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Popular Mechanics

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WHICH IS BEST?**
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CARS**

- Prices
- Features
- Specs
- Tech Highlights





THE BEST-SELLING COMPACT TRUCK

THE NEWLY DESIGNED 1989 FORD RANGER XLT.

We took the best-selling compact truck in America* and made it even better for you in 1989. Because you don't stay on top by standing still.

IT'S WHAT'S NEW IN COMPACT TRUCKS.

Ford Ranger XLT's changes for 1989 start with a new, more aerodynamic exterior styling and continue inside the cab, where the improved interior environment features redesigned seating and a newly designed instrument panel with tachometer. Thanks to its 2.3L Dual

Plug engine, this year's Ranger XLT features more horsepower than last year's model. And also this year, Ranger XLT features standard anti-lock rear brakes.

IT'S A LOT OF TRUCK FOR THE MONEY.

With so many new features — and some returning favorites like a fully synchronized five-speed trans-





IN AMERICA JUST GOT BETTER.

mission, power steering, tinted glass, and AM/FM stereo cassette — you might think Ranger XLT can't possibly be a bargain. But Ranger XLT gives you all that, plus Twin-I-Beam Front Suspension and one of the highest payload capacities of any compact truck, for a price that might surprise you.

6/60 WARRANTY.

Covers you and future owners, with no transfer cost, on major powertrain components for 6 years/60,000 miles. Restrictions and deductible apply. Ask to see this limited warranty at your Ford Dealer.

STANDARD XLT B64A PACKAGE EQUIPMENT:

Power Brakes (rear anti-lock); Gauge Package; 60/40 Cloth Split Bench; P215 All-Season Radials; Chrome Rear Step Bumper; Elec. AM/FM Stereo w/Clock and Cassette; Power Steering; Tachometer; Sliding Rear Window; Deluxe Two-Tone Paint; Tinted Glass.

CAB AVAILABILITY:

Regular Cab; SuperCab.

DRIVETRAINS:

2.3L I-4 Dual Plug Engine; 5-Speed Manual Overdrive; 4-Speed Column-Mounted Auto. Overdrive (Optional).

BEST-BUILT AMERICAN TRUCKS 8 YEARS RUNNING.

Ford Trucks are the best built — based on an average of owner-reported problems in a series of surveys of '81-'88 models designed

and built in North America. At Ford, "Quality is Job 1."

*Based on 1988 calendar year manufacturers' reported retail deliveries through 8/31/88.

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COMFORTABLE.**



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69 COVER STORY

The cruise ship of tomorrow will be a floating "Fantasy Island" that will offer more than just a relaxing boat ride.

—PM illustration by John Berkey



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From East or West, thrifty or fast, there's a car from abroad to satisfy every driver.

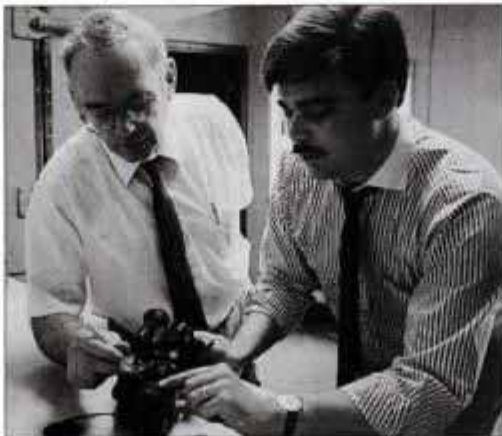
100 Tech Review

Subaru's Justy takes the spotlight with the first constantly variable transmission in the U.S.



EDITOR'S NOTES

OUR HOME ELECTRONICS testing program takes a quantum leap forward this month. We have used testing labs and special analytic equipment before in bringing you test reports on the latest home electronic devices. But this month's comparison test of five different camcorders (page 72) is, at once, the most advanced test we've ever done with consumer electronic equipment and also the first of many such test reports we'll be bringing you in the pages of POPULAR MECHANICS. This level of testing sophistication is possible because of our new relationship with Frank Barr and his Advanced Product Evaluation Laboratory in Bethel, Connecticut. Previously, the facility was the CBS Technology Center which tested and evaluated equipment for all the CBS radio and television stations, and other clients around the country. Now Barr is on his own and we've got him—at least to the extent that he and his facility will be doing the lab testing for all our home electronics reports from now on. Barr and his facility are, together, one of the most respected and accredited electronics testing facilities in the nation. For several years, our automotive and boat testing programs have utilized the latest in advanced computerized electronic test gear. Now the same level of technical prowess comes to our audio and video comparison testing on a regular basis. Electronics Editor Steve Booth has devised a standard battery of tests for various types of electronic equipment that will yield meaningful results to you, the PM reader. Between



Barr and Booth at state-of-the-art testing lab.

Booth, Barr and the Advanced Product Evaluation Laboratory, PM readers will be getting the most accurate, understandable comparison test data available anywhere. And that is how it should be. . . . I'm the first guy to admit that I've never been on a cruise because I'm afraid of getting seasick. And you can't check out of a cruise ship once you're underway. However, after reading our cover story on what future cruise ships hold in store (page 69), I might be tempted to try a trip. Imagine high-rise hotel luxury, water skiing, ship-to-shore air service anytime you want it, and a private island floating in a lagoon—all right on board! It boggles the mind, but the concepts are real and several steamship companies are studying their plans for the next century right now. The only trouble is, I'm sure a ticket on one of these floating islands will also boggle your wallet. . . . For the past several years, videogames have been in disrepute. There was nothing new. They were boring. Nobody cared about them anymore. All that changed about 18 months ago. Nintendo and Sega led the way with new-age graphics on their sports games that brought arcade realism into your home. Now the graphics, and the games, are even better and the choice is wider than ever. If you haven't tried some of the new video sports games, you owe it to yourself to check them out. As Contributing Editor Frank Vizard told us after researching our story for this issue (page 79), "They're not just for kids anymore."

"Til next time.

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LETTERS

Barn Again

THE PITCH on the roof of your Country Barn caught our eye because it matches that of our house.

It was the plan we selected when we wished to build a new structure on our property after converting our original single-car attached garage into a family room. The PM design from the Sept. '84 issue ("Build Our 'Country Barn' Garage," page 90) is extremely versatile.

In situating it on our property and adapting it to our needs, we made a few extra modifications:

- Width extended to 28 ft.
- Overhead garage doors added.
- Window and side door locations changed.
- Provision made for underground furnace to heat our home.
- Cedar siding stained to match house.
- Maintenance-free aluminum soffits installed.

Our future plans include installation of the furnace and finishing the upper level for a craft workshop. Skylights will also be added. The walkway/deck between the garage and house provides an area for outdoor grilling, and firewood storage.

I hope our construction shows how well this design can be adapted to almost any situation. Thanks for a fantastic plan!

MR. & MRS. PHIL SCHNEIDER
FREDERIC, WI

The fantastic plan is available from PM, Box 1014, Radio City Station, New York, NY 10101 for \$30.

Dream Machines

Your article on the Buick Riviera, equipped as "Tomorrow's Car Today," (page 71, Oct. '88) was terrific. I have installed many similar elec-



PM Country Barn Garage was built to fit with the Schneider's house.

tronic devices in my Honda Accord. As an avid reader of PM, I look forward to articles on automotive and audio/video advances. I share your enthusiasm in seeing these concepts become realities.

Keep up the excellent work and thanks for the peek into the future—it keeps me dreaming.

DOUGLAS HAMILTON
SEATTLE, WA

I'm 42 years young and have always admired Corvettes. I can recall when I was in Vietnam in 1967 thinking of someday owning one. Well, my dream has just come true, thanks in part to your September issue which rekindled my interest in these American classics ("Happy Birthday, Corvette!" page 58). I now have a '64. It's wonderful having a dream come true.

BILL SMITH
SOMERS, NY

Not New

In "Tomorrow's Car Today," you list the Electronic Oil Check Model 150 as a futuristic innovation. You have reinvented the wheel!

This was a feature of the

1933 Terraplane. It was also push-button activated and converted the gas gauge to an oil-level gauge.

Your avid reader,

TODD GALLIGHEN
HUDSON ESSEX
TERRAPLANE CLUB
GARDEN GROVE, CA

Seal That Grout

Thanks for your excellent report "How To RegROUT Ceramic Tile" (page 115, Oct. '88). You did, however, forget to wrap it up completely: Always finish the job with a good sealer. For best results, keep the tile dry for 2 to 3 days after sealer is applied.

RALPH CLARK
SANTA CLARA, CA

Two If By Sea

Your HydroRunner is an outboard boat and must comply with U.S. Coast Guard regulations (33CFR181 and 183), if manufactured for resale ("Fast Fun!" page 80, Aug. '88).

The length of 8.5 ft. with a 4.5-ft. transom beam would only calculate to use a 5-hp outboard engine. PM rates the boat for 25 to 35 hp. An engine larger than 5 hp can be used only by completing the quick-turn test, as provided in the Federal Regulation. An outboard boat less than 20 ft. overall must also be manufactured to pass the level flotation test.

I realize that an individual can build and use his own product and the U.S. Coast Guard regulations do not apply. Legally, if the boat is ever sold, the builder becomes a manufacturer.

G. MEDFORD SMITH
MANAGER,
CERTIFICATION SERVICES
NATIONAL MARINE
MANUFACTURERS ASSN.
CHICAGO, IL

Plans for PM's HydroRunner, a personal watercraft meant to be used by the builder, are available from POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101 for \$15.95.

PM



Plans for HydroRunner include 36-page instruction booklet.

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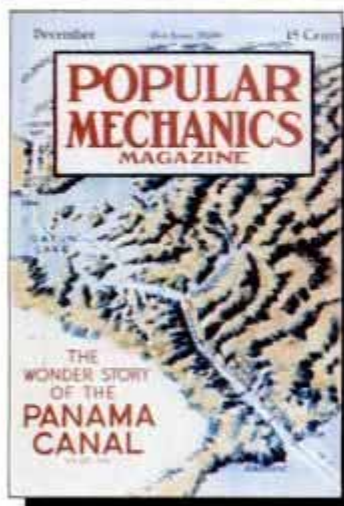
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TIME MACHINE

75 YEARS AGO: DECEMBER 1913



Diggin' The Ditch

The technological milestone of pre-World War I years was the completion of the Panama Canal, a monument to 20th-century engineering that graced our cover three-quarters of a century ago. President Wilson sitting in the White House triggered the charge that ignited the last 40 tons of dynamite, uniting Atlantic and Pacific—and altering the course of history. Canal facts: Some 40,000 workers led by the Engineer Corps of the Army used 263 cranes, barges and

tugs to excavate more than 230 million cubic yards of Earth and pour an estimated 5 million cubic yards of cement. The immensity of the task goes unchallenged—even today as cross-Channel tunnelers work to connect England and France.

First Flying Wing

Automatic stability was the chief benefit of the Dunne Dart, a French-financed aeroplane designed by a British Army officer. The tail-less box-wing had vertical rudders at the wing tips and radically swept airfoils.



50 YEARS AGO: DECEMBER 1938



On Target

Hitler had made ominous political thrusts in Austria and Czechoslovakia by late '38, as a world braced for war. But the wheels of military technology were already beginning to spin as artilleryists devised a system to direct and fire antiaircraft guns.

Trigonometric calculations produced by an optical rangefinder precisely fixed an aircraft's altitude and azimuth. A fire controller established target speed and distance, automatically aiming the antiaircraft piece and

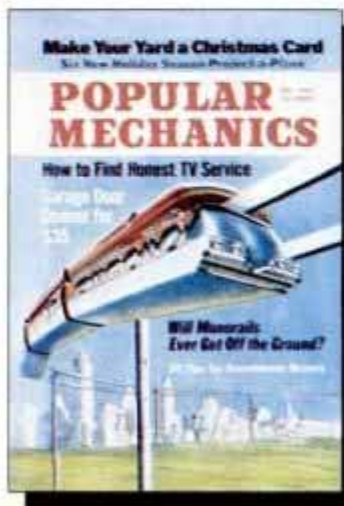
arming a proximity fuse. A shell lofted to a maximum altitude of 30,000 ft. created a lethal burst 100 yards wide.



Early Sensing

The crucible of war had yet to create RADAR, or radio detecting and ranging, so British defense forces experimented with a rudimentary form of early warning device—the human ear. Highly sensitive listening apparatus could pick up the thrum of approaching aircraft—but not always in time to alert fighter interceptors. Radar extended threat detection to the horizon.

25 YEARS AGO: DECEMBER 1963



Tomorrow's Trains

Monorails posed both a promise and a challenge to mid-'60s urban planners. These low-cost people movers from manufacturers like Goodell and Alweg (of Disneyland fame) were being touted as the solution to increasingly congested highways. The key: simple-to-construct monobeams that could be erected along existing rights of way.

Critics countered that beneath the sleek exterior of most monorail systems

lurked complex and costly wheel assemblies that did little to advance the state of the transportation arts.

Monorails—either suspended or supported—remain little more than theme park amusements.

Flight Skis

Backyard innovators a quarter-century ago were seized by a curious passion to place hydrofoils on sailboats, motorboats, water toboggans—and, of course, water skis. Dynafite fashioned these queer appurtenances

that could achieve lift at a mere 8 mph behind a 35-hp motorboat. **PM**





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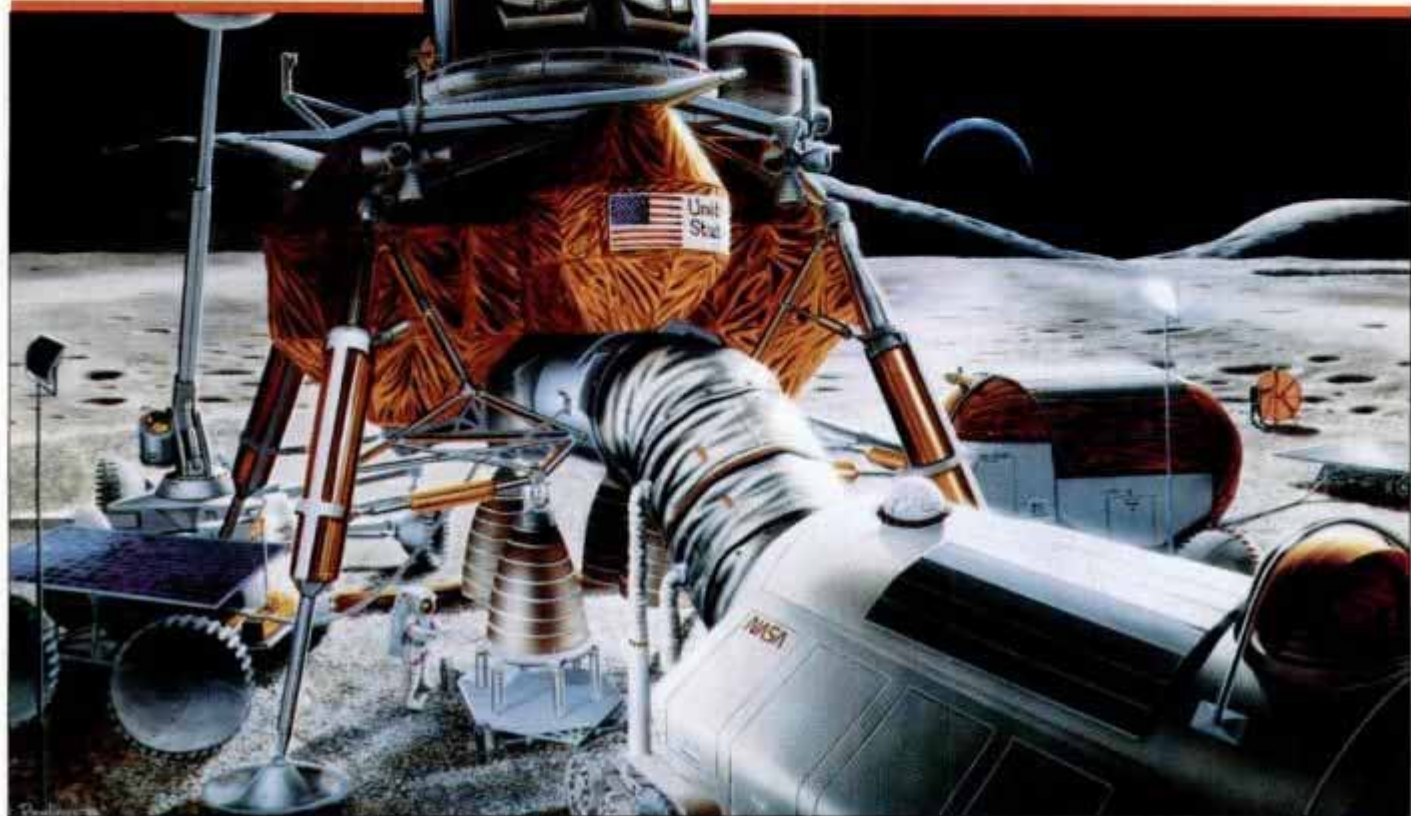
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TECH UPDATE



Back To The Moon With Reusable Lunar Lander

HOUSTON, TX—NASA researchers are hammering out specifications for a 21st-century lunar lander that would operate out of the Space Station to support a lunar base. Details were aired at a recent conference here sponsored in part by NASA and the Lunar and Planetary Institute.

The scenario? An orbital transfer vehicle (OTV) ferries the lander from the Space Station to low lunar orbit. After separation, the lander touches down using a fully throttled 4-engine thruster.

Once on the surface, a 6-man crew exits via a pressurized tunnel running between fuel tanks. The tunnel doubles as an equipment bay and airlocks with a pressurized surface rover. The crew shuts down the lander for a layover. But before leaving the vehicle, they must siphon

remaining fuel into a lunar-surface cryogenic storage tank to prevent the sun's heat from evaporating the liquid hydrogen. Liquid oxygen is less of a concern, because the lunar base includes

a plant to produce oxygen from moon-surface material.

On the return flight, the lander docks with the OTV, which then aerobrakes into low Earth orbit.

Further maintenance and

refueling take place at the Space Station.

Other unmanned landers would carry 25 tons of cargo instead of a personnel module. A series of such expendable landers would have transported the lunar-base shelters prior to the first manned missions.

What will spark the jump from concept to reality? Probably the development of a reusable, space-based thruster engine capable of handling a high throttling ratio. Some investigators feel that the same engine could power the OTV. Detailed simulations of a 21st-century lunar landing will help define requirements for the engine, so that technology development can begin soon.



Lander is docked with pressurized rover (top). Crewman is seen replacing engine while, at right, robotic propellant refill vehicle salvages liquid hydrogen. Lander (above) separates from OTV.

Editor: Tim Cole
Assistant Editor: Gregory T. Pope
Contributors: Mike Fillon,
Nick Nichols, Arthur Wieget

No-Touch Bearings

PALO ALTO, CA—Researchers have reversed the Meissner effect, in which a repelled magnet levitates over a superconductor.

Physicists at a Lockheed lab first lowered a permanent magnet over a superconductor, inducing a current and causing repulsion.

When the magnet was pulled away, however, the change in magnetic field strength reversed the current in the superconductor. The phenomenon could suspend frictionless bearings.



Gravity balances superconductive magnetic attraction.

Build Your Own Fighter

LOS ANGELES, CA—Northrop Corp. has tailored its computer-aided design systems into a hands-on exhibit shown most recently at last summer's Dayton Air and Trade Show. Guided by a voice synthesizer, users tap a touchscreen to pick design options—such as wing profile, top airspeed and fuel economy—and also select mission characteristics. Once completed, the plane's performance specifications are shown along with several 3-D representations of the fighter in action.



Interactive fighters.

The Human Factor In Space Station Hardware

HOUSTON, TX—At Johnson Space Center, researchers are already creating the Space Station lifestyle, hatching designs to keep space living convenient, comfortable and safe.

Engineers at the Anthropometrics and Biomechanics Laboratory use a computer to simulate Space Station operations. The programs generate animated microgravity scenarios impossible to reproduce on Earth. They draw on videotapes from SpaceLab and Shuttle flights.

For example, Station occupants sleep in a modified fetal position, with arms extended. At work, they float in the so-called neutral body position. Designers of workstation controls and displays must take into account knees that swing forward and arms that reach at different angles.

The programs also factor in physical changes, such as height increases of 1 to 1½ in. and thinner legs.

Meanwhile, other engineers are developing the 2-yd.-dia. centrifuge that will fit into the Station's Life Sciences Research Facility.

The centrifuge will simulate variable-gravity conditions to study the effects of weightlessness.

Researchers hope the first model will be a forerunner to a 4½-yd.-dia. Space Station



Retriever shifts unconscious astronaut into bear-hug retrieval position.



Space-based centrifuge will test artificial-gravity theories on small animals and plants.



Computer programs work out simulations of exercise facilities located in Space Station mode.

centrifuge for human experiments. The bigger version will test whether artificial gravity can counter physical deconditioning during long-duration flights.

And for extravehicular activity, engineers are now testing a robotic assistant who will double as a lifeguard. The EVA Retriever will fit into a manned maneuvering unit and accompany crew members on ventures outside the Station.

By the time the Space Station is ready (sometime in the late 1990s), the Retriever will have fully supervised autonomous capabilities. That is, it will respond to voice commands but also carry out searches, rendezvous and other complex actions on its own. The robot will benefit from multijointed arms and a variety of replaceable hands.

Planners envision the robot holding lights and cameras or fetching dropped tools and equipment. And at 8 ft. tall, the Retriever is big enough to slap a tackle on an astronaut in the event of accidental separation.

Johnson Space Center researchers have mounted a Retriever prototype on a triangular support platform that generates an air cushion to simulate microgravity. Further tests will take place on the Space Shuttle.

TECH UPDATE

RoboCaddy

SPRING MILLS, PA—This 3-wheeler may put the human caddy out of business. A belt-worn radio transmitter broadcasts a shortwave signal at an individualized frequency. Mounted on each side of the caddy chassis is a receiver coil. Each coil controls the turning rate of one back wheel, based on the direction of the signal.

Thus the cart follows the



Rear-wheel-driven caddy follows short-wave radio transmitter on golfer's belt.

golfer, turning as he turns and pacing itself up hills and down valleys.

Laser Shades

WASHINGTON, DC—Concerned over the growing use of battlefield lasers, the Army and Marines will soon issue antilaser eyewear for

combat troops. The plastic wraparound goggles will protect against certain infrared and visible-light laser wavelengths used in weapon guidance, rangefinding and target-detection systems.



Goggles will also shield against small, low-velocity fragments.

New Phased-Array Eyes And Ears

WASHINGTON, DC—Advanced phased-array technology is one of the hottest research topics at Air Force laboratories. The aim is to garner a variety of benefits from clustering receivers and transmitters of electromagnetic radiation, such as light or radio waves.

In an unusual program at Kirtland AFB, New Mexico, optics engineers are fashioning phased-array telescopes.

The project derives from research into phased-array lasers, in which the lengths of

laser beams are adjusted so that the wavefronts are synchronized. Fast-steering mir-



Four clustered telescopes have 16 times the resolution.

rors are used to shorten or lengthen each laser beam. The result: Energy delivered from a cluster of lasers is multiplied rather than added.

The same technology can be used to synchronize lightwaves coming into a cluster of telescopes, enhancing resolution.

The hardware may find its way onto both astronomical telescopes and spy satellites. In addition to the leaps in resolution, phased-array optics pay off in improved reliability since telescopes back each other up in case of individual failure. Clustered telescopes would also make unnecessary the technological struggle of creating huge mirrors.

Meanwhile, engineers at the Avionics Laboratory at Wright-Patterson AFB recently tested a next-generation aircraft radar system developed by Texas Instruments. The solid-state phased-array system promises to fix radar's vulnerability to single-point failures. In phased-array radar, banks of electronic elements transmit or receive in sequence, sweeping back and forth without moving parts.

The key to the new system: an integrated electronic architecture that allows individual transmitter/receiver elements to back up each other. The technology will be used in the Air Force's Ultra Reliable Radar (URR) program.

SDI Super Scope

EL SEGUNDO, CA—Sensor technology continues to pace strategic-defense progress. The latest development is a longwave infrared sensor for SDI experiments on board a modified Boeing 767 known as the Airborne Optical Adjunct.

Longwave infrared radiation (LWIR) is characteristic of ICBMs during their mid-flight trajectory. The LWIR sensor will fit into a telescope trained over a wide field of view toward space.

Previous infrared sensors were scientific instruments aimed at narrow fields of view. The new sensor's advances include a thousand-fold increase in optical resolution and real-time signal processing. Detectors and telescope mirrors are chilled with liquid helium.



Zinc selenide viewing port of LWIR sensor.



Solid-state phased-array radar aperture is tested in anechoic chamber. Aperture combines transmitter and receiver functions.

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Ford Tempo All-Wheel-Drive

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NASA's Performance Engine

PASADENA, CA—Fuel efficiency is becoming a major consideration as NASA pushes for an ambitious planetary exploration agenda.

At the space agency's Jet Propulsion Laboratory and Lewis Research Center, researchers are testing a new high-performance rocket combustion chamber made of the rare metal rhenium.

Conventional rocket chambers are forged from

stainless steel. During combustion, some of the propellant is wasted because it lines the inner wall of the chamber to prevent the steel from melting in an effect known as film cooling.

But rhenium, with its much higher melting point, will support more complete combustion. In conjunction with the program, NASA contractors have developed a propellant injector that

sprays fuel into the center of the chamber, to decrease unnecessary film cooling.

One drawback: hot rhenium is prone to oxidation. To prevent that corrosion, researchers plan to use chemical vapor deposition to line the chamber with another rare metal, iridium, which resists oxidation. The materials will allow engineers to stick with existing engine technology while increasing spacecraft payloads.



Red-hot rhenium chamber torture-tested in vacuum chamber.

Tracking Train Tech

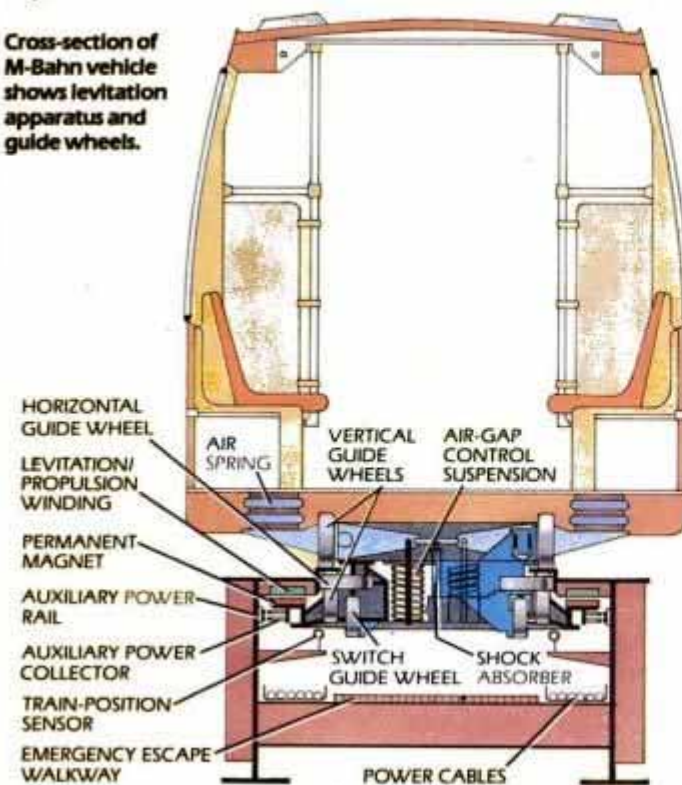
NEW YORK, NY—Faced with a future of gridlocked traffic, local planners are paying increased attention to new rail technologies to relieve road congestion.

One near-term solution might be M-Bahn, a low-speed magnetic-levitation system now operational in West Berlin. Unlike high-speed experimental maglevs (see "Supertrain," page 78, June '88), the M-Bahn vehicle doesn't break contact with a guideway. Magnetic lift simply takes the load off a system of guide wheels.



Flight Train roars along highway median strip.

Cross-section of M-Bahn vehicle shows levitation apparatus and guide wheels.



Lift is provided by the attraction between magnets on the undercarriage and two electrically charged windings. Current traveling through the same windings provides propulsion.

The guide wheels keep the train on track and also hold the magnet-to-winding air gap constant. A large spring also stabilizes the air gap by compensating for variable passenger load.

Interestingly, the on-board magnets aren't the electromagnets of other systems, but permanent magnets. Benefits of using permanent magnets include reduced energy consumption and maintenance of levitation in case of power failure.

Developed by the West German industrial colossus AEG, M-Bahn will make its U.S. debut in Las Vegas,

shuttling passengers between the convention center and a downtown location.

Meanwhile, a South Florida inventor has patented a different breed of levitating locomotive.

Known as the Flight Train, George Bell's invention relies on a series of stubby wings on the roof of each car to provide aerodynamic lift. Tracks run along all sides of the train, which carries magnetic sensors that move through grooves in each track. Retractable wheels deploy at low speeds or in emergencies. The sensors pick up any deviation in movement and feed data to a central computer, which then controls flaps on wings to keep the train steady. Reaction-control thrusters also supply corrective forces. Power is provided by a rear-mounted jet engine.

(More Tech Update on page 33)

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D. IRON GRENADIERS D.E.M.O.N.
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C. TRANSFORMERS PRETENDER BEAST
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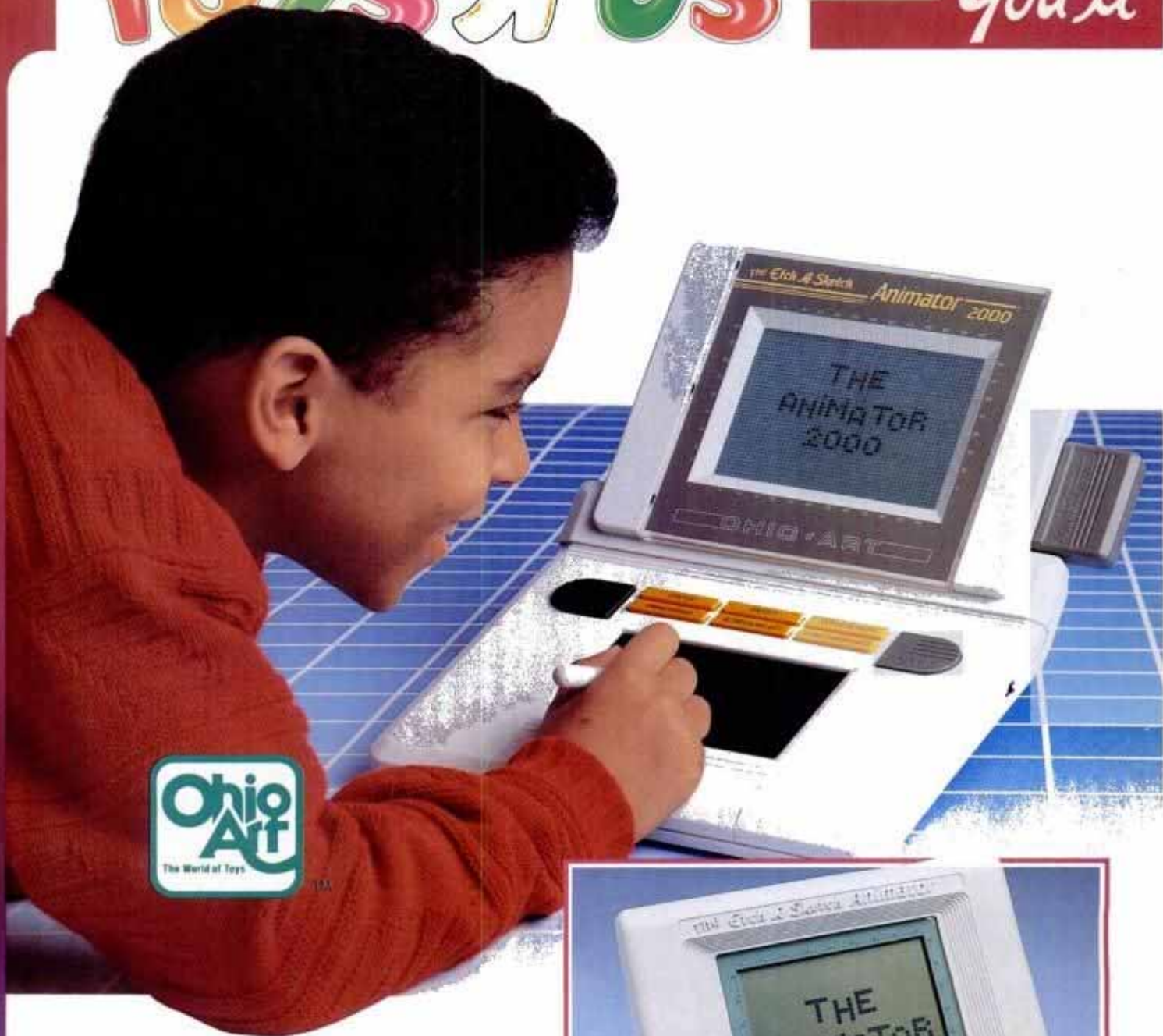
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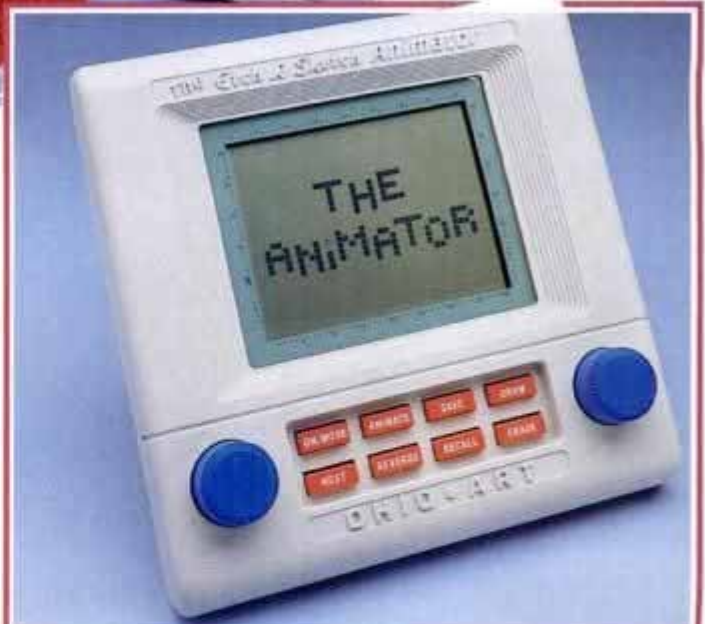
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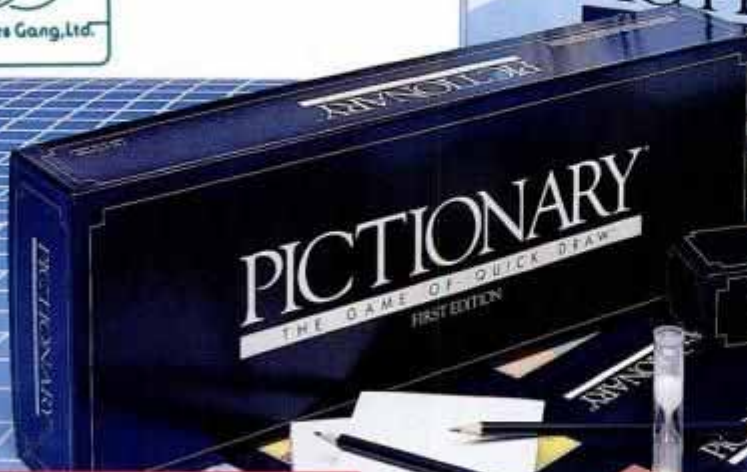
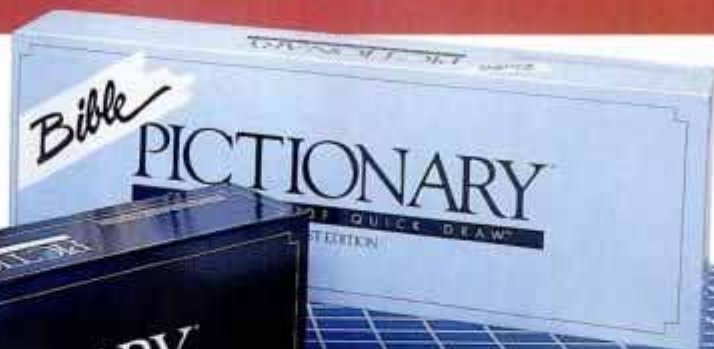


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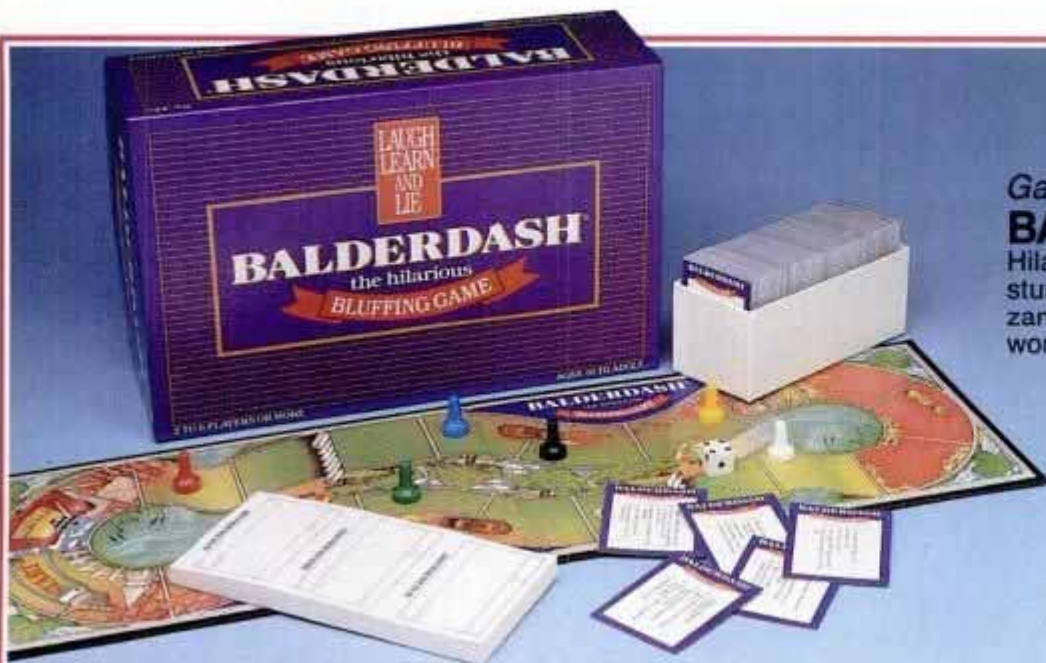
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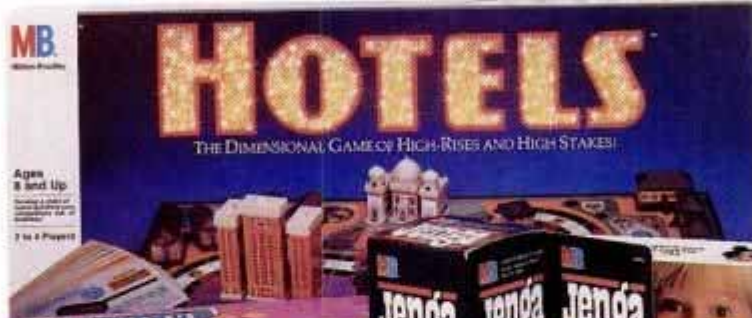
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TECH UPDATE

Dummies Get Smarter

NEW YORK, NY—The intelligent mannequin has arrived, ready and willing to serve as a human stand-in for military and medical research.

At Holloman AFB, New Mexico, a dummy named ADAM will test the Air Force's experimental CREST ejection seat. Buffeted by speeds over 800 mph, ADAM will eject from a rocket sled to see how a human occupant affects the CREST seat's aerodynamics. The seat ADAM (right) has gravity and mobility. Eddie (below) is a patient patient.



will rely on reaction control thrusters to lift a pilot out of the plane's way and shelter him from windblast and G forces.

ADAM (short for Advanced Dynamic Anthropomorphic Mannequin) has been built with a sophisticated joint system and a network of sensors and telemetry circuitry. He will relay 1000 samples per second, to determine whether erratic body movements will hinder CREST's performance.

Meanwhile, at the Army's Dugway Proving Ground, "Manny" will be trying on protective clothing and venturing into dangerous environments. Built by Battelle's Pacific Northwest Laboratories, Manny may be the most human-like mannequin ever developed. He can walk, bend, squat, crawl—even breathe and sweat.

A cable running out of his back hooks Manny up to a computer that controls his hydraulic joints. His flexible skin has pores through which water is squeezed, and a tube opening at his mouth and nose dispenses moist air.

And at Stanford University, students and physicians can



Manny can breathe heavily and work up a sweat.

practice administering anesthesia on a dummy named Eddie Endo.

