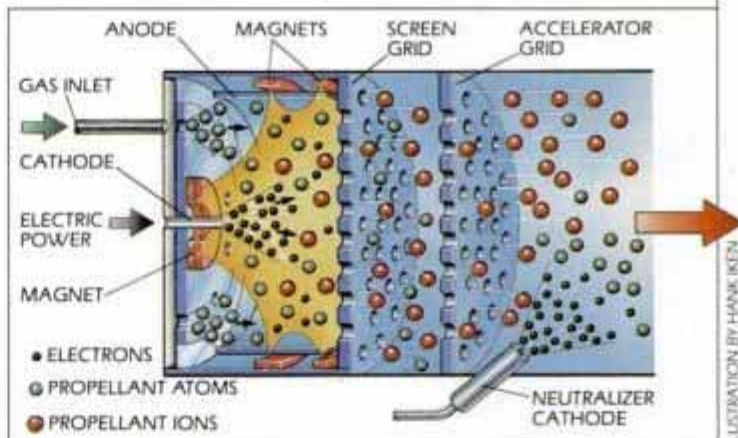
TULLAHOMA, TN—Seeking alternatives to chemical rockets, NASA and other space agencies are eyeing weight-saving electric propulsion systems. One front-runner is the ion thruster, which has the potential to cut a Mars mission round-trip time to nine months.

In an ion thruster, a gas such as xenon is fired into an ionization chamber, where it meets a shower of electricity—electrons racing from a cathode to an anode. The

electrons strip other electrons from the gas atoms, converting the atoms into charged ions.

Charged grids located behind the chamber accelerate the ions into a thrust beam. Beyond the grids, a second cathode restores neutrality.

Small-scale European and Japanese ion thrusters will be launched on test satellites in 1992. Meanwhile, NASA is probing durable grid materials with an eye to scaling up for a Mars mission.



Inside ionization chamber, magnetic field (yellow) keeps ions and electrons away from walls to improve engine efficiency.

PM ILLUSTRATION BY HANK IKEN

NASA's Green Machine

MOUNTAIN VIEW, CA—When astronauts return from missions, they're sick of freeze-dried rations and often crave fresh produce. To satisfy that desire in space, NASA's Ames Research

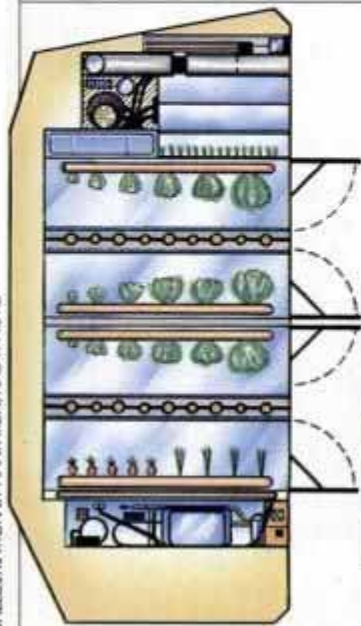
Center is developing a hydroponic garden to fit a standard equipment rack on Space Station *Freedom*.

Inside the salad machine, lettuce, carrots, tomatoes and other vegetables will

grow in soilless nutrient solutions. Output requirements: three salads per person per week for a crew of four.

Water transpired by the plants will recycle into the nutrient delivery system and may ultimately supply potable water for crew consumption. In addition, the plants will add oxygen to and remove carbon dioxide from the machine's air, which can be furnished to the cabin environment as part of a bioregenerative life-support system.

Ames currently has a working model and aims for an operational rack system by the launch date of the Space Station.



Space plants in slide-out chambers (left) can sprout upside-down in microgravity. Working model (above) has grown lettuce.

PM ILLUSTRATION BY HANK IKEN; NASA PHOTO



PM ILLUSTRATION BY ED VALIGURSKY

Super Cargo Seaplane

PARIS, FRANCE—A gigantic 8-engine cargo plane would operate strictly from the seas, under a proposal aired by a study group here.

The plane, designated Hydro 2000, would have a maximum takeoff weight of 2.2

million pounds, outlifting the current world heavyweight champion—the Russian An-225 *Mriya*—by a million pounds.

The Hydro 2000 group suggests maritime shipping outfits that have heavy-lift

machinery and container facilities in place could operate the aircraft. This would keep the behemoth from pummeling runways and adding to congested freight-terminal airspace. The plane would have no landing gear.

The group is currently soliciting interest in feasibility

The 330-ft.-long cargo seaplane will be world's biggest, strongest aircraft, if French backers win support from planemakers.

studies from U.S., Soviet and Japanese aerospace companies, aiming ultimately to assemble a multinational consortium to build the cargo plane.

Rover That Rolls Over

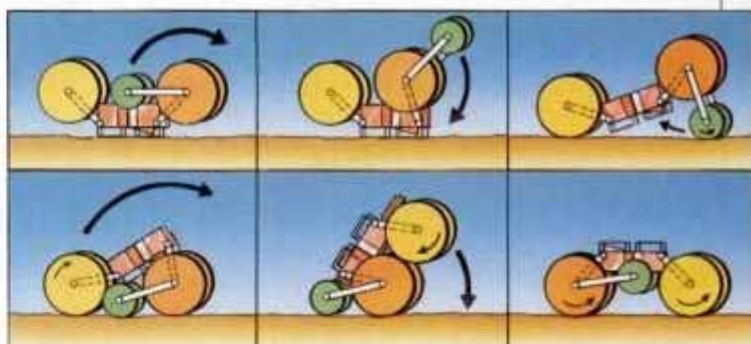
PASADENA, CA—Continuing the quest for a foolproof Mars rover, engineers at NASA's Jet Propulsion Laboratory (JPL) have tackled this question: What happens if the unmanned explorer accidentally flips over?

A pair of auxiliary wheels, linked to the front wheels by twin levers, would enable a capsized rover to right itself, as well as negotiate steep slopes and ledges. Wheels and levers on the unmanned

vehicle would be independently powered.

Should the rover land on its back, the auxiliary wheels would swing forward and under the front wheels, raising the front of the articulated vehicle. The rear wheels, mounted on movable arms, would then climb over the auxiliary wheels and front wheels until the rover turns over.

The extra wheels would also act as outriggers to sta-



In top three frames, extra wheels move under flipped rover. Bottom frames show rear wheels rolling over other wheels to right rover.

bilize the vehicle on uneven terrain and help drive the

rover up Martian hills as steep as 40°.

Fiberoptics' Latest Angle

LONG BEACH, CA—Game fish that feed at great ocean depths often ignore conventional lures because surface light doesn't penetrate far enough to make them visible.

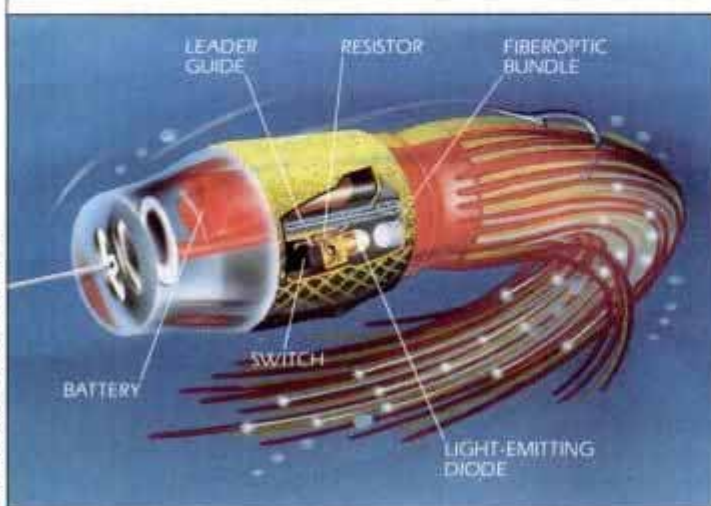
A California inventor may have overcome the problem by developing an electrically powered deep-sea lure that mimics bioluminescence, the firefly-like light given off by

deep-sea shrimp, squid and some small fish. Tuna, marlin and shark often dive deep to prey on these bioluminescent organisms.

Light-emitting diodes feed optical fibers, which distribute a deceptive glow through the mock-squid's tentacles. The lure's body resists deep-water pressures and has a flashlight-style depressible-plastic on/off switch.

Inventor Mark Treon has patented the device and is testing prototypes.

Artificial bioluminescent squid uses the flash of fiberoptics to fool preying fish.



PM ILLUSTRATION BY GEORGE RETSECK

Rush Hour

Let's get it together... buckle up.
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• 160 horsepower.

• Shift-on-the-fly Insta-Trac.[™]

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Chevy S-10 Baja 4x4, 4.3L V6. The biggest engine in a compact pickup. It's another reason more truck owners switched to Chevy last year than to any other truck.* Chevy S-10 Baja 4x4. Winning the hearts and minds of bona fide off-road enthusiasts. With more standard horsepower than Ford. More standard torque. Anytime you buckle in, it's a rush.

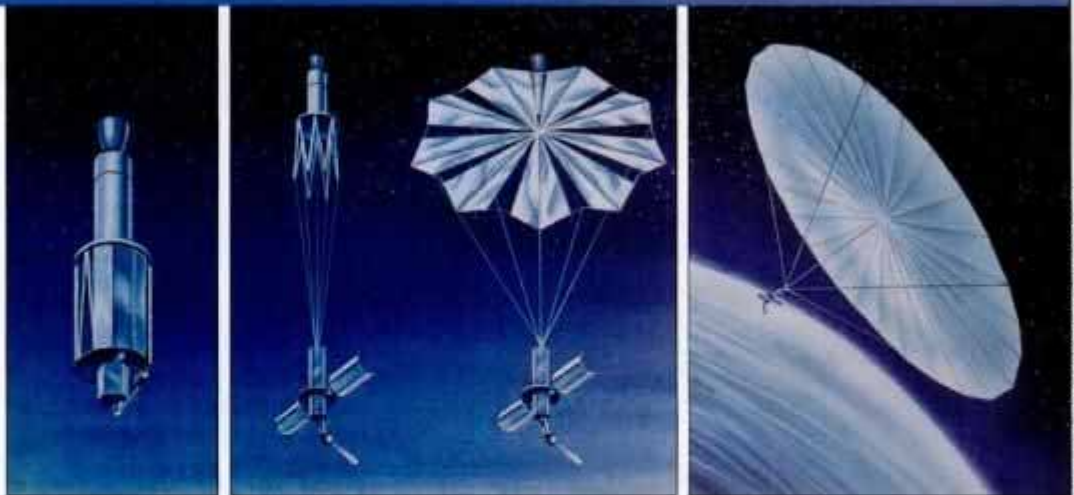
More People Are Winning With *The Heartbeat*  of America. **TODAY'S TRUCK IS CHEVROLET.[™]**

Solar-Wind Sailcraft

WASHINGTON, D.C.—Five hundred years after Columbus made his voyage of discovery, a 6-country flotilla of solar sails will race across the void between Earth and Mars, if current plans hold.

The solar sails are sheets of aluminized plastic, some as broad as a city block. They would unfurl from canisters rocketed into a high Earth orbit. Solar wind, consisting of particles streaming out from the Sun, would propel them past the Moon and to Mars in one to five years.

Three U.S. design teams have submitted entries. Johns Hopkins University offers a disc-shaped sunflow-



Launched via Pegasus booster, Johns Hopkins University's solar sail unfurls in space. The disc-shaped sunflower sail would carry a scientific-instrument package to Mars.

er sail made of thin, triangular petals. The World Space Foundation has designed a huge square-rigged entry, while an 8-armed, rotating

"heliogyro" comes from the Massachusetts Institute of Technology. Italy, England, China and the Soviet Union have also designed sails.

To launch the vehicles will require at least \$10 million up front, funds that race organizers are currently trying to raise.

Micro-Powerplants

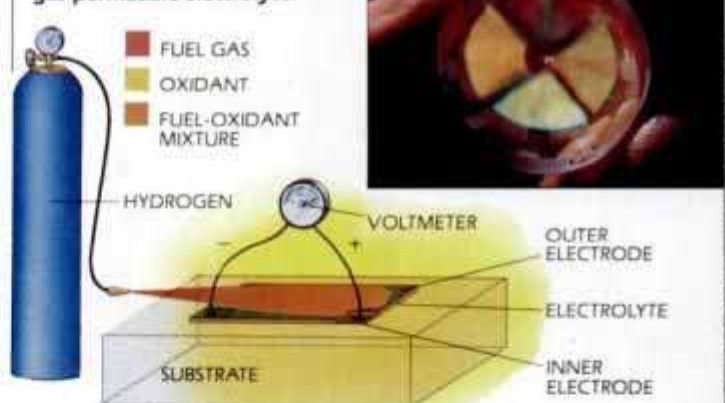
MORRISTOWN, NJ—Perhaps the smallest electrochemical devices ever made, tiny fuel cells built right on to microchips could power electronic equipment without batteries. Prototypes of such fuel cells, less than 20 millionths of an inch thick, have been developed at Bell Communications Research.

The device generates power when a mixture of air and fuel gas, such as hydrogen, is blown over its surface,

starting an oxidation-reduction reaction that creates an external flow of electricity.

The Bellcore researchers believe the cells could be printed on continuous plastic sheets, which could then be rolled into open spirals through which the fuel gas could be passed. They are also investigating how to deposit the cells right onto microchips, to supply power to tightly packed high-speed switches.

Micro fuel cell consists of two thin electrodes separated by gas-permeable electrolyte.



Magellan's radar mapper has returned an image of a 12-mile swath of Venusian landscape (right), featuring lava-filled valleys and mountain ridges.



Magellan Starts Mapping

PASADENA, CA—After teasing NASA's Jet Propulsion Laboratory with temporary communications losses, *Magellan* has settled down to begin mapping Venus and has already returned images of startling clarity.

Both the main and backup attitude-control computers on board the probe went haywire, and the spacecraft shifted into safe mode, turn-

ing its solar panels toward the Sun and pulling the antenna off-line with Earth. JPL controllers regained contact, lost it again, then re-established a linkup with the probe. They then radioed instructions to override the fault-protection system and keep the antenna pointed at Earth.

Meanwhile, tests revealed that the synthetic-aperture radar is working flawlessly, cutting through cloud cover to resolve details spaced as finely as 130 yards apart. Geologists are surprised at the scale of wrinkling on the planet's face, which suggests a violent past. 

PENTAX

When the view is priceless...

make sure you've packed a Pentax. Pentax binoculars deliver unsurpassed clarity, ruggedness, and design at a price that won't break your back! Pictured (top to bottom) Models 10x24 UCF, 7x20 DCF, and 7x35 PCF.

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FLASH AND DASH

This year's import crop emphasizes sexier styling, more power and new standards in luxury.

BY RICK TITUS, West Coast Editor



ACURA NSX

● We hate to be the ones to say this, but we're going to anyway. The '70s and '80s were pretty dull as far as imported cars go. Sure, there were exceptions. There always are. But once you get past a handful of cars—the Ferraris, the Z-cars, the Porsches—what did we really get from foreign shores? Mainly econoboxes. Long gray lines of small sedans that did a yeoman job of transporting several people from point A to point B. And all of them were as reliable as a tooth filling. And about as exciting to drive.

But now here we are into the '90s, and things are definitely heating up. If you like cars for more than merely

their utilitarian value, then this is going to be your decade. Yes, there will be the usual and necessary stable of point-A-to-point-B hardware (most of which is quite good). But for the automotive romantic, some seriously hot performers are on the boards.

What makes this news even better than usual is that we're talking about performance cars with exciting styling and luxurious comfort, yet aimed at the real world middle-market. Cars that, despite their slick looks and fantastic acceleration numbers, sell for figures attainable by mere mortals. And that *is* something to get excited about.

Alfa Romeo

Since its takeover by Fiat nearly two years ago, Alfa Romeo has been busy introducing its all-new 164 sports sedan and refining its aging Alfa Spider.

The new 4-door 164 is the result of a 4-year joint development effort between Saab and Alfa Romeo on a sports/luxury sedan platform for shared use. The outcome is a product of outstanding handling, performance and comfort. A car that should give Alfa Romeo a far greater presence in the American market in 1991.

As for the Alfa Spider, driving comfort was the principal focus in



ACURA LEGEND COUPE LS



ACURA LEGEND L

its updates. Interior trim and finish levels are refined with new seats, door panels and center console. Standard power steering and now an optional automatic transmission speak volumes about Alfa's intention to take the old Spider upscale. And refinements made to the Spider's 2.0-liter, 120-horsepower, 4-cylinder engine go a long way toward improving its driveability.

Last, but certainly not least, are a number of external cosmetic changes. There's a new bumper, with an enclosed grille, which serves to give the Spider a lower, sleeker, more aerodynamic look. New side skirts and new rounded trunk and fender lines with a smooth-edged full-width taillight bring the Spider's styling well into the '90s. In total, these small adjustments



ALFA ROMEO SPIDER

add up to a very refreshing—and much needed—facelift on a timeless sports car.

Acura

Although the superb NSX sports car is soaking up most of the attention,

Honda's Acura division has also been working overtime on its real breadwinner, the Legend series. The result is brand-new replacements for the popular Legend coupe and sedan, redesigned, in the Honda tradition, from the ground up.

The Legend story starts with a re-engineered version of the car's 24-valve sohc aluminum-alloy V6 engine, bumped up to 3.2 liters (from 2.7) and a robust 200 hp (from 161 hp), in response to criticisms of rather ordinary performance in the original car. A redesigned valvetrain reduces reciprocating mass by 15 percent, which improves throttle response and overall operating smoothness.

Honda has mounted the redesigned V6 longitudinally, rather than transversely, improving front/rear weight distribution to 60/40 from 62/38 in the original.

The chassis has also had its share of attention, with a general stiffening to improve handling, and the double wishbone all-independent suspension has also been revised.

The new Legends are slightly larger than their predecessors in every dimension, and are also a tad heavier. As you'd expect, there are new bends in the sheetmetal to go with all this engineering. What you might *not* expect is that the new Legends aren't quite as aerodynamically efficient as the originals.

However, it seems certain that this small step backward will be more than



SPOTLIGHT

Mitsubishi 3000GT VR-4

● Sporting every conceivable high-performance gadget known to an engineer, the 3000GT VR-4 is Mitsubishi's way of serving notice to the motoring world that they're here—with a vengeance. With 24 valves, four cams, two turbos, two intercoolers and 307 hp, the 3-liter V6 propels the 3800-pound 2+2 to 13.7-second quarter miles and 160-plus mph top speeds. Shod with 245/45 R-17 rubber on all four corners, there's plenty of 4wd traction, and enormous 4-wheel

discs to haul it down as well. There's 4-wheel steering, an airdam and spoiler that deploy electrically at higher speeds and retract in town. Even the muffler has a dashboard switch to alternate between performance and quiet modes.

With styling guaranteed to attract every cop within miles, the Mitsu will readily leave an L98 Corvette behind—and still have room for a couple of short people or some suitcases.

—Mike Allen



INFINITI G20



ISUZU IMPULSE

offset by the Legend's many other improvements, as well as its new-found muscle.

BMW

Floor traffic in BMW dealers' showrooms in 1991 should prove an interesting mix of personalities and economic profiles. With a lineup of mouth-watering products ranging in price from \$20,000 all the way to nearly \$80,000, BMW sales personnel are going to have to quickly decide if they're talking with rich people or their servants.

The new 318i is based on the old 320 platform, which, with a slightly decontented appointment list and a smaller (but thoroughly potent) 16-valve, 1.8-liter, 134-hp, 4-cylinder engine, brings the old 320 body back to affordability. In execution, the package works quite well. Still a satisfyingly snappy performer if driven hard enough, the new 318i is light and precise to the touch, yet provides plenty of comfort, quality and that good old BMW mystique.

As for the economic high-rollers, BMW's new dream machine is likely to be the all-new 850i coupe. And who could blame them? Built as the replacement for the long-loved and still gorgeous 635CSi, the new 850 is totally state-of-the-art in terms of engineering, styling and manufacturing.

Powered by the same 300-hp V12 that propels the sumptuous 750iL sedan, this super aero luxury sports coupe isn't likely to take any prisoners in its market segment, where it goes head-to-head with the new Mercedes-Benz SL 2-seaters.

Honda

With the station wagon market about to stage a significant comeback, Honda is positioning itself to capitalize on this trend with the introduction of its new Accord wagon. It will be built on the current sedan platform, beginning in late winter.



TOYOTA MR2

Already manufactured and sold in Japan, the new American market version will be assembled at Honda's

Marysville, Ohio, plant, with little likelihood of export to any other markets in the short term.



SPOTLIGHT

Mercury Capri

● Already selling at \$3000 or \$4000 over list, it looks like the Mercury Capri is this year's Miata. Imported from Ford of Australia, the little 2+2 roadster is available in two levels of trim and with a choice of two engines. The base powerplant is a 1.6-liter, 4-cylinder with 16 valves and multiport fuel injection. Output is 100 hp. The upscale XR2 adds a turbocharger and an air-to-air intercooler, giving the XR2 132 hp.

Driving the Capri confirms one suspicion immediately. This is a sports car for

the masses—a no-hassle, trouble-free, easy-to-use, top-down sportster with the mainstream automotive type in mind. Long doors make it easy to get into, power steering is light and precise and the transmission is clean shifting.

In its fully loaded XR2 trim, with optional hardtop, fog lamps, air conditioning, cruise control, power door locks, cassette player, rear spoiler and fancy alloy wheels—all things we've come to expect today—the Capri is by all measures a '90s sports car. —Rick Titus



BMW 850i



ISUZU STYLUS

PHOTO BY MIKE ALLEN

Hyundai

Hyundai is one of the fastest-growing car companies in North America, but up to now, its lineup has lacked a sexy model to attract the younger, image-conscious buyers into its showrooms. Hyundai's newly unveiled 2-door Scoupe sportster should do just that. Designed as a 2+2, the sleekly styled Scoupe fleshes out Hyundai's lineup, which now embraces three different nameplates.

Powered by a 1.5-liter, electronically fuel-injected, single overhead cam, 4-cylinder engine, the new Scoupe can be ordered with either a 5-speed manual or 4-speed automatic transmission. The Scoupe is offered in several trim levels with base pricing starting around \$8400 and a fully loaded model at just under \$11,500, making it one of the most affordable sports coupes on the market.

Infiniti

If in fact the 1990s is the decade of more practical thinking, then the all-new Infiniti G20 is the right car, at the right time for the right price. The G20 is targeted at the entry-level image-conscious buyer. Its 2.0-liter, 16-valve, 140-hp 4-cylinder engine pulls smartly, and its front-wheel-drive chassis displays surprising balance and cornering power.

The G20 has the feel, both in terms of comfort, general roominess, precise handling and power of several makes costing twice as much. Its appearance is a bit understated for a car with luxury aspirations, but its price of under \$21,000 will make it the perfect third model for Infiniti dealers.

Infiniti's flagship, the Q45, is outwardly unchanged for '91, but the world's first production active suspension system comes aboard as a \$5000 option. At first glance, the price may drive some buyers away from the handling and comfort advantages of an active suspension system, but a



TOYOTA TERCEL LE

foul weather, bad-road demo ride may very well drive them back.

Isuzu

For '91, Isuzu brings to market some

small cars with big technology. After the reintroduction of the Impulse line in late spring of 1990, Isuzu follows with the Impulse RS.

Not a mere case of fancy label work,



PHOTO BY MIKE GASPAR

SPOTLIGHT

Acura NSX

● A great deal has already been written about this new 2-seater from Honda, including our own initial impressions (see [Drive Report, page 106, Sept. '90](#)). And in all this verbiage, you'd have to look hard to find a single criticism. Honda's first foray into the world of world-class sports cars is about as close to perfect as any manufacturer ever gets.

Although there are cars in this price class—about \$58,000—that are quicker in a straight line, the NSX's all-around blend of speed (0-60 mph, about 5.5 seconds, top speed 160 mph), flawless

handling and superb road manners is unique. The 270-hp dohc 24-valve aluminum V6 is spirited, without being quirky. The aluminum-alloy chassis is as flex-free as a railroad trestle. And the leather-lined cockpit is exactly what you'd expect of a supercar—or maybe even a Learjet.

The NSX goes beyond being an outstanding first effort from a company renowned for its first efforts. It's one of those rare cars, sports or otherwise, that sends all the other guys scurrying back to their drawing boards. —Tony Swan



HYUNDAI SCOUPE



NISSAN 240SX



BMW 318i



the RS has a Lotus-tuned suspension system and the sure-footed traction of full-time all-wheel drive. Mated to its turbocharged and intercooled 160-hp, 16-valve, 1.6-liter, 4-cylinder engine and 5-speed transmission, this little terror is a 2+2 sports car with big-buck technology at under \$20,000 fully loaded, including sunroof.

Another new product, conceived to assist in Isuzu's march back into the mainstream car market—the company's already become a sales leader in

the sport/utility segment—is the all-new Isuzu Stylus.

A 4-door, front-wheel-drive chassis designed for the entry-level subcompact class, a crowded segment of the market now shared by some 50 mod-

els, the Stylus is available in three models, with two engine offerings. The top-of-the-line XS has a Lotus-tuned suspension system and a 1.6-liter, twin-cam, 16-valve, 130-horsepower, 4-cylinder engine that pulls the car quite well.

Performance capabilities notwithstanding, interior space and styling are the Stylus's best marketing weapons. The interior is very well laid out and offers a surprising degree of comfort for a car of this class.

From any angle but the front, the Isuzu Stylus draws no particular attention to itself. However, its nose, or more specifically, its grille and lower valance, have a strong European flavor and give the car a purposeful stance.

Mercedes-Benz

Mercedes-Benz is just about standing pat for 1991, with only two model changes planned. Both are content changes to current platforms. The 190E, powered by a 2.3-liter 4-cylinder engine, is back.

Last sold here in 1988, the new 190 looks the same as the current 190 models, and lacks only the 2.6-liter 6-cylinder engine and electric seats to be identical. The 190E 2.3-liter is designed to be the entry-level Mercedes-Benz and is priced under \$30,000—the *only* Mercedes-Benz that can make that claim.

The other new Mercedes model is



SPOTLIGHT

Toyota Celica GT Convertible

● One year after the introduction of the current Celica, Toyota is once again offering a convertible version. And once again, the new ragtop is an improvement on its predecessor.

Like previous Celica convertibles, the new GT is subcontracted by ASC, in Michigan, a company that gets high marks for its conversions. The new GT convert has respectable punch—130 hp—in its 2.2-liter 16-valve dohc 4-cylinder engine, and buyers can choose be-

tween 5-speed manual (standard) and 4-speed automatic transmissions.

The Cambria cloth soft-top is power-operated, stowing neatly beneath a rigid tonneau cover, and the engineering efforts of ASC and Toyota have produced a much stiffer chassis, which pays off with improved handling.

As the photo indicates, the Celica takes well to toplessness. And for affordable 4-seat fresh-air fun, the GT convertible is worth a test drive. —Tony Swan



TOYOTA LAND CRUISER



MERCEDES-BENZ 190E 2.3



HONDA ACCORD EX WAGON

an S-class 350 turbo diesel. A direct successor to the 300SD, the diesel-powered S-class model will not be sold in California.

The resurrection of the 4-cylinder 190 and the addition of the 350 turbo diesel gives Mercedes-Benz 18 cars in its model lineup—its largest line ever in North America.

Nissan

The 240SX has been a real record setter for Nissan, and though it goes largely unchanged for 1991, it does get several welcome updates. For starters, the car gets a facelift or, more accurately, a nose job. Smoother, and more aerodynamic, the fresh

sheetmetal gives the 1991 240SX a more current look. Engine and suspension are the other two areas of refinement. The 2.4-liter, 16-valve, 4-cylinder now makes 155 horsepower, which gives the 240SX one of the best power-to-weight ratios in its class.

The 240SX fastback is available with Super HICAS 4-wheel steering as an option. This package is based on the same system used on the current 300ZX.

Slicker looks, smoother power and better handling, all added to a car that was already a sales success story, should make for some heavy traffic on the floors of Nissan dealer showrooms in 1991.

Toyota

Toyota enters 1991 with the strongest and widest-ranging product lineup in the import market. From pickup trucks to sports cars to sport/utility vehicles to luxury touring sedans to econoboxes, Toyota has it all.

The coveted Land Cruiser gets only better for the new year. Fresh styling, roomier interior, improved comfort, full-time 4-wheel drive and numerous luxury options will likely make this year's hardest-to-get new vehicle even harder to find on a dealer's showroom floor in 1991. But for those who hang in, the wait will surely be worth it.

For all its size, the Land Cruiser is fully off-road capable, with good ground clearance and a supple suspension system—just the thing for big families with lots of camping gear. It's not the best choice for families in a hurry, though. The straight-Six engine, though smooth and torquey, makes only modest power for a vehicle this big.

The all-new Toyota Tercel is one of the few subcompacts to add more comfort and luxury for '91. Available in either a 2- or 4-door model, the Tercel is powered by a 1.5-liter, sohc 12-valve 4-cylinder engine that produces 82 hp and 90 ft.-lb. of torque. For an entry-level product, the car is packaged with plenty of options, which include everything from three types of transmissions to three levels of trim and six different exterior colors—choices not often found on this level of car.

Introduced as a '91 last spring, the 2-seater MR2 adds bright yellow as a color choice. This little exotic continues to please with its low, sleek, expensive looks, its race-car-like handling, its flexible and willing powertrain (with either the 130-hp 2.2-liter, or the turbocharged 200-hp 2.0-liter), and its amazingly affordable price. It's the working class Ferrari, and for that it gets high marks from us.

FM



SPOTLIGHT

Nissan Sentra

● This latest redesign of Nissan's solid-selling subcompact marks an important turning point in its history. As of 1991, the Sentra becomes a car people will covet, as distinct from the kind of car people buy to get from A to B as economically as possible.

Part of this will come from the subdued but tasteful styling, very much in the Maxima/Stanza school, and improved quality inside the car.

But the more compelling reasons are hidden by the new sheetmetal. Although the new Sentra's dimensions are virtually identical with the old, the chassis has been given a thorough overhaul, includ-

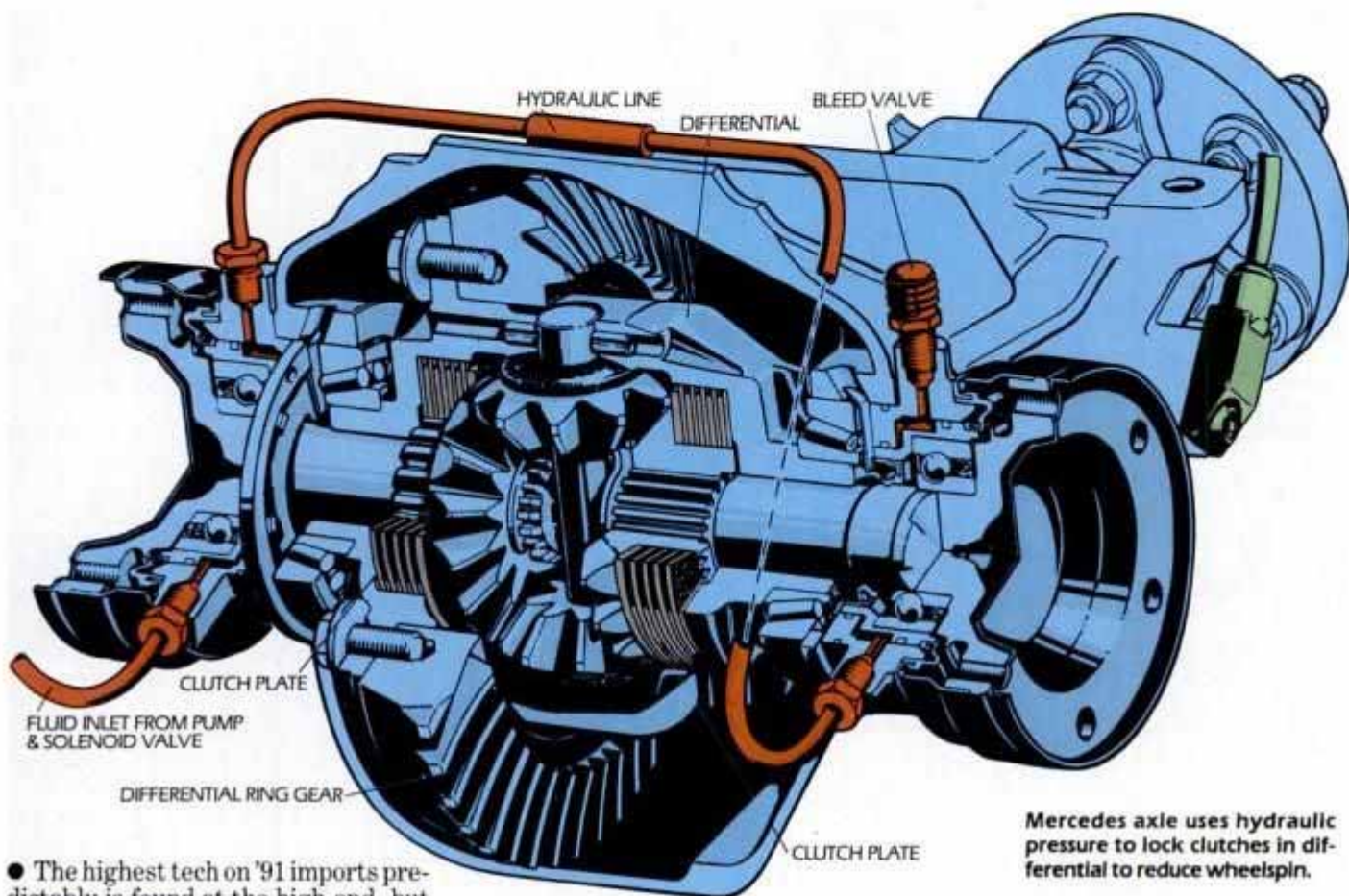
ing a new front subframe and increased front tread. Other suspension elements have been retuned to produce better handling and a marked improvement in ride quality, which now ranks with the best in this car's class.

There's also more muscle, with two new engines. The standard powerplant is a 1.6-liter dohc 16-valve 4-cylinder rated at 110 hp—20 hp more than the previous model—with solid fuel economy ratings to boot: 30 mpg city, 39 highway. If you want more go, the optional 2.0-liter dohc 16-valve 4-cylinder makes 140 hp, giving you the hottest subcompact on your block.

—Tony Swan

INSIDE THE IMPORTS

Engineering leads the way to the changing imported car landscape.



● The highest tech on '91 imports predictably is found at the high-end, but there's engineering action at entry-level, too.

Variable valve timing

The \$60,000 midengine Acura NSX features a new approach to variable valve timing, worth 20 horses on its 270-horsepower 24-valve 3.0-liter V6. The camshafts have groups of three lobes for each pair of valves, with one wide lobe in the center shaped for more lift and different open/close schedules at high speed. All three actuate rocker arms, but at lower speeds, only the outer lobes' rockers operate the valves.

