

Popular Mechanics

PM PROJECT



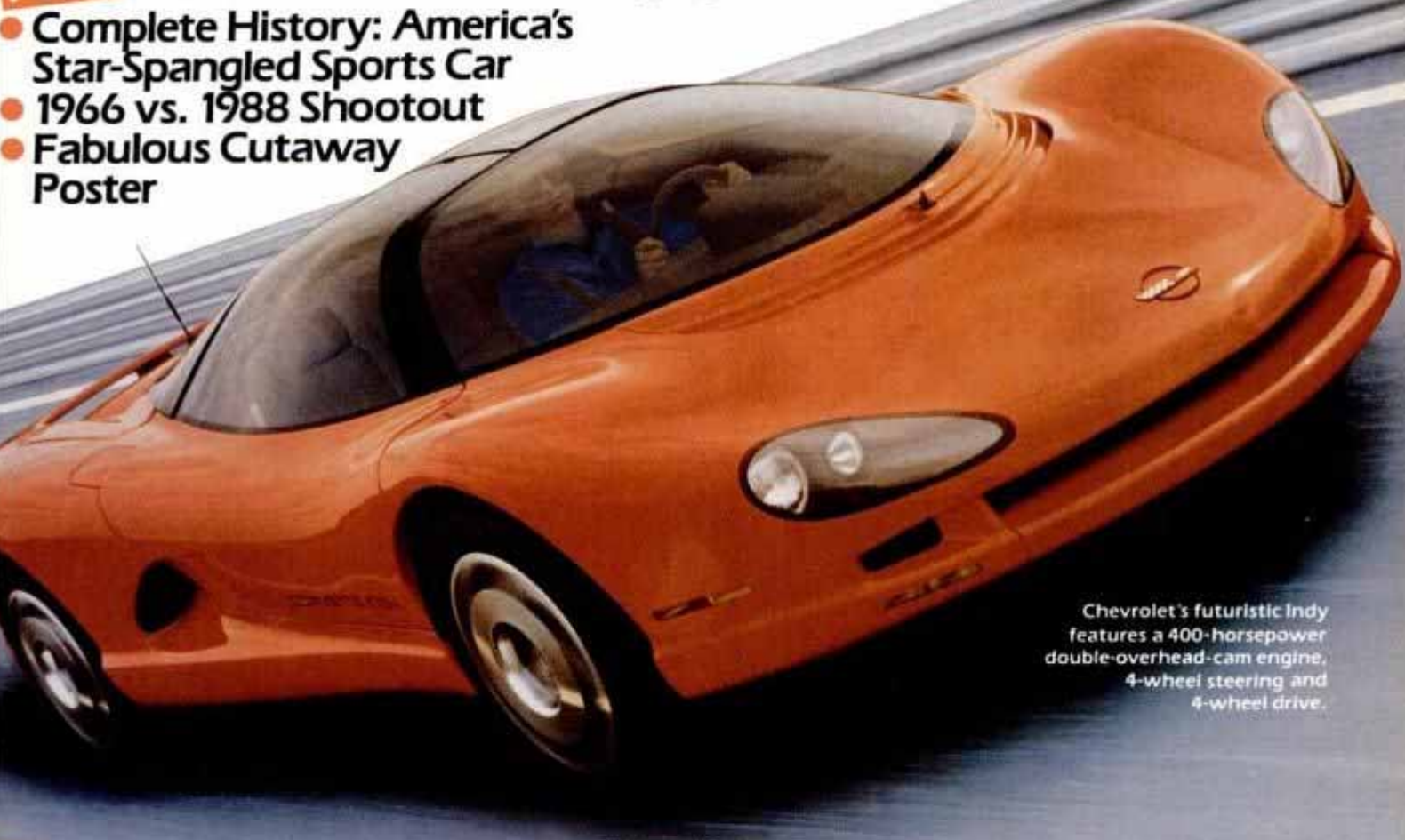
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AMERICA'S SPORTS CAR FUTURE

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PLUS A Corvette 35th Birthday Special

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- 1966 vs. 1988 Shootout
- Fabulous Cutaway Poster



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Radical Wing Design Makes Sails Obsolete

REVOLUTION IN HOME OFFICE ELECTRONICS
Work At Home. Forget Those Rush-Hour Blues



0

754744



There's one mini-van that stands apart from the crowd with its distinctive aerodynamic look—the Ford Aerostar. It offers optional touches of luxury and convenience, from headphone jacks and heating/cooling fan controls for rear-seat passengers, to an overhead console trip computer.

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4800 lbs. when properly equipped**

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Ford. Best-Built American Trucks—Eight Years Running. 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."

*Seat bed standard on Eddie Bauer model and optional on XL.

**Towing rating is reduced by passenger and cargo weight in towing vehicle.

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This One



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58 COVER STORY

The Chevrolet Corvette has been labeled the Great American Dream Machine, and since its inception 35 years ago, the seductive 2-seater has lived up to its legendary status with each passing year. Improving in power, speed and sex appeal with every redesign, its future promises only the ultimate.

—PM photo by Martyn Goddard

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EDITOR'S NOTES

IF THERE is one car that stirs the blood of every American male—and plenty of females—it is the Chevrolet Corvette. I'm on my fourth one and, still, every drive is like a new adventure. The Corvette is a car that has been lusted after since the first one hit the streets in 1953. Today, 35 years later, it's still America's only real world-class sports car. Legend has made the car somehow bigger than life. It's more than a car. It's a cult. You can prove that to yourself by going to any of the myriad Corvette shows that take place every summer. Used Corvettes have skyrocketed in value in recent years. Especially the rare models with rare options. For instance, a 1967 427 Sting Ray Roadster that listed for around \$5000 when new in 1967 recently changed hands for \$75,000. They even write songs about the Corvette. With this kind of interest in the car all America loves, and with the car celebrating its 35th birthday, we thought it fitting to salute the Corvette (page 58). Because it's a special car, we wanted a special writer working with us. Cliff Gromer, who has contributed several articles to POPULAR MECHANICS over the years, is the editor of *Vette* magazine. *Vette* magazine is the class act in its field, with lots of color photos and



Vette magazine Editor Cliff Gromer at work.

authoritative articles on the Corvette hobby. What better person to work with us to develop a special section saluting the past, present and future of America's favorite sports car? And if you appreciate fine art, check out David Kimble's cutaway poster of Chevrolet's futuristic Corvette Indy experimental car (page 67). Kimble flew to Lotus Engineering in England where they disassembled the actual Corvette Indy show car while he took notes. After reassembly, Auto Editor Tony Swan drove the Indy to bring you our exclusive report on a sports car you may be able to buy in a few years. It's this kind of extra effort and attention to detail that separates the men from the boys. . . . **Speaking of extra effort**, Science/Technology Editor Tim Cole recently spent three days on an attack submarine, the *USS Norfolk*, in and under the Atlantic, and a couple of days with William R. Anderson, the man who commanded the first nuclear-powered submarine, *Nautilus*. In fact, Anderson and Cole were aboard the *Norfolk* together to research the changes that have taken place in nuclear-powered submarines in the 30 years since the *Nautilus* made her historic transpolar crossing under the ice. As our article on page 51 reports, the contrast in machinery 30 years apart is startling. . . . **Some futurists** are saying that, soon, the formal office will be a thing of the past (page 76). We'll merely sit down in front of our home computer and be "at work." As efficient as that may seem to some people, I'll miss coming to the office every day. The social aspects of working in an office, and interacting with other human beings, are as important to most people as the actual work produced. Just as Earth's creatures have always gathered around the water hole for socializing, mankind gathers around the water cooler. And it's in an office. I hope that doesn't change for many, many years. 'Til next time.


Joe Oldham

Popular Mechanics

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LETTERS

Fancier French Doors

THANK YOU for your article on building French doors ("Two Sets Of French Doors You Can Build," page 104, Dec. '84). I built two pairs of the leaded-glass version and installed them in the door openings to our dining and living rooms. I did, however, make some changes to personalize them to our home. The doors and jambs were made of solid cherry and stained to match the dining room set. I added beveled glass diamonds in the glass pattern to dress it up, and treated the lead channels with patina to give them a formal, consistently dark color just as the natural aging process of the lead would do.

I discovered some work methods that might help other readers in tackling the leaded-glass project. I made the heat of my soldering iron adjustable by wiring a light dimmer switch and an outlet together. When used in conjunction with the iron I had much better control over the heat, eliminating both "cold" joints and vaporized lead. I also used my band saw to cut the lead to length. This eliminated having to reform the ends of the leaded channel after being compressed when cut with a lead knife.

BRIAN JENSEN
DUNLAP, IL

Nice job. Good tips. Readers can get a copy of the 7-page French door story by sending \$5.25 to POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101.

The Chase Is On

I was interested to see an item in PM May '88 (page 12) "Time Machine: 75 Years Ago: May 1913—Les Gangbusters." I've made a study



Reader Jensen's French doors use diamond-shaped insets.

of the origins and history of international anarchism and terrorism, and readers might be interested in a few minor corrections and additional information. The Parisian Apaches were particularly dangerous because of their innovative use of automobiles, including brand-new Darracqs and Renaults, as getaway vehicles. They were sometimes called the Motor Bandits. One of the most notorious Apaches was Peter the Painter, or Piatkov Peter, originally a native of Pskov, Russia. Four gang-leaders died in bloody police sieges—Bonnot (the Demon Chauffeur), Garnier, Dubois and Vallet. Bonnot and Dubois were dynamited in a garage at Choisy-le-Roi, April 28, 1912. Garnier and Vallet were surrounded and killed by 1000 troops and police at a Nogent-sur-Marne villa,

May 14-15, 1912. PM always makes fascinating reading—keep up the good work!

C. J. ARGYLE
LEICESTERSHIRE,
ENGLAND

Not By Speed Alone

I was amused by the unmanned radar speed trap in your June '88 issue ("Tech Update: Robo-Cop Speed Trap," page 15). Wouldn't it be nice if the law officials, or anyone else, could create a machine that would ferret out drunk drivers, and/or those operating motor vehicles under the influence of anything else. Speed properly handled, all other things being equal, won't kill anyone. It's when it's mixed with other factors, like inebriation or not knowing how to handle the car or situation, that brings 'em down. This machine only grabs the easy ones. How about inventing something that gets to the heart of the matter.

HAROLD A. TENCATE
GRAND RAPIDS, MI

T&P Valves

"How To Replace A Water Heater" in July '88 (page 107) was well done. As the Senior Member of the American Gas Association's Z21.22 Safety Committee for Temperature and Pressure Relief Valves, I would, however, like to call your attention to some points:

■ Only under the most unusual set of conditions would a T&P valve "bleed off excess steam pressure" should the control mechanism on the heater stick in the ON position. A T&P valve protects a water heater from overpressure and overtemperature.

An AGA-approved valve will begin to operate on over-temperatures at about 200°

F. It is designed to protect the system from *ever generating steam*. Steam would only be generated if at the same time the operating thermostat of the water heater failed, there would be no pressure in the system to allow the cold water to push the hot water out through the relief valve.

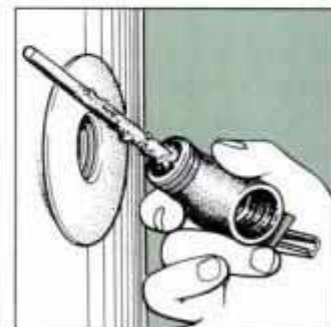
Since T&P relief valves are designed to and expected to discharge water, the piping of the drainline to a suitable drain *is vital*.

When a relief valve is called upon to protect the water heater, due to over-temperatures, the thermal element will open the relief valve and allow the large volumes of water to escape.

■ Good practice always would require a new relief valve to be installed with a new water heater. The cost of a relief valve is minimal, yet its safety features are extremely vital.

■ The critical thing to look for, when buying a T&P valve, is its BTU-per-hour rating, much more so than its psi set. Different relief valves have different BTU-per-hour discharge capacities and this must be matched or in excess of the BTU-input rating of the water heater.

DEANE E. MADDEN, P.E.
A. W. CASH VALVE CORP.
DECATUR, IL



Clogged T&P valve cannot protect for overpressure and temp.