Eddie breathes through a tube running from his windpipe to tanks of oxygen and anesthetic gases. An external ventilator pumps the gases in and out of his plastic lungs. Inside his torso, electronic components simulate blood pressure and heart-

rate, while sensors on his arm measure gas levels.

Dr. David Gabo, Eddie's inventor, sets up imaginary anesthetic errors on a computer that controls the gas flow. Monitor readings show the effects of the mistakes on Eddie's vital signs. Students must react quickly, adjusting the gas flow before Eddie expires.



Giant Oil Cat

THE HAGUE, NETHERLANDS—Naval architects at Allseas Engineering are planning to create the world's largest catamaran by connecting two 1000-ft. oil tankers. Oil rigs will fit between the twin bows, supported by cross beams. The beams in turn rest on steel tanks that float inside larger water-filled tanks.

The water tanks can be filled or drained to raise and lower the rig in place.

In addition, the tanks' water serves to keep the rig stable during deployment in choppy seas.



Rig straddles bows, ready for deployment on support platform, even in inclement weather.

U.S. AIR FORCE PHOTO

STANFORD PHOTO

BATTELLE PHOTO

PM ILLUSTRATION BY ED VALUJURSKY

ELECTRONICS

BY STEPHEN A. BOOTH

How We Test—And Why

OPEN A typical issue of **POPULAR MECHANICS**, and you'll find quite a lot of material concerning tools. Our Home and Shop articles regularly evaluate and review the latest tools—while features such as the "Shop Techniques" and many building projects suggest worthwhile ways to use them. On the Automotive side, "Saturday Mechanic" provides a similar service.

You probably don't think of "Electronics" stories in connection with tools, but that might change with this month's issue. It contains our first-ever lab tests of electronics equipment ("Camcorders On Trial," page 72), and we hope you'll use the test report as a tool when you're shopping for a video camcorder—or advising a friend on the matter. Let me explain why we see the test report as a tool.

For some time now, **POPULAR MECHANICS** has considered lab-testing for consumer electronics products. Publishing lab tests is easy enough to do. But as in all such matters, our primary consideration is: How will the tests serve our readers?

At any given time, there are hundreds and hundreds of electronics products on the market. And, like cars, the models change each year. This makes comparative testing virtually impossible. Even if you could test a single product category over the course of a year (all the 100 or so camcorders, for example), readers would have to wait 12 months to have all the comparative data in hand. By that time, a whole new generation of products would be entering the marketplace. Herein lies the frustration of testing.

For our first lab reports,

we might have tested five different electronics products, for example, a VCR, a TV, a compact disc player, a loudspeaker system and a car radio. But such arbitrary testing would not provide you, our readers, with very useful information. The test results would be out of context: A report on the Brand X loudspeaker and Brand Y television would tell you only how those particular items

ly, we've tested five video camcorders, each of a different format (Super VHS and VHS-C, 8-mm, conventional VHS and VHS-C). By testing the formats comparatively, you will be able to learn the pros and cons of each.

This is why we consider the lab reports a tool. Although the test involves camcorders from Olympus, Toshiba, Canon, Sharp and Magnavox, you shouldn't



Tops in the test: APEL's John Kiefer (left) and President Frank Barr.

performed—not how they compare with others of the same type. The same applies to video camcorders, which come in five different operating formats. Had we chosen to test five models of a single format, Super VHS, for example, you'd have no point of reference from the other four camcorder types.

Camcorders are the hottest item in consumer electronics today. Nearly two million households purchased one during 1988. In our experience, the greatest apprehension that would-be buyers suffer is over which format to select. According-

view it as a contest among the five. Instead, use the comparative results to match a format to your needs. Then, because each camcorder tested here is an excellent example of its format, use its performance results as a standard to judge other models of the same format that you might encounter when you shop.

Once we decided on a testing policy that would give you the most bang for your buck, we had to find an independent test lab that could deliver the goods. Enter the Advanced Product Evaluation Laboratory (APEL) in

Bethel, Connecticut.

APEL has a long and distinguished legacy in electronics testing. Until recently, it was known as the CBS Technology Center, and under the direction of Frank C. Barr it established the industry's highest standards for testing. When CBS decided to sell the lab, Barr made a bid and set up shop independently. He and test technician John Kiefer now train a highly expensive and state-of-the-art battery of test equipment on virtually any electronics product a client would want to test. In addition to PM, these clients include large national retailers, magazines such as *Good Housekeeping*, even the U.S. military. In fact, APEL's expertise is so highly regarded that manufacturers themselves often visit the lab to learn better ways of testing the products they make. We figure we're in good company—and so are you.

In issues to come, you can look forward to more test reports. I, for one, will look forward to working with the APEL staff. Most of the time, we'll follow the comparative format of this month's report. But we won't hesitate to put individual products under the 'scopes—especially when they promise technological breakthroughs. Meanwhile, we'll continue the hands-on product evaluations you've come to expect from our regular electronics articles.

News Flash

As we go to press, Canon has just introduced the first filmless, electronic still camera for consumer use, priced below \$800.

Tune into next month's column for a full report on the RC-250.

(Please turn to page 36)

MORE HOT SHOWERS FOR YOUR MONEY.



Switch to gas.
It heats water
for half the cost
of electricity.

GAS. AMERICA'S BEST ENERGY VALUE.

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ELECTRONICS (Continued from page 35)



Mitsubishi's portable cellular phone can fit in your pocket.

Pocket Phone

Mobile cellular telephones are getting more mobile still.

Mitsubishi's latest, the Model 900, measures just about 7 in. high x 3 in. wide and an inch deep, while weighing in at 19 ounces.

Despite its dimensions, the phone is no lightweight when it comes to features. The unit offers 832 channel operation—which means that compared to older cellular phones, it has access to 25 percent more radio spectrum in markets where expanded service is available. You can leave your little black book at home, too. This battery powered phone has a 100-number memory built in. You can access the directory by name or phone number, and see it displayed on the liquid-crystal screen. At this rate, it won't be long before an answering machine comes built in!

Hand-Me-Downs

Last month, we reported on JC, the Junior Computer, for kids ("Electronics," page 47). Okay now, your kid either has grown up, or is a kindergarten Einstein who needs a real computer. You still don't want the whiz-kid monkeying around with your computer, and the price of a new entry-level rig is still too steep. You might investigate the used-computer market.

That's how one of our readers is introducing his youngsters to the world of computing—on a shoestring budget. (We learned of this through our "Hotlines" call-in program, whereby readers speak directly to our editorial staff every Wednesday from 3 p.m. to 5 p.m.)

According to our correspondent, the used-computer market operates very much like the used hi-fi market. We're not talking about buying a PC from an individual through a classified ad in the newspaper or a notice on the supermarket bulletin board. Instead, the seller is usually a new-computer retailer whose service department has reconditioned or tuned up a used machine, and who offers a warranty of at least 90 days (and possibly an extended-warranty contract as well). A warranty is a good idea, because even though the computer itself has few moving parts, there are enough mechanical components in the keyboard, disc drive and printer that might fail from previous abuse, overuse or neglected maintenance.

Besides getting your kid a PC cheap, a previously owned computer might be a cost-effective way to get yourself a backup system, a unit you can use away from the job, or, just test the waters, without committing to the full price.

If you've got no interest in computers-for-work at all, but wish to graduate from videogames to more sophisticated computer-simulations of sports and other entertainment programs, a used PC might be the way to go. In fact, once you've read about the great sports simulations covered in this issue ("Computers," page 66), you'll see that computers can be fun.

You'll find sources of used computers locally, through newspaper ads or the telephone directory. Meanwhile, here are some mail-order phone numbers.

Specializing in reconditioned Apple equipment is Sun Remarketing, (800) 821-3221. Carrying multiple brands are Exel Computers, (203) 325-1408, Computer Interchange, (201) 890-9090, and Wolf Computer, (212) 307-6545.

Instant Energy

Well, almost . . . Everything's moving faster these days, and rechargeable batteries are no different. Eveready Battery is just introducing its Quick Charging line of battery rechargers that cut refueling time in half, to 7 from 14 hours. The innovation comes in response to the proliferation of battery-powered devices that use rechargeable NiCd cells—everything from portable



New batteries from Eveready recharge in only 7 hours—half the normal time.

power tools to pocket TV sets.

Meanwhile, Eveready has launched another first. It will sell lithium batteries in the popular AA (1.5-volt) size that accounts for half of all battery sales. Lithiums should last twice as long as alkalines, and have a 10-year shelf life.

Boob-Tube Hits 50

We take it for granted today, but television was a wish-list item in 1939, when RCA demonstrated the first broadcast at the New York World's Fair. PM covered it then—and we'll be celebrating TV's 50th birthday in feature articles in 1989. If you're visiting the nation's capital, be sure to see the year-long "TV At 50" exhibit at the Smithsonian Institute's Museum of American History. **PM**

PEOPLE WRITE TO PENNZOIL®

Straight answers from the automotive experts.



Kerosene Flushing.

Q. Every 3,000 miles, I change the oil and filter on my Cadillac. It has 97,000 miles on it. Before this procedure, I flush the motor out with a mixture of oil and kerosene, and let it run about three minutes. Then I drain the old oil and change the filter. Is this a good practice?

W.P., Longmont, CO

A. You're taking good care of your engine by changing the oil and filter at 3,000 mile intervals. There is no reason to flush your engine. A solvent such as kerosene has few lubricating qualities, is too thin to cushion engine parts and can present a fire hazard if used in a hot engine.

Viscosity Confusion.

Q. How does multi-viscosity oil function? For instance, considering a common 10W-40, does the viscosity vary evenly between a range of SAE 10W and SAE 40, depending on the temperature of the oil? Or does the viscosity rapidly change from SAE 10W to SAE 40 and vice versa at a certain temperature?

J.R.M., Portland, OR

A. All oils thicken in cold weather. Multi-grade oils, like SAE 10W-40, contain a special additive which helps them resist thickening at low temperatures. In fact, SAE 10W-40 is just as thin at low temperatures as SAE 10W, and just as thick at high temperatures as SAE 40. Remember that temperatures affect multi-grade oils less than single grade oils. So with multi-grade oils, you have the best of both worlds: easier starts in winter—and better high temperature protection in summer.

"HD" Inquiry.

Q. I notice that some Pennzoil motor oil products carry the letters "HD"



By Don Johnson

*Vice President, Product Engineering
Pennzoil Products Company*

on the label. Does this mean "heavy duty" or "high detergent"?

M.L.B., Rocky Mount, NC

A. Actually, "HD" is the tradename we use for our single grade motor oils such as SAE 30, SAE 40, etc. "Multi-Vis" is our tradename for multiple grade oils such as SAE 10W-30, SAE 10W-40, and the like.

Help Wanted.

Q. I recently purchased a 1988 Pontiac Bonneville LE with the 3.8-liter engine. I would like to use Pennzoil Multi-Vis 10W-30, (API Service SG/CD) but the owner's manual recommends the use of *energy conserving* oils. Is Pennzoil Multi-Vis 10W-30 an energy conserving oil? How can I tell by looking at the label?

R.N., Ringsted, IA

A. Pennzoil Multi-Vis 10W-30 is an "energy conserving" oil. Refer to the lower right corner on the back label of the bottle and find the round symbol. If the oil conserves energy, the lower half of this symbol will contain the words

"energy conserving." This means the oil has passed certain tests and is found to improve the fuel economy of an engine.

EDITOR'S COMMENT

Regarding the last question—I would like to expand on the API Seal of Approval. This symbol is a service mark of the American Petroleum Institute (API), and is licensed to motor oil marketers who certify that the oil in their package meets or exceeds industry standards.



The top half of the symbol indicates the API Engine Service Classification Category. The two-letter designations, (i.e., "SG") represent the type of engine the oil can be used in, and the performance level of the oil. The "S" stands for "Service", (gasoline engines) and the "G" represents the performance level of the oil. "SG" is better than "SF", which is better than "SE". The "C" stands for "Commercial", (diesel engines) and the "D" represents the performance level for diesel applications. Always use the motor oil recommended by automobile manufacturers in their owner's manuals.

The center of the symbol is reserved for the Society of Automotive Engineers (SAE) viscosity grade of the oil.

WE'RE OPEN TO QUESTIONS
about motor oils, lubricants and engines. But, you can tell us a few things, too. Maybe you've discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Don Johnson, Pennzoil Products Company, P.O. Box 2967, Houston, TX 77252-2967.



World Class Protection™

CAR CLINIC

BY MORT SCHULTZ

The Higher Authority

THE MANUAL for my 1987 Buick Skyhawk says to use SAE 5W-30 oil. Two reliable sources claim that SAE 5W-30 oil is too light for the type of driving I do, and I should use SAE 10W-30 all the time. I average 2000 miles a month, traveling between 50 and 65 mph at least 50 percent of the time and between 60 and 65 mph at least 25 percent of the time. Should I switch to SAE 10W-30?

DAVID J. RAY
VALLEY STATION, KY

The ultimate reliable source for this question is Buick, and according to Buick, your sources may not be as reliable as you think.

The number 30 indicates the viscosity (thickness) of the oil at normal engine temperatures. On the highway, with the engine at normal operating temperatures, it doesn't

matter if your engine is filled with SAE 5W-30 or SAE 10W-30.

A 5W-30 oil will give the best starting performance in cold weather and maximum fuel economy. The fuel economy difference, if you notice it at all, isn't much, but it is a factor.

Let's be specific. If your Skyhawk engine is not equipped with a turbocharger and if the ambient temperature is not expected to exceed 100° F before your next oil change, the oil preferred by Buick is one with a viscosity rating of SAE 5W-30 and API (American Petroleum Institute) designations SF and CC, SF and CD, SG and CC or SG and CD.

Do not use an oil identified by an SF or SG designation alone or only by the designations CC or CD. If the ambient temperature is expected to exceed 100° F before your next

oil change, Buick recommends that you use an SF/CC, SF/CD, SG/CC or SG/CD oil having a viscosity rating of SAE 10W-30.

Finally, for a nonturbocharged engine if the ambient temperature is expected to exceed 100° F, but is not likely to go below 40° F between oil changes, you have the option of using an oil having a viscosity rating of SAE 30 rather than SAE 10W-30.

If your Skyhawk engine has a turbocharger and the ambient temperature between oil changes is not expected to exceed 40° F, use an SF/CC, SF/CD, SG/CC or SG/CD oil having a viscosity rating of SAE 10W-30—no other. If the ambient temperature is expected to exceed 40° F, use an SF/CC, SF/CD, SG/CC or SG/CD oil having a viscosity rating of SAE 30—no other.

So, if you feel better about it, use SAE 10W-30 all-year round. There won't be any ill effects, but neither will there be the benefits that SAE 5W-30 provides.

have a new EGR valve installed and the oil and oil filter replaced.

Your Ranger, however, apparently got away without a warning light having been installed. This has led to Recall Notice 87E64.

To atone for having accidentally failed to equip your truck (and others) with the warning light, Ford is providing a new EGR valve, oil filter and oil at no charge when you bring your truck in for the 60,000-mile service. (If your truck has not reached the 60,000-mile mark, you can postpone having the service done until then.)

As far as that other matter goes, are you sure you didn't misunderstand what the dealer said regarding how long it will take to do this service? Two days is awfully long. Two hours is more like it. If he can't do the job within a reasonable period, keep in mind that any Ford dealer should honor this commitment. Try another.

Three's His Lucky Number

My 1987 Chevrolet Celebrity 2.8-liter engine starts in the morning, but stalls when put into gear. It will do this once, twice, or at most, three times before it catches. It then starts and runs fine the rest of the day. The dealer has tried his hand at repair several times, but the only part that's been replaced has been the fuel filter. This is the third time I've written you over the years and never got a response. How about giving me a break, Mort?

ALBERT WEGNER
MORAVIA, NY

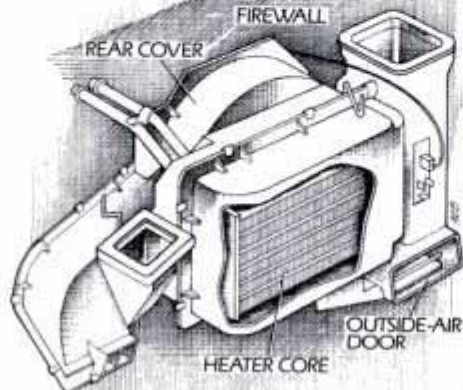
I apologize to you and others who write and don't get answered. Given the space available to "Car Clinic,"

(Please turn to page 40)

Cold Heat

"While stationed at Ft. Wainwright, Alaska, I owned an older model car which didn't give much heat from the heater," Sgt. Tom Cocker writes. "This is a noticeable inconvenience when driving to work in an Alaskan winter." After going through the usual checks (flushing the cooling system and replacing the thermostat) he removed the cover from around the heater core to replace the heater hoses. While the cover was off, he decided to check for a corroded, leaky heater core. Guess what?

"The leaves and bugs that had accumulated for years inside the box were preventing air from flowing properly through the heater core," Tom says. Cleaning up the matter resulted in a welcomed strong blast of warm air from the heater.



Can't Keep A "Secret"

I recently received Recall Notice 87E64 from Ford Motor Co. regarding my 1986 Ford Ranger which has a 2-liter engine. Neither the dealer nor the Ford zone office will tell me what this is all about. The dealer says I have to leave the vehicle for two days which is difficult, because I use the truck for work. Why is everyone being so secretive?

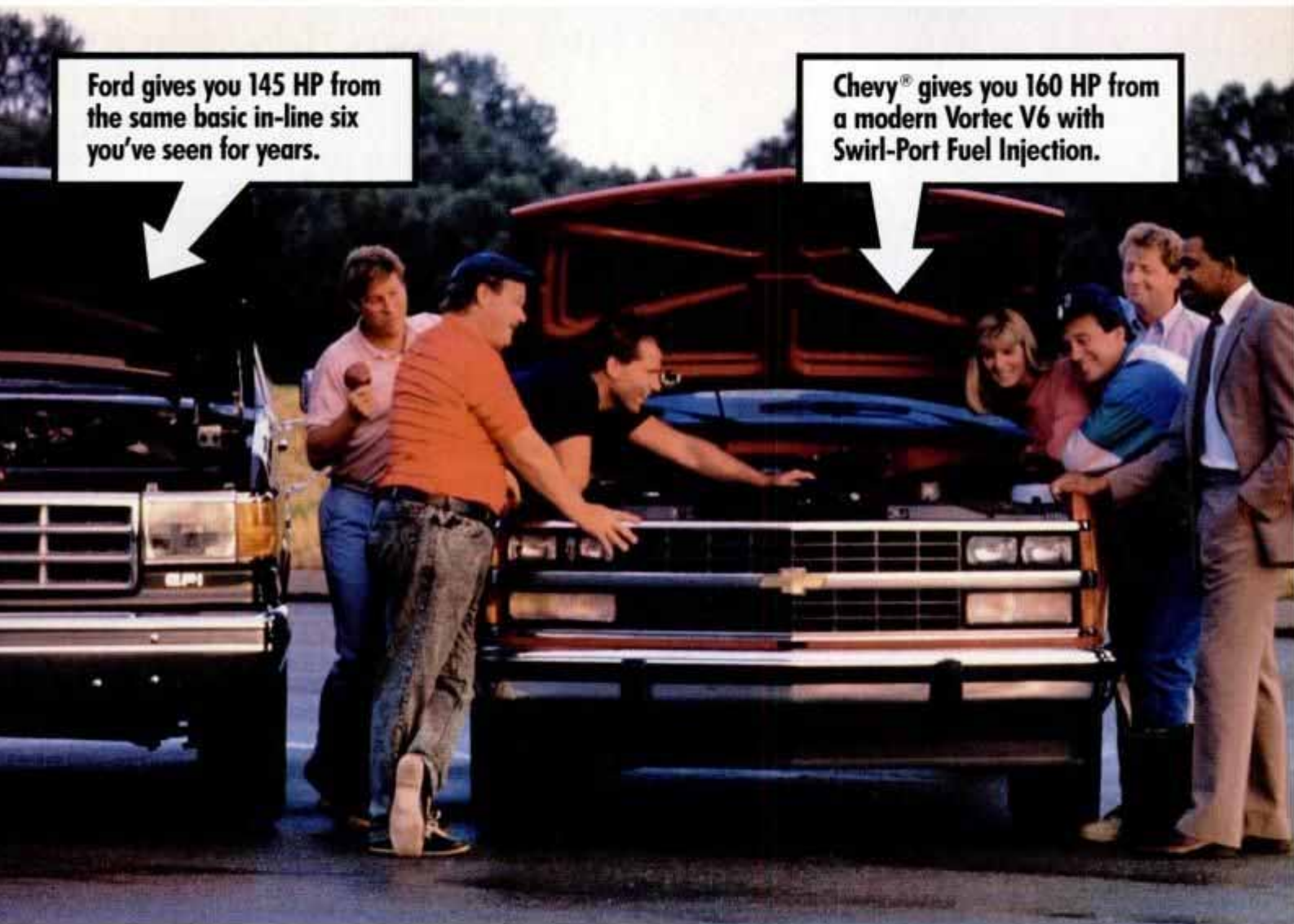
M.H. DEFFENBAUGH
MEMPHIS, TN

There is supposed to be a warning light in your truck that begins to glow at about 60,000 miles. When this happens, the truck is supposed to be brought to the dealer to

WHY AMERICA'S HAVING A CHANGE OF HEART.

Ford gives you 145 HP from
the same basic in-line six
you've seen for years.

Chevy® gives you 160 HP from
a modern Vortec V6 with
Swirl-Port Fuel Injection.



And while you're looking, notice the half-ton Chevy's bigger, heavier frame. The advanced double A-arm independent front suspension, bigger base payload, greater cab room and two-tier load advantages Ford doesn't offer.

In fact, come see all the advantages of the first all-new full-size pickup introduced in this decade, on display now at your Chevrolet® dealer's. Everybody else is.

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



Overwhelm your Five reasons this season for

#1 Giving the Very Best

Remember those few times when you came up with the perfect gift? The recipient was so overwhelmed he kept asking how you knew...

That's the effect Passport and Escort have on drivers, because drivers know what the experts say about radar detectors.

Car and Driver has tested radar detectors six times in the last ten years, and we've come out on top each time. In 1987 they even called us "the leader of the radar detector industry." And *Road & Track* has rated us "the leader in detector technology."

For the driver on your list, no other gift is as sure to please.



#2 The Exclusive Source

We designed Passport and Escort, we make them in our factory in Cincinnati, and we sell directly to you. Not through stores.

Our direct connection to you assures fast response on orders, on questions, and on repairs. We take care of everything.

As a gift giver, you benefit even more. It will be obvious you cared enough to seek out the exclusive source. And there's no chance the recipient will see Passport and Escort in the after-Christmas clearances.



#3 Incredibly Easy Shopping

Just call us toll-free (1-800-543-1608). You'll avoid traffic jams, parking hassles, pushy crowds, and long lines.

Instead you'll find a friendly radar expert who can answer any questions you may have. Just pick up the phone.

Order before 5:00 PM eastern time Monday through Friday and we'll ship your package the same day. A gift box is available at no

extra charge, and we pay for delivery by UPS. (If you're really in a hurry, see Joy #4.)



Call toll free...

1-800-543-1608

CAR CLINIC

(Continued from page 38)

there are obviously a limited number of questions we can address each month. I'm pleased, though, that the new PM Hotline is helping to take up the slack. So now you can try either the mail or phone. By phone, I'm available Wednesdays from 3 p.m. to 5 p.m., Eastern time. The number is (212) 265-7537.

As for the problem you're having with your Celebrity, there are the usual things your dealer should have checked. These are outlined in the service manual and include: making sure that there is no leakage of air into the intake manifold because of a loose or leaking air duct between the mass airflow (MAF) sensor and throttle body, any other vacuum leaks, the electrical connectors at the ignition coil and MAF sensor are tight, base engine idling speed is as specified, there is no loss of fuel pressure when the engine is cold, and the EGR transfer tube is sound and sealed.

Is the engine idle faster for the first few minutes after a cold start? The engine computer is supposed to increase idle speed briefly, and failure to do so may mean a malfunction of the Idle Air Control Valve or its wiring.

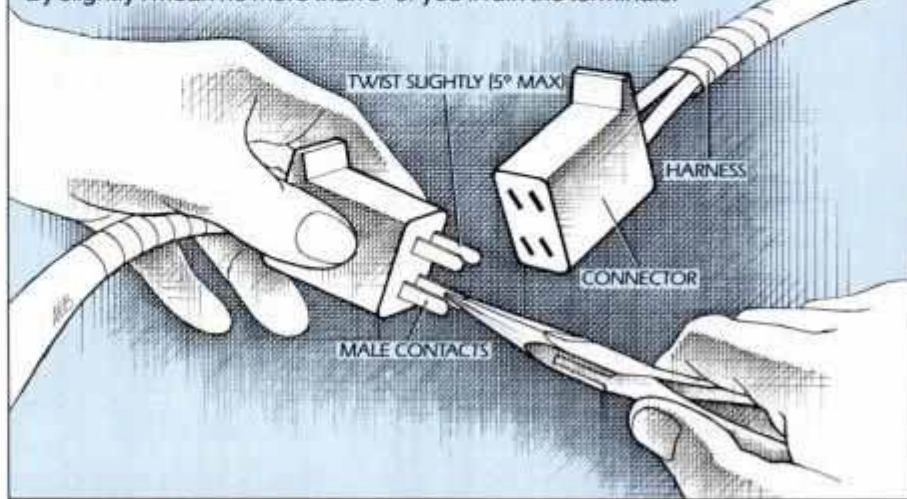
In addition, if you have a 5-speed manual transmission in your car, it may be a candidate for a new MEMCAL (for

40

Connubial Bliss

Here's some sound advice to keep in mind about the male and female halves of blade-type connectors that can help prevent an electrical failure.

First, if you're doing electrical tests to try and track the cause of a performance condition, don't force the probe of the testing instrument into female terminals. Doing so will spread the contact surfaces and provide an insecure fit for male terminals. The end result can be loss of contact and a dead circuit. To get an accurate reading on the instrument, just touch terminals with the probe. Second, if your vehicle develops a problem that may be the result of a poor connection between the male and female parts of a connector, pull apart the connector. Using a pair of needle-nose pliers, twist each male terminal slightly to provide a more solid connection with its corresponding female terminal. By slightly I mean no more than 5° or you'll ruin the terminals.





Favorite driver Escort and Passport

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We know that sometimes the holidays can sneak up, and waiting even a few days for the UPS truck is waiting too long. But here's the solution:

Through a special arrangement with Federal Express we can offer their overnight delivery for only \$10 extra. Just call us anytime before 8:00 PM and your package will arrive the next day (except Sundays).

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Overnight delivery by Federal Express is only \$10.

#5 Satisfaction Guaranteed

Here's the best joy of all: Passport and Escort are guaranteed to please. Quite simply, if for any reason you're not satisfied within the first 30 days, just return your purchase.

We'll immediately refund all your money and all your shipping costs. There are no hidden charges. Passport and Escort are also covered by a full one year limited warranty.

We've been delivering on these promises for over ten years. Call now and see how easy gift-giving can be.



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By mail send to address below. All orders processed immediately. Prices slightly higher for Canadian shipments.

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\$295 (Ohio residents add \$16.23 tax)

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Cincinnati, Ohio 45249

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MEMORY CALibration) which is another term for PROM (for Programmable Read-Only Memory).

This is the brain of the Computer Command Control system which calibrates the engine and the Electronic Control Module (ECM). The dealer can determine which MEMCAL is necessary by referring to TSB 88-88-6E.

One additional point—GM had a problem with MAF sensors. Therefore, your dealer may find that to stop this starting nonsense he will have to install a new sensor. The ones now in the supply system are much more reliable than the ones that were originally installed.

Cat Food

My 1983 Mercury Cougar equipped with a 5-liter engine and purchased new has been a fine automobile, with one exception: It eats a set of 50,000-mile radials in 16,000 miles. The car has been driven 48,000 miles, and I'm about to buy my fourth set. The wear is concentrated on the outer edges of both front tires. Wheels have been aligned every 3000 to 4000 miles alternately by dealers, alignment shops and service stations. No one has helped. Can you tell me what they're missing?

DR. MARVIN J. OLIM
KATY, TX

POPULAR MECHANICS • DECEMBER 1988

Those who have done alignment have in all likelihood been going by the book—the book in this case being the service manual—or instructions derived from the service manual.

The book is wrong.

Give the next one who will be doing the job the following procedure, and let's see what happens with that new set of radial tires:

1. Balance and mount the new tires. Then, set tire pressure (cold) to the maximum as stipulated on the tire pressure decal mounted on the door pillar.
2. Adjust front camber to the most in-board (most negative) position within the limits of the available adjustment slots.

Each camber adjustment hole is equal to $3/8^\circ$ of camber change. Check alignment readings to make sure that side-to-side camber (left camber minus right camber) is within plus or minus $1/4^\circ$. If necessary, readjust camber to maintain this side-to-side reading.

3. Adjust front total toe to $1/16$ -in. toe-in. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to Car Clinic, Popular Mechanics, 221 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ A 1987-88 Jeep Cherokee, Wagoneer or Comanche with 4-liter engine that demonstrates a harsh bucking or surging should have the distributor modified to get rid of the cause, which is ignition cross fire. A new distributor cap (part No. 33004024) is also needed. Ask your dealer to check TSB 18-53-88.

■ Suppose your 1988 Honda CRX is emitting a loud, metallic cracking noise from the front when you accelerate rapidly or come to a hard stop. Honda Service News of 8/88 advises the dealer to try retorquing the four front beam bolts to 47 ft.-lb. If this doesn't stop the noise, front beam washers (part No. 90509-SH3-000) should be installed between the body and beam.

■ Switching to snow tires for the winter with a 1985-88 Merkur XR4Ti or 1988 Scorpio isn't that simple. You'll need steel wheels (part No. E7RY-1007-D for the XR4Ti and part No. E8RY-1007-C for the Scorpio) and different wheel nuts (part No. D6RY-1012-A). These winter-time parts have just become available at Ford dealers. Details are in TSB 88-16-8.

■ TSB 88-T-33 addresses the problem of an occasional delay in shifting or a lack of shift with a 1988 Oldsmobile Cutlass Calais equipped with a Quad 4 engine and model 125C automatic transaxle, but no cruise control. A new accelerator control cable (part No. 22542664) should put a stop to this.



“CHARGE UP WITH AC-DELCO AND SAVE UP TO \$6.00.”

— Chuck Yeager

If you want to start something, you can depend on a Delco maintenance-free battery. And if you charge on over to your local retailer between October 16 and December 10, 1988—you can even get money back!

Buy a top-quality Delco Freedom or Dura Power 50, 60, 72 or Voyager battery and you can qualify for a \$6.00 rebate. Choose a 40-series battery and get \$2.00.

Your AC-Delco retailer has rebate coupons and details. Call 1-800-AC-DELCO for the retailer nearest you.

While you're there, ask about the manufacturer's limited warranty that applies to all Delco batteries.

All rebate coupons must be received by January 16, 1989. So get started soon with the battery of your choice from AC-Delco!



GENERAL MOTORS CORPORATION

AC-DELCO. THEY DON'T JUST FIT. THEY MATCH.

BY TIM COLE

Aerodynamicists View The B2

MOLECULES of air pass around sculpted foils of carbon composite—shifting, splitting, coalescing. Studying the way these atoms of nitrogen and oxygen interact with airborne structures is called aerodynamics—a science born in the Renaissance contemplations of Da Vinci, maturing on the sands of Kitty Hawk. Aerodynamics reached full stride in the middle part of the 20th century—with the X planes, the Delta Dart, Concorde.

Right now, there is an entirely new airplane for aerodynamicists to ponder—a plane of the 21st century. The B2 flying wing, America's next-generation, long-range bomber/penetrator, promises to keep the peace by exploiting so-called stealth technologies. It is reportedly imbued with improvements in materials, construction and control.

But like any new weapons system, controversy has enveloped the B2 ever since it appeared in an Air Force concept illustration last spring. And, naturally, aerodynamicists at major academic centers have joined the debate—raising issues that strike at the heart of B2's basic design. The discussions are spirited—the conclusions far from unanimous. They also highlight key aspects of a science crucial to national security.

Speed sacrifice

On the one hand is Dr. Pasquale Sforza, head of aerospace engineering at New York's Polytechnic University. He is severely troubled by the flying wing.

"The cornerstone of my argument is that speed means survivability. Here you have an airplane that is generally

all-wing—and the wing is the chief contributor to drag. It's just not the way to accommodate supersonic dash—the kind of speed you need to outrun fighters."

Sforza sees problems with keeping the B2 in the air long enough to deliver

its load of short-range attack missiles or gravity bombs.

"If it's spotted, it will never be able to outfly an air superiority fighter. Poor speed and inadequate maneuverability won't let it. And it's not just the wing. There appear to be a number of design features predicated on reducing radar cross section—like inlets and exhaust—that aren't helpful to improved performance."

Sforza points in particular to the engine ducts that are angled to prevent radar energy from bouncing off spinning compressor blades.

"You certainly compromise the capability of the duct to deliver low-pressure losses during normal flight."

And all of that, Sforza adds, does not mention B2's potential for detection. Even though some reports give the B2 a head-on radar cross section no larger than a bird, Sforza views increasingly sophisticated sensing technology as its primary nemesis.

"Clearly, look-down radar from a fast fighter like a MiG-29 will be able to spot the relatively huge anomaly the flying wing will create as it moves across the terrain. And sensitive infrared detectors based in low-Earth orbit will be able to sort out a continuous trail of slightly high-

The Northrop B2 bomber—sleek, stealthy, controversial.



wings as the XB-35 and YB-49.

"My outlook for the B2 is very favorable. Artificial control and stabilization using redundant fly-by-wire controls is now an accepted part of aerodynamics, and the peculiarities of the wing are well understood."

Lessons learned

Sears does suspect, moreover, that the control difficulties of the B2 are not dissimilar to those faced by Northrop in 1941.

"I'm sure the problem with any flying wing has already been dealt with. You have to provide a nose-down moment for high-speed cruise. But on landing, you have to reconcile landing flaps—which need to be in the down position—and nose-up control surfaces—which need to be in the up position. It takes sophisticated electronic controls to get it sorted out.

"We recognized back in the '40s that we had to give up inherent stability, and people in those days didn't believe you could have artificially stabilized airplanes. But it's routine now and artificial stabilization doesn't scare anybody. And if you get the wing loading up to desired values with the power to match, then you're back in the same speed category as a conventional plane."

It comes down to a conflux of important variables, aerodynamicists agree—speed, maneuverability, low radar cross section and thermal signature, load carrying and range. One thing aerodynamicists also agree on: They'd like to know a lot more about America's stealth bomber—a costly pillar of nuclear deterrence. They aren't alone. **PM**

er exhaust temperatures against cold backgrounds—regardless of how successful the B2 is in masking its thermal-exhaust signature."

That leaves problems with range, with airfield escape to avoid incoming missiles, with locating moving rail-based Soviet missilery. Not to mention the cost of the B2—estimated at \$600 million apiece.

The positive side

Dr. Barnes McCormick, the Boeing professor of aerospace engineering at Penn State, is more optimistic.

"I'm not sure the flying wing has to be inherently slow. With automatic control systems for a given weight and volume, there are a lot of attractive reasons why a wing might be aerodynamically more efficient."

Albert R. George, professor of mechanical and aerospace engineering at Cornell University, agrees.

"I don't see any reason why you can't make a wing go supersonic. Let's face it. Concorde is basically a flying wing with a vertical stabilizer—and it goes Mach 2."

William R. Sears is naturally supportive of the B2. Sears worked for Northrop from 1941 to 1946 and was present at the creation of such famed Northrop flying

OUTDOORS

BY JOE SKORUPA

Heating Up Winter's Deep Freeze

GENTLEMEN, stop your engines. Cold weather tends to put a freeze on most outdoor sports, but it doesn't have to. In many ways, adventures are more spectacular in winter than in summer.

Last winter I traveled to the wild-west Montana town of West Yellowstone to cover Olympic preparations by the U.S. Biathlon team.

The deserted outpost was shuttered tight and I toured the gateway to Yellowstone National Park by walking the



Al Unser Jr. pushes snowmobiles as hard as race cars.

middle of the streets.

I rented a snowmobile on my final day, went through the rustic park gates, and rode all the way to Old Faithful Geyser. Around every corner were incomparable sights—glistening ice sculptures, waterfalls frozen in motion and, of course, the thermal geological marvels that make the park famous.

But the most marvelous thing about my adventure—before the devastating fires of last summer—was that I was able to experience Yellowstone on its own terms, without crowds or waiting lines. The pureness of the winter landscape filled me with something too little encountered these days—undiluted awe.

Another man who appreci-



Sending snow flying are the Formula Mach I (left) and the Formula Plus by Ski-Doo.

ates winter's special charm is Indy Car driver Al Unser Jr., a member of the racing Unser family that includes father Al and uncle Bobby, both Indy 500 winners.

When the racing season is over, Al Jr. and the rest of the clan head for mountain ranches in northwestern New Mexico where there's plenty of snow to pursue a favorite offseason sport—snowmobiling.

Speed On Snow

"It's fairly well known around Indy Car racing that the Unser family does a lot of snowmobiling in the winter," Al Jr. told me recently. "Dad got into it in the 1960s and it's been a popular family tradition ever since."

The snowmobile Al Jr. is excited about riding this year is Ski-Doo's Formula Mach I (\$5999). This brand-new, high-performance machine is powered by what Al Jr. calls "the number one 2-cycle engine on the market." He's speaking of the 580-cc Rotax RAVE (Rotary Automatic

Variable Exhaust) engine.

Al Jr. had a chance to ride a prototype Formula Mach I last winter and was impressed with its 100-mph capability. He was equally enthusiastic about the Mono-shock Progressive Reaction Rear Suspension.

Ski-Doo's technical advances in snowmobiles are impressive," noted Al Jr., "especially in the Rotax engine and rear suspension that gives a wobble-free ride."

I didn't get a chance to ride a prototype Formula Mach I,

so it's only fair that I revisit Yellowstone this winter and do so. Look for this and other hands-on snowmobile reports in future issues.

Great Outdoors

I could feel a ghost from the hunger-crazed Donner Party lurking over my shoulder as I bit into the quail eggs and caviar. The ghost was upset. Memories of winter 1846, when the infamous Donner Party was trapped by an early blizzard not far from

(Please turn to page 46)



North Face camp gear hits the trail high over Donner Lake.

Latest HLDI Report on Highway Safety:

GM CARS RATED BEST AMERICAN MAKES.

11 YEARS
IN A ROW

"Best overall injury loss experience" among
1985-1987 passenger cars made in the United States

	Model	Body	Relative Frequency
✓	1. Pontiac Parisienne/Safari	SW	44
✓	2. Buick Electra	SW	48
✓	3. Buick LeSabre	SW	52
✓	4. Oldsmobile Custom Cruiser	SW	55
	5. } Tie Mercury Grand Marquis	2D	57
	5. } Ford Crown Victoria	SW	57
✓	7. } Tie Pontiac Bonneville	4D	58
	7. } Mercury Grand Marquis	SW	58
✓	9. Chevrolet Caprice	SW	59

Source: Highway Loss Data Institute. Body Styles: SW = Station Wagon, 4D = Four Door, 2D = Two Door. All results are stated in relative frequency of overall injury claims: 100 is average.

The Highway Loss Data Institute (HLDI) is a non-profit public service organization associated with the Insurance Institute for Highway Safety. As it does annually, HLDI has just summarized and published its findings on the frequency of automotive insurance claims.

We are pleased that GM cars are once again highly rated, as they have been each and every model year for eleven years in a row. Of the American models that HLDI categorizes as having "the best" overall injury loss experience, six of the top nine are General Motors cars, including a sweep of the top four places.

We believe this continued excellence reflects not only our cars—their quality, size, weight, and design—but also how and where our customers drive them.

GM Leads the World in Safety Research

GM has become the world leader in safety research, pioneering investigation into the basics of vehicle crashworthiness. We've developed better tools to engineer the design of our cars and trucks.

We've sharpened the world's understanding of human injury tolerance. Our commitment to safety is a big part of our commitment to our customers.

GM Responds to Customers' Needs

Throughout GM, people from every discipline are teaming up to put the best thinking and the best technology into the best products in GM history. We're taking our cues from our customers, responding to their needs for value, for utility, and for safety. Studies like this help measure the results of our efforts.



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NOVUS

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OUTDOORS (Continued from page 44)

where I was sitting, still gnawed at its emaciated soul.

I was in a campsite in the mountains of California's Sierra range about 50 miles west of Reno, Nevada. Unlike the Donners, who were part of an ill-fated wagon-train expedition forced to resort to cannibalism to survive a trip westward to the Sacramento Valley, my party, hosted by North Face, of Berkeley, California, was well stocked with food. I could feel the ghost's agitation increase as I reached for the stuffed mushrooms with melted cheese.