At 5800 rpm, a solenoid valve opens and pressurized engine oil flows through the rocker shaft to a piston in an outer rocker, pushing it partly into the center rocker. This forces the center rocker's piston partly into the other outer rocker, locking the three rockers together. The valves now open according to the more aggressive shape of the center lobe pushing against the center rocker. Close the solenoid valve, a spring pushes back the pistons in the rockers and it's back to normal valve timing. The advan-

tage here is better low-end torque and emissions, and no choking off of the high-end breathing.

The '91 Nissan Sentra gets the variable valve timing system introduced in '90 on Infiniti and 300ZX. It's not as sophisticated as on the NSX, but it brings high-tech down to an entry-level 1.6-liter 4-cylinder that develops an impressive 110 horsepower (69 per liter). Sentra's computer also controls a solenoid valve, through which pressurized engine oil flows into a chamber in a 2-piece hub in the camshaft sprocket. When the computer closes the valve, oil pressure builds and pushes a geared piston that turns the camshaft relative to the sprocket, advancing valve timing, though valve lift and overlap are the same. The result is smoother idling and improved emissions.

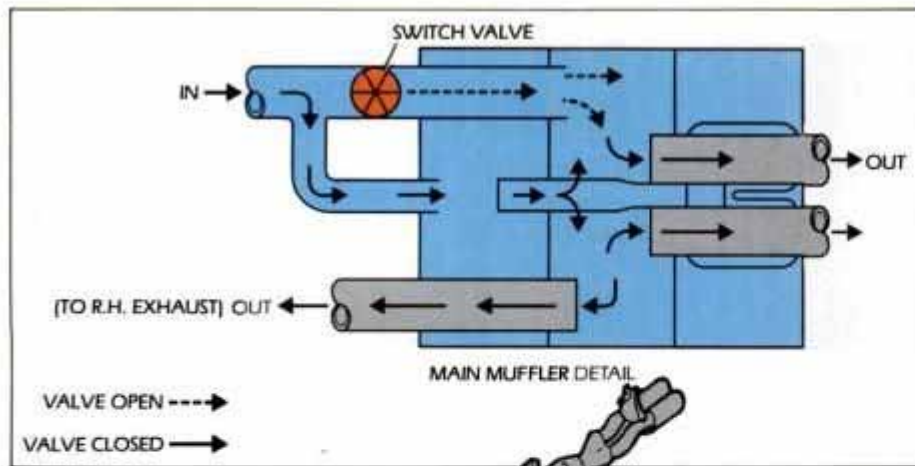
Drive-by-wire

Is all-wheel drive already becoming yester-tech? For maximum traction and no wheelspin on foot-to-the-floor acceleration, a computer-controlled throttle ("drive-by-wire") is a must, even though an opened-throttle fail-

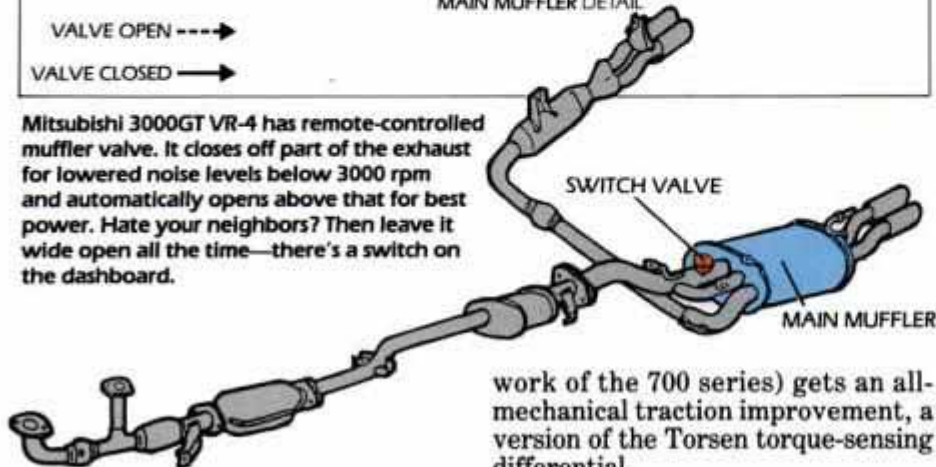
ure has obvious safety ramifications.

BMW and Mercedes-Benz take the plunge in '91, dropping the conventional throttle cable. The gas pedal instead moves a variable resistor, signaling a computer that in turn commands motorized throttle butterflies. These have variable-resistor feedback circuits, so the computer knows where the throttles are, and can compare them with the gas pedal signal for plausibility.

BMW, which is using the system on the 750i and 850i, is "pure." If the computer detects a failure in the throttle plate motors, it provides a limp-home mode based on the gas pedal signal. If the computer thinks the gas pedal signal may be flawed, it shuts down. Springs close the throttle plates and the car won't move. Mercedes, which offers the system on Sixes and V8s with automatic transmission, has a backup cable from the gas pedal to the throttle, permitting up to about 40 percent of full-throttle if the computer shuts down the throttle motor. In either case, when the system is operating properly, the throttle smoothness on both accelera-



Mitsubishi 3000GT VR-4 has remote-controlled muffer valve. It closes off part of the exhaust for lowered noise levels below 3000 rpm and automatically opens above that for best power. Hate your neighbors? Then leave it wide open all the time—there's a switch on the dashboard.



work of the 700 series) gets an all-mechanical traction improvement, a version of the Torsen torque-sensing differential.

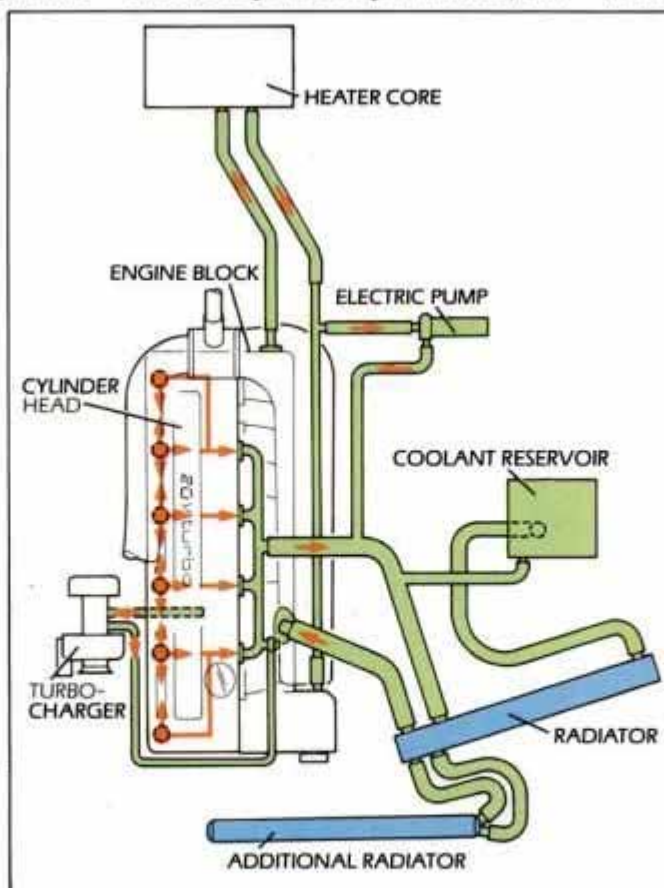
Turbos, torque and horsepower

Turbos usually mean top-end torque and horsepower improvement, and

tion or deceleration is spectacular. And with logic from wheel-speed sensors added to the mix, there's never any wheelspin to boot.

Mercedes-Benz is offering a dual-traction enhancement on Fours, plus Sixes with manual transmission: a rear axle with both mechanical and electronic-mechanical lock-ups. Like BMW, Mercedes uses wheel-speed sensors to sense a slipping wheel, and then clamp the brakes on the offender. At the same time, throttle opening is closed by the engine computer to reduce horsepower until the tire regains traction. This system is operating full-time, at any speed. The electronic system disengages above 15 mph, when it could adversely affect handling. But it's really intended to improve starting from a standstill on slippery surfaces. It uses a separate hydraulic pump built into the power steering pump to provide hydraulic pressure. When wheelspin is sensed, a valve opens, clamping a pair of clutch packs and effectively locking the rear differential, without the harshness and noise associated with full-time limited-slip.

Volvo's new 940 series (a mildly aero rear-body re-



Audi 5-cylinder has crossflow cooling for reducing hot spots, two radiators for ample cooling and an electrically run coolant pump to provide after-shutdown cooling for turbocharger bearings.

'91 has its examples. But smaller, quick-spin turbos are available, and there's a pair of cars that set the turbo blades and boost to provide lots of torque benefit at low end.

The **Subaru Legacy** 2.2-liter 16-valve 4-cylinder, for example, gets a turbo that has much of the boost in by 1750 rpm, and by 2800, the torque is at peak—181 ft.-lb., compared with 127 at 4400 for the standard engine. Horsepower rises from 130 at 5400 to 160 at 5600, a more modest gain.

Audi's 2.2-liter 20-valve 5-cylinder in the 200 Quattro is a long-stroke engine (which normally gets lots of low-end torque) and does even better with a turbo. Torque goes up from 177 ft.-lb. at 3000 rpm to 228 at only 1950 rpm. Horsepower rises from 162 at 5000 to nearly 100 hp per liter—217 at 5700 rpm.

Much attention was paid to the 200 Quattro Turbo cooling system—coolant flow is across the cylinder head to maintain even temperatures, and there's a twin-radiator design for adequate cooling in peak operation. In addition, if the coolant is hot, an electric pump turns on when the engine is turned off, circulating coolant briefly to cool the turbo's sensitive center bearing.

Mitsubishi's 3000GT sports coupe, with its all-wheel drive, 4-wheel steering and such options as a 300-horse turbo 3.0-liter V6 and computer-controlled automatically deployed rear spoiler and front airdam, is absolutely loaded with high-tech. One of the more novel features, however, is a dual-mode muffer. Coupled with the twin intercoolers and turbos, center and rear differentials with viscous-coupled limited slips, 24 valves, four camshafts, 4-wheel steering and ABS, it's a heavy but stunning performer, able to leave many more expensive cars in the dust.

After a year's absence, the turbo returns on the **Porsche 911** 3.3-liter Six, about the last of the air-cooled breed. Porsche has refined the air-intake and exhaust systems, added a larger turbo intercooler and rewritten the computer ignition timing map to produce increases throughout the range, with the peak numbers showing up at higher rpm. Turbo engine horsepower and torque go from 282 at 5500 and 288 ft.-lb. at 4000 to 320 horses at 5750 and 332 ft.-lb. at 4500.

(Please turn to page 76)

FAST FERRY

A new breed of cat breaks the transatlantic record, and enters service as a 50-mph car-and-passenger ferry.

BY ABE DANE, Science/Technology Editor



● Shortly after dawn on the peaceful waters of Massachusetts' Taunton River, seafarers looked up from their labors to behold a bizarre sight. Gliding past still-sleeping villages on a pair of razor-thin pontoons, a towering white vessel made its way quietly inland. Jutting down from its underside was a sharp, hollow-ground wedge that skimmed a few feet above the water, a keenly honed cutting implement intended to slice through rough seas at high speeds.

Phones were soon ringing at local newspapers and TV stations as baffled mariners sought to learn what brought this peculiar conglomeration of sharp edges and acute angles to these normally predictable waters.

It turned out that what they had glimpsed was an unintended preview of the future of high-speed water transport. The craft, christened *Hoverspeed Great*

Britain, was scheduled to make its formal debut a few days later in New York Harbor. Afraid that leaks would undercut the fanfare they had planned, the owners stayed mum.

But POPULAR MECHANICS had been following the progress of the vessel since its beginnings at the International Catamarans shipyard in the distant town of Hobart, Tasmania. Commissioned by Hoverspeed of England, the all-aluminum 243-ft. craft had been built to bolster the company's hovercraft fleet in anticipation of competition from the coming tunnel under the English Channel, scheduled for completion in 1993. Able to continue high-speed running through seas that would shut down hovercraft operations, the wave-piercing catamaran, it was hoped, could save the trans-channel car-and-passenger ferry industry.

FAST FERRY



But the toughest test of the *Great Britain's* speed and seakeeping would come a few days later, when it set out to challenge a 38-year-old record for the fastest crossing of the Atlantic by a passenger vessel (see "To The Victor Goes The Hales," below). To get to know the craft, I accompanied the crew on an overnight voyage from New York to Gladding-Hearn Shipbuilding in Somerset, Massachusetts, where it underwent last-minute fitting out before embarking for England.

On the bridge

Arrayed below a curved windscreen running nearly the full 86-ft. width of the vessel, computerized nav instruments give the darkened bridge the appearance of a quiet video arcade.

John Lloyd, the ship's master, is testing controls that direct thrust from two massive, Italian-built waterjets mounted at the rear of each pontoon. Each maneuvering jet is paired with a nonsteerable boost jet that cuts in for high-speed running.

Lloyd twiddles two joysticks used to control the jets' steering and reversing buckets in low-speed maneuvers. Ceiling-mounted dials indicate the response to his inputs. At first, one of the jets won't steer, but within a few minutes the problem is traced to a circuit breaker and set right. Word comes from the engine room that the maneuvering engines are ready, and we cast off.

Backing the vessel gingerly out of its downtown Manhattan slip, Robert

Clifford, managing director of International Catamarans, stands in the starboard bridge wing, working a duplicate set of joysticks. Clear of the wharf, the flip of a switch cuts in a computer that coordinates the movements of the steering buckets with those of a small, stainless-steel steering wheel at the center of the bridge. "This is wild," exults the harbor pilot.

As we pass the Statue of Liberty, two of the four engines ticking over lazily are enough to push the slender hulls through the water at 10 knots. Clifford, watching the engine rooms on a video monitor, orders the engineers below to start the boost engines.

Gathering speed, we head toward the Verrazano Narrows Bridge, its lights casting a glowing white curtain

SEA CONTAINERS PHOTO

To The Victor Goes The Hales

● By averaging 36.966 knots over 3000 miles, the *Hoverspeed Great Britain* shaved 2 hours and 45 minutes off a transatlantic record that had stood since 1952. She also sparked some controversy by claiming the coveted Hales Trophy, a 4-ft., gilt silver bit of hardware held for 38 years by the now-retired SS *United States*.

Considered by many to represent the pinnacle of a golden era in ship design, the 990-ft., 240,000-horsepower *United States* bested such seagoing greyhounds as the *Queen Mary* and the *Normandie*. According to Frank Braynard, curator of the U.S. Merchant Marine Academy Museum, where the *Hales Trophy* now rests, a relatively light craft such as the *Great Britain* is not a fitting successor to the great ocean liners of the past.

But the trustees of the trophy saw it differently, and in July of this year, ordered that the cup be sent back to Britain.

—A.D.



Record runs of the magnificent *United States* (top left) and challenger *Great Britain* are compared (above). At stake was the Hales Trophy (top right).

PH ILLUSTRATION BY PAT RUGGERO; BETTMANN ARCHIVES PHOTO

Inside The SeaCat



Great Britain holds 80 vehicles on its car deck, and 450 passengers in airline-style seats above.

across the dark waterway. All four engines are now at 600 rpm, well short of their 774-rev maximum. At 22 knots, the vessel seems to move as effortlessly as it had at 10—one advantage of burying the noise of the engines far below in the pontoons.

The mouth of the harbor approaches, and swells increase to 6 ft. With our speed creeping up past 39 knots, white shavings of spray curl back from the tips of the pontoons as they spear through the waves. On the bridge, the wave motions can be felt now. But there is no pitching or rolling to speak of, just small, well-damped movements that feel like turbulence in an airplane. Stephen Quigley, project manager for IN-CAT, the Australian company that designed the *Great Britain*, explained that one of the main strengths of wave-piercing vessels is that it doesn't get much worse than this. Even in far rougher waters, the ship will continue to bore through, rather than ride over the waves.

Into the pontoons

With the ship on course for Somerset, things settle down on the bridge, and William Perkins, head engineer, offers to take me below to see the powerplants. On the way down, we pass through the main passenger space. Empty of seats that will eventually hold 450, it looks like a vast, carpeted ballroom. Off-duty crewmen bed down in sleeping bags in the corners, since the short-haul ferry lacks sleeping quarters.

Access to each engine room is through a companionway atop the rear of each pontoon. Perkins opens a hatch and a truly painful blast of noise strikes my ears before he can hand me a set of ear protectors.

Below, staggered one behind the



Great Britain, welcomed by fireboats in New York (top), has a race-car-size helm (above left), flanked on right by radar and throttles for 16-cylinder diesels (above right).

other to fit into the narrow pontoon, two shiny new 16-cylinder Ruston diesels deliver 5000 hp each to shafts driving the jet impellers directly through sealed thrust bearings. The engines' low operating speed eliminates the need for gearboxes. Sticking up between the cylinder banks are immense turbochargers, which force-feed air and a little over 5 gallons of fuel to each engine every mile at cruising speed. Although heavier than some other propulsion options, the turbodiesels are strong on reliability and fuel efficiency.

The racket reverberating within the aluminum-walled chamber is so intense that Perkins and I can communicate only by written notes. Fortunately for the engineers, an elaborate electronic engine-monitor-

ing system lets them keep an eye on every imaginable operating parameter from the bridge, rather than lingering below.

Up from the infernal depths, I step into the quiet of the deserted bar and settle back on the virgin cushions of a banquette, imagining the crowds of convivial holiday-makers that will soon inhabit this space. A total of 10 of these wave-piercing craft will make their way from Tasmania to the English Channel over the next few years. There, they will eventually replace the slightly faster, but far less seaworthy and efficient, hovercraft altogether. But before this bar serves its first drink, the *Hoverspeed Great Britain* has the Atlantic Ocean to cross. It's too bad I'm getting off at Somerset.

PM

PHOTOGRAPHY

POINT AND SHOOT SHOW

We put five radical new cameras to the test.



● Combine many of the features of a modern 35mm single lens reflex (SLR) camera with the auto-everything operation of a compact point and shoot 35mm and you've got the latest in picture-taking: the compact, lens/shutter 35mm zoom.

Zoom is the operative word here. These new breed cameras all sport an integral power zoom lens, covering focal lengths in the moderately wide to telephoto range between 35- and 105mm. Touch a button and the lens flies in and out of the camera body, bringing distant subjects closer or offering a wider view of the world. The five cameras evaluated here have the biggest zoom lenses in the point and shoot category.

Though these cameras all fall in the 35mm lens/shutter category, they offer much more than ordinary snapshot cameras. They have auto-everything operation (load, wind, rewind, focus and exposure included), plus enough overrides and options to make them attractive to the most avid photo fan. The prices on these cameras also separate them from the simple point and shoot models—most have a suggested retail of around \$500, though some judicious shopping will land one for less.

The zoom lenses are integral to the body designs of the cam-

DOWN

BY GEORGE SCHAUB; PM Photos by Michel Tcherevkoff



eras. Unlike an SLR, they cannot be interchanged for other lenses. You don't see focus shift when you zoom, just the framing of the picture. The autofocus systems confirm sharp focus by some form of "focus OK" signal. The thinking behind these cameras is that the lens range is sufficient to most picture-taking needs.

The cameras we're covering here are the current crop—more will probably follow. To see how these cameras stack up against one another, PM decided to put them through a series of tests. Along with general handling, PM tested flash coverage, lens resolution and red-eye effect. These are home-grown tests, ones you can try yourself with practically any camera system (see "Tests You Can Do" on page 37). Finally, we compared them on a feature-to-feature basis. Some have surprisingly sophisticated

The Olympus SuperZoom 330 and the Canon Photura 35mm cameras are radically designed for 1-handed picture taking. Both feature fingertip control of the 35-105mm zoom lens.

POINT AND SHOOT SHOWDOWN



Canon Photura

The flash is fitted onto the inside of the lens cover. The flash zooms in and out in tandem with the lens.



operating systems, compliments of the microcomputers and intelligent programming of their internal works.

The lineup

The zoom compact crop includes the Canon Photura (\$500), Fuji Discovery 2000 (\$420), Minolta Freedom Zoom 105i (\$512), Olympus SuperZoom 330 (\$610) and the Pentax Zoom 105 Super (\$438). The hallmark of this group is bold new body design—the Pentax and Fuji are the most conventionally styled, while the Canon entry is the most avant garde.

The lens and focusing systems are at the heart of these cameras. Most focus automatically as close as 2.3 ft., though some rely on "macro" (close-up) switches to get that close, or can only focus as close as about 4 ft. with the lens at telephoto position. The same goes with the flash coverage range. All can cover subjects about 15 ft. away with the lens at the wide-angle setting and ISO 100 film in the

camera, but in almost every case, this falls off to about 10 ft. when the lens is at tele range. Why is this?

If you check the lens specs, you'll notice that the maximum aperture (the f-number) shifts as you go from wide to telephoto. The lower the number, the wider the opening in the lens diaphragm—thus, more light gets in. This shift occurs on many SLR zoom lenses as well. It's a price you pay for making complex, compact lenses.

But the aperture shift in SLR zooms is nothing like you see in some cameras here. For example, the Fuji Discovery 2000 zoom camera shifts from f/3.9 to f/9.5 when you go from wide to tele, and the flash coverage distance is almost cut in half. This characteristic is shared by all cameras in this class, except the Canon Photura. Though the maximum aperture



Pentax Zoom 105 Super

The zoom lens moves in incremental steps or in one continuous motion.



Olympus SuperZoom 330

The lens cap of this camera doubles as an infrared control, so you can get yourself into the picture more easily.

does change, the Photura keys flash output to focal length and offers a constant 20-ft. coverage throughout the entire range. All the cameras have compensating flashes, but the Photura's the only one that doesn't drop off dramatically in tele range.

This dropoff can be disconcerting. One of the reasons you'd use a tele setting is to get closer to distant subjects. However, if that subject is more than 10 ft. away, it won't be well-exposed if you use flash in a dim-lighting situation. Fortunately, there are two solutions to this problem. One is to load your camera with a faster film, such as an ISO 400 speed. This brings all of these systems to the 20-ft. flash-coverage range. Another option, available with the Fuji model, is

CAMERA SPECIFICATIONS AND DIMENSIONS

| CAMERA | Canon Photura | Fuji Discovery 2000 Zoom | Minolta Freedom 105i | Olympus Super-Zoom 330 | Pentax Zoom 105 Super |
|-----------------------|--|--|---|--|--|
| AF ZONES | 188 | 48 | N/A (CCD Sensor) | 200 | 24 |
| FOCUS RANGE | 2.6 ft.-infinity (1.8 ft. w/acc.) | 4.3 ft.-infinity; macro (2.6-4.3 ft.) | 2.3 ft.-infinity (4 ft. min. w/105mm) | 2.6 ft.-infinity (4.3 ft. min. w/105mm) | 4.4 ft.-infinity; 2.5-4.4 ft. (macro); 1.5 ft. (super-macro) |
| LENS | 35-105mm f/2.8-6.6 | 40-105mm f/3.9-9.5 | 35-105mm f/4-6.7 | 38-105mm f/4-5.6 | 38-105mm f/4-7.8 |
| FLASH RANGE (ISO 100) | 2.6-19.7 ft. | 2.6-20 ft. (wide); 4.3-11.6 ft. (tele) | 2.3-18 ft. w/35mm; 3.9-10.8 ft. w/105mm | 2.6-15.4 ft. w/38mm | 4.4-16.5 ft. (wide); 4.4-10 ft. (tele); 2.5-4.4 ft. (macro); 1.5 ft. (super-macro) |
| ISO RANGE | 25-3200 | 50-1600 | 25-3200 | 25-3200 | 25-3200 |
| WARNINGS | Too close, shake, flash | Too close, flash | Too close, flash | Too close, flash | Too close, flash |
| WEIGHT/SIZE | 21.3 oz./3 3/8" x 2 1/8" x 5 1/2" | 17.6 oz./5.9 x 3.3 x 3" | 19.75 oz./6 x 2 1/2 x 3 1/2" | 21.5 oz./5.4 x 3.1 x 3.9" | 16.9 oz./5.6 x 3.2 x 2.7" |
| PRICE | \$500 | \$500 | \$512 (\$462 black) | \$610 | \$507 |
| SPECIAL FEATURES | Eye-level finder; 3-point AF (wide AF detection zone) smart framing; camcorder-like grip | Accessory flash; slow synch flash | TTL autofocusing; Advanced Program Zoom; Predictive AF; wide AF detection zone; Eye-start operation | Portrait and closeup zoom modes; spot metering; remote control | Step and continuous zoom; interval timer; 1-60 second shutter speeds; super-macro; multiframe self-timer |

to mount an auxiliary, more powerful flash on the camera.

Programmable options

All of these cameras are "user-programmable," that is, you have some degree of control over exposure and/or creative shooting techniques. For example, you can choose to have the flash on all the time (useful outdoors when your subject is backlit or in the shade). You can defeat the flash (for available light shots indoors when the flash ordinarily kicks on automatically). And in some cases, you can have the flash go off during a long exposure. Called "slow synchro flash," this comes in handy with night or interior shots when you want to have both the foreground and the background detail in the picture. The Olympus and Pentax models also allow you to override exposure, known in the trade as exposure compensation. This means you



Minolta Freedom Zoom 105i

The 105i begins working automatically as soon as you bring the camera up to your eye.



can add or subtract exposure time manually. This comes in handy when you want to bracket exposures, important if you want to shoot slides or

want to get the best results in high-contrast shooting conditions. Olympus, Pentax and Fuji offer multiple exposure on one frame for special effects. Pentax offers an interval timer for sequence shooting, and almost all have motorized consecutive shooting for action events.

A common problem in point and shoot 35s has been red-eye, those glowing circles of red that surround subject's pupils in flash-exposed pictures. This occurs because the flash is mounted too close to the lens on compact camera bodies. Three of the cameras in our group have new red-eye reduction systems, all based on the premise that the pupil will constrict if exposed to a bright light prior to the actual flash picture being made.

Smart features

Some of the built-in features on these cameras are downright amazing, though some of the buzzwords need explaining. For example, the Pentax Zoom 105 Super has both continuous and "step" zoom operation. The step zoom moves at set intervals. Hit the continuous option and you speed along until you take pressure off the zoom control.

The Minolta Freedom Zoom 105i has an Advanced Program Zoom, a compositional tool that actually picks what it considers the best framing for subject matter. Don't agree with the camera? Override it by activating the zoom control to a framing of your lik-

Tests You Can Do



Children can sometimes look devilish (left), but red-eye reduction makes them look angelic.

● PM designed its tests so that each camera could be judged on performance rather than on how it makes a needle jump or a gauge fluctuate. Also, our tests can be performed easily by you at home and can be applied to almost any camera, flash and lens system. To test flash coverage, PM set up each camera 2 meters from a white board in a darkened room and set off the flash at the minimum, maximum and halfway point in the zoom range. Negatives were then inspected for flash falloff at the edges of the frame.

To test lens sharpness, PM set up a newspaper at the same 2 meters and shot pictures at the same focal length ranges as the flash test. We then enlarged the negatives to 8 × 10 in. and visually inspected the prints.

To test red-eye effect, PM photographed a young child in a darkened room at 2 meters at the three focal length ranges. If a camera has a red-eye reduction mode, we used that for the test. Prints were made of the exposures.

These tests were made with one camera from each of our models. Naturally, some manufacturing leeway should be allowed for and considered when judging these tests. Here's what we found.

Our sharpness test indicated that all cameras deliver acceptably sharp pictures at all settings, a fact borne out by field shooting lat-

er. Though images do not have the crispness delivered by the best 35mm SLR lenses, they rank among the best with cameras in the lens/shutter class.

According to our tests, flash falloff at the wide-angle setting was endemic to all cameras. This means that the center received more light than the edges of the picture frame. In no case was falloff severe. (Keep in mind that falloff also occurs with some mounted flashes on SLRs as well.) Falloff becomes virtually unnoticeable at other than wide-angle settings.

Our tests show that the red-eye reduction systems in the Canon, Minolta and Olympus models work. Red-eye was present with the Pentax and Fuji cameras. It should be noted that red-eye was present in the normal auto-flash mode with the Olympus camera—you have to anticipate red-eye and switch to the red-eye reduction mode to eliminate it. With the Canon and Minolta cameras, the red-eye reduction systems came on automatically.

Both the Olympus and Minolta red-eye systems work with a pre-flash system. This means you have to prep subjects to hold their pose—something kids seem baffled by. The Canon bulb/spotlight system didn't cause this kind of confusion.

—G.S.



Fuji Discovery 2000

Your fingers fall naturally to the controls with this comfortable camera. Eyepiece is rubberized, a plus for eyeglasses.



ing. Photura has a similar system called Smart Framing, while the Olympus has an automatic framing feature that you program in.

The Minolta Zoom 105i also has an Eye Start program. Once you turn on

(Please turn to page 89)

10 GIFTS YOU WON'T BE GETTING FOR CHRISTMAS

...unless your Santa lives in Japan. Here's a look at some neat items you can buy there, but not here.

BY BRYAN HARRELL



Translator Pen

Epson's TRAN PRO-1000 Cyber Translator (\$230) can recognize 30,889 English words in Gothic type between 8 and 20 points in size. Scanned words are shown on the screen for confirmation, then translated into Japanese at the touch of a button. Also doubles as an English to Japanese electronic dictionary. Whether Epson develops other pen translators remains to be seen. But just imagine being able to scan a restaurant menu in Paris. You won't have to consult a waiter. I'll skip the frog legs, thanks just the same.



Wireless Printing

No more computer wiring headaches! Just connect the PC module (\$500) of Nippon Denshin Kogyo's SKIP-LINK wireless printer interface to your laptop computer and the printer module (\$570) to your printer, and print the files quickly and easily.



Robot Vacuum Cleaner

Panasonic's Home Cleaning Robot vacuums your house automatically at any time. It moves unobtrusively around furniture and other obstacles, and almost silently vacuums about a foot a second. When the Robot encounters extremely dirty areas, its "fuzzy logic" (artificial intelligence) tells it to work the area thoroughly until the job is done. Cleans for 20 minutes on a charge.



Palm-Sized Fax/Copier

Scan any document with Fuji Xerox's FAX Sharaku (\$640), then set it in the fax adapter base and fax the document to any G3 machine. If you're sending to another FAX Sharaku, the printout can be in one of 18 different user-selected colors. It can enlarge a document to 200 percent or reduce to 50 percent.



Wireless Walkman

Sony's new WM-805 Wireless Walkman (\$260) not only delivers the music without the wires, but also features wireless remote control of tape functions from the tiny LCD-equipped receiver unit. The Walkman, meanwhile, stays out of sight in a pocket or bag. Transmissions are done using a radio (RF) signal.



A TV To Sleep By

Clamp the gooseneck of the tiny Seiko LVD-503 alarm/color television (\$430) to your bedpost and doze off while watching the late movie. The LCD TV wakes you up with computer graphics full of birds and the morning sun. When you're not watching TV, the screen can be set to show the time.



Books On Disc

Sony's DD-1 DATA Discman (\$415) let's you listen to books recorded on 3-in. compact discs. Each disc can hold up to 200 megabytes of data, which makes for quite a lot of reading. Current software is of the reference variety, such as dictionaries, music CD catalogs, medical guides for the home and a businessman's guide to North America. More titles are expected.



Cordless Listening

Listening to music with headphones is enjoyable but the cord connected to the stereo system limits your mobility.

Hitachi's FX-99 model (\$850) sends a radio signal to the remote control supplied with the system. The headphones plug into the remote control for maximum mobility. Since the signal to the remote is RF, you're able to wander around the house with no wires encumbering you—the umbilical cord is cut.



Electronic Car Navigation

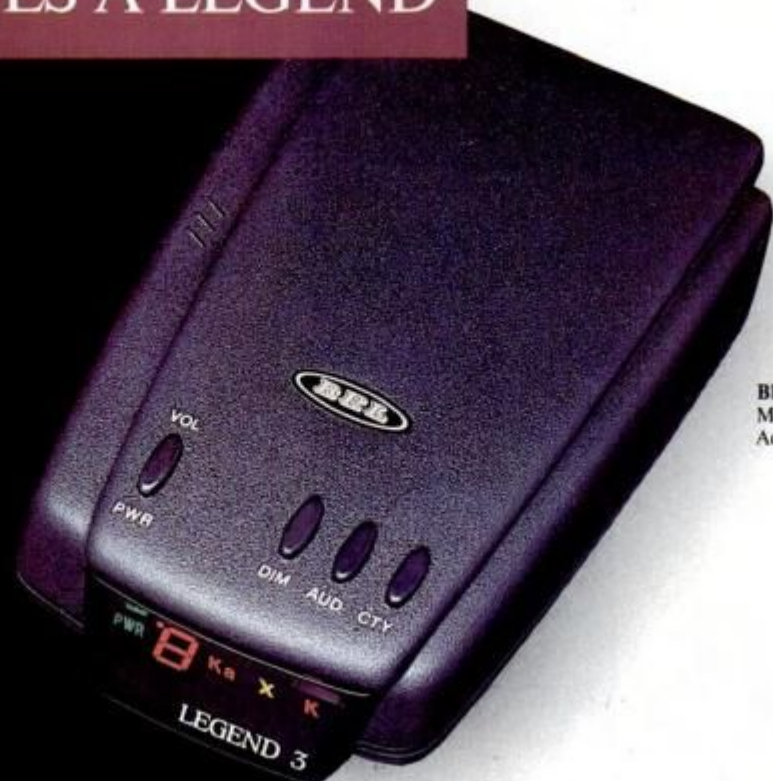
Available as an option (\$2150) on its high-end domestic models, Nissan's Multi A/V System incorporates a navigation system that uses an electronic compass and sensors on all four wheels to keep track of a car's location. Maps of Japan are stored on CD-ROM and shown on the system's 6-in. color monitor. Map scale is variable. Also provided is a full-blown stereo system to enjoy along the way. TV reception is also possible, but only when stopped.