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per cigarette, FTC Report Feb '85

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TIME MACHINE

75 YEARS AGO: SEPTEMBER 1913



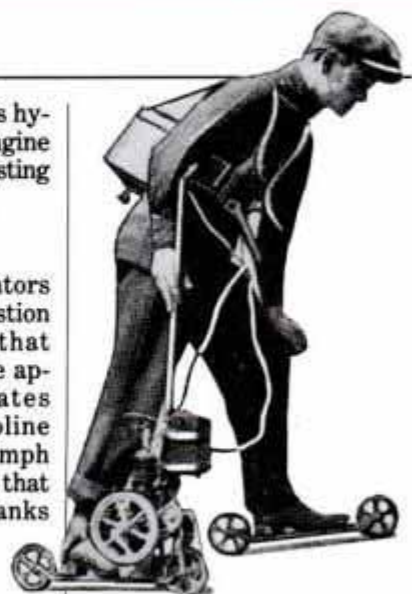
Power Canoe

The formative years of motorboating saw unbridled experimentation, naval architects borrowing freely from their automotive and aeronautical counterparts. In 1913 PM looked at aerial propellers, which were emerging from the shallow waters of the tropics to find employment on conventional boats. One New York State inventor equipped his canoe with a 5-ft. airplane propeller. A 7-hp motorcycle engine pushed the craft to 20-mph speeds. Meanwhile, a Michi-

gan boater souped up his hydroplane with a 90-hp engine and two outriggers consisting of galvanized-iron tanks.

Motor Skating

Pre-World War I inventors slapped internal-combustion engines on anything that moved. One memorable application: roller skates powered by ½-hp gasoline engines. Skaters did 8 mph gripping steadying rods that held engines and gas tanks upright. An electric version ran off hand-held batteries.



50 YEARS AGO: SEPTEMBER 1938



Gyro Fever

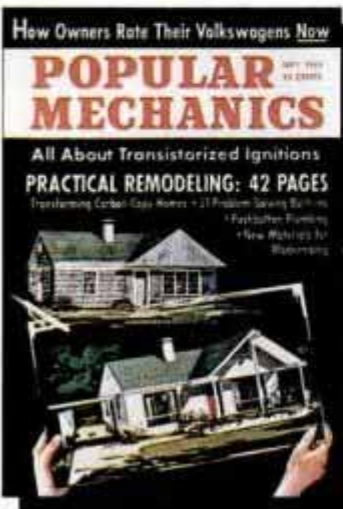
During the 1930s, while helicopter designers labored over prototypes, autogyros captured public enthusiasm. An autogyro pilot wrote in our September 1938 cover story that his machine gave wings to the motorist, and convenience and safety to the aviator. He predicted a future in which autogyros played the roles of family car, airport shuttle and military scout vehicle. But WWII spurred helicopter development, leaving autogyros as evolutionary curiosities.

Auto Amphibian

This hydrophilic hybrid floated on a watertight bank of air tanks welded under the chassis. Rubber collars and washers protected brakes and driveshaft. A separate transmission drove a motorboat propeller mounted behind the differential. To go boating, the driver simply shifted to the "wet" transmission. The 3-ton vehicle held 12 people and was capable of 80 mph on land and 20 mph on water.



25 YEARS AGO: SEPTEMBER 1963



Home Sweet Home

After the post-World War II boom in endless cookie-cutter housing developments, the 1960s became the do-your-own-thing decade. PM tapped that burgeoning spirit of individualism in our September 1963 cover story. We profiled some low-cost projects to personalize the ubiquitous modern split-level and other look-alike designs. Our suggestions included new siding, porches, chimneys, patios, windows and walkways to enliven carbon-copy homes. Costs ran to about

\$5000, which sounds like a bargain until you recall that in 1963 the median cost of a new home was \$18,000.

Lethal Weapon

Vietnam's jungle battlescape was the proving ground for the Armalite AR-15. The rifle's smaller size, lighter weight and minimal recoil made it a favorite among both South Vietnamese militiamen and the United States Special Forces in the early 1960s. But the .223 cartridge had a varmint-round reputation, and it wasn't until 1967

that the gun evolved into the mainstay long arm of the United States Army: the M16. **PM**





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Get More From Life... Buckle Up!



BIGGEST PAYLOAD IN ITS CLASS
2655 LBS.



*Including occupants, equipment, and cargo.
**With manual transmission and optional Towing Package. Not to exceed GCWR of 6500 lb. Requires an additional 5000-lb. weight-carrying frame-mounted class III tow hitch.
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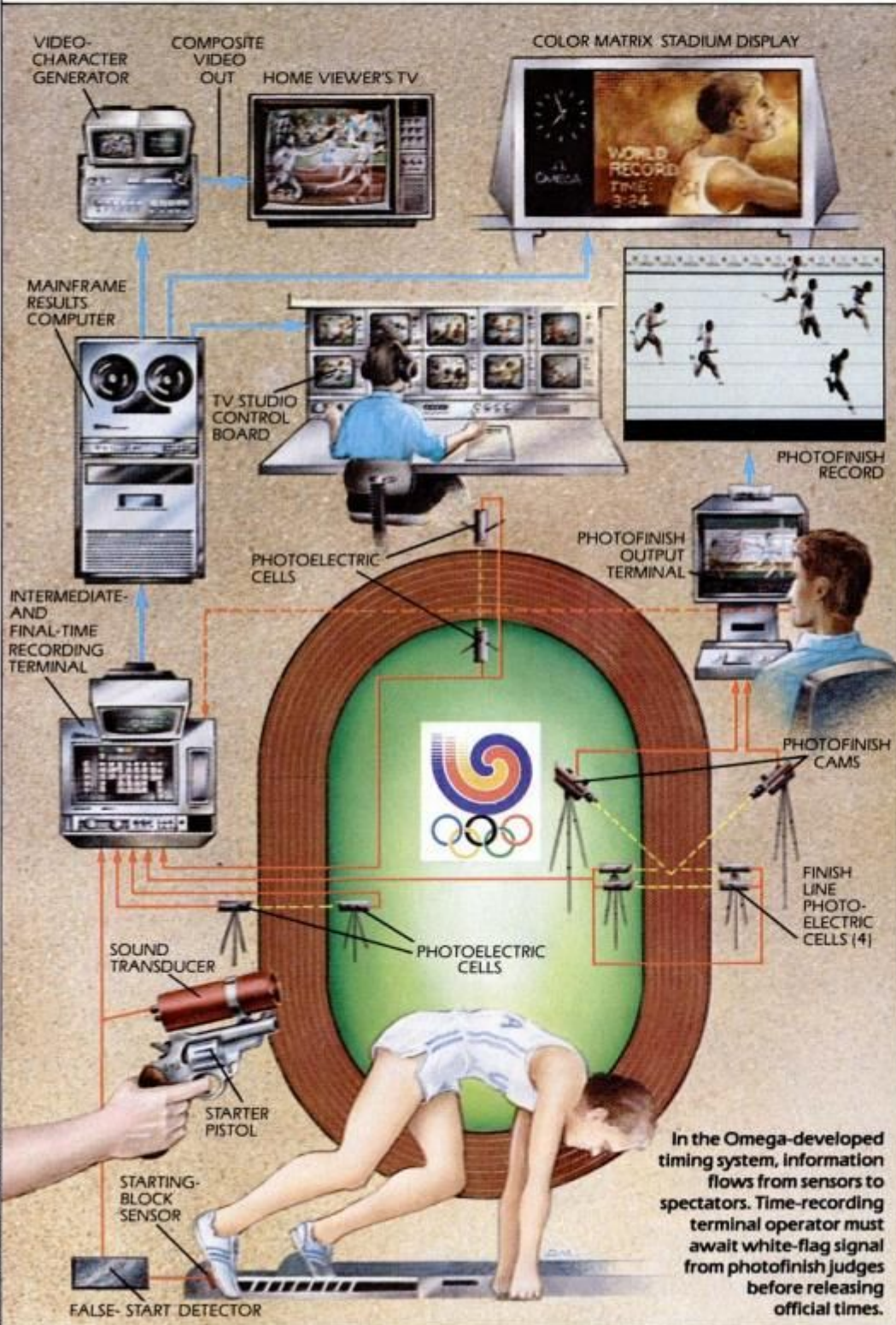
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WHO COULD ASK FOR ANYTHING MORE!

TECH UPDATE

Latest Timing Tech To Clock Summer Olympians

OMEGA PHOTO

PM ILLUSTRATION BY DON MANNES



SEOUL, SO. KOREA—Omega Sports Timing technicians have installed a vast network of sensors, cameras, quartz crystals, recorders, processors and cables in the Olympic Stadium at Seoul Sports Complex. For the first time, stadium spectators and home television watchers will get the same instantaneous intermediate and final times, because data from photoelectric cells positioned around the track will flow simultaneously to the stadium scoreboard and TV production booths.

At the start of an event, a transducer mounted on the starter's gun converts the cartridge's explosion into an electrical signal that starts the clocks running. The signal also flows to a processor that monitors pressure sensors behind the starting blocks to keep track of false starts.

At the finish line, two pairs of photoelectric cells capture the finishing time of the first arrival. Meanwhile, the now-traditional photofinish cameras provide judges with a visual record of runners crossing the finish line for official determination of places.

Inside the photofinish cameras, film runs continuously behind a shutterless .004-in. aperture aligned with the finish line. Time is plotted along the bottom edge of the film, and the film moves at a speed synchronized with the speed of the runners. Thus, when runners cross the finish line, their images are frozen over their finish times.

In the Omega-developed timing system, information flows from sensors to spectators. Time-recording terminal operator must await white-flag signal from photofinish judges before releasing official times.

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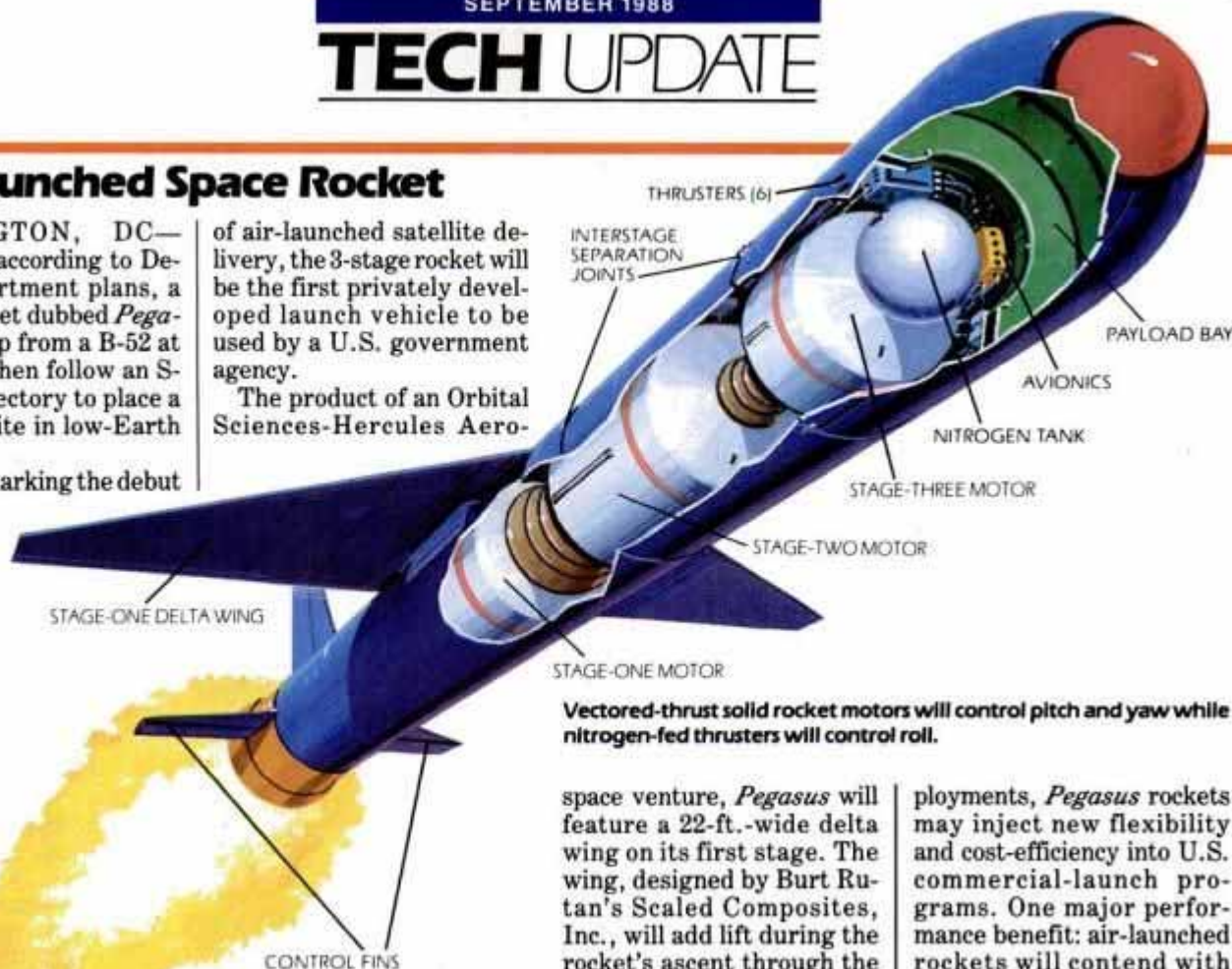
Air-Launched Space Rocket

WASHINGTON, DC—Next year, according to Defense Department plans, a winged rocket dubbed *Pegasus* will drop from a B-52 at 40,000 ft., then follow an S-shaped trajectory to place a small satellite in low-Earth orbit.