I'd always known that the North Face company was an expert in camping gear—backpacks, sleeping bags, tents, clothing and so forth—but I was pleasantly surprised to find it also had a fondness for haut cuisine. In addition to the quail eggs and stuffed mushrooms, our dinner included a salad with some kind of edible flowers, a 2-pasta entree with pesto sauce, bagels and butter, Colombian coffee and herbal tea.



Inflatable, self-bailing kayak with unique drop-stitch floor, handles Hawaiian waters.

With each sumptuous course, the ghost, apparently destined to go hungry through eternity to atone for the Donner Party's transgressions, became increasingly disturbed. To appease it I threw a shot of tequila over my left shoulder around midnight.

The Compleat Outdoorsman

Outdoor life has come a long way in the past few years, not only in menu planning, but in high-tech gear. This point was especially brought home the day after the North Face camping trip at the Outdoor Retailer Expo West show at Bally's Reno Hotel.

Interesting product innovations on display were:

■ **Katadyn PF Pocket Filter** (\$225), a Swiss-made water purifier distributed by Katadyn U.S.A. of Scottsdale, Arizona. As backpackers become increasingly aware of the dangers of parasites in domestic waters, purifying systems like the Katadyn, which is 10 in. long and weighs 23 ounces, are gaining prominence. Place it on a sturdy, flat surface, pump a plunger in and out and three-fourths of a liter of pure water is pro-

duced every minute. We used it on the North Face trip and easily quenched the thirst of 20 well-fed people.

■ **Superfeet**, based in Custer, Washington, is a system of customizing the inshoe fit of ski and hiking boots. The system works toward solving two different problems. One is discomfort caused by hot spots where boots don't follow the form of the foot. Mechanical and hydraulic expanders enlarge boots for greater width and toe box height.

The other problem is fine-tuning boots to the biomechanics of the foot. Ideally, foot and lower-leg bones line up perfectly for minimal stress on joints. Unfortunately, misalignment is all too frequent. Many athletes spend \$400 to \$500 to correct this problem with orthotics to compensate for misalignment. Superfeet has a vacu-formed system that produces Foototics, custom-fit pads, for less than \$100.

■ **The Tradewind**, made by Maravia, of Boise, Idaho, is an inflatable, self-bailing kayak designed by Bob Crane, Mike Crane and John Gray, of Adventure Kayaking in Oahu, Hawaii. Made of a plastomer-coated polyester fabric, the Tradewind (\$1500) is sturdy enough to handle the demanding tours led by Adventure Kayaking through the rocky-shored Hawaiian Islands.

Innovative Tradewind features are Feathercraft rudder system, low windage profile and a removable drop-stitch floor—stitches inside the bladder eliminate the need for baffles. The 2-person, 16-ft. 10-in. kayak weighs 43 pounds.

■ **Between meals on the North Face trip I tested three of its products, the Yeti (\$155) sleeping bag, Bullfrog (\$260) tent and Back Shadow (\$350) backpack.**

I only put in a few hours of hiking time with the 6-pound 12-ounce Back Shadow, but it was enough to convince me it's one of the most comfortable packs I've worn. The leather hip belt connects to an articulating frame that follows the motion of your hips. The effect is incredibly smooth, resistance-free support.

The 4-pound 3-ounce Yeti sleeping bag, with its Polarguard insulation rated to 20°, got me comfortably through a night that dropped into the 30s. And the Bullfrog tent, which weighs 5 pounds 7 ounces, formed a roomy, freestanding 2-person space.

The morning after the North Face banquet on the trail, I wandered over to the campfire and picked up a plate of scrambled eggs with mole sauce. The chef apologized that he had no bread for breakfast. He'd brought muffins and croissants, but during the night, "marmots broke into the supplies and ate them all." Marmots, I thought, had nothing to do with it. It was the Donner ghost releasing years of pent-up frustration and finally getting a good meal. **PM**

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OLD HOUSE RESTORATION

BY BOB VILA

Interior Painting

WHEN it's time for some interior decorating in your period home, think paint. Not only is interior painting an easy way to make a room look clean and fresh, it's relatively inexpensive, too. Thanks to the many fine companies that offer historical paint lines, old-house owners won't sacrifice authenticity when making this choice.

Of course, like everything else, paint and the way it's made has changed over the years—for the better. So if you're looking for a 100-percent reproduction of the look and feel of the original material used in the past, you're not likely to find it. But, I assure you, the reproduction paints you do find are more than adequate for even the *purist restorer*.

Some paint companies base their historical paint lines on documentary research. Usually, this includes old color cards, product information and books. Some go a step further and actually base a historical paint color on physical research conducted on existing period buildings. Layer after layer of old paint is carefully removed until the original coating is found. Samples are taken of this original coating and through laboratory analysis a reproduction color, based on its pigment, is duplicated in a modern paint.

You must remember, though, that our tastes today aren't necessarily the same as those of our ancestors. With this in mind, some companies have modified period colors to appeal to the modern eye. Unfortunately, many suppliers don't tell you when they've done this. So if

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



Victorian decorating tends to be dense with different textures and surface treatments. The choice of a proper period wall paint can pull the whole atmosphere together.

you're striving for a museum-like reproduction in your home, you'll have to study the color cards carefully. If not, these slight adaptations shouldn't matter.

To further complicate things, many companies don't distinguish interior from exterior colors on their paint cards. (I'll talk more about exterior historical painting in a spring issue.) Of course, there is a difference between the two. Unfortunately, many times it's up to you to decide which is which. But with the help of this article and further research you do on your own, this shouldn't be too difficult.

Before we get into the typical colors used in period homes, it's important to understand a few things. First, there are no hard and fast rules of where and when cer-

tain colors were used. Like today, there were always exceptions to everything. The best I can do is give generalities or norms based on the period research available. There have been, and always will be, eccentrics who did their own thing, so to speak—even back then. So, remember, I'm talking generalities.

Secondly, before you choose an interior paint, you should have a good understanding of your personal color preferences. Don't paint a room a particular color because it's appropriate for your home's period if it's not something you can live with. And, of course, you should be familiar with the proper historical look of your home, which most old-house owners are. It's usually possible to blend the two. The following

brief history of paint usage should help you make the right choices.

Paint through the ages

Prior to 1700, whitewash was a popular interior paint used in the colonies. An inexpensive and easily available mixture of two basic ingredients, slaked lime and water, it resembled a liquid plaster. (You can still find whitewash paints in some historic lines.) Easy to use, whitewash was a way to make things look clean and neat. One problem with whitewash, though, was its impermanence. It didn't last long, and washed off easily with water.

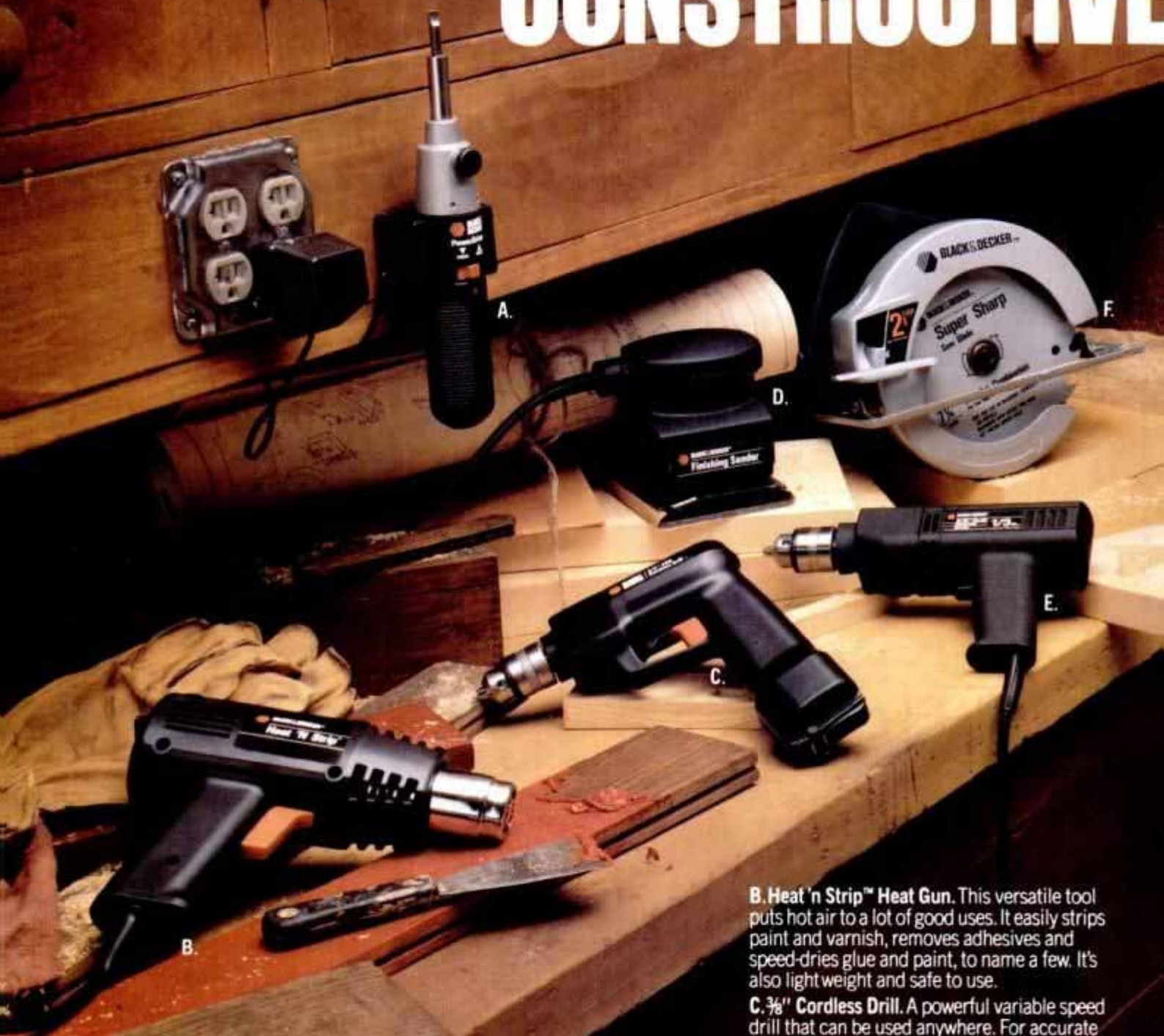
Another early paint that goes back to the founding of this country is milk paint. Often preferred for interior

(Please turn to page 53)

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two handles provide excellent control and, for accurate cutting, it has an easy-to-use pivot depth adjustment.

G. Auto-Scrolling Jigsaw. The auto-scrolling mechanism on this jigsaw lets the blade pivot in any direction for cutting intricate patterns and designs. Great for fine woodworking projects.

H. Cordless Jigsaw. The convenience of cordless lets you take this saw out of the workshop for use where a cord won't reach. The adjustable shoe allows bevel cutting up to 45 degrees.

I. Precision Router. For perfect moldings and decorative edges, this powerful router fits the bill. It cuts lock mortises and hinge recesses for door hardware and works with all $\frac{1}{4}$ " shank bits.

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OLD HOUSE RESTORATION

(Continued from page 48)

work because it didn't have an unpleasant odor—like the also available oil-based paints—milk, as its name implies, was used as the water and binder.

No matter what type of paint you're talking about, if it was made before the onset of the commercial paint industry (around 1860-1870), it was hand mixed. So, you didn't see the uniform consistency that we take for granted today—it had a different texture and was a bit *streaky*.

The coloring agents or pigments used in early paints were largely *earth-based*. For example, some reds came from iron oxide, yellows from ocher, black from lamp black, and blues from cobalt. Because of this, you never got the same color twice. So a painter had to prepare a big enough batch of paint to complete the job on hand to ensure uniformity of color. Many old-house restorers long for the rather uneven look of old, milk-painted walls. Fortunately, I know of one company that still makes milk paint the old-fashioned way, using earth-based pigments for a truly authentic look (The Old-Fashioned Milk Paint Co., Box 222, Groton, MA 01450).

The period palette

Many times, colored woodwork provided a rich contrast in a Colonial home's whitewashed rooms. Sometimes, too, a different hue was used on the doors, providing even more contrast. It wasn't uncommon to find, in the more elite homes, fancy molded woodwork painted white against softly colored walls. A search through your color cards will show various hues of blues, greens, yellowed-greens, tawny roses and golds common in the Colonial period.

The Victorians usually changed color by room and are in-

famous for their use of musty, muddy colors. Generally, you saw these darker, somber colors later in the period, probably after 1870, when the paint company's pigments became more stable. I think the earlier part of this period tended to lean toward lighter, pastel colors and returned to lighter colors again at the very end of Victoria's long reign.

Victorian hallways were usually painted neutral colors, like buff, off-white or cream. Parlors were considered a woman's room, and were usually colored as such. You might see mauves or magentas on the walls here. Studies or libraries, on the other hand, were considered the men's rooms, and were often painted in strong, dominant colors, like dark greens with plenty of blue.

You may be tempted to "lower the ceiling" in a Victorian home today by painting it a shade darker than the walls. But if you're striving for authentic period look, choose a lighter shade to keep the high-ceiled look the Victorian's loved. Be sure, too, to either use more than one shade of color or pick a contrasting one to highlight the beautiful architectural detail in these rooms. Treat the frieze, ceilings, cove and any plaster moldings with this contrasting color.

As I mentioned earlier, to do a successful painting operation, you must be familiar with the proper historical look of your home. Spend an afternoon at your local library looking through period decoration books. A good one for Victorian homeowners is: *Victorian Interior Decoration, American Interiors 1830-1900*, by Gail Caskey Winkler and Roger W. Moss (Henry Holt & Co., New York).

Remember when you're making your color choices that the Colonial and Victorian periods cover an enormous span of time, geographic area and architectural styles. I'm sure that you'll find more than enough colors to choose from, that not only achieve an authentic interior period look, but are also very enjoyable to live with.

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Road & Track, Nov. 1988



Model 976

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Laboratory Tests*

Model	Sensitivity, dBm/cm ²	
	X-band	K-band
BEL Vector 3	117.2	115.6
Audiovox RX-4	104.1	93.9
Cincinnati Microwave Escort	112.9	106.8
Cincinnati Microwave Passport	114.1	107.8
Cobra Trapshooter RD-3170	113.4	110.8
Fultron 15-0900, Snooper D-4000	109.4	108.8
Kraco KR0-16	102.7	104.7
Masport PH222	101.5	94.6
Maxon RD-25	109.3	106.8
Radio Shack Micronta Road Patrol XK	107.6	106.0
Uniden RD9XL	113.1	108.8
Whistler Spectrum 2	115.6	110.4
Average unit	110.1	106.3

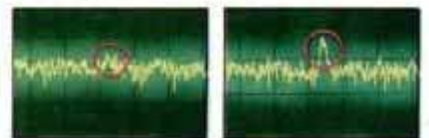
Source: Road & Track, Nov. 1988

*Conducted by Advanced Product Evaluation Laboratory, Inc.

BEL VECTOR 3 is the only unit in this test that also detects Ka band radar.

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INSIDE DETROIT

BY JIM DUNNE

The Saturn Symphony

SATURN will be a car in which "everything makes sense," says President Skip LeFauve. "It will be balanced in design, kind of like good music where the strings, drums or horns don't dominate."

But don't get the idea that Saturn will be a ho-hum kind of car. Sports car instrumentation, state-of-the-art engines and dramatic styling touches are in the plans.

"We will emphasize the whole car," reports LeFauve. That's a good plan. Just what Honda and Toyota, Saturn's announced competition, have been selling for years.

This prototype Saturn model is heavily disguised in the windshield and backlite



Saturn prototype indicates GM has abandoned minicar concept for more mainstream small-car approach.

strip along the side. It follows a kick-up path behind the B-post, a departure from the straight line of most other cars.

Jeep ZJ

A new design for the Jeep

models will stay in production and be sold side by side. The thinking is that the ZJ would sell at a higher price than the current Cherokee.

Then there is the future of the Jeep Wagoneer to be decided. Will this moneymaker stay in production, or will the ZJ replace it instead of the Cherokee? Stay tuned.

British Town Car

About a dozen fully finished 1990 Lincoln Town Car prototypes were brought in to Ford's testing grounds at Dearborn from Middlesex, England. A British engineering company, International Auto Design, is doing extensive work for U.S. carmakers that includes designing the chassis and body structure, and a complete body buildup.

The Town Car is shown here in final testing. IAD does not build every component in the cars.

Some of the important parts such as the engine, transmission, drive line, suspension and interiors are made in the U.S. and then shipped to England where the finished car is assembled.

Ford is not wholly dependent on IAD for prototype buildup. A large number of prototypes were also assembled in Dearborn to fill out the Town Car test fleet.

Chrysler/Maserati Problems

Chrysler has yet to announce the final introduction schedule for the TC by Maserati convertible, even though the car is more than a year past its original debut date. Evidently, the program has been plagued by problems ever since the first prototypes came off the Maserati assembly line in 1987.

The problems have been in
(Please turn to page 58)



Jeep ZJ for 1991. Chrysler may offer a sequel with Dodge badges.

areas. Close inspection reveals more extensive glass than you find on almost any other car.

The windshield appears to have wraparound curves at the A-posts, though this portion is covered by a piece of masking plastic. At the rear, an elaborate cap disguises the shape of the backlite and C-post, possibly covering another wraparound design for the rear window.

An interesting styling touch is the shape of the rub

Cherokee presents a number of decisions for Chrysler Corp. This model is a prototype of what Chrysler's Jeep/Eagle division will be offering in 1991. Still to be decided is whether Dodge dealers will be given a version they can sell in Dodge showrooms.

At the same time, Chrysler executives will have to decide whether the new ZJ will replace the Cherokee completely, or whether the two



1990 Town Car prototype was assembled in England.

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quality, emissions and safety, according to Chrysler executives. In addition, Chrysler has been making running changes in the design of the chassis.

Chrysler announced earlier this year that it would finally introduce the car in October, 1988. But that date has slipped, and the official introduction is up in the air as of this writing. One of the problems in the program that has been evident from early 1987 was the clash of wills between Chrysler and Alejandro DeTomaso, president of Maserati's parent company. DeTomaso has his own ideas about how a car should be built, and those ideas did not always coincide with Chrysler's.

One sign of progress in bringing the \$30,000 car to America has been the appearance of half a dozen prototypes in various Chrysler centers in the U.S. However, when the car does appear, Chrysler will make a strong effort not to identify it as a sports car.

Chrysler's Alfa Plan

Although the liaison with Maserati still hasn't produced much for dealers to work with, Chrysler has turned to another Italian carmaker to help brighten up its showrooms. In a deal struck with Fiat, Chrysler will soon market Alfa Romeo cars through selected Chrysler-

Plymouth dealers across America.

Fiat acquired Alfa in late 1986 to thwart a proposed merger with Ford. Although Fiat markets Ferrari sports and GT cars here, the deal with Chrysler promises to give Alfa's new parent its first significant presence in the U.S. since Fiat pulled out in 1982.

Alfa's current U.S. offerings are limited to the venerable Spyder 2-seaters and the Milano sedans, a lineup that produced about 6000 sales through 160 dealers in 1988. By dramatically expanding the number of dealers, and offering the popular 164 sedan later in 1989, Chrysler hopes to boost Alfa sales to the 40,000 to 50,000 range.

Air Bag Costs

What happens after an accident when the air bag has to be replaced and damage to the steering wheel or instrument panel housing must be repaired?

The cost should be substantial, but auto executives are mum when the subject is mentioned. Instead they point to expected lower costs for insurance or savings on hospital bills when the passenger in an air-bag-equipped car is saved from major injury.

One big problem remains: how to convince passengers to use seat and shoulder harnesses in air-bag-equipped cars.

Metered Seating

Now they can measure how comfortable your car ride will be. A seat comfort meter developed by Toyota measures three different vibrations—up and down at the floor and on the seat cushion, and side to side on the seat back.

Vibrations may be too fine a word for what is measured. Bumps and turns are also recorded. What the researchers did was put sensitive accelerometers in the three positions, and measure the results against what a test group of human passengers felt.

By fine tuning the accelerometer readouts, they came up with a way to reduce specific vibrations.

Pussycat Tiger

Corvette engineers say the new ZR1 engine has a tiger and pussycat personality. At low speeds it runs as smoothly as a low-power V8 in a luxury sedan. But at high speeds, it puts out a mighty 380 or so horsepower. One of the secrets is a 3-stage throttle control. At moderate driving speeds, the engine runs on a restricted number of air intake butterflies. At all-out acceleration—when the ZR1 catapults from 0-to-60 mph in 4.3 seconds—all butterflies are opened, and all fuel injectors spray. **PM**



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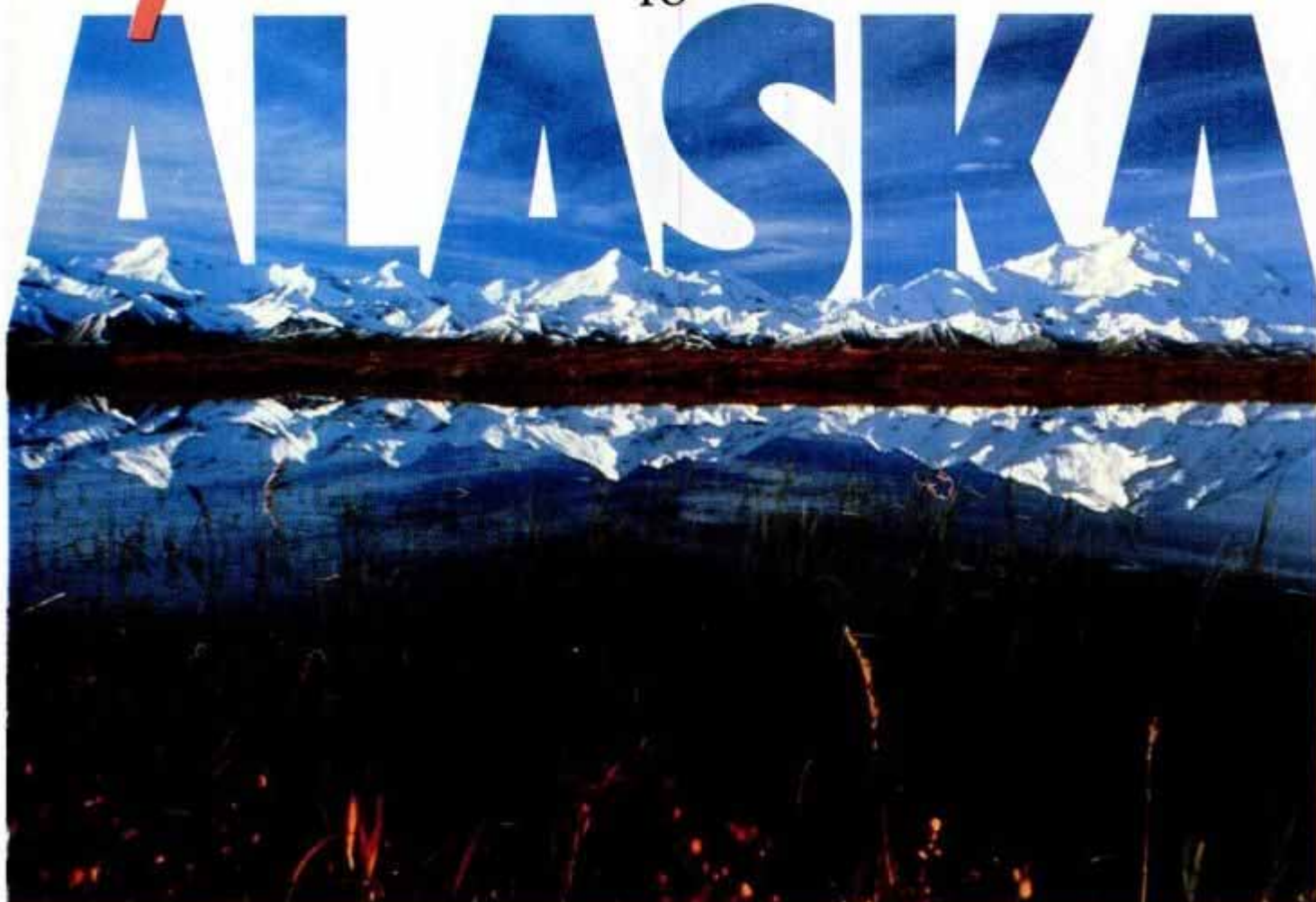
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Motown Sound '89

BY FRANK VIZARD, Contributing Editor

THE relationship between car manufacturers and audio companies such as JBL and Bose continues to evolve and expand. In the case of Ford, its partnership with JBL has evolved to the point of excellence. Bose, meanwhile, is improving the sound quality of 1989 General Motors cars to a remarkable degree. Bose also has struck a deal with Nissan, although in this instance the sound is less than satisfying.

The Ford/JBL systems in the 1989 Thunderbird and Cougar are real landmarks in terms of factory autosound systems. Most factory systems appear as if the sound systems were tacked on as an afterthought. In this instance, Ford clearly viewed the sound system as an important element of the car.

This is evident in the repositioning of the cassette receiver and loudspeakers in locations that make sense. The cassette receiver is installed high on the dashboard where it can be easily seen and operated. Many cassette receivers, unfortunately, are placed in locations where it is nearly impossible to tune in a station without taking your eyes off the road. Music shouldn't cause accidents.

A compact disc player is available as an option for both the Thunderbird and the Cougar. The CD player, though, gets positioned low down on the center console—not as convenient as the cassette receiver but in the case of a CD player it's acceptable.



User-friendly: Ford/JBL places radiocassette high on dash.

The door speakers in both Ford cars have been moved higher up for better stereo imaging. Each door speaker is actually two speakers in one: a 4-in. midrange and a 1-in. tweeter enclosed together in a 5½ × 7½-in. enclosure. Moving the door speakers has an interesting side effect. The repositioning of the door speakers occupies the space required for a window crank. Power windows therefore are standard equipment.

The rear speakers also have been moved from their traditional cavities in the rear deck and into the rear

side panels. Back-seat passengers in particular will notice the improved sound quality. The rear speakers are optimized for rear seat listening. Previously, the rear speakers had been optimized for the ears of those sitting in the front seats.

By moving the rear speakers off the rear deck and into the side panels, Ford and JBL have freed up enough space for the installation of a subwoofer. The subwoofer is a single 7-in. woofer reproducing bass frequencies below 50 Hz. The subwoofer, which is housed in its own 10-liter enclosure, is mounted to

the far right of the rear deck. Because bass notes are omnidirectional, the positioning of the subwoofer is not as critical as the positioning of the other four speakers.

The subwoofer unquestionably is the reason behind the big improvement in Ford's sound quality. Powered by an independent 85-watt amplifier, the subwoofer lets you hear music that is generally masked by road and engine noise. The power of the subwoofer is augmented by a 4-channel amplifier delivering 15 watts to each of the door speakers.

From a power standpoint, this Ford/JBL system isn't going to win any decibel contests. Nonetheless, there's still enough wallop in the system to provide you with a very pleasurable musical experience. The system should list for about \$1100 as an option, without the CD player.

The new Thunderbirds and Cougars are not the only Ford cars getting an auditory upgrading. The Lincoln Continental is being offered with a Sony-made, 10-disc CD changer or a digital audio tape (DAT) player as an option. DAT players, by the way, are being introduced by a number of car audio equipment makers at very high prices—in the \$2000 range.

Ford/JBL systems are also now available for the new Taurus, Sable and Bronco II vehicles. If you're wondering just how broadly across car lines premium sound systems will be offered, let me say this: Expect a Ford/JBL

(Please turn to page 115)



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How To Use Wet Abrasives

BY ROSARIO CAPOTOSTO, Contributing Editor

STANDARD sandpaper is indispensable for smoothing wood. To smooth and polish a wood's finish, specifically lacquer, varnish or shellac, there are special wet abrasives available. These are used with water or oil (paraffin or mineral) which acts as a lubricant to rid of abraded material and reduce friction. Water is favored because it's cheap and easy to clean up. However, *do not* use water on shellac. Use oil only.

Waterproof abrasive paper, coated with silicone-carbide, is commonly available in 9 x 11-in. sheets ranging from 220 grit (fine) to 600 grit



Use special waterproof abrasive paper to sand between coats of a finish. As a lubricant, use water, paraffin oil or mineral oil.

(very fine). Use wet abrasive paper with water or oil to sand between finish coats to remove drips, brush marks and other imperfections. Wrap the paper around a rubber sanding block or a wood block covered with felt. Keep the work surface well lubricated and rinse the abrasive paper frequently.

After sanding with 600-grit wet paper, polish surface with pumice stone followed by rottenstone. Use water or oil as a lubricant. Pumice stone, from lava rock, comes in four grades from coarse (1F) to very fine (4F). Super-fine rottenstone is made of decomposed limestone. **PM**



Waterproof abrasive paper comes in various grades ranging from 220 grit to 600 grit.



Use a rubber sanding block and rinse off the paper frequently in the lubricant.



Paraffin oil is a popular lubricant for sanding, especially when working on shellac.



After final sanding, polish the finish with pumice first and then with rottenstone.



Polish finish with a wood block that has a piece of short-nap carpeting glued to it.



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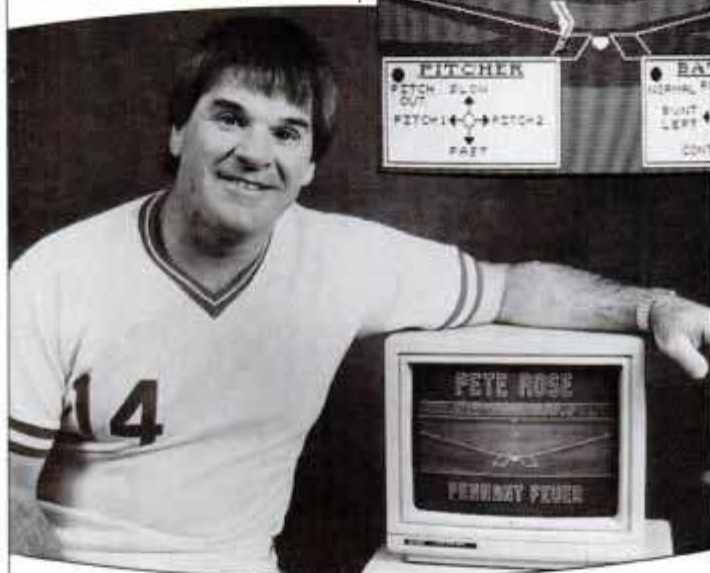
BY RON SCIBILIA

NAME a sport—any sport. If it's played in real life, odds are it can be played on your computer screen too. Sports-minded computer buffs can choose from an amazing array of high-quality, realistic simulations that offer greater sophistication than regular videogames. Selections range from such popular spectator sports as professional baseball, football, basketball, hockey and soccer, to more participatory pastimes such as golf, racquetball and bowling. There's even a menu of relatively esoteric fare that includes skateboarding, surfing and off-road racing. Fact is, sports competition alone might justify your purchase of a personal computer, even if you have no need to use it for word processing or spreadsheet calculations.

Baseball fans who can't wait for the return of spring can make April come early with two simulations that give Accolade's hot-selling *Hardball* a run for its money. Both games, *Earl Weaver Baseball* from Electronic Arts and *Pete Rose Pennant Fever* from Mediagenic's

Gamestar division, combine a ton of fun with some serious baseball education straight from the game's masters.

Unlike some of the sports simulations designed for



Pete Rose helps your expansion team hustle in *Pennant Fever*.

videogame play, you're not likely to exhaust this pair of games in a hurry. These computer-based simulations dazzle with the sheer amount of data they include and the options they afford the player. They're complex worlds unto themselves, and demand both manual and mental dexterity to exploit to the fullest. Although neither game absolutely requires a joystick, you're well advised to use one to get the most from your playtime. With *Earl Weaver Baseball* you can use a mouse, if you prefer.

In *Earl Weaver Baseball* (\$50, for IBM/Tandy, Apple II, Commodore 64/128, Amiga) you share the world



in—with different wind conditions for each park. If these won't do, you can even design your own playing field. As commissioner of your league you can indulge the whims of a baseball czar—customize the team

names, change stadiums and modify uniforms. Just about anything you can do in real baseball, you can do in this game. There's even an Instant-Replay mode to reprise the last play, frame by frame if you wish. You can get a radar gun reading of the speed of the previous pitch. Pitchers tire, just as in the real thing, and relief pitchers are more effective if warmed up. There's effective animation too, using both a pressbox-high perspective view of the field and a split screen, TV-like shot from behind the batter.

Pete Rose Pennant Fever (\$40 for IBM/Tandy, \$35 for Commodore 64/128), as you might expect from a game endorsed by "Charley Hus-

(Please turn to page 139)

of the diamond with Earl Weaver, former managing great of the Baltimore Orioles. You can both play and manage against Earl, just manage against him, or let Earl do the managing while you do the playing. Earl's also around to give timely advice on baseball strategy whenever you want it. The manual includes several pages of Weaver wisdom, gleaned from his highly successful major-league managing career.

Like to match the great teams of history against each other or mix and match stars from different eras? You can. You also have your pick of 32 different ball parks to play



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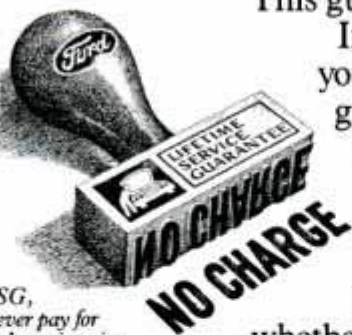
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SUPERSHIPS

Cruising the high seas in the coming century will place an emphasis on age-old luxury, innovative design and high-tech engineering.

BY ALLAN E. JORDAN

PM's notion of the cruise ship of tomorrow—aided by Wärtsilä's Proa concept—includes an atrium/hotel on a SWATH-derived trimaran hull. Gas turbines propel this fantastic assemblage of restaurants, casinos, sports centers and swimming pools.



JUST WHEN YOU thought passenger liners had gone the way of the woolly mammoth, along comes an emerging class of cruise ships designed to titillate even the most jaded Sybarite. Far surpassing the passenger vessels that once plied global sea lanes, these new cruise ships will be destinations unto themselves, floating Xanadus that will offer an invigorating mix of sea-

going pleasures for all aboard.

The push to design these fun factories has been sparked by efforts to entice more travelers to take ship-board vacations. The quest is leading the \$4 billion cruise industry through an evolutionary growth period that may one day spawn a generation of innovative vessels twice the size of today's largest ships.

Right now, passenger shipping's

SUPERSHIPS

standard bearer is Royal Caribbean Cruise Lines' *Sovereign of the Seas*. At 74,000 gross tons, *Sovereign* is the largest cruise ship ever built, and her 2282 passengers are surrounded by unrivaled luxuries—including a 5-deck interior atrium with two glass elevators, and a 275-seat lounge cantilevered 12 stories above sea level.

In the continuing progression of cruise-ship design, experts predict super cruise ships like *Sovereign* will become the stepping stones to the megaships of the 21st century. This next generation will not only be two to three times larger, but will introduce tennis courts, beaches and in-hull harbors as they strive to become the vacation dream of millions.

Phoenix—A foretaste

The inspiration for these 21st century megaships may come from *Phoenix World City*. A consortium of German shipbuilders has completed initial agreements and design studies to create this 5600-passenger cruise ship of tomorrow. *World City* will be more than three times the size of *Sovereign of the Seas* and will incorporate a split stern that will shelter a harbor where four 400-passenger day cruisers/tenders can dock. *Phoenix World City's* hotel areas are located in three



A trimaran SWATH concept permits additional space amidships for recreation.

8-story buildings atop her 1243-ft. semicatamaran hull. Designers anticipate tropical gardens, parks, promenades, cafés and a 4-pool lagoon with palm trees and a real sand beach.

Cutting a SWATH

Hull design has a direct bearing on passenger comfort, particularly in

heavy seas, and designers looking beyond *World City* see great promise in the SWATH design (Small Waterplane Area Twin Hull).

Swift and ultrastable, SWATH is a platform lifted above the water by struts which are attached to two submerged pontoons that provide the vessel's buoyancy. The struts define the ship's "small waterplane area." Whereas conventional ships ride the waves, this strut and pontoon concept permits the SWATH to safely manage surface turbulence.

Moreover, large cruise ships have length-to-width ratios of between 6:1 and 7:1, a SWATH vessel's ratio is approximately 2.5:1. This feature makes the SWATH well suited to be a cruising holiday center, according to officials at Finland's pioneering shipbuilder, Wartsila Marine. Wartsila, which has built more than a dozen leading cruise ships, has developed the SWATH 2000 Cruise Liner, a 500-ft.-long, 200-ft.-wide vessel to accommodate a minimum of 2000 people.

Key feature of SWATH 2000 is a large 30,000-plus-sq.-ft. central recreation area, derived from the wide beam. This outdoor court would be sheltered on three sides by 1000 passenger cabins, many of which would have private balconies facing either the ocean or recreation area. Within the recreation area would be cafés, gardens, a large swimming pool, a surfing beach, squash courts, even escalators and a water slide. Also envisioned are underwater and celestial observatories.

While SWATH matures on the drawing board, it has also served as the starting point for other future



Extending the principal, future SWATHs might include separate deployable harbors.

cruise-ship designs. One such design, the Wartsila-developed *Proa*, is a ship whose main weight is placed on a central hull. A smaller side pontoon supplies SWATH-like stability.

Tricruiser employs two side pontoons to form a triple hull. The passenger facilities are contained in a high-rise building located on a platform deck surrounded by a beach area complete with palm trees.

Big MACS

While many future designs are emerging from Europe, Japan's famed industrial companies are also seeking to establish themselves as builders of large passenger ships. One such organization is Nippon Kokan KK (NKK), which has joined with leading Norwegian architects to produce a concept called MACS (Multi Activity Cruise Ship).

The 3000-passenger MACS are based on a wide-beam hull: 853 ft. long with a 141-ft. waterline beam that expands to 177 ft. at the superstructure. She would include a split stern for an internal harbor similar to that of *World City* and *Tricruiser*.

Future prospects

In the near future, no less than a dozen new ships are due to be introduced, including five 70,000-gross-ton super cruise ships. These vessels will continue the competition to introduce features ranging from expanded recreational facilities to glass-domed observatories and taller atriums.

If one wonders where all this is heading, France's leading shipbuilder, Chantiers de l'Atlantique, functioning at the mouth of the Loire River for more than 100 years, may have designed the ultimate cruise experience with its island cruiser.

At first glance, the large circular ship might appear to be strictly fantasy, but closer observation reveals a vessel not all that different than the megaships. On the island's platform deck is a lagoon surrounded by hotels, beaches, marinas, tennis courts, landscaped gardens and an amusement park. The design includes lifeboats suspended below the platform deck.

While this design may seem unobtainable, one must remember that the evolution to the 74,000-gross-ton *Sovereign* from the 1960's cruise ship—a 18,000-gross-ton, 700-passenger vessel—was made possible by a quadrupling of consumer demand for cruises in the past two decades. As this passenger growth continues unabated, the leap to these megaships is just another step in an ever-expanding marketplace. **PM**

The Shape Of Ships To Come



ROYAL CARIBBEAN CRUISE LINES PHOTO



ALLAN JORDAN PHOTO



WARTSILA ILLUSTRATION



CHANTIERS DE L'ATLANTIQUE ILLUSTRATION

Royal Caribbean Cruise Lines' *Sovereign of the Seas*—nearly twice the size of today's contemporary cruise ships—has started a design revolution that may result in *Phoenix World City*, the SWATH-influenced *Tricruiser* and Chantiers de l'Atlantique's fantasy ship, *Island Cruiser*, a motorized atoll that sports a roller coaster.

CAMCORDERS ON TRIAL

Home video camcorders come in five different formats. We've lab-tested a top sample of each to help solve your multiple-choice questions.

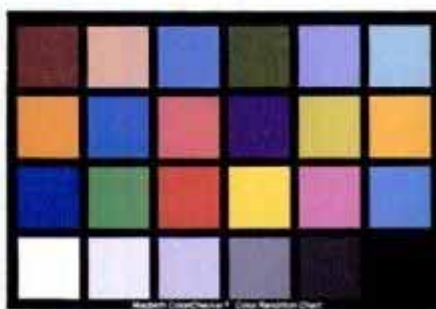
BY STEPHEN A. BOOTH, Electronics Editor, and
FRANK C. BARR, President, Advanced Product Evaluation Laboratory

IT SHOULD come as no surprise that video camcorders are the hottest-selling commodity in electronics today. Since the advent of hand-cranked motion picture cameras in the 1920s, Americans have taken a shine to rolling their own home movies.

Not everyone is possessed by a desire to be a second Cecil B. DeMille. But most humans do share an instinct

to record and preserve a personal and family history. In this regard, the modern home-movie might play the role formerly fulfilled by the totem pole or the hearthside storyteller.