Computer Pen

Imagine how big a keyboard you'd need for the thousands of Chinese characters used in Japanese. Sony engineers didn't care to think about it too much, so instead, they came up with the PalmTop PCT-500 (\$1400). This computer recognizes up to 3500 characters hand-written on the unit's pad with a special pen. The internal 320 KB RAM holds over 100 pages of data. **FM**

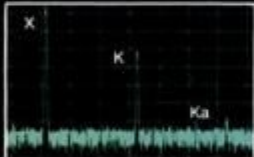
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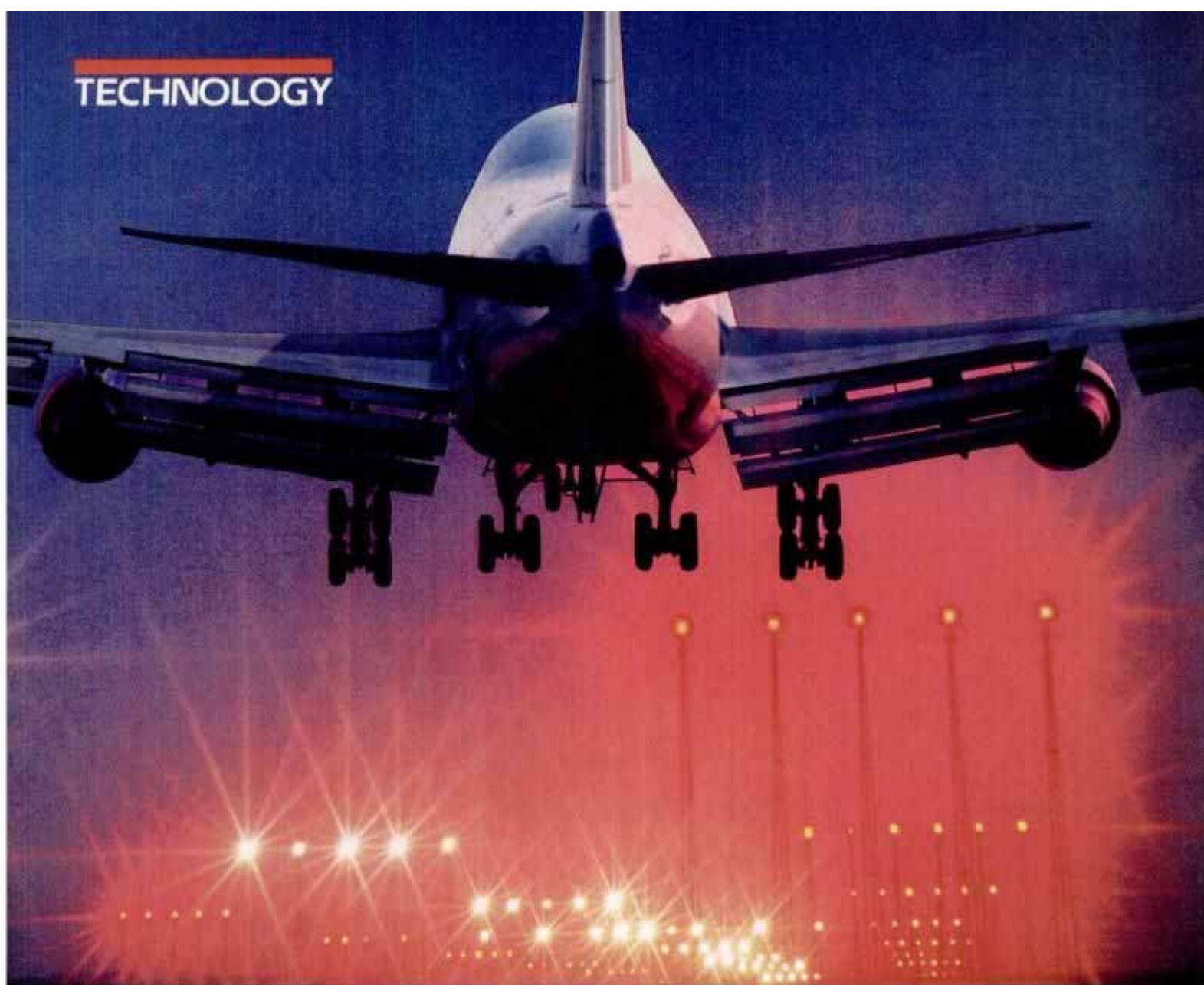
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HAPPY LANDINGS

● August 2, 1985, Delta Flight 191 was on its final approach to Dallas/Fort Worth Airport. As the flight crew settled in for landing, the wide-bodied jet entered a strong head wind and began to rise out of its glide path. Reacting as trained, the pilot cut power to keep on course. Suddenly, the head wind disappeared, a downdraft struck, and the plane dropped sharply. The pilot desperately hit the throttle. But by the time the engines spooled up, the downdraft had turned into a tail wind. The crew was helpless as airspeed plummeted, lift evaporated, and the aircraft plunged into the ground. One hundred and thirty-seven people died.

Adding an ironic twist to the tragedy is the fact that technology exists that could have prevented it. But it's hardly a quick fix. Working improvements into the aging and labyrinthine,

With our aging and overloaded air traffic control system near the breaking point, the race is on to bring in new technology.

BY WALTER SORRELLS

thine, albeit remarkably reliable, system, which has evolved to guide air traffic from place to place, is a huge and delicate task.

The Federal Aviation Administration's response to the challenge is a multidecade initiative known as the National Airspace Plan (NASPlan). Begun in 1981, NASPlan consists of about 100 separate projects with a total cost of \$15.8 billion.

The overall aim is to upgrade air traffic control facilities, improve air-

craft avionics and generally prepare our commercial aviation system for the century to come. In the following pages, we'll highlight the key NASPlan projects.

What happened to Flight 191?

Why did an experienced pilot with a healthy airplane fly into the ground? The answer has little to do with either pilot or plane. Flight 191 had the bad luck to run across a peculiar meteorological phenomenon called a microburst.

Microbursts are the most deadly form of wind shear—which, broadly speaking, is simply a sudden shift in the direction of wind. Microbursts are unusually strong downdrafts, generally no more than a few miles in diameter. They are also the biggest killers in our skies. An estimated 30 acci-

HAPPY LANDINGS



ILLUSTRATION BY DEAN ELLIS

TDWR alerts tower to microburst on glide path, so controller can warn pilot away.

dents have been caused by wind shear since 1964, with several of the crashes resulting in more than 100 deaths.

But a solution is on the way. Over the next few years, a high-resolution radar system that will allow air traffic controllers to identify deadly microbursts with great accuracy will be installed in major airports throughout the country.

Built by Raytheon, the Terminal Doppler Weather Radar will be installed by the FAA in 47 locations across the U.S. by late 1994.

TDWR works by sending out S-band radio frequency pulses at 1-microsecond intervals. These bounce off of rain, or even wind-borne dust and insects. By measuring the Doppler effect (slight shifts in the frequency of the returning signal), the radar determines not only the relative distance of a target, but also its movement toward or away from the receiver. Computers scrutinize the patterns of the wind, revealing the location of wind shear. Monitors in the control tower display the information, which is then passed on to pilots.

Raytheon expects to have a prototype up and running by late this year. If TDWR performs as expected, says Thomas McDonagh, Raytheon's program manager for the project, "Things like [Flight 191] shouldn't happen anymore."

Advanced automation

The core of the FAA's NAS-Plan is a massive project to replace the guts of the air traffic control system—the so-called Advanced Automation System—with all-new hardware and software.



SIGMA PHOTO

The tragedy of Flight 191 spurred research into microburst detection.

With 20 en-route centers and hundreds of tower control centers to overhaul without a minute's interruption in service, it's a project that one former FAA manager likened to changing the tires on a moving truck.

The program will cost a tidy 3.5 billion dollars, but Charles Stith, manager of the FAA's Air Traffic Control Automation Division, justifies it this way: "We were running on 15- to 20-year-old technology. It was becoming very difficult to provide logistics support. [The system] was running out of capacity." The IBM 9020 mainframe



High-resolution consoles form the heart of the FAA's Advanced Automation System. Raytheon will install more than 5000 of them.

computers that drove the 20 en-route air traffic control centers were built in the late '60s and, in many respects, had performance levels below those of current personal computers. In short, system reliability was quick-marching toward the brink.

The FAA blueprint calls for a 5-stage solution: First, get rid of the old 9020 mainframes. This stage is already complete. IBM, the prime contractor for the AAS program, has replaced the 9020s with IBM 3083 "host" systems—newer, faster computers that employ the old software. Why no new software? Because the FAA wants to avoid procedural changes that might lead to dangerous mixups in the tower.

Next, IBM will replace the geriatric interfaces, some of which still employ vacuum tubes. These new programmable interfaces connect tower computers to external systems, such as radars, and will make it easier to update radar and other peripheral equipment without having to tear out tower equipment.

The third phase of the AAS program will be to put in new terminal displays. These displays will be engineered with the latest graphic technology, including raster imaging, color and windowing. A prominent feature of the new displays will be their ability to replace paper flight strips, which controllers currently slide around on racks to keep tabs on aircraft locations.

The fourth step in AAS will require updating the aging ATC software and replacing the host platforms with fresh gear. Finally, and roughly concurrently with step four, the FAA will consolidate its en-route and terminal air traffic control operations, which are run separately.

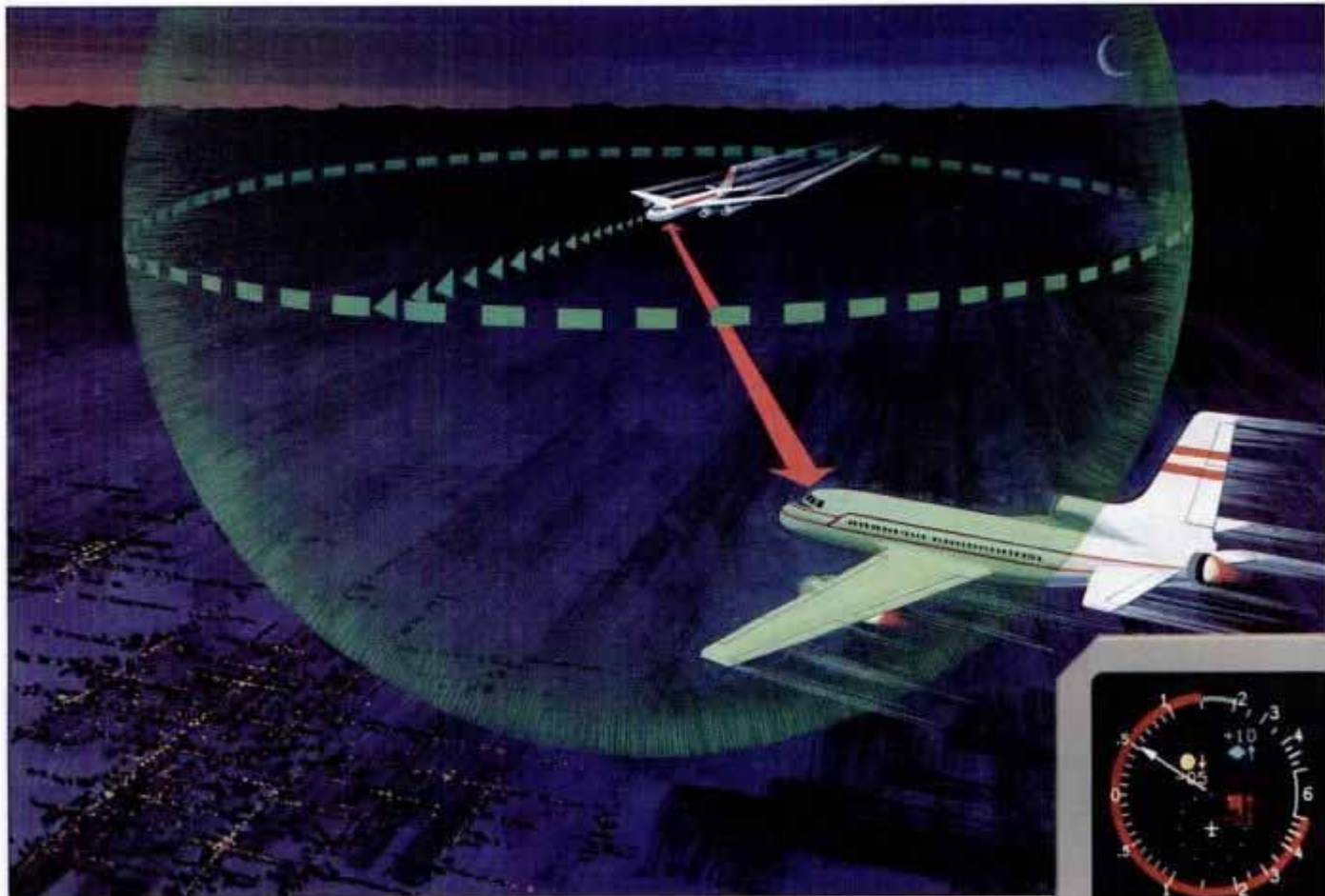
TCAS: Traffic! Traffic!

As a result of occasional equipment problems, air traffic controllers are not always able to spot small private planes on their radar. These blind spots can be fatal. In 1986, for instance, an Aeromexico DC-9 slammed into a Piper Warrior over Cerritos, California, killing everyone aboard. Controllers never even saw the Piper.

In order to head off this kind of tragedy, the FAA has pushed development of the Traffic Alert and Collision Avoidance System (TCAS), which provides a cockpit readout of nearby air traffic.

The mainstay of the collision avoidance program,

RAYTHEON PHOTO



PH ILLUSTRATIONS BY DEAN ELLIS; ROCKWELL INTERNATIONAL PHOTO

TCAS-II-equipped aircraft entering sphere defined by transponder signal aboard aircraft at center responds by interrogating for altitude, name and type of aircraft. Relative bearing and velocity appear on screen (right).

TCAS-II, has been mandated for installation on all commercial aircraft with 30 or more seats by the end of 1992. TCAS-II relies on information from transponders aboard other aircraft to map out their locations in the nearby airspace. Mode S transponders required on every commercial aircraft will transmit information on the altitude, name and type of aircraft they are attached to. TCAS-II uses this information to calculate the relative bearing and velocity of the planes around it.

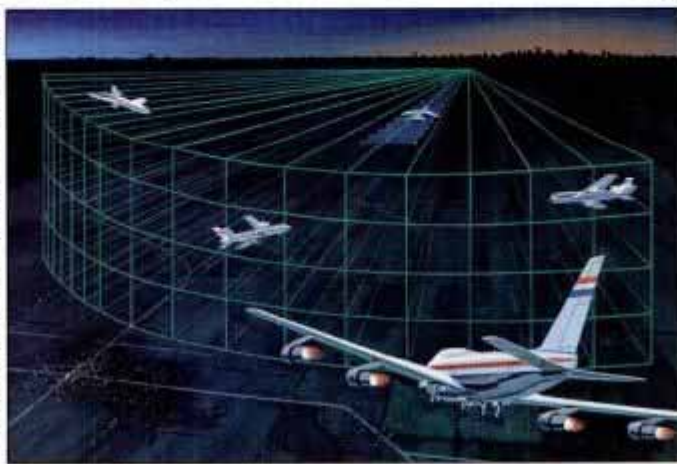
TCAS-II not only shows the location of surrounding aircraft, it also calculates trajectories of the aircraft it is tracking, warning the crew of potential collisions. In its first level of notification, TCAS-II causes the color of the target aircraft to change on the cockpit radar screen while the message *Traffic! Traffic!* bursts out over the audio system. If the conflict is not resolved, the target turns red on the screen and the message *Climb! Climb!* or *Descend! Descend!* fills the cockpit.

If the Aeromexico flight crew had heard that mes-

sage, there would have been a near miss, a bump for the passengers, a few more gray hairs for the flight crew—but no tragedy.

Clouds over MLS

Another important FAA program, the Microwave Landing System (MLS), guides aircraft to the runway when clouds of rain prevent safe, visual landing approaches. The MLS will probably replace the current Instrument Landing System (ILS) at most major airports. Why abandon the ILS in favor of the new MLS?



Microwave Landing System can guide in aircraft on curved approaches, allowing more planes to use the runway without crowding them.

First, the ILS is in danger of hitting a capacity wall. In some areas, such as New York, Philadelphia and Houston, the system is on the verge of using up all of the radio channels allotted for its operation. MLS will allow 200 channels, as opposed to ILS's 40. Not only that, ILS is a little finicky. Reflections from buildings and objects on the ground interfere with transmission and reception, leading to dropouts and garbled signals. Finally, ILS frequencies begin at 108.1 MHz—unsettling close to FM bands—subjecting ILS channels to interference from extremely powerful commercial radio transmitters. Sometimes you get ILS approach guidance, sometimes you get Merle Haggard.

Another touted advantage of the MLS is its ability to guide aircraft through curved approaches to the runway. ILS requires long, steady, straight approaches, making it tricky to get aircraft vectored into queue. According to the FAA's MLS program manager Richard Arnold, MLS would allow airports such as JFK in

(Please turn to page 80)

When you're by yourself, you enjoy the company.



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The 2-door Explorer from Ford is just what you had in mind. Its versatility means real independence. Its spaciousness holds lots of friends and cargo. The engine's a big 4.0L EFI V-6.

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Your Explorer is ready.

JOURNAL



SHOP PROJECT

WINTER WONDER

A Christmas present sure to become an heirloom.

BY ROSARIO CAPOTOSTO, Contributing Editor

● A Christmas sled is a prized possession, especially one that's handmade. Long after we've outgrown it, we cherish the memory of receiving it while looking forward to the day when we can hand it down to another happy child. That's why when we decided to build our sled we chose red oak, a wood noted for its strength and durability. Like any good sled, this one is sure to become an heirloom.

At 30 in. long, this petite coaster is designed as a child's first sled, one for sliding on gentle slopes. Its handle is securely anchored to the body for towing, and a railing helps keep the

occupant safely aboard. Assembled with water-resistant glue and finished with exterior-grade polyurethane, it will take winter rigors in stride.

Runners/Crossmembers

Begin by drawing the pattern of the runners onto thin cardboard. To do this, either buy 1-in. grid paper at an art supply store or simply draw a grid pattern on a piece of paper. Copy the shape of the runners, drawing free-hand, on the pattern. Cut out the pattern then trace it onto the runner stock. Be sure to tack or tape the pat-

tern in place so it won't move. Poke an awl through the pattern, into the stock, to center mark for the holes that are bored to form the cutouts in the runners (Photo 1).

Next, make stopped cuts on the table saw to establish the straight portions of the upper edges of the runners (Photo 2). To avoid cutting into the curved section of the runner, mark the table saw bed and the runner with a piece of tape, correspond-

Color photos: J.R. Rost
How-to photos: Rosario Capotosto
Technical art: Eugene Thompson
Photo stylist: Gabe Herick



1 Tape a runner pattern to the stock. Mark the hole centers for the cutouts by poking an awl through the pattern.



2 Make straight cuts on runner with the table saw. Attach tape to the workpiece and saw table to mark the end of the cut.



3 Bore holes in the runners to start the cutouts. Saw between holes with a scroll saw to drop out the waste.



4 Using a router, cut the stopped dados in the runners that house the crossmembers. Guide cut with a scrap block.



5 U-shaped plywood guides router to make the cutout for the front crossmember. Chisel the ends of the cutout square.



6 Fit crossmembers to runners without glue. Mark the runner radius on the front crossmember and plane down to the line.

ing to where to stop the straight cut. Stick the tape on the table saw bed so its edge is even with where the tip of the blade's teeth meet the stock. This is important since this portion of the blade will be buried in the cut and will not be visible. Mark the runner with tape where the straight cut ends. When the two pieces of tape line up, stop the cut. Turn off the saw and wait for the blade to stop spinning, then pivot the runner off the saw blade.

The apparatus ahead of the saw blade (Photo 2) is a kerf "splitter." It prevents the offcut side of the workpiece from flexing toward the saw blade and pinching it. This not only makes for easier cutting, but also reduces kickback.

Cut the curved ends of the runners with the band or scroll saw using a $\frac{1}{4}$ -in.-wide blade.

Next, use the drill press with $\frac{3}{8}$ - and 1-in.-dia. bits to bore the holes for the curved runner cutouts. Draw connecting lines from hole to hole, then use the scroll saw or a handheld sabre saw to drop out the waste (Photo 3). Use a moderately course 10 tpi (teeth per inch) blade, which is ideal for straight-line cutting.

Mark the dados for the crossmembers in the side runners, including the dados for the heavy

crossmember in the front. Use a router, with a straight mortising bit, to cut the stopped dados in the runners. Tack a straight board to the workpiece to guide the router for the side dados (Photo 4). To guide the router for the wider front-end recesses, use a simple C-shaped guide cut from scrap plywood, 8 in. wide \times 10 in. long.

Regardless of the router bit diameter and the router's base diameter, the formula for determining the width of the guide's opening is as follows: Measure from the cutting edge of the bit to the outside of the base. Double this figure and add the desired width of the recess. Mark the width on a piece of plywood and cut it to shape. Be careful to cut the sides of the U-shaped opening smooth and parallel. Any irregularity in the cutout will be transferred to the router cut and will need to be straightened afterward.

Tack the guide to the workpiece, and align it with a spacing block (Photo 5). The block's width is equal to the dimension from the cutting edge of the bit to the outside of the router's base. After routing, chisel the ends of the slots square.

Cut the crossmembers to size and dry fit them in place. Mark the projecting part of the front member prior to trimming it to fit the runner profile

(Photo 6). Hold the piece in a vise and shape it with a hand plane.

Simply attach a pair of small blocks to the top edge of the center and rear crossmember to provide a notch in which to seat the deck slats.

Use a $\frac{3}{16}$ -in.-rad. rounding-over bit in the router to ease all exposed corners (Photo 7). Prevent tearout while routing over the notches for the front crossmember by inserting a pair of filler blocks in the notches. Make them so they fit snugly in the notches,

MATERIALS LIST—OAK SLED

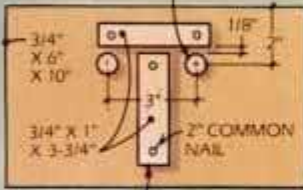
| Key | No. | Size and description (use) |
|-----|-----|--|
| A | 2 | $\frac{3}{4}$ x 6 x 30" oak (runner) |
| B | 2 | $\frac{3}{4}$ x 2 $\frac{1}{2}$ x 12" oak (crossmember) |
| C | 4 | $\frac{3}{4}$ x $\frac{3}{4}$ x 1 $\frac{1}{2}$ " oak (block) |
| D | 1 | 1 $\frac{1}{16}$ x 1 $\frac{3}{4}$ x 12" oak (front crossmember) |
| E | 2 | $\frac{5}{8}$ x 2 $\frac{1}{4}$ x 27 $\frac{3}{8}$ " oak (slat) |
| F | 2 | $\frac{5}{8}$ x 2 $\frac{1}{4}$ x 26 $\frac{1}{2}$ " oak (slat) |
| G | 1 | $\frac{3}{4}$ x 3 $\frac{1}{2}$ x 10 $\frac{1}{2}$ " oak (lower rear rail) |
| H | 1 | $\frac{3}{4}$ x 4 x 13 $\frac{1}{4}$ " oak (upper rear rail) |
| I | 2 | $\frac{3}{4}$ x 1 $\frac{1}{4}$ x 19 $\frac{1}{2}$ " oak (lower side rail) |
| J | 2 | $\frac{3}{4}$ x 1 $\frac{1}{4}$ x 15" oak (upper side rail) |
| K | 1 | $\frac{3}{4}$ x 1 x 27" oak (handle rod) |
| L | 4 | $\frac{3}{4}$ "-dia. x 6" maple (post) |
| M | 3 | $\frac{3}{4}$ "-dia. x 6 $\frac{1}{2}$ " maple (post) |
| N | 1 | $\frac{1}{8}$ x $\frac{3}{4}$ x 11" aluminum (handle) |
| O | 2 | $\frac{1}{8}$ x $\frac{3}{4}$ x 2 $\frac{1}{2}$ " aluminum (bracket) |

Misc.: 1, $\frac{1}{2}$ -20 \times 1 $\frac{1}{2}$ " hexhead bolt and nut; 1, $\frac{1}{4}$ -20 \times 1 $\frac{1}{2}$ " hexhead bolt and nut; 2, $\frac{1}{4}$ " washers; 6, 1 $\frac{1}{2}$ " fh screws; 2, 1" oval-head stainless-steel screws; 16, 1" No. 8 oval-head stainless-steel screws; 4, $\frac{3}{4}$ " No. 15 escutcheon pins, from Garrett Wade, 161 Avenue of the Americas, New York, NY; Krylon metal primer, Krylon cherry red spray paint, McCloskey's Gloss Polyurethane Exterior Varnish.

OAK SLED

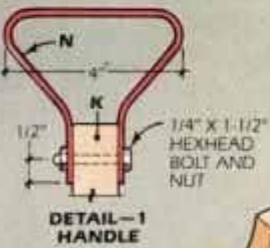
11-1/2" HIGH X 13-3/4" WIDE X 30" LONG

3/4" DIA. X 2" DOWELS SET IN 5/8" DEEP HOLES (2 RECD.)



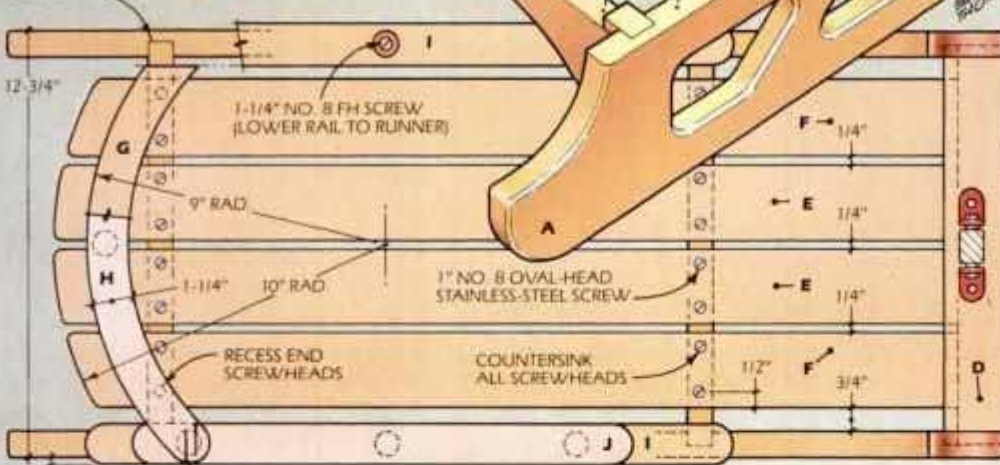
ATTACH AFTER INITIAL BENDS ARE MADE

BENDING JIG FOR HANDLE

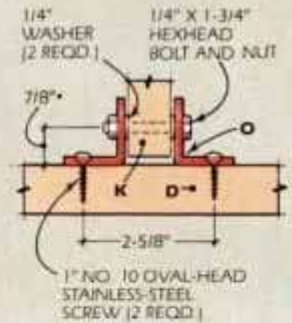


DETAIL-1 HANDLE

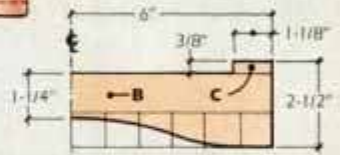
3/8" DEEP X 3/4" WIDE X 2-1/2" LONG STOPPED DADO



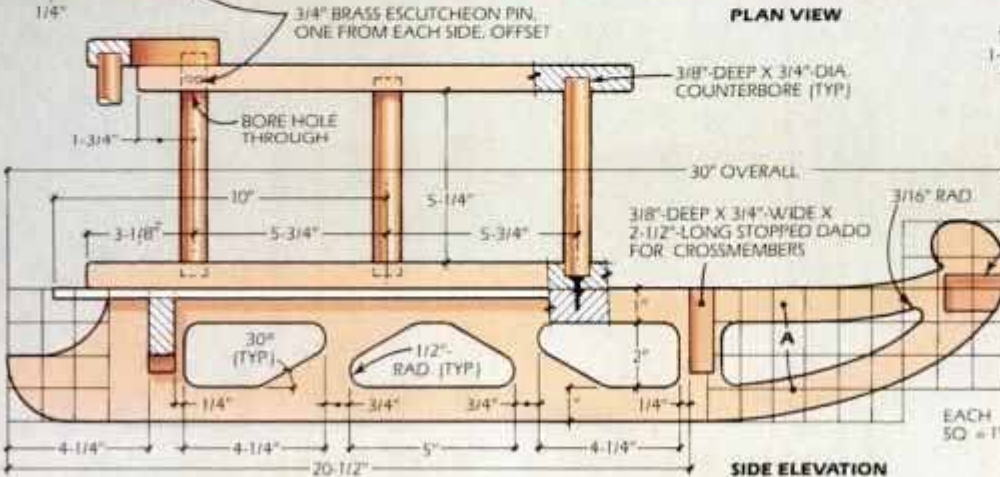
PLAN VIEW



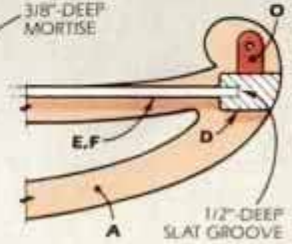
DETAIL-2 BRACKET



DETAIL-3 CROSSMEMBER



SIDE ELEVATION



DETAIL-4

then rout over them. Reposition the clamp as necessary to finish routing the runner edges.

Glue and clamp the two runners to the three crossmembers. Apply pressure with pipe or bar clamps, using clamping pads of scrapwood to distribute the pressure and to keep from marring the work. Note that the clamps are positioned in pairs, one below and one above the crossmember. This prevents uneven pressure on the joint, assuring that, when dry, it will be as strong as possible. Measure diagonally across the assembly for squareness (Photo 8). Let glue set.



7 Ease corners with rounding-over bit. Place blocks in crossmember cutouts to prevent tearout as bit moves over edge.



8 Using water-resistant glue, clamp the crossmembers to the runners. Measure the diagonals to check assembly for square.

Rail/Deck

Resaw the 3/8-in.-thick deck slats from 3/4-in.-thick stock with a band saw or table saw (Photo 9). Sand or plane out the saw marks. Cut the curved back rails to shape with a band saw or sabre saw and sand them smooth.

Bore the dowel holes in the side rails, clamp the rails on the runners and then bore the pilot holes (Photo 10) for the screws that attach the rails to the runners.

Most dowels are less than their



9 Resaw the 3/8-in.-thick deck slats from 3/4-in.-thick stock. Smooth away the saw marks by planing or sanding.

stated diameter, so the dowels may fit loosely in their holes. To prevent this, I grind a 3/4-in.-wide spade bit to match the dowel diameter.

Cut the deck slats to size, then bore the countersunk holes for the oval-head screws that attach them. Countersink the holes slightly deeper for the two screws under the lower curved railing. When countersunk, oval screwheads project above their surroundings. The two screws would otherwise prevent the lower rail from



10 Bore post holes in lower rails, and clamp rails to runners. Bore pilot holes for screws that attach rails to runners.

being firmly seated on the deck slats.

Cut the dowels to size and dry fit the parts to check for fit (Photo 11). Pin the rear posts where they project through the upper rails with a brass escutcheon pin (see Misc. section of Materials List on page 46). Bore pilot holes and drive the pins. We used No. 15 pins, but No. 14 (a bit larger) and No. 16 (a bit smaller) will also work. Offset the pins so they won't meet. Attach the side rails and posts, then add the rear post and rail.



11 First assemble rails and dowels without glue to test fit the parts. Rear and side dowels are pinned to top rail.

Hardware/Finish

The handle and bracket are made from 3/8-in.-thick x 3/4-in.-wide aluminum flat stock. To form the brackets, cut the stock to size, then bend each piece in a vise, applying pressure with a stout piece of wood.

The handle is formed with a simple jig consisting of two dowel posts and two backup blocks. Clamp an 11-in.-long piece of aluminum to the block, and bend the legs of the bar around the posts (Photo 12). Nail a block centered on the jig, perpendicular to the backup block. Finish bending the handle using a parallel jaw clamp (Photo 13).

We applied a coat of Krylon metal primer and sprayed on two light coats of cherry red enamel to finish the han-

dle and the bracket. The wood portions of the sled received three coats of McCloskey's Gloss Polyurethane Exterior Varnish. We sanded be-



12 Clamp aluminum flat stock to jig. Stock should be centered to produce a symmetrical handle, then bent to shape.

tween the coats with 220-grit sandpaper, wiping off the dust with a tack cloth before applying the next coat of exterior varnish. **PM**



13 Nail block to jig and complete bend using parallel jaw clamp. Sand or file off sharp edges, prime and paint handle.

NEW TOOLS

SHOP WORKERS

14 tools to help get the job done.

BY ROY BERENDSOHN, Assistant Home Improvement Editor



Keyless

No key is required to tighten the chuck on this 3/8-in., reversing, variable-speed drill. Simply twist its rubberized chuck ring to lock in the bit. According to the manufacturer, the chuck increases the tightening torque applied to the bit by 25 percent, reducing slippage. This Black & Decker drill is powered

by a 3.5-amp motor and includes a 2-way level to plumb the drill while boring. The drill comes with a 2-year warranty and will be available in January 1991. It will cost about \$87 at hardware stores and home centers. For more information, write to Black & Decker, Communications Dept., 10 N. Park Dr., Hunt Valley, MD 21030.



Packs A Punch

Punch through gasket material, rubber, canvas, cardboard, plastic and soft sheetmetal with this kit. It includes nine heat-treated, alloy-steel punches that cut holes from 1/4 in. to 1 in. in diameter and a spring-loaded, self-centering steel mandrel. Thread the appropriate punch on the mandrel, place the mandrel's pin on the mark and strike it with a hammer. It costs \$37 at hardware stores. For details, write General Hardware Manufacturing Co., Inc., 80 White St., New York, NY 10013.



Let Go

Unlike most locking pliers that require two hands to unlock, these require only one. Just flip the lever that projects out the end of the lower handle. The pliers come in 5-, 7- and 10-in.-long curved, straight jaw and narrow nose models. All of them are available in nickel-plated finish or a flat black corrosion-resistant finish. The pliers range in cost from \$8 to \$12 at most hardware stores and home centers. For more information, write to Crescent Locking Pliers, P.O. Box 728, Apex, NC 27502.

A Bit Faster

Vermont American says its Sidewinder drill bit bores three times faster and lasts three times longer than standard high-speed steel bits because its fluting removes chips more quickly and keeps the tip cooler. The company says the Sidewinder drill bit is designed to be self-centering, also increasing speed, and drills steel without lubricant. A 7-piece kit (1/16 in. to 1/2 in.) costs about \$11 at hardware stores. For more information, write to Vermont American, P.O. Box 340, Lincolnton, NC 28093-0340.





Production Class

Porter-Cable's four new production-quality routers, all in the \$400 range, are designed for the professional or serious hobbyist. Shown is plunge Model 7538, with a 3/4-horsepower, 15-amp motor. Another 3/4-horsepower nonplunge model is available, as are two 2 1/2-horsepower models. Porter-Cable says improvements to the routers include a turbine motor fan that improves cooling and a redesigned armature shaft that deflects less under load and delivers a smoother cut. They are sold at hardware stores and industrial suppliers. Contact Porter-Cable, 4825 Hwy. 45 North, P.O. Box 2468, Jackson, TN 38302-2468.