Besides marking the debut

of air-launched satellite delivery, the 3-stage rocket will be the first privately developed launch vehicle to be used by a U.S. government agency.

The product of an Orbital Sciences-Hercules Aero-



Vectored-thrust solid rocket motors will control pitch and yaw while nitrogen-fed thrusters will control roll.

space venture, *Pegasus* will feature a 22-ft.-wide delta wing on its first stage. The wing, designed by Burt Rutan's Scaled Composites, Inc., will add lift during the rocket's ascent through the atmosphere.

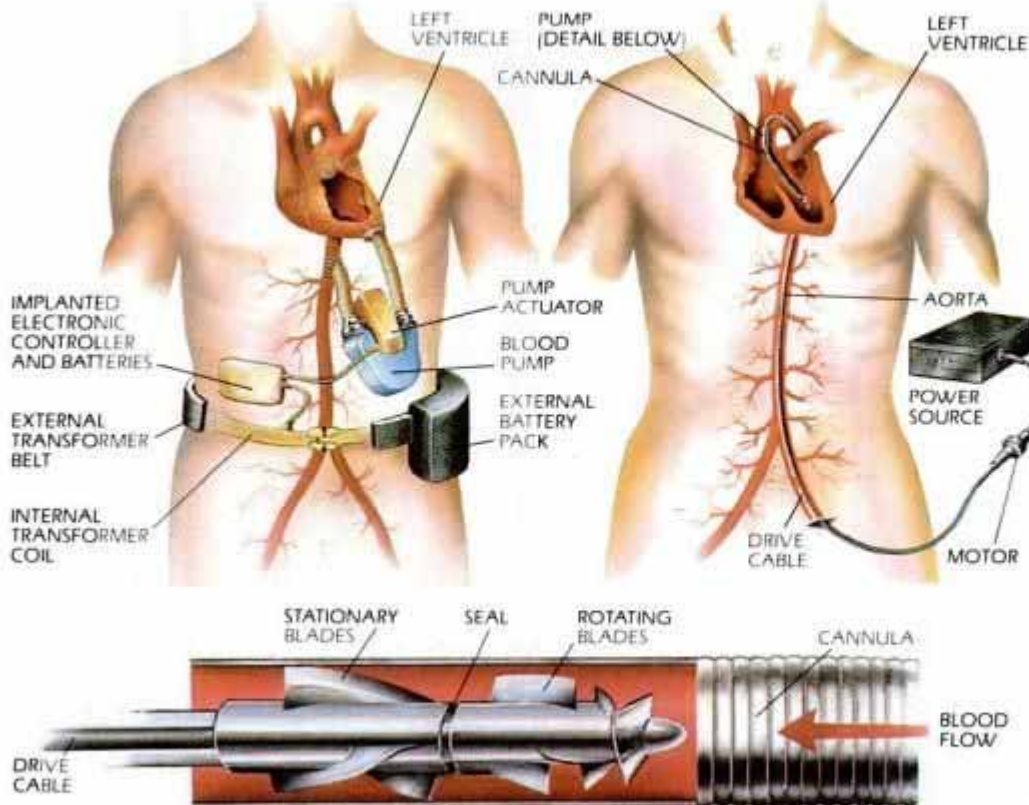
Beyond handling Defense Department and NASA de-

ployments, *Pegasus* rockets may inject new flexibility and cost-efficiency into U.S. commercial-launch programs. One major performance benefit: air-launched rockets will contend with only 25 percent of the atmosphere that resists rockets launched at sea level.

Simpler Alternatives To Artificial Heart

LVAD

HEMOPUMP



LVAD will run off external or internal batteries. Hemopump's blades pull up blood through cannula.

BETHESDA, MD—Recent decision by the National Institutes of Health to suspend, then reinstate, sponsorship of artificial-heart research has put the spotlight on alternative technologies.

Federal funds will now also go toward development of the left-ventricular assist device, or LVAD. One promising model, developed by Novacor Medical Corp., uses a solenoid-based actuator, rather than compressed air, to pump oxygenated blood into the aorta. Several hospitals have used externally powered versions as temporary bridges to heart transplants. Novacor is currently developing a permanently implantable version.

Meanwhile, for temporary emergency applications, Nimbus Medical, Inc. has developed a pump that can be threaded into the left ventricle in 20 minutes. The externally powered Hemopump takes the workload off a heart weakened by acute cardiac arrest.



THIS IS THE STUFF THAT KILLS WATER HEATERS.

The Reliance Sta-Kleen® 805 gas water heater has the cure for killer sediment buildup.



Sediment inside the tank of an ordinary water heater can be deadly. It destroys efficiency increasing fuel use. And it promotes corrosion causing premature tank failure.

Sta-Kleen's patented self-cleaning design creates a vortex of turbulence inside the tank to prevent sediment accumulation. So it takes advantage



of the economy of gas for years of trouble-free operation. Years of more hot water for less money.

And every Reliance Sta-Kleen 805 comes with an 8-year limited warranty on the tank and a 5-year limited warranty on all parts.



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For the name of your nearest Reliance dealer, just call 1-800-365-4054.

Gas. America's best energy value.
© 1988 American Gas Association

Gas heats water for one-half the cost of electricity.

Sta-Kleen 805 is manufactured under patent number 4,505,231.

Propfan Mufflers

SANTA CLARITA, CA—Lockheed engineers are testing resonators that will absorb the noise generated by propfan propellers. Each 5-in.-dia. hemispheric resona-

tor includes a replaceable tube-like nozzle. The length and diameter of the nozzle determine the sound frequency trapped by the resonator. On a commercial plane, resonators would fill space between the inner cabin wall and outer airframe.



Series of 225 Hz resonators flew in propfan-modified test plane.

Laser Missile Simulator



Slide projectors cast terrain background inside simulator dome.

STEVENAGE, ENGLAND—A new combat simulator for British Aerospace's Rapier air-defense system uses lasers both to project target images and simulate hot missile plumes. Laser-target projections, manipulated by an instructor at a computer console, move with attitudes consistently realistic from trainees' perspective.

Robot Armored Vehicles To Navigate With Lasers

ANAHEIM, CA—Remote-control tanks may find their way around tomorrow's automated battlefield with a laser-navigation system now being explored by Odetics, Inc. The research project, funded by

the Army's Tank Automotive Command, is aimed at a system to update inertial-navigation systems, which tend to drift and lose accuracy over time.

Instead of relying on Global

Positioning System satellites, a robot vehicle would fire laser rangefinders to ascertain distances from surrounding hills or other elevation features.

The tank would then corre-

late the distances with digital terrain maps in an on-board computer.

The wholly self-contained system could eliminate vulnerability to electronic jamming or antisatellite warfare.



Vehicles controlled by mother tank (right) check laser rangefinder distances against digital terrain map (inset).

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GE HALOGEN HEADLAMPS.
Single beams. H5001, H5006,
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BEAMS. SALE 11.96 ea.

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Installed at no additional charge in stores
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DE-BUG SHIELD.
62" or 48". Smoke, red or
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and vans. Mounting
brackets sold separately.

Deflecta-Shield
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SLIDING TRUCK WINDOW.
Clear glass, aluminum frame, sizes
to fit many trucks. Style & mfg. may
vary.

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Wheel-to-wheel. 68" or 85"
extruded. For most pickups and
vans.
96" RUNNING BOARD, 79.97

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Heavy-duty rubberized vinyl. Has pre-
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SIX-INCH OFF-ROAD LIGHT.
100-watt, round halogen truck light.

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NINE-INCH RECTANGULAR.

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**STAINLESS STEEL UNIVERSAL
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Universal light bar for most trucks.
Available in most stores.
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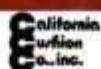
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**CLASSIC VELOUR
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High or low backs.

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PICKUP MATS.
Twin front for full-
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KRACO



**FOUR-PIECE
CARPETED
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Twin front and
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PORTABLE WINCH.
2000-pound capacity.
Take a load off pulling
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Model #P-2000 with case.

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DELUXE CAR COVER.
35% cotton, 65% polyester.
Water repellent. All-elastic
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With plastic storage case.

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SIX-TON WITH CASE 16.97

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TWO-TON HYDRAULIC FLOOR JACK.
Swivel casters. Compact for home or business.
Model 41-14. Style and mfr. may vary.

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THREE-TON JACK STANDS,
SALE 19.97 PAIR



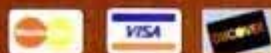
AIR TOOL MAIL-IN OFFER.
Purchase a 2 H.P. air compressor and receive a drain cleaner, air chisel, or spray gun at no additional charge, direct from the mfr. Details in store.



TWO-HORSEPOWER AIR COMPRESSOR.
125 PSI air compressor mounted on a 20-gallon tank. Includes 15' air hose, tire chuck, fast couplers, inflator kit, blow gun.

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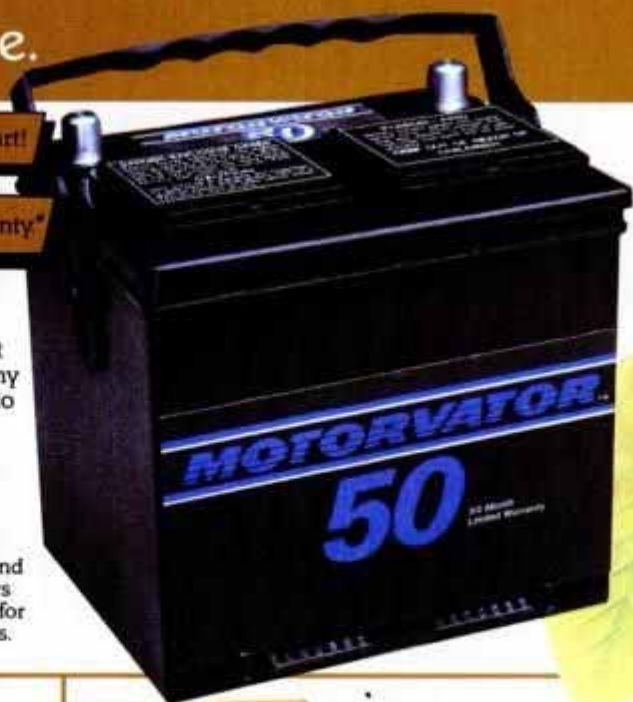
MOTORVATOR 50 BATTERY.
Premium starting power. Excellent replacement battery. Sizes for many U.S. and import cars. Delivers up to 450CCAs. Mfr. may vary.

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WITH EXCHANGE

Installation available in stores with service.

Starters and alternators available for many cars.

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Schauer

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DELUXE ROLL AROUND CHARGER.

For fast charging and boosting 6- or 12-volt batteries. Features one-hour timer and automatic shut-off. Manufacturer may vary.

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SALE
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TEN-AMP MANUAL BATTERY CHARGER. Mfr. may vary.



CAROL

12ft 8 GAUGE All Copper BOOSTER CABLE



12-FOOT 8-GAUGE BOOSTER CABLES

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12ft 10 GAUGE All Copper BOOSTER CABLE

12-FOOT 10-GAUGE BOOSTER CABLES. Heavy-duty copper. Tangle-proof. For side or top terminals.

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8 FOOT 10-GAUGE HEAVY-DUTY BOOSTER CABLES.

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PORTABLE AIR TANK. Six-gallon tank with on/off switch, solid brass manifold, pressure gauge and industrial hose.

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ARMOR ALL
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Protects and beautifies. 16 fl. oz.
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64-OUNCE ECONOMY REFILL SIZE.
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SWIRLON MARK II BRUSH.
Water-powered brush with hose connector. Cleans cars, RVs, home or vans.
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TURBO WASH PRESSURE WASHER.
For home, autos, trucks, vans, RVs, boats, motorcycles, windows. With 16 oz. of Soft Suds.
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Great for wheels, tires, floor mats, upholstery and many household uses. 24 fl. oz.
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MR. RATCHET SCREWDRIVER SET.
Complete with six bits and seven sockets.
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DL Blue Label

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Cleans without water
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DL HAND CLEANER.
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WIPER BLADE & REFILLS.
Popular sizes to fit many U.S. cars and light trucks. Choose one blade or pair of refills 16-19".
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ECONOMY SIZE WD-40.
Multi-purpose lubricant stops squeaks, protects metal, loosens rusty parts, frees sticky mechanisms. 12 fl. oz.
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10-GAL. PLASTIC WET/DRY SHOP VACUUM.
Includes six-foot hose, two extra wands, and 10-inch nozzle.
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SPRAY
PAINT.
 Dries in minutes, recoats any-time, uniform coverage, clean and easy. No runs, no drips or errors. Choice of colors.