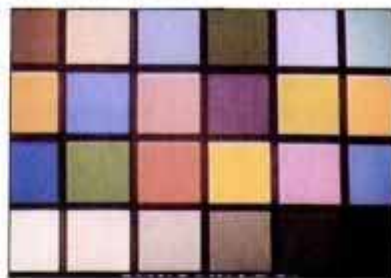
Camcorders, those battery-powered units that combine a motion-picture camera with a videotape recorder for direct display on a TV set, make the job of documenting family antics considerably more convenient



VHS

Olympus VS-S405

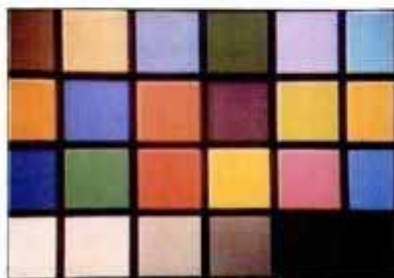
This feature-packed \$2500 Super VHS moviemaker renders accurately balanced, though undersaturated, colors. Its Super VHS recording system yields resolution in the 400-line range.



Serial No. G8WA20297

VHS-C

Toshiba SK-S80



Serial No. 76512153

This Super VHS-C model uses the compact, 20-minute videocassette—but gets big results. Color accuracy and saturation were the best tested, and resolution rivals its full-size cassette cousin. Price: \$1996.



than developing and projecting movie film—or carving a totem pole. Even compared to the 2-piece video camera and video recorder combos of just five years ago, today's camcorders are easier to lug around and use.

Trouble is, more than 100 camcorders from 36 brands are available

today—a selection broad enough to baffle the first-time buyer. To confuse matters further, camcorders come in five different operating formats. In automotive terms, the difference might be described as high-performance roadster versus touring car, full-size versus compact. As in select-

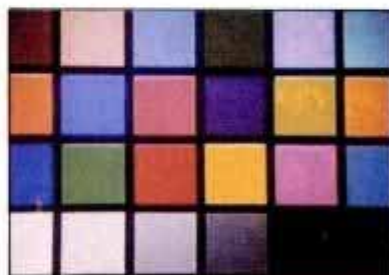
ing a car, you'll match a model to your wants and needs based on convenience features, performance and operation. Sticker price might not be so great a factor as in buying a car, because with camcorders, the spread between econocar and a "loaded"



VHS-C

Magnavox VR9256AV01

Colors are nicely balanced, though they veer to yellow and oversaturation. The resolution and noise ratings are typical for the VHS-C format. The \$1499 sticker includes two fast shutter speeds.



Serial No. 57124400

VHS

Sharp VL-L80U



This \$1799 camcorder yields performance typical of the VHS format, in resolution and video noise. Reds lean to magenta. Color is slightly oversaturated. Variable-speed zoom is a plus.

Serial No. 533622



8

Canon E708

8mm video has come a long way. Color saturation is right on, though reds veer to magenta. More important, this \$1950 machine gives the best low-light performance of any tested.



Serial No. CE0300359



CAMCORDERS ON TRIAL

model is limited to about \$1000.

Hoping to make our first-ever electronics test as meaningful as possible to the greatest number of readers, POPULAR MECHANICS submitted one camcorder of each format to the Advanced Product Evaluation Laboratory (APEL) in Bethel, Connecticut (for more about APEL and our testing criteria, see "Electronics," page 35). Had we chosen to test five machines of the same format, for example, Super VHS, all the test might tell you is how the five camcorders stack up against one another. You'd have no basis for comparison with the other 100 or so—and no clue as to the relative performance of other formats.

In our experience, the first hurdle most would-be camcorder buyers encounter is the question of format. Accordingly, by lab-testing one of each type, we hope to show you how the formats compare in performance and operation.

Once you've determined the format that suits your requirements, selecting a specific brand and model will depend on convenience features, price and—how it feels in your hands.

Before describing the results of our tests—and explaining how to interpret them—these preliminary observations might prove helpful:

■ All of the camcorders performed more than satisfactorily. This owes in part to the fact that despite the many brand names, only a handful of manufacturers actually turn out the camcorders—and these manufacturers

must maintain the quality levels specified by the patent holder in order to retain their licenses. The rule of thumb, as far as picture quality goes, is that all camcorders are good but some are better.

■ The only great difference in performance among formats is in horizontal resolution. Here, the relatively new Super VHS format (and its compact, Super VHS-C cousin) delivers about 60 percent greater detail resolution than conventional VHS, VHS-C and 8mm video (this also holds true for home VCRs). Accordingly, to benefit from the super formats' greater resolution, your TV monitor must be able to reproduce 400 or more horizontal lines. Many current models do.

Interpreting the numbers

The first measurement on our chart, *Minimum Illumination*, tells you the smallest amount of light needed to register an image with a camcorder. It's measured in lux—10 lux being about the amount of light falling on an object some 8 in. from a lighted candle. By comparison, 100,000 lux is about the light level outdoors when it's clear and sunny at noontime.

Our test samples are typical of most camcorders today, which weigh in between 7 and 15 lux (a handful handle lower light levels). But the image a camcorder picks up at minimum illumination is far from ideal. It is likely to be noisy—afflicted with a grainy, snow-like texture—with murky colors (if any color registers at all).

Moreover, at minimum illumination, the lens iris is open to its largest aperture (lowest f-stop) to admit the most light. This means that depth of

field is limited. Only your immediate subject is likely to be in focus—so long as the subject doesn't move.

Fact is, minimum illumination—the specification that manufacturers tout most loudly—is almost meaningless unless it's qualified by the amount of video noise in the picture, called the signal to noise ratio. On our test results chart, this is listed as *Chroma Noise* and *Luminance Noise*, and it is measured at *Minimum Light* and *Optimum Light*.

Seeing noise

Specifically, these measurements tell you how noisy, or distorted, the *Chroma* (color) and *Luminance* (black-and-white brightness) portions of the video signal will be at a specific light level. They are measured in decibels (dB); the higher the number, the better the rating.

Our noise figures for *Minimum Light* are based on each camcorder's *Minimum Illumination* level, as tested by APEL (5.9 lux, in the case of Olympus). For *Optimum Light*, all camcorders are tested at 1600 lux, a level at which APEL believes most camcorders no longer need supplemental lighting to get a good image. For the record, *Chroma* is measured for the color red—the most difficult for video equipment to reproduce accurately (we'll have more to say on this later).

You'll notice that all of the camcorders obtain better chroma and luminance ratings at optimum light than at minimum light. How much better? Most experts believe that a difference of 1 to 2 dB is barely visible to the human eye, and therefore insig-

LAB TESTS*

	OLYMPUS VX-S405	TOSHIBA SK-S80	CANON E708	SHARP VL-L80U	MAGNAVOX VR9256AV01
Minimum Illumination (LUX)	5.9	15.1	7.0	8.1	7.0
Resolution (Lines), Camera	420	450	400	340	320
Resolution (Lines), Video Out	400	380	250	250	250
Resolution (Lines), TV Out	330	340	250	250	230
Chroma Noise, Optimum Light ¹ (dB)					
Camera	41.2	34.7	41.0	44.7	33.4
Video Out	40.9	36.2	41.3	43.8	39.5
TV Out	42.5	36.4	41.6	44.8	39.3
Luminance Noise, Optimum Light ¹ (dB)					
Camera	39.6	41.0	44.4	41.2	41.6
Video Out	41.0	40.9	45.0	42.1	41.3
TV Out	39.6	40.1	42.7	40.5	42.2
Chroma Noise, Minimum Light ² (dB)					
Camera	32.4	30.5	40.5	33.8	27.4
Video Out	33.0	31.4	42.6	36.5	33.8
TV Out	33.7	31.4	42.1	35.5	34.0
Luminance Noise, Minimum Light ² (dB)					
Camera	29.6	33.6	33.1	30.6	29.5
Video Out	31.8	35.3	36.7	32.7	31.5
TV Out	31.0	34.8	36.0	32.5	34.4

* BEST MEASUREMENT IN EACH TEST CATEGORY IS INDICATED BY BOLDFACE TYPE. ALL MEASUREMENTS MADE IN THE STANDARD RECORD/PLAY MODE. 1. Measured at 1600 lux for all camcorders. 2. Measured at each camcorder's minimum illumination level according to APEL tests.

nificant (keep this in mind when reading the charts comparatively). But a difference of 10 dB (seen in some of our samples) is like night and day.

For the noise and resolution tests, APEL provides measurements for *Camera*, *Video Out* and *TV Out*. This describes the three different aspects of camcorder performance.

The *Camera* measurement tells you how good the image is *before* it is recorded on tape. *Video Out* and *TV Out* measure the quality of the tape-recorded image that will be transmitted to your TV screen (via direct-connection to the TV's video input jacks, or an RF connection to the antenna).

Notice that in the *Resolution* tests, the camera measurement is always the highest. This is because current tape-recording systems do not store all the information they are fed. We'll discuss horizontal resolution shortly. Paradoxically, though, video-out and TV-out ratings sometimes equal or exceed those of the camera section in our video-noise measurements. This is because manufacturers, anticipating degradation of the *recorded* signal, often employ internal circuitry to optimize the signal before display.

Seeing red

Internal circuitry also affects four more of our measurements—all taken from the camera section (at 1600 lux) and having to do with color.

You'll find no numbers on the chart for *Color Phase Accuracy* and *Color Saturation*. Instead, these are de-

scribed by words—and graphically via the color charts beside each camcorder at the beginning of this report.

APEL uses a vectorscope to measure how well each camcorder renders the difficult color red. The camcorder is trained on an industry-standard Macbeth color chart. What the camera section sees is represented by a point of light on the vectorscope. Then, for visual purposes, the camcorder's reproduction of the actual chart is fed, directly via the video output, to a Polaroid Freeze-Frame Video Recorder, which takes the snapshots shown here. (For comparison, the actual Macbeth chart is also reproduced here.)

Although the Polaroid instant-film adds its own color bias to the camcorders' color rendition, that the bias is the same for all machines—so the snaps provide a viable indication of the relative color-rendition performance of the camcorders' camera sections. Moreover, the Polaroids accurately visualize what the vectorscope measures.

In *Color Phase Accuracy*, we see whether the camcorder deviates from true red ("in phase")—either to yellow (yielding an orange tint) or to magenta (for a violet tint). *Color Saturation* shows how vividly the camcorder reproduces colors. Under-saturation delivers a pastel appearance. Colors are punchier than in reality when oversaturated. Bear in mind that actual color rendition might be different from our *Camera* measurements when it is recorded on tape, depending on how the signal is processed by internal circuitry. It might vary too when it is displayed on your

TV screen. Color is a subjective matter: You can suit your personal tastes by manipulating the color, tint and other display settings on your TV.

Two performance parameters you cannot influence are *White Balance* and *Color Contamination*. These are inherent to each camcorder.

White balance reveals how well the camcorder corrects itself to render pure whites under different lighting conditions. Color contamination measures the extent to which unwanted speckles of color emerge in a black-and-white image. By the standard Institute of Radio Engineers test, each is measured on a scale of 1 to 100—the lower the reading, the better. All of the camcorders proved excellent.

Keeping resolutions

To measure *Resolution*, the camcorder is focused on a chart that presents varying numbers of parallel, vertical lines arrayed left to right across the chart. The spacing between the lines decreases as their number increases. At the point just before the lines merge into a solid field, or where one can't be discerned from the next, the camcorder has achieved its maximum resolution.

The VHS, VHS-C and 8mm tape recording systems can accommodate 250 lines, at best. The Super formats up the ante to about 400 recordable lines. By way of comparison, the best TV telecast delivers about 330 lines to your TV's antenna.

Inasmuch as camcorders record live images, the more resolution, the better. But live images are usually *moving* images—and the human eye

(Please turn to page 128)

LAB TESTS

	OLYMPUS VX-S405	TOSHIBA SK-S80	CANON E708	SHARP VL-L80U	MAGNAVOX VR9256AV01
Color Phase Accuracy (Red)	In Phase	In Phase	To Magenta	To Magenta	To Yellow
Color Saturation (Red)	Under	Even	Even	Over	Over
White Balance (I.R.E. ¹)	10	10	9	20	7
Color Contamination (I.R.E. ¹)	4	3	2	5	13
Image Sensor	1/2" CCD	2/3" CCD	1/2" CCD	1/2" CCD	1/2" CCD
Image Striking/Lag Rejection	Excellent	Excellent	Excellent	Excellent	Excellent
Zoom Lens Focal Range (MM)	8.5-68 (8X)	12-72 (6X)	8.5-68 (8X)	8.5-68 (8X)	9-54 (6X)
Lens, Maximum Aperture	f/1.2	f/1.7	f/1.4	f/1.2	f/1.2
Minimum Focus Distance (Inches)	40	47	46	36	42
Minimum Focus Distance, Macro (Inches)	1/32	1/4	1/32	1/32	1/4
Zoom Speed (Seconds)	8.0	5.0	7.0	5.0 ²	6.0
Fast Shutter Speeds (1/X Seconds)	250/500/1000	1000	500/1000	1000	500/1000
Fast Forward Time (Minutes, AC ³)	6:45	1:50	4:41	9:12	2:06
Fast Rewind Time (Minutes, AC ³)	6:35	1:07	4:20	9:09	2:00
Test Tape (Length in Minutes)	120	20	90	120	20
Power Requirements (AC, Watts)	14.0	11.0	11.5	11.0	10.0
Battery Recording Time (Minutes)	100	60	80	120	60
Weight ⁴ (Pounds)	9	4	4 1/4	7 1/4	4
Size ⁵ , Inches (Height/Width/Length)	9x5x17	7x5x12	8x5x14	9x6x17	6x5x11
Suggested Retail Price	\$2500	\$1996	\$1950	\$1799	\$1499

1. Institute of Radio Engineers, measured at 1600 lux. 2. Speed is a variable from 5 to 20 seconds, wide to tele. 3. With supplied AC adapter. With battery, time is 50 percent longer. 4. Including battery and tape. 5. Rounded up to the nearest inch.

COLLECTIBLES

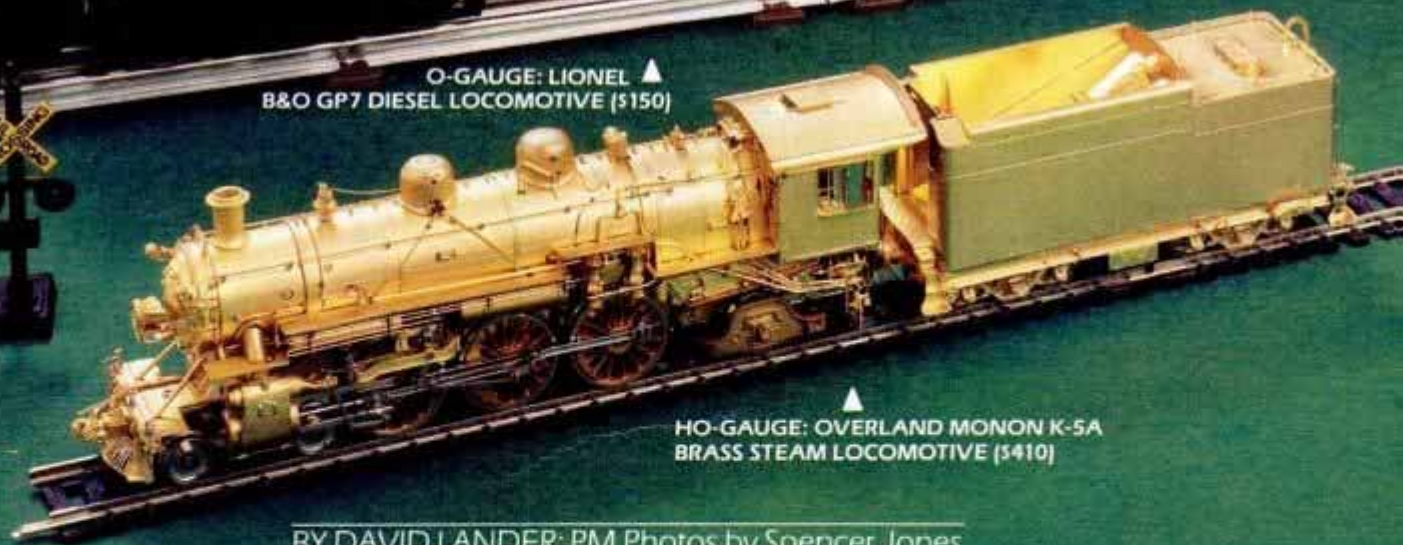
TREASURE TRAINS



▲ 1-GAUGE:
KALAMAZOO
GONDOLA
(\$550) AND
BOXCAR (\$570)



▲ O-GAUGE: LIONEL
B&O GP7 DIESEL LOCOMOTIVE (\$150)



▲ HO-GAUGE: OVERLAND MONON K-5A
BRASS STEAM LOCOMOTIVE (\$410)

BY DAVID LANDER; PM Photos by Spencer Jones

JOSHUA LIONEL COWEN, Lionel Corp.'s founder and motive force, put the passion for toy trains on an express track by making his promises to American boys very clear: "All the excitement, action and high adventure of real railroading," the company's 1941 catalog proclaimed. "The swift speed of the Express as it flashes by! The ponderous, methodical movement of the loaded freighter! Crossing gates being lowered! Warning bells ringing! Signal lights flashing!"

Children have loved their trains since the first wooden and cardboard models appeared as pull-toys. Engines powered by clockwork motors and live steam followed, and in the late 1800s, the first battery-powered electric trains appeared. Those who bought the earliest electric models hadn't a hint of the addiction they would foster in so many of their children and, in turn, their children's children. To many, old electric trains are prized collector's items now, and countless more who were transported by

Model trains, those iron hobbyhorses of youth, have grown into cash cows as they evolve from toys to collectibles. Here's how to ride the rails to profit or pleasure.



O-GAUGE:
K-LINE CNJ 6415
BOXCAR (\$20)

HO-GAUGE:
W&R NEW HAVEN 3442
PAINTED BRASS STEAM
LOCOMOTIVE (\$540)

N-GAUGE:
KEY P.R.R. H-95
PAINTED BRASS
STEAM LOCOMOTIVE
(\$295)

N-GAUGE: ORIENTAL EMD E8A
BRASS DIESEL LOCOMOTIVE (\$150)

Z-GAUGE: MARKLIN 8871
ELECTRIFIED INTERCITY
EXPERIMENTAL (ICE) TRAIN (\$495)

them in their early years have grown up to become model railroaders.

There's a good deal of crossover between contingents of train hobbyists, but a natural division exists between those who collect toys, such as trains made by Lionel and American Flyer (the two most popular among American collectors), and model railroaders. The latter group prefers its trains highly detailed and reproduced to exact scale. While some modelers like to run the trains on elabo-

rate layouts, many collectors treat their scale models as carefully as fine porcelain and refuse to risk compromising their condition by derailment. A leading maker of scale trains with a century of history in the hobby is the German firm, Marklin. A smaller market exists for brass models, which were first produced in the 1950s in Japan and now are made almost exclusively in Korea.

Train buffs often seem to talk in code. Lionel's scale-model Hudson engine, for example, is known as the 700E,

TREASURE TRAINS

its catalog number, or 5344, the number the model actually carries. A locomotive is often referred to as a 0-4-0 or 4-6-6-4. The first number refers to lead trucks, the second, and sometimes a third, to the sets of drive wheels, and the last to trailing trucks. The 700E, with four lead trucks, a single set of six drive wheels, and four trailing trucks is a 4-6-4.

In the early years of this century, toy trains bore little or no resemblance to actual locomotives or cars, and the concept of scale was unimportant. They were, however, made to fit track of a specific gauge. Gauge refers to the distance between a track's rails (in the case of 3-rail track, distance is measured between the two outside rails). The first Lionel trains rode track that spanned $2\frac{3}{8}$ in., but the company soon switched to a narrower gauge—designated standard—that featured rails $2\frac{1}{8}$ in. apart.

Standard gauge trains were expensive, and layouts occupied a great deal of floor space. In the years following the Depression, Lionel's O-gauge, with track rails $1\frac{1}{4}$ in. apart, increased in popularity and standard gauge was discontinued. Immediately following World War II, now-defunct American Flyer introduced its popular S-gauge, with track $\frac{3}{8}$ of an inch wide.

Scale is a ratio and refers to a model's size in relation to that of the car or locomotive on which it is based. O-scale, for example, is 1 to 48 or a $\frac{1}{48}$ of an inch to the foot while S-scale, at 1 to 72, is $\frac{3}{16}$ of an inch to the foot. Because the scale known as HO, which dominates today's model-train market, is 1 to 87, the often-repeated comment that HO stands for half of O is not true in terms of scale. But with its track width of $\frac{5}{8}$ of an inch, the gauge of HO is half that of O-gauge. N-gauge and Z-gauge respectively, used in

scale models, are narrower still.

Suffixes are sometimes added to the letters denoting gauge or scale. Lionel, for example, produced engines for O-27 track as well as O. Clearance between rails is the same in both cases, but a circle of O-gauge track measures $30\frac{3}{8}$ in. in diameter (outer rail to outer rail) while eight sections of curved O-27 track form a 27-in. circle. Some engines built for O-gauge are unable to negotiate the tighter curves of O-27.

Scales of value

Because a large engine built to scale would have been too long to handle O-27 or O-gauge curves, toy locomotives designed for these gauges are always foreshortened in relation to their width and height. In the late '30s, however, Lionel steamed forward with its model 700E Hudson engine. To allow its length to accurately reflect that of its prototype, the model was designed to run on O-72 gauge track, 16 curved sections of which form a circle 72 in. across (measured from center rail to center rail). This degree of realism—including "hex-head bolts accurately shaped though they are smaller than a pinhead"—accounts in part for the 700E's \$2000 value on the collector's market.

If you're a would-be train collector, familiarizing yourself with such designations is only the first step in a long educational process. Novices often start out by purchasing a few randomly selected pieces that appeal to them. More sophisticated buffs work toward a focused collection, unified by manufacturer, by gauge, scale and/or time period. Becoming a sophisticated collector requires research. Visiting hobby shops that specialize in trains is a good way to begin. At The Train Shop in midtown Manhattan, for example, you're exposed to an un-

usually large collection of models, and knowledgeable personnel. Just across the street is The Red Caboose, a source for books on trains.

New Lionel collectors may want to read one or more of the six volumes in *Lionel: A Collectors Guide And History* by Tom McComas and James Tuohy (TM Productions, Box 189, Wilmette, IL 60091). Ron Hollander's *All Aboard* (Workman Publishing, 1 W. 39 St., New York, NY 10018) packs the history of Lionel up to 1981 into a single volume and includes a great deal of information on toy trains. Of the many magazines devoted to the hobby, the one that may prove interesting to the new collector is *Railroad Model Craftsman* (\$21 a year from Carstens Publications, P.O. Box 700, Newton, NJ 07860).

There are several organizations devoted to toy and model trains. For collecting purposes, the most important of these is the Train Collectors Assn. (Box 248, Strasburg, PA 17579). Al Ruocchio, a former president, stresses the importance of membership and attendance at some of the many meets held by its regional divisions and chapters each year. This, the toy-train expert notes, exposes beginners to a great deal of material and to the information that seasoned hobbyists carry in their heads.

Ruocchio, who focuses on pre-war Lionel equipment, notes that key sources of information on the brand are the company's catalogs. While the originals are themselves collector's items, those no longer protected by copyright laws have been reproduced and are available from trade sources.

The most valuable trains are invariably the ones listed there last, Ruocchio points out. Condition and rarity are the two most important determinants of a piece's value, and these

(Please turn to page 112)

Brass: Riding The Rails In Class

ONE FACTOR that insures the collectibility of trains modeled in brass is limited availability: All brass pieces are produced in small quantities. Whereas 15 years ago, a typical production run consisted of about 1000 units, 250 is closer to the norm today. A few brass models are produced in editions as small as a handful. These, of course, are the most valuable.

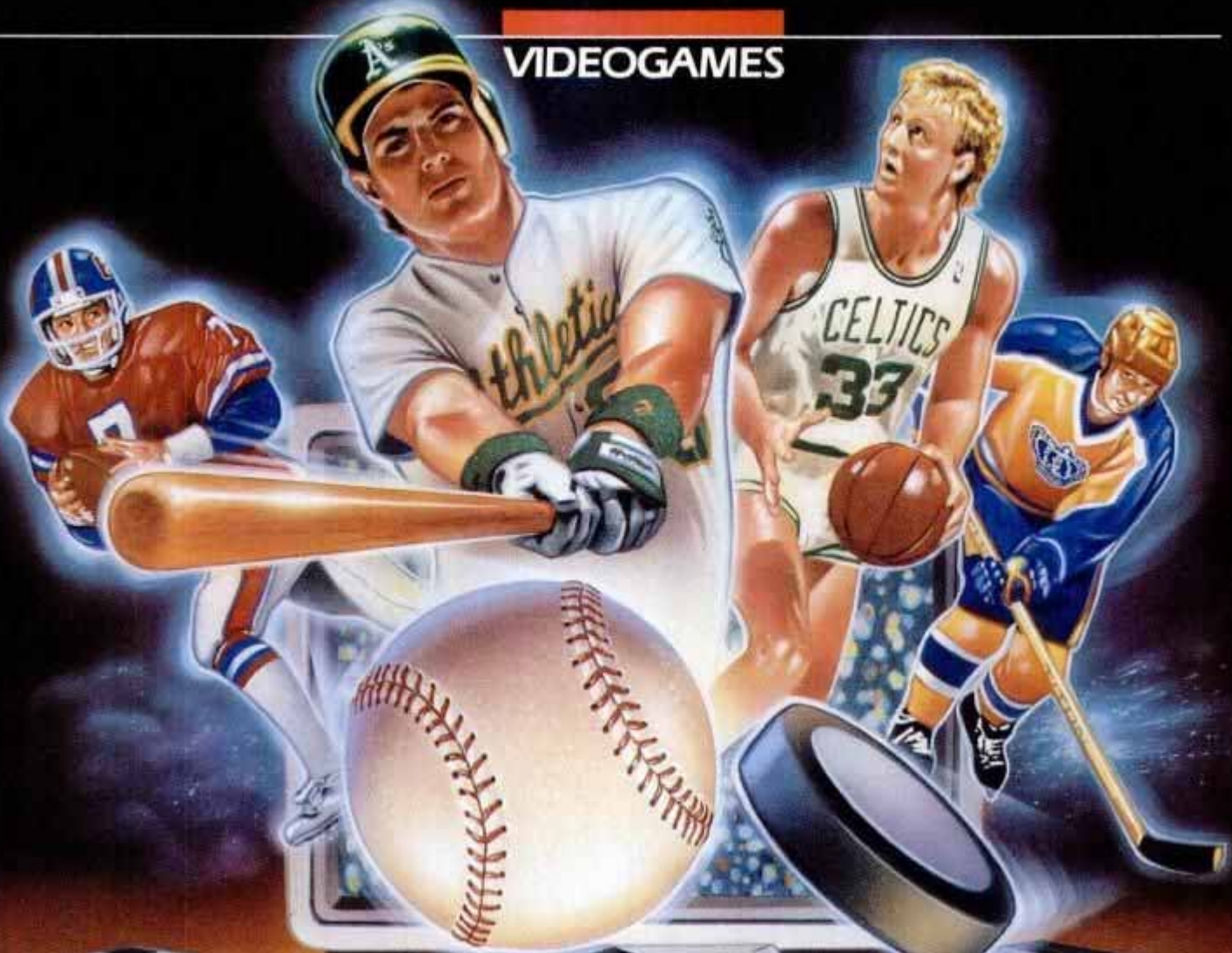
Brass models are done to scale and are highly detailed. The industry started in Japan in the 1950s, and the quality of the earliest imports is not nearly as good as that of today's pieces, which are primarily made by Korean companies. Still, some of the earliest brass models

are collectible simply because of their age.

The fact that brass models of a certain locomotive or car might be reissued at a later date complicates matters for collectors. Improvements in detailing and/or motors often make the newer editions more desirable. Another incentive for collectors to favor the new versions might be factory paint, which adds value.

As for prices, new cars begin around \$60 while highly detailed steam locomotives start at about \$250. An older piece that sold new for \$40 might fetch up to \$500 today while a few limited-edition models now command prices close to \$3000.—D.L.

VIDEOGAMES



New-Breed ARMCHAIR ATHLETICS

Videogames are making a comeback — with enough computer power to handle team sports. Here's a report on the most realistic games.

BY FRANK VIZARD, Contributing Editor

IF YOU'RE A sports fan, you can keep your competitive juices flowing long after the big game by playing videogames of your favorite sport. While they might not be as physically taxing as the real thing, the best

videogames do capture all the flavor and atmosphere. They demand that you not only exercise your playing skills, but also your mental, managerial talents. Here at POPULAR MECHANICS, we were ready and willing to take

BASKETBALL

Double Dribble (for Nintendo)



FAST-BREAK action characterizes the *Double Dribble* basketball game made for the Nintendo system by Konami, a Nintendo licensee. Basketball games are available in every videogame format, but we found *Double Dribble* the best in realistic play. You can compete at three different skill levels, and quarters can be timed for 5, 10, 20 and 30 minutes.

Double Dribble offers you a choice of four teams, each with its own strengths and weaknesses. As in the real sport, contestants play 5-on-5, but most of the on-screen action consists of a 3-on-3 or 3-on-2 running game reminiscent of the Los Angeles Lakers. Don't look to set up a slow-moving half-court offense: Pass and shoot immediately. On defense, it's difficult to guard against your foe—so look to steal the ball.

Shooters get fouled and go to the line for free throws, but the similarity to real basketball doesn't end here. This is a pro game, so you have only 24 seconds to bring the ball up the court and shoot. Also, watch out for backcourt violations. If the ball goes out-of-bounds, you have to pass it back within 5 seconds—the best time to exert defensive pressure and double-team a man without the ball.

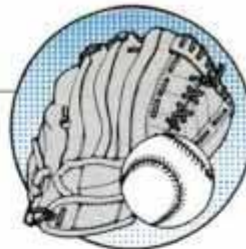
Double Dribble is an exciting game, especially when a shooter gets loose under the opposition's basket. As the shot is attempted, the video screen switches from a full-court view to a closeup of a phantom-like basketball player going in for a slam-dunk. There are three versions of the dunk—the 2-hand jam, the reverse and the 1-handed slam. The slam-dunk can be missed if the shooter is positioned under the basket improperly. The ball then bounces back into play with a rim-rattling sound that leaves no doubt the shot was missed. **Honorable Mention:** *One-On-One Basketball* by Electronic Arts for Atari's XE System.



The action's fast-paced in *Double Dribble*.

BASEBALL

RBI Baseball (for Nintendo)

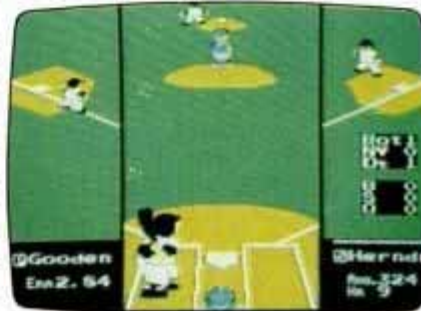


SINCE baseball is the national pastime, it's no surprise that there is a plethora of baseball videogames available. PM's choice for the pennant is *RBI Baseball* by Tengen, another Nintendo licensee.

Baseball is the only sports videogame in which managerial skills are as important as playing skills. Batting averages, home runs, speed and the ability to make contact with the ball are either stated or rated for every player on every team roster. These statistics are important. For example, on-screen players with lower averages swing the bat a little slower, and those with a low-speed rating run a little slower. Pitchers are rated on the speed of their fastball and the movement of their curveball.

RBI Baseball is played with a 16-man roster for each team, which is less than that offered by some other games. But *RBI Baseball* is one of those new games with an extra 64K of memory. Two-step functions required in other games are done with a single push of the button in *RBI Baseball*. The shift from the pitcher/batter screen image to the overall field is instantaneous when the ball is hit. Unlike some games, the pitching and hitting motions are realistic.

RBI Baseball features three levels of play, so you can work your way up from Double-A ball to the majors. Contestants have to choose from among 10 National and American League teams and two All-Star teams composed of major-league greats. Play ball! **Honorable Mention:** Baseball fans who really like the managerial side of the game will also like *Hardball*, by Accolade, for the Atari XE system. The roster choices are extensive, but compared to the more powerful computer version of this game (see "Computers," page 66), the action tends to move more slowly.



You'll manage real pros in *RBI Baseball*.

up the challenge of finding the most realistic videogame in each of four sports.

Videogames are experiencing a strong resurgence following the introduction of powerful game consoles by Nintendo, Sega and Atari—the new leaders in the field. Compared to earlier game consoles, these new systems are essentially computers, boasting 128K (kilobytes) each of random-access (RAM) and read-only (ROM) memory. In processing power, that's roughly comparable to the top personal computers of just a few years ago.

Additional processing capability is contained in the game cartridge itself. The amount of extra processing pow-

er varies from cartridge to cartridge depending on the needs of the game, but a range between 256K and 512K is the norm. The more processing capability a game has, the more realistic it is likely to be.

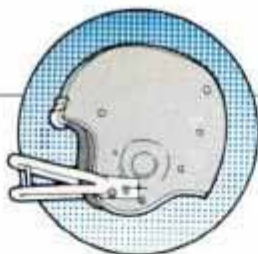
Some of the newest games, in fact, exceed the normal 512K limit by adding an additional 64K of memory. The number of games with this extra capability is small at the moment, but the menu will definitely expand with time. Unfortunately, there's no way to tell if a game has extra processing capability simply by looking at the package. The more powerful games, though, are generally characterized by superior graphics and complexity. *The Legend Of Zelda* by Nintendo is

an early example of the genre.

Most videogames are derived from successful coin-operated arcade games. A computer programmer often working with a graphics artist translates the arcade program into the home-videogame format. This is more difficult than you might imagine, because while the hardware for an arcade game can be designed to suit the needs of the game, a home videogame must be designed to operate on an existing piece of hardware. Since the amount of processing ability in the home-videogame console is already fixed, extra processing capability must be built into the cartridge to help make what programmers call routines—the mimicking of a real act

FOOTBALL

Great Football (for Sega)



SEGA'S *Great Football* videogame takes you back to the days when quarterbacks called their own plays. Prior to each play, the screen displays four passing formations and four running formations to the offense. Don't worry, the defense can't tell in advance which one you've picked. Once the ball is snapped, how well the offense does depends on good execution and the ability of the defense. And, unlike most other football videogames, there's a full squad of 22 men on the field.

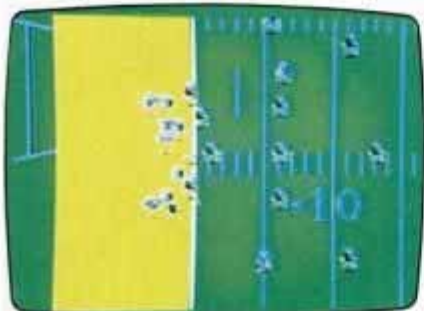
On defense, the defensive secondary is key. If you can anticipate the offensive play's direction, then you can stop the offense before it gets the mandatory 10 yards for a first down. With luck, you might be able to intercept a pass. Blitzing, of course, is allowed.

A kicking formation appears as a formation choice for punts, field goal attempts and after touchdowns. In each case, the offense has control over the effectiveness of the kick. Kicks are handled automatically only on kickoffs.

Great Football is a very clean game as far as penalties are concerned. At no time did we get assessed for penalty yardage. Off-sides might be difficult to discern, but there definitely were some late hits by the defense. A referee does come onto the field to announce down changes, but we couldn't locate the instant-replay officials.

Players choose from among 12 teams in the "NFC" and "AFC." Sega must know that the NFL is going to expand, since these fictional team names are not to be found on current league schedules. Now any town can have an NFL franchise!

Sega, incidentally, also offers *Sports Pad Football*. Both videogames are essentially the same but *Sports Pad Football* is designed for use with a more advanced control pad that is sold separately.



Great Football lets you quarterback plays.

such as the swing of a bat—realistic.

In our search for the most realistic sports games, PM evaluated every game available at press time in four sports: baseball, basketball, football and hockey. Each game cartridge retails for about \$30. Videogame makers produce games for a great variety of sports, but we chose to limit our tests to those popular team sports where two individuals can play and manage against one another.

Therefore, in addition to realism and ease of play, a major judging criterion was 2-player action. Some videogames, we found, promote themselves as 2-player games when, in fact, contestants alternate against the computer or jointly play the com-

HOCKEY

Ice Hockey (for Nintendo)



PURISTS might dispute our choice of Nintendo's *Ice Hockey* as our favorite hockey videogame, because only five players take the ice instead of six. But the realistic action more than compensates for the missing skater. Given the large amount of time most real hockey players spend in the penalty box, playing with a man short is not that unusual!

Hockey videogames illustrate a dilemma that confronts programmers. In a video hockey game, seeing the stick movement of the characters on the screen is part of the realistic action. Being able to see the stick movement, though, means the characters would have to be rather large in size. Unfortunately, if all six skaters took the ice, there would be very little actual ice left to skate around on. Characters would be bumping into each other continually. Other videogames do field a full squad, but the on-screen characters are very small.

Hockey is problematical also because it is a game of perpetual motion. Updating the movements of on-screen characters is done as often as every $\frac{1}{30}$ th of a second. To update the movements of continually moving skaters requires a great deal of processing power.

The lack of processing power becomes evident when "ghosting" occurs. Two characters might appear on the same horizontal plane, and if the processing power isn't sufficient, one of the characters might partially or completely disappear. The 5-player approach of *Ice Hockey* minimizes ghosting. *Ice Hockey* also offers the greatest flexibility of any hockey videogame we evaluated, in that a variety of skaters with different skills can be called upon. Icing and other penalties are called against the six teams. And, just like the real game, fights break out and skaters get sent to the penalty box. Then you're really playing with a man short.



Play a man short in Ice Hockey.

puter. In our minds, the essence of sport is challenging head-to-head competition—not head-to-computer competition.

PM played sports videogames designed for the videogame systems from Nintendo, Sega and Atari. The Nintendo and Sega systems cost about \$80. Atari's 7800 system sells for about the same price, but PM used the more advanced Atari XE system selling for \$150. The Atari XE system includes a keyboard so that it can be expanded for use as a computer.

The Nintendo and Sega systems utilize rectangular control pads with a direction controller for player movement and buttons for specific actions. The Atari XE system includes only

one joystick, so you'll have to buy another one for 2-player action. Joysticks compatible with the Atari XE system range in price from \$8 to \$20 and are made by accessory companies such as Beeshu.

Connection to a television is simple with the Nintendo and Sega systems, but the Atari XE system is less so. Depending upon the configuration of your TV, you might have to purchase an inexpensive adapter to make a proper connection. The Atari XE system also requires you to use a manually operated switching device to move between the videogame and a normal TV picture. The Nintendo and Sega systems perform this chore automatically when the game is turned on. **PM**



SLASH AND FLASH

BY JOE SKORUPA, Boating/Outdoors Editor

High-tech hits the slopes with heated boots, adjustable skis and other cool gear.