In The Swing

Stanley's Deckmaster hammer is as well suited for general carpentry as it is for building decks. The 21-ounce hammer has a drop-forged, rim-tempered head with an extra-large face diameter and a straight ripping claw for heavy demolition prying. For increased durability, the head is mounted to the 16-in.-long hickory handle with a cross-wedged ax eye joint (two wedges, one parallel to the head's long axis, another perpendicular to it). The Deckmaster hammer costs about \$20 at hardware stores and home centers. For information, write to Stanley Tools, 600 Myrtle St., New Britain, CT 06050.



Scrolling Along

Built of die-cast aluminum and cast iron, this 13-in. scroll saw is Dremel's latest addition to its popular line of benchtop power tools. A



scaled-down version of the 16-in. model, this saw has a 10-in.-dia. steel table that tips from 0° to 45° to handle a range of cutting jobs. It accepts pin-end or plain-end blades which can be mounted for front or side cutting. The blade tension adjustment is located on the front of the pivot arm for easy access, and the clear plastic blade guard is self-tensioning. It's powered by a .9-amp, [1/16-hp] direct-drive motor. It costs about \$180 at hardware stores and home centers. For more information, contact Dremel, 4915 21st St., Racine, WI 53406-9989.



Quiet Driver

This drywall screwdriver operates without the usual screech, says its manufacturer, because the airflow through its drive mechanism has been redirected, and its clutch mechanism has been redesigned to reduce noise. The drill is powered by a 5.2-amp motor, activated by an oversized, variable-speed, dustproof trigger switch. It costs \$145 at hardware stores and industrial suppliers. For more information, write to Hitachi Power Tools U.S.A., Ltd., 4487 E. Park Dr., Norcross, GA 30093.

Splinter Puller

We tried these tweezers and found them effective, rugged and compact. Their protective plastic case keeps them clean while stored in your toolbox or kitchen drawer. Made of 301 hardened stainless steel, they have a unique pincerlike point with a tiny burr to increase their grip. They are sold at hardware stores or from the manufacturer. The tweezers cost \$4.49 postpaid and \$5.64 postpaid as part of a mini first-aid kit. They're available from Miracle Point, P.O. Box 71, Crystal Lake, IL 60014-0071.



New Angle

You can tip this saw's blade past the standard 45°, all the way to 60°, for making difficult bevel cuts on rafters and deck framing. The 13-amp, 8¼-in. saw cuts to nearly 3 in. deep with the blade at 90°, and 1½ in. deep with the blade at 60°. Raise the blade guard with a remote lever near the handle. The saw has a built-in pushbutton spindle lock, a blade-wrench storage compartment, quick-release bevel controls and a 10-ft.-long rubber cord. It costs about \$225, and is available at hardware stores and home centers. For more information, contact Skill Corp., 4300 W. Peterson Ave., Chicago, IL 60646.



Odd Fellow

Just a glance at this ½-sheet sander tells you it's different. Its handle carries a built-in, detachable dust container. With the dust container removed, you can hook up a vacuum hose to the back of the sander. The sander picks up dust through the platen (a sandpaper punching kit is included). A compact hand grip and motor/drive housing allow for flush sanding against objects on the front and sides. The sander weighs 4.4 pounds and is powered by a 2-amp motor that drives the sander at 10,000 orbits per minute. It costs about \$60 at hardware stores and home centers. Write to Ryobi America Corp., 1424 Pearman Dairy Rd., Anderson, SC 29625.



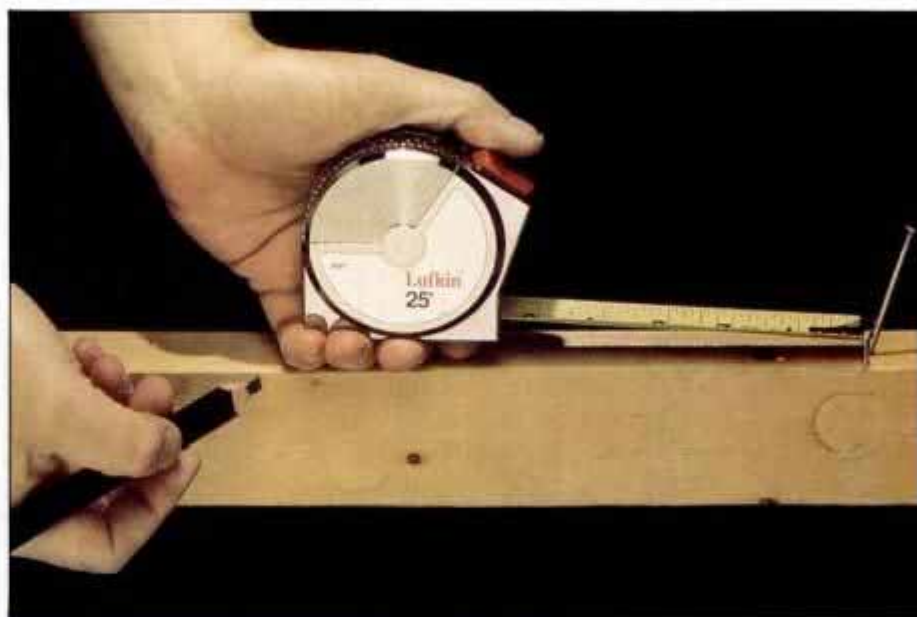
Lighten Up

This 2-speed, 12-volt cordless drill has a detachable work light. It has 10 clutch settings, and it's reversible. Unsnap its chuck and the end of its drive

shaft accepts ¼-in. hex shank bits. It comes with a steel carrying case, battery pack and a charger that accepts 1.2-, 7.2- and 9.6-volt battery packs. The drill weighs 4.4 pounds with the standard battery (a larger battery is available, \$164 extra). The ABSE 15 costs about \$400 at industrial suppliers. Contact AEG Power Tool Corp., 3 Shaw's Cove, P.O. Box 6003, New London, CT 06320-1777.

Take It Away

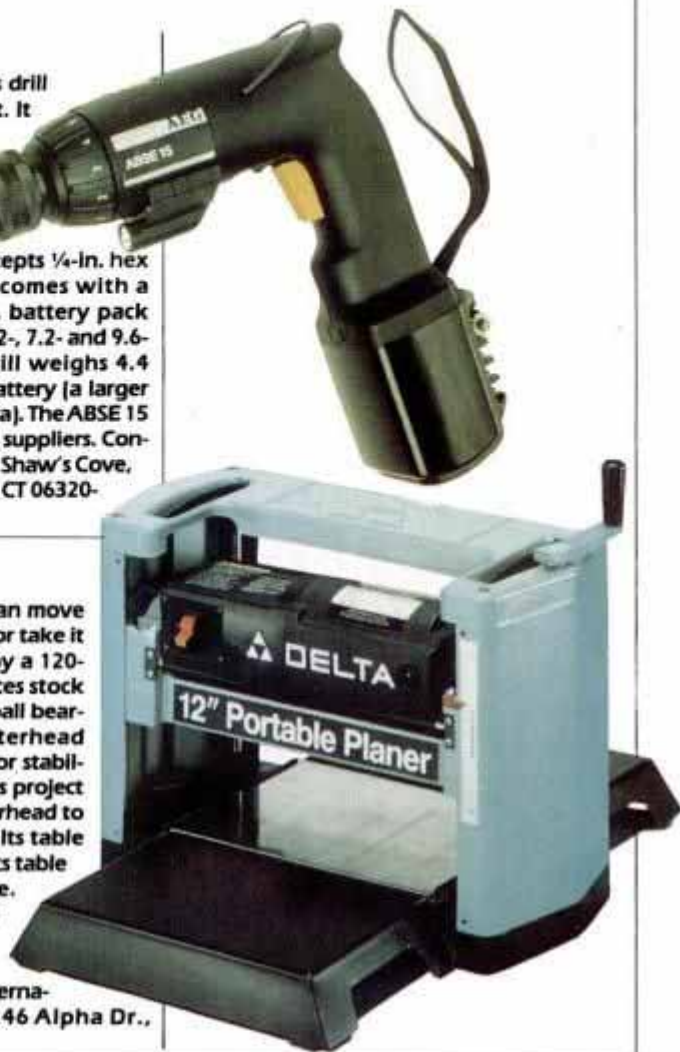
Weighing 68 pounds, you can move this planer around the shop or take it out of the shop. Powered by a 120-volt, 15-amp motor, it surfaces stock from ¼ in. to 6 in. thick. Its ball bearing-mounted, 2-knife cutterhead rides on four steel columns for stability under load. Its two knives project only .065 in. above the cutterhead to reduce noise and kickback. Its table platen is stainless steel, and its table extensions are detachable. The planer costs about \$600 at hardware stores and home centers. For more information, contact Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15238.



Thumbprint

Lufkin positioned this tape ruler's latch so you can reach it easily with your thumb while you're using it. It comes in 12-ft., 16-ft. and 25-ft.-long sizes. The tape is tempered spring steel finished with a wear-resistant coating. Each tape is inspected for accuracy its manufacturer says. To ensure du-

rability, its end hook is triple riveted to the tape. The 3-in.-dia. tape housing fits inside most tape holders and is made of chrome-plated, impact-resistant plastic. The 25-ft.-long tape shown costs about \$23 at most hardware stores and home centers. For more information, write to Lufkin 2000, P.O. Box 728, Apex, NC 27502. **PM**



HINTS FROM READERS

Sanding With Sole

If you use a belt or disc sander, you know that abrasive cleaning sticks are available to remove the clogged sawdust that reduces cutting effectiveness and shortens abrasive life. Well, if your crepe-soled shoes are a little down at the heel, you can extend their usefulness along with your abrasives. Simply holding the crepe sole against the moving belt or disc unclogs and revitalizes the abrasive for continued use.

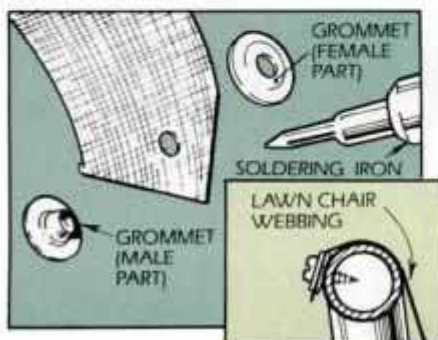
—August Capotosto



Lawnchair Repair

Most of the lawnchair repair kits that I have seen use screws forced through the plastic webbing to hold the webbing to the aluminum chair frame. Because the webbing soon tears around the screws, it's no wonder that so many repaired lawnchairs are thrown away. My solution uses No. 0 grommets to reinforce the screwhole. I first burn the hole in the webbing using a soldering iron with a 3/8-in.-dia. tip. Then I install the grommet halves and fasten the webbing to the frame. I found that an ordinary vise, carefully used, is effective for squeezing the grommet halves together and can be used in place of a special tool.

—Arthur C. Erdman



Sunvisor Fix

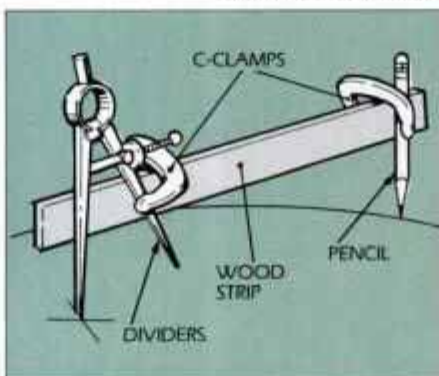
I had a terrible time keeping the sunvisor of my car in the up position. To solve the problem, I glued strips of Velcro to the sunvisor and to the headliner. Now the sunvisor stays put, even with the weight of my automatic garage-door opener.

—George I. Thompson

Extra-Large Compass

Laying out an extra-large circle exactly to size or transferring dimensions from a full-size drawing to your work is no problem if you have dividers, a pair of C-clamps and a wood strip. First, clamp a pencil to one end of the wood strip. Then, clamp the dividers to the other end so the distance between the free point and the pencil is close to the desired radius. Adjust the radius by fine tuning the dividers with the adjustment screw.

—Frank LaSaracina



Magnetic Sweeper



The best way to pick up nails, screws and other small steel objects—and leave everything else behind—is with a magnet. However, instead of crawling around with a magnet in your hand, try this simple device. It's a strong magnet mounted on a block of wood. A broom handle is secured to the top of the block, and the entire assembly is mounted on wheels. Now, a simple walk around the shop does the job. It's also great for removing dropped nails from the driveway and worksite.

—Walter E. Burton

Removing Screws

If you have a roundhead screw that can't be bugged or the slot has worn, file two sides of the head flat and parallel. Then, use an adjustable wrench to turn the screw.

—Lane Olinghouse

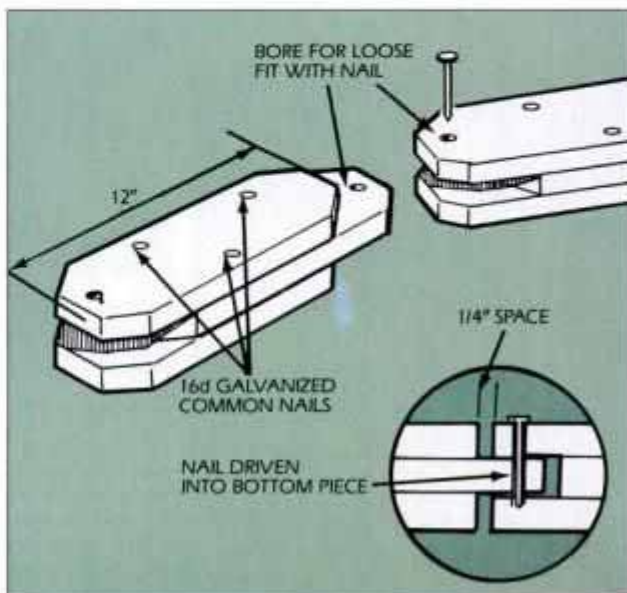
Border Guards

After replacing the decks on two porches, I was left with a pile of 1 1/4 x 5 1/2 x 12-in. scraps of pressure-treated decking lumber. Determined that nothing should go to waste, I came up with this idea for a flexible garden border system.

Each piece of wood was ripped in half and chamfers were cut on the corners. Then, I made a number of 3-piece sandwich units (right). Each unit is attached to the next with 16d galvanized common nails that pass through oversized holes in the top of one unit and in the midsection of the adjoining unit. The nails driven tightly into the bottom section of the first unit act as hinge pins to create a flexible link of

two units. The sections can be assembled in any length for use around garden plots, walkways, trees and any other outdoor areas that require a border.

—Robert H. LeSage



Peg-Board Shelves

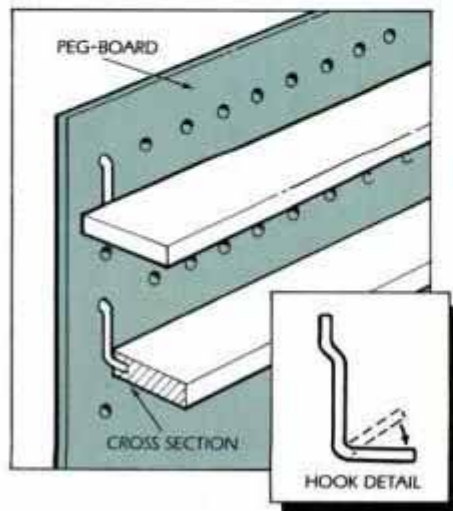


Peg-Board, a mainstay for utility storage, becomes even more useful with this hint. You can use Peg-Board to mount narrow shelving for holding jars and other small objects that can't be hung from a hook. And, because the shelves are hung on the Peg-Board, they're completely adjustable or can be removed to hang equipment in the normal manner.

It takes 4 ft. of wall space to mount a standard 1/4-in.-thick sheet of Peg-Board, and the shelves can be made out of 4-ft.-long 1 x 4s supported by modified Peg-Board hooks. To reshape the standard hook that's designed for hanging, first secure it in a metalworking vise. Then, use a hammer to tap open the hook so that it's bent at 90° and projects horizontally when installed in the Peg-Board (see below). Next, bore two holes in the back edge of each shelf in which the hooks will be mounted. Bore these 1 1/2 in. deep using a 1 3/64-in. bit. This size will provide a tight fit for the hooks.

For a 4-ft.-long shelf, locate the hooks about 6 1/2 in. in from each end. For narrower shelf units, measure the distance between Peg-Board holes that are a few inches in from each edge of the panel. Use a hammer to secure the hooks in the shelf holes, and install the shelves.

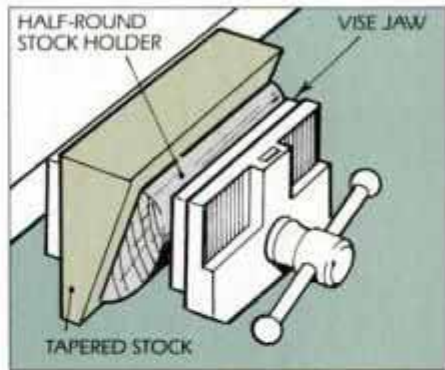
—Leonard Heiferling



Holding Tapered Stock

If you've ever had to hold tapered work in an ordinary vise that has parallel jaws, you know that an additional filler piece is necessary. Instead of cutting a custom filler block to suit each particular tapered piece, make a half-round stock holder as shown (right). This half-round shape fits between the tapered stock and one vise jaw, and automatically adjusts to a wide range of tapered angles.

—Federico Strasser



Polishing Screwheads



If your interests lie in restoring antique clocks or guns, or if you simply want every part of a classic door latchset to gleam like new, then don't overlook the details. Polishing the screwheads will add the final touch to the job. It's easier if you group the screws in a plate with holes such as a steel drill gauge. Then, scrub the heads with a metal-bristle, suede-shoe brush. If you don't have a drill gauge, then bore holes in a piece of hardwood.

—Walter E. Burton

Gutter Fix

Like many homeowners, I've had my share of ice dam troubles—a layer of melting snow on the roof that collects and refreezes in the gutter causing water to seep under the shingles and leak through the roof. So I came up with a simple solution. I drilled 1/4-in. holes spaced about 6 in. apart through the underside of the gutter. During the snow season, the water weeps through these holes and doesn't back up onto the roof. When spring arrives, I simply insert stainless-steel screws into the holes for normal gutter operation.

—Arthur R. Mullen

Beach Float Apron

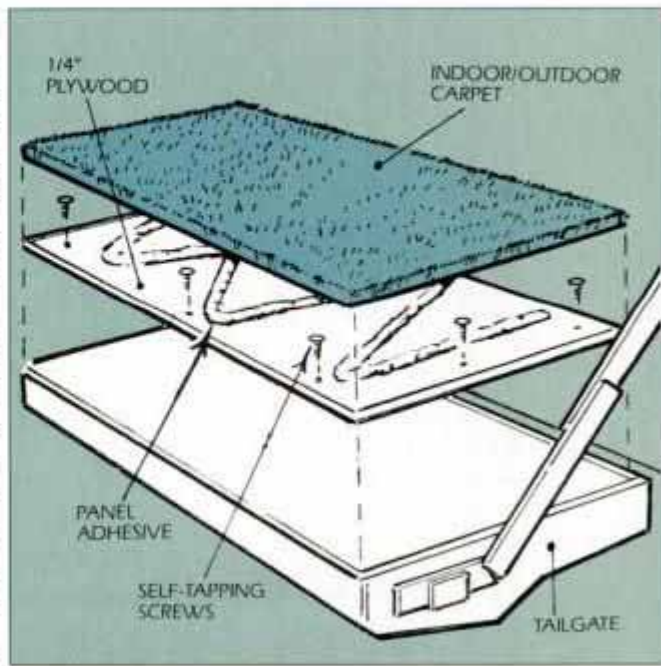
Old plastic air mattresses make great all-purpose aprons. They're impervious to water, oil and grease, and are perfect for working on the car. I made mine by first cutting an old beach float to length. The top corners are cut off so the apron fits under your arms. Install a neck and two back tie ropes through holes that are reinforced with grommets.

—Charles A. Fish

Tailgate Pad

Climbing in and out of the back of a pickup truck can be hard on the knees. We attached a 1/4-in.-thick sheet of plywood to the inside of the tailgate and covered it with indoor/outdoor carpet. This also protects the tailgate from normal wear-and-tear. The plywood panel can be attached with stainless-steel self-tapping screws. Panel adhesive applied with a caulking gun does the job when attaching carpet.

—Dorothy Herbert



APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Tub Rocks

I have a 1½-year-old Norge automatic washer model No. LWF912924, serial No. AX154790. When the washer goes into high-speed spin with a normal load, the tub rocks so badly it sounds as if it's hitting the sides. It does not do this in low spin.

Can you help?

ROBERT E. GENTRY
HAUBSTADT, IN

First, check that the machine is level and on a solid floor. Place a 2-ft.-long level on its top. Check for level front to back and side to side.

Next, raise the lid and look at the agitator. Notice if it is centered in the opening in the top. If it's off-center, one of the suspension springs that holds the mechanical assembly to the snubber assembly on the base of the machine may be too tight or loose. This can usually be corrected by adjusting the J-bolts that attach the suspension springs to the base.

Next, unplug the washer and remove the front access panel. Check around the base inside the cabinet for pieces of the nylon snubber pad. If the pad is broken or worn, it may cause the machine to spin out of balance. In this case, you need to call a servicer.

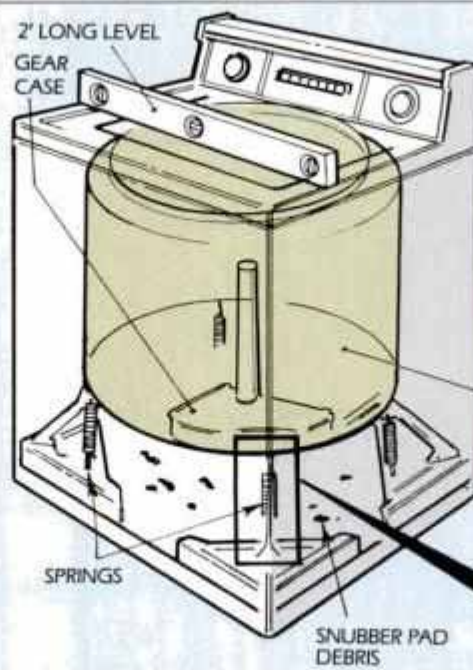
If after checking these areas you find nothing wrong, call an authorized Norge servicer. You may have an internal problem in the transmission, and the servicer will need to do a torque test on it. To locate an authorized Norge servicer in your area, call (800) 447-8371.

Gurgling Fridge

Our Whirlpool limited series refrigerator model No. ET18NKXSW03, serial No. 75115290, has a gurgling noise when the unit stops running after completing a cycle. The instruction booklet says it may be caused by defrost water draining into the defrosting pan or something loose at the rear that rattles. There is nothing loose at the rear for this noise to occur. I hope you will be able to explain the problem.

J.L. LUND
PECKVILLE, PA

The gurgling noise you are hearing is the sound of the high-pressure refrigerant



Check washer for level and measure around the agitator to check that it's centered. Adjust the suspension springs below the washer if it is necessary.

erant in the sealed system boiling or equalizing in the evaporator.

You will usually hear the noise for a period of time until the pressure settles down in the system. This is a normal sound in any refrigerator and usually will not go away.

No Parts

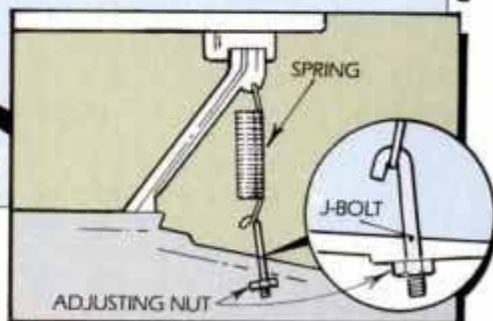
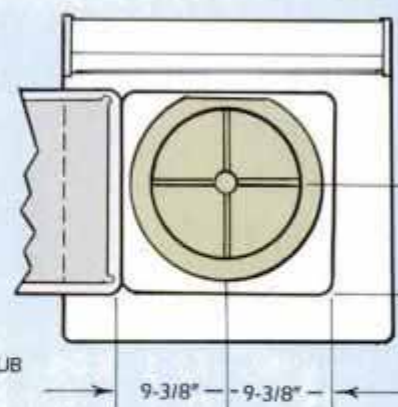
I have a natural gas tankless water heater by the Tankless Water Heater Corporation/Thorn EMI Domestic Appliances, model No. TL200, serial No. 105404890. I saw this water heater advertised in your magazine and have been very satisfied with it. Now I need parts, but cannot find a parts source. The original address is no longer correct.

JOHN DEVINE
CHICKASAW, AL

Thorn EMI, which manufactured a tankless water heater for Tankless Water Heater Corp. was bought out by Myson, Inc., about three years ago. Myson still has parts for both gas and electric water heaters and should be able to supply you with the parts for your model heater. Write to Myson, Inc., P.O. Box 7789, Fredricksburg, VA 22404, Attn: Parts Dept.

Frostless It's Not

We own a General Electric frostless refrigerator model No. TBF-16D. Lately, frost has built up around the freezing coils in the freezer compart-



ment and will not defrost. Food immediately thaws out and, if not caught, spoils. The frost must be manually removed by thawing with an electric blow dryer. Once defrosted, it will work again for a time and then the problem comes back. Do you have any suggestions?

FRANK LOVELY
W. LEBANON, NH

There are a number of things that can cause your problem, including a defective defrost timer, an open defrost heater and open contacts on a defrost thermostat. The list goes on from there.

Because there are so many possibilities, I suggest you pick up a GE Step-By-Step Repair Manual for refrigerators and freezers. Check the heading "Evaporator Fails To Defrost" in the manual's diagnostic chart. It lists the causes of this, and the rest of the manual explains test and repair procedures.

The GE manual is part No. WX10X100 and costs about \$7. To locate a GE parts distributor in your area, call the company's 24-hour-a-day consumer service line at (800) 626-2000.

PM

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

TOOL TEST

**NEW FLEX
SHAFT
TOOL**

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO
Contributing Editor

● It was quite a revelation for me to test the Dremel Heavy-Duty Flex Shaft Carving Kit. My only similar experience had been to use a flexible shaft chucked in an electric drill. This is a far more capable tool than a drill/flex shaft combination. Its $\frac{1}{5}$ -horsepower motor is capable of driving rotary tools at up to 20,000 rpm with plenty of torque.

You adjust its speed by pressing its foot pedal. This allows you to better handle the tool, as you suit the speed to the job, whether it be slow enough to cut plastics without melting them or at top speed to hog off hardwood.

Without discernible vibration in the handpiece, I found it easy to do fine carving while holding the tool like it was a pen. I was impressed that it was quiet and smooth.



Flex Shaft Carving Kit includes motor, shaft, foot pedal control and bit assortment.

To test its torque, I chucked in a structured-tooth carbide cutter and went all out chewing up chunks of hard maple in an attempt to stall the motor. At slow to moderate speed, there was occasional hesitation. But at top speed, the motor just kept buzzing.

The Dremel 7390 Heavy-Duty Flex Shaft Carving Kit, which includes the

Model 732 flex shaft and motor, Model 221 foot speed control, handpiece, $\frac{1}{4}$ -in. and $\frac{1}{8}$ -in. collets, cutters, sanding drums and grindstones. The kit costs about \$410 at hardware stores and hobbyist suppliers. An accessory hanger stand, Model 2222, costs about \$35, and any component is available separately. Contact Dremel, 4915 21st St., Racine, WI 53406-9989. **PM**



To change bits, insert pin to lock the motor shaft. Unlock collet nut with the wrench provided, insert new bit and tighten.



The tool carves delicate details using only a light touch. It derives its cutting power from speed, not pressure.



Even with large structured-tooth carbide cutter, turning at full speed, the tool is easily and precisely controlled while carving.



The variable-speed foot control permits low-speed cutting, a necessary feature to prevent burning when cutting plastics.



Polishing metal is a snap with the brush wheel loaded with polishing compound. Light pressure easily removes tarnish.



The sanding drum makes short work out of deburring even hard-to-grind metals. Here, the coarse drum deburrs cast iron.

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Electrical Interference

I have a 1-year-old house with a 200-amp service panel grounded with two grounds, one at the water pipe and another to a rod in the backyard. The problem is that there is severe interference on the TVs in the house when wall switches are used, the door bell is rung, the bathroom fan is switched on or if an electric shaver is used. This happens even though the branch circuits are unrelated. Any suggestions?

GLENN MAJKA
CARY, IL

This type of problem is often caused by a loose neutral line, possibly at the pole, the meter pan or in the main breaker panel. Call the local utility company and have them check the connections at these points. The utility company may complete its inspection, but ask that a licensed electrician check the connection at the breaker panel.

Covering Turbine Ventilators

While installing a new roof, the installer recommended two large spinners that would turn in the wind for ventilating the attic. My question is whether to cover them in the winter or leave them open.

ERNEST BAYS
COLUMBUS, OH

The only reason that I know of for covering the turbine vents is if you

live in an area where the winter snowfall is great enough to cover the vents. In this case, when the snow melts, water will leak into the attic through the openings between the vent vanes.

If the attic's ventilation is dependent on the turbine's free air opening, you must provide alternative ventilation during the winter when the turbines are covered.

As has been discussed in previous columns, the unobstructed vent opening should be $\frac{1}{300}$ of the attic floor area when there is a vapor barrier on the underside of the insulation, and $\frac{1}{150}$ of the attic floor when there is no vapor barrier.

Antifreeze In Pipes

I have a second home in upstate New York and plan to put in an oil-fired hot water central heating system. Since I am not there all the time and the water pipes are all drained and traps filled with nontoxic antifreeze, I was wondering if I could protect the hot water heating pipes by using the proper mixture of nontoxic antifreeze and water. Can you think of any problems that may occur?

JOHN A. WHITE
UNIONDALE, NY

There are a few things you should do before adding antifreeze to the house's plumbing system. First, if the house doesn't have one already, add a

back-flow preventer on the water feed line. This prevents the antifreeze from contaminating the house's potable water supply.

Next, determine how much antifreeze to add to the system. To do this, estimate the volume of water in the house's pipes, then add the correct ratio of antifreeze. A free 4-page booklet by the Hydronics Institute has information to help you determine the pipes' volume and other useful tips. Send a letter with a self-addressed stamped envelope to: The Hydronics Institute, 35 Russo Place, Berkeley Heights, NJ 07922. Ask for "Technical Topics No. 2A."

Winterized Hose Bib

The water pipes that run to the hose bibs on the outside of my house are inaccessible. Should I replace my hose bibs with those that shut off the water inside the house (freezeproof hose bibs)?

WALTER SKJEI
GRAND FORKS, ND

Replacing the hose bibs with freeze-proof models would be one approach. The other would be to install an interior shut-off valve that is accessible so the hose bib can be drained.

Service Tip

When repairing a cedar wood shingle or shake roof, the new shingles will generally not match the weathered appearance of the existing roof. It can take up to a year for the shingles to weather the same color as those around it. The process can be accelerated by spraying the new shingles with a solution recommended by the Texas Forest Products Laboratory in Lufkin, Texas.

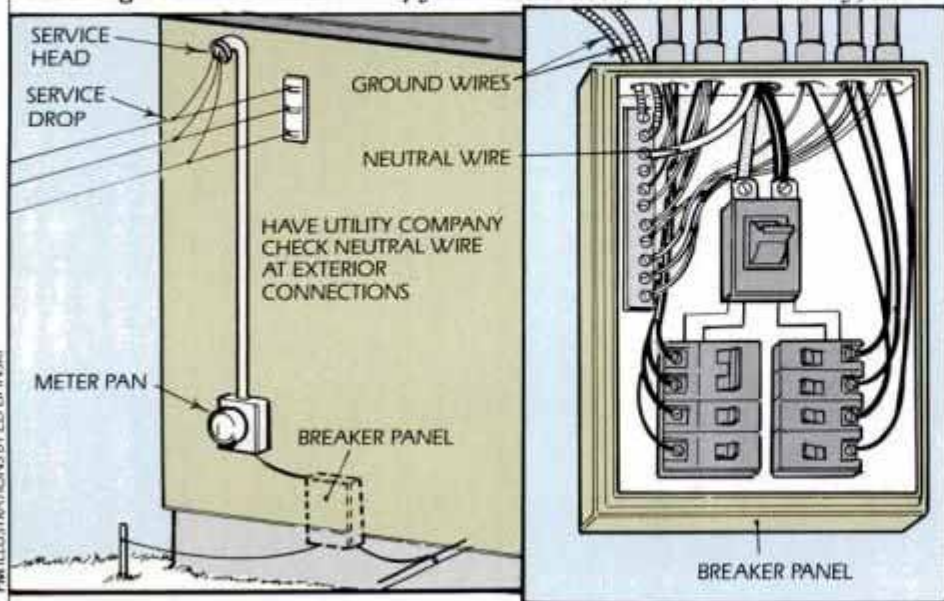
Spray the new shingles with a simple solution of 1-pound baking soda dissolved in a gallon of warm water.

Place the sprayed shingles in the sunlight. In about 4 to 5 hours, they turn a weathered-gray color. Wash off the powdered residue. Unlike stains, which may discolor over time, this process is permanent and results from a chemical reaction.

PM

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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



A loose neutral wire outside of the house or in the service panel can cause severe interference on televisions in the house. Have an electrician or your utility company check the exterior connections for a loose line.

PM ILLUSTRATIONS BY EDD LIPINSKI

HANGING WALLPAPER

BY GENE & KATIE HAMILTON
PM Illustrations by
George Retseck

● If you can survive scanning endless pages of wallpaper books and find a pattern that suits your decor, color scheme and budget, hanging the paper will come easy.

For your first job, choose a wallpaper that is easy to install, such as an inexpensive (less than \$20 a roll) pre-trimmed vinyl paper. Vinyl wallcoverings come paper-backed and fabric-backed, and both go up nicely. These papers don't stretch out of shape, even if you reposition them several times on the wall. Fabric-backed papers are more expensive and well suited for bathrooms and kitchens, where humidity can be a problem. Fabric-backed vinyls can be scrubbed and easily stripped off the walls at a later date.

You can choose between pre-pasted wallpaper and those requiring adhesive. Pre-pasted paper only needs to be dunked or soaked in warm water to activate the paste impregnated in its back. Other wallcoverings are hung on the wall with an adhesive applied with a roller. If you use one of these papers, ask your wallpaper dealer for an appropriate adhesive.

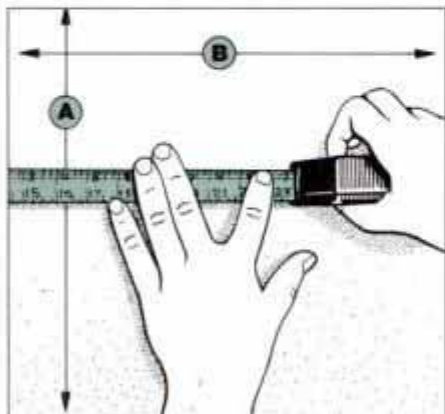
Look for a paper with a pattern repeat or drop of 10 in. or less. Pattern drop or repeat refers to a pattern's length (a repeat or drop of 10 in. is a pattern that repeats itself every 10 in.). The larger the drop, the more paper is wasted getting the pattern to align between pieces.