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 Net wt. 11-12 oz.



ELMER'S
READY-TO-USE
COMPOUNDS.
 Patch small holes and cracks. Use indoors or outdoors. Pint.
REDI-SPACK, SALE 1.37
WOOD FILLER OR GLAZE TUFF,
SALE 1.77



10BC FIRE EXTINGUISHER
 U.S.C.G. AP.
 UL rated
 10-B:C,
 effective on
 gasoline,
 kerosene,
 grease, oil
 and other
 flammable
 liquids. Dry
 chemical
 type.

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2BC KITCHEN FIRE
EXTINGUISHER . . . SALE 8.77.



"MASK IT!"
 One-hand tape applicator, cuts precisely and evenly. Ideal for window and door trim, baseboards, wall and ceiling edges.

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HEAVY-DUTY
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 Use for jobs such as houses, garages, decks, and fences. Sprays up to one gallon of latex in 20 minutes. Complete 10-piece outfit.



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FIRST ALERT SMOKE
DETECTOR.
 Detects smoke. Battery test button. Beeping signal for low battery.

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DETECTOR . . . SALE 6.97



GR60 ELECTRIC
GLUE GUN.
 Heavy-duty trigger feed regulates glue flow. Reliable solid state circuitry, easy to use, and no mess. Retractable front stand keeps hot glue gun upright when not in use.

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30 CT. GLUE STICKS, SALE 4.96.



6 oz.
KWIK
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SALE
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ACRYLIC
LATEX
CAULK.
 Mildew and moisture resistant, paintable, and easy to clean-up.

SALE
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Net Wt. 10.5 oz. tube



STURDY UTILITY TOOL BOXES.
UTILITY HIPROOF TOOL BOX 16" x 7 1/2" x 7", SALE 7.88

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It's a home sale



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FASHION FRESH INTERIOR PAINT. Custom-tinting available, six-year durability, easy cleanup.

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PERFORMER EXTERIOR PAINT. 10-year durability, one-coat coverage, fade-resistant colors, easy soap-and-water cleanup, can be used on all surfaces. Tinting at no extra cost.



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OUR BEST INTERIOR FRESH LOOK PAINT. Soap-and-water cleanup, superior washability, excellent stain removal, fast dry, tough durable finish, easy to apply.

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SEMI-GLOSS, SALE **9⁹²**

All paints available in choice of colors.



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MISER FLOOD LIGHT.
Indoor flood. 50 watts of lighting for only 45 watts of cost.



SALE
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25-40-60-WATT BULBS FOUR-PACK.
Decorative bulb, candelabra base, and bent tip. Clear or frosted.

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Pkg.



40-WATT BULBS MEDIUM BASE FOUR-PACK, SALE 1.99



55-70-95-WATT SOFT WHITE MISER BULB FOUR-PACK.
Less glare and fewer shadows. Lower energy cost.

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FIVE-WATT NITE LIGHT BULBS, FOUR-PACK.
Lower wattage, white and clear color.

SALE
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Pkg.

FULL RANGE ROTARY DIMMER.

On/off switch. Adjustable brightness level. Solid state. 75 watt to 600 watt. Maximum 1200 AC incandescent only.

SALE
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SIX-WAY TAP.

Grounding hex tap in brown or ivory color. Rigid plastic construction with flat base. Converts duplex three-wire grounding receptacle to six grounding taps. For temporary or permanent installation.

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AIR TOOLS.

Your choice of 3/8" air drill, air hammer, 1/2" impact wrench, 3/8" air ratchet, or dual action sander.

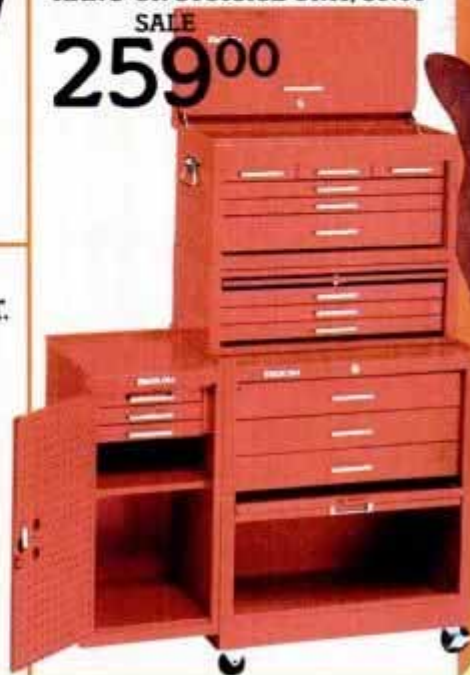
SALE
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HI-SPEED SANDER,
SALE 19.97

FOUR-PIECE MECHANICS' TOOL CHEST SET.

INDIVIDUAL PIECES ALSO SOLD SEPARATELY.
6-DRAWER CHEST, SALE 69.00
3-DRAWER CABINET, 92.00
3-DRAWER ADD-ON CHEST, 39.00
HANG-ON STORAGE UNIT, 59.00

SALE
259⁰⁰



14-PIECE 3/8-INCH DRIVE SOCKET SET.
Your choice of fractional or metric sets with case.

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16-PIECE 1/4-INCH DRIVE SOCKET SET OR 1/2-INCH DRIVE TORQUE WRENCH.
SALE 9.97

Only at K mart.



Purchase \$8.00 worth of Stanley tools, and receive a home video of your choice. Also enter to win 1000 Stanley tools, a library of 24 home videos, one of nine Chevy Trucks, or a grand prize of a Chevy Truck and a \$20,000 home improvement. Details in store.

STANLEY TOOL SALE — 25% OFF



12-INCH SQUARE.
Grooved blade. Scratch owl. Level vial.

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6 5/8-INCH BLOCK PLANE.
Hand adjustable. Tempered steel cutter.

SALE
8¹²



16-OUNCE FIBERGLASS HANDLED HAMMER.
Curved claw. Exclusive tapered design and rim tempered face for safety. Vinyl grip for comfort.

SALE
9³³
STANLEY

50-FOOT CHALK REEL.
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24-INCH ALUMINUM LEVEL.
Three 360 degree cat's eye vials. Dust-resistant vial covers. Handy hand holes. Aluminum body.

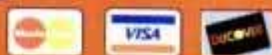
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MAGNETIC TIP SCREWDRIVER.
Aluminum magnetic shank. Five screwdrivers in one, five bits stored in handle. Black oxide protected bits.

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9509 CAR VAC.
Compact 12V car vac. Plugs into cigarette lighter. For cars, vans or RVs.

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9013 CORDLESS DRILL.
Lightweight. 3/8" two-speed cordless drill. Complete with three-hour charger, chuck key, and double-ended screwdriver bit. 300-600 rpms. Ideal for around-the-house jobs.

SALE
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9530 EIGHT-INCH RANDOM ORBIT POLISHER.
Professional quality. Polishing bonnet and two wax applicators.

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7391 CIRCULAR SAW.
2 1/8 HP saw. Wraparound steel shoe. Two handles for greater control. Includes 7 1/4" combination blade.

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9537 SIX-INCH SANDER/POLISHER.

Professional quality. 1/3 HP. Polishing bonnet, backing pad, and three assorted sanding discs.



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7571 SCROLLING ONE-INCH JIG SAW.

Two-speed. High speed for wood and compositions; low speed for metal cutting. Built-in sawdust blower keeps cutting line clear.

SALE
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THE ULTIMATE TEAM MEANS THE ULTIMATE IN PERFORMANCE.



Bullet

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BULLET™ DRILL BITS

Drill up to 4 times faster in metal and last up to 7 times longer. 8-PIECE SET

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PIRANHA® CIRCULAR SAW BLADES

Cut faster and last up to 50 times longer than steel blades.

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SALE

LIGHT MAKER GARAGE DOOR OPENER.

½ HP. Turn on indoor/
outdoor house lights
from the safety and
convenience of your
own car. Variable
light time delay. One
lamp module
included.



SALE
168⁰⁰

½ HP GARAGE DOOR OPENER.

½ HP opens 18' x
7½' doors. Safety
reverse. 4½-minute
light time delay.
Multiple digital codes
for greater safety.
Quiet direct gear
drive. Solid state.



SALE
139⁰⁰



52-INCH HUNTER CEILING FAN.

SALE
68⁸⁸

Three-speed, reversible. Two
extra capacitors allow motor
to run efficiently and quietly
even at low speeds. Specially
designed stronger hanger
system reduces vibration
noise. Non-tarnishing,
scratch-resistant brass
finish.

- Wood and brass
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EVEREADY HEAVY-DUTY BATTERIES.

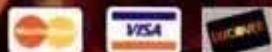
Use for clocks, cameras,
flashlights, stereos and more.
Eight-pack "AA", six-pack "C", or
"D" cell.

YOUR CHOICE

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ON SALE AUGUST 25 THROUGH SEPTEMBER 10 AT MOST K MART STORES ACROSS THE U.S.A.

Probing Chemistry Of Stars

MOUNT LOCKE, TX—A new low-cost telescope here will aid spectroscopy—the analysis of light energy at discrete wavelengths. Penn State University and the University of Texas are co-operating on the project.

The Spectroscopic Survey Telescope (SST) will cost only \$6 million—a bargain compared with telescopes of similar light-gathering capacity. Two key money-saving features: a modular primary reflector made up of dozens of smaller mirrors, and an immobile base.

The modular design eliminates expenses in casting a single 27-ft. mirror. Though the reflector's shape is a section of a sphere, rather than a paraboloid, the resulting im-

age distortion doesn't affect spectroscopy.

The stationary base makes unnecessary the precision machinery that would move the primary mirror. Typically, large telescopes have to track celestial objects as the Earth's rotation moves them across the sky. But on the SST, twin light receivers—mounted on rails 40 ft. above the reflector—take care of the tracking movement, guided by TV cameras housed behind secondary mirror assemblies. The secondary mirrors focus most of the light onto an optical fiber, which carries the light to spectrographic equipment.

The SST will provide data on the chemistry of many of the fainter objects in the sky.



PLESSEY ILLUSTRATION

Robot submarine can turn any vessel into a minesweeper.

Robotic Mine Hunter

TEMPLECOMBE, ENGLAND—A remotely operated vehicle (ROV) tracks down and destroys mines in an operation developed by Plessey Naval Systems.

Tethered by a 3280-ft. power and data-transmission cable, the ROV swims ahead of its parent vessel. On-board search-sonar sweeps an area ahead of the vehicle, which then focuses a high-frequency sonar beam to aid identification of detected objects. Final classification is made via TV camera.

The ROV can hover over an identified mine, thanks to tandem fore-and-aft propellers, as it lowers a disposal charge. The remote operator detonates the charge acoustically after the ROV withdraws to a safe distance. Plessey has matched the ROV with a containerized control console for rapid deployment in troubled waters.

Shaking Truck Predicts Quakes



LRL PHOTO

Vibrator's internal piston slams housing to create seismic waves.

PARKFIELD, CA—Every month here on the San Andreas Fault, a 26-ton truck lowers its midsection, raises its wheels and shakes, producing waves of vibration that seismometers can detect 9 miles away.

Researchers at Lawrence Berkeley Laboratories use the seismic waves to look for new cracks in the fault. Such cracks, which may herald catastrophic failure, change the speeds of sound waves traversing the rock.