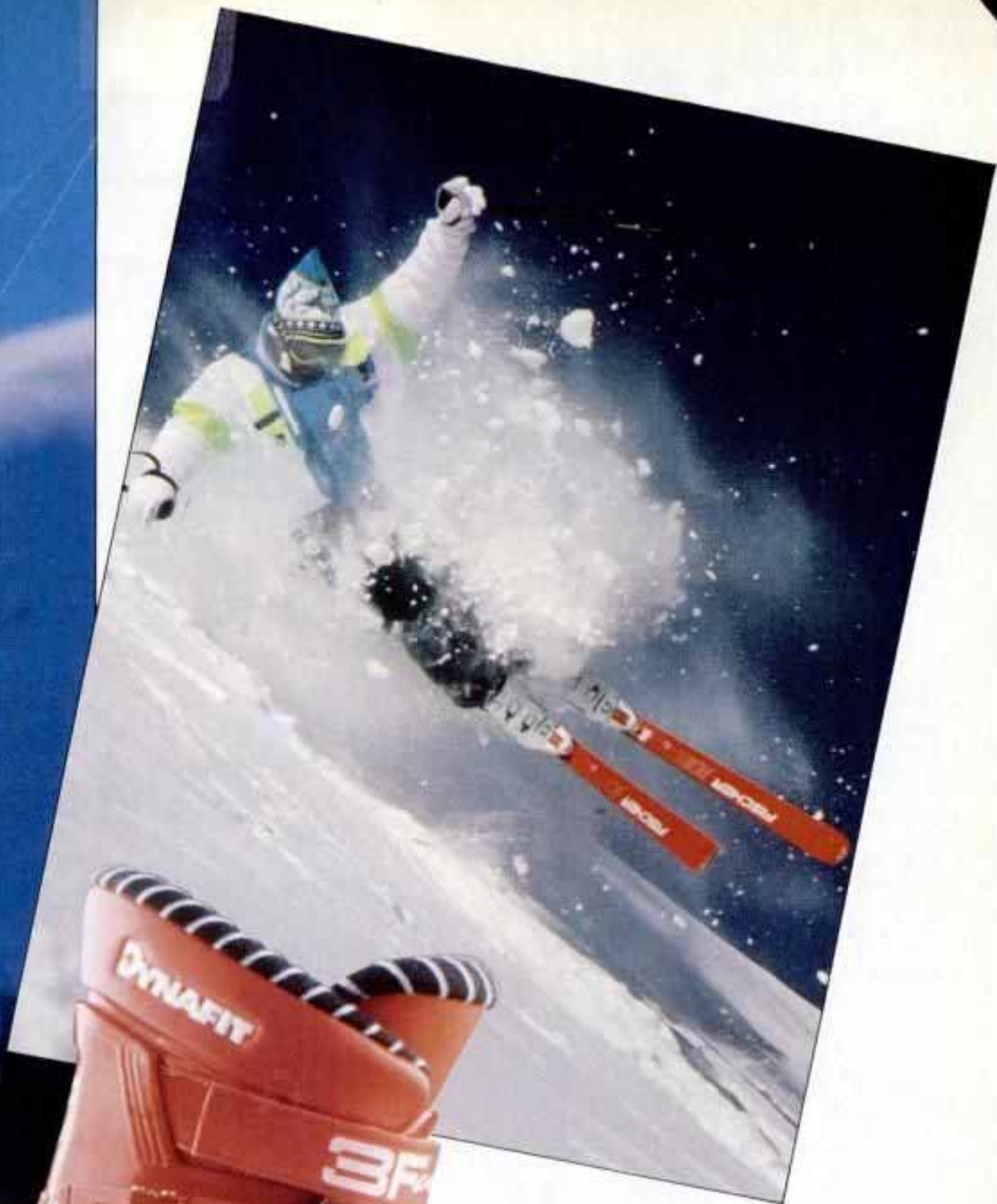
FIRE AND ICE. Whether you attack the steep and deep or cruise gracefully down a well-groomed trail, skiing is so cool it's hot. Not only for the adrenalin rush of bold risk taking, but for the enduring satisfaction of conquering a harsh-but-beautiful environment with exuberance and pizzazz. In what other sport do you regularly outdress Michael Jackson and outmaneuver his moonwalk?

Yet skiing, with its emphasis on pure freewheeling joy, is an extremely technical sport. Boots, bindings, skis and poles are high-tech marvels of space-age materials and innovative designs.

Today's ski boots are programmable, with up to seven control points for a personalized fit. Some have battery-powered heating elements. Cross-country ski poles feature new-wave, powerthrusting grips. Skis are multi-adjustable and bindings move in increasingly complex articulations to ensure firm retention and an injury-free release. Perhaps the most exciting new product to emerge on the ski scene is the snowboard—a monoski, similar to a slalom waterski, that's handled like a surfboard.

With high-tech innovation surging through the coolest of sports, now is the time to head for the mountains and ride the great white wave.

PM



The totally programmable boot (above, in action, and at left) is the Dynafit 3F Comp S (\$375). Custom fit is accomplished by:

1. Flex control to stiffen boot,
2. Clip to release angle for walking in comfort,
3. Forward lean adjustment from 16° to 26°,
4. Lateral cant control to ensure a flat stance, and
5. Tension refiner on top three buckles to tighten final fit.

The new king of the mountain is a monoski sport called snowboarding, shown here (far left) on a hot model called the Burton Air.

SLASH AND FLASH



Hotfingers

Cool skiers seek the heat, especially for their hands. DuPont's new Thermolite insulation material gives Wells Lamont's Hotfingers gloves a built-in baffle-grid system (see cut-away) that allows warm air to circulate through ducts. Arched thermoregulatory loops (see enlargement), made of resilient Saran monofilament, were developed for use by NASA. The Sirocco model (shown here) costs about \$130. Wells Lamont is based in Chicago.



High-Tech Hybrid

Rear-entry ease combines with custom-fit programmability in Salomon's new SX82 E boot (\$375). Points of adjustment are: 1. Forward lean control, 2. Lower leg cable adjustment, 3. Flex adjuster between unique 2-part shell, and 4. Forefoot Memo control. Cant and heel-hold controls (not shown) are on the heel.

Snowboarding U.S.A.

The cry "snow's up!" will be heard on the nation's slopes this year as snowboarding, surfing on snow, explodes onto the winter scene. The Burton Air snowboard (\$479), a monoski with two boot bindings, allows you to "get around, round" on the great white wave.



Lost & Found

For emergencies, passive radar reflectors (\$24.95), by RECCO of Vancouver, British Columbia, can be attached to boots (above) or sewn into clothing to pinpoint a missing skier's location for search-and-rescue teams using an active radar detector (left). We tested the RECCO attachment on a Koflach In-tech 1.9 boot (\$379), an overlay/rear-entry hybrid.

Power Thruster

The grip on the Power Thruster, by Swix, of Wilmington, Massachusetts, was once banned from competition because it was thought to give an unfair advantage. The ruling was changed this year. The poles cost \$75 to \$90.



Catch & Release

In the high-pressure world of ski bindings, movement beyond a certain point trips a cam and the binding releases. The Marker Twincam (\$180) has a second cam (left) that allows the toe and sole plate to move as a single unit during the retention phase. This cuts friction build-up, which inhibits release.



True Colors Shining

Eye relief is in sight with new double-lensed goggles by Carrera. Exterior gold lens, on the Ultrasight goggles (\$50), brightens low-light conditions while the interior gray lens allows true-color transmission. Polarization cuts glare from hot spots and 100 percent of UV light is blocked for protection against the sun's most harmful rays.

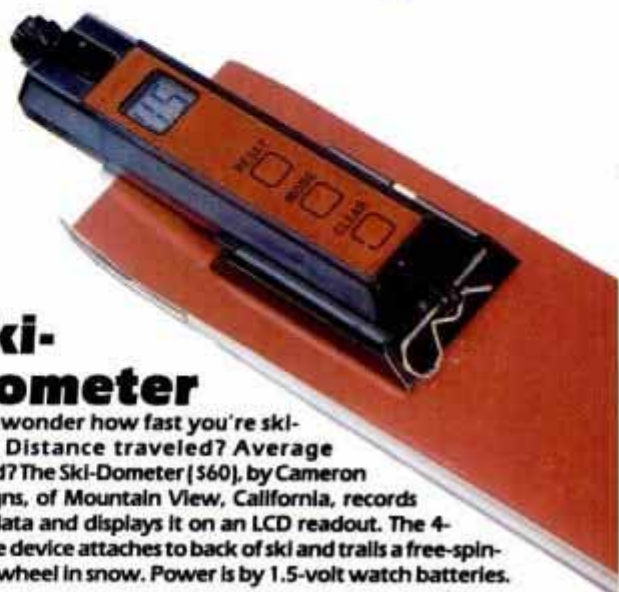
The Joy Of Flex

Ideally, you change your skis when you go from icy terrain to powder. With Chameleons, by DP Skis, of Taos, New Mexico, you simply make adjustments. How? With special hex tools inserted into three control points (see arrows) in the sidewall. Flex adjustment is effected by selective tensioning of stainless-steel strips in the foam core. This core construction allows for variable stiffness in the tip, middle or tail, independently or in combination.



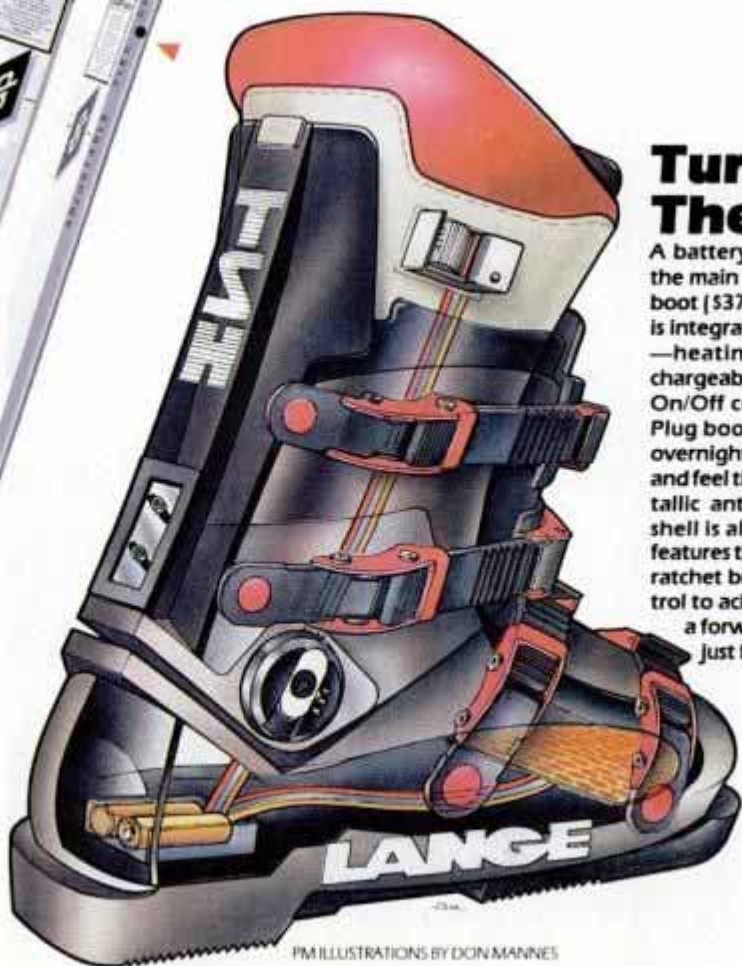
Ski-Dometer

Ever wonder how fast you're skiing? Distance traveled? Average speed? The Ski-Dometer (\$60), by Cameron Designs, of Mountain View, California, records this data and displays it on an LCD readout. The 4-ounce device attaches to back of ski and trails a free-spinning wheel in snow. Power is by 1.5-volt watch batteries.



Turn On The Heat

A battery-powered hot foot is the main feature of Lange's TSH boot (\$370). The heating system is integrated into the inner liner—heating element in toe, rechargeable batteries in heel and On/Off control switch on top. Plug boots into a house outlet overnight, using a transformer, and feel the heat all day. The metallic anthracite-colored outer shell is also a hot performer. It features the tight fit provided by ratchet buckles, a side cant control to achieve a flat stance, and a forward lean control to adjust for comfort.



PM ILLUSTRATIONS BY DON MANNES



TINY TOWN, USA

Build our small-town country village and watch the kids smile.

BY AUGUST AND MICHAEL CAPOTOSTO

HERE'S YOUR CHANCE to be a hero with the kids. Order our easy-to-build plans and construct PM's small-scale country village. Make the toys from readily accessible materials such as pine, hardwood dowels and 1/4-in. birch or lauan plywood. Some parts can be found at craft shops or in woodworking supply catalogs. Keep in mind that some of the toys have small parts, and therefore, are not intended for use by infants or young children. Also, use only nontoxic paints and finishes.

The eight toy plans are sold individually, or in a cost-saving 4-plan set. The music-box mechanism used in the musical Santa Claus bank is available for \$4 postpaid from Armor Products, Box 445, East Northport, NY 11731.

How to order plans

The toy plans are available for \$6.95 each. Or, choose any four plans for \$24.95. The easy-to-follow plans provide full-size drawings, a complete materials list, and construction notes to help you through the cutting, assembling and finishing process. Send a check or money order along with the name of the toy plan to: POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101.

The Orient Express—All aboard! Includes two drawings for building the locomotive engine, passenger car, coal car and caboose. The 5-car train shown has two passenger cars and measures 7 ft. long. Get both drawings for \$6.95.

Pine Hollow Train Station—Quaint village train station comes complete with crossing signals. Detailed station features dormer with half-round window and clock-tower cupola. Station building measures about 12 in. deep x 14 in. high x 18 in. wide.



Circus Wagon—Wagon features wood-dowel bars through which you view a pair of ferocious lions. Drawing includes plans for building wagon, horses, lions and harness/hitch assembly. The overall size of the horse-drawn wagon is 6 in. wide \times 7 in. high \times 17 in. long.

The Ol' Barnyard—Charming farm set features a big red barn, silo, corral, tractor and six different animals. Barn measures about 9½ in. wide \times 10 in. high \times 12 in. long and has a hinged roof and two sliding doors.

Joe's Garage—Kiddie mechanics will love our country filling station. Plan shows how to build the garage, gas pumps, sign, roadster and working tow truck. Garage measures about 11 in. high \times 12 in. wide \times 18½ in. long.

Ladder Company No. 7—These brave firefighters are always ready for action. Full-size plan details the firehouse, 12-in.-long firetruck, ladder, firefighter, hydrant and even the trusty dalmatian. Firehouse is about 9½ in. deep \times 11½ in. high \times 17½ in. wide.

Pine Hollow Lumber—Well-stocked lumberyard will keep young contractors busy. Plan includes 2-story lumber shed, flatbed delivery truck and dimensional lumber. Lumber shed is 9½ in. deep \times 11½ in. high \times 17½ in. long.

Santa Claus Musical Bank—Put a coin in Santa's hand and watch him flip it into the bank. Falling coin activates an electronic music box that plays a charming melody. Santa stands about 12 in. tall. Bank-slot music-box mechanism must be purchased separately, from source mentioned earlier.

PM



MAKING TIME

Build this handsome cherry veneer mantle clock in just one weekend.

BY ROSARIO CAPOTOSTO, Contributing Editor

SOME HOME workshop projects are destined to become treasured family heirlooms. The traditional tambour-style mantle clock shown here is just such a piece. And best of all, we designed it so that even a novice woodworker can build it.

The clock case is constructed of $\frac{1}{4}$ -in. and $\frac{1}{2}$ -in. lauan plywood. To form the clock's curved top, we used a simple wood-bending technique called kerfing. That is, cutting a series of deep, closely spaced saw cuts, or kerfs, that allow the plywood to bend.

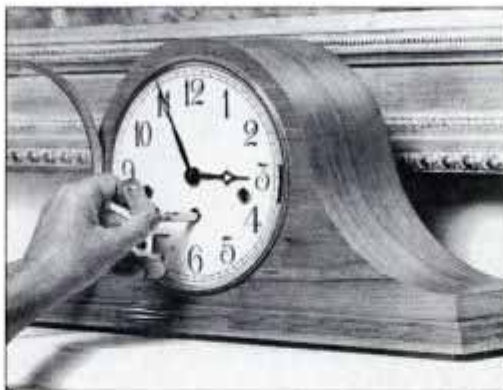
The assembled case is then covered with rich cherry veneer. To simplify the veneering process, we used adhesive-backed veneer. Simply peel off the protective backing and press the veneer in place.

A 2-ft.-wide \times 4-ft. sheet of peel-and-stick cherry veneer can be mail-ordered from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461 for \$29.95 postpaid.

The clock's mechanical movement, chimes, dial with glass cover, and other necessary hardware, was ordered from Craft Products, Box 326, Clintonville, WI 54929—a clock kit mail-order company. The key-wind, 8-day, German-made movement comes fully assembled and ready for installation. It features solid-brass construction and a choice of three different chimes. The complete clock-movement package (part No. 92755) is available from Craft Products for \$123.50 postpaid.

Case construction

Begin by cutting the $\frac{1}{2}$ -in. plywood top to the size given in the materials list. Note that the top is cut longer than needed and then trimmed after it's installed. Although we used lauan plywood, birch veneer or any other hardwood veneer plywood could also be used. Next, use a router or table



Tambour-style mantle clock has a key-wind, 8-day movement and choice of three chimes.

saw to cut a $\frac{1}{8}$ -in.-wide \times $\frac{3}{16}$ -in.-deep rabbet along both edges of the top (see drawing detail 2).

Move to the radial-arm saw to cut the kerfs. Raise the saw blade slightly and make a crosscut in a scrap piece of $\frac{1}{2}$ -in. plywood. Adjust the blade as needed until the kerf is about $\frac{1}{16}$ in. deep. Still working on the scrap piece, make about a dozen saw cuts spaced $\frac{1}{4}$

in. apart. Then, check the flexibility of the kerfed piece. If the plywood is difficult to bend, then the kerfs are not deep enough. If the piece bends, but small, flat ridges appear on the curved surface, then the kerfs are too deep. Readjust the blade and try again.

To ensure evenly spaced kerf cuts, drive a 6d common nail into the radial-arm saw fence to the right of the blade. Then, use the nail as an indexing pin to align each kerf cut (Photo 1). Now, with the saw blade adjusted properly and the indexing pin (nail) in place, kerf the clock top.

Next, cut the case front and back from $\frac{1}{4}$ -in. plywood. Using the drawing pattern as a guide, mark the curved shape on $\frac{1}{2}$ -in. grid paper. Then, use carbon paper to transfer the shape to the plywood (Photo 2). Cut both the front and back simultaneously using a band saw or sabre saw. Smooth the curved edges with 100-grit sandpaper. Rout a $\frac{1}{8}$ -in.-deep \times $\frac{3}{8}$ -in.-wide rabbet along the curved inside edges of both the front and back (Photo 3). These rabbets will join the rabbets cut in the edges of the top when the case is assembled.

Now use a sabre saw to make a $6\frac{1}{2}$ -in.-wide \times 7-in. cutout in the back panel for the round-top door. Also, bore the dial hole and key-wind holes and cut the chime bar slot in the front panel. Before assembling the case, glue two $\frac{1}{8}$ -in.-thick mounting strips to the inside of the case front.

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

MAKING TIME

Case assembly

Cut the base from 1/2-in. plywood. Then, glue and nail the front and back panels to the base with 1-in. brads. Next, use a small brush to apply glue to the rabbets along the edges of the kerfed top (Photo 4). Brush glue into the rabbets on the inside of the front and back panels, too. Then, install the top and secure it with six or seven short bar clamps (Photo 5). If you don't have enough clamps, use double-thickness masking tape. Allow for the glue to dry before proceeding.

Next, install 1/2-in. plywood blocks (Parts F) to close off the ends of the case. Use a router fitted with a flush trimming bit to trim the edges of the front and back panels flush with the top (Photo 6).

Then, make the rear, round-top door from two pieces of 1/4-in. ply-

wood. Note that the inside door panel (Part D) is smaller than the door in order to form a 1/4 x 3/8-in. rabbet.

Veneering the easy way

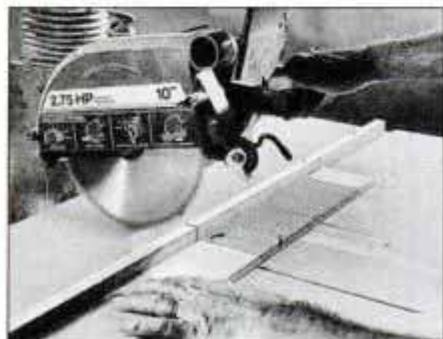
Begin by cutting veneer pieces to cover the case ends, top, front, back and outside door surface. Be sure to cut the pieces slightly oversize to permit final trimming after application. Although we used peel-and-stick veneer, you could also use standard veneer and apply it with contact cement.

Start by veneering the small ends of the case. Peel off the protective backing, press the veneer in place and rub it with a round-edged softwood block to ensure a strong bond. Carefully trim the excess veneer with a sharp utility knife and then sand the veneer edges flush with the case.

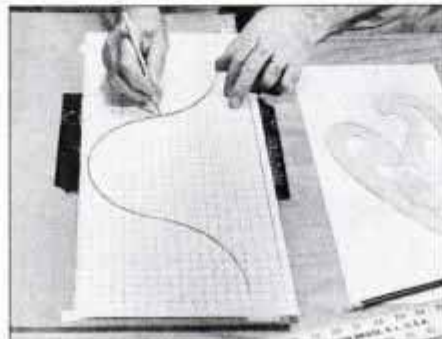
Next, apply veneer to the curved

top. Peel back only a couple of inches of the protective backing and lightly press the veneer in place. Then, slowly pull away the backing a few inches at a time and continue to press the veneer in place (Photo 7). Use a veneer roller, as shown in Photo 8, to press the veneer to the plywood case. Carefully trim the excess veneer and sand the edges as described above. Now use the same procedure to veneer the front, back and door. Use a sharp utility knife to trim the veneer from the holes and chime bar slot.

Mill the decorative molding (Parts J and K) from solid cherry stock. Shape the molding using a router fitted with a Roman ogee bit. The easiest way to mill the molding is to shape the edge of a cherry board that's at least 3 in. or 4 in. wide and then rip the molding from the board. An invisible fastening



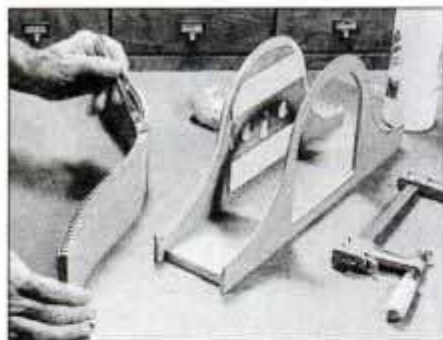
1 Kerf the top using a radial-arm saw. To space kerfs evenly, drive a nail in the fence to the right of blade for use as an indexing pin.



2 Draw a pattern of the clock's contour on 1/2-in. grid paper. Lay carbon paper under the pattern and trace it onto plywood.



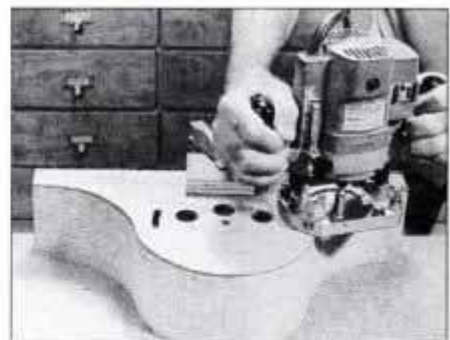
3 Rout a 1/8-in.-deep rabbet into the curved, inside edge of the front and back. Use a ball-bearing piloted 3/8-in. rabbeting bit.



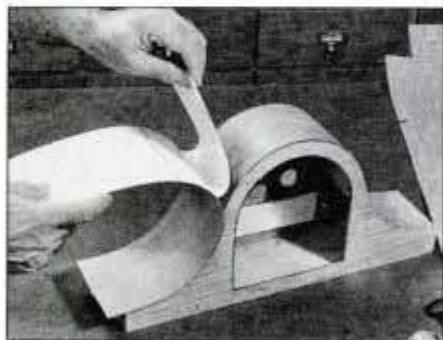
4 Apply carpenter's glue to kerfed edges of the top with a narrow brush. Apply glue to the rabbets cut in the front and back, too.



5 Secure the top between the front and back with several short bar clamps. Be sure that the top fits tightly into the rabbet joint.



6 Use a router fitted with a flush trimming bit to trim the overhanging edges of the front and back flush with the curved top.



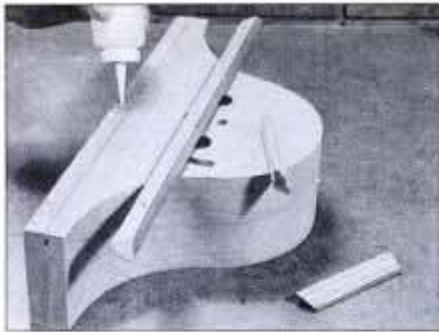
7 When veneering the top, peel off the protective backing a little at a time as you press the veneer to the plywood case.



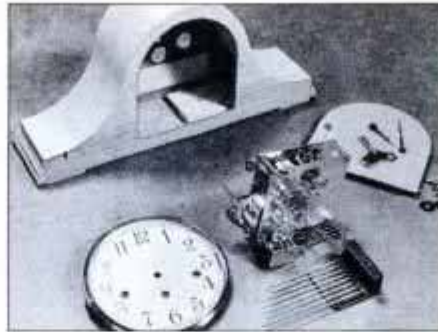
8 To ensure a strong bond, press down the veneer with a veneer roller. Then, trim off the excess veneer with a sharp utility knife.



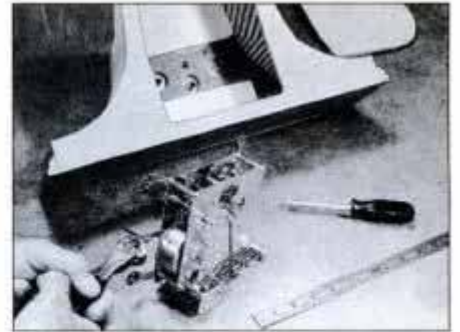
9 Remove backing on edge of veneer. Prop up veneer with a tape measure, align it exactly and peel off remainder of backing.



10 Shape solid cherry molding with a Roman ogee router bit. Glue on the front molding first and then add the two end pieces.



11 Clock kit components come ready for installation. They include dial with glass cover, solid-brass movement and chimes assembly.



12 In order for the movement to fit into the case, the chime selector lever must be shortened $\frac{3}{16}$ in. Use end nippers to trim the lever.

MANTLE CLOCK

5" DEEP x 9" HIGH x 19" WIDE

DETAIL 1

5/16" 1/16" 1/4" 1/8"

WIDTH OF SAW BLADE

DETAIL 2

5/16" 3/8" 3/16" 1/8"

FRONT/BACK—A

DETAIL 3 — CHIME BAR BOLT HOLES

6" 1-3/8" 1-1/16" 1-1/16" 1/4" DIA. HOLE (4 REQ.)

MATERIALS LIST—MANTLE CLOCK

Key No.	Size and description (use)
A	2 1/4 x 8 1/4 x 18" lauan plywood (front and back)
B	1 1/2 x 3 1/4 x 27" * lauan plywood (top)
C	1 1/4 x 7 x 7 1/2" lauan plywood (door)
D	1 1/4 x 6 1/4 x 6 1/4" lauan plywood (inside door panel)
E	1 1/2 x 3 1/4 x 17" lauan plywood (base)
F	2 1/2 x 1 x 3 3/4" lauan plywood (end block)
G	1 1/2 x 2 1/4 x 4 1/4" chime bar spacer block (hardwood)
H	2 1/2 x 1 1/4 x 6 1/4" plywood (mounting strips)
I	2 1/2 x 3 1/4 x 4 1/4" cherry (foot)
J	2 1/2 x 1 1/16 x 4 1/4" cherry (end molding)
K	1 1/2 x 1 1/16 x 19" cherry (front molding)

Misc: Carpenter's glue, cherry veneer, 1" brads, sandpaper, sanding sealer, satin-sheen finish.
 * Top is cut long and trimmed to fit after it's installed.

FRONT SECTION VIEW

6-1/2" WIDE x 7" CUTOUT IN BACK FOR DOOR

27/64" DIA. DIAL HOLE

4-1/16" RAD.

3/8" WIDE CHIME BAR SLOT

1" DIA. KEY/WIND HOLES

4-1/2" RAD.

1-9/16"

FRONT/BACK PATTERN

EACH SQUARE EQUALS 1/2"

MAKING TIME

technique, using blind brads, is used to apply the molding to the case. Snip off the heads of 1/2-in. brads, insert them into holes bored in the back of the molding—with their points protruding. Now apply glue to the case (Photo 10) and push molding in place.

Cut the feet (Part I) from solid cherry stock. Glue them in place and line the bottom surfaces with adhe-

sive-backed felt. Before installing the clock movement, finish the case with a coat of sanding sealer and three coats of a clear, satin-shen finish. We used Wood-Glo finish from Constantine's.

Movement installation

The fully assembled, triple-chime clock movement comes with detailed instructions that make installation

fairly easy. The movement is screwed to the mounting blocks on the inside of the case front. Glue a 3/8-in.-thick wood block (Part G) to the floor of the base to support the chimes.

The dial, with hinged glass cover, is secured to the front with brass escutcheon pins. Use the key to wind the clock and then set the chime selector. **PM**

Clock Kits: No Experience Necessary

ANYONE with a little time and patience can build a beautiful, accurate timepiece. You don't have to be a highly skilled craftsman, nor do you need an elaborate workshop full of expensive woodworking equipment. All you need is a kit clock.

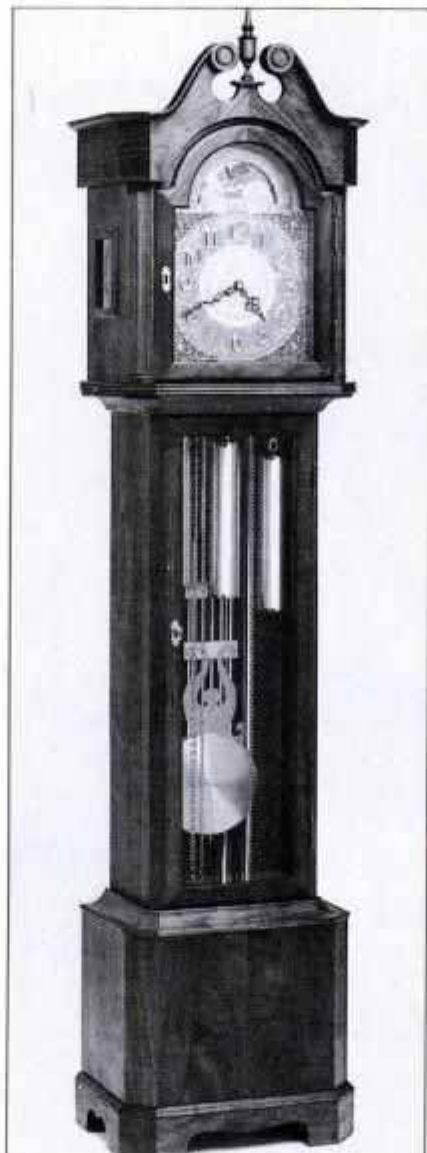
Today, there are several manufacturers selling clocks in do-it-yourself kit form. Each manufacturer offers a wide variety of clocks to satisfy all skill levels, budgets and tastes. Select from a simple 1-piece, ready-to-finish clock with an electric movement to an elegant, 7-ft.-tall grandfather's clock with precise solid-brass movement and rotating moon dial.

Note that manufacturers also sell weather instruments and musical jewelry boxes in kit form.

The most popular way to buy a clock kit is to order a pre-cut kit that comes complete with all the wood parts cut and ready for assembly. The kit also includes a fully assembled clock movement, dial, hardware, fasteners and

ready to try clockmaking, some kit manufacturers offer fully assembled, finished clocks in a wide variety of styles and wood finishes.

Listed below are brief descriptions of five major clock kit manufacturers.



Kuempel Chime Clock Works offers this beautiful Spirit of Peace grandfather clock kit in walnut, cherry or red oak.

Write to each and request a catalog—they're free except where noted. From the hundreds of do-it-yourself clock kits offered, there's sure to be a clock for you.—J. T.

Source List

■ **Craft Products**—Box 326, Clintonville, WI 54929. A 36-page catalog (\$2.50) that offers a full line of clock kits including grandfather, wall-hung and free-standing clocks. Also offered: clock movements and hardware, weather station instruments and music box kits.

■ **Emperor Clock Co.**—Emperor Industrial Park, Fairhope, AL 36532 (\$1). A good selection of grandfather clocks and movements and some traditional wall-hung and free-standing clock kits. The 40-page catalog also offers a line of kit furniture at affordable prices.

■ **Klockit**—Box 629, Lake Geneva, WI 53147. A popular 64-page catalog offering a few grandfather clocks and a full line of wall-hung and free-standing clocks. Also offered: an excellent selection of battery-operated quartz clock movements, various clock components, music box movements, woodworking tools and wooden toy kits.

■ **Kuempel Chime Clock Works**—21195 Minnetonka Blvd., Dept. PM88, Excelsior, MN 55331. An attractive 20-page catalog that specializes in beautiful, handcrafted grandfather clocks. Also offered: traditional wall-hung and free-standing parlor



Marquis clock from Emperor Clock Co. has beveled glass door and side panels, triple chime movement and brass dial.

finish. All you have to do is follow the manufacturer's assembly and finishing directions.

For those who wish to be more involved in the actual clockbuilding process, many kit manufacturers sell kits that include all the mechanical components and hardware required, but not the lumber. Or, order just the blueprints and build the clock from scratch.

For homeowners who aren't quite



Mason & Sullivan offers this unique mahogany scroll clock with a choice of traditional key-wind or quartz movement.

clocks, etched bronze dials and custom hand-painted moon wheels.

■ **Mason & Sullivan**—586 Higgins Crowell Rd., Dept. 1142, West Yarmouth, MA 02673. A 56-page catalog that offers an excellent variety of traditional and classic clock kits including cuckoo clocks. Check out the Shaker-design clocks and collection of clock kits from Holland. Also offered: music and jewelry box kits, weather instruments, quartz movements, finishing supplies and clock components and hardware.

IMPORTS '89



MITSUBISHI ECLIPSE

From East or West, thrifty or fast, there's a car from abroad to satisfy every driver.

BY TONY SWAN, Auto Editor, and LEN FRANK, West Coast Editor

AS CAR BUYERS, we're fortunate to live in the biggest market in the world. It means that we're offered an array of choices that's one of the most tempting anywhere. And the more models we see crowding into the marketplace—the escalation doesn't look to level out before the mid-'90s—the more it favors the buyer.

There are mitigating conditions, of course. The relationship of the dollar to foreign currencies has produced substantial price increases on the part of every importer represented here. Nevertheless, it's a buyer's market, with temptations unlike anything that's gone before. Between the imports and our own domestic manufacturers—a distinction that's increasingly vague—there's a car out there somewhere, at the right price, with the right stuff, for anyone. Whether you want pure transportation or pure fun, this is a

glittering inventory.

A word on window stickers. The chart near the end of this story was compiled before some importers had finalized their '89 pricing. As a result, some of the prices listed are estimates, either our own best guess or a number worked up in cooperation with the manufacturer. They are furnished as a guide, not gospel.

The Europeans

Although dedicated *Alfisti* might not feel particularly enthusiastic about Alfa Romeo's absorption by giant Fiat earlier this year, the merger means this perennially underfinanced concern will finally have the capital to pursue pet projects without worrying about money. However, while this assures the continued survival of one of Italy's oldest makes, it won't hasten the U.S. debut of the excellent 164 sedan, which has been pushed back to late next year. Alfa's offerings for '89 will continue to be the venerable Spyder, still a favorite with fresh air fanatics, and the Milano sedan series, both offered in several trim levels.

Aston Martin is another company that recently gave up its indepen-



**VOLKSWAGEN
CORRADO**

IMPORTS '89



PEUGEOT 405 Mi 16



JAGUAR XJ-S CONVERTIBLE

dence, in this case to Ford. What long-term effect this will have on this thoroughbred lineup isn't clear at this point, but the 1989 cars are essentially carryover, with a small (percentage-wise) price increase across the board.

Meanwhile, Audi continues its comeback with an evolutionary update on the 5000 sedan series. As with the 80/90 cars, introduced last year, the new line has a European designation—100/200. And even though the shapes will be familiar to most, Audi has made a number of changes to interior design and has also installed the new TORSEN torque-sensing center differential on all-wheel-drive editions. The focal point of the interior redesign is a handsome wraparound instrument binnacle similar in concept to the 80/90.

While the 100/200 update makes the top-of-the-line Audi available here for the first time—pending the arrival of the new V8 edition—it also propels the series even further up the price ladder. The flagship 200 Quattro now carries a suggested retail of over \$36,000.

Following up on the successful launch of its superluxury 7-series sedans last year, BMW has re-engineered the middle of its lineup. The new 5-series sedans—525i and 535i—have all-new exteriors, al-

though the changes, which include small increases in length and width, are difficult to perceive unless the cars are parked next to their predecessors. The BMW engineers have also been busy under the sleek new surfaces, refining suspension elements and coaxing a bit more horsepower from the 6-cylinder engines: 170 for the 2.5-liter 525, 211 hp for



SUBARU JUSTY CVT

the formidable 3.5-liter 535i.

The 525i replaces the anemic 528e. Elsewhere, the L6 (for Luxury) version of the 6-series coupe has become the 635 CSi once again, and a long-wheelbase "L" model has been added to the 735i range.

Besides its Mitsubishi-built models, Chrysler will offer two European cars in 1989, one French, one Italian.

On-sale timing for the TC by Maserati, which has had plenty of U.S. exposure already, remains uncertain at press time. The Renault Medallion, imported under the new Eagle banner, is unchanged from 1988. Although this car has become something of an orphan, Chrysler officials insist there are "no current plans to discontinue" it.

Although the news is academic, since this car is already back-ordered, Ferrari plans to import its outrageous F40 in 1989. A thinly disguised racer, the F40 has the distinction of being the fastest production car on Earth, with a top speed in excess of 200 mph. The price is also stratospheric, with estimates for a U.S. model running upward of \$250,000.

Ford's Euro lineup will continue to be a gang of two, although the obscure Merkur brand name has quietly been consigned to history.

Aside from the badge removal job, both the XR4Ti sports coupe and Scorpio luxury sedan are essentially unchanged from '88.

In contrast to the F40, Jaguar's handsome XJ-S Cabriolet seems a veritable bargain at \$56,000. While this car has been available in the U.S. for over a year as an aftermarket conversion, Jaguar has taken production in-house for 1989.

Lamborghini heads into yet another season with its evergreen Countach—the only change is a small upward revision in price—while Lotus carries on with its handsome Esprit Turbo, also unchanged after last year's redesign.



NISSAN MAXIMA

NISSAN 240SX



Maserati's '89s went on sale Oct. 1, when the company met federal safety standards by installing passive belts in 40 percent of its cars. So, step right up—the 430, with its 2.6 V6, is now here in numbers.

Although the 190 series has undergone minor revisions, including the elimination of all gasoline-powered 4-cylinder engines, Mercedes-Benz is saving its big news for late in the year when the long-awaited 560SL replacement will finally make its appearance. The new roadster is scheduled to debut at the Geneva Auto Show, in March.

In the meantime, elimination of the Mercedes 2.3-liter Four means that all 190-series sedans will have either a 2.6-liter Six or M-B's 2.5-liter diesel. The latter is the only oil-burner left in a lineup that was 80-percent diesel during the fuel crises.

After years of pleading, Peugeot dealers are finally getting a hot new model to brighten up their showrooms. The new front-wheel-drive 405 sedan series, dubbed European Car of the Year in '88, is already on sale, with prices ranging from \$14,500 for the basic DL to \$20,700 for the dohc 16-valve Mi 16. Although the Mi 16 is the hot rod of the family, with 150 hp on tap, all models sport independent suspension, power rack-and-pinion steering and 4-wheel disc brakes.

Peugeot's 505 sedan series, including three powertrains and two different wagons, one of them capable of swallowing eight passengers, continues largely unchanged, save for the availability of the new TORSEN limited-slip differential.

While the basic models are familiar, Porsche has added some new variations for 1989, along with eye-widening price increases. Zuffenhausen has added a soft-top version of the 944, a 4-wheel-drive edition of the immortal 911 and the Speedster revival, another 911 variant. Established models should be available right now, the newcomers sometime after the first of the year.

Speaking of prices, Rolls-Royce has yielded the absolute high end to Ferrari, but a couple models are crowding the \$200,000 barrier quite closely.

New for '89, and reportedly sold out prior to the start of production, is the Bentley Turbo R, a 2.75-ton behemoth that is nevertheless capable of 140 mph, with handling to match its high-speed performance.

Sterling's sedan offerings will be enhanced by the addition of the 2.7-liter 16-valve Four that first appeared in certain Acura Legend models,

tion of performance—it's capable of topping 140 mph—and price should help to lend a little spice to the VW showrooms.

VW's Quantum line of sedans and wagons will also disappear for '89, in anticipation of the mid-year introduction of the new Passat.

Volvo's lineup looks about the same as it has the past few years, save for



while Saab will offer a notchback version (CD) of the 9000 4-door liftback.

One of the most interesting European imports for '89 belongs to Volkswagen. Although it's not in the same price bracket, VW's new front-wheel-drive supercharged Corrado sports coupe is essentially a replacement for the Scirocco, which disappears from the lineup. The Corrado's combina-

tion of performance—it's capable of topping 140 mph—and price should help to lend a little spice to the VW showrooms.

Finally, there's Yugo. The much-modified former Fiat has soared above the \$4000 mark for 1989, though not by much.

New for '89 is a Cabriolet version, which is about twice the price of the basic transportation special.—T.S.



IMPORTS '89

Cars of the Far East

For 1989, the Acura Legend sedan gets subtly revised sheetmetal, and the coupe rear suspension (double wishbone) and the 2.7-liter engine (sohc V6 24-valve) become standard. A new alloy wheel, new taillight design on the sedan and new badging for both coupe and the sedan help ID the '89. A V8 version of the Legend is rumored for the near future.

The Integra continues with no changes—a sure tipoff that a mid-year model will be introduced, certainly as a 1990.