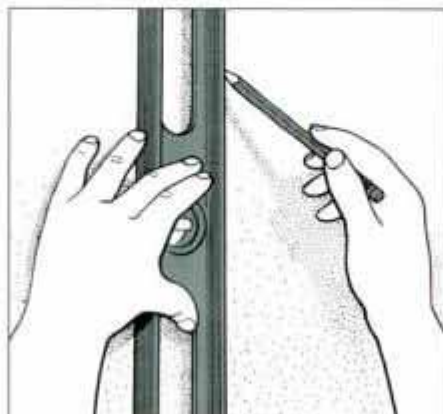
You'll find the pattern repeat on the back of each pattern in your wallpaper sample books and on the roll's wrapping. By choosing a pattern with a small repeat for your first project,

you can avoid excessive waste.

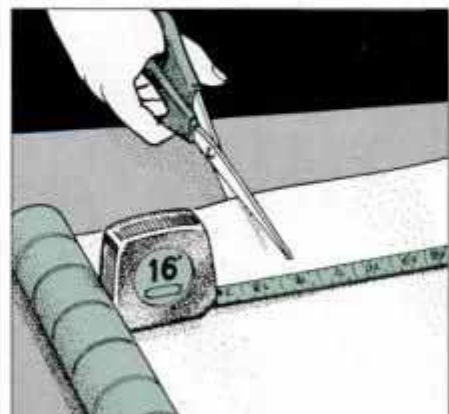
Build success into your first attempt by choosing a simple bedroom. Don't try a bathroom, kitchen or 2-story hallway at first.



1 First, measure wall height, A. Now measure wall length, B. Multiply A x B and subtract door and window areas.



2 Use a level or chalkline to make a vertical layout line on the wall. Align the first strip of paper with this line.



3 Unroll paper and measure the length of strip allowing for pattern drop and trimming. Mark with a small scissor cut.



4 Fold the roll back on the paper you just measured. Crease the paper at the small cut and use it as a cutting guide.

Estimating paper and wall preparation

First, look in the back of the wallpaper book for a notice that tells you the area of each roll. Most rolls of American wallpaper contain about 36 sq. ft. of material. Allowing for waste due to the pattern drop and trimming, the roll covers about 30 sq. ft. A roll of European (metric) wallpaper contains about 28 sq. ft. and covers about 23 sq. ft. of wall (these are based on wallpaper with a drop under 18 in.).

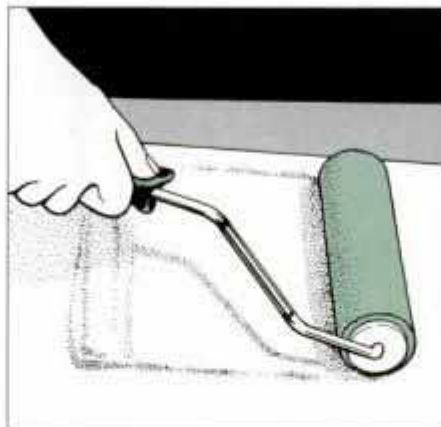
To calculate how much paper you need, first find the wall area. Add the length of each wall, and multiply this total by the ceiling height (Fig. 1). Multiply the height of each door and window by its width. Add the door and window areas and subtract this from the wall area. This gives you the surface area to be papered. Add about 20 percent to the total papered area to allow for the few bad cuts you'll make (inevitable on your first job).

Divide this number by the area that your wallpaper roll covers, and that's the number of rolls you need.

Make sure the paper is from the



10 When working with small patterns, check alignment between strips using a level. This assures pattern stays even.



5 Apply wallpaper paste using a paint roller or a wallpaper brush. Spread paste evenly over paper's back and edges.

same lot or batch. The batch number is stamped on each roll, and all the rolls should have the same number. If you run short and have to order extra paper later, you might get a roll from a different batch run. The color or repeat pattern might not match exactly, even if you order the same pattern from the same store.

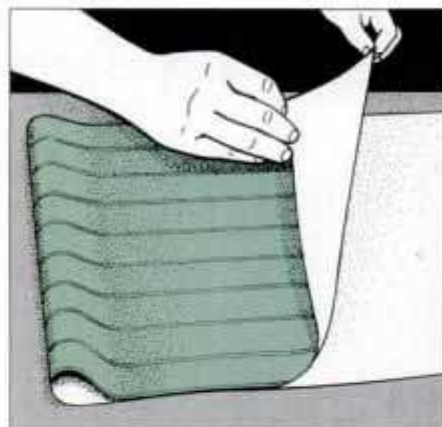
Clean the walls thoroughly and repair holes, cracks or dents. Wash or paint the room's woodwork and trim. Unless the woodwork is natural or its paint is in good shape, it will probably look dingy next to the new paper. It's easier to paint it now than after the paper is in place.

Turn off the electricity to the room, and remove the light switch and outlet covers. You could hit an outlet or switch wire with your razor knife while trimming the paper and get a shock, so leave off the power while papering. Light the room with a lamp on an extension cord plugged into an outlet outside the room.

Next, size the walls. Sizing makes it easier to slide the paper around without tearing while you align the



11 Push broad knife tight into corner at ceiling (or molding). Run razor knife along broad knife to cleanly sever scrap.



6 To prevent paste from getting all over when you handle the strips, fold the paper back over itself (pasted sides together).

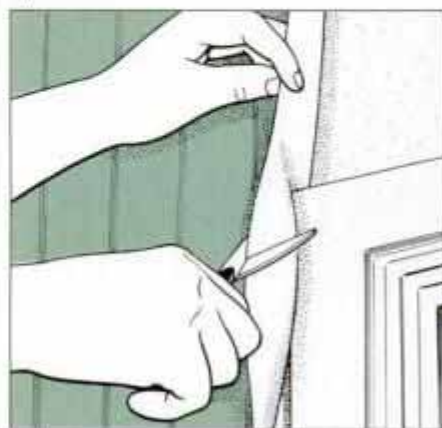
pattern. Because it seals the wall, sizing makes paper easier to remove at a later date.

Premixed sizing is easier to use, but more expensive than the type you mix. Either is simple to apply. Use a paint roller and pan to spread the somewhat watery solution. When it's dry, the wall is ready for papering.

When hanging a wallpaper with a light-colored background on a dark wall, you may be able to see the wall where there's minute misalignment between seams. Prime dark walls with a coat of inexpensive white latex primer or use a combination primer/sizing.

Layout: Getting started

Begin your paper layout by establishing vertical guidelines to help you position the paper. Even with guidelines there's sure to be some misalignment between the first and last strip of paper you hang. To conceal this, lay out your job so you start and finish in an inconspicuous spot, such as over a door, a window or on the least conspicuous wall.



12 Make diagonal relief cut from corner of window or door trim to paper's edge. This lets you work around projection.



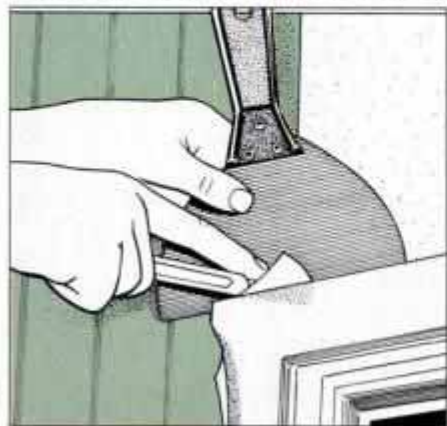
7 Align first strip with vertical layout line. Smooth strip with wallpaper brush, working out from its center to the edges.

Hold up a roll of paper where you want to begin. Make a pencil mark equal to the paper's width minus $\frac{1}{2}$ in. Use a carpenter's level or a chalkline to make a vertical plumb line through this mark (Fig. 2).

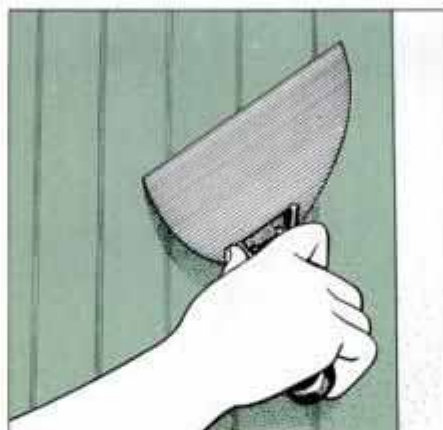
Align the edge of your first strip to be parallel and about $\frac{1}{2}$ in. inside this layout line. This prevents the line from showing through the seam, but keeps the paper's edge close enough for accurate alignment.

Don't cut the first strip by measuring it. Take the roll over to the wall and unroll enough paper to reach from the floor to the ceiling. Hold the paper in place at the ceiling and move it up and down so you have a complete pattern at the top (if your paper's pattern requires alignment).

Make a light pencil mark on the paper at the ceiling. Remove the paper, and place it on a flat surface. Trim the paper 2 in. above the mark you made at the ceiling. Then, measure down from the ceiling, and mark the distance that the wall is high. Add 2 in. to this measurement for trim at the bottom. Make a small cut with a pair of



13 Guide cut around window and door trim using broad knife. Trim away scrap before hanging next strip of paper.



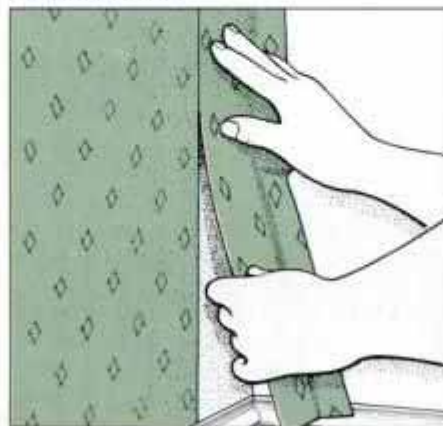
8 If you work carefully, you can smooth paper with a broad knife. Pull knife gently across paper to avoid tearing it.

scissors, fold across the paper at the cut, then use the fold as a guideline to cut the strip (Figs. 3 and 4). Test fit this strip.

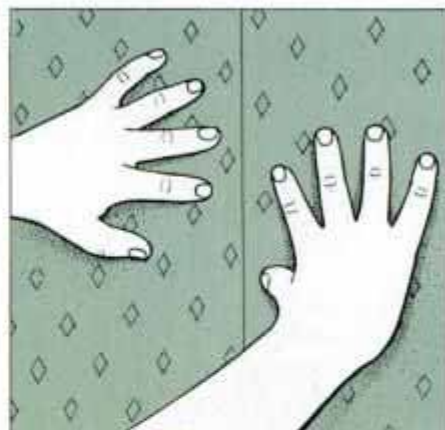
To cut the second strip, unroll the paper and lay it next to the first strip. Move up the paper until the pattern matches (the wasted paper should always be located at the top of the roll). Cut the paper so it's 2 in. longer at the bottom, leaving some paper to trim at both ceiling and baseboard. Avoid cutting a large batch of strips until you've tested a few pieces of paper to see how the pattern is lining up.

Hanging paper

If you're using a prepaste wallpapering, use an inexpensive plastic container called a water box or trough. Fill this about half-full with warm water and place it on a plastic garbage bag covered by old towels to blot up spilled water. Let the strips of paper soak for the amount of time specified by its manufacturer (usually less than a minute). Keep the paper rolled loosely from bottom to top and rotate it in the water.



14 Hang strip on an inside corner with about 2 in. of scrap on adjacent wall. Smooth paper toward corner and to seam.



9 Slide next piece of paper into position while adhesive is still moist. Smooth paper after pattern is aligned.

Follow the manufacturer's advice for wallpaper that requires adhesive. A vinyl paste is usually a good choice because it resists mildew. If you have had a mildew problem in the room, buy a mildewcide additive and mix it in the paste.

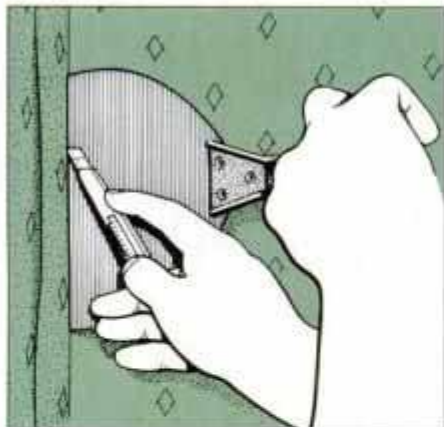
Smooth the paste onto the paper's back with a paint roller or wallpaper brush (Fig. 5). Spread the paste evenly, including the edges. To keep the paste from getting over everything, fold the pasted side of the paper back on itself (Fig. 6). This also prevents the adhesive from drying out. Work ahead and paste up a couple of strips so one strip can soak while you work with the other.

Wait at least 5 minutes after brushing adhesive onto a strip of wallpaper for it to set, or "wet out" as it's called, before you hang it. Wallpaper expands when wet and contracts as it dries, so this wetting out lets it reach its maximum expansion and prevents bubbles from forming behind the paper once it's hung.

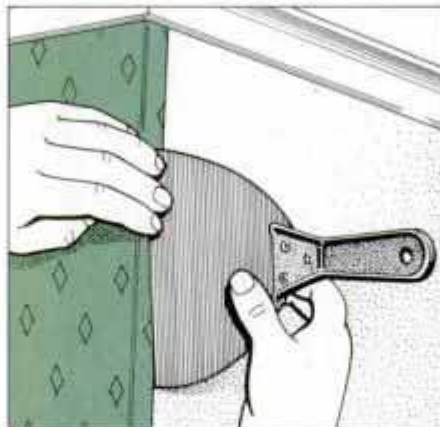
Have your ladder in place and your tools at hand before bringing the fold-



15 Trim paper flush working with broad knife and razor. This leaves a small bit of paper overlapping in the corner.



16 Start next paper strip with an overlap. Match the pattern and plumb the strip. Cut through top strip to remove overlap.



17 Overlap around outside corner should be under 1 in. Next strip should cover overlap. Then, trim strip flush to corner.



18 To make a double-cut joint, align the pattern with the strips overlapping. Press hard enough to cut both strips.

ed and pasted strip to your starting point. Unfold the top section and position the strip so it lines up with the plumb line. Don't forget that you allowed for an extra 2 in. at the top of the piece. Hold the top in place and unfold the pasted bottom section so it drops to the floor. Work your way down the strip checking alignment with the plumb line.

Press the strip firmly against the wall. Work out from the center of the strip using a brush or sponge to push air bubbles or wrinkles to the edges (Fig. 7). If you are very careful, you can use a broad knife (a 6-in.-wide scraper, also called a flat knife) to do this also (Fig. 8). Wipe off excess glue that oozes out of the edge of the strip. Hang the next strip and align the pattern by eye or with a level (Figs. 9 and 10). Use a seam roller to press the edge in place and again after each strip is hung to prevent the seams from opening.

Trim the paper at the top and bottom after you've hung several strips. This is best done using a broad knife and a razor knife. Press the knife into the corner where the wall meets the ceiling, and draw the razor along it (Fig. 11). Move the knife over as the razor reaches its end, then repeat the cut. Trim the paper at the floor the same way.

You have to negotiate around doors, windows, cabinets and other projections. To get the paper to lie flat next to these protrusions, use a pair of small pointed scissors or a razor to make relief cuts.

We'll use a window frame as an example. Carefully align the strip so it's plumb and its pattern matches the piece next to it. Smooth out the paper as much as possible. Make a 45° relief cut starting at the corner of the window trim, extending into the waste

paper (Fig. 12). Then, finish smoothing the paper, and work out remaining wrinkles and air bubbles. Trim the paper flush against the edge of the opening the same way you trimmed up against the ceiling (Fig. 13).

Hanging outside/inside corners

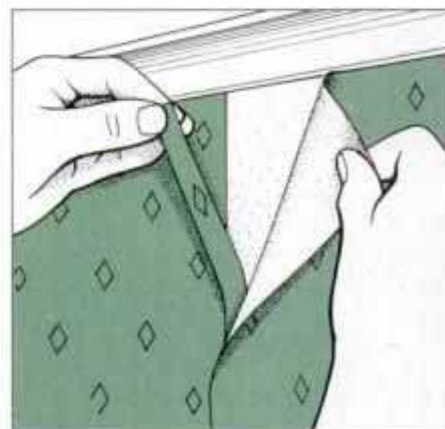
There's a great temptation to wrap a strip of wallcovering around an inside or outside corner, then continue on by butting the next piece of paper to it. This often results in a sloppy looking job. Corners are seldom square, and wrapping the paper around the corner will cause the pattern to run out of plumb. For best results, use a lap joint or double cut the seams.

To make a lap joint in an inside corner, trim the last strip so it's up to the corner and overlaps the adjoining wall by a couple of inches (Fig. 14). Push the broad knife into the corner and cut off the paper that overlaps on to the adjoining wall (Fig. 15). This leaves about ¼ in., or less, paper overlapping.

Make a plumb line on the new wall to align the first adjoining strip. This first strip on the new wall should wrap around the corner and overlap an inch or so into the wall you just papered. Carefully match the patterns of the overlapping paper in the corner and check the new strip for plumb.

Trim the new strip flush in the corner. Use a light touch and a sharp blade in the razor knife to cut through the top strip only (Fig. 16). This overlaps about ¼ in. and covers any gap between the new strip and the wall.

Next, add more adhesive to the joint by peeling the strip you just trimmed back and applying the adhesive with an artist's brush. Then smooth out the joint and sponge away excess adhesive.



19 The overlap falls away, but you must peel back the top strip and remove the cut-off section. Then, roll the joint tight.

Wrap the paper around an outside corner and trim it back so ½ in. of paper rounds the corner (Fig. 17). Mark a plumb layout line on the unpapered adjacent wall. Align the first strip with the layout line and trim it flush with the corner.

The inside and outside corner joints described here overlap. Some heavy papers will show a lump at the joint, and other vinyl papers do not stick well to one another. In these cases, and anywhere you want a joint that butts perfectly, you can use the double-cut method.

Overlap the strips where you want the joint, then cut through both strips with a sharp razor guided by your broad knife. The trimmed piece will fall away from the top strip, but you have to peel back the top strip to remove the trimmed piece from under it (Figs. 18 and 19). Smooth the top strip back into place.

While the paste is still soft, sponge away excess paste from the wall-paper's face and woodwork. Go back several times with a clean sponge to be sure you get it all.

PM

THE OFFICIAL MILITARY ISSUE GENUINE LEATHER A-2 FLYING JACKET

A Piece of American History.

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

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Cooper Sportswear was an original supplier of the A-2's worn by America's World War II flying heroes. Now, after a 45-year retirement



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Proudly Made in the U.S.A.

The Cooper A-2 is made in the U.S.A. using materials and production methods specified by the U.S. Air Force.

Premium hand stitched goatskin ensures ruggedness and great looks. Knitted cuffs and waist band and a spun cotton-blend lining ensure draft-free comfort. Details include regulation snap-down collar, shoulder epaulets, and roomy snap-close pockets.

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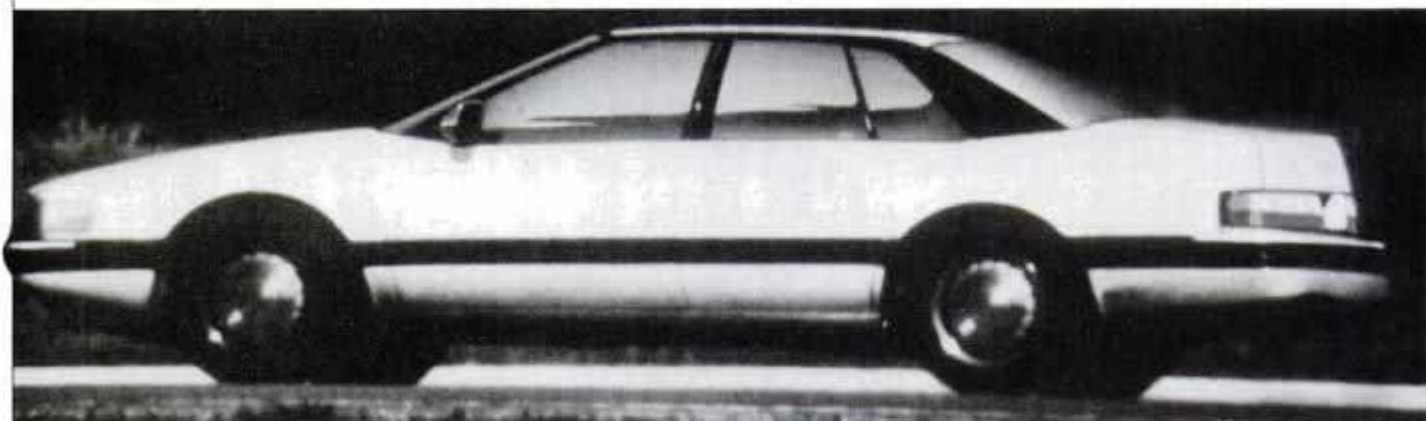
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606-304

AUTOMOBILES

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Cadillac Unveiling

● Look to the Cadillac Seville to be among the future cars on display at the Detroit Auto Show in January, at least a full six months before it goes on sale. Seville for 1992 will be all new in appearance, with a larger body, smoother, more rounded lines on the outside and equipped with Cadillac's new Northstar V8 engine under its hood. Cadillac plans to ship Sevilles to dealers beginning in June, but rich folks will get the first glimpse at the Detroit, and probably the Los Angeles and Chicago auto shows.

Taurus, 1992

Look for smaller headlights and a lower hoodline in the newest Taurus set for its first public appearance early in 1991. The smaller lights and longer wraparound turn lamps change the front end to a strong painted look. At the rear, taillights are altered, and contain round lenses for brake and running lights. A change in the trunk lid lowers the load height.



Due for '92, first Taurus redesign will be minor facelift.

Turbo Lag

Automakers may deny it, but turbochargers are dropping out of the performance scene on newer cars. Early designs of turbos that resulted in shaft burnup are still giving the booster a bad name among repeat customers.

Pontiac is out of the turbo business altogether with the cancellation of the Turbo Grand Prix and turbo-powered Sunbird models. At Chrysler, turbos are still in the lineup, but V6 engines are playing a bigger part in performance models, like the Daytona. However, in smaller cars, turbos remain the best bet for boosting overall performance.

Saturn Plastic

Saturn officials say that plastic panels were designed for the body of their car to have an advantage over Japanese competitors. Sure, they go through the litany of plastic features like dent-resistant, no-rust and lighter weight. But the plastic fenders, doors and quarter panels on the Saturn have set it apart from

Toyota, Nissan, Honda, and others. In Japan, steel is the least expensive material available for car bodies, so that the practice of building plastic-free bodies is likely to continue.



Next-generation Suburban will wear current pickup front end.

GMC Jimmy

A major styling change is in store for GMC's full-size sport/utility 2-door next summer. Up front, the Jimmy will take on the appearance of the full-size pickup truck and feature more rounded front and flush glass in the windshield. At the side, larger windows for rear-seat passengers are featured.

The restyling of the 1992 Jimmy along with the revised Crew Cab pickup and Suburban will complete the C/K truck redo at GMC.

Thicker Glass

Glass is heavy. So one of the ways the automakers cut weight in recent years was to make door glass and windshields thinner. They figured

(Please turn to page 64)

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DETROIT SPY REPORT (Continued from page 62)

maybe a couple of millimeters thinner, a change so slight that the vehicle owners wouldn't notice.

But now that trend is being reversed. Glass is getting thicker. Carmakers and owners found that the thicker glass is a good sound barrier. It

keeps the passenger compartment quiet, isolated from outside noise. So the glass on the 1991 GM-10 cars—Grand Prix, Cutlass Supreme, Regal and Lumina—is now 5mm thick instead of 4. The improvement, a 25 percent increase, helps make the cars quieter on the road and seem more luxurious to owners.

1991 Eldorado

A blacked-out grille and unusual paint pattern are designed to disguise this 1992 Cadillac Eldorado prototype.

Captured during ride and handling development work at the GM proving ground, the next-generation Eldo looks to be longer and wider than the current edition—a change that can be traced to the switch to GM's C-Body (Cadillac DeVille, Olds 98, Buick Park Avenue) platform. The current Eldo is an E-Body.

The new Eldo will reportedly use Cadillac's new 200-hp dohc 32-valve Northstar V8 engine.

Whitewalls

Look for whitewall tires to be around for a long time even though some criticize them for being tacky or old-fashioned. You will continue to see them on American-made sedans in the mid-price and luxury ranges. Olds, Buick, Cadillac, Lincoln, Ford, Mercury, Chrysler, Dodge and some Chevy cars are among the 1991 models that favor whitewalls.



'92 Mercury Sable will retain distinctive light panel across front.



Wider and lower for '92, Cadillac Eldorado rides C-Body platform.

However, virtually all the imports and smaller cars are sticking with black-wall designs. It is ironic that the most affected of the white tire designs—white lettering—is still the choice of muscle car and 4-wheel-drive vehicle buyers.

Toronado's 25th

Olds' Toronado is 25 years old this year, and that anniversary is a good time to recall just how revolutionary the car was when new. Toronado was the first American car in the modern age (post WWII) to offer front-wheel drive. It caused immense interest at the time since front drive was poo-pooed as a system that caused heavy understeer, one that lost traction going up hills and was, after all, too expensive for the average buyer.

In its original design, the Olds 425-cu.-in., 385-hp V8 engine was set in a north-south position directly over the front axle line. Prototype designs of the driveline had the right-side half-shaft located in a tunnel through the engine's oil pan. At production, a hump was built into the bottom of the pan to allow the shaft to pass underneath the engine.

The engineer behind the Toronado, Bob Stempel, became chairman of General Motors last August.

Subtle Sable

Like their contemporaries at Ford division, the Mercury product planners

don't seem to be anxious to take chances with their mainstream sedan, the Sable.

The sheetmetal changes for 1992 are subtle. Sable will retain its distinctive light bar across the front of the car, although the height of the bar has been reduced to give a steeper fall-away to the hoodline. **PM**

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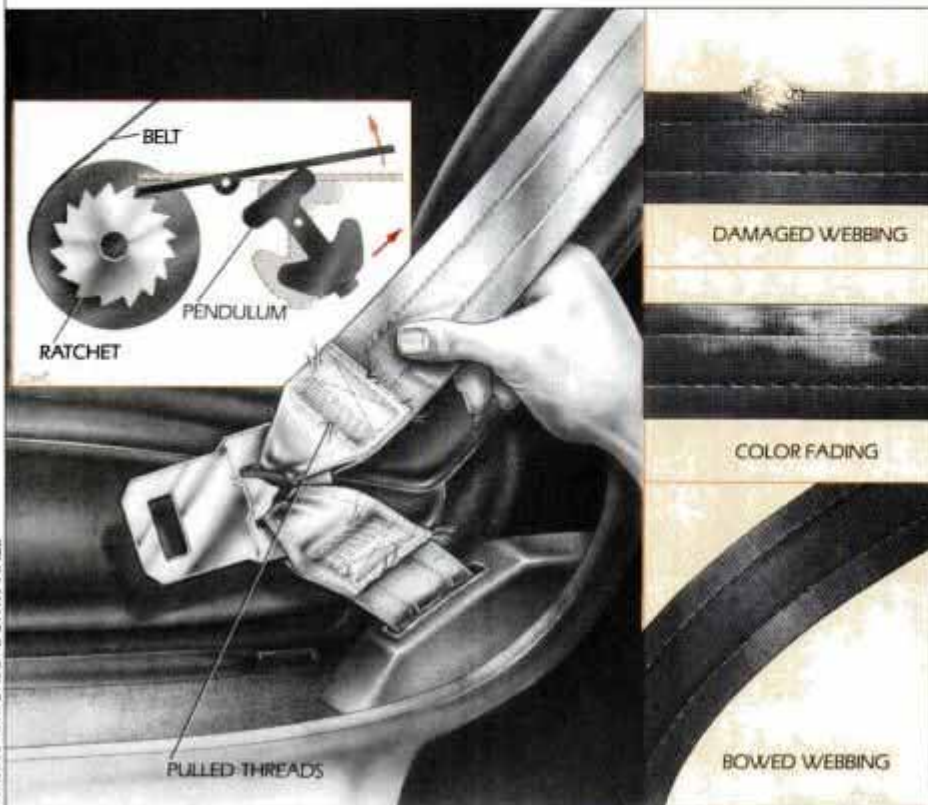
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AUTOMOBILES

CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PH ILLUSTRATIONS BY DON MANNES

Suspenders And Belts

I would really like to know how to check the automatic seatbelt mechanism in my 15-year-old car. It's supposed to lock up when you run into something, but I don't really trust it—and no one seems to know how it works or how to fix it, or even to be able to tell me if it will work when it's needed.

AMY DEVONE
CHRISTOPHER, WY

Seatbelt retractors are considered a nonfield serviceable item by car manufacturers—which is warrantspeak for: "If it's broken, you can't fix it. It has to be replaced." But how do you tell if it's broken?

There are basically two kinds of mechanisms used. The simplest is mechanically related to a window blind—pull the belt out really fast, and it locks up. Test this kind by grabbing the belt and yanking.

The second uses a pendulum to tip a pawl into a ratchet whenever the vehicle is rapidly slowing down (or speeding up)—before the belt starts to unreel. To check one of these, find a

deserted stretch of road, check for traffic and hit the brakes fairly hard. You should not be able to pull the belt out of the retractor until the car stops and you've released tension on the seatbelt.

If this doesn't work, you might take out the retractor mechanism and check for obvious defects, like undercoating gumming up the works or some other foreign object preventing proper operation. If that's easily rectified, fine. Otherwise, buy a new one.

Of equal concern is the condition of the belt material itself, especially in older cars. Check for these problem conditions:

- **Pulled threads**—Obviously, if the stitching at the buckle is coming apart, the belt may not be strong enough.

- **Damaged webbing**—Leaving the belt material dragging along the ground for a few miles or cutting it on a sharp edge of a door frame or child seat will compromise the strength of the belt.

- **Color fading**—A more subtle damage is from the ultraviolet in the sun, solvents or chemicals. Anytime

there's a noticeable change in the color of the webbing nylon, the belt should be replaced.

- **Bowed webbing**—If the webbing is no longer straight, it's because the longer edge has stretched—and should no longer be trusted.

Fortunately, any good trim shop should be able to reweb your belts for a reasonable cost. If the retractor is not functioning properly, you'll have to replace the entire assembly.

An Arresting Problem

My Cutlass has some sort of metal and metal mesh filter inside the replaceable air-cleaner housing. It seems to be clogged. There's no mention in the manual of this element or how often it should be serviced. It's pretty plugged up—my car seems to be strangling for air. And a replacement part is more than \$100. Do I really have to replace it?

JOHN BADNYE
POUGHKEEPSIE, NY

No, you don't have to replace it. It's not a filter, really. It's a flame arrester, intended to keep an occasional backfire from setting the paper air-cleaner element on fire.

Remove the air-cleaner housing from the car. Soak the housing in solvent, and brush away the grunge. You may need to use compressed air and a certain amount of patience.

And that flame arrester is inside of the paper filter, where the air passing through it is supposed to be clean. When you're reinstalling it, find out where that grunge is getting in, and plug the leak(s). You're digesting a lot of things with your engine that aren't good for it.

Reminders

When I change the oil in my Camry, I'm careful to be sure the vehicle is level. But even so, there are 8 to 10 ounces of oil remaining in the pan after it finishes draining. I know this because I made a J-shaped tube to siphon out the last little bit. This seems like too much dirty oil to leave inside the engine. Or am I just being too particular?

JOSEPH RANSIL
SARATOGA, CA

(Please turn to page 68)

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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.

In an ideal world, all of the oil would drain out of the oil pan, obviously. But packaging considerations and other auto design limitations sometimes mean that the little hole in the oil pan can't be at the exact low point in the pan, leaving a few ounces of oil behind.

If you can't block the car up safely at an angle to eliminate this, then I think your Toyota will probably do just fine if you drain what you can—especially if you change the filter every time as well.

Welcome Home

I just arrived home after a 3-week trip, and all three of my Hondas had the same weird problem. The rear brakes were frozen.

One of them was so tight that I had to remove the brake drum, which had rusted so badly that the brake shoes were glued to them.

The other two cars I rocked back and forth and got to break loose. The brakes sounded a bit rough for a while, but were soon fine.

Have you ever heard of this problem before?

Is it peculiar to Hondas?

JAMES EBY
PENNINGTON, NJ

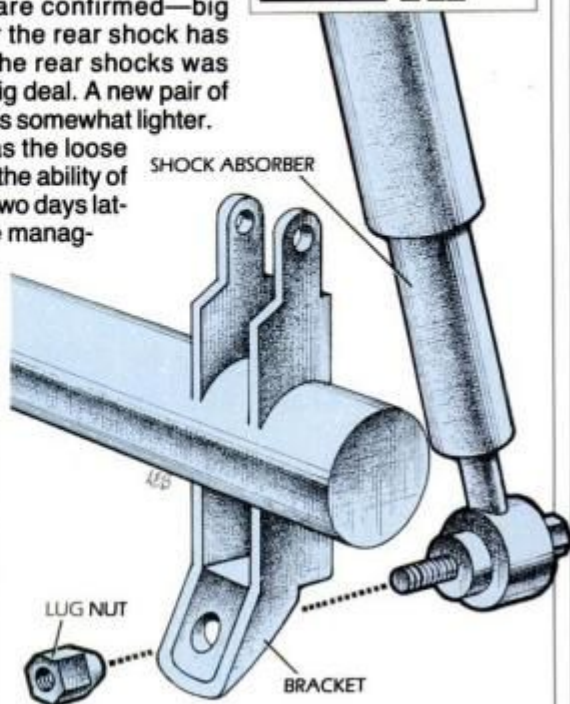
Nuts To You

● You've been driving around for a month now with a rattling noise from the back end of your car. Finally, you manage to sneak it into the shop for a quick diagnosis, and your worst fears are confirmed—big bucks. The mounting stud for the rear shock has come adrift. Well, replacing the rear shocks was overdue anyway, so that's no big deal. A new pair of dampers go on and your wallet is somewhat lighter.

Unfortunately, that noise was the loose stud enlarging the hole beyond the ability of the hardware to stay tight. And two days later, it's back. The shop's service manager says it's your fault for waiting so long, and . . . he's right.

He can fix it, of course. He'll have to weld something over the hole. The guy who does the welding is on vacation, and oh-by-the-way-no-warranty. If you want a warranty, they'll have to replace the axle housing—mucho dinero.