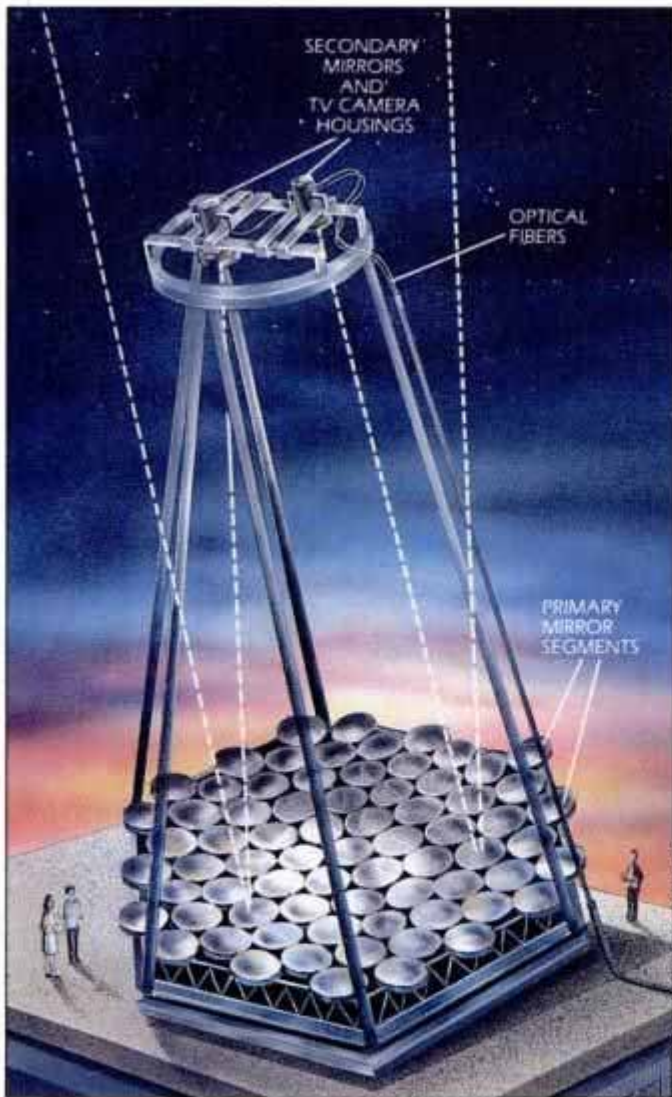
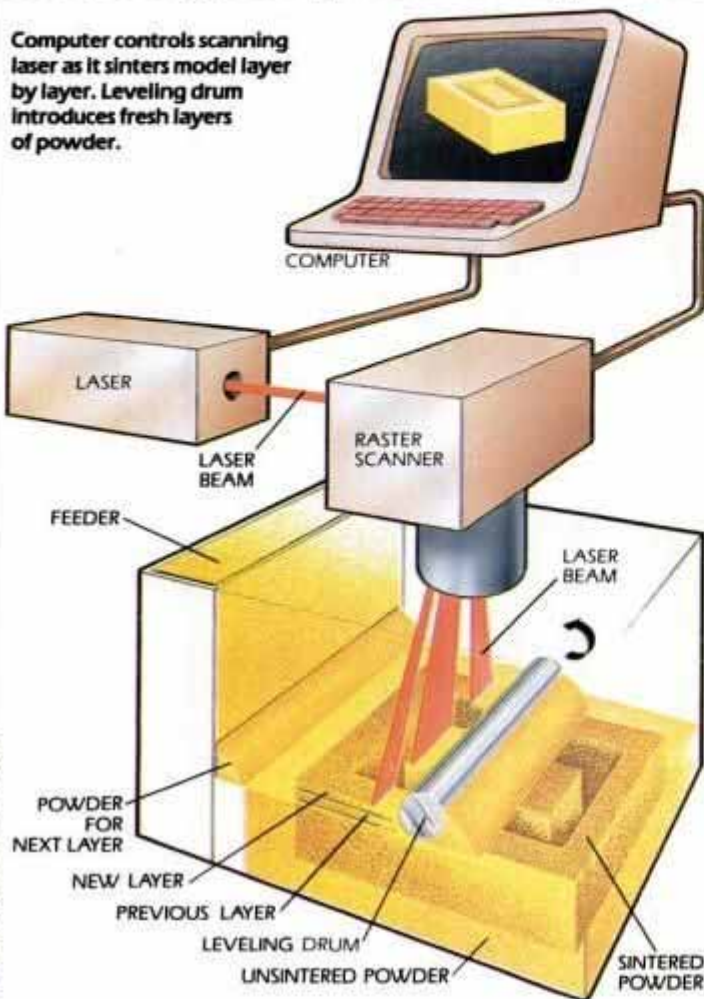


ILLUSTRATION BY LEON MARWEL

Light receivers can track independently two objects 12° apart.

Modeling Computer Designs With Lasers

Computer controls scanning laser as it sinters model layer by layer. Leveling drum introduces fresh layers of powder.



AUSTIN, TX—Lasers forge 3-dimensional models from computer designs in a new method invented by a University of Texas engineer.

Carl Deckard's process, known as selective laser sintering, begins with the arrays of data that describe a computer-designed object. The information flows to a laser and a raster scanner. Based on the data flow, the laser turns on and off, while mirrors and prisms inside the scanner cause the beam to flash back and forth across a layer of plastic powder.

The laser beam hits the powder in key areas, its heat fusing particles into solid plastic—a process called sintering. The beam follows a rolling drum that flattens out a layer of powder, then raises itself and pushes a new layer across.

The apparatus may rival stereolithography as a modeling adjunct to computer-aided design. Guided by CAT and PET scans, the process could one day give doctors 3-dimensional models of bones, organs and tumors.



Left finger has sensor pad.

Fingers Help Robot Hand

UNIVERSITY PARK, PA—Three fingers, controlled by step motors and airflow valves, can grasp a variety of objects in a versatile new robot hand designed by Penn State engineer Uri Tsach.

Each polyurethane finger is flat on the inside and belled on the outside. When filled with air, the finger bends because the belled side elongates more than the flat side. Grip firmness is controlled by adjusting airflow independently to each finger. Meanwhile, the step motors can rotate the fingers into different gripping modes.



RPV Packs Latest Recon Tech

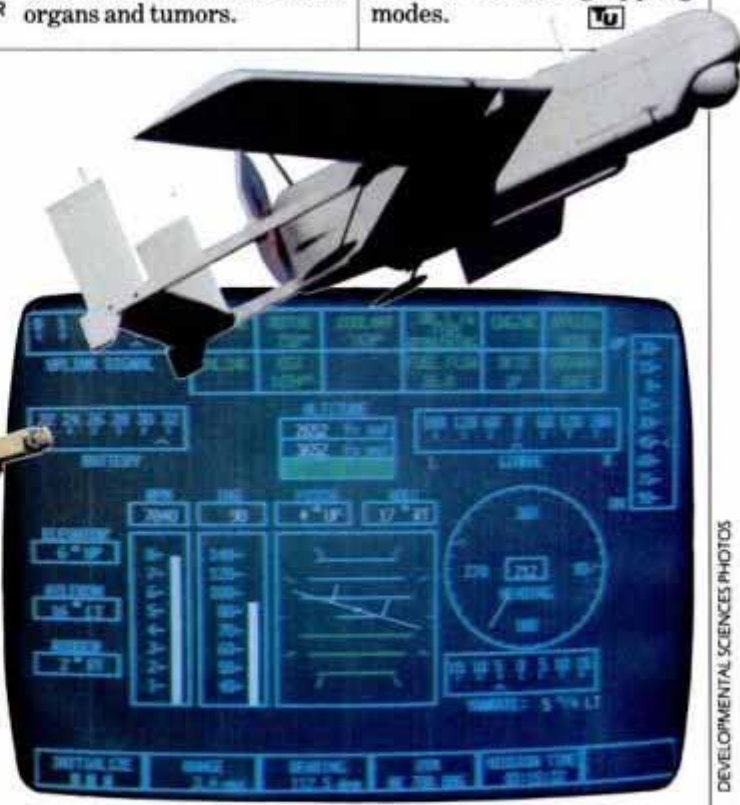
ONTARIO, CA—A new remotely piloted vehicle promises to address problems that have plagued RPVs like the canceled Aquila.

Developmental Sciences Corp.'s newest Skyeeye model has a forward-looking infrared camera for nighttime or bad-weather missions. The vehicle can hold such payloads as radar-jamming apparatus or panoramic cameras. Ground-based tracking

of the new Skyeeye is based on optically stored video maps. Associated software allows operators to preprogram flight paths and fill in maps with objects located by the RPV. The combination of air and ground improvements may bring Skyeeye attention as a joint-service effort gets under way to field a family of workable RPVs by 1991.



Skyeye is launched from truck-mounted catapult. Air vehicle has 20-ft. wingspan and packs fuel in wing bladders for 10-hour flight.



In flight, Skyeeye's rotary engine minimizes vibrations for electronic payloads. Remote display (above) is part of ground station.

PH ILLUSTRATION BY GERHARD RICHTER

URI TSACH/PHOTO

DEVELOPMENTAL SCIENCES PHOTOS

THE RESPONSE HAS BEEN TERRIFIC:

In the latest J. D. Power & Associates Initial Quality Survey, new car owners put three General Motors makes at the top of the list of 1988's best-built American cars.

Among the various measures of automobile quality, the J. D. Power survey is one of the better known. This year, owners surveyed reported fewer problems with three GM makes during the first 90 days of ownership than with any other domestic car line.

- ✓ **Cadillac**
- ✓ **Buick**
- ✓ **Oldsmobile**

Overall, these three GM car lines were the only U.S. representatives among the survey's top ten. The other leaders included some makes well recognized for luxury and quality—Porsche, Mercedes-Benz, and newcomer Acura, to name just a few.

RESPONDING TO CUSTOMERS' NEEDS

People throughout General Motors have worked long and hard to build quality and value into our cars and trucks. 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 and utility, while sticking to our own high standards for materials and manufacturing.

MEASURING THE RESULTS

Now our efforts are beginning to be recognized. Not only by the owners in the Power survey, but by others who are just as qualified to judge the results of our commitment to quality.

- ✓ **Pontiac Grand Prix, Oldsmobile Cutlass Supreme, and Chevrolet Beretta swept the competition for MOTOR TREND Magazine's 1988 Car of the Year honors.**
- ✓ **Chevrolet's Full-Size Pickup was named by readers of FARM INDUSTRY NEWS as one of the top farm products of the year. It was the only vehicle of any kind to make the list.**
- ✓ **The Chevrolet K1500 Full-Size Pickup won FOUR WHEELER Magazine's award as "the 4x4 of the year."**
- ✓ **The Oldsmobile Aerotech, powered by a version of GM's revolutionary Quad 4 engine, set a new closed-course speed record of 257.123 miles per hour.**

While all these achievements were hard earned, and the recognition well deserved, the most important reaction to our efforts has come directly from our most important constituency—our customers. Their response has been one of overwhelming approval: as of June 10, GM sales for this calendar year had increased by 9.4%. That's the strongest indicator that our vision of our customers' needs has been sharp and clear.



Chevrolet Pontiac Oldsmobile Buick Cadillac GMC Truck

CAR CLINIC

BY MORT SCHULTZ

Airing Air Bags

WITH Chrysler's announcement that it will be the first domestic auto manufacturer to make air bags standard equipment, these questions come to mind:

1. Who repacks a bag after it deploys?
2. Do you consider repacking to be a job for the Saturday mechanic?
3. If the job has to be done by a professional technician, how long will the customer have to be without the car?
4. Is an air bag effective in side-impact accidents?
5. Can I get an air bag installed in my present car?

ARTHUR L. SCHULTZ
ORLAND PARK, IL

■ *There is no repacking an air bag once it deploys. It's not like a parachute. The deployed unit is discarded, and a new unit in the form of a module about the size of a cigar box is installed in the steering wheel. If it's improperly installed, the new unit could deploy prematurely in the face of the installer—or*

not deploy at all. The consequences of either of these possibilities is pretty chilling.

Replacement should be done by someone who has the required special tools and training, and who can get another module. At present, that someone is the dealer.

■ *I don't consider this a job for the Saturday mechanic, for the reasons above and for one other—most insurance companies have announced that insurance will cover replacement of deployed air bags. Installing a new module costs about \$350 to \$400 right now.*

■ *Once the technician starts, extracting the old module and putting in a new one takes about 15 minutes.*

■ *An air bag is only effective against the impact of a frontal or nearly frontal collision (within 20° to 30° of head-on). It won't afford protection against a side or rear impact, or if the car rolls over. It also won't help if the vehicle hits something else, like another vehicle or a stationary object after the original collision,*

because the bag deflates almost instantly. That's why seatbelts must be worn, air bag or not.

■ *You can probably have an air bag retrofitted to a car that has air bags available as an option. Vehicles that weren't engineered to have air bags from the beginning are a different, complex proposition, and I don't recommend attempting it. If you can find a shop that can do the job, the cost will be in excess of \$2000.*

Promises To Keep

I purchased a set of seat covers for my 1981 Plymouth Reliant 2-door sedan but I can't install them, because I can't get the headrests out of their sockets. The service manual doesn't explain how to do it. I hope there's a way you can help me.

ANTON SANVICTORES
PLANO, TX

How to remove these headrests is a tightly guarded secret, because Chrysler doesn't want car owners driving around without them.

So here's how:

Get a 12-in. piece of thin-gauge flat metal. A length of banding steel of the type used to secure cargo to a shipping pallet is ideal.