Chevrolet's Geo nameplate separates the imports from domestics. Not every Chevy dealer will handle the Geo cars: Metro, Spectrum, Tracker and Prizm. Metro, by Suzuki, replaces the Sprint. Still with the 1.0-liter 3-cylinder 48-hp engine, it

BMW 535i



bishi products since 1972. For '89, Plymouth and Dodge share the Mitsu Mirage line from the economy-oriented Colt to the E, GT, through the DOHC 16V Turbo all in the new hatchback body. All are fwd with styling somewhat like the successful Honda Civic Hatchback. The first three share the use of the 1.5-liter

be sold by Chrysler dealers.

The 1.0-liter, 3-cylinder Daihatsu is available in three trim levels: CES, CLS, CLX. A turbo and an automatic may be added later. The CES has a \$502 lower list price than last year, and the CLX \$153 lower. Standard wheels/tires grow to 155/13.

Ford brings the Festiva in from Korea—it's a Mazda 121. It gets a multiport EFI with automatic transmission. The Mercury Tracer is a version of the Mazda 323 built in Mexico and is a carryover for '89.

Honda's full Civic line was new for 1988, so 1989 brings only one new model—the Hatchback Si, virtually a 4-seat CRX. For '89 both the HB Si and CRX Si get the sohc 16-valve engine, now up from 105 hp to 108. Gas shocks are now standard on both with the HB Si getting front and rear anti-roll bars, body-colored bumpers, electric moon roof, chin spoiler and CRX-sized 185/60R14 Michelins. The CRX gets a passive door-mounted seatbelt system similar to Prelude's.

The Civic 4wd wagon gets an automatic transmission for the first time, while the unique 6-speed manual continues to be available. Larger, all-weather tires are now standard. The latest Accord 4-door is the SEi with standard leather, 4-wheel disc brakes, bronze-tinted glass, special alloy wheels, reshaped seats and a Honda-BOSE stereo. The Prelude Si, Honda's 4-wheel-steering model, gets a new rear wing spoiler. The Prelude S with auto gets the sports-mode control on the shift.

Hyundai's big news is the Sonata, a



SAAB 9000 CD

continues with two bodies—3- and 5-door—and 5-speed manual and automatic transmissions. Spectrum is the Isuzu-built version of the I-Mark with 1.5-liter Four, fwd, in 3-door and 4-door notchback models. Tracker is a 1.6-liter, 97-hp sports/utility 4wd from Suzuki that's larger than the Samurai and smaller than the S-10 Blazer. Prizm is from NUMMI, the GM/Toyota operation in California and is closely related to the new Toyota Corolla. It uses a dohc 4-cylinder engine with 102 hp at 5800 rpm. Four-door notchback sedan and 5-door hatchback models are available.

Chrysler has been importing Mitsu-

multipoint f.i. Four, while the DOHC Turbo 16V is an option in the GT. Automatic is available only as an option in the GT. Also available are the Colt DL and DL with 4wd in station wagon body, the Vista sedan-wagon with and without 4wd. The 4wd models use viscous coupling for full-time use, and a 1.8-liter transverse Four. Eagle calls the Mirage 4-door by the name Summit, which is available in three trim levels, with the 16-valve Four as an option on the LX version. The Summit will eventually be built in Illinois by Diamond-Star Motors. The Conquest TSi, a.k.a. Starion, has been further refined and continues to



AUDI 100 WAGON



SUBARU
TOURING WAGON

PORSCHE 911 CLUB SPORT



new fwd, transverse-engined car with 110-hp, 2.4-liter sohc Mitsubishi-designed engine. Larger powerplants (Mitsu V6 most likely) are coming in the near future. Transmissions are 5-speed manual and 4-speed automatic. The Sonata will be available initially only as a 4-door in GL/GLS trim levels. Styling began with Ital Design (Giugiaro) and was finished at Hyundai. The promise is a new car every year for the next four years, at least, including a sports car.

Hyundai intends to position the Sonata as a Honda Accord competitor, and the new car will roll out with attractive pricing.

The Isuzu I-Mark Lotus turbo, introduced mid-'88, didn't have the major suspension mods made to the Impulse. Instead, tires (RE88 Bridgestones 185/60R14) and fine tuning of the fwd I-Mark's front MacPherson struts and rear trailing link, twist-crank rear axle through the usual medium of shocks, bars, springs and bushings, transformed the turbo into a wonderful handling but rather underpowered package.

For '89, the 1500-cc 110-hp turbo has been replaced with a 1600-cc 16-valve screamer pulling 125 hp at 6800 rpm (102 lb.-ft. of torque at 5400), and the car becomes the I-Mark RS DOHC. This engine is available in either the hatchback or the 4-door notchback sedan with Lotus suspension. Sometime at mid-year Isuzu will introduce a truck-based sport/utility called Amigo.

The latest Mazda is its first entry in the minivan category. The rear-drive

MPV (Multi Purpose Vehicle) is offered in three versions: 5- and 7-passenger configurations and a commercial setup. A brand-new 4-cylinder engine (2.6-liter, 3-valve-per-cylinder) provides great low- and mid-range torque—149 lb.-ft. at 3500 rpm—only 16 less than the larger optional V6 (a version of the V6 used in

mechanically similar—but sportier—MX-6 GT Turbo Coupe. The MX-6 shares the same floorpan as Ford's hot-selling new Probe.

Mitsubishi's newest for '89 is the 1990 Eclipse which arrives next month. It's manufactured by Diamond-Star Motors, in partnership with Chrysler in Illinois. Mitsu sees



**BENTLEY
TURBO R**

the luxury 929), and at a 500-rpm lower engine speed. This engine is also slated for availability in Mazda's new pickup truck when production increases.

The MPV has a C_d of 0.36, a hinged rather than a sliding door on the passenger side, and the promise of 4wd mid-year.

The RX-7 for '89 has increased power, slight sheetmetal changes and improvements to suspension and shift linkage. Development continues on a 3-rotor engine.

The 4-wheel-steering option on the 626 Turbo has been switched to the

the new coupe as a competitor for everything between the CRX and RX-7 Turbo, with emphasis on the Ford Probe. Four levels are available: Standard, GS, GS DOHC and GS DOHC Turbo. A prototype roadster has been shown. The low C_d (between 0.294 and 0.331) fastback 2+2 is based on the brand-new Galant with front drive. Standard model has a 1.8-liter sohc 8-valve with balance shafts and 90 hp. A 2-liter intercooled turbo version (dohc, 16-valves) comes in at 190 hp, with the dohc 16-valve normally aspirated version capable of producing 135 hp.



**ISUZU
I-MARK**



MAZDA MPV

IMPORTS '89



GEO TRACKER



MITSUBISHI MIRAGE

The Galant sedan is available with sohc (102 hp) and dohc (135 hp) 2-liter engines. Transmissions are 5-speed manual and multiprogram 4-speed automatics. Front drive with optional electronically controlled air suspension (coils with auxiliary air springs, antiroll, antidive-variable rate, 3-position shocks). MacPherson struts are used in the front and beam axle rear. If that's not enough, 4-wheel drive and turbo are in the future.

The Mirage was all new mid-year so it continues into calendar year '89 without change. The short-wheelbase hatchback is available with f.i. 135-hp 16-valve 1.6 turbo with dohc, or a sohc

1.5-liter coupled to a standard automatic 3-speed.

Mirage 4-doors use the longer wheelbase, manual or automatics, and the 81-hp, 1.5 sohc Four.

The sedan will be the next product of Diamond-Star.

Dimensionally bigger than the old Mirage line, the new car will also take the place of Mitsubishi's Cordia and Tredia models, which have been dropped for 1989.

The front-drive Sigma, formerly Galant Sigma, is largely unchanged, though it is now positioned more as a luxury entry, opposing cars like the Toyota Cressida and Nissan Maxima.

A completely new replacement may appear during calendar year '89.

The 188-hp, 2.6-liter sohc turbo-intercooled Starion will be available in what was the premium ESI-R version. There is an optional Sports Handling package with 225/50 tires front and 245/45 rear, on 8x16- and 9x16-in. alloy wheels and manually adjustable 8-position shocks. It's the oldest car in the Mitsubishi line and is expected to be replaced by a new dual-turbo V6 coupe, possibly with 4wd and certainly with ultrasophisticated electronic everything else.

Nissan has a new Maxima, a new 240SX and a new engine for the Pul-

1989 IMPORT CAR PRICES*

ACURA

Integra	\$11,600
Legend Sedan	22,500
Legend Coupe	25,000

ALFA ROMEO

Spyder Graduate	\$16,900
Spyder Quadrifoglio	23,800
Milano Gold 2.5	18,600
Milano Verde 3.0	23,000

ASTON MARTIN

V8 Coupe	\$144,000**
Vantage Coupe	160,000**
Volante	170,000**
Lagonda	189,500**

AUDI

80	\$19,158
80 Quattro	23,381
90	25,060
90 Quattro	28,551
100E	24,980
100	27,980
100 Wagon	28,960
100 Quattro	30,805
200	32,455
200 Wagon	37,855
200 Quattro	36,355

BMW

325i	\$24,650
325is	28,950

325i Cabriolet	33,850
325iX	29,950
M3	34,950
525i	37,000**
535i	44,650**
635 CSi	47,850
M6	58,200
735i	54,850
735iL	59,050
750iL	71,850

CHEVROLET

Geo Metro	\$5790**
Geo Spectrum	7300**
Geo Prizm	9000**
Geo Tracker	10,195

CHRYSLER

Colt	\$6717
Colt GT	8860
Colt Turbo	11,597
Colt Vista	11,773
Colt Vista 4wd	13,083
Conquest TSi	19,229
Eagle Medallion DL	10,405**
Eagle Medallion Wagon	11,649**
Eagle Summit	9084**
TC by Maserati	30,000**

DAIHATSU

Charade	\$6197
Charade CLX Turbo	10,497

FERRARI

328 GTB	\$75,000**
328 GTS	80,000**
Mondial 3.2	77,000**
Mondial 3.2 Cabriolet	85,000**
Testarossa	135,000**
F40	250,000**

FORD

Festiva	\$5699
Mercury Tracer	8556
XR4Ti	19,759
Scorpio	25,052

HONDA

Civic	\$6385**
Civic Si	9980**
Civic Wagon 4wd	12,210**
CRX	9310**
CRX Si	10,930**
Prelude	13,945
Prelude Si 4ws	18,450
Accord	11,230**

HYUNDAI

Excel 3-door	\$5499
Sonata	9950

ISUZU

I-Mark	\$7779
I-Mark RX Twincam	9359
I-Mark Turbo LS	11,369
Impulse	14,329
Impulse Turbo	16,329

JAGUAR

XJ6	\$43,500
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XJ6 Vanden Plas	47,500
XJ-S	47,000
XJ-S Convertible	56,000

LAMBORGHINI

Countach 5000S	\$145,500
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LOTUS

Esprit Turbo	\$67,500
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MASERATI

Spyder	\$44,500**
228	52,500**
430	43,500**

MAZDA

323	\$6299
323 GTX Turbo (4wd)	12,999
626 DX	11,299
626 Turbo	15,049
MX-6	11,399
MX-6 GT 4ws	16,699
RX-7	16,600**
RX-7 Convertible	22,200**
RX-7 Turbo	23,400**
929	21,290
MPV 5-passenger	12,909

MERCEDES-BENZ

190D 2.5	\$30,700**
190E 2.6	34,000**
260E	39,750**
300E	45,500**
300CE	54,700**
300SE	51,800**
300TE Wagon	49,600**
300SEL	55,475**

* Prices in effect Oct. 1, 1988

** Estimated price

IMPORTS '89



**MERCEDES
190E**



**YUGO G1V
CONVERTIBLE**

sar. The Maxima is still 3.0-liter V6-powered, but with more punch, and it still has front drive, but with an improved suspension, optional ABS, optional Sonar II suspension, optional head-up display instrumentation, antilock, antiyaw braking (w/ABS), struts at all four corners, the rears controlled by parallel links. There's more interior space, longer wheelbase, wider, better aero than '88. Models are GXE (Luxo) and SE (Sports). This is the biggest car ever imported by Nissan.

Although the Pulsar's new 1.5-liter 12-valve Four has the same displacement as the sohc 4-banger it replaces,

the architecture is new and so is the output, which jumps 21 percent to 90 hp. This same engine will also lend a little more oomph to the modest little Sentra, which gets a new nose for '89.

The top-of-the-line Pulsar SE still gets the 113-hp dohc 1.6-liter Four. The nifty SportBak option has been dropped.

The 240SX is a completely new car, replacing the 200SX. It'll compete with Probe and Prelude. It has front engine, rear drive, fully independent suspension, multilinks rear and struts front. Engine is new 2.4-liter 4-cylinder, 12-valve sohc engine (140 hp at 5600 rpm, 152 lb.-ft. at 4400). Notch-

back XE and fastback SE are the two models. The XE has HUD available, 4-wheel discs. The replacement for the unloved Stanza wagon appears mid-year, and meanwhile Nissan has discontinued the Stanza wagon to make room.

Pontiac continues to import the Opel built by Daewoo in Korea and known as the LeMans. At the bottom of the line is the Aerocoupe value leader, then the LE Aerocoupe, LE Sedan, SE Sedan and the GSE Aerocoupe. All are fuel-injected, transverse-engined fwd, with strut front suspension and semi-independent

(Please turn to page 111)

420SEL	61,600**
560SEL	73,000**
560SEC	80,500**
560SL	65,000**

MITSUBISHI

Eclipse	\$10,500**
Eclipse Turbo	14,500**
Precis	5395
Mirage	8859
Mirage Turbo	11,969
Starion ESI-R	19,859
Galant	10,971
Sigma	17,069
Wagon/Van	14,269

NISSAN

Sentra	\$6900**
Sentra Wagon	10,000**
Sentra Wagon 4wd	11,300**
Stanza	11,800**
Pulsar NX	12,100**
Pulsar NX SE	13,300**
Van	15,200**
240SX	12,999
Maxima	17,500**
300ZX	22,300**
300ZX Turbo	24,800**

PEUGEOT

405 DL	\$14,500
405 S	17,700
405 Mi 16	20,700
505S 2.2	19,295
505S V6	21,435

505 Turbo	26,335
505 DL Wagon	17,590
505 Turbo Wagon	25,540

PONTIAC

LeMans Aerocoupe	\$6714
LeMans Sedan	8314

PORSCHE

944	\$36,360
944 S2	45,285
944 S2 Cabriolet	52,650
944 Turbo	47,600
911 Carrera	51,205
911 Carrera 4 (4wd)	69,500
911 Speedster	65,480
911 Cabriolet	59,200
911 Targa	52,435
911 Targa Turbo	77,065
911 Turbo Coupe	70,975
911 Turbo Cabriolet	85,060
928S 4	74,545

ROLLS-ROYCE

Bentley Continental	\$199,000
Bentley Eight	107,000
Bentley Turbo R	145,000
Bentley Mulsanne S	117,000
Silver Spirit	127,000
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Corniche II	199,500

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900S	19,695
900 Turbo	23,795

900 Turbo Convertible	32,095
9000S	24,445
9000 Turbo	30,795
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GL Sedan 4wd	12,221
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GL Hatchback 4wd	12,521
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XT GL	13,071
XT6	17,111
XT6 4wd	17,951

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Sidekick	8995

TOYOTA

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Camry Wagon	13,018
Corolla Deluxe	9198
Corolla SR5	10,628
Corolla All-Trac Wagon	11,498

Cressida	21,498
MR2	13,798
MR2 Supercharged	17,628
Celica ST	11,808
Celica GT Convertible	18,318
Celica GT-S	15,388
Passenger Van	13,608
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Golf	8465
GTI 16v	13,650
Jetta	9690
Jetta GLI 16v	14,770
Vanagon GL	17,035
Vanagon Syncro	20,560

VOLVO

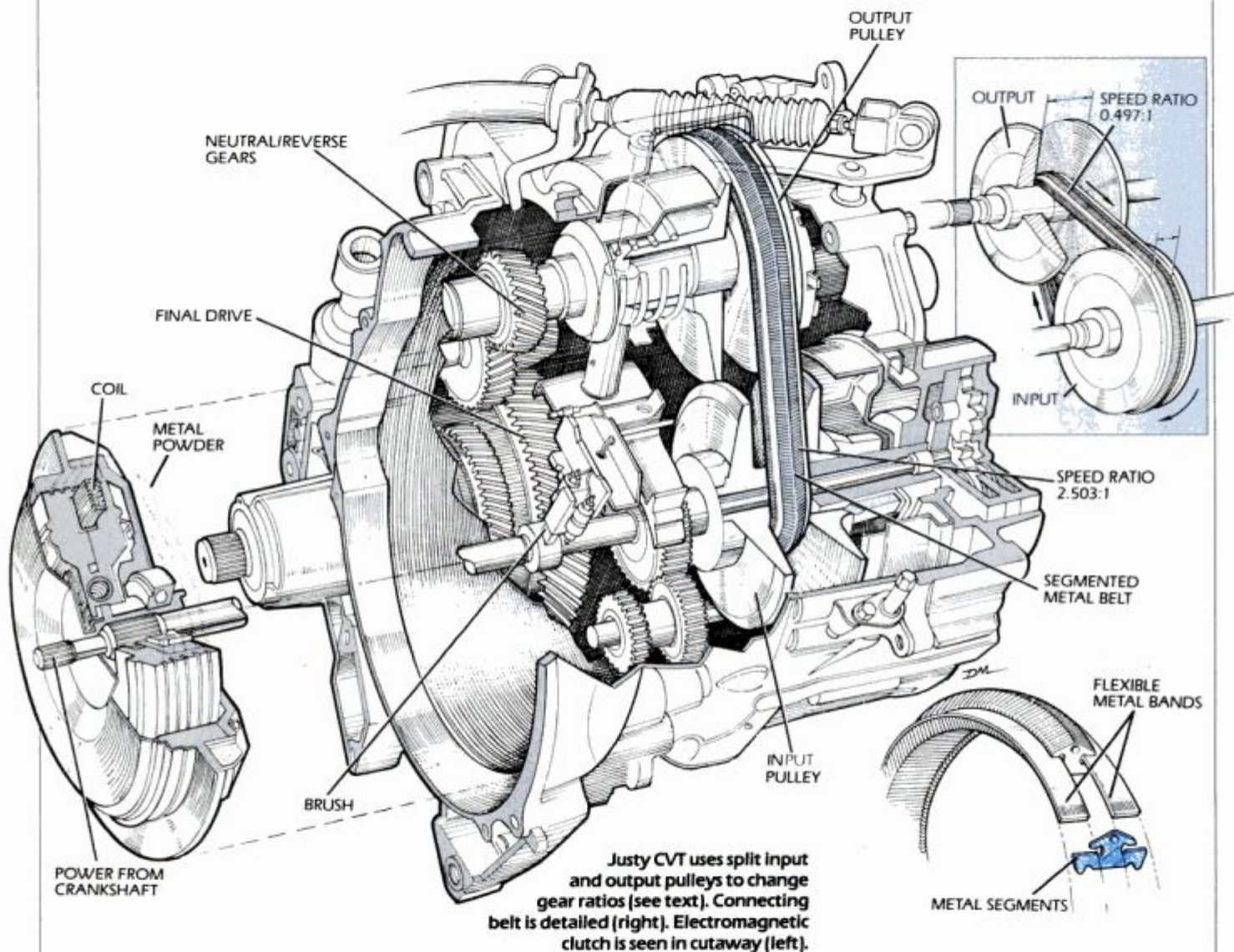
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740 GL	19,800
740 GLE 16v	22,000**
740 Turbo	24,925
740 GLE Wagon	23,500
740 Turbo Wagon	25,605
760 GLE	32,155
760 GLE Turbo	32,940
780 Coupe	39,880

YUGO

GV	\$4480**
GVT Convertible	8300**

TECH REVIEW

Subaru's Justy takes the spotlight with the first constantly variable transmission in the U.S.



SUBARU has scored the '89 technology coup, with the first continuously variable transaxle (CVT) sold in America.

The CVT in the Justy doesn't shift gears, but continuously changes ratios. It's an automatic that can out-accelerate or out-economize an expertly driven manual. It dates to the 1959 rear-drive Dutch Daf (now Volvo), but only the shifting principles are similar: There's a pulley at the end of the input shaft from the engine and a second pulley at the end of the output shaft to the wheels, and there's a met-

al belt around these two pulleys.

The input and output pulleys are split, so the halves move apart or are pushed together (by oil pressure). When accelerating from a stop, the input pulley halves are apart and the belt rides near the center. The output pulley halves are forced together by input pulley tension on the steel belt, so the belt rides near outer edge (see illustration above). The effect: a small input pulley driving a large output pulley, equal to a small gear driving a large gear, for a low gear ratio—2.503:1, in this case.

As road speed increases, hydraulic pressure holding the input pulley halves apart is reduced, so the pressure on the output pulley halves partly overcomes it. The input pulley halves close up and the output pulley halves spread. This shiftlessly reverses the situation, increasing the effective diameter of the input and decreasing that of the output, so the differences in diameter gradually narrow and eventually switch. When the output is smaller than the input, the transmission is in overdrive—a ratio of 0.497:1 is shown in the inset above.

Dependability:



Profile in quality #9. For the 8th year in a row owners of Ford Motor Company cars and trucks have reported fewer problems, on average, than owners of any other vehicles designed and built in North America.* And this dependability is backed by Ford with a 6 year/60,000 mile powertrain warranty on all Lincoln, Mercury and Ford cars and light trucks.**



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NEW BREAKTHROUGH

Girl Watching Glasses

*It's not really X-ray vision
but get ready for the next best thing.
Amazing new sunglass concept.*

You can't see the eyes of the wearer.



By Joseph Sugarman

What you are about to read is a major new design change in sunglasses—one so different that there is nothing like it anywhere.

What if you had eyes in the back of your head? Just imagine the fun and even the safety you would enjoy. Well, we've got the next best thing.

THREE NEW FEATURES

They're called RearVision™ sunglasses and they let you actually see behind your back. First, the lenses are flat not curved like other sunglasses. Second, RearVisions have a reflective mirror coating not only on the outside like many pairs but on the inside too. Finally, RearVision™ sunglasses are wider than other sunglasses.

The three design features (patent pending) combine to produce a pair of sunglasses that let you view other people (without them knowing it) no matter if they're at the side of you, in front or even behind you. Here's how.

EYES BEHIND HEAD

The special lens is wider than your face and angled slightly. By turning your head slightly to the right or left and glancing to the edge of the frame, you see the scene behind you. It's like having rear view mirrors or even eyes behind your head. But there's more.

The front mirror coating reflects light like a mirror so it doesn't let anybody see your eyes to tell who you're looking at.

For girl or boy watching, the RearVisions are ideal. That might seem

obvious. But think of the sunglasses as a great security device and a great pair to wear while riding a bicycle. Teachers can keep an eye on their class while they write on a blackboard. And back seat drivers can feel a lot less tense.

But for watching the opposite sex it's the ultimate pair. Guys can keep an eye on a lovely lady long after she passes and a girl can see which guys turn their heads after she passes. RearVision™ sunglasses have a few more great features.

ADDED SAFETY

The lenses have the popular BluStar™ coating which helps reduce glare and filters out the dangerous ultra violet light. You get added safety for your eyes as well as the latest in lens design and technology.

Finally, the lenses are scratch resistant Delstar™ designed to give you years of use. But if you ever damage your sunglasses, no problem. The manufacturer will replace a pair for simply a small postage and handling charge for a period of three full years during their 3-year limited warranty.

AS AN EXTRA PAIR

If you already own a pair of sunglasses, you'll enjoy a pair of RearVisions as an extra pair. There's simply nothing like them. Use them for security, for sports or for girl or boy watching. Take them to the beach, ski or take a bike ride. Or simply amaze your friends. The sunglasses come in either cool matte black or bright glossy white.

Each pair weighs only 1½ ounces, measures approximately 6" wide and comes complete with a free carrying case and 3-year hassle-free limited warranty. And, if for any reason, you are not completely satisfied with your pair, simply return them anytime within 30 days for a prompt and courteous refund.

RearVisions are manufactured by Nubaloo™, a division of BluBlocker® Corporation—one of America's most innovative and creative sunglass companies.

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The clutch arrangement uses an electromagnet with grooves filled with metal powder. As the driver steps on the gas pedal, a computer sends a low burst of current to partly engage the clutch, and as the pressure on the pedal increases, clutch engagement is correspondingly increased.

The original van Doorne design used a 30,000-mile rubber belt, compared with today's lifetime steel belt. The Dutch developed the steel belt, but when plant delays held up the original production schedule, Subaru sent engineering staff members to help in exchange for guarantees of initial production. Several other manufacturers are still clamoring for belts for their vehicles.

engagement for 2wd. The '88 Corolla 4wd has a simpler version of this system, but without the sensors-into-computer controls.

The Supra has a novel approach to decreasing power steering assist with increasing road speed. Instead of fluid bleeds and flow control valves to reduce assist, a hydraulic reaction chamber under the control valve in the steering box adds resistance.

In this chamber are pairs of pistons that exert opposing pressure against a lever on the end of the control valve. The opposing pressure is determined by a partial power steering pump fluid flow to the reaction chamber, which is controlled by a computer-operated duty-cycle solenoid valve (it flutters

digging ice out of the recess to free up the wipers.

Nissan

Putting butterfly plates in the intake manifold and cylinder head isn't new, but everyone else uses them as secondary (or tertiary) throttles. Nissan has a couple of novel new uses.

The 3.0-liter V6 in the new Maxima has a dual-plenum intake manifold and it's designed for good low-end performance. At higher rpm, however, airflow is out of sync with the opening and closing of the valves, so there are feedback disturbances that actually impede airflow and, therefore, high-speed performance.

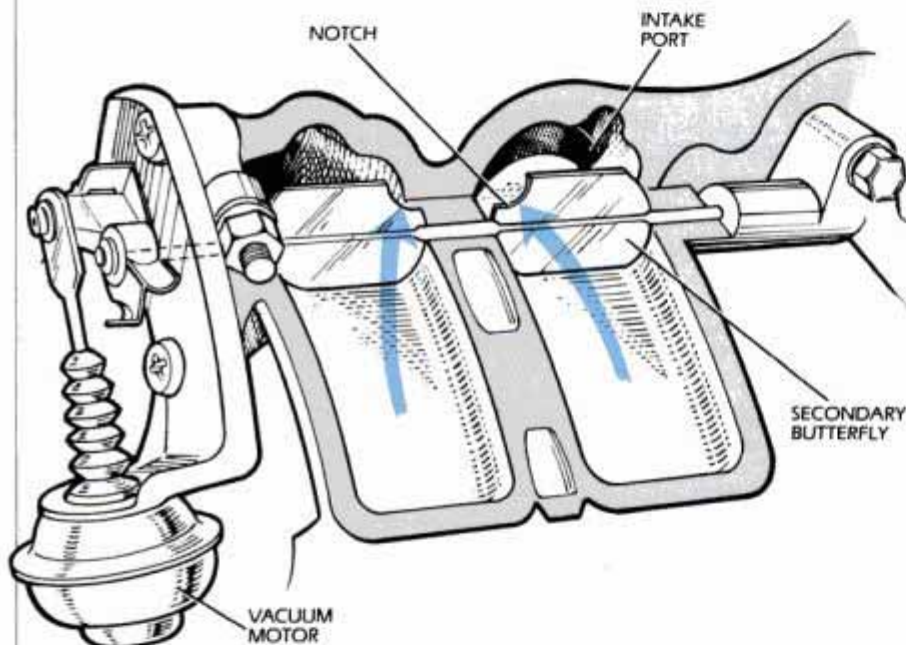
Nissan's answer is a butterfly plate (controlled by a vacuum diaphragm unit) in the common wall between the two plenums, and at 3200 to 3500 rpm (depending on readings from the throttle position sensor), the engine computer triggers a solenoid vacuum valve that operates the diaphragm unit to open the butterfly, balancing pressures between the plenums.

The 2.4-liter 3-valve 4-cylinder in the new 240SX has a notched butterfly plate in each intake runner, with all four butterflies on a shaft controlled by a vacuum diaphragm (see Fig. 1).

At idle, the butterfly is closed so only a narrow air stream gets through, and only at a particular location, where it flows through the intake port to create a swirl through the two intake valves to the combustion chamber. Swirl promotes good air mixing with injected fuel, for more complete combustion and smooth idle. At 1000 rpm the engine computer triggers a solenoid valve and the butterflies pop open, leaving wide-open aerodynamic ports for maximum airflow and good performance—140 horsepower at 5600 and 152 lb.-ft. of torque at 4400 rpm.

The new 240SX, a rear-drive, has an advanced 4-link independent rear suspension, to go with its strut-type front. There's a wishbone-type lower arm, two upper arms and a lateral link that connects the wheel spindle to a subframe. The lateral link resembles the toe link Ford uses on its '89 Thunderbird, to force the rear wheels to toe-in on braking, overcoming oversteer in hard cornering.

Nissan gets more uniform toe-in by splitting what could be a single upper arm into two arms with different pivot points. These multilink designs, of which you'll be seeing more, permit use of some softer bushings to reduce suspension harshness.



1 Notch in 240SX's computer-controlled secondary throttle aids low-rpm turbulence. Engine computer signals vacuum motor to close secondary throttles at idle.

Toyota

Toyota's go-slow-on-technology reputation surely doesn't apply to multi-valve engines. The last 2-valve, in the Cressida, is replaced by the Supra's 4-valve-per-cylinder in-line Six.

Toyota also picked up an expensive 4-wheel-drive design feature from Porsche: a computer-controlled center differential to vary the torque-split between the front and rear wheels. The most sophisticated Toyota version, on the 1989 4wd Camry, transmits sensor inputs from vehicle speed, rear-wheel speed, throttle position and the antilock braking computer to the transmission computer. It controls solenoid valves that regulate hydraulic pressure to the center differential's hydraulic clutch, to manage the torque split. And of course, there's manual disen-

to maintain a desired fluid flow, much like a carburetor feedback solenoid). As road speed increases, the solenoid valve allows increased fluid flow to the reaction chamber.

In this design, the torsion bar in the steering box that provides the baseline effort can be very light, and even with a system failure, there's still only a relatively moderate effort. Only a slight force overcomes the torsion bar, so with power assist parking effort is minimal, while the addition of resistance with road speed provides a very stable feeling even in the straight-ahead position.

Just to prove it hasn't ignored the simple-but-helpful, Toyota has a WINTER PARK position in the Cressida's recessed wipers. Manually push the wipers up to an exposed position and they'll park there. This eliminates

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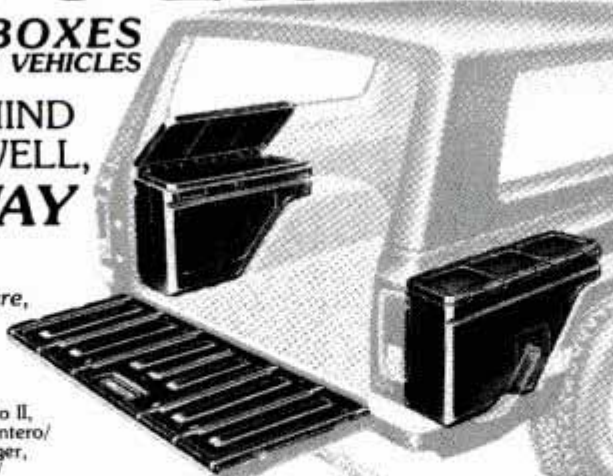
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Mazda

The standard 2.6-liter 4-cylinder in Mazda's new MPV van has the same displacement as a Mitsubishi Four Mazda once used, including counter-rotating balance shafts, a Mitsubishi trademark. However, the new 3-valve engine is pure Mazda.

The multipoint fuel-injected engine develops a so-so 121 horsepower at 4600 rpm, but Mazda wanted a flat torque curve for a van and got it, surprising for a multivalve engine. There's 125 lb.-ft. available the instant the throttle is cracked, and the peak of 149 comes in at 3500 and holds until 4500 rpm. Some 80 percent of production, however, will get the optional 3.0-liter V6 taken from the 929.

Helping with the flat torque curve is the resonator, a plenum chamber at the manifold end of the intake runners. Adapted from motorcycles and used by Mazda in other engines, it causes sound waves produced by the inrushing air to create a mild additional push for the air, sort of a free supercharging effect.

The balance shafts are in a horizontal line with each other, just above the crankshaft centerline. They don't provide the lower-speed benefit of the patented Mitsubishi design (one shaft high, the other low), but as GM and Chrysler can attest, this arrangement is very helpful too.

Instead of the widely used main bearing girdle (all bearing caps in one rigid frame), the Mazda Four has a steel plate (with crank throw depressions) bolted to the bottom of the block to add rigidity.

Daihatsu

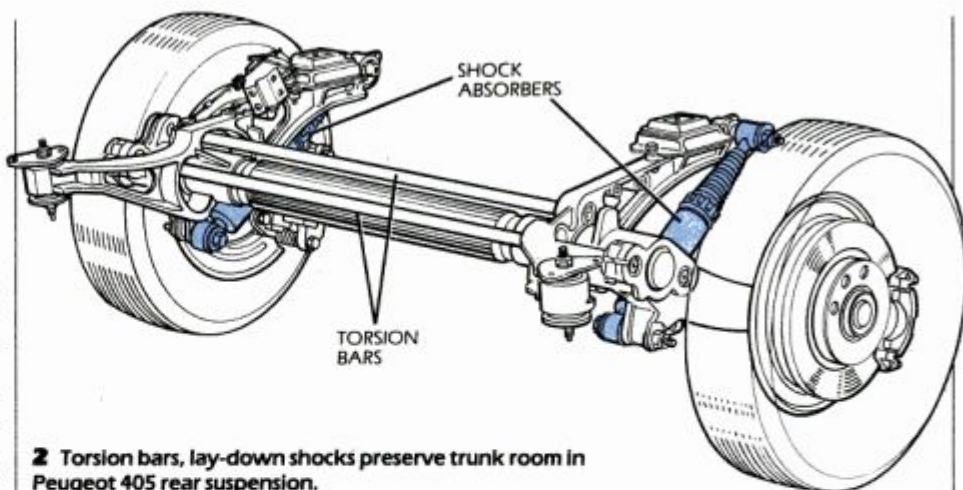
Daihatsu's Charade gets a 4-valve-per-cylinder 1.3-liter 4-cylinder engine (replacing the 1.3-liter 3-cylinder) and an optional auto trans (joining a manual 5-speed).

Honda-Acura

Although the 1989 Honda and Acura lines are basically unchanged carry-overs, the Acura Legend sedan gets a double-wishbone rear suspension, replacing the low-friction MacPherson struts. Adapted from the Legend coupe, it has gas shocks, progressive rate coils and a sway bar.

Mitsubishi

Anything over 61 horses/liter (equal to a horse per cubic inch) is needed to be competitive in a naturally aspirated 4-valve engine. Mitsubishi's first 4-valve engine, introduced in the '89 Galant GS, comes in at 67.5 per liter, 135 horses for the 2.0-liter mill.



2 Torsion bars, lay-down shocks preserve trunk room in Peugeot 405 rear suspension.

It takes plenty of revs to get the power, which peaks at 6000 (the engine redline is a hearty 7000). Peak torque (125 lb.-ft.) is at 5000.

The fuel-injected, distributorless-ignition engine has Mitsubishi's league-leading version of counter-rotating balance shafts, which are at different angles to the crank, and start reducing secondary engine vibrations at slightly above fast idle.

The dual-overhead camshafts are belt-driven, with automatic tensioners to eliminate adjustment.

There's a second 4-valve 4-cylinder in the Mitsubishi lineup, for the Mirage (and Chrysler's Mitsu-built Colt). It also produces 135 horsepower, and from only 1.6 liters. However, it's a turbo.

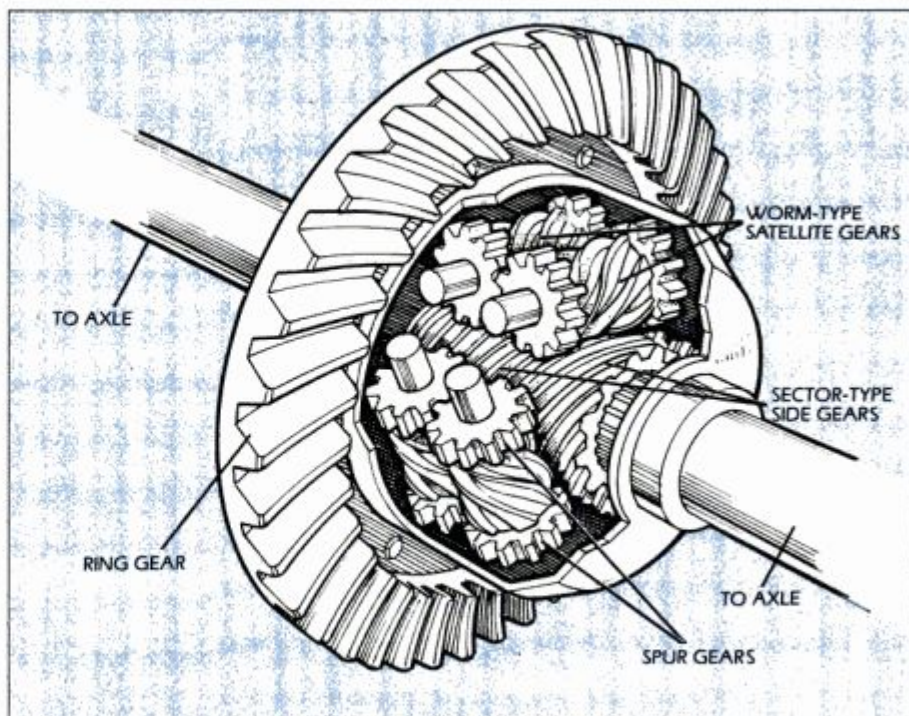
On the way: a near-200-hp inter-

cooled turbo 4-valve 4-cylinder for the Eclipse, the car Mitsubishi will get this winter from its Diamond Star alliance with Chrysler (which will have a version called the Laser).

Suzuki

Companies with motorcycle experience are hard to beat for power in a small package. The 1.3-liter aluminum 4-cylinder in Suzuki's new minicar, the Swift GTi (0 to 60 in 8.2 seconds) produces 100 horses from 1.3 liters (77 per liter) at 6500, close to the high-output GM Quad 4's 78/liter. The Suzuki also has four valves per cylinder and multipoint fuel injection.

The Sidekick utility vehicle (sister to the Chevy Geo Tracker) has an 80-horse 1.6-liter aluminum engine with hollow crankshaft and camshaft.



3 Torsen differential on Peugeot 505 uses worm-and-sector-type satellite gears, locked together by spur gears, to provide limited-slip action without clutches or springs.

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Peugeot

While only time will tell if this French maker has improved quality to meet stiff international competition, we can say with certainty that Peugeot's

new front-drive 405 sedan is a technological front-runner.

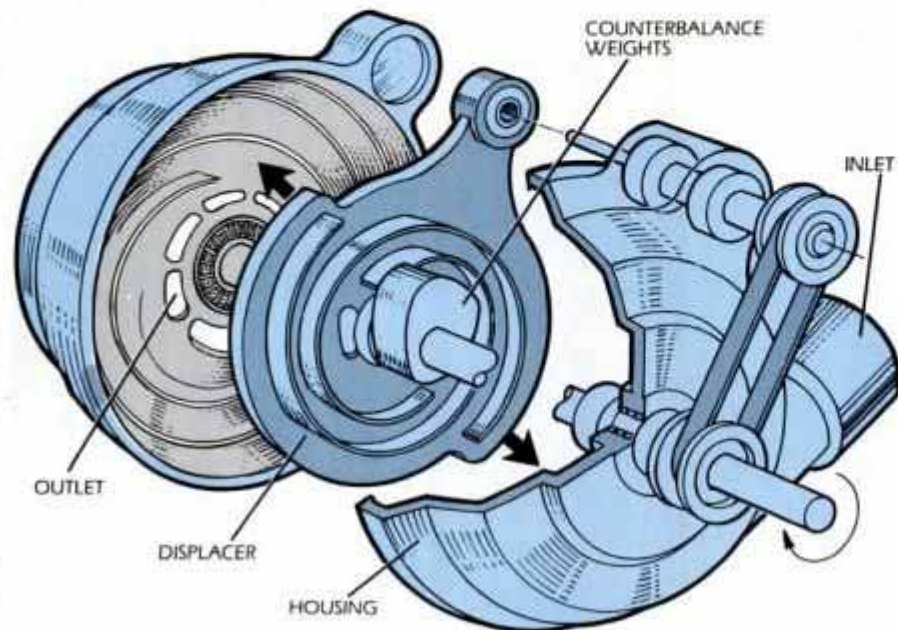
An 8-valve single-overhead-cam version develops 110 horsepower at 5200 rpm. A 16-valve, dual-overhead-

cam powerplant for the top-of-the-line 405 Mi 16 pounds out 150 hp at a sky-high 6400 rpm. As you'd expect in an engine with 7000 rpm potential, the cams are direct acting on bucket-type followers.