Try the coward's way out. A lug nut just happens to have the same 1/2-in. threads. With its chamfered face, it'll usually find a home in that egg-shaped hole, snugging up tight and staying that way.



PM ILLUSTRATION BY ACOULPHE BROTMAN

It's a bandwagon.

Thanks to Chevy Lumina APV's modular seating option, it can carry a band of 7, 6, 5, or a duet in perfect harmony.



It's not a problem peculiar to Hondas. Any car with drum brakes will do the same thing when the conditions are right.

Apparently, it was hot and humid enough to really make the rust in your cast-iron brake drums accumulate rapidly. I've experienced the same phenomenon myself with a number of cars, although, generally, it's taken considerably longer than three weeks.

I'd be a trifle concerned about out-of-round conditions cropping up in the near future on these cars—the pits left by the rust will wear at a different rate than smooth metal. You may need to have the drums lightly turned if you experience any pulsating under braking.

I'd also suggest leaving the cars with the handbrake not set if there's going to be any further extended periods of disuse.

Hummer

There's a humming noise coming from the bottom of my '87 Thunderbird. It does this whether the car is moving or sitting—but only when the engine is running, not when just the key is on. The noise is not coming from the stereo speakers.

What is it? How can I make it go away?

RONNIE DAINES
SALINA, KS

It's the electric in-tank fuel pump. This pump comes on when you turn on the key. If the engine isn't running, it shuts off itself in a few seconds, partly to keep from running down the battery, but mostly to keep from feeding a fire in case of a burst fuel line or accident.

Some humming noise is normal. It's a simple test of the electrical circuits to the pump and the fuel injection—turn on the key, and the hum should start and then shut off.

If the humming noise is getting louder, then it's possible that the pump is on its last legs. Sometimes, the rubber mounts inside the fuel tank will shift, letting the pump touch the mounts or tank wall, making a different, louder noise. But usually, it means the bearings in the pump are wearing out.

Premature wear can be a problem if you're in the habit of running around with next to no gas in the tank. These submersible pumps depend on gasoline on the bearing surfaces for lubrication. If you constantly run with very little gas, they'll

suck air and wear very rapidly.

So—fill 'er up when you get gas, don't just add a couple of bucks worth. And if that noise is getting progressively louder, think about replacing the pump before it dies some dark, rainy night. Be warned—this piece has a 3-figure price, so shop around.

Puddle-Jumping

I recently drove my 1989 Cougar XR7 through a puddle on a rainy day, and the engine blew a rod. Ford is in the process of replacing the engine, but I do not believe that this will solve the problem. Could this be a manufacturing defect?

BOB CHRISTIANI
BRONX, NY

When you say "blew" a rod, I assume you mean it broke the rod itself, rather than just spun the bearing. Also, you say Ford is replacing the entire engine, not just rebuilding it. If that's true, then it's not a manufacturing defect.

You went through enough water fast enough to splash water into the air intake in the grille—lots of water. This water went into the engine

(Please turn to page 70)

It's a turn for the better.

It maneuvers into and out of tight spaces. Its proven front-wheel drive pulls you through turn after turn. Chevy Lumina APV. One very easy way to get around.



quickly enough that one cylinder had more volume of water in it than the minimum volume of the combustion chamber at Top Dead Center. And when the piston came up there, the incompressible water had no place to go. The weak point was the rod—bang.

And after taking that big of a shot, I wouldn't give a plugged nickel for the crankshaft either. Dollars to doughnuts, the crankshaft is twisted or cracked. So be glad that you're getting a fresh motor.

Find that hard to believe? I once saw a fellow ride a motorcycle into a stream that was a little deeper than he figured—the same phenomenon blew the bike's cylinder and head clean off the studs and a good 50 ft. into the air.

Slow down going through those puddles.

Runnin' On Empty

For many years I have changed my own oil. I run the engine for 2-5 seconds after the drained oil stream subsides to void the oil pump and pipes. I now have an '86 Cadillac De Ville. Any problems with this procedure?

D. HAWKLEY
DOWNAL, VA

I have big problems.

You're deliberately making the oil pump lose its prime—all in order to purge a few ounces of oil out of the crankcase. This means that the pump will have to spin much longer to fill the oil filter and oil galleries after you refill the engine and start it up.

If you're changing your oil regularly, there's no harm being done by the small amount of used oil left in the system. But the wear caused by running dry, even for a few seconds, can potentially cause premature bearing failure.

If it's possible, I even recommend prefilling the oil filter with fresh oil before screwing it on. Obviously, this only works if the filter is vertical or close to it.

Just be really careful not to introduce any dirt or grunge into the filter. The last thing you want to do is force any dirt directly into the pressure side of the oiling system.

Some people like to disconnect the electrics and spin the motor with the starter until oil pressure comes up. Aside from the fact that on some modern cars that's a good way to fry the ignition module, it doesn't help. The bearings are still running dry, and the system is still full of air for

the same number of crankshaft revolutions.

On some engines, it's possible to pre-oil the system by removing the distributor and using an old distributor shaft and a drill to spin the pump until oil pressure comes up. I usually do that for a freshly rebuilt engine. But it's overkill for an ordinary oil change.

Just drain the pan, replace the filter, add fresh oil and start the engine.

Tired

I have a 1989 Ford Escort with 175/70R14 radial tires. It's hard to find this size of tire. Would it be possible to substitute a 185/70R14?

Would this affect the speedometer readings? Would I get a better ride or better handling?

T. R. ROUND
KELLANING, PA

I just looked through three tire catalogs here in my office—your size wasn't even listed. A Ford dealer would have that size—but the price would be dear.

A 185/70R14 tire would actually fit onto your rims and clear the wheelwells of your Escort, so it's mechanically possible to substitute for the smaller tire.

It's a quick-change artist.

One. Two. Three. That's how easily its modular seats come out. Arrange and rearrange. They each weigh just 34 pounds so they're definitely user-friendly.



But there are larger issues here. First off, your suspicions are correct—it will affect the speedo/odometer calibration. The 185/70R14 will be a few percent larger in diameter, making your speedo read lower than your actual speed. The overall gearing change will affect acceleration as well, costing you a second or two in passing situations.

Also, the minimum recommended rim width for a 185/70R14 is just 5 in.—which is what you have. This will make the sidewalls more compliant, improving ride at the cost of precise handling.

A better substitute would be a 185/65R14 or 185/60R14. These are closer to the original diameter. Unfortunately, these lower profile sizes are considered high-performance—and the tires available are more expensive.

Best solution of all would be to upgrade to a 195/60R15—a size available as original equipment on Escorts. Get some used 15x6-in. Escort rims from a salvage lot, and get a different speedometer drive gear at the Ford dealer to correct the speedo.

Tapped Out

Whenever I change my oil filter, I

first run a tap into the threads on the filter. I do this because a few years back, I purchased a filter with bad threads. It tightened down onto the engine, but not far enough for the gasket to seal, and I had oil all over the floor.

FRANK LASARACINA
WHITING, NJ

Don't do it.

You're making fine shavings of steel filter baseplate by the hundreds and dropping them directly into the filter. The large threaded hole in the filter (the one you're tapping) is the exit point for filtered oil back into the engine. Any foreign objects go directly to the bearings from there.

There's no way you could possibly shake or blow all of the shavings out of the pleats in the filter before installing it.

Inspect the threads on the filter visually before you install it. Always inspect the filter for leaks immediately after you start the engine.

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

- Owners of California-spec Yugos may not be aware that turning off the ignition isn't supposed to shut off the engine immediately. The engine is supposed to run for a few seconds, to burn fuel in the float bowl and reduce HC emissions. TSB 0-03
- According to the Automotive Engine Rebuilders Association, don't ever remove the lifter-carrier housing from the valley of a 4.1-liter Cadillac V8. The housing is machined for the camshaft after it's bolted to the block, and it will be plain impossible to re-align it properly if it's shifted.
- Ford TSB 89-10-4 says the C-11 power steering pumps used on many larger Ford products use a new type of quick-connect fitting for the 1990 and later model years. The new fitting is not interchangeable with earlier fittings—mixing types of fittings will cause damage to the fittings and fluid leakage. New replacement pumps are being supplied with both kinds.
- Pontiac TSB 89-8-27 says that 2.8- and 3.1-liter 6000s and Grand Prix with oil lights that flicker at idle when temperatures are high may benefit from a new vented oil pressure sender, PN10096199.

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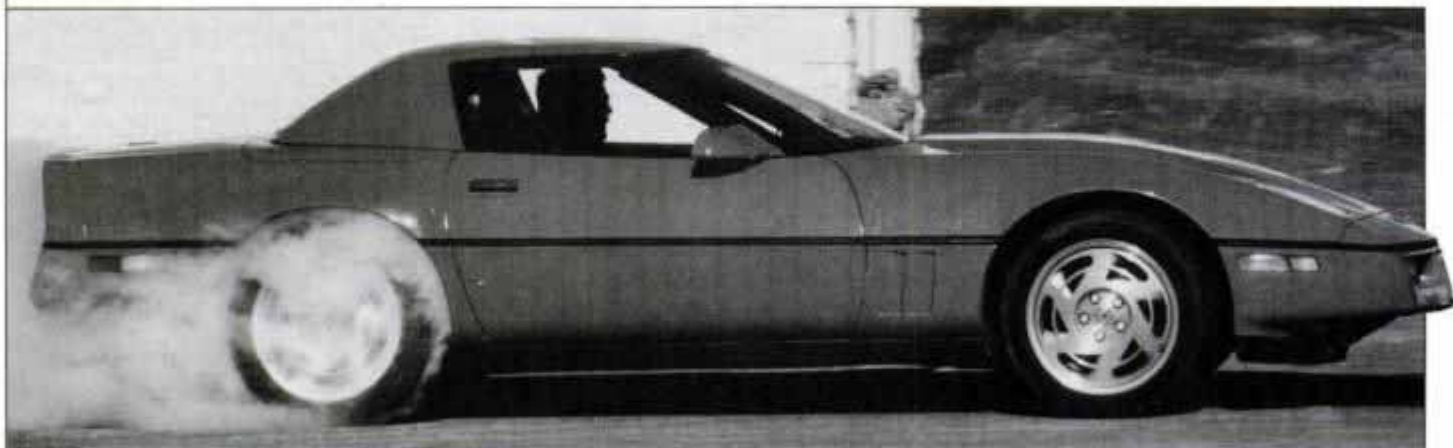
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AUTOMOBILES

FREEWHEELING

BY CLIFF GROMER



● The big-block engine in passenger cars is not dead, it's just in hiding—and not in Argentina, either. Fat cubes are already in showrooms, but they're planted between the frame rails of full-size pickup trucks—Chevy's heartbeat 454-cubic-incher and Ford's hoofbeat 460. But trucks aren't cars, obviously, and you'd be hard pressed to find something over 350 cu.in. (5.7 liters) powering a family coupe or sedan.

Looking For Mr. Big Block

But if you look hard enough through the fence at the General Motors proving grounds, you'll see a bright orange '89 Corvette convertible, with hardtop in place, fitted with the huge Goodyear tires that normally hold up the rear of a ZR1 Vette. If your eyes are really sharp that day, you'll notice that the power bulge in the center of the hood is just a tad higher than it's supposed to be. And, if the rear end of

the car isn't obscured by smoke from expensive tires being incinerated by massive torque, you might be able to make out the brass-colored ZR2 nameplate.

Corvette fans steeped in the lore and legend of the marque will recognize the ZR2 as a 1-year-only option offered on the 1971 Corvette. It was essentially a competition package based on the 425-horsepower, 454-cu.in. LS-6 engine. A total of 12 cars were produced.

ZR2 logic

The ZR2 name is entirely logical when you consider that the late-model ZR1 Corvette, powered by an exotic 32-valve 350-cu.-in. small block, carries the same name as a factory racing package, option-coded ZR1, that was available on 1970-'72 Corvettes. The '70s ZR1s were based on the 350-cu.-in. small-block LT-1 engine, heavy-duty 4-speed transmission, heavy-duty power brakes, aluminum radiator and special suspension. Boulevard amenities, including air conditioning, power steering and a radio were not available.

Big-block swap

The ZR2 prototype you see here was a special project handled by two Corvette development engineers,



ZR2 project—and badge—were created by Corvette development engineers.

Scott Allman and Scott Leon. It seems the technical folks at the Corvette Works were getting queried by late-model Corvette owners on how to swap in a big-block engine and they decided to try it themselves and find out.

Using parts readily available to the average enthusiast, the engineers scarfed up a 454-in. LS-5 engine—actually an old boat motor that was laying around. Stock engine details include 2-bolt main caps, hydraulic cam, 9:1 compression and an output of 365 horsepower.

Hybrid exhaust

The exhaust system starts with manifolds from an early '70s smog motor. The engineers removed the air-injection lines and plugged the holes with bolts—a common performance modification of the day. No cat converters are fitted, and the exhaust gas routes through a pair of mufflers and then out through square exhaust tips lifted from ZR1 parts bins.

The intake system is rather unusu-



Chevy big block's custom injection system and modified exhaust.



Gale Banks Engineering big-block Camaro delivers 300 hp.

al. It may look like a port fuel-injection system at first glance, but it's a custom-made setup using a semihigh-rise tunnel ram manifold (the reason for the increased height of the hood bulge) and twin inline throttle body injectors. A standard Corvette on-board computer, fitted with a custom-burned chip, orchestrates the various engine functions. The stock 6-speed manual transmission and 3.08 rear are strong enough to stand up to the big-block torque, but it took some doing to squeeze those humongous rear skins under a stock L98 body. The engineers machined down the brake calipers 14mm to get the extra clearance they needed.

Monster torque

Behind the wheel, the torque of this monster takes you back to the muscle heyday of the late '60s. Stomping on the loud pedal flattens your spine into the seatback and keeps it there. Quarter-mile excursions clock in the low 13-second bracket. That's just a tick behind a high 12-second time we've recorded with the ZR1.

It would seem that a big block would fill the gap nicely between the current base L98 and optional LT5 powerplants available in the Corvette. But official Chevrolet sources say no thanks, they prefer to keep their project in hiding in Detroit.

Camaro big block

Meanwhile, halfway across the country, the Gale Banks House of Horsepower is assembling a 454-powered Camaro.

PM readers will be familiar with Mr. Banks. His company, Banks Engineering, builds turbo kits for diesel trucks and motorhomes. He also built a twin-turbo Firebird that set a record (almost 300 mph) at Bonneville a few years back—a stock-bodied Firebird that carried POPULAR MECHANICS' sponsorship.

Banks remembers well the good-old days of the big block, and he's built a 454 Camaro, ostensibly as a research test bed for future Banks Engineering projects. We know why he really built this car, though.

He did it for the fun of it.

Banks says he's seen 300 horsepower at the rear wheels of this car, but he's not telling very much about what's been done to the engine to achieve that. The output is pretty close to what Detroit was getting

before OPEC, using carburetors the size of dinner plates. Banks' car, however, has fuel injection and gets in the

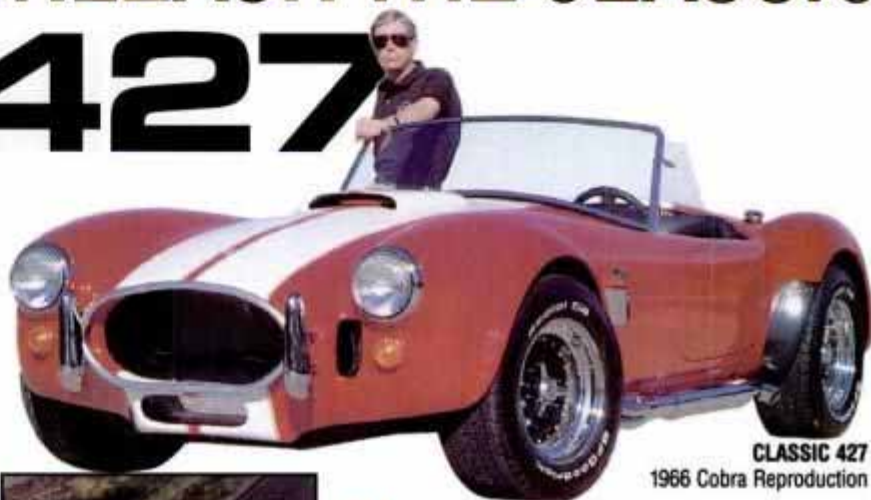
neighborhood of 15 mpg when driven sensibly, something which doesn't occur very often.

Externally, there's no tipoff about the herd of buffalo living under the hood. But sitting in the seat and tickling the throttle immediately points out the need for bigger tires, as gobs of torque will easily light up the stock rubber. The tach rapidly winds up to about 1000 rpm over the redline before the trans shifts.

Gale Banks is definitely *not* taking orders for copies of this car. But wouldn't you like to be the only kid on the block to have one? **PM**

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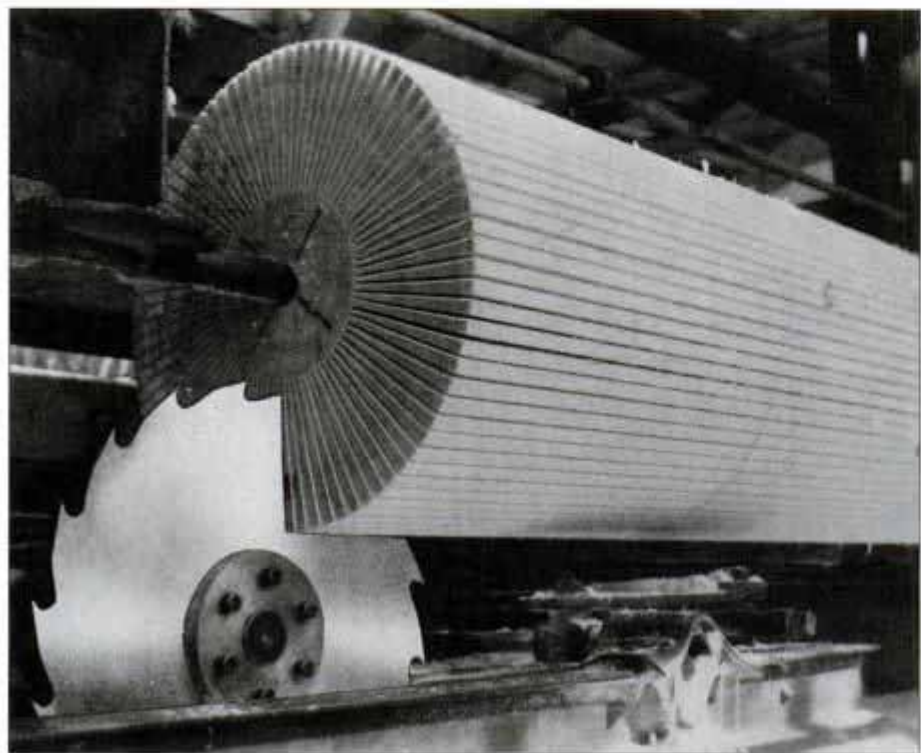


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OLD HOUSE RESTORATION

CLAPBOARDS

BY BOB VILA, Contributing Editor



DONNELL CLAPBOARD MILL PHOTO

● The exterior of every house tells a story. As a sensitive restorer, the one you want yours to tell is that of a properly executed and maintained structure, rather than a tale of modernization gone awry.

Maintaining an old house's original wood clapboards is one of the major components of a successful restoration. It's usually not a difficult thing to do. In most cases, you should be able to make spot repairs or replace damaged boards for the end result of a unified period exterior.

Understanding how a board is milled and the importance of its grain are the first steps in understanding clapboards. A brief history of clapboard-making in America is an interesting place to start.

In the beginning

Up until the early 1800s, clapboards were pried radially out of logs by hand. Called riving, each piece of wood was loosened by working with its natural grain. The resultant boards, rarely longer than 4 ft., were extremely stable.

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

Since it followed the tree's natural structure, the grain ran parallel to its length and tangent across its edge. This straight grain, which runs vertical to the board, resists warping and twisting. Hence, the term vertical grain board was born.

The Industrial Revolution saw the creation of clapboard mills. Now band saws could resaw rough lumber at a bias, creating beveled siding. Resawing has remained a popular and quick way to make clapboards. In fact, most of today's mass-produced beveled boards are made this way.

As its name implies, resawn wood requires two operations. To get an idea of how it works, it helps to picture a log going through a machine like a meat slicer. Now, see each "slice" of that log cut on a bias, creating two boards that form right triangles when viewed on edge. The grain in most of these beveled boards is generally curved or horizontal, which may cause the wood to warp or twist over time. This type of wood is called flat-grain resawn.

Quarter-sawing

The most long-lasting, stable type of clapboards milled today are rift or

High-quality clapboards are cut radially from the log. This process, called riftsawing, yields boards highly resistant to warpage.

quarter-sawn boards. Riftsawing is, essentially, riving done by machine. Like resawing, riftsawing was a result of the industrialization of America, and was developed at about the same time. When riftsawing, logs are suspended over a circular saw, and when the log is rotated, beveled clapboards are cut around its circumference, like pieces of a pie.

These traditional New England clapboards will last for generations, even under some benign neglect. The secret to their longevity and stability, like that of the early rived clapboards, lies in the board's perfectly cut vertical or edge grain. When viewed on end, a rift or quarter-sawn board forms an isosceles triangle with a sometimes fine-feathered top edge. As you can see, the way the grain runs is important to the end product's strength.

Riftsawing reached its zenith in the late 1800s, but many mills existed into this century. There are still some operating today, turning out quarter-sawn vertical grain clapboards. One of these, Donnell's Clapboard Mill (County Road, R.R. Box 1560, Sedgwick, ME 04676; (207) 359-2036), has the only 8-ft. rift mill I know of. Another, Granville Manufacturing Company (Granville, VT 05747; (802) 767-4747), turns out vertical grain clapboards in 6-ft. lengths.

The types of wood used for clapboard-making in the past depended on what part of the country the mill was located and what kind of wood was available there. The following is a brief rundown of some of the more popular woods used in historic clapboard milling.

Different wood, different wear

When it comes to species, the premier wood used for clapboard-making in my part of the country (New England) was No. 1 Eastern white pine. You'll see clapboards made from this material still functioning on houses 200 years old and older.

When pine wasn't available, hem-

(Please turn to page 76)



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lock was considered a close second, with spruce running a close third. Both of these substitutes wore and eroded faster than pine. Northeastern cedar had perhaps the shortest life of all, and, as far as I know, it was never used for clapboards. It tended to powder and flake as it weathered, making it an unlikely candidate for beveled siding.

Other woods were popular in other areas where they were plentiful. For example, poplar and cypress were often used in the South. Many native Western woods, like California pine and Western red cedar, entered the fray in the early 1900s when they could be shipped by rail to other parts of the country. Today, you'll find beveled siding in various varieties of woods, including redwood, cedar, pine and spruce.

Repairing old boards

As you can imagine, the common problem with lots of old clapboard is that it tends to split and crack over time. Usually, when this happens it's not with No. 1 pine, but with a lesser grade or different species of wood. If the split or crack is small, often restorers simply glue the board back together again, without causing much disturbance to the rest of the side. Use a good waterproof glue, then clamp the split together until it dries. You can do this by driving nails below the lower edge of the damaged board, turning them up so they brace the pieces together. Small wood blocks secured with a nail or two will do the same thing. Be careful the nails don't split the siding.

If you find boards that are damaged beyond repair, spots where warping, rot and the weather have taken their toll on old wood, you can usually cut out the bad piece and replace it with a freshly milled clapboard.

Use a backsaw to cut out the damaged section. Angle it carefully while you work to avoid cutting the siding below. After the board is cut, a sharp hammer and chisel is usually all that's needed to remove pieces of the damaged wood. Chances are the board is nailed to the one above it. If the nail is visible from the surface, try to pull it out. If not, you'll have to insert small wooden wedges or a screwdriver up under the siding to pry it out slightly to cut the nails with a hacksaw.

If you must start from scratch and re-side an old (or new) house with clapboard, the following installation tips and techniques will guide you.

Bottoms up!

Traditionally, most beveled clapboards were laid from the bottom

up. It's still the preferred way to side today. The historic way the hand-rived boards were secured to the structure is also the one that those milling riftsawn clapboards today recommend: nailing through two courses. Spaced less than an inch above the butt of the clapboard, the nails also penetrate the top of the board in the course below. Because of vertical grain clapboards limited expansion and contraction, this is the best way to install this type of siding. I recommend 5d galvanized wire box nails. Its thin shank, of course, prevents the wood from splitting.

If you are working only on one side of the house, then you should have the exposure on your new clapboards match that on the other sides of the house. The exposure on a clapboard is that part of the board that's visible after it's nailed down. Since a 1- to 1½-in. lap is necessary on most traditional clapboards to keep them weather-tight, you'll generally find about a 3-in. exposure on 4½-in.-wide boards and a 4-in. exposure on 5½-in. ones.

Installing the boards is not difficult, especially if you're just working on a single-story house. A couple of step ladders and a helper on the other end of each board should be all you'll need. But if you're working on a wall that goes higher, then you should rent a sturdy scaffolding system. Good scaffolding not only makes the job go easier and faster, but it also gives you a margin of safety that working off an extension ladder can't provide.

As always, the largest component of safety is good common sense. Never work when it's raining, and be sure to make all power saw cuts on the ground. Use only a handsaw when working on the scaffolding.

As far as finishing goes, be prepared to use more paint on vertical grain boards. The smooth, edge-grained face will really absorb it. If you want to leave it in its natural state for a weatherbeaten look, a good weathering oil or stain will help preserve it and allow the wood to weather evenly.

Don't be tempted to leave the wood uncovered. Since different parts of the house will weather and age differently, you're likely to end up with an uneven look. And all wood, no matter what the species or grade, benefits from some sort of protection against the elements.

So, you can see the beauty of a clapboard-sided house is really all in the grain. With good quality vertical or edge-grained beveled siding, the part of your house that everyone sees first will reflect your commitment to the sensitive restoration. **PM**

Luxury-car electronics

Electronics are being used for a lot more than managing powertrains at the high end. BMW's 850i is equipped with multiplexed wiring, which means many computers transmitting many signals simultaneously across just a couple of wires, eliminating fat, troublesome harnesses. Sample bells and whistles: Wipers can be preset to run faster with increasing road speed. The fresh air system progressively strangles itself as the road speed increases, giving you a flow of air through the vents that remains constant sitting in a traffic jam or blasting along the autobahn. Open side windows close themselves automatically when you lock the car.

The 850i also gets a new electronic hydrocarbon sensor wired to a computer programmed to recognize increasing air pollution. If necessary, it shuts off outside air to the passenger compartment and just recirculates inside air through a filter. Once you get out of the city, the fresh air starts again as soon as the outside has less contaminants than inside.

Power steering may not be mandatory with a super-high-performance midengine car, but the Acura NSX has an all-electric option. A motor wraps around the steering rack, controlled by a computer to reduce assist as road speed rises. This eliminates the power-robbing pump and plenty of messy hoses and belts, and makes it simple for the computer to regulate required steering effort.

Entry-level luxury

Toyota may have put most of its technical marbles in the Previa minivan introduced early this year, with its tilted midengine and a long driveshaft to a cradle of belt-driven accessories in front. However, it's given its '91 Tercel a couple of formerly high-ticket passenger-car features. One is a fully counterweighted crankshaft, for greater smoothness with the 1.5-liter Four. Also, the entry-level Deluxe and LE models get dash panels and wheel housings with metal sandwich panels separated by fiber shells to insulate road and engine noise from the passenger compartment.

Suzuki

Wondering what you might buy if the availability of gasoline becomes a real issue? A 1991 Suzuki Swift sedan, which has a 70-horsepower 1.3-liter fuel-injected engine, is an example of what's available. It's 12 ft. long, weighs less than 1800 pounds and delivers 44 mpg with a 5-speed manual transmission. **PM**

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THEATER AT HOME

BY FRANK VIZARD, Electronics Editor



● For a lot of people, a television isn't just a television anymore. It's the foundation for a home theater system. And if it's a home theater you want, then it only makes sense that the foundation block you're using be as large as possible.

While the 20-in. color television is still a staple of the American viewing diet, manufacturers are also offering more larger-screen, direct-view televisions that are real head-turners.

Among the more notable is the RCA ColorTrak 2000 line of televisions. This RCA line includes direct-view screen sizes of 35, 31 and 27 in. Screen size is only part of the story, however.

RCA uses a recently developed INVAR Shadow Mask technology that's used in the making of the picture tube. The INVAR Shadow Mask is a special thermally stable alloy that maintains the tube's color purity and white uniformity, even under high-power conditions.

By using the INVAR Shadow Mask, RCA is able to boost power to the tube to 55 watts, up from the 40 watts that's more commonly used. This increase in power translates into a picture that has more lifelike characteristics.

RCA does not rely on the INVAR Shadow Mask for a better picture. The new ColorTrak 2000 line includes a digital comb filter that greatly reduces the "edge crawls" and other distortions caused by detailed patterns, such as those on plaid suits or on striped ties. There's also a dynamic gamma correction circuit

that increases the contrast by extending the dynamic range of the luminance signal. The luminance signal, as opposed to the chrominance signal, which governs color reproduction, determines the brightness.

Audio, of course, is as big a part of the home theater as video. The RCA ColorTrak 2000 models offer either 5 or 10 watts per channel of amplifier power. All have some type of surround-sound capability, while a few also include Dolby decoding circuitry. Many top movies use Dolby encoding circuitry for surround-sound effects.

RCA also offers you a degree of flexibility with its VideoLink universal remote control. The VideoLink remote is compatible with 56 different VCR brands and 27 cable boxes.

Big direct-view televisions will put you into the action in a dramatic way, but the experience isn't cheap. RCA's 35-in. G35300WK model lists for \$2899, while 31-in. models like the F31222SB list for \$1649.

Other TV manufacturers, of course, are using or will be using the same technologies available to RCA. Whichever the manufacturer, how-

ever, the level of technology used for big-screen direct-view models is higher than anything seen before.

Much of the best that RCA has to offer is being included in a new TV line being offered by the company. Called ProScan, the line includes six color TVs in four sizes and a laser disc player. The RCA name appears only on the back panel.

ProScan is fundamentally different from standard RCA products in two ways. The cabinets are subtly curved to highlight the screen itself, and the cabinets have a textured-black finish.

The big difference, though, is the use of the first no-glare/dust-free picture tube. The tube minimizes room reflections to provide better contrast. At the same time, the buildup of dust on the tube is virtually eliminated.

The ProScan line is also notable for the design of the external speakers included on some models. These new speakers can be placed vertically, horizontally or at an angle, thanks to a wedge-shaped design.

Prices for ProScan TVs range from \$499 for a 20-in. model to \$2799 for a 35-in. console model.

Big Zooms

One of the great things about camcorders is the zoom lens that lets us get close to the action. Now you can get closer still with two new camcorders from Chinon and Panasonic.

Chinon's CV-T124 model sports a *(Please turn to page 80)*



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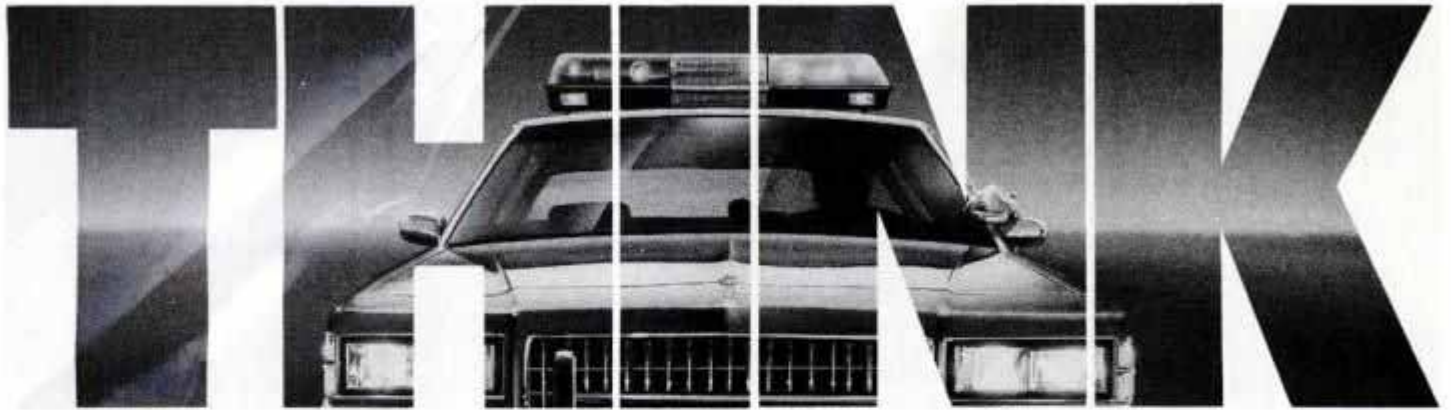
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12:1 zoom lens that operates as most others do. However, pressing the DIGITAL ZOOM button on the side of the camcorder boosts magnification to either 30:1 or 96:1.

Panasonic's PV-660 has the same capability, but the manufacturer only feels comfortable claiming the 30x capability. That's because the resolution deteriorates noticeably beyond the 30:1 range. The picture is viewable, however.

Both of these camcorders feature other special effects, as well. Both offer electronic image stabilization, which cuts down the jittery picture often caused by handheld operation. Another interesting feature is the ability to create a mirror image of a scene being recorded.

The Chinon CV-T124 lists for \$2395, while the Panasonic PV-660 lists for \$1599.

Games And TV

NEC is joining Nintendo and Atari in competing for the handheld videogame business. Called the TurboExpress, NEC's machine has an edge over its competition in two regards. First, you can buy an optional tuner pack that connects to the player. Presto! The videogame player is now a portable TV.

Second, the existing library of games that are available on NEC's TurboGrafx home system can be used on the portable unit. With both Nintendo's Gameboy and Atari's Lynx machines, separate game libraries have to be bought.

TurboExpress has a 2.7-in. screen. There's also a communications link for 2-player games. The machine uses six AA batteries for between 3 and 5 hours of playing time. TurboExpress will sell for around \$250, with the optional tuner pack selling for around \$100, says the company.

Phone Managers

Two new products are now available to help regulate the flow of incoming telephone calls.

From Lynx Automation comes RingDirector, a product that allows you to run four different telecom-



Getting close to your subject is as easy as pushing the DIGITAL ZOOM button (below) on the Chinon CV-T124 camcorder. Magnification leaps to either 30:1 or 96:1.



munications devices off a single telephone line. You can, for example, connect a fax machine, computer modem and telephone to the same line rather than going to the expense of adding a second line or more.

RingDirector utilizes a new telephone company classification called "distinctive ringing." This feature assigns two or four new phone numbers to an existing line which, when called, generates distinctive rings. The RingDirector distinguishes the rings and routes them to the appropriate machine.

A 2-line RingDirector lists for \$89, while the 4-line model lists for \$149. Lynx is located in Lynnwood, Washington; (206) 744-1582.