Raise the headrest as high as it will go and slip the metal strip down alongside the headrest mount. Feel around until you hit a pin in a detent. Maneuver the metal tool so it trips the pin, pull the headrest out, and install the seat covers. The final step is to reinstall the headrests.

Popping Paint

In 1982 my son purchased a new Saab 900 from a dealer in Colorado. This vehicle had been painted with a clear coat of paint, whether by the factory or the dealer I'm not

certain. Three years ago he moved to San Antonio, and a year ago he began to notice blisters on the hood and roof. I've enclosed a photo so you can see what the hood looks like. The explanation he's getting is that beads of water left after a rain act as magnifiers for the sun's rays, causing the clear coat to blister. Is this true?

JACK R. GARTON
CHEYENNE, WY

What a mess! I've spent a lot of time in the San Antonio-San Marcos region during the summer—not to mention Florida where it's just as rainy and just as hot—and I've never seen any car that looked as bad as this.

What caused the condition? You state that you aren't certain whether the clear coat was provided by the factory or dealer. Clear-coat paint is getting pretty common nowadays, and any paint the dealer applied was probably to repair shipping damage.

One cause of blisters in a finished surface is specks of dirt left on the surface. These specks hold moisture. When the finish is exposed to the sun, moisture expands, builds up pressure and breaks the coating.

It's academic whether beads of water magnifying the sun's rays speed up deterioration, but they aren't the cause.

Other reasons for clear coat as well as non-clear-coat paint finishes blistering include application of an excessively thick film and using a reducer or thinner that isn't compatible with the finish coat. In your son's case, it's too late for recourse against the dealer or automaker. But for what it's worth, you have your answer.

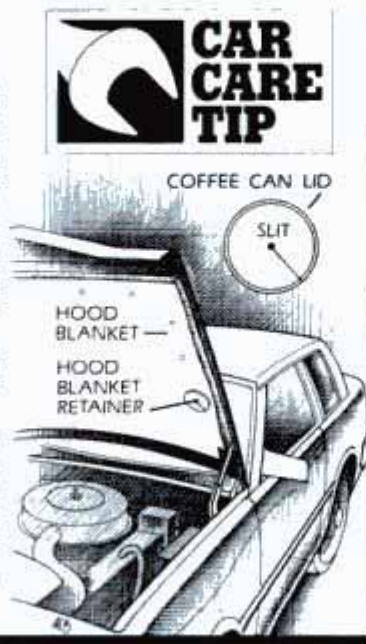
Repainting is your only option.
(Please turn to page 22)

Slid Lid

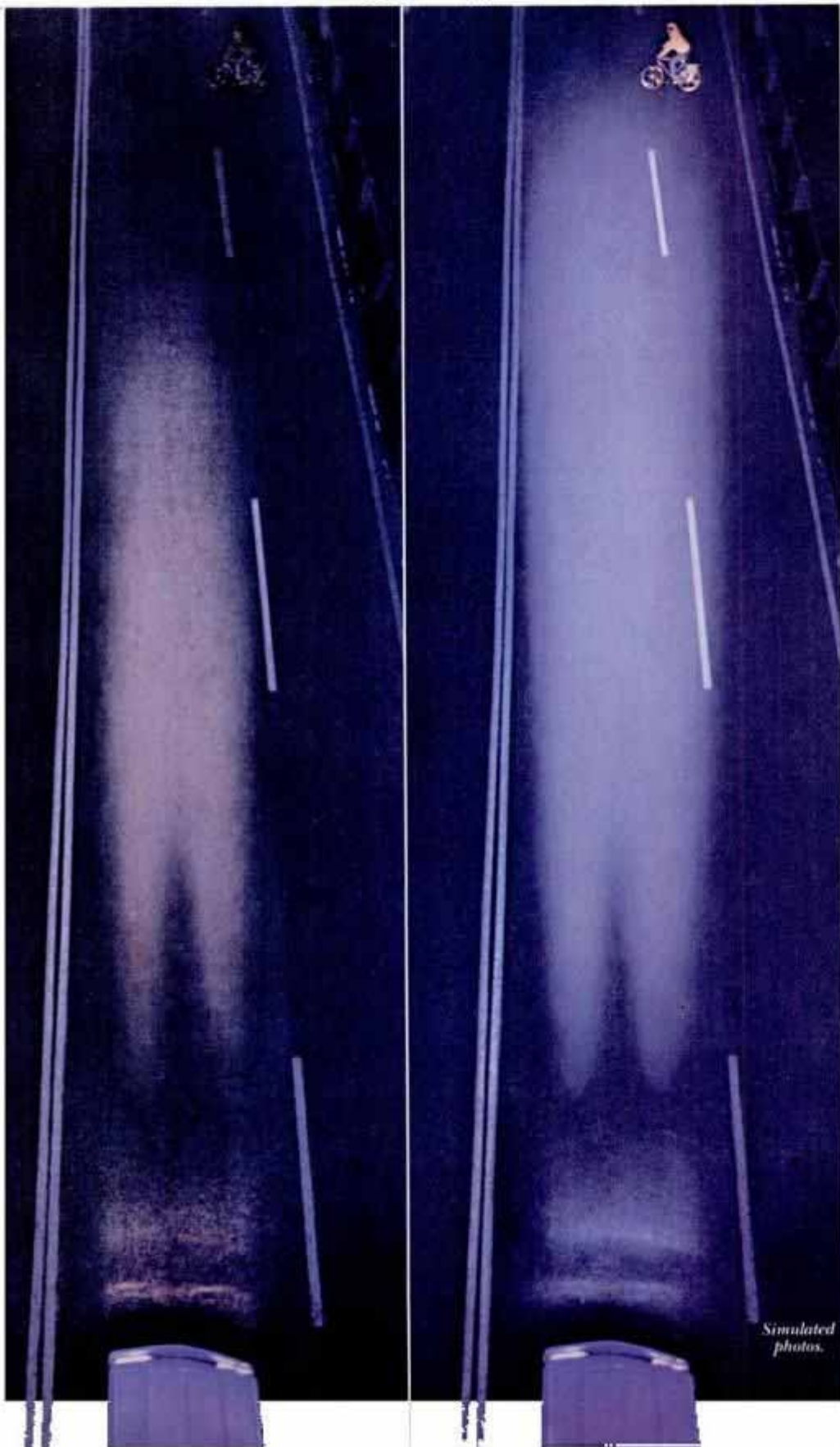
Chris Warner of Titusville, Florida, has a solution to the problem of under-hood insulating blankets that come loose and droop from their small rubber-plug retainers. Chris recommends saving the 4-in. plastic cover that comes on a 1-pound can of coffee.

Punch a hole in the center of the lid and cut a slit from the hole to the edge.

Slide the cover between the insulation and the unretentive rubber plug to form a huge washer that offers tremendous support. Apply a little adhesive to keep it firmly in position.



If you don't have GE Halogen Headlamps, you may be missing something important.



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Number of lamps purchased: 1 2

Name of retailer/store where purchased: _____

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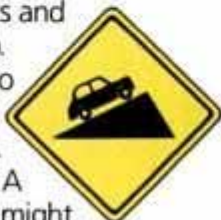
Courage for your car.

Does your car turn into the gutless wonder on a hill? Does it crawl instead of climb? Do you press the pedal too much for too little acceleration?

Your car's lack of courage could mean dirty fuel injectors are robbing it of power.

But one bottle of STP® Super Concentrated Fuel Injector Cleaner quickly dissolves deposits and unclogs grimy injectors. It helps restore lost power and improve acceleration. Helps eliminate tough starts and rough idling, too. And it's so easy to use, just add it to your gas tank.

So take heart. A dose of courage might be all your car needs to perform better.



B FIRST BRANDS

CAR CLINIC

(Continued from page 20)

tion, of course. Just be sure that the shop strips all the paint on the car, right down to the bare steel.

And if your son isn't planning to move to someplace like Seattle where there isn't much sun, he might consider repainting with one of the urethane paints that have better ultraviolet resistance.

Missing A Diagnosis

My 1987 Chevrolet Caprice, purchased new, has a 4.3-liter engine and fuel injection. There continues to be an excessive amount of vibration given off by this engine from idle to about 35 mph. The dealer says he's tried everything, including replacing the harmonic balancer and flywheel.

I hope you can help.

WILLIAM J. WALICKI
ORANGEVALE, CA

Chasing down vibrations is one of those things that have to be done systematically and thoroughly. Assuming the cause of the vibration is in the engine bypasses the possibility that it's in the drivetrain elsewhere.

I would think that any engine vibration that occurred at the rpm your engine passes through between 0 and 35 mph would recur at higher speeds in higher gears as the rpm pass through the same range again. This leads me to suspect

problems with the driveshaft, trans or rear axle.

The dealer may need to replace the torque converter as well to be sure the problem is indeed in the engine. After that, your last resort is an engine rebuild, with attention to proper balance and trueness.

Assuming that internal parts like the crankshaft or the driveshaft aren't bent or out-of-balance, it's possible that your vibration is not vibration in the way that term is normally used. In other words, you may not have a vibration, but an engine miss.

Have a good mechanic try a cylinder-balance test, shorting out the plugs in sequence. A misfiring cylinder won't show as much change in idle rpm when its plug is grounded. Here are a few other things to check:

■ Sparkplugs. Service Bulletin 87-47 announced a change in the sparkplug designation for this engine. The sparkplug originally installed, ACR43TS or equivalent, should not be used, because it has a tendency to foul.

The plug that is now recommended is the copper-core type AC.R45TS or equivalent. (The [.] in the AC designation indicates a copper core.)

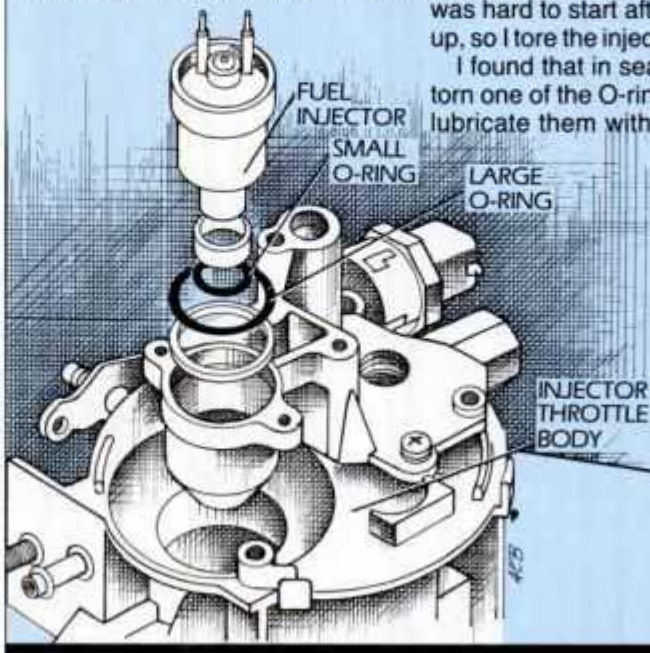
■ Sparkplug cables. Test each cable to determine if it exceeds resistance allowances. Also, make sure no cable is

Scoring Ringers

This is one of those things you usually learn the hard way—and that's always just after the parts stores have closed for a holiday weekend. A few weeks ago I overhauled a throttle-body injection unit from a 2.5-liter GM engine, but this tip also applies to Ford and Chrysler.

I was replacing the fuel injector into the injector throttle body, which should be easy enough to do. Went right back together. In the days that followed, the engine was hard to start after it had been warmed up, so I tore the injector apart again.

I found that in seating the injector, I had torn one of the O-ring seals. Now I know to lubricate them with something like transmission fluid, so they'll slide into position easily. This is a good procedure to use with any type of O-ring seal. Don't use any type of gasket sealer or silicone on any O-ring or you'll probably have a leaky joint. O-rings rely on the small amount of movement that the ring permits, and gluing it down will prevent it.



cracked, allowing current to short to ground. See to it that cables are attached securely on both ends.

■ Exhaust-gas recirculation valve. It could be damaged.

■ Electronic Engine Control. A fault should leave a trouble code stored in the electronic-control module. Retrieve this code by following procedures in the service manual.

Coy Joy

In "Car Clinic" of March '88, I'm sure you made a lot of Dodge Dakota owners happy, including me, I thought, by announcing that difficulty in shifting the manual transmission can be overcome by having a clutch disc of different design (part No. 4338352) installed. My joy, however, was short-lived when the dealer told me the technical service bulletin governing this repair (TSB 06-01-88) covered only trucks with 2.2-liter engines. Can you please find out what's going on?