Both engines are equipped with advanced Bosch Motronic fuel injection/ignition management. On the 16-valve engine, the system includes a knock-sensor circuit that can retard ignition timing on a cylinder-by-cylinder basis, overcoming spark knock problems with minimal loss of output.

Another 405 engineering plus is an independent rear suspension system that doesn't use up all the vertical space at the rear of the body that is better reserved for passenger cabin and trunk (Fig. 2). This suspension system locates the rear wheels by means of trailing arms. Transversely mounted torsion bars provide the spring action. Horizontally mounted 8-valve shock absorbers accomplish damping while rising only a bit above the axle centerline to their upper mounting place on the axle subframe.

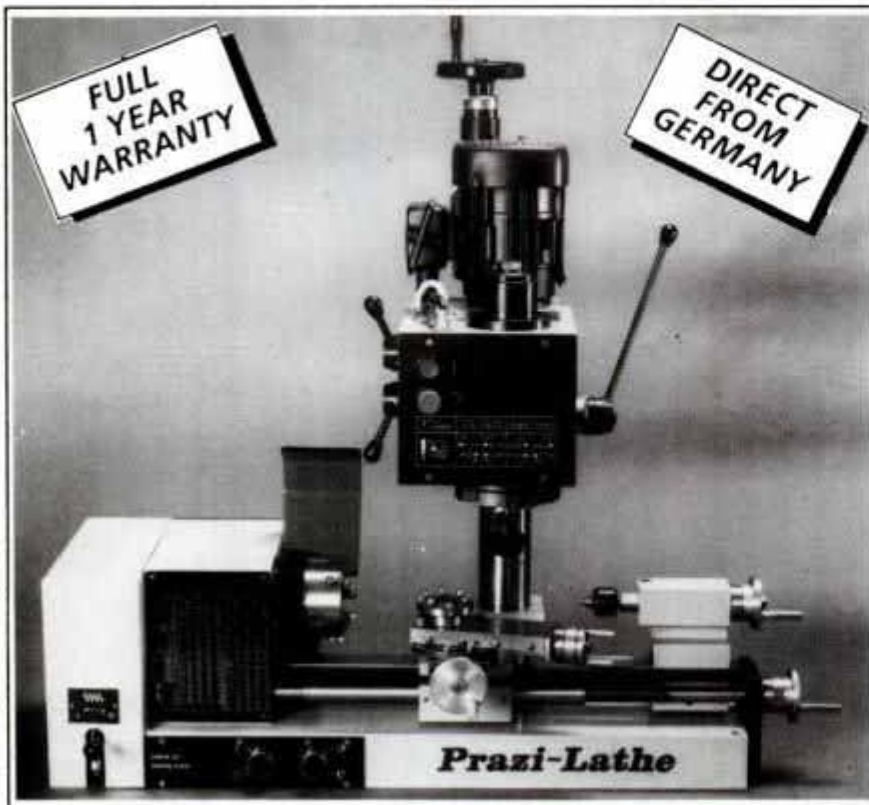
Peugeot's restyled 505 will now be fitted with a TORSEN limited-slip differential (Fig. 3). This type of dif-



4 G-lader positive-displacement supercharger bumps 1.8L 8-valve VW Corrado to 150+ hp. Snail-shaped vanes pump air from tangential outlet to center of housing and into engine.

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IMPORTS '89

ferential utilizes worm and sector gears to achieve a torque-sensing drive.

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But in the TORSEN, the low-traction wheel's sector gear tries to spin the satellite's worm gear around the satellite's axis. It's almost impossible for any sector gear to spin its worm gear because of pure mechanical inefficiency, so the whole differential carrier rotates—and so do *both* wheels.

Under normal cornering, the outside wheel needs to describe a longer arc, and travel a longer distance than the inside wheel, necessitating some rotation speed difference from one wheel to the other. In this case, the satellite worm gear on the outside wheel rotates its sector gear forward, while the inside worm gear rotates backward, because the two gears are locked together by the spur gears on

their ends. Because a worm gear *can* drive a sector gear easily, the differential action is free of the chattering and drag of a conventional friction-clutch limited-slip.

Volkswagen

Volkswagen's new front-drive Corrado sports car entry won't be hitting stateside streets until about March, but it may well be worth the wait. Corrado's 15-in. wheels, 5-speed manual and IRS are standard fare, but its 4-cylinder engine is not.

This little powerhouse reportedly knocks out some 150 to 160 horsepower from only 1.8 liters of 8-valve 4-banger. The power boost comes from a positive-displacement, belt-driven supercharger. Unlike a turbocharger or centrifugal supercharger, this unit provides boost immediately when you tromp on the pedal.

In contrast to other constant displacement superchargers, Volkswagen's huffer—or G-lader as the Germans call it—is not a Roots type (Fig 4). Instead it is a spiral pump that resembles a Nautilus shell. The supercharger driveshaft incorporates a central eccentric that passes through

a displacer. The scroll-shaped wall of the displacer separates the two scrolls of the supercharger case into inner and outer chambers. The displacer is fitted with a guide that allows it to achieve an eccentric, rocking motion between the scrolls but doesn't allow it to turn with the shaft. This motion opens and closes inner and outer chambers, allowing the supe to alternately draw air in and then expel it. A similar unit is already in use on VW's European-market Polo Coupe.

The G-lader's operation is best understood if you consider one rotation of its driveshaft in terms of four 90° phases. In phase one, the inner and outer chambers are both open to outside or ambient air pressure because the displacer's wall is centered in the opening of each scroll. The outer chamber has just passed the point of maximum volume. In phase two, the driveshaft turns, the displacer wall swings up, extending the inner chamber, which fills with air. In phase three, the inner chamber is still expanding but the outer chamber is displaced toward the central outlet area. In phase four, the inner chamber closes to ambient and the enclosed

volume is pushed into the outlet area where airflow from the outer and inner chamber mixes and is delivered to the engine's intake.

Later in the year, VW will introduce a Rallye version of its GTI, mating the Corrado blown Four to a viscous-coupled full-time 4-wheel-drive system.

Volvo

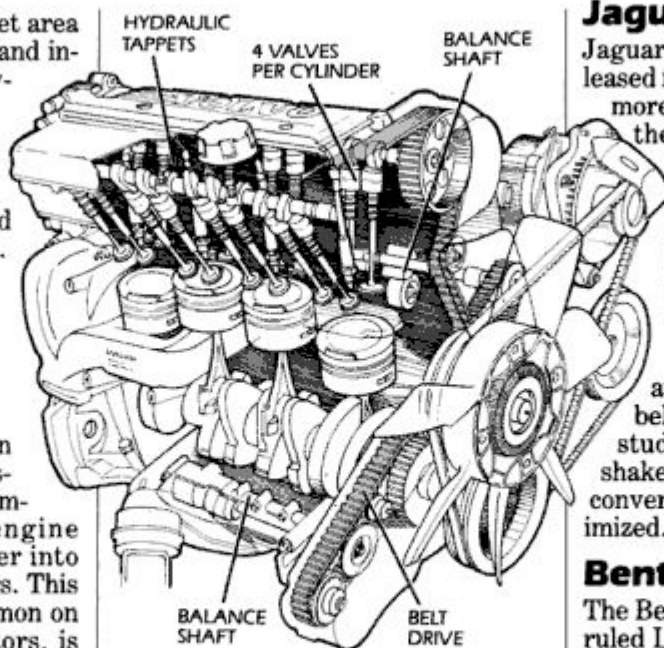
Those stubbornly logical engineers from Gothenburg have introduced what may well be the world's most well-mannered 4-cylinder engine in the 740 GLE sedan (Fig. 5). Displacing 2.3 liters, the aluminum-head dual-overhead-cam engine packs four valves per cylinder into pent-roof combustion chambers. This configuration, now fairly common on better high-performance motors, is complemented by a twin balance shaft arrangement that keeps those four big barrels from becoming unruly. Rotating at twice the engine speed in opposite directions and positioned at different heights, the shafts balance the forces generated by the paired pistons of a 4-cylinder engine.

In keeping with the high-civilization theme, the engine is fitted with self-adjusting hydraulic tappets.

Mercedes-Benz

Daimler-Benz has added a passenger-side air bag to its Supplemental Restraint System for certain models in the 1989 North American lineup. Mounted behind the right dashboard panel, the passenger-side bag is approximately three times as big as the driver's bag. Since it must inflate just as quickly as the driver's bag, two inflator units are used.

The new passenger-side air bag and the driver-side air bag, which was first offered for some North American models in 1984, are deployed by a 2-threshold sensor system that was introduced last year. This electronic circuitry measures deceleration force vectors to determine when the air bags and/or emergency tensioning seatbelt retractors (ETR) should be deployed in a frontal or offset frontal impact. At a first or lower magnitude threshold, only the ETR is activated—provided the seatbelt is buckled. If a belt is not buckled, the air bag for that seating position is inflated. At a second, higher magnitude threshold, the air bags are inflated, and—if either belt is buckled—the ETR is activated. If the passenger's seat is not occupied, the passenger's air bag is not inflated.



5 Volvo 740 GLE motor sports twin balance shafts, 16 valves, hydraulic tappets.

Sterling

Sterling gets the 2.7-liter V6 that will be used in Acura Legend, beginning in February. It replaces the current 2.5-liter unit and will reportedly upgrade what is now merely Sterling performance to Legendary levels.

Introduced with the new engine is an electronically controlled 4-speed automatic. Replacing an existing 4-speed auto, it is reportedly much more efficient. Controlling shift points based on data from various sensors, including engine load and speed, it should better utilize engine torque and improve drivability.

BMW

The new BMW 5-Series premiered on this side of the Atlantic in October. In strictly hardware terms, there's little that's brand-new. The powerplants are the current 2.5 Six and the fine 3.5 6-cylinder from the 735i. Front suspension is the fairly common but very efficient independent strut—a design that, unlike MacPherson strut types, permits optimization of strut and spring location.

Rear suspension employs BMW's traditional semitrailing links. This is supposedly a dated design, but BMW engineers seem to be able to work magic with it.

And that's apparently the key to the new 5-Series: a really super job in terms of making all the parts work well together for a remarkably well-balanced, confident automobile, a fully developed, finely honed rendering of current technologies.

Jaguar

Jaguar's 1989 XJ-S Convertible, released for sale mid-year 1988, is much more than a chopped-top version of the current coupe. Jaguar engineers beefed up the package with steel tubes in the inner sills and A-posts, while strengthening the transmission tunnel, front and rear bulkheads, and rear floor area.

Finite element analysis—a computerized way of looking at how a complex structure will behave under load—was used to study the results. Thus the cowl-shake that normally plagues ragtop conversions has reportedly been minimized.

Bentley

The Bentley flying wings, which once ruled LeMans, were long ago clipped as the racing marque fell into default and became a sistership of Rolls Royce. But in recent years, Rolls has worked to reshape the Bentley performance image.

The latest effort is a turbocharged version of Bentley's aluminum 6.75-liter pushrod V8. No technological wonder to be sure, the V8 is nevertheless a precisely machined, meticulously assembled engine, utilizing a wealth of fine materials. Although the pushrod design is perhaps dated, high technology has left its mark in the form of a Motronic engine control package with continuous flow MK injection and a twin distributor, twin-coil ignition system. Boosted by a Garrett AiResearch turbo, the engine probably knocks out in excess of 300 horsepower, although Bentley spokesmen—traditionally—will say only that the power is "sufficient."

Ferrari

If we had an extra quarter million plus change to devote to a good cause, we'd probably buy a Ferrari F40. That is, of course, if we could somehow get to the front of the line of the hundreds of well-endowed who are begging to spend their perhaps not-so-hard-earned dollars on one of the 200 units scheduled to pound U.S. pavement.

We're talking full-bore high-tech 200-mph race car here: carbon-fiber body; a rigid steel space-frame; a 478-horsepower, 4-valve, turbocharged, dual-overhead-cam V8 mounted midship; huge Pirelli P Zero rubber hung on two A-arms per corner. Weighing in at a bit less than a ton and a quarter, this Maranello marvel explodes to 124 mph in 12 seconds. The wonders of modern science!

PM

IMPORTS '89

(Continued from page 99)

rear. The SE and GSE share a 2.0-liter TBI engine, the others a 1.6-liter TBI. The base car uses a 4-speed, the other's a 5-speed or optional 3-speed automatic.

Subaru introduces the first production electronically controlled, constantly variable transmission ever sold in this country on the Justy. The Justy also has new styling and upgraded suspension to go with the stepless transmission. The familiar Subarus are redesigned—the wagon gets a raised roof—and the veteran Hatchback is in its final season.

A whole new line, called Legacy (Camry and Accord competitors), will originally be sourced from Japan, then from the new Subaru-Isuzu plant in Indiana. Loyale and Legacy, both 1990 cars, get an April intro.

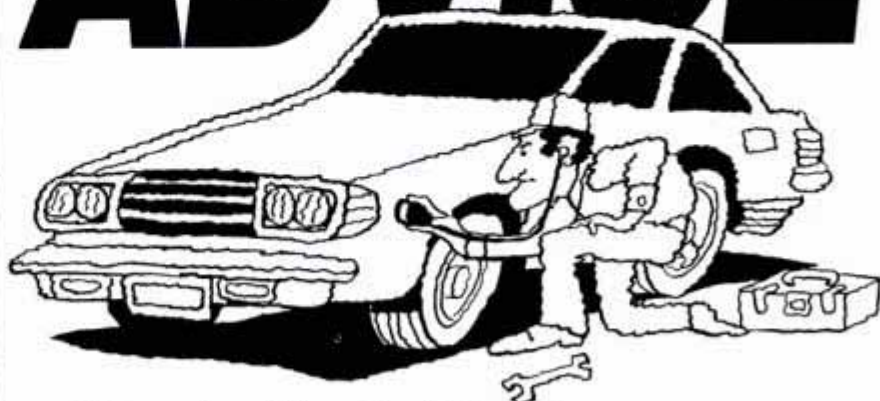
Suzuki adds the Swift GTi, a 1.3-liter dohc 4-cylinder, multipoint fuel-injected 100-hp hatchback, with styling somewhat like the smaller Metro sold by Geo dealers. It should be the quickest small car sold in the U.S. with a 0-60 time of just over 8 seconds. The front-drive subcompact has struts and coil springs front and rear. An automatic transmission is available. The Swift is joined by the Sidekick, a new sport/utility vehicle essentially identical to the Geo Tracker. The 4wd Sidekick will be available in hard and soft-top versions. It has a throttle-body injected 1.6-liter ultra-light Four, sohc, 80 hp at 5400 rpm, alloy block, alloy head and hollow crankshaft. Both 5-speed or 3-speed automatic transmissions are available. The Sidekick is larger and wider—a "grown-up" Samurai.

Toyota has a brand-new Cressida, much smoother, rounder and rather blander than the angular car it replaces. Cressida is still front-engined, rear-drive with a 3.0-liter 24-valve dohc inline Six. It has a strut-type front suspension, twin-wishbone rear with coil springs all around, all bearing on a much more rigid unit body. ABS is optional. The new Cressida is longer, lower, wider. The engine management system interrupts power when the automatic transmission shifts to smooth the shift further. A transmission computer provides antisquat and consistent transmission braking.

The Corolla line, new for '88, adds 4wd as an option on the sedan. The rest of the Toyota line is refined but essentially carried over.

Lexus, Toyota's luxury division, will have its offerings ready next September. The 1991 models will be previewed in PM next month.—L.F.

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TREASURE TRAINS

(Continued from page 78)

were the high-end items, the most expensive, and therefore, the ones produced in the smallest quantity. For example, one oddity (now valued at \$600 to \$800) is the Lady Lionel set from the late '50s. With its pink engine, white and gold transformer and cars painted in a rainbow of pastels, the Lady Lionel represented a distinct departure from the main line. Not surprisingly, it derailed.

Items selling for top-dollar must not only be in mint condition but must include their original boxes as well. At the upper end of the Lionel price scale is the standard gauge State set that couples any one of three different engines to four passenger cars emblazoned with the names New York, Illinois, Colorado and California. This combination can fetch \$8000.

The figures associated with Marklin are substantially higher. An extremely rare HO locomotive, made in 1938, sold at auction in 1981 for just under \$40,000. Fewer than a dozen of the model are known to exist.

Always known for its quality and workmanship, Marklin produces trains ranging in size from I-gauge (1 1/2 in. between rails, 1 to 32 in scale) to the tiny Z (1 to 220). With Z-gauge, elaborate layouts can be set up and operated in minimal spaces. One such outfit is available in a briefcase.

Marklin was the first to introduce digital electronics to model railroading. Its digital system lets you operate up to 80 HO trains and 256 switches and/or signals on a single layout, and can be programmed through a personal computer. The company's catalog currently contains several digital engines and, with the simple retrofitting of a chip, others can be converted to digital operation. It's a good bet that these first Digital HO models already are collector's items.

Aside from the astronomically priced rarities, acquiring toy trains is not necessarily a rich man's sport. Many older Lionel cars are available for under \$5, about what they sold for when new. Small 4-6-4 steam engines can be had for about \$100, and some 2-4-2s sell for as low as \$50. Brass scale-models are another story.

If you've got trains in your attic or cellar, and you're curious to learn their value, author Ron Hollander offers free appraisals of toy and model trains by all manufacturers. Send Hollander a stamped, self-addressed envelope and the following information: manufacturer, type of engine or car, numbers and lettering, color and condition. Sharp photos help, but aren't necessary.

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AUDIO

(Continued from page 62)

system in the Escort in the early 1990s.

JBL, of course, is not the only speaker company working with a carmaker. Bose has a longstanding relationship with the Delco Electronics division of General Motors. A sneak preview of the Delco/Bose system designed for the 1989 Cadillac indicates that this partnership is evolving as well.

As in previous Delco/Bose systems, the front door speakers are ported 4½-in. full-range speakers. The rear speakers, once the same size as the door speakers, are now 6 × 9-in. full-range models. The larger rear speakers give the system better bass response. Also improving the sound quality is the deci-



Ford/JBL subwoofer gets punch from its 10-liter enclosure, concealed in trunk.

sion to double the power output of the four amplifiers to 45 watts each.

While the Bose system for the 1989 Cadillac was generally pleasant sounding and enjoyable, Bose seemingly hasn't fared as well in the partnership it has developed with Nissan.

The Nissan/Bose system has a third, silent partner. As demonstrated in Nissan's new Maxima, the cassette receiver is supplied by Clarion. The Clarion cassette receiver incorporates three special circuits designed by Bose specifically for the Maxima. One of the circuits acts much like a loudness control in that the low-frequency content of a signal is reduced less than the high-frequency content as the volume decreases.

The second circuit compensates for what Bose characterizes as deficiencies in some FM radio broadcasts. If the circuit perceives a signal overload from a very strong station, it automatically drops the level to a safe position.

The third circuit affects the rear volume control. Since most bass information is coming from the rear speakers, it wouldn't be wise to eliminate the sound of them entirely. Some people do just that when they adjust the fader control all the way forward. The Bose circuit makes sure the rear speakers can't be turned off entirely. Even if you push the fader control as far forward as possible, the rear speakers will continue to reproduce those frequencies below 200 Hz. Each of the four speakers, incidentally,

is powered by a 30-watt amplifier.

Despite the use of some impressive circuitry and good quality speakers, the Nissan/Bose system really doesn't deserve its premium label. The bass response, in particular, seemed poor and muddy in quality. Overall, this Nissan/Bose system exhibited a singular ability to make exciting music sound dull.

Bose and Nissan, of course, have the opportunity to make a change in their audio system if they want. So while I can't recommend the Nissan/Bose audio

system as an option right now, it may be worth relistening to in six months or a year. Bose, meanwhile, seems intent upon being the brand-name speaker in as many cars as possible. The Bose system already is in the Acura made by Honda, and visitors to Audi showrooms will soon see a Bose option there as well. Bose wants to be your car speaker company and while it has every right to try, it's already been demonstrated that what works well in one car doesn't always work as well in another. **PM**



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How To Install A STORM DOOR

BY JOSEPH TRUINI, Shop And Tools Editor; PM Illustrations by George Retseck

AS THE LONG shadows of summer fade and cooler weather approaches, it's time to think about the upcoming heating season and ways to improve the energy efficiency of your home. Or, stated more simply, how to reduce heating costs and save money.

Creating a formidable first line of defense—blocking cold air *before* it can enter the house—is a key step in defeating old man winter. One of the major culprits of heat loss is a home's front door. Each time the door is opened and closed, a blast of cold air steals some warmth. The traditional way to deal with this problem is still the best way—install a snug-fitting storm door.

A storm door is more than simply another barrier against the cold. A properly installed storm door forms a buffer of air between the two doors to insulate and protect the house from extremely cold, windy conditions. A storm door also allows you to open the front door from inside without inviting in snow, rain or the most recent northerly cold front. Many of today's storm doors come with screens and removable windows for year-round use. Some homeowners prefer to remove the storm door each spring and install a screen door for use during spring and summer only.

Storm doors are available in a wide variety of sizes and styles to fit your home and budget. A prehung unit is the easiest to install since it comes with the hinge and outside mounting flange attached to the door. Choose from doors made of wood, aluminum and new tough plastics.

Before you go shopping for a door, measure the *inside* dimension between the door jambs on the front doorway. Also, measure the height of the door opening.

The prehung door we installed, called the Forever Door, is made of tough polypropylene and is guaranteed not to rust, crack, dent, split or



rot. It features the latest energy-saving design and easy do-it-yourself installation. In fact, the entire installation took less than 2 hours. One of my favorite features is the self-storing window and screen that slide down into the bottom half of the door for safe, convenient storage. The 36-in.-wide × 80-in. door costs about \$200. A 32-in.-wide model is also of-

fered. Contact Emco Specialties, Box 853, Des Moines, IA 50304. Or, call toll-free (800) 262-0075.

Prepare the opening

The first step is to prepare the opening to accept the new storm door. Remove the old storm door, if necessary, and any ornate trim or molding that will interfere with installing the new



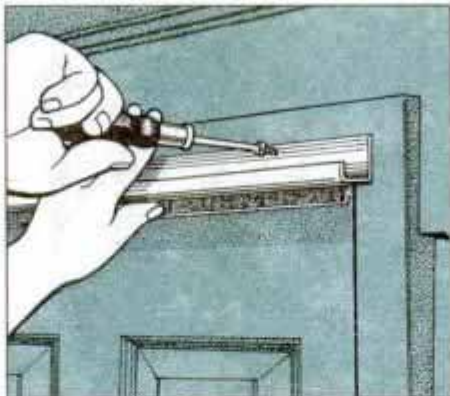
1 If the door opening is a little too wide for the door, fasten a thin wood strip to the inside of the door jamb with finishing nails.

door. Next, hold the door in the opening and check the fit.

It may be necessary to add a thin wood strip to reduce the opening (Fig. 1). Now's a good time to repaint and touch up, if necessary.

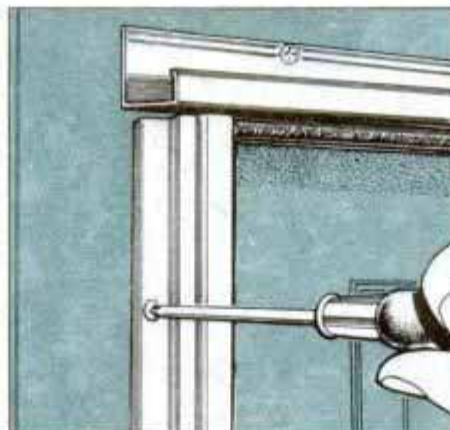
Once the door opening is prepared, check the installation instructions for the height where the rain cap that fits over the door should be installed. For the door shown, the rain cap was positioned 80 $\frac{3}{4}$ in. above the sill. Attach the rain cap with just one screw at this time. Next, take the distance from the sill to the underside of the rain cap and subtract $\frac{1}{8}$ in. In our case, this comes to 80 $\frac{1}{4}$ in. This measurement determines the length of the hinge-side mounting flange, also called the Z-bar. Note that the flange is several inches longer than necessary so that you can cut it to fit your door opening exactly. Use a hacksaw to cut the flange to length (Fig. 3).

Run a bead of latex caulk down the back of the mounting flange. Tilt the door into the opening and align the top, outside edge of the flange with

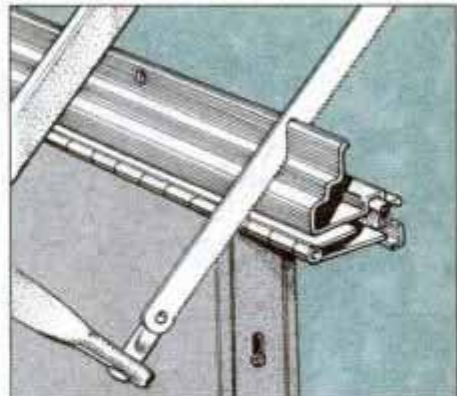


2 Screw the rain cap to the top of the door opening. The extruded aluminum cap helps divert rainwater away from the opening.

the end of the rain cap. Drive one screw through the uppermost screw hole on the flange to hold the door in place. Next, hold a level against the flange to make sure that it's plumb, then drive in the remaining screws (Fig. 4). Remove the one screw holding the rain cap in place and apply a bead of caulk to the back of the rain



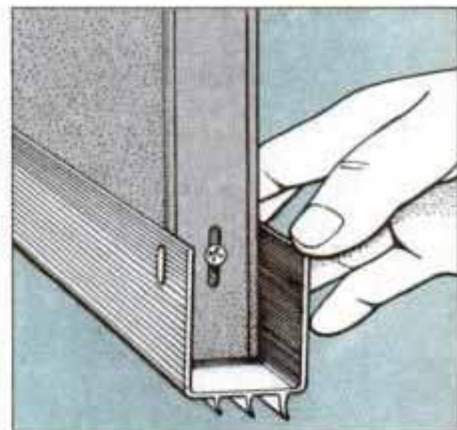
7 Fasten the latch-side mounting flange with screws. Check space between the flange and door before driving screws.



3 Prehung unit comes with hinge and mounting flange attached to door. Cut off oversized hinge to fit opening exactly.

cap. Reinstall the rain cap with even space along the top of the door, and drive in the remaining mounting screws.

Now, measure from the sill to the underside of the rain cap on the latch side of the door to determine the length of the latch-side mounting flange (Fig. 5). Cut the flange to



8 Slip door sweep over bottom of door and adjust it so that it forms a tight seal against sill. Fasten sweep with screws.



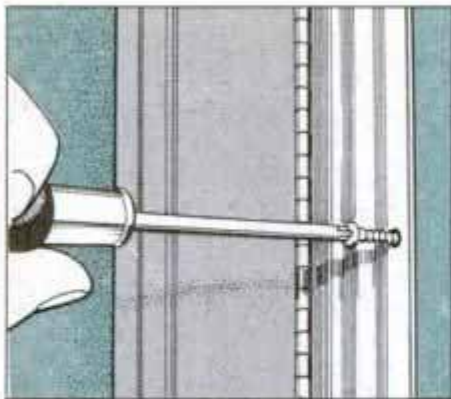
11 Install the dead bolt opposite the key lock. Be sure that the flat spindle is seated properly in the center of the bolt assembly.



12 A simple L-shaped strike plate is used to engage the latch and hold the door closed. Screw strike plate to door jamb.

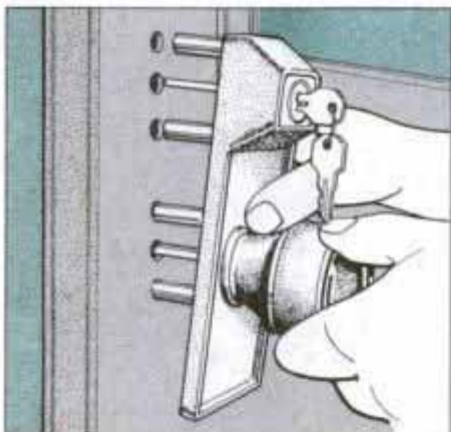


13 Screw the jamb bracket in place, as shown, to support the automatic door closer. Fasten it with four 1 $\frac{1}{2}$ -in. No. 12 screws.

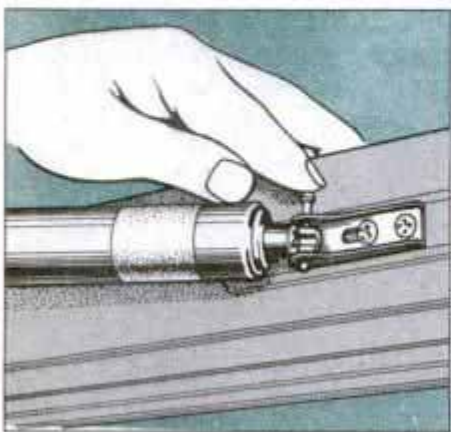


4 Drive screws through predrilled holes in the mounting flange to secure door. Check flange with a level to be sure it's plumb.

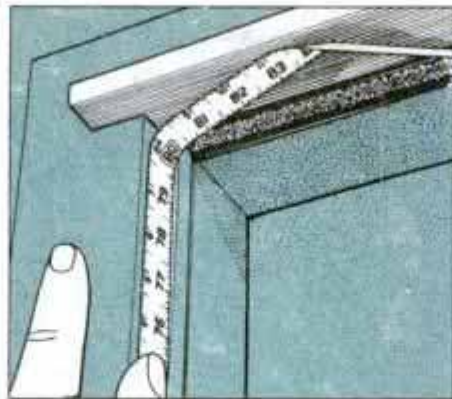
length with a hacksaw, apply a bead of caulk to its back surface and install it with screws (Fig. 7). Be sure that there's an even space between the flange and the edge of the closed door. Also, check the installation instructions to see if it's necessary to leave space between the door and flange for expansion and contraction. This will



9 Easy-to-install door knob and lock assembly mounts to the outside of the 1½-in.-thick door through six prebored holes.



14 After screwing the door bracket to the inside of the door, attach the closer by inserting a locking pin through the bracket.

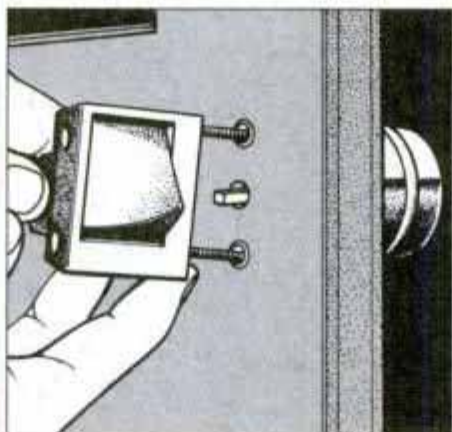


5 Measure from the sill to the bottom of the rain cap to determine length of latch side mounting flange, also called a Z-bar.

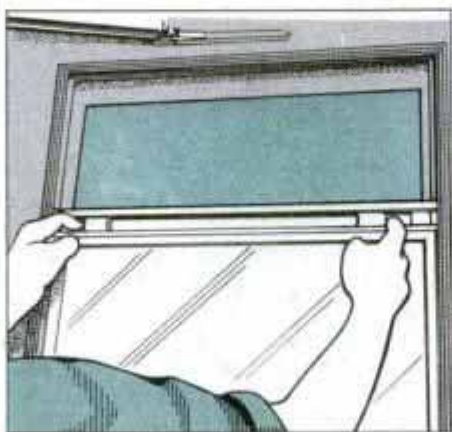
be the case for most plastic (PVC or polypropylene) doors. The required space will depend on the air temperature at the time of the installation.

Installing the hardware

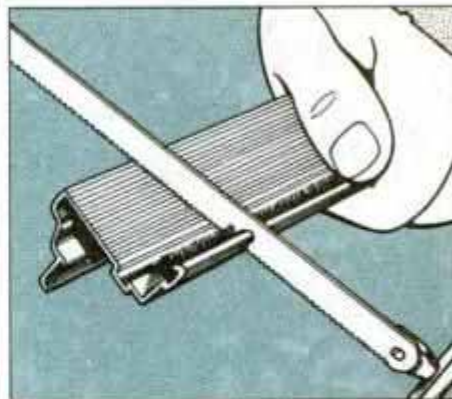
Most doors come with some sort of weatherstrip for the bottom of the door. Our unit has an easy-to-install



10 Mount finger-latch mechanism to inside of door, opposite the door knob. Secure the latch with two machine screws.



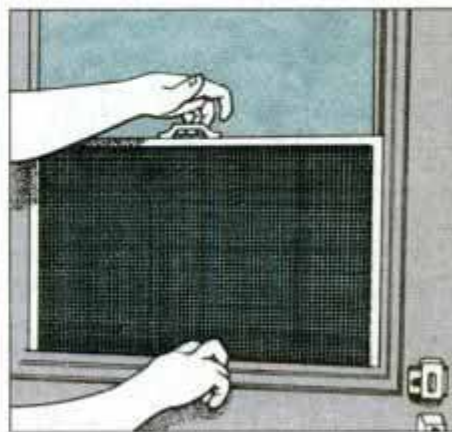
15 Door features an adjustable window that locks at several positions. Window can be lowered and stored in bottom of door.



6 Cut extruded aluminum flange to length with a hacksaw. Be careful not to pull out factory-installed weatherstripping.

door sweep that slips over the door bottom (Fig. 8). Adjust the height of the door sweep so that it forms a tight seal against the sill when the door is closed.

The door comes with prebored holes so that installing the knob and lock assembly is quick and easy. Simply follow the manufacturer's instructions. Note that our door also has a key-operated dead bolt for additional security (Fig. 11). Another nice feature of the Forever Door is that it comes with *two* automatic closers. To install, first attach the jamb bracket to the hinge side door jamb (Fig. 13). Next, fasten the door bracket to the inside of the door and attach the closer with simple drop-in pins (Fig. 14). A small setscrew on the end of the closer cylinder allows you to adjust the speed in which the door closes. Turn the screw clockwise to slow the door; counterclockwise for faster closing. Open the door all the way and allow it to close. Make adjustments to keep the door from slamming shut or to ensure that it closes completely. **PM**



16 Fiberglass screen stores in bottom, too. Pull up screen when needed. Window and screen can be used simultaneously.

How To Install Interior WINDOW SHUTTERS

BY ROSARIO CAPOTOSTO, Contributing Editor; PM Illustrations by George Retseck



DRESSING UP your windows with wood shutters is a great way to add an exciting visual accent to the decor of your home. Installing shutters, however, is not simply window dressing. These fully functional accessories can be swung aside for maximum light and visibility, or adjust the louvers for just the right combination of sun and privacy.

In addition to the traditional adjustable-louver variety, shutters are also available in fixed-louver and non-louver, fabric-covered versions. Whatever style you choose, however, the installation procedure is the same.

Tools and types

While installing interior wood shutters isn't a difficult job, it does require careful measuring and trimming. To get the job done you'll need a few basic

tools—a tape measure, saw, plane, awl, chisel, drill and screwdriver are the essentials.

Wood shutters are available at home centers and lumber dealers in single panel sizes ranging from 6 x 16 in. through 12 x 36 in. In addition to being sold as individual panels, you'll also find them in sets of four.

Shutter hardware is sold in a separate kit that includes everything you'll need for a 4-panel installation. Also available is a hanging-strip hardware kit that permits vertical and horizontal shutter adjustments.

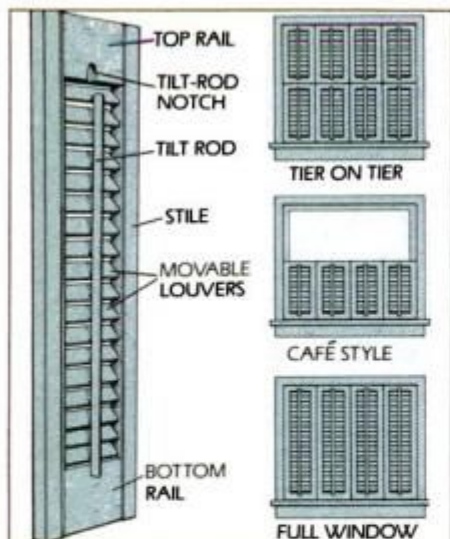
Don't forget to consider the style of the installation. As an alternative to a full-window installation, café style features a row of shutters along the bottom half of the window leaving the top open. In a tier-on-tier installation, one set of shutters is hung above an-

other. One of these alternates is a good solution if your window height is greater than the tallest available shutter (Fig. 1).

Measuring the window

First, decide whether you'll be mounting the shutters on the inside of the window (jamb), or outside the jamb on the trim (casing). Installing the shutters on the casing is accomplished with a hanging-strip kit and shutter fitting is somewhat easier. Our instructions describe inside mounting, but the general procedure for either installation is similar.

Measure the height and width of the area to be covered by the shutters. Because the jambs or casings may not be parallel, measure at several locations and take note of the shortest height and narrowest width



1 While their components are standard, shutters are offered in a range of sizes and can be installed in three basic ways.

measurements (Fig. 2).

Using a large steel square, check that the window jamb is square (Fig. 3). If it's severely out of square, then mounting the shutters on the casing may be the easiest solution.



3 Check the window jambs for square. Severely out-of-square jambs make an outside, casing installation a better idea.



5 A sharp hand plane removes stock when trimming. Remove an equal amount from all shutters for uniform appearance.

Trimming the shutters

Check the instructions supplied with the shutters to determine the amount of stock that can be safely trimmed. Then, lay out the shutters in the positions that they'll be hung. The tilt rods should be face up with the wide rails at the bottom. Place $\frac{1}{32}$ -in. clearance shims between the shutters and allow for $\frac{1}{16}$ -in. clearance where the shutters meet the jamb (Fig. 4).

Unless the amount to be removed is very slight, it's best to divide the excess among all the shutters and trim both sides of each to reach the desired dimension. Use a hand plane to trim the shutters to width (Fig. 5).

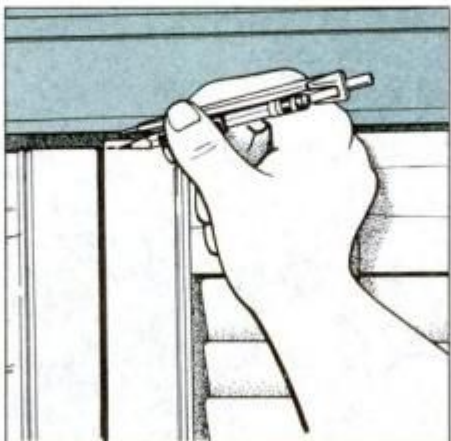
If the window jamb is slightly out of square, hold one shutter against a jamb and lean it so the top can be held against the top of the window opening. Then, scribe the cutting angle with a compass (Fig. 6).

Lay out the top and bottom cutting lines allowing $\frac{1}{8}$ in. for clearance. If you're installing the shutters in a tier-on-tier configuration, allow for a $\frac{1}{16}$ -in. clearance between the rows. Use a sharp, fine-tooth crosscut saw to cut the shutters to length (Fig. 7).

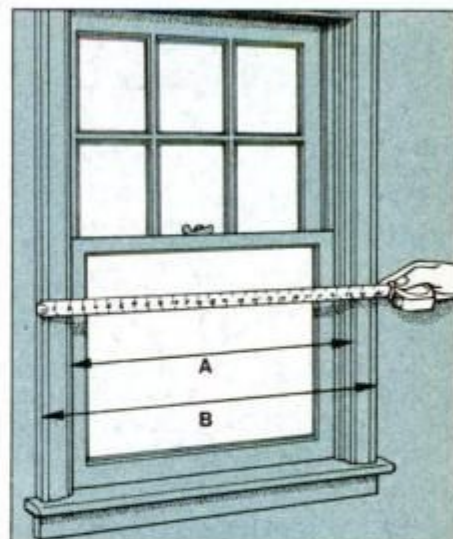
Installing hinges

Fixed-pin butt hinges are used between shutters and loose-pin angled-leaf hinges connect the end shutters to the window jambs.

The shutter-to-jamb hinges are usually installed in recesses cut in the shutter stiles. First, lay out the hinge positions. Cut each hinge recess by making a series of cuts with a backsaw (Fig. 8). Then remove the waste with a chisel (Fig. 9). If you prefer, you can omit the recess. In this case, you'll have to increase the clearance be-



6 Shutters for slightly out-of-square windows can be cut to fit. Scribe line with compass while holding shutter in place.