Unwanted calls can be as much of a problem as managing them. Lineminder, made by LM Communications of Dayton, Ohio; (513) 439-2313, is designed to screen unwanted telephone calls. Callers must enter a 4-digit security code to complete a call. If they don't, Lineminder hangs up. An on/off switch means Lineminder can be used just for certain hours, like early Saturday morning when telephone marketers call. List price for Lineminder is \$80.

Organizing your telephone directory is a task willingly accepted by Radio Shack's electronic rolodex. The EC-340 can organize 500 business cards alphabetically. Names and numbers can also be organized into seven filing categories. Data can be transferred to a small portable unit. Other features include a calendar, currency exchanger and calculator. List price is \$150. **PM**



Radio Shack's electronic rolodex.

HAPPY LANDINGS

(Continued from page 43)

New York, which have close parallel runways, to bring aircraft into one runway on a curved approach, decreasing stagger necessary to maintain a safe separation between aircraft. Net result: Efficiency is increased without corresponding risk.

At one time, as many as 1200 MLS systems were planned. The General Accounting Office, however, has questioned the need for MLS, pitching it into bureaucratic limbo. For the time being, the implementation schedule remains, well, cloudy.

ATMS: Going with the flow

The Advanced Traffic Management System, designed and operated for the FAA by the DOT's Transportation Systems Center in Cambridge, Massachusetts, offers an intriguing view of what the future may hold.

Strictly speaking, ATMS is for flow control, rather than air traffic control, meaning it regulates air traffic on a national scale so that airports don't become overloaded during peak hours or bad weather. The system ties together all the information on the computers of all 20 en-route air traffic control centers. The result: A map on a video screen showing every aircraft in flight in the U.S. The user can zoom in or out, look at individual airports, pull up flight plans on any plane and display particular categories of aircraft. ATMS also predicts traffic overloads before they occur, allowing flow managers to nip system bottlenecks in the bud.

Most exciting, though, is an enhancement (still in development) that uses artificial intelligence to work out solutions to flow problems, minimizing the human interpretation work necessary for traffic managers to keep planes flowing smoothly.

Flight into the future

In fact, if there's a common thread holding together the 100-odd projects being pursued under NASPlan, the effort to cut down the mind-numbing quantity of mental spade work involved in keeping planes out of trouble is probably it. From a technical point of view, there's no reason computers couldn't one day handle many of the duties now performed by air traffic controllers. Says Raytheon's air traffic control marketing manager, James Burkley, "The system is designed to evolve so that more and more of the routine functions are taken over by the computer. So as part of the automation process, the controller becomes more a manager than a manipulator of data." **PM**

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OUTDOORS

WILDERNESS WINCHING

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY RICH COX

● Three teenagers—ripped jeans, billed caps, spikey hair—come out of a gas station at a rural crossroads in Colorado. They eye my new 4x4 sport/ute. It's plain they think it's a never-leaves-the-road yuppie mobile. But just before hopping into their battered pickup, the boys notice a winch mounted on my front bumper. Everything changes. "Wow. Look at the winch," they say, nodding to each other. "This guy is serious."

Yes, and no. I'm serious when necessary, but prefer to find humor in most situations. The above photo illustrates this point. On the serious side, I'm stuck in the mud. On the lighter side, I'm there because I helped a fellow off-roader out of a jam. The fellow then guided me into a ditch. He's just off-camera holding the end of my winch cable, and if he's smart, he'll stay that way.

Despite being stuck in the ditch, I felt certain that I'd soon be out of the muck and happily bouncing down the road. Possessing a winch, as the three

teenagers from Colorado pointed out, meant that I was serious about the security of my vehicle. A winch serves as a precaution against the possibility that I might screw up big time.

Know thy winch

Wilderness driving isn't something that should be taken lightly. Had I not arrived on the above scene, my stuck-in-the-mud friend was facing a long, cold night. I can safely assert that a major goal of all off-roaders is drive in, drive out. The other options are undesirable. A winch helps ensure that off-roaders will realize this goal.

With some difficulty, I freed my 4x4 from the above ditch. But the experience taught me that I'd better bone up on winching. Here's what I found.

A winch is an electric-motor-driven drum that reels in steel cable. It's generally used to pull a vehicle out of a bad situation. Occasionally, it's used to drag logs or other unwieldy objects. Pulling capacities, for the most

common winches, range from 4000 to 12,000 pounds.

Winches are most often thought of as being mounted on the front bumper of a vehicle, but there are other options. Some winches are portable, and some can be mounted to the rear bumper.

Just as there are multiple ways to find trouble in the outback, there are multiple ways to set up a winch pull. The most common one is the straight-line pull. Here, the winch cable is connected directly to a solid anchor.

But what happens when a vehicle is stuck that's heavier than the pulling capacity of the winch or when you can't position your vehicle directly in front of the object you want to pull? To effectively double the pulling power of a winch,

you can use a snatch block. Just as in a straight-line pull, run the winch cable to a solid anchor, but instead of hooking it there, run it through a snatch block and double back to the vehicle. This is called a double-line rig. It can be effectively used for heavy vehicles stuck in deep mud or for those that need to be pulled up severe angles.

A third setup, which also requires a snatch block, is called the 3-point pull and it enables the winch to work from a sharp angle. It's ideal when trees, boulders or unsuitable ground prevent you from positioning the winch directly in front of an object that needs to be pulled. Position the winch safely and set up a solid anchor near the line you want to pull along. Then, hook up the snatch block to the anchor and run the cable through it to the object being pulled. Once again, the snatch block increases the versatility of your winch.

As you can see, winching isn't as straightforward as it first appears.

(Please turn to page 86)

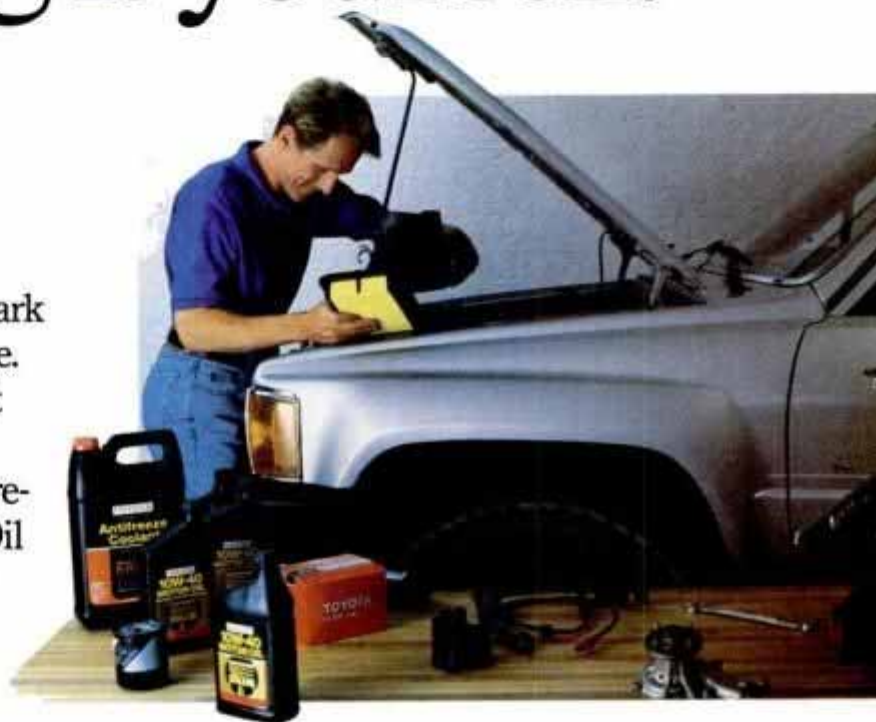
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Multiple techniques and accessories play an important role. Accessories are especially vital. A short list of accessories that are smart to have on hand are gloves, a clevis shackle, a tree-trunk protector, a snatch block and a choker chain. These items are packaged together in a handy Warn Winching Accessory Kit from Warn Industries, of Milwaukie, Oregon, which retails for about \$127. It comes in a rugged Cordura soft case that has plenty of room for add-on items such as a roller fairlead, a nylon recovery strap and an extra tow hook. I carried this kit on a recent off-road trek and put it to good use.

Basic tips

The first order of concern is inspecting the cable, and the first thing to do is put on gloves. Look for frayed wires, kinks or loose connections. Frayed wires and kinks can be caused by running a cable over rocks or other objects, which should always be avoided. Problems with the cable can lead to both winch failure and personal injury. So, even under the best of circumstances, it's wise to keep all spectators at a safe distance.

It's best to free spool cable off the drum by hand, rather than using the

slow winch motor. This saves time and battery power.

Select an anchor point carefully. Make sure it can withstand the intended load and keep in mind that extra pulling power is required when a vehicle or object is stuck in the mud. If another vehicle serves as an anchor, make sure it's heavier than the object being winched.

Most winching setups typically involve using a hefty tree as an anchor point. A solid tree can make a perfect anchor, but the process could do irreparable damage to the trunk or to the cable. To prevent this damage from occurring, always use a tree-trunk protector strap. Wrap the heavy-duty nylon strap around the trunk and secure it with a shackle. Then attach the cable hook to the shackle. Never wrap the cable around a tree trunk, or any object, and hook it back on itself. This could result in a severe kink, causing permanent damage to the cable.

Here are some additional tips that



Warn Accessory Kit—everything needed for off-road winching.

will help guarantee safety:

- Drape a blanket or floor mat over the midway point of the stretched cable to prevent it from whipping back onto the winching vehicle if the cable breaks or comes loose.
- On hard pulls, stop winching every minute or two to prevent the motor from overheating.
- Don't touch the cable when it's under tension or when someone else is at the control switch.
- Make sure at least five coils of cable are around the drum to avoid the possibility that the line will come loose from the drum under load.
- Pull as straight as possible to minimize cable buildup at only one end of the drum.
- Take up any slack in the line by pulsing the switch to avoid shock loads when the line becomes taut.

Selecting a winch

A good rule of thumb for off-roaders looking to install a winch is to choose a model with 1½ times the pulling power of the vehicle's gross weight. This figure should be a combination of the weight listed in the owner's manual plus an estimate of the weight of carried and add-on gear.

During the off-road expedition where I performed my ill-fated Samaritan deed, I was driving a Ford Explorer. It has a curb weight of 4336 pounds. A week's worth of gear and equipment easily pushed my gross vehicle weight to around 5000 pounds. I could have gotten away with installing a winch that has pulling power in the 7500- to 8000-pound range, but I played it safe and installed one with an extra margin of power. The model I used was the Warn XD9000 (\$785), which is rated for 9000 pounds. I wanted to be ready for anything.

And I was, which is the point of owning a winch. If you know what you're doing, a winch can get you out of any jam that you could have avoided if you did everything right in the first place.



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AUDIO

SIZING UP SHELF SYSTEMS

BY FRANK VIZARD, Electronics Editor



● Putting a rack of electronic components and a pair of large speakers into a small apartment, dorm or upstairs bedroom is obviously not the best use of space. But being short on space doesn't mean you have to be short on sound.

Many audio manufacturers now offer space-saving tabletop audio systems for people who love music but don't love the amount of space a stereo system requires. While not every tabletop system is the musical equivalent of a larger system, the best tabletop stereo systems narrow the gap considerably.

Among the more notable is Kenwood's UD-7 system. The UD-7 merits high praise not only because of its musicality, but also because it sports a level of artificial intelligence that makes operating the UD-7 extremely easy. A lot of the audio listening chores once done by hand are now done automatically.

Listing for \$1200, the UD-7 is comprised of separate components that include a 38-watt-per-channel receiver, a compact disc player, a dual-well cassette player, a graphic equalizer and a pair of speakers. The system is also expandable in that there are inputs for surround-sound speakers, a subwoofer and an additional electronic component.

The artificial intelligence of the

UD-7 is most evident during CD playback. When you press the AUTO AI button on the remote control, the UD-7 electronically samples each track on the CD. The music on the CD is compared against an optimum playback setting for musical genres, like classical, rock or jazz, stored in memory. The data is then transferred to the graphic equalizer where bass and treble response is adjusted accordingly.

The UD-7 also has some other features that make living with a stereo system easier. If you want your tapes specially equalized for car stereo or headphone playback, the UD-7 does the job automatically. If you're listening at a low-volume level, the UD-7 boosts or cuts frequencies as necessary to maintain musicality.

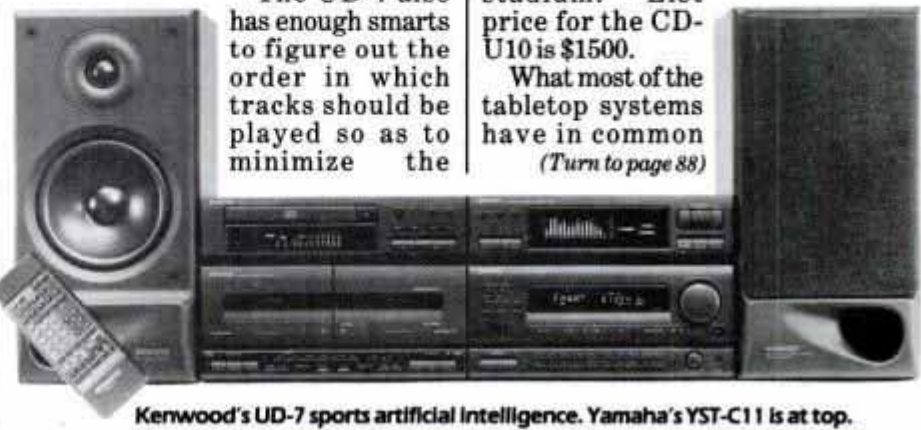
The UD-7 also has enough smarts to figure out the order in which tracks should be played so as to minimize the

amount of tape wasted when you're making a recording. Proper recording levels are set automatically. And if you need a wakeup call, the UD-7 will do that too.

The UD-7 features a set of factory-set equalization curves designed to get the best sound from a variety of musical sources. The 10 preset curves include ones for classical, jazz, heavy metal and even movies.

Other tabletop systems offer the same thing. Sharp's Optonica CD-U10 system is one example. A push of the button puts you in a concert hall, sitting either onstage or midhall. Another button puts you in an outdoor stadium. List price for the CD-U10 is \$1500.

What most of the tabletop systems have in common
(Turn to page 88)



Kenwood's UD-7 sports artificial intelligence. Yamaha's YST-C11 is at top.

STATEMENT OF OWNERSHIP

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STATEMENT OF OWNERSHIP

AUDIO (Continued from page 87)

is a combination of electronic circuitry and ported speakers that generate more bass response than small speakers normally deliver. In Yamaha's Unity YST-C11 system, the company uses matching and feedback circuitry to create a relationship between the speakers and the amplifier that yields accurate and low bass response from speakers less than 10 in. in height. The electronics is optimized to work with the system's speakers so substituting different speakers will cause a dropoff in performance.

The YST-C11 bundles the amplifier, tuner, CD player, equalizer and dual-well cassette player into a single chassis. List price is \$1000.

Pricing varies among tabletop stereo systems mostly according to the features and power. Denon's G-05 system offers 28 watts per channel and Dolby B noise reduction for quieter tapes at a list price of \$800. Kenwood's UD-7 ups the power and adds Dolby C, an even more sophisticated noise-reduction system. Aiwa's NSX-800, listing for \$1100, is among the more powerful systems at 55 watts per channel, but lacks Dolby C.

MusicBank

Compact disc changers, machines capable of playing more than a single CD, are convenient. A small drawback is that for many players you have to load the disc into a cartridge for insertion into the machine.

Nakamichi, however, has developed a CD changer which eliminates the need for a cartridge. Called the MusicBank system, these CD changers stock up to six discs internally. Each disc is played on the same disc tray. There's also a storage slot for an additional disc, upping the number of discs that can be handled to seven.

The MusicBank system is available in two Nakamichi changers, the CDPlayer 2 and CDPlayer 3, listing for \$649 and \$499, respectively.

Multiroom Sound

If you've got two people with different tastes in music living under the same roof, two audio systems are almost inevitable. At least that's the way it used to be. Now you can hear music from the compact disc player in one room and music from the tape deck in another with just a single audio system.

Multiroom distribution of different signal sources is a job for a receiver like the new Pioneer VSX-D1S. All you need to control the VSX-D1S from another room is an infrared adapter. This adapter is wired to the receiver as are a second set of speakers. Once the adapter is in place in the



Nakamichi's CD changer mechanism stores six discs internally, not in a cartridge.

second room, you can control the receiver via the remote control.

The VSX-D1S lists for \$1350. More than multiroom sound distribution is included in the price, of course. The VSX-D1S also offers Dolby Pro Logic surround sound and digital signal processing (DSP). The DSP circuitry can electronically duplicate the acoustic interior of a theater, dance hall, jazz club, concert hall or church.

The VSX-D1S also offers you a choice regarding how the amplifier power is distributed. One mode delivers 130 watts through the front channels. In a second mode, 70 watts is distributed through the front and center channels and 40 watts through the rear channels. This lets you decide how big a sonic boom you want with a particular audio or video selection.

While the VSX-D1S offers a quick way of getting an audio/video signal to another room, wiring every room in the house remains a rather large undertaking. Sony is making the task a little easier with a new audio component called the CXD-2502S, which acts as a signal router.

The CXD-2502S is basically a master control center that converts the audio signal into digital form before sending it on its way to the desired room. The digital conversion circumvents the degradation and distortion that normally comes with sending sound over long distances via wires. The digital signal is received by a small decoder/amplifier that converts the signal back to analog so it can be reproduced by the speakers in the room. Each satellite decoder/amplifier offers 40 watts per channel. A separate control panel, which can be mounted in the wall, controls volume and other features.

Coaxial cable is used in the installation since it offers better shielding than conventional wire while also being inexpensive and readily available. By using coaxial cable, Sony is able to utilize the wiring from cable television systems. This means that you can dedicate an unused television channel to the delivery system for the audio/video signal coming from the components connected to the CXD-2502S.

The CXD-2502S lists for \$1000, while each satellite decoder/amplifier lists for \$500. Additional remote controls are \$100 each.

FM

POINT AND SHOOT SHOWDOWN (Continued from page 37)

the camera, raising it to your eye (or putting it down close to another object) starts the camera operation. The 105i also has predictive autofocus (a feature shared with their SLR Maxxum cousins), which tracks moving subjects and keeps them sharp.

All of these cameras have autofocus, and all but one use an active (infrared beam) system for getting pictures sharp. The focusing is not on the actual subject but in "zones"—ranges of discrete distances, or blocks of space. Though there's much dispute over how many zones are sufficient for these complex zoom lenses (some say the more zones the better the chance for a sharper picture at all distances), all of the cameras here deliver comparatively sharp pictures at most camera-to-subject ranges.

The Minolta 105i offers something new in a lens/shutter camera. Actually, it's something borrowed from the Minolta Maxxum SLRs. Rather than rely on an active infrared beam, the focusing system in the 105i is a charged-couple device (CCD) chip, known as a passive AF system. The 105i couples a predictive focus control program (which focuses by measuring the changes in a subject's position prior to shutter release) and a low-light autofocus illuminator (passive systems have a bit of trouble finding focus in very dim light), which works just like those in conventional lens/shutter autofocus cameras. The Minolta 105i may auger a new type of CCD camera.

PM picks

The ease of loading film and unloading film, how the camera feels in the hand, how basic controls fall naturally to the fingers, portability, clear view (especially for someone wearing eyeglasses) and the quickness with which optional programming modes can be set all go into making picture-taking a difficult or pleasant experience. While all of these cameras take good pictures, we did develop some preferences.

1. Canon Photura—The design of the Photura had people stopping us everywhere we went—a real conversation piece. With the grip in place, the camera feels like a minicamcorder and can be easily carried with one hand, though the size and shape is hardly pocketable. Zoom and shutter release buttons can be worked with one hand, and essential controls fall naturally to the fingers. Viewing is comfortable, and the top-plate viewfinder option opens up additional point-of-view opportunities. A flash on the lens cap is a clever idea, but when opened, we feared for its safety

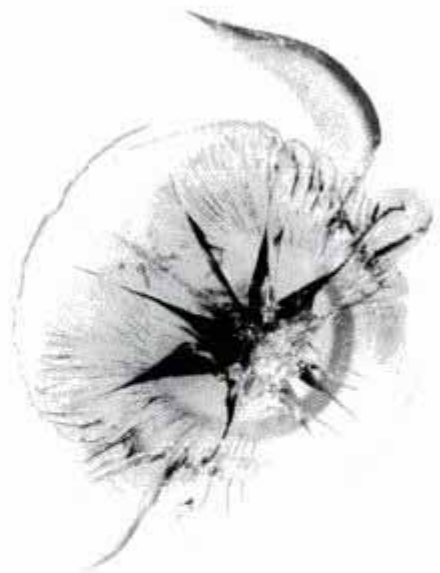
in a crowd, especially when we carried it in a ready-to-shoot position by our side. Optional controls are easy to set.

2. Pentax Zoom 105 Super—It's the most pocketable of the class, though the righthand grip is smallish and makes for difficult 1-handed carrying. Zoom control and shutter release fall naturally to fingers on the righthand side. Viewfinder is bright and easy to use, even with glasses. LCD panel lights up with button and helps tremendously in dark rooms. Supermacro closeup is aided by measuring wire enclosed in a side panel. A myriad of functions on this camera are easy to program with a host of back panel pushbuttons.

3. Olympus SuperZoom 330—Largish body is unpocketable, but the grip makes for comfortable 1-handed carrying. Zoom controls sit on the left side, with the shutter release on the right, so 2-handed operation is preferable. Viewfinder is bright and clear, but placement on far right means that your nose is flattened against camera body when shooting. Functions are accessed through flip-back panel on top plate. LCD is clearest to read of this class, and all function displays are well-marked. Separate lens cap doubles as IR remote control, but be sure to click it in or it can pop off.

4. Minolta Freedom Zoom 105i—A newly released camera, so a production model was not available at press time; hands-on was only with preproduction model. The 105i has a rectangular, boxlike shape that is too big for pocketability, but size gives a feeling of stability. Slightly raised, contoured hand grip allows for 1-handed shooting, though fingertip-small zoom controls on left side of camera force use of left hand for full use of features. Function buttons are limited to flash modes and self-timer; buttons are quite tiny on this pre-production model. Intelligent features are mostly built-in, so no other buttons are present on the body of this camera. Once you give in to the camera's opinion on framing and other controls, the 105i performs admirably.

5. Fuji Discovery 2000—Similar in design, but somewhat larger than the Pentax model, the Discovery 2000 is a conventionally comfortable camera. Hand grip is large enough for 1-handed carrying, and all essential controls (zoom, shutter release) fall naturally to the fingers of one hand. Pocketable in a sports jacket, if a bit heavy. Rubberized eyepiece is a nice touch that prevents scratching of glasses, with viewfinder bright and clear. Functions are easy to operate, with good readout in top-panel LCD. **PM**



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SNOW/MOBILES

100-MPH SNOW SCREAMER

BY CHARLES PLUEDDEMAN



● Twenty-thousand fans line the solid-ice oval track. Clouds of frozen breath hang in the subfreezing air. Drivers mount 100-mph Formula One twin-track racing sleds and stomp down on the running boards to set steel studs into the ice. They snap the throttles of their snarling 2-stroke engines to clear the carbs.

Engines roaring, the racers concentrate on the starting flag. When it flashes, they pop the clutch. With engines revving to 6000 rpm, the sudden acceleration nearly rips them off their seats. Heading for the first turn, they bump bodywork and jockey for position. Ice chips strafe their face shields like machine-gun fire, and sleds fish-tail through clouds of icy snow. At 100 mph for 25 laps, this is Eagle River, home of the World Championship of snowmobile racing and the hottest ride on ice.

Indy of the North

Twin-track racers, a unique concept in snowmobiling, compete in the top class of snowmobile racing, Formula One, on the NKG/Ski-Doo Sport Series Circuit. Last season, the circuit included 11 events in the U.S. and Canada. The biggest event is the World Championship Snowmobile Derby, held each January for the past 27 years in Eagle River, Wisconsin.

The derby crowns world champions in a dozen classes, but the main event is the Formula One race. We traveled to the 1990 derby to get a close look at these high-tech screamers.

Class rules limit Formula One sleds to 340 cc of engine displacement, a minimum track length of 100 in. and a minimum weight of 340 pounds. But almost anything else goes, which leaves a lot of room for creativity.

Single-track snowmobiles drift sideways through the icy turns of a fast oval course. A sled with twin tracks, linked through a differential and a driver positioned on the inside of the chassis, pins turns like a Penske Indy car.

Ski-Doo, a division of Bombardier, Inc., has been building twin-track racing sleds, which were developed by Gaetan Duval, since 1980. The company produces a limited number of twin-track racing sleds, just as March and Lola supply cars to the Indy-car circuit. No other snowmobile manufacturer currently builds Formula One racers, although Pro 5, a Minnesota-based Polaris tuner, is rumored to be preparing one for the 1990-'91 season.

Compared to other motorsports, competing at the top level of snowmobile racing is relatively affordable. The Ski-Doo Formula One sled costs

\$12,500, including engine. Another \$10,000 in spare parts and tuning will probably be enough to field a competitive team. Travel, support vehicles, entry fees and other racing expenses come after that. First place in the World Championship paid \$10,000 in 1990, but purses at other events are considerably smaller. Nobody gets rich racing snowmobiles.

In the pits

The pits at Eagle River echo with the snarl and whine of unmuffled, 2-stroke engines. Savvy fans wear hearing protection. One of the better U.S. teams is Goodwin Racing, of Zion, Illinois, which features the driving skills of brothers Jeff and Greg Goodwin. The Goodwins let us look under their racer's trick bodywork.

The engine is a liquid-cooled, twin-cylinder, 2-stroke that displaces 339 cc. It's produced by the Austrian engine builder Rotax, which is owned by Bombardier.

The block is aluminum with Nicasil-coated cylinders. A pair of flat-slide 44mm Mikuni carburetors (fuel injection is not permitted) deliver fuel through a rotary valve intake system that seals the charge in the crankcase on the piston's downstroke more effectively than reed valves. The same

(Please turn to page 92)



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ing a sports car around the corners."^{††}

"An uncommonly civilized vehicle," wrote *Car and Driver*, "the Montero takes you where you want to go in style, in comfort, and in the right price bracket." Their final judgment: "Best Buy, 1990" in sport utility vehicles under \$20,000.

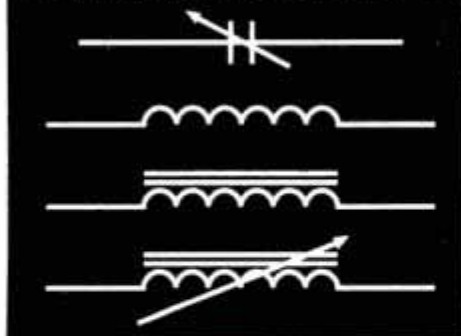
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SNOWMOBILES (Continued from page 90)

gear that drives the rotary valve also drives a pump that circulates a 50/50 mixture of antifreeze and water through a nose-mounted radiator and an aluminum heat exchanger mounted over the track. The heat exchanger is cooled by ice chips thrown up by the frozen track.

Fat power curve

The engine also features a unique RAVE (Rotax Automatic Variable Exhaust) valve, a guillotine-type slide valve located just above the exhaust port. It's connected to a diaphragm and spring located outside the cylinder head. Two small passages in the cylinder head allow exhaust gas pressure to reach the diaphragm. As the throttle is opened, the pressure of the exhaust on the diaphragm overcomes the spring and the RAVE valve slides open the exhaust port. A RAVE-equipped engine has a fat, flat power curve, which gives the twin-track better acceleration at the hole shot and coming out of turns.

The race engine runs a 16.5:1 compression ratio on 120-octane racing gas with a 30:1 gas/oil ratio. Peak power from the factory is 95 hp at 10,000 rpm. Top teams tweak engines well beyond triple-digit horsepower.

Power is transferred through a belt-drive constant velocity transmission (CVT) with a modified primary clutch. The clutch is highly adjustable. Track conditions, the dimensions of the track and the weather must all be considered when tuning the clutch. Formula One races use a standing start, and a racer who takes the lead into the first turn has a great advantage. The clutch is set to engage at approximately 6000 rpm, but engagement must be fine-tuned to meet existing conditions, especially outside temperature and firmness of the ice.

Power is transferred from the secondary clutch to the track driveshaft via a titanium shaft and a chain-drive gearcase. Here the upper and lower sprockets can be changed to create different gear ratios.

The twin Camoplast drive tracks are made of rubber reinforced with Kevlar and have a circumference of 115 in. and a width of 7.5 in. The tracks are suspended by an aluminum slide rail system, similar to a production snowmobile. The slide rails are lubricated with a solution of water and nontoxic antifreeze, pumped from a 2.5-gallon tank on the chassis through tubes located above the rails.

Traction on the ice track is achieved by studding the tracks with 3/8-in. steel picks, some with carbide tips. The number of picks and their pattern are again determined by track condi-

tions. Because picks add weight, racers use as few as possible.

The differential system is located on the driveshaft between the two tracks. As the driver enters a turn and rotates the handlebars, a cable from the steering system pulls open the clutch and effectively disengages power to the inside track. When the handlebars are returned to the straight-ahead position, the clutch re-engages and both tracks have power. It's primitive, but it works.

The ski legs are massive aluminum forgings, and the skis are really nothing more than extruded aluminum runners. Steering traction is maintained with razor-sharp carbide runners attached to the bottom of each ski. These are available in lengths from 4 to 14 in. Runner length affects bite on the front end, another variable in setting up the sled on race day.

The driver sits on a motorcycle-type seat over the left track tunnel and steers with a contoured handlebar. A large tachometer on the handlebar and a smaller water temperature gauge are the sled's only instruments. The driver controls the throttle with his right thumb and the hydraulic disc brake with a lever on the left.

Drivers wear Day-Glo orange helmets, and the sleds have bright taillights for maximum visibility in the cloud of ice chips that fly off the studded tracks. Drivers draft each other on the straights and dive low to gain position in the turns, hanging off the seat with their left knee skimming the track. A sled with a good setup carves sharply through turns and subjects the driver to serious g-forces. There are snowmobiles that can outrun these specialized machines in long straightaways, but none are faster in turns or quicker around the oval.

The 1990 World Championship was dominated by veteran racer Dave Wahl of Greenbush, Minnesota. Wahl established a new Eagle River qualifying mark with a lap speed of more than 97 mph. He led the World Championship race from start to finish.

With the tiny Rotax engine already running on the verge of destruction, Ski-Doo sees improved aerodynamics as the best route to improved performance. Last season, Ski-Doo worked with the Galles racing team and Indy-car driver Al Unser Jr. to develop a new body for the twin-track sled, incorporating front and rear wings and a ground-effect tunnel between the tracks. The results of that research will appear on the track in the 1991-'92 season, and Formula One snowmobile racing will move even closer to becoming an Indy on ice. **FM**

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DRIVE REPORT

CONSULIER GTP

BY RICK TITUS, West Coast Editor



● Bruce Springsteen's *Born In The U.S.A.* would make the perfect company anthem for Warren Mosler and his Consulier Industries, Inc., manufacturers of the Consulier GTP. His tiny army of Americans, building a purely American sports car in Riviera Beach, Florida, takes pride in the fact that its product is based entirely on Yankee knowhow and American components. Yet there's more substance here than mere flag-waving. The Consulier GTP is, in every respect, a world-class performer. One only needs to meet Warren Mosler to understand why.

Mosler, a successful Florida-based bond broker, felt a need for a really serious American production sports car. Five years and a sizable sum of money later, Consulier Industries and the Consulier GTP are on line, on market and on target—a major accomplishment in and of itself. The fact that the car performs, handles and rides like the best combination of all the finest production sports cars in the world, and is the only current production-based composite monocoque chassis/body car on the market, magnifies the achievement.

Mosler is really a racer at heart, and it shows in the kind of car he builds. The overriding goal of the Consulier GTP is performance—in its fullest sense. The car had to have light weight, neutral handling, good ride, exceptional strength, rapid acceleration and top speed. These design

parameters were given to McKee Engineering, a long established and proven race car design consultant.

McKee's response included an in-board rocker-style suspension system that reduced unsprung weight, lowered the hardware profile, eliminated bumpsteer and controlled roll-induced camber changes.

The 2.2 turbo

Engine details were next on the agenda. Chrysler had a shelf full of fire-breathing 4-cylinders called Turbo IIs, which Carroll Shelby had used to power several slick makeovers.

Chrysler's 175-hp turbocharged, intercooled 2.2-liter engine is a perfect match to the Consulier's featherweight 1950-pound body/chassis. The engine/transmission sits amidships and gives the Consulier a 37/63 front/rear weight distribution.

In the cockpit Mosler wanted a mix-



Chrysler's 175-hp 2.2-liter Turbo II hustles Consulier to 60 mph in just 5.5 seconds.

ture of comfort and function, so Recaro bucket seats were used for both hard cornering support and comfort, while the dashboard is loaded (nearly overloaded) with gauges. Oil pressure, oil temp, water temp, boost pressure, alternator and trans temp gauges all fill the center dash area in a panel that looks all too speedboat-like. Lots of info, but difficult to read. In the top-of-the-line LX model, leather covers the Recaro bucket seats, center console and door panels. There's also air conditioning and a compact disc player.

Race car looks

Externally, the Consulier's message is pure race. Styling influences from several International Motor Sports Association (IMSA) sports prototype race cars are obvious, and if you like attention, you'll love the Consulier. In testing more than 300 different cars, we have never seen another automobile generate so much reaction.

Since the completion of our tests, Consulier has redesigned several points around the car. They include a slight restyling of the front fender and headlamp area, a reshaping of the roofline and doorsill cut-in line, an enlarged fender radius in the rear and several modifications to the tail-end spoiler area. And Consulier Sales and Promotions Director Pete Magnuson told us a new convertible is production-ready.

The enlargement of the rear-wheel

arches came as a particularly interesting upgrade, as that change resulted in a move to larger 16-in. rear wheels and new ZR speed-rated General tires. General Tire has been working quite closely with Consulier in developing an all-American performance tire that would match the car's performance capabilities.

Race car performance

Though opinions may differ on the looks of the Consulier GTP, they quickly become united about driving the car. Performance is what Warren Mosler wanted, and performance is what he got. Our testing produced quarter-mile trap speeds of 112 miles-per-hour at 13.9 seconds. Zero-to-60 mph took 5.5 seconds, and skidpad testing gave us .97 g. These numbers clearly indicate that the Consulier GTP is more than just a rich man's toy. It delivers comparable performance at less than half (and in some cases less than one-quarter) the cost of some of Europe's best. Base pricing for the Consulier GTP starts at \$49,900, with a fully loaded convertible at \$62,500. Granted, there are cars out there that will outperform the Consulier in one category or another, but none that will humiliate it.