MATTHEW HARRIGAN
SAN JOSE, CA

When I wrote that item, I hadn't seen the TSB. "Car Clinic," often gets this kind of information verbally before TSBs are distributed. It didn't dawn on me to ask if the repair applied to Dakotas with the optional 3.9-liter engine as well as the standard 2.2-liter.

So, yes, it's true that TSB 06-01-88 offers the repair only for 1986-87 Dakotas equipped with 2.2-liter engines. However, there's another TSB that may cover you—TSB 06-02-88.

It, too, addresses the problem of hard shifting, this time in all Dakotas as well as Ram vans, Ram wagons and Ram pickups.

According to this bulletin, the main reason for difficult shifting, clutch chatter, damaged transmission pinions and bushings, and vibration is that the clutch housing wasn't torqued in the correct sequence.

The TSB instructs a dealer to loosen, reposition and sequentially tighten the housing and struts.

Low-Profile Pile

Over the years you've mentioned the carbon-pile battery-load tester, most recently in the April 1988 segment of "Car Clinic." However, you never say whether the carbon-pile resistance unit in the tester can be obtained as a separate unit. Like most Saturday mechanics I have a combination voltmeter/ammeter, and the carbon pile would be a valuable addition. Can you tell me where to get it?

FRANK X. MEYERS
BALTIMORE, MD

I've searched and not found any company that sells only the carbon pile, which is a resistance unit that puts a car's charging system under load to simulate operating conditions so you can tell if the system can handle that load and still function normally.

A carbon-pile resistance with enough capacity to simulate the starter motor cranking the engine on a cold morning is a pretty heavy-duty item.

Usually the carbon pile is part of a single instrument that includes an ammeter and voltmeter, which are simple, inexpensive gadgets.

The carbon pile represents most of the cost of the instrument.

For example, the Carbon-Pile Battery Tester (tool No. AE 6038) sold by Kent-Moore Tool Group of Roseville, Michigan, carries a \$439 price tag.

By comparison, almost any discount store or Radio Shack can sell you a voltmeter for \$10 or so. Even a high-quality digital meter can be had for less than \$100.

FM

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

■ GM has this updated advice concerning actual and perceived cooling-system leaks. First, tracks of residue around the lower part of the water pump or even a film of coolant on your fingers after wiping them over the bottom of the water pump doesn't necessarily mean that the pump is leaking. In other words, seepage from the water-pump weep hole is normal, so don't rush to replace the pump unless you're sure it's leaking. Second, to seal small leaks (except for a leaky hose), pop two engine-coolant sealant pellets (part No. 3634621) directly into the radiator—not into the recovery tank.

■ That clattering noise you may be hearing in your Toyota Celica could be coming from the speedometer drive cable. If so, there's a newly designed cable. It carries the same part number (83710-20530) as the old cable, so watch it. The new cable has a smooth outer casing, while the old noisy cable has a spiral casing.

■ Has the cause of an intermittent rough idle, stall and/or hesitation from the 5-liter engine of your 1988 Ford, Mercury or Lincoln been undetectable? It could be hiding—literally. FoMoCo tells "Car Clinic" that a car built between 10/20/87 and 2/15/88 may have a throttle-position sensor with a broken internal wire. Refer your dealer to TSB 88-9-8.

■ According to a recent directive to its dealers by Honda, only if oil consumption exceeds 1 quart/1000 miles should the engine be repaired under warranty.

Will your new car outlive your new car loan?

Introducing STP® Supra Wear Control for Newer Cars—formulated to help your engine run like new longer. If you've purchased a new car recently, you know what a huge investment it is. To help make sure that investment pays off add new STP Supra Wear Control regularly to your new car's oil. It's an easy way to give your engine extra protection against heat and stress. So down the road, you'll have something to show for your money.



INSIDE DETROIT

BY JIM DUNNE

The New Shape Of Cougar



1989 Cougar:
the slickest yet?

LIKE ITS Ford-division cousin, the Thunderbird, Mercury's Cougar will wear all-new sheetmetal when it comes to the marketplace this fall. The major distinction between Cougar and T-Bird continues to be in the greenhouse area, where the Mercury version uses a more formal roofline. However, the treatment this time around isn't as stylized as the past couple editions, and insiders are calling it the best-looking Cougar yet.

Mercury's personal-luxury coupe shares the same engine and chassis changes as the Thunderbird, including Ford's corporate 3.8-liter V6 as standard equipment with an optional supercharged 3.8 V6 available.

Lincoln 1989-90

A split-personality Lincoln Town Car was spied running near Ford's proving grounds



Lincoln Town Car
mule shows
1990 nose.

in Dearborn. The front end of the car is a near copy of the all-new 1990 edition of the luxury sedan, while the rear is identical to the '89 model.

Cars altered in this way are used to prove out engine cooling of future models. Air intake through the new grille and lower fascia must be determined earlier than most other features of a new car.

Ford and other auto companies save money and time by attaching the front end of a future model to a current production body for this kind of testing. When the 1990 Town Car appears, it will have a completely redesigned body, new from bumper to bumper.

Buick 1990

Buick will add a 4-door sedan to the Regal line next year. The prototype shown here is cosmetically correct, even though the panels on this car

are made of fiberglass and secured in place with tape strips for shipping.

Consistent with the launch of the GM-10 cars for the 1988 model year, each of the divisions—Buick, Olds, Pontiac and, later, Chevrolet—will maintain distinctive divisional styling themes. The Regal

Buick Regal: two
more doors in '90.



sedan takes a conservative approach, but maintains the overall GM-10 aero theme.

Chrysler's V6

Chrysler is going whole-hog in the design of its new V6 engine, slated for introduction late in 1989. Fuel injection, balance shafts and 24-valve breathing are all planned. Displacement for the base engine will be 3.3 liters, but insiders expect that 3.8- and 3.0-liter versions will also be available within a year after the basic 3.3 is introduced.

Chrysler will stick with cast iron as the material for the block and heads, more for

reliability than any other design reason.

Chrysler bosses can't wait until the new engine is in production. That's because the company is dependent on an outside supplier—Mitsubishi—for its current V6, the 3.0-liter used in vans, in the luxury Fifth Avenue and the

Dodge Dynasty.

Look for the Chrysler V6 to eventually replace the Mitsubishi engine, but not for a couple of years at least.

Hot Cars

In more than one way, GM's Camaro and Firebird are considered hot cars. The sportsters topped the latest list of most frequently stolen automobiles in the United States. The rankings, compiled by the National Highway Traffic Safety Assn., showed that during 1985 GM models took eight of the top 10 spots in the most-stolen list. Other GM cars included

Corvette, Riviera, Eldorado, Monte Carlo, Grand Prix and Regal.

But don't conclude that GM builds the most coveted cars. It's just that the GM models are among the easiest for thieves to get started without keys.

King Corvette

"I told them that when I stepped down on the throttle, I wanted to be scared."

That's the way Chevy chief engineer Fred Schaafsma described his instructions to his engineers building the Corvette ZR1 option, the "King of the Hill" model. Reports from folks who actually drove prototypes of the ZR1 indicate Schaafsma's instruction was followed to the letter.

"I hit 70 mph at the bottom of an entrance ramp," one driver of a late prototype reports. "I had to back off to merge in with the traffic."

Raw power is not the only feature of the special Vette. A separate "valet key" that limits top speed lets the owner turn the car over to another driver or parking-lot attendant without fear of abuse. Also, an adjustable suspension that regulates the settings of the shock absorbers lets the driver select a hard ride for best cornering, or a softer ride for most comfort.

1991 Saturn

Look for the new Saturn to hit the streets in late 1990, or early 1991. In any case, the car is slated to be a 1991 model when it makes its appearance.

Three body styles are planned right from the start, a 4-door sedan and two 2-door types. One of the 2-doors will be a sporty coupe. Additional models—or an additional model line—would not be ready for a couple of years after Saturn startup.

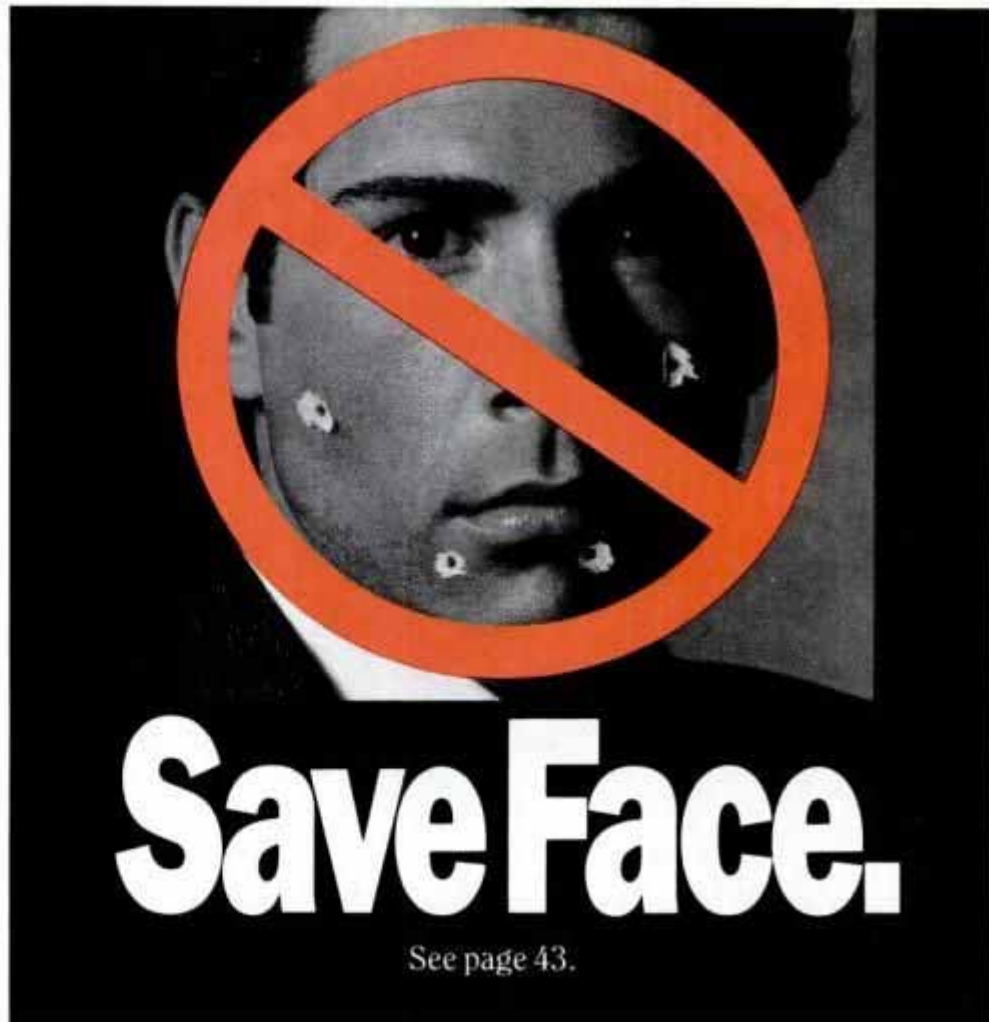
GM will build the car at a completely new plant in Tennessee. Saturns will be subcompact to compact in size, and use a new 1.9-liter aluminum engine.

Chrysler TC By Maserati

Chrysler is taking so long to launch its luxury-sports convertible that the changes planned for 1990 and beyond may show up in first production models.

Of special interest at Chrysler are an independent rear-suspension system—to give the TC a "Maserati feeling," according to Maserati chief Alejandro DeTomaso—in place of the beam rear axle planned for the first production models.

In addition, an automatic transmis-



Save Face.

See page 43.

sion that will fit the Maserati-designed 16-valve engine may also make the first production run. The automatic transmission is important because Chrysler planners project that about 80 percent of the TCs sold here will have them.

Miracle Fluid

It sounds as incredible as the green fuel extender a con man once sold Henry Ford for \$10,000. But this system really works. It is a different type of electrically sensitive fluid that could revolutionize the design of valves, fluid couplings, clutches or shock absorbers. The fluids will harden instantly as electrical energy is applied. Cut off the electricity, and the fluid returns to its normal liquid state. Apply smaller doses of electrical field, and the fluid becomes syrupy.

This sensitivity makes the fluid controllable by computer, without any intermediate mechanical hookup.

Such fluids have been around for decades, but problems with high heat and corrosion have slowed their wide use. Now, a promising new formula developed by Frank E. Filisko, a University of Michigan engineering professor, seems to answer those problems.

In a fluid clutch, for example, the new fluid could idle in a liquid state, breaking the connection between engine and driveshaft.

But when an electrical field is thrown

around the fluid, in milliseconds it thickens until ultimately it forms a near-solid connection between the engine and driveshaft. Cut off the electrical field and the fluid loses its hardness and returns to its liquid state.