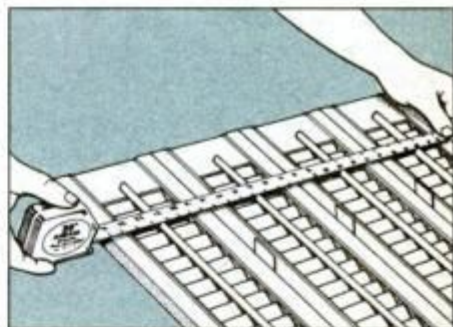


2 Measure window based on where you want the shutters installed: between the jambs (A), or overlapping the casing (B).

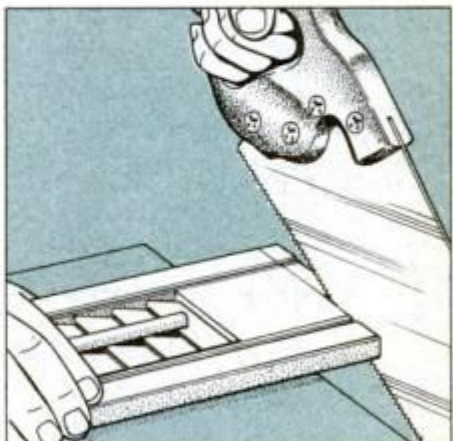
tween the shutters and jamb.

Use an awl to mark the screw locations, bore the screw pilot holes and install the hinges.

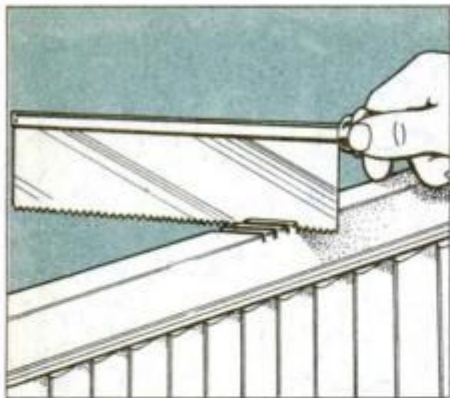
To install the shutter-to-shutter hinges, place the shutters face down



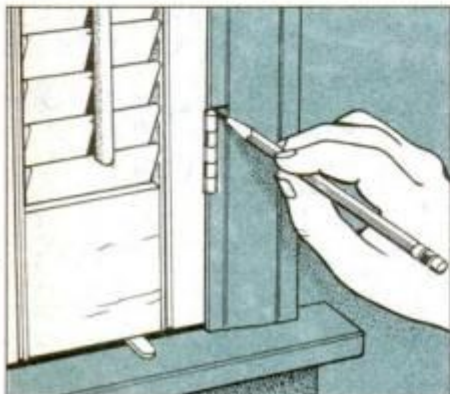
4 Lay out the shutters on a flat surface and place $\frac{1}{32}$ -in. shims in between. Then determine amount to be trimmed from edges.



7 After marking cutting lines, remove excess length from shutters with a sharp, fine-tooth crosscut saw. Sand edges smooth.



8 To recess loose-pin hinges in shutter edge, first make saw cuts. Cut only as deep as the thickness of the hinge leaf.

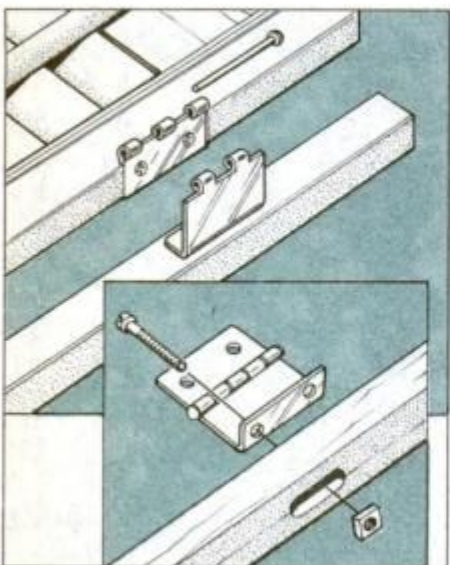


11 Temporarily position shutters in opening and shim for appropriate clearance. Carefully mark hinge locations on jamb.

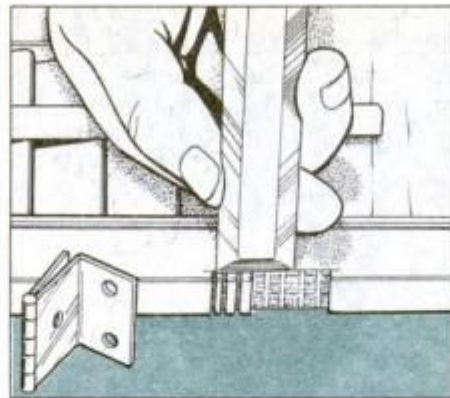
with $\frac{1}{32}$ -in. shims in between. Then, mark and bore the pilot holes and secure the hinges (Fig. 10).

Securing to the window

After the hinges have been installed,



13 Hanging kit has strips with slotted holes for adjustment. After bolting hinge, mark shutter hinge location and install.

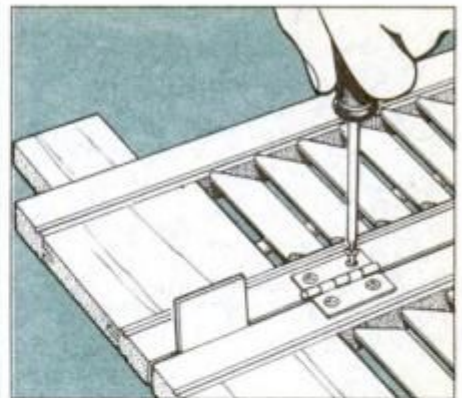


9 Finish the hinge recess by removing the waste with a chisel. Then, mark screw positions, bore pilot holes and secure hinges.

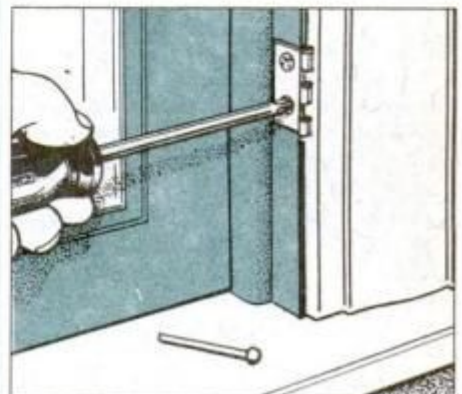
place $\frac{1}{16}$ -in. shims on the window sill and position the shutters in the opening. Then, mark the hinge locations on the window (Fig. 11). Remove the shutters and lift out the loose pins. Screw the four hinge halves to the window (Fig. 12).

Finally, align the knuckles of the hinge halves on the shutters and window and insert the pins.

If you're mounting the shutters on hanging strips, first bolt the loose-pin hinges to the strips by passing the bolts through the slotted holes in the strips (Fig. 13). Center the bolts in the slots and temporarily tighten. Then, align the shutters with the strips and mark the hinge locations on the shutter edges. Remove the loose pins and install the hinge halves on the shutters. Then, screw the strips to the window and hang the shutters. Loosen the bolts and adjust for correct clearance. Then tighten the bolts



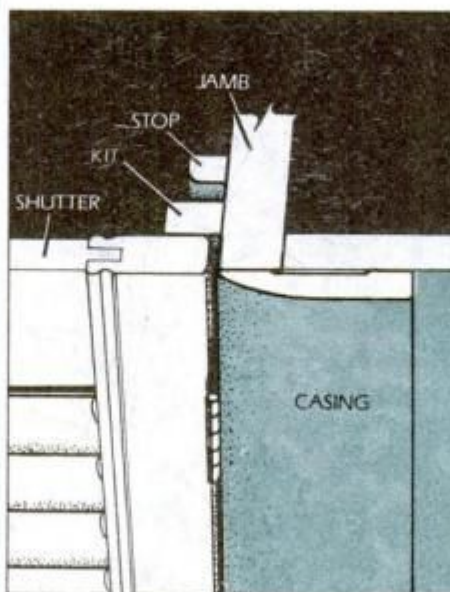
10 Mount fixed-pin hinges by first laying out shutters with shims for clearance. Shutters rest on wood strips to protect tilt rod.



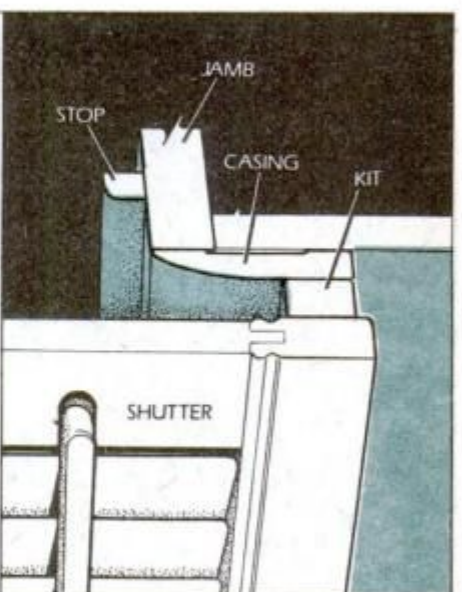
12 After boring the screw pilot holes, secure hinge halves to the jamb with the supplied screws. Align and install shutters.

and install the remaining screws.

Although shutters are available prefinished, a spray stain or paint is an easy way to top off the unfinished type. Coat the back side first, allow it to dry, and then coat the front. **FM**



14 A hanging-strip kit can be used for inside window mountings (left) or securing shutters to casing (right). First, secure strips to window, engage hinges and insert loose pins.



Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Up-Flush Toilet

I'm interested in installing a half toilet in my basement. However, I don't want to dig up the basement floor for tanks or piping and the sewer line is 5 ft. above the floor.

An up-flush toilet would be the solution, except that it's not approved by New Jersey.

I have been advised that an ejector system is approved for this application, but have found no one who is familiar with such a system.

What is an ejector system and who manufactures components?

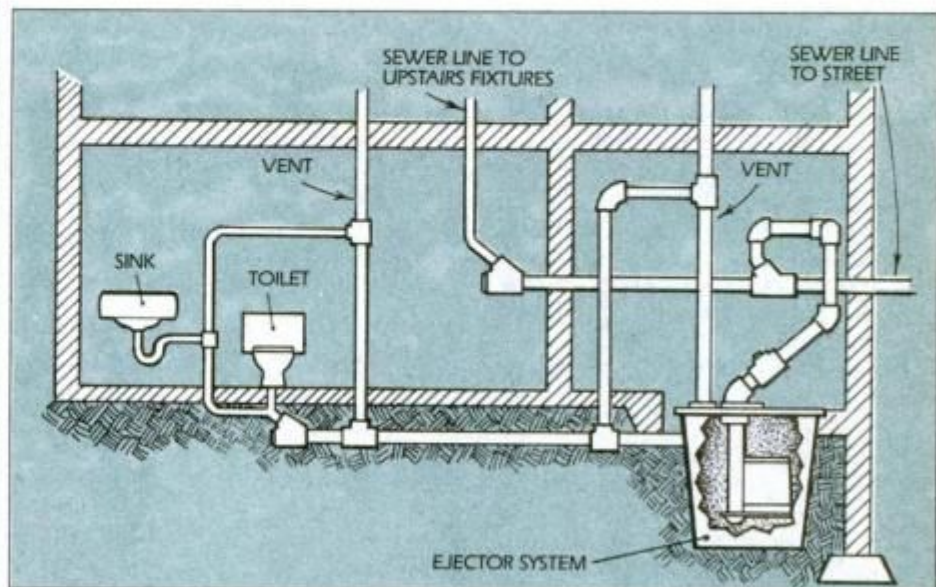
B.P. LINDHOLM
MANASQUAN, NJ

I checked with the New Jersey Code Enforcement Bureau to find out why up-flush toilets are not approved. They said that these units fall into the category of alternative products which must be tested and approved by a nationally recognized testing agency. Since the up-flush toilets do not carry the seal of approval of an accepted testing agency, New Jersey will not approve of their use.

The only solution to your problem is an ejector system. Unfortunately, this will involve digging up a section of your basement floor.

An ejector system is basically a submersible pump mounted in a tank which is located below the lowest fixture. The pump lifts the waste to the level of the municipal sewer line. Although the tank is usually below the basement floor slab, it could be buried in a side yard below the level of the basement floor. This, however, would require a hole through the foundation wall so the tank could be connected to the waste line.

One manufacturer of components for this system is Gould Pumps, Inc., Seneca Falls, NY 13148. Since you will not have many fixtures discharging into the tank, you can use a Simplex Sewage Ejector System which Gould sells for about \$650. It includes an 18-in.-dia., 30-in.-high tank, pump, 1/2-hp motor, check valve and float switch. If you're doing the job yourself, don't forget to get a permit from the municipal building department and an inspection and approval by the municipal building and plumbing inspector.



An ejector system allows toilet installation below sewer line. It incorporates a tank installed below the slab level and a submersible pump to lift the waste to the sewer line.

Covering A Concrete Floor

I'd like to cover the concrete floor of my basement with tile flooring. The concrete is even and has no cracks or holes. Can you offer any advice as to what kind of flooring to buy and any hints on installation?

R.W. BARTLETT
RINGWOOD, NJ

Since your floor has no irregularities, cracks or holes, it will require no other preparation than cleaning. You can use vinyl tile or vinyl-composition tile. The latter used to be called vinyl-asbestos tile, but because of the nationwide scare over asbestos, the word asbestos is no longer used. Actually, a product containing asbestos is not a health hazard unless it has been damaged or is deteriorating to the point where the asbestos fibers are becoming airborne. The asbestos in floor tiles is encapsulated by the vinyl and, as such, does not pose a health hazard.

Before laying the tiles, make sure that the concrete is dry enough to ensure a good bond. You can test for excessive moisture by laying a floor tile or similarly sized piece of aluminum foil on the floor. Seal the edges with tape and leave it overnight. If there's any visible moisture under the tile or foil the next day, then there is too

much moisture for a good bond. If your excessive moisture is caused by a seasonal high ground-water table, then you'll have to wait for the water table to drop.

If you find that the concrete is dry enough, then you can apply the adhesive and install the tiles. Be sure to use an adhesive that's appropriate for the type of tile you buy. For example, adhesive for vinyl-composition tile shouldn't be used with vinyl tile because it is not strong enough.

Kerosene Heater Safety

*If your municipality allows the use of kerosene heaters and you intend to use one or more of these units in your home, there are serious burn, pollution and asphyxiation dangers that you should be aware of. To help educate consumers and reduce these hazards, the Insurance Information Institute has published a Kerosene Heater Safety booklet. Single copies can be obtained free of charge by phoning (800) 221-4954. **PM***

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH, Contributing Editor

Misfiring Gas Range

Our Kenmore gas range, model No. 628.3528191, serial No. 1K57597, has electronic ignition. The left and right burners are each controlled by a separate ignitor. Both ignitors are activated by the same spark module.

The left side works fine. However, when a right burner is turned on, the gas comes out, but the left ignitor fires. We have to light the right burners with a match.

KEN TEEPLES
HACIENDA HTS., CA

Normally, both ignitors should spark when you turn on any burner. Remove the burner grates, lift the cook top and prop it up. Turn on one of the left burners while looking carefully at the right ignitor to see if it's sparking. If there is no spark, then you may have a broken high-voltage wire or the ignitor wire may be shorted to the frame of the range.

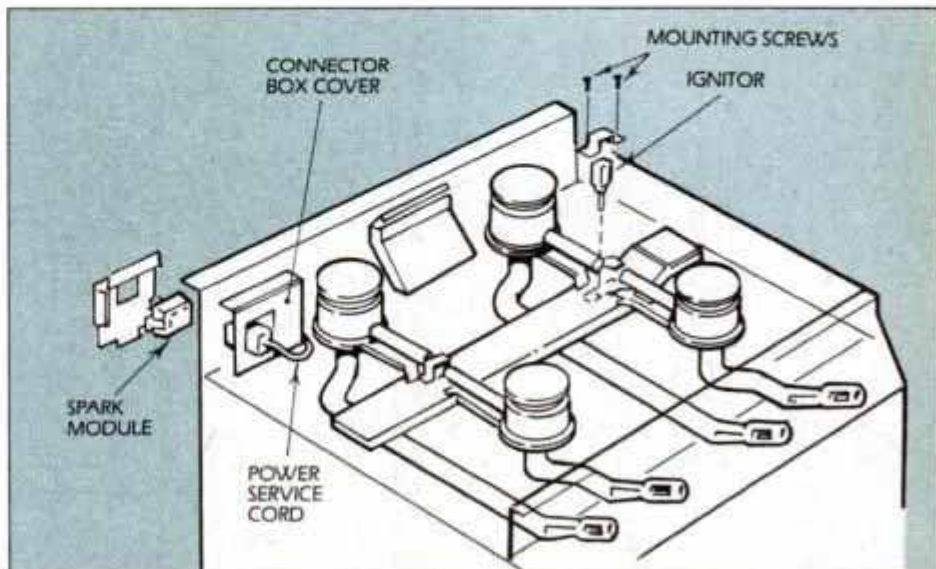
Another possibility is a defective spark module. To test the spark module, first lift and prop up the cook top. At the rear left corner you'll see the power service cord plugged into a black, metal connector box. Unplug the service cord and remove the cover from the connector box. Underneath you'll find the spark module with four wires attached. Two of the wires are braided white high-voltage wires which attach to small, $\frac{3}{16}$ -in. flag terminals on the module.

Remove these wires and reconnect each to the opposite terminal. In this way, you're reversing the ignitor connections left for right. Replace the cover and plug in the power cord.

Now turn on a right burner while watching the ignitors. If you get a spark at the right ignitor and not the left, then the ignitors are fine and the spark module is at fault. If the right side doesn't spark and the left side does, then you'll need to replace the right ignitor.

After determining which part needs replacing, unplug the service cord, and restore each wire to its original terminal.

To replace an ignitor, disconnect the power and remove the connector box cover. Remove the wire that connects to the bad ignitor and tie a string to the end for fishing the new ignitor's wire back to the spark mod-



If burners on one side fail to light, test for a faulty ignitor or spark module by lifting the top, removing the power service cord and box cover, and reversing ignitor leads at module.

ule. Take off the ignitor ground strap and lift the ignitor off the burner support. Carefully pull the wire through, attach the new wire to the string, and pull it back to the module. Secure the new ignitor, attach the wire and test. Both the ignitor and spark module are available from any Sears parts center in your area.

The spark module is part No. 1321426 and costs about \$28. The right ignitor is part No. 1321435 and costs about \$14.

Needs Face Lift

I have a Wizard Upright Freezer model No. 2J1722-AGF7FRA that needs a new door seal. Further, when the door is closed it sags nearly 1 in. below the box. Where can I get a new seal and how can I fix the sag?

L.A. TENOLD
ALPHARETTA, GA

The Wizard brand is a trade name of Western Auto Stores and the door seal for your 1957 freezer is still available. It can be ordered from Western Auto Parts Center, Box 183, Birmingham, AL 35283, (205) 328-1501. The seal costs about \$54 and is part No. 54779-1.

As far as the sag is concerned, oversize screwholes in the cabinet outer shell allow you to adjust the relationship of the door to the cabinet.

After installing the new seal, check

its effectiveness by closing the door on a 1-in.-wide strip of paper. A slight drag should be noticed as the strip is pulled from the door. Repeat the check every few inches around the door. To tighten the seal on the hinge side, pry off the hinge cover with a thin-blade screwdriver. Then, loosen the two screws that hold the hinge to the cabinet while pushing lightly on the door.

Repeat this procedure on the remaining hinges until the door seals properly and is aligned.

FM

Service Tip

Although you may think that wringer washers are a thing of the past, people do still own and use them. The last U.S. manufacturer of wringer washers is Speed Queen which sells the washers under its own name and the Amana brand.

The company still stocks parts and service manuals for most of its washers including many of its older models. If you have any questions about parts availability or are looking for a manual, write to Speed Queen Co., Parts and Service Data, Box 990, Ripon, WI 54971.

If you have a problem with any appliance, send your question, along with model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

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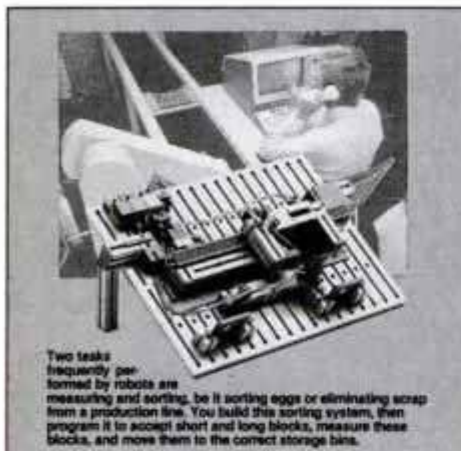
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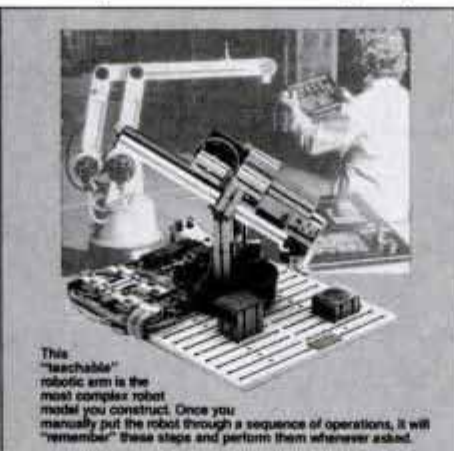
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Two tasks frequently performed by robots are measuring and sorting, be it sorting eggs or eliminating scrap from a production line. You build this sorting system, then program it to accept short and long blocks, measure these blocks, and move them to the correct storage bins.



This "teachable" robotic arm is the most complex robot model you construct. Once you manually put the robot through a sequence of operations, it will "remember" these steps and perform them whenever asked.

the job or start a new career as a robotics and industrial control technician.

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Nothing is left out, nothing is left to chance. You get everything you need—the skills, the confidence, and the equipment—to feel completely at home with today's robotics technology.

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CAMCORDERS

(Continued from page 75)

is less sensitive to detail in moving images than in still ones. Accordingly, if you intend to use a camcorder primarily for conventional home movies, the conventional formats will serve your purpose. If you want to use a machine's High-Speed Shutter, Freeze-Frame and Slow-Motion functions to record time-motion studies—your golf swing, for example—you'd best get all the resolution you can buy.

A word about lenses is in order here. If camcorder focal lengths seem short by photographic standards, remember that in video, the focal plane is a *CCD Image Sensor* that is smaller than a frame of 35mm film. To equate a video lens to that of a 35mm film-camera lens, multiply focal length by 4 for a 2/3-in. CCD, and by 5.33 for a 1/2-in. chip.

Speaking of chips, you won't see any *Streaking* in your images, or see them *Lag* across the TV screen. These forms of distortion were eliminated when solid-state image sensors replaced vacuum-tube pickups.

You'll also notice that all the camcorders here offer at least one faster *Shutter Speed* in addition to the standard 1/60-second shutter. The higher speeds will yield more detailed slo-mo and freeze frames—but remember, the higher the shutter speed, the more light needed to form an image.

Conclusion

If you're in the market for a camcorder, you'll do well with any of the five we've tested. Questions of performance aside, your choice of a format might be determined by the way you'll use the moviemaker.

Here, recording time—and camcorder weight—are important factors. A camcorder is no burden at all if you only pick it up briefly to record snatches of a child's birthday party. It is another beast altogether when you lug it all day on a trip to the zoo.

After you've determined your performance requirements and settled on a format, you'll weigh the convenience features and other special aspects of a particular brand and model.

Fast shutter speeds might be more important to you than zoom speed or remote control. No lab test can decide these questions for you. What we hope this report *will do* is make you aware of the questions you must ask to arrive at a decision. Use it to evaluate whatever camcorder model attracts your fancy. Because home movies mean so much to so many of us, the money you spend is an investment in the future. Invest it wisely.

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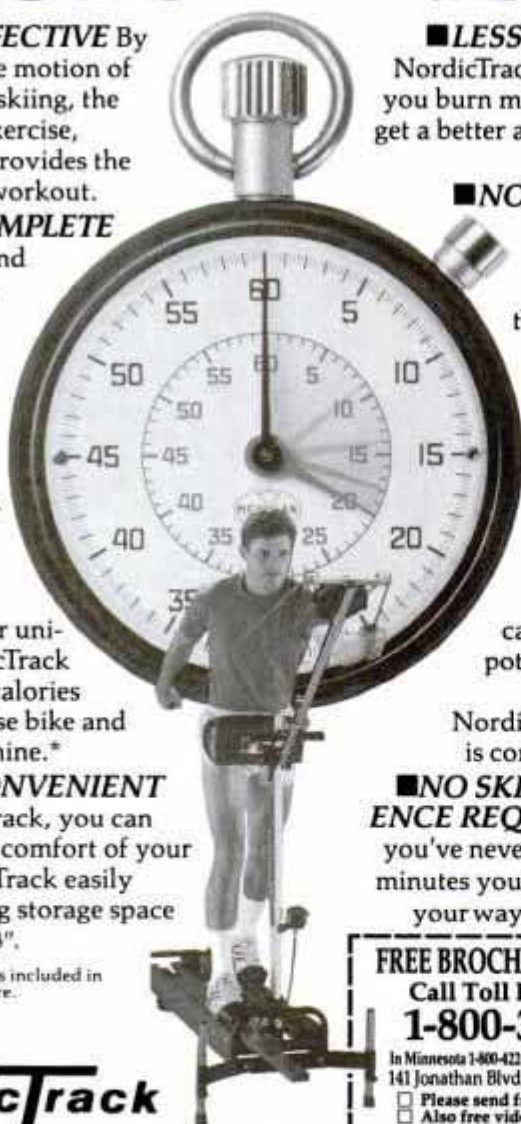
■ **MORE CALORIES BURNED** In

tests at a major university, NordicTrack burned more calories than an exercise bike and a rowing machine.*

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*Scientific test results included in NordicTrack brochure.



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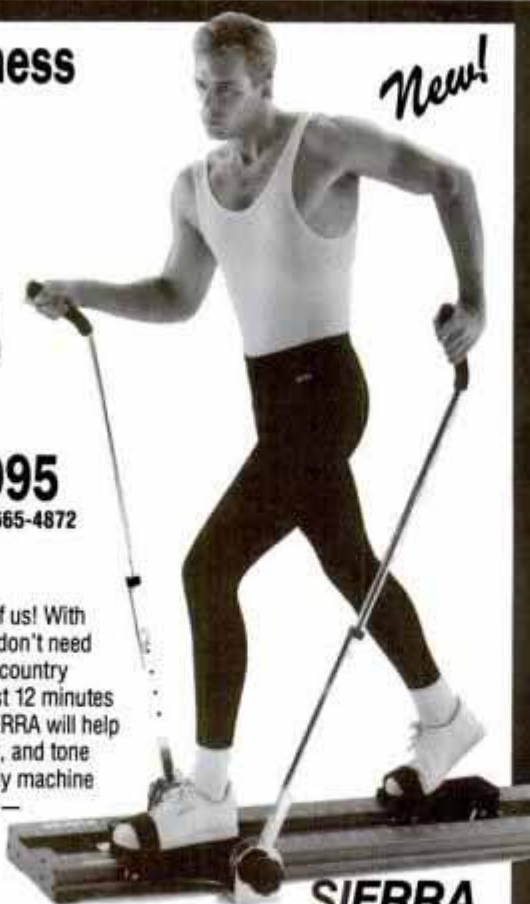
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Years of Testing and Use Have Proved it True!

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

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

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

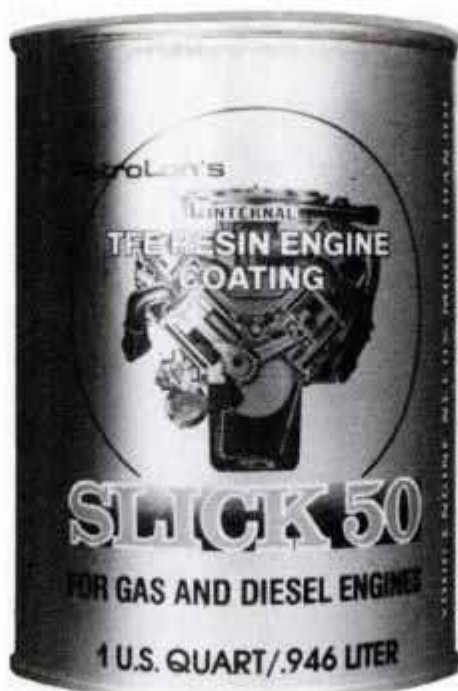
TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

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

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

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

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



It's Easy to Treat Your Engine

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

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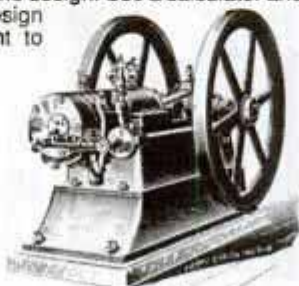
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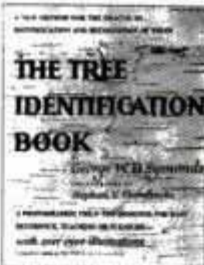


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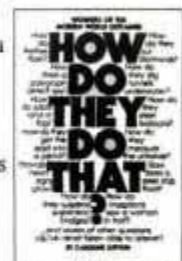


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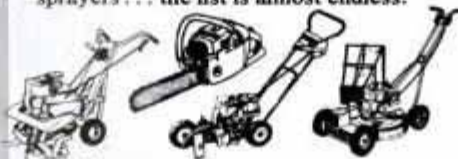
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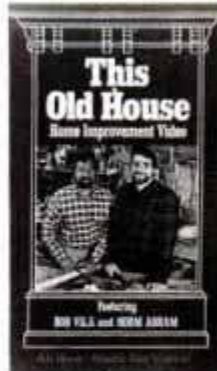
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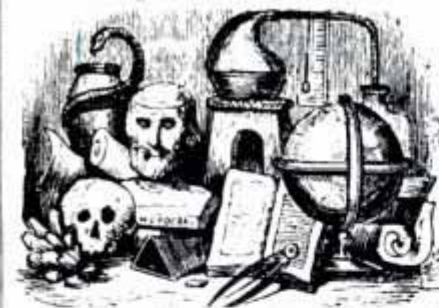


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HOW TO DRILL A BACKYARD WATER WELL

BILL HARRINGTON

I've been drilling water wells in Oklahoma for about 15 years.

When I first saw the ad that claims a man can drill his own water well with a Hydra-Drill, I was extremely skeptical. I thought to myself — how can that be? That's impossible. It takes a big rig to drill a water well. But my curiosity kept nagging me, so I sent off for the information.

My daughter's boyfriend is a well driller over in Arizona. I showed him the Hydra-Drill literature. His first reaction was, "I don't believe it. I don't believe a 3 hp. drill can do the same thing my 100 hp. drill does." But the more I studied it, the more it sounded like a good idea.

A WATER SHORTAGE

Another thing on my mind was the drought. We're having the worst drought here since the dustbowl days back in the '30s. A lot of towns around here all the way over to Tulsa are running short of water, and some of them have started water rationing. It's very hard on a lot of people, but business is good for well drillers. I'd been thinking about buying another drill and putting my son, Robert, in business. He's 18 years old, and he'd never worked on a drill before. I decided he could learn with a Hydra-Drill.

EASY SET-UP

Now when I started out in the drilling business 15 years ago, I had a big drill that just about worked me to death. Later, I got a rotary drill. It was easier to operate, but it took a day and a half to set up and drill a well in this area. You can't imagine how I felt when they delivered our Hydra-Drill. It was so compact, very simple. Robert and a young friend of his took it out and set it up in just a few minutes.

OUR FIRST HYDRA-DRILL WELL

The day we went out to drill our first well with the Hydra-Drill, I was all fixed to work with the boys and give them plenty of advice. However, it was a very hot day — about 100 degrees — and once they got started drilling, I could see they didn't need me standing right there; so I went over and sat down in the shade of a tree. In about an hour, they came over and I asked them if they were taking a break, and they said no, they had just finished drilling the well.

It was amazing. They had drilled down forty-seven and a half feet and hit a layer of beautiful, coarse sand — the kind that produces good water and a lot of it. They had drilled that well in less time than it takes me just to set up my big drill.



PHOTO BY TONY JACOBY

Later, I figured they had drilled that well with less than one gallon of gas. My big drill would burn up at least fifteen gallons of gas for that job!

MAKES MONEY

The next day we drilled a well 115 feet deep through rock, and it went fast too. The Hydra-Drill really takes the hard work out of it. It's fast and economical, and that's what it takes to make money drilling wells.

Also the Hydra-Drill is so portable we can set up and drill anywhere. In the past, I've lost out on some jobs because people were afraid my big drill would tear up their yard. With the Hydra-Drill, we can drill without tearing up anything or making a mess. This is a big selling point to my customers.

I'm just grateful to have this Hydra-Drill. I've got my son started in a good business he can make some money with. If I had bought another big drill, it would cost thousands of dollars, and that is just ridiculous because the Hydra-Drill does the job just as good. In fact, I figure we earned enough to pay for the Hydra-Drill the first week. From here on, we're in the blue chips.

GOOD, PURE WATER

I believe anyone can drill a well with a Hydra-Drill. Even if they just wanted to drill their own well, they'd save money. It's simple and it's easy if they just read the instructions. And the best part about it is that you get good, pure water without all those chemicals in it, and the water costs you, say, 5 cents for a thousand gallons. You certainly can't buy city water for that.

And it's a great feeling to have all the water you want even when the city is rationing water to everyone else.

The man who invented the Hydra-Drill really knew what he was doing. Modern technology is a wonderful thing, isn't it?

NOTE: Readers can get a big, fully illustrated kit on the Hydra-Drill including a booklet, "How to Drill Your Own Water Well". The information kit is available free, without obligation. Also, watch a Hydra-Drill well being drilled -- on videotape! Send \$5 with coupon. Call toll-free or mail coupon to the address below.

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"If man was meant to fly he would have been born with wings."
"Solar electric energy is still 20 years away."

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 President ● Solar Electric

Due to quiet but dramatic breakthroughs in solar electricity, the costs have come down. Utility companies and Wall Street insiders are beginning to buy up photovoltaic company stocks (ask your broker!). You may know that people are currently using solar cells for charging batteries for RVs and boats, for powering ham radios and running water pumps. **THESE ARE PERFECT APPLICATIONS OF SOLAR ELECTRIC ENERGY AND THERE ARE HUNDREDS MORE!**

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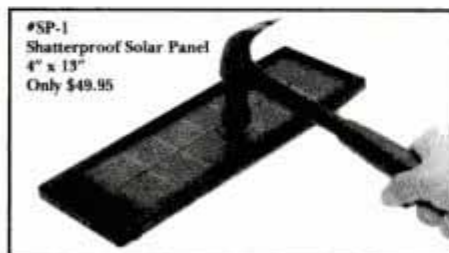
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Gary Starr, President
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COMPUTERS

(Continued from page 66)

tle" himself, gives you more than a good time. It sharpens your competitive instincts, too. The object here is to turn an expansion team into a championship squad, and you're involved on all levels.

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The point of view here is more cinematic than in *Earl Weaver Baseball*, putting you down on the field for every play. You get impressive player's-eye viewpoints in *Pete Rose Pennant Fever*, including perspectives from behind the plate, from second base and from the outfielders.

When your indoor baseball season's over, Mindscape has two first-rate simulations, called *Superstar Ice Hockey* and *Superstar Soccer*. (Commodore 64/128, \$35; IBM, Apple II \$40; Apple IIGS, Amiga \$45). Both offer outstanding animation and a host of details—in both games players not only tire during play, they age as the seasons wear on. Meanwhile, Mindscape's *Clubhouse Sports* and *Indoor Sports* prove that computer simulations don't necessarily have to take on big-time sports to provide hours of fun.

Offbeat thrills

With *Indoor Sports* you can compete at darts, bowling, Ping-Pong or air hockey. *Clubhouse Sports* adds six more indoor games: foosball, billiards, skeeball, crazy pool, pinball and a shooting gallery. You can play against a friend in a 2-player game, play by yourself against the computer, or just watch the computer go through its paces. *Indoor Sports* is available for the Amiga and Atari ST (\$50), the Apple II Commodore 64/128, and IBM (\$30). *Clubhouse Sports* (\$30) is for the Commodore 64, with new formats on the way.

Epyx, a leading sports-software publisher whose wide variety of simulations includes the recently introduced *Sporting News Baseball* (Commodore 64/128, Apple II, IBM, \$40), has moved out of the mainstream with some of its newer

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offerings. Promising radical thrills for up to eight players, *California Games* (Commodore 64, Apple II/IIGS, IBM, and Amiga \$40), features six diversions for what Epyx describes as the "totally tubular" set, starting—you guessed it—with surfing. Also on the disk are roller skating (on a beach boardwalk), skateboarding, bicycle motocross, Frisbee tossing and foot-bag (in which you try to escape from a sack without using your hands).

For those who have OD'd on conven-

tional sports, there's Epyx's definitely tongue-in-cheek *Sports-A-Roni*, a wacky multi-event game set in Italy (Amiga, IBM, Commodore 64, Atari ST, \$25). In this zany affair, players engage in a sack race down potholed streets in Naples, try to balance pasta plates near Pisa's Leaning Tower, pole vault across Florence's Arno River, and climb an olive-oiled pole in Verona. There's a pillow fight in a Venetian gondola, a boot toss in the Coliseum, and

(Please turn to page 140)

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COMPUTERS

(Continued from page 139)

up-the-wall runs and pogo stick parties in Roman ruins. Now that's Italian! Speaking of Italian, if you like racing, get behind the wheel of *Ferrari Formula One* by Electronic Arts (\$50).

MacSports

The Apple Macintosh, despite its reputation for great graphics, has gotten less attention from software publishers than it deserves, probably because until the colorful Mac II came along, the Mac was strictly a monochrome machine. Despite this color blindness, there are many excellent games available for the Mac, including XOR's carryover from the IBM environment, *NFL Challenge*, and Avalon Hill's *MacPro Football*.

Two Mac standouts come from Practical Computer Applications, Inc. in Champlin, Minnesota. *MacGolf Classic* (\$95), the enhanced version of the publisher's best-selling *MacGolf 2.0* (\$60), takes full advantage of the powerful Macintosh II, including 16-color graphics on that machine and compatibility with most large-screen monitors. The program includes six golf courses to play on, four more than the original version packaged as standard fare. The program also features nine practice greens and a driving range, and five enlargement options for closeup views when you're putting. You can run the program from either a floppy-disk drive or install it on a hard disk. The program very effectively simulates the joys—and frustrations—of real golf, with highly detailed graphics and realistic digitized sound effects.

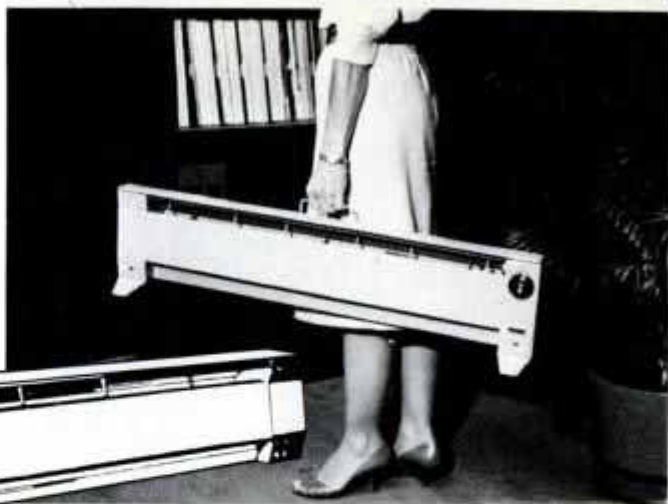
PCIA's second effort, *MacRacquetball* (\$60), makes the most of the Mac's magic, incorporating high-quality sound effects, stunning 3-D graphics, and impressive animation that's based on over 1000 frames of live-action video. This one gets right down to the squeak of tennis shoes on the floor!

More than just a game, this program qualifies as a full-fledged teaching tool that can help racquetballers master both technique and strategy. As with most of these games, you can control almost every conceivable aspect of play, including strength, agility, stamina and accuracy.

No easier to master than the real thing, *MacRacquetball* offers more than the solipsistic computer pleasures of you versus the machine. This game runs on Apple's AppleTalk network, so you can take on a friend at another workstation for a quick "nooner" without ever leaving your own workstation. Moreover, a good game of racquetball can now be as near as your phone—and your modem: You can play this game, in real-time, against someone thousands of miles away. All I can say is, "Serve!" **PM**

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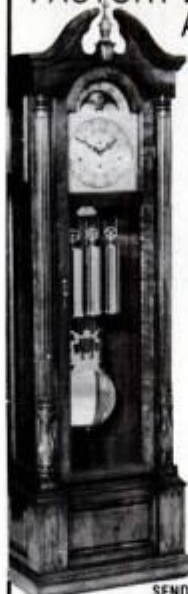


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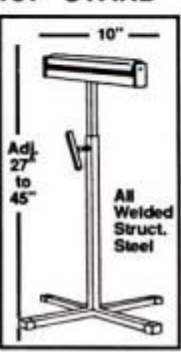
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