To that point, Mosler has offered a \$25,000 reward for any street stock, volume-produced production car that can lap an American road course faster than a stock Consulier.

The Consulier In combat

Racing is definitely in the corporate plan for Consulier. The car has competed three times in the 24-hour event held annually at Nelson Ledges, Ohio, qualifying on the pole all three times, leading all three events, and finally winning the 1990 running of the Longest Day, with the author listed among the winning car's drivers.

Later, in an hour-and-a-half twilight mini-enduro last fall in Florida, PM Auto Editor Tony Swan and Consulier racing boss Chet Phillip co-drove to another victory, finishing one lap ahead of a 66-car field.

As soon as production of the Consu-



Interior is snug, but comfortable. Assembly work is good; componentry average.



Aircraft-style gauge array in center console is long on info, short on readability.

lier GTP reaches full steam, there's a Sports Car Club of America professional series for production cars that Mosler has his eye on.

As good as the Consulier is on the race track, it's equally good on the street. After just a couple of encounters, it quickly became a car we looked forward to driving. Once snuggled in its supportive seats, legs straight out in front of us, sitting just inches from the ground and peering through its slanted windshield, we felt ready to take on the windiest roads on the map. Instantly we grew to respect the car's responsiveness. A flick of the wrist and you've rounded the bend. A quick stab to the brakes and you've slowed by 50 mph. A fast jab at the shift lever is all it takes to swap gears.

Fun factor

Most of all, driving the Consulier is great fun. It's an experience we've sensed in other cars, but rarely enjoyed in such comfort, such reliability. Here's a car that makes you feel like a Grand Prix driver, without the rock-hard discomfort of race car suspension. McKee's rocker suspension system takes bumps like they aren't there, yet delivers predictable high-speed handling, with a bit of oversteer at the limit—an issue that should be resolved with the new, larger rear tires.

Although the Consulier has the feel of an old British sports car—the Lotus Europa comes to mind—it has none of the usual nasty sports car habits. Potholes don't re-aim the Consulier in another direction. Rain doesn't leak in through the door sills. It starts every time, it doesn't overheat at traffic lights—even with the air conditioning on—and it'll go like stink in an instant. A well-balanced mixture of speed and handling, comfort and distinctive good manners. That, in our view, is what a world-class performance car is all about. And it makes us happy to say it was "born in the U.S.A." **PM**

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WHEN YOUR CAR USES TOO MUCH OIL

BY PAUL STENQUIST

● You push on the throttle when the light turns green. A cloud of noxious blue smoke quickly forms behind you. The six or seven cans of oil that are in your trunk roll toward the rear and bang against the bulkhead. Your fellow motorists hurl insults at you as they pass by. The nation's petroleum reserve is in jeopardy.

Some oil consumption problems are the result of serious engine damage—like holes in pistons, for example. But similarly severe oil loss can be caused by relatively simple problems and can be fixed just as simply.

Outy or inny?

The first step is to get down on the ground and have a good look at your parking space. If there's a puddle of oil, you can assume that at least some of your difficulty is caused by an external leak.

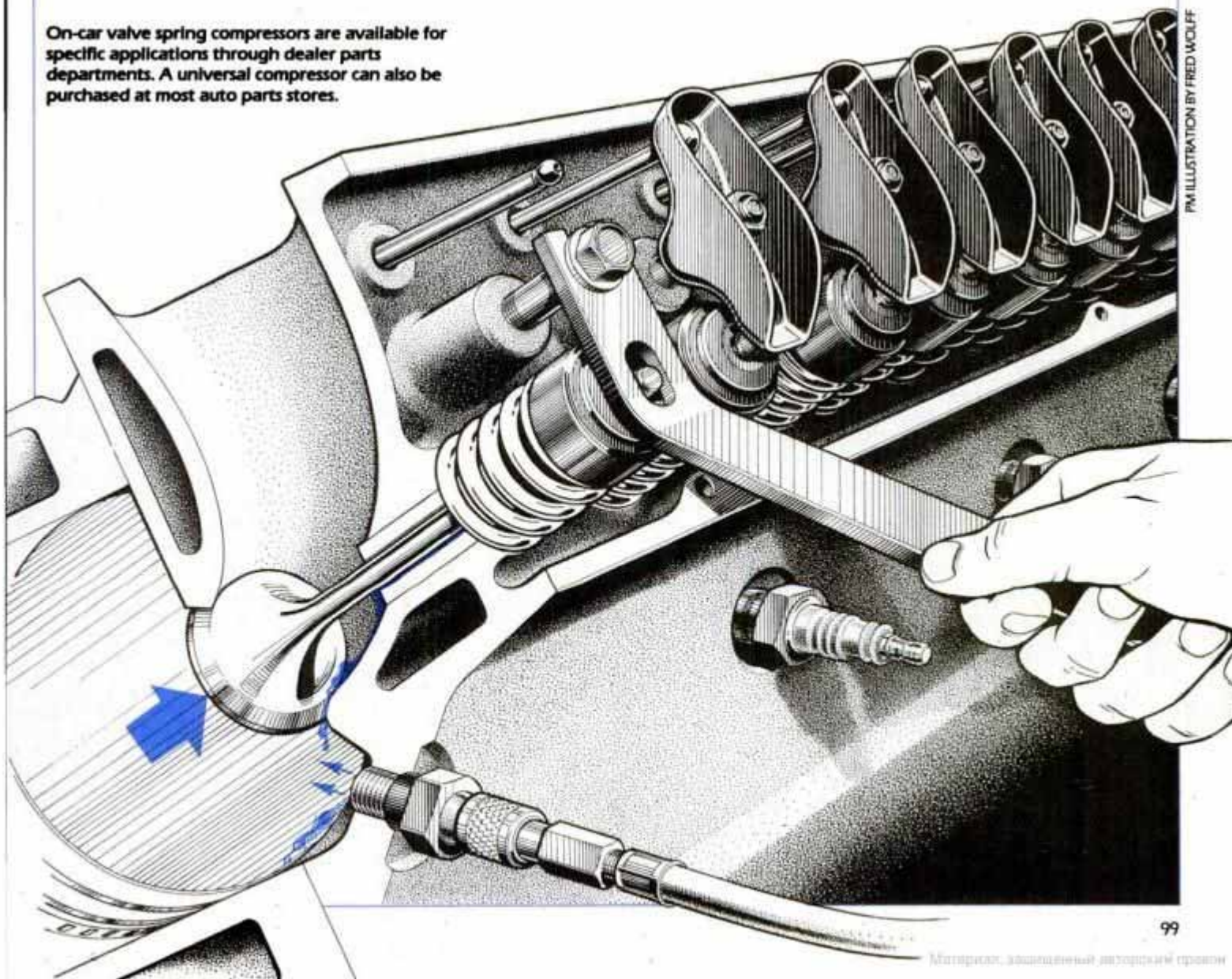
If you don't find any oil on the ground, inspect the underside of your car. If everything rear of the engine is coated with wet oil, suspect a gusher that only activates when the engine is running. But make sure you don't confuse leaking trans oil or differential oil with engine oil.

If, on the other hand, your engine's leak is internal, oil will be drawn into the combustion chamber when you drive and your car will smoke. When will it smoke? Perhaps at idle, when accelerating, when decelerating, after long periods of idle or right at startup. Pinpointing the driving condition that generates smoke can help you track down the cause.

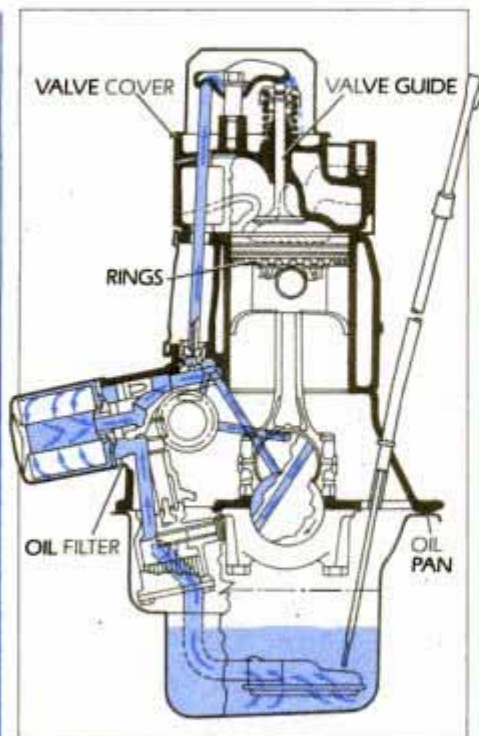
Internal leaks

Smoke is the most obvious symptom of internal oil consumption, but not the only one. Oil mixing with the air/

On-car valve spring compressors are available for specific applications through dealer parts departments. A universal compressor can also be purchased at most auto parts stores.



PM ILLUSTRATION BY FRED WOLFF



There are plenty of potential internal and external leakage points on an engine.

fuel charge can cause spark knock. And, when the engine operates low on oil much of the time, clicking and clacking noises—along with accelerated wear—will result.

There are several ways that oil can get into the combustion chamber: through the valve guides, the piston rings, the PCV system or past a blown head gasket. On some engines, particularly V8s where the intake manifold does double duty as a valley cover, oil can leak past the intake manifold gaskets.

Here's where that smoke can help you shorten the list. If your tailpipe

smokes only when the car is first started after several hours at rest, valve guides are probably the culprit. Ditto if the smoke belches out only when the engine is first accelerated after extended idling.

If the engine smokes throughout the rpm range, worn or stuck oil rings are the likely cause.

Although these rules can help you narrow down an oil-consumption problem, they aren't hard and fast. For example, as guide wear increases, smoke may be obvious at all speeds and loads.

Removing all the spark plugs may help you localize the problem. What you're looking for are the heavy, black oily deposits that indicate oil consumption. If they're limited to one or two cylinders, you can focus your troubleshooting on those cylinders.

PCV system

The PCV system allows crankcase gases to escape to the intake manifold where they are drawn into the engine and oxidized. One PCV system hose joins the PCV valve and engine crankcase (via the rocker cover on most applications). The PCV valve is connected to the intake manifold. On some systems, the valve may be located at the rocker cover end of the hose, but its function is the same.

Under high engine-vacuum conditions, such as idle or light load, crankcase gases flow through the PCV valve into the intake manifold. On most PCV systems, a second hose connects the crankcase (again via the rocker cover) to the engine air cleaner. In many cases, a small separate filter is provided for the PCV hose. This

hose allows fresh air to be drawn into the crankcase as the gases are purged.

If the PCV valve clogs, crankcase gases won't be purged, pressure will build up, and oil may be pushed back up the fresh-air hose into the air cleaner. In some cases, the high crankcase pressure may allow oil to be pushed past oil rings that might otherwise be adequate.

You can check the PCV valve by disconnecting it from the crankcase end, starting the engine and checking for vacuum at the valve with the engine idling. Next, remove the valve from its hose and shake it. You should hear a rattling sound. If you don't feel vacuum at the valve and/or the valve won't rattle, replace it and check the hose for obstruction. Since the valve is quite inexpensive, it might be a good idea to replace it in any case. (Always replace the PCV valve at your 15,000-mile maintenance intervals.)

If the PCV system continues to deliver an excessive amount of engine oil to the air cleaner even when the PCV valve is functioning correctly, it may be that the engine's compression rings have worn to the extent where the crankcase is overpressurized. A cranking compression or leakdown test can help you verify this.

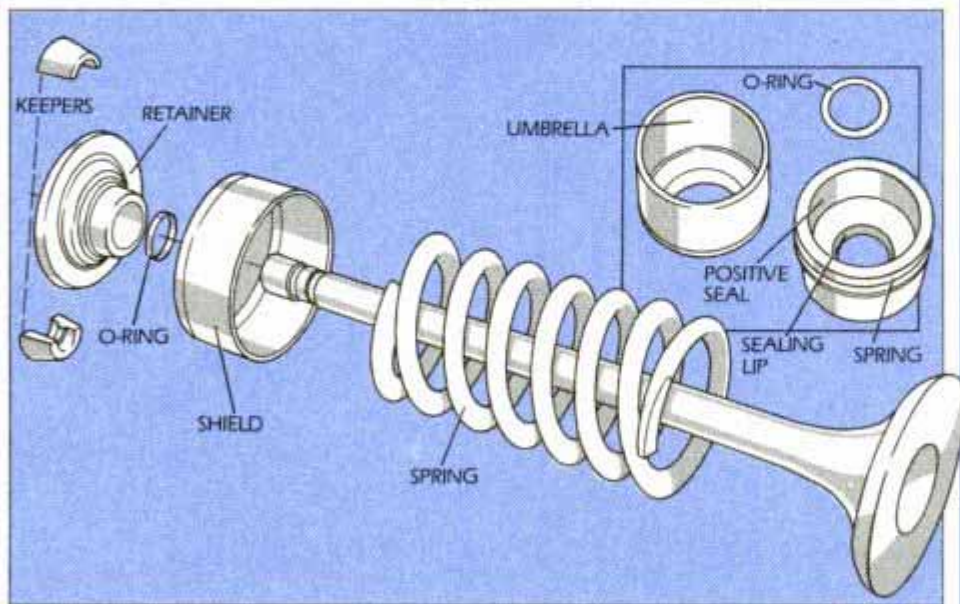
Valve guide and seal failure

Even if smoke emissions suggest that your problem is a likely case of oil-ring leakage, you'll probably want to check the valve guides and valve seals first as this can be accomplished without removing the cylinder heads.

The valve guides are the bushings that support the intake and exhaust valve stems. When the valves open and close, they slide up and down in the valve guides. The valve seals limit the amount of oil that reaches the top of the guide. Both guide wear and seal failure will allow oil to enter the combustion chamber via the guides.

There are two ways to check valve guides and seals. One way requires removal and disassembly of the cylinder head(s). The other easier way is an on-the-car method. To do the job the easy way, you'll need an air compressor and a spark-plug-hole/air-chuck adapter. This last item plugs into an air hose disconnected on one side and screws into the spark-plug hole on the other side. This allows you to pressurize each cylinder while you remove the valve keepers and retainers to check the seal and guide.

In addition to the compressor and



Valve stem seals might be O-rings, umbrellas or the positive-lip type.

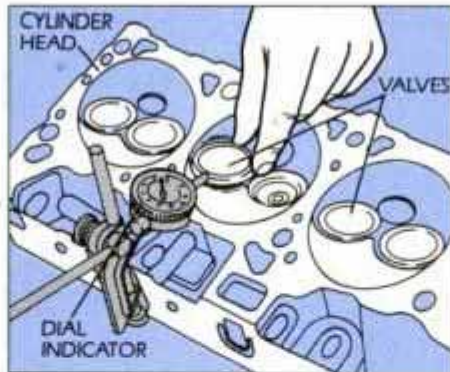
adapter, you'll need a new rocker cover (or cam cover) gasket, a set of engine valve seals, some quick-drying gasket adhesive and some nonhardening gasket adhesive.

You'll also need an on-the-engine valve spring compressor. There are several types available. Some are specific to a certain type of engine. Others are universal. Most auto parts stores carry this tool.

To check the guide, carefully route or disconnect any wiring or tubing that might interfere with rocker cover removal. Tag any lines that you disconnect, so you'll be able to reconnect them properly.

Remove the rocker cover(s) and screw the air hose adapter into the first spark-plug hole. (If you've isolated the problem to certain cylinders, you can move right to those locations.) With the adapter in place, turn the engine until that cylinder is at top dead center (the highest point of piston travel) on its compression stroke. You can tell when the cylinder is approaching top dead center/compression stroke because air will come shooting out of the adapter. When the airflow stops, you've reached approximate top dead center, which is close enough for our purposes here.

On cam-in-block engines or overhead cam engines with rocker-arm actuated valves, remove the rocker arms from the first cylinder's valves. On some engines, including most domestic V8s, this is merely a matter of unscrewing the jam nut from the shaft that supports the rocker. On other engines, you'll have to unbolt a rocker shaft that supports the rocker arms for the entire bank of cylinders.



Measure valve guide clearance on the chamber side of the head with a dial indicator.

On overhead cam engines where the cam is positioned directly above the valves, you'll have to disengage the timing belt or chain and remove the cam. Procedures vary widely here. Consult your service manual for specific cam removal instructions.

Once rocker arms or camshafts are out of the way and you can see the top of the valves, connect your air compressor hose to the adapter. If the engine turns due to air pressure pushing down on the piston, you'll have to hold the crankshaft in place with a wrench on the front pulley bolt or with a screwdriver wedged against the flywheel ring gear. A helping hand may be necessary here.

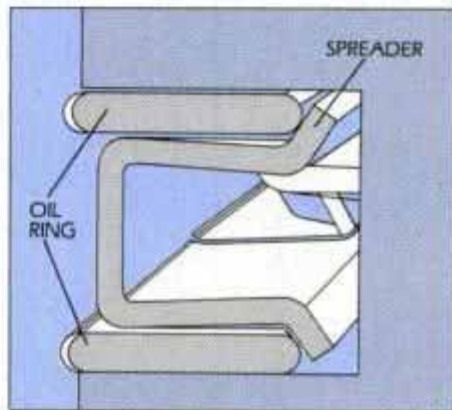
With the cylinder pressurized, tap the retainer of the intake valve with a worn socket and hammer, locating the socket over the end of the valve stem in such a way that it contacts the retainer but not the keepers. Compress the valve spring and retainer with the compression tool and remove the keepers. Use needle-nose pliers if your fingers are too big to grasp

them. Make sure you don't drop a keeper into the engine.

Once the keepers have been extracted, remove the valve spring and retainer. Air pressure will prevent the valve from dropping into the cylinder.

Examine the valve stem seal. If it's an umbrella stem seal, you'll find it on top of the valve guide. If it's an O-ring seal, it should be in the second groove on the valve stem, just below the keepers. In either case, the seal should be soft and pliable. If it's hard or cracked, it may be the cause of your oil-consumption problem. Upon reassembly, replace all valve stem seals.

To check the intake guide, release the air pressure from the cylinder while holding the top of the valve stem. Be careful. If you drop the valve, you might have to disassemble the engine to retrieve it. Try wiggling



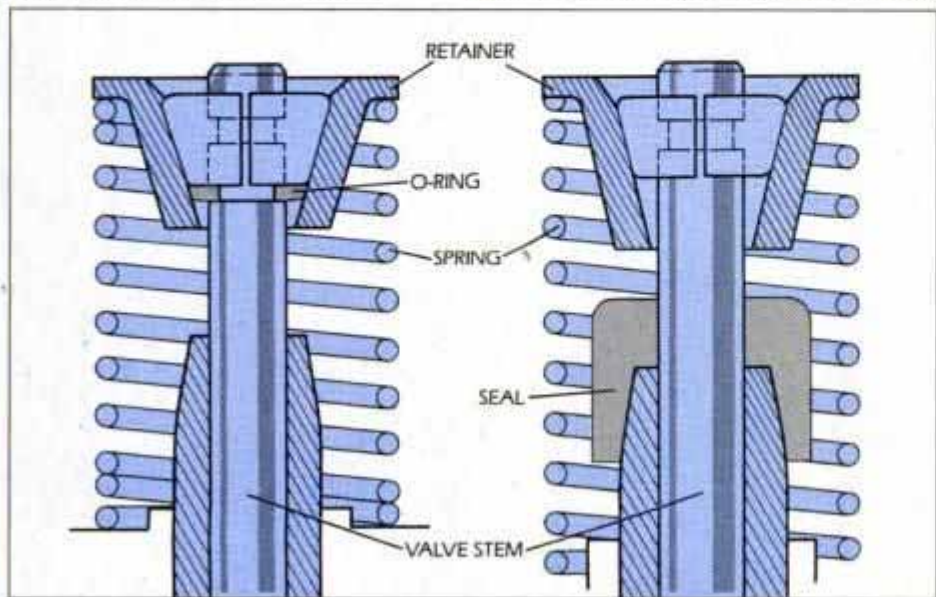
The oil-ring spreader (or expander) pushes the oil-ring rails against the cylinder wall.

the valve stem back and forth. If it moves a visible amount, the guides are excessively worn, and the heads will have to be removed for guide replacement and grinding of the valve seats.

If you're not sure whether clearance is excessive, mount a dial indicator perpendicular to the valve stem and wiggle the stem. A typical intake valve specification calls for 0.001- to 0.003-in. valve stem clearance from the factory. The high-end tolerance for used parts is about 0.004-in. on most engines.

Check the exhaust guides in a similar manner, but note that exhaust guides are usually engineered with a bit more clearance than the intakes. Here, a slight amount of lateral movement is okay. More than 0.005-in. clearance is excessive on most applications.

If the guides are okay, reinstall all valve train parts with a new valve seal. If your engine is equipped with



O-rings are installed on the valve stem, and umbrellas or lip seals fit over the guide.

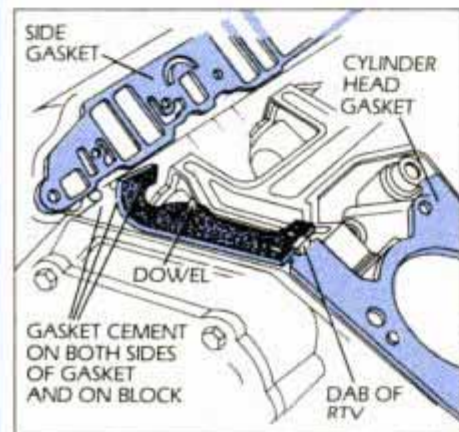
O-ring type seals, you can push them into the proper groove with a keeper half before the split keepers are installed. If you found cracked or broken seals, they could be the sole cause of even serious oil consumption.

Attach the rocker cover or cam cover gasket to the cover with fast-drying adhesive. Apply nonhardening gasket compound to the engine side of the gasket before installing.

If you found excessive guide wear, the head(s) will have to be removed for guide replacement and valve-seat grinding. (Because the guides locate the valves in respect to the seat, you can't replace the guides without grinding the seats.)

Oil rings

Once you're certain that an internal oil-loss problem isn't due to some simpler cause, you may have to bite the



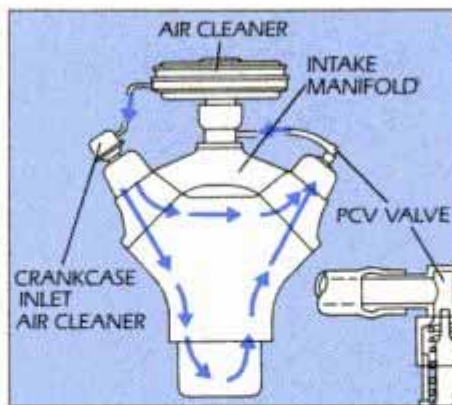
The gasket must be firmly cemented to the block before installing the manifold.

bullet and consider the oil rings. But before you do, perform a quick compression test with a handheld gauge. Crank each cylinder four to five times with all plugs removed and compare readings. If one cylinder is way off (and one spark plug was oil soaked), you might be looking at a blown head gasket, a hole in a piston, broken rings or other major damage.

If all cylinders are quite low, both the compression rings and oil rings may be worn. As noted earlier, worn compression rings can cause oil loss through the PCV system and/or past seals and marginal gaskets.

If all cylinders are okay, you may still have worn oil rings. Oil rings sometimes fail (or stick) before the compression rings are worn out, and bad oil rings can help mask bad compression rings by providing plenty of lube to seal the gaps.

Of course the only cure for worn oil and/or compression rings is an engine



PCV can deliver engine oil to air cleaner if the valve fails to purge the crankcase.

rebuild, but sticky oil rings can sometimes be loosened. If you want to give it a try, fill the crankcase with SAE 10W oil and a thin oil additive meant to free sticking lifters and oil rings. (Don't use a viscosity booster.)

Drive the car for at least 30 minutes. If engine temperature doesn't reach the maximum end of the allowable range, cover part of the radiator with a piece of paper. Before the engine cools down, drain the oil and refill with your normal engine oil, such as a 10W-30. This treatment is somewhat hard on the engine, but when a total rebuild is your only alternative, it may be worth a try.

External leaks

If you're simply losing oil rather than burning it, the fix may be less expensive. But it can be equally difficult.

Because there are so many locations from which oil can leak, it's sometimes hard to find the gusher.

If the oil drip is evident while the car is parked, wash the underside of your car with soap and a high-pressure hose to remove the oil that has probably been blown all over the underside of your car while driving. Then, clean your engine with one of

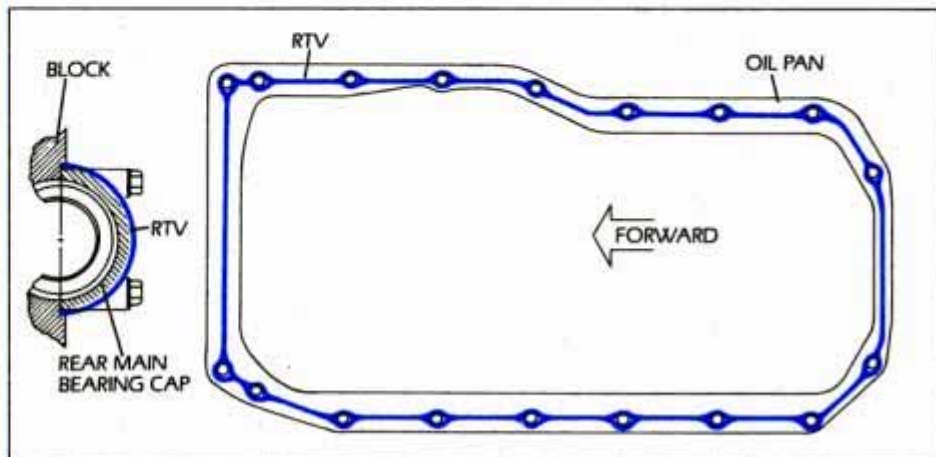
the commercially available engine cleaners. You may have to apply the cleaner several times to clean a really filthy engine. Make sure you protect all electronic parts with plastic bags.

With engine and undercar clean, cover your garage floor or driveway with white paper. Engine oil leaks will leave dirty spots. Automatic trans fluid leaks will leave pink or light brown spots. You can usually locate the leak by concentrating on the area right above the spot on the paper. Likely sources include rocker or cam covers, timing cover, oil pan, fuel pump gaskets and, where applicable, intake manifold end seals. This last location is found only on some V-type engines where the intake manifold seals the valley, an arrangement that is seemingly quite prone to leakage. This is particularly true in cases where the manifold has been removed for service, as the end seals can be quite difficult to install.

If normal methods fail to uncover a leak, try a black-light kit. This oil-detection device comes with a fluorescent oil additive. You simply add the fluorescent stuff and let her leak. Once the oil with additive has leaked, you aim the black light at various locations until the glowing oil can be seen.

Quite a few engines use RTV sealants in place of regular gaskets in some oil-sealing locations. Bathtub caulk is for bathtubs—get an RTV sealer intended for automotive use at the auto parts store. Apply a continuous bead inside of the component's bolt holes.

Some gasket makers supply a conventional gasket for certain applications that were originally RTV from the factory. In many cases, the gasket provides a superior seal. If an RTV joint has failed, you might ask your auto parts counterperson whether or not a conventional gasket is available. **PM**



A uniform, unbroken bead of RTV must be applied inside of the bolt holds.

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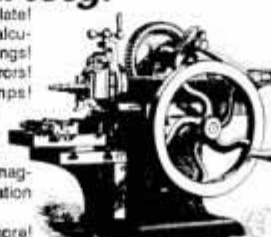
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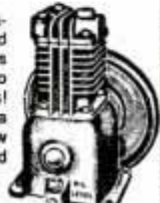
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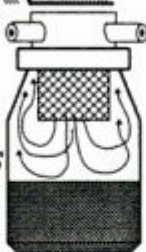
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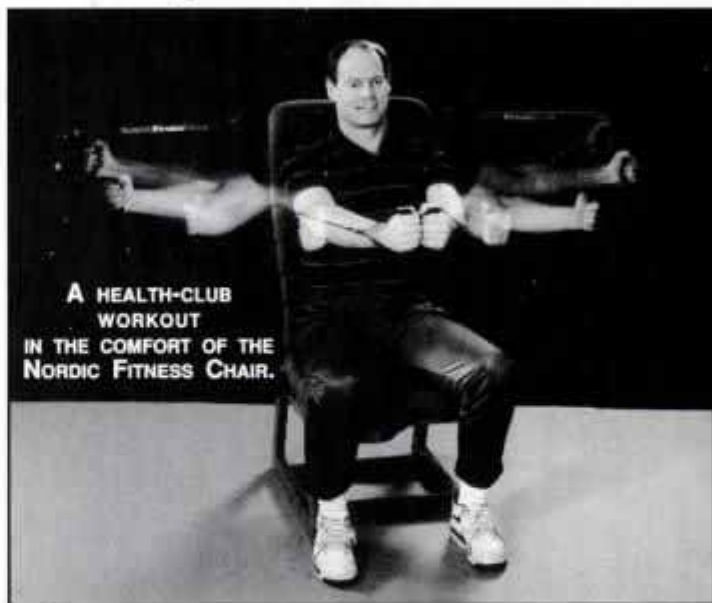
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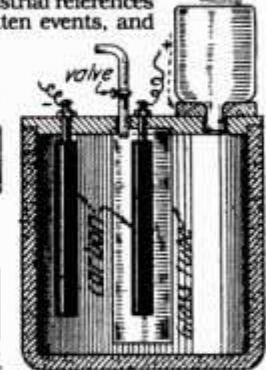
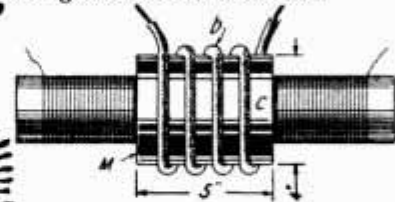
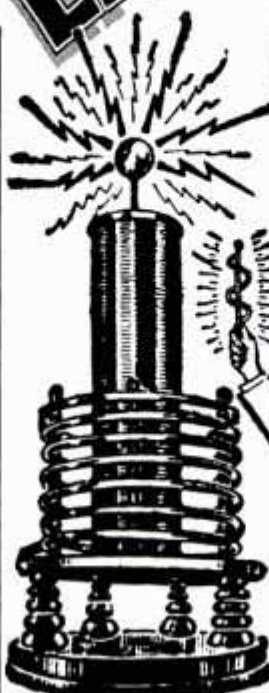
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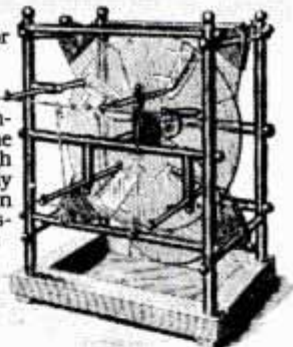


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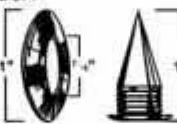
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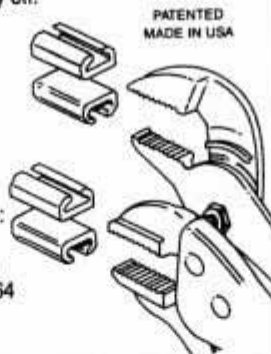
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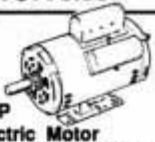


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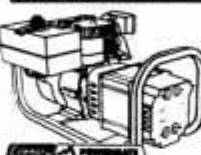
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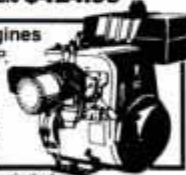
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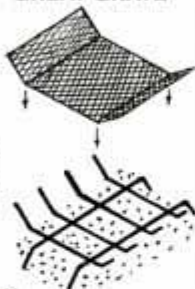
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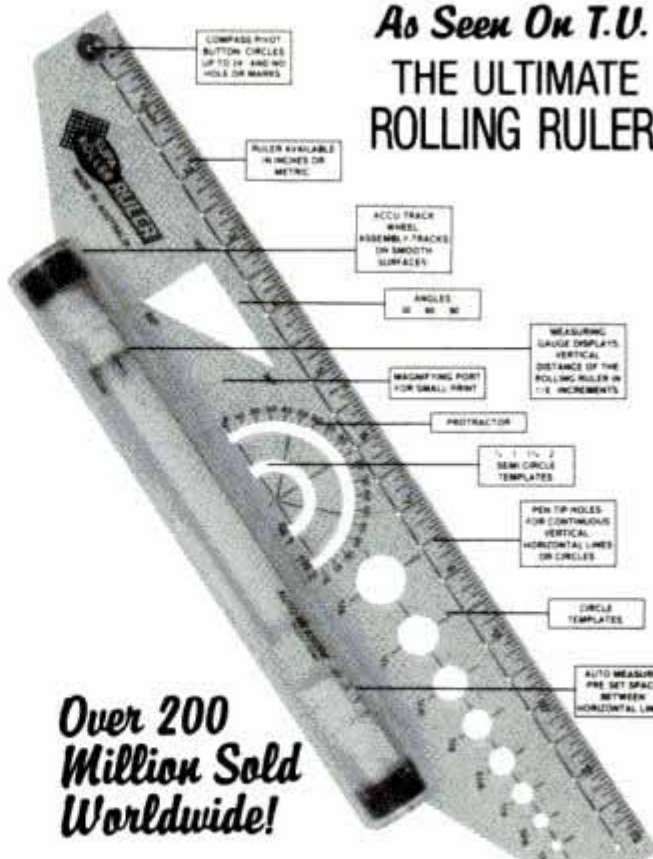
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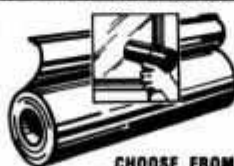
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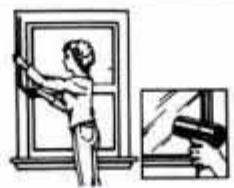


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(Continued from preceding page)

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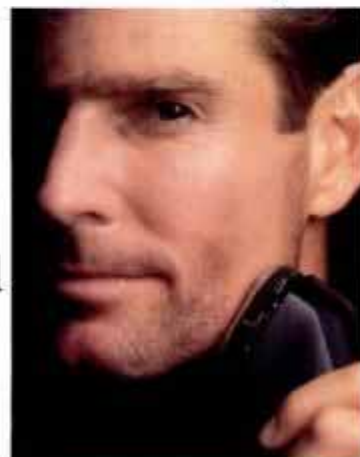
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NOT FOR QUALITY

*Including occupants, equipment and cargo. **With manual transmission, not to exceed GCWR of 6,900 lbs. (8,600 lbs. — One Ton). Requires additional 3,500-lb. (5,000-lb.) weight-carrying frame-mounted Class II (Class III) tow hitch. Get More From Life... Buckle Up! © 1990 Toyota Motor Sales, U.S.A., Inc.