In shock absorbers, the fluid's viscosity can also be controlled to become thicker or thinner depending on the need to adjust a car's ride.

Chrysler's Plastic Car

Starting in 1991, Chrysler will begin to use carbon-impregnated plastic in its car bodies. Don't look for whole cars to be done in plastic. That won't come for a long time. But stronger plastics that do the work of steel will show up in new models planned for 1991.

Most of the plastic parts will be out of sight, used in the underbody or as backing for the exterior body parts.

GM In Russia

It's tough to negotiate a business deal with the Russians, at least for GM chairman Roger Smith, who reports GM has had long-term discussions with Russian officials about building vehicles.

"We tried to get an agreement with the Russians that provides us with cash," Smith told GM shareholders at the annual meeting. "Unfortunately, there doesn't seem to be a word for cash in Russian." **PM**

**The new and revolutionary
Beware of the imitations that**



Goodyear Wrangler MT radial. are bound to follow in its tracks.



"Breakthrough" is one of the most overused words in the tire industry.

Yet, the new Wrangler MT radial really is a breakthrough in design and performance.



A Goodyear Wrangler MT "contact patch." Where the Wrangler MT demonstrates its difference and superiority.

It is the first radial light truck tire with a unidirectional, "one way" tread pattern.

This may not sound too important, until you need Maximum Traction in the mud, or sand, or over rock.

And that's where the unidirectional tread of the Wrangler MT radial really delivers.

It also delivers on the road. With superior wet traction. Superior dry traction. Excellent handling. While it also gives you exceptional treadwear.

As you can see, the Goodyear Wrangler MT even looks different than other light truck tires.

And this difference ultimately shows in the most critical area of all: the "contact patches" of the tires. Where your truck or sport vehicle ultimately meets and responds to the road. Or the mud. Or the sand. Or the rock.

The Goodyear Wrangler MT radial is the newest member of the Wrangler family of light truck radial tires.

No one else has a radial like it.

But we fully expect that it won't be too long before some other tire companies try to copy its unidirectional design.

So beware of imitations that are bound to follow. A year or so down the line.



GOODYEAR
BECAUSE THERE REALLY IS A DIFFERENCE.

SCIENCE

BY TIM COLE

Science At Sea

A PROFOUND sense of wonder swept over me as Cmdr. Alfred E. Ponessa, USN, passed the tuna salad.

We were seated in the wardroom aboard the nuclear attack submarine *Norfolk*, enjoying the expertly prepared food and the convivial discourse, when I glanced up at the instrument repeater on the bulkhead. This little party was taking place somewhere off the coast of Florida along the 100-fathom curve. Our speed? Well in excess of 20 knots. Depth? Much deeper than 400 ft.

As *Norfolk's* nuclear reactor quietly simmered just a few steps aft—converting water into steam, steam into turbine energy—men were casually taking their evening meal or standing watch, living comfortably on America's front line against numerically superior Soviet attack and ballistic-missile subs. As I learned on a 3-day mission aboard *Norfolk* to research our story in this issue called "The Captain Comes Home," (page 51), there is a significant amount of science involved in maintaining men and machinery at extreme depths for extended periods.

Start with the nuclear pressurized-water reactor that powers *Norfolk*. Requiring refueling every 13 years, the powerplant's continuous, controlled fission generates on-board electricity, drives an electrolysis process that separates hydrogen from water to produce oxygen, operates the lithium-hydroxide scrubbers that cleanse the atmosphere of carbon dioxide, and desalinates and demineralizes ocean water. The science of underwater life support means *Norfolk's* 112-man crew can stand watch in



SSN-714 *Norfolk* provides a closeup of modern sub technology.

their shirtsleeves, or study for their qualification reviews in a crew's mess.

Beyond life support, passive phased-array and towed-array listening devices detect and evaluate the

sounds of ships and subs—or "biologicals," as I found out one evening as a pod of whales crossed our path far above us. An imposing array of torpedoes, tube-launched antiship missiles and cruise

missiles multiply the force with which *Norfolk* stands alert—equipped with terrain-mapping features and sophisticated seeker heads to accurately put ordnance on target.

As top Navy planners point out, the role of the submarine will be shifting in the months and years ahead to encompass activities beyond strategic-missile delivery or antisubmarine warfare. Having cruise missiles like the *Tomahawk* aboard gives *Norfolk* a new and significant land-attack role. And *Tomahawks* can accurately strike surface ships 250 miles off. Nuclear subs are now being coupled to dry hangars to transport swimmer-delivery vehicles used by Navy SEALs. Clearly, science is changing the traditional way the Navy uses its underwater fleet.

More importantly, improved real-time communication, between surface ships like the *Aegis* cruiser and submerged vessels will mean improved interaction to detect, track and defeat an array of threats. Satellite-based real-time laser communication, or fiberoptic systems positioned on the sea floor, will make these vital links possible.

The platform for these and other improvements in the fleet will be the SSN-21 *Seawolf* (see illustration). The next generation in propulsion, quieting, endurance and armament, *Seawolf* will provide the basis for future improvements in sensing and ordnance. *Seawolf* will also embody an important concept that Hyman Rickover and other submariners have always taken to heart.

Peace through strength. Strength through science.

PM



SSN-21 *Seawolf* is the sub tech of tomorrow.



Instant-on radar: How it works. How to defend yourself.

Instant-on radar—sometimes called “pulse” radar—has been around for years. But it’s being used more frequently now as radar operators try to defeat detector users. Here’s how it works.

First things first

Ordinary radar and instant-on radar use exactly the same type of radar beams. In fact, most radar guns can operate either way. It’s just a matter of which buttons the operator pushes.

How ordinary radar works

In an ordinary radar trap, the radar gun is aimed at traffic and it continuously transmits a beam of radar waves. The effective range for the radar to “see” your speed is less than a half mile for most cars, longer for trucks.

How radar detectors work

A radar detector is a radio receiver tuned to radar frequency. A high-performance radar detector is sensitive enough to pick up the radar waves before you drive within speed-measuring range. It’s as simple as that.

How instant-on radar works

The instant-on radar trap is set up just like an ordinary radar trap. The only difference is that the gun doesn’t transmit until the operator pushes a button. So there is no radar signal for a radar detector to find.

Then when you’re within speed-measuring range, the operator triggers the beam. Hence the term “instant-on.” The radar reads your speed within a fraction of a second, too quickly for a human to respond.

Your only hope

Because instant-on radar is faster than your reflexes, your only defense is to identify it before you are within its range. You must detect it when the operator zaps the traffic ahead of you. For this, your detector must reach out for distant radar signals.



The Kustom Signals HR-12 and KR-11, two of the many radar units that can be operated in an instant-on, or “pulse” mode.

You’re looking for weak radar that lasts only a few seconds. Finding even one such “pulse” is cause for alert. Finding a series of them, each stronger than the previous one, indicates you’re approaching an instant-on radar trap that’s picking off traffic ahead.

Same old strategy

Identifying instant-on radar before you come in range is the only defense today, just as it was when we first introduced Escort. That’s why our warning system, used on both Escort and Passport, tells you both the strength of the signal and the length of it. You need to know both to defend yourself.

Nothing but the truth

Our warning system indicates signal strength two ways: by a meter for a visual check, by a variable-rate beeper if you prefer to listen. The length of the signal is indicated by the duration of the alert. Knowing signal strength and signal length of every radar encounter is the only way to find instant-on radar before it finds you.

Escort and Passport are the most effective radar-warning instruments available. But don’t take our word for it.

In 1987, *Car and Driver*, *Popular Mechanics* and *Roundel* each published independent tests of radar detectors. And each gave us the highest ratings. Call toll-free and we’ll send reprints of the complete tests, not just excerpts or quotes.

We’re as close as your phone

We sell direct to you, and we guarantee your satisfaction. If you’re not entirely satisfied within 30 days, return your purchase. We’ll refund your money and shipping costs.

To order, call toll-free. Orders in by 5:00 pm eastern time go out the same day by UPS and we pay the shipping. Overnight delivery is guaranteed by Federal Express for only \$10 extra.

Call now and the best defense against instant-on radar can be in your car tomorrow.

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DOING IT WRONG

When you understand that instant-on radar is nothing more than ordinary radar being turned on and off, the threat loses its mystery. Defense comes down to detecting the radar before it’s strong enough to find you.

Baloney breakthrough. Yet one detector maker has added a feature it calls “Pulse Protection” to one of its models. Here’s what it does:

When this unit detects the sudden presence of a high-strength signal, a “P” appears on its display and it sounds a special alarm. This is your “Pulse Protection.”

The fine print. Unfortunately, the sudden presence of a high-strength signal describes an instant-on encounter when you’re within range. True protection from instant-on depends on responding to weak signals, but “Pulse Protection” doesn’t respond to weak signals.

The maker says this feature “tells you when you’re being shot at.” And that’s the problem. When you’re being shot at, it’s too late.

ELECTRONICS

BY STEPHEN A. BOOTH

Battery-Powered Hot Stove

THE 1988 baseball season was well under way when Frank Robinson and Lou Piniella became field managers, of the Baltimore Orioles and the New York Yankees, respectively. Yet even before getting the call, these dugout chieftains had faced off in a 9-inning duel of diamond smarts.

The box score for that matchup shows Robbie on the debit side—the result of his deciding to stick with his starting pitcher when, with two outs, none on and the score five-all in the bottom of the ninth, Sweet Lou sent George Brett to the plate as his designated hitter. Brett's home run snatched the win for pitcher Roger Clemens.

No, Brett and Clemens haven't been snatched up by the Yankees. And even if they did draw paychecks on the Bronx Zoo, it's highly unlikely that they'd be locking horns with Cy Young, who left the mound in 1911. Unless, that is, the contest were to take place in the Elysian Fields of computer-assisted fantasy. That is precisely what happened earlier this year at Manhattan's 21 Club, where Robinson's roster of Hall Of Famers met Piniella's team of contemporary All-Stars in Starting Lineup Talking Baseball, an electronic game from Parker Brothers.

Although the plastic baseball stadium has the appearance of a kid's \$89 toy (four C cells not included), Starting Lineup employs sophisticated computer electronics to simulate real game situations—and announce the play-by-play in real time. Games can be played in a variety of ways, by up to two "managers."

The stadium-like game console itself boasts a megabyte of processing power. In con-



Computer chips and major league stats make Starting Lineup more than a kid's game.

junction with the team cartridges—which contain between 256 and 512 kilobytes of player information—Starting Lineup can generate 250,000 different plays, with 15,000 possible outcomes. Moreover, each play is called as it happens, in the voice of Oakland Athletics' announcer Lon Simmons. The speech synthesis chip accounts for the other part of Starting Lineup's name: Talking Baseball. The chip contains more than 10,000 sentences that apply specifically to what is happening on the field. The announcer even keeps up a good line of patter when nothing's happening—such as when one player is deciding on a pitch. Voice quality is good—it's modulated, not a monotone—and is accompanied by sound effects that include crowd noise, the ballpark organ and the crack of the bat.

The outcome of the plays in Starting Lineup is determined by probabilities of what a player might achieve in a particular game situation. These probabilities derive from the individual player statistics contained in the team cartridges—stats current

through the 1987 season. Something in Brett's career indicated a high probability that he'd park one against a right hander in a two-down, none-on, tie-game situation.

This doesn't mean that Starting Lineup's outcomes are predetermined—because you're not a lame-duck manager overruled by rolls of the dice. To the contrary, you call the shots from the game's two control consoles.

For starters, you write the lineup card from the roster programmed into the team cartridge. When your team is at bat, you determine how the batter swings at each pitch, call steals, squeeze plays or direct a batter to try for an extra base on a hit. When your pitcher's on the mound, you can pinpoint the location of fastballs, changeups or curves, call for an intentional walk, a pick off or a pitchout. It's only after you've made a managerial decision that the

Active-matrix LCD drive yields sharp TV pics.

probabilities of its success or failure take over. You can make player substitutions at any time, call for time out, even ask for an instant replay. Other modes of playing the game begin in any inning with a game-in-progress score, in order to replay historic games and find out what would have happened "if." For example, would a tie-breaking run have scored on a grounder to short if the manager had called his infield in?

For its debut, Starting Lineup comes packaged with a cartridge for American and National League All-Star teams. As an introductory bonus, you get 20 Hall Of Famers on another cartridge. In the future, Parker Brothers will issue eight more cartridges, priced at about \$25 each and representing all 26 major league teams. Stats will be updated each season. There also will be another Hall Of Fame cartridge containing the life's work of 60 old-time greats. To help you manage your team (or see what Cy Young looked like), each cartridge comes with picture cards that provide each player's lifetime stats.

Tiny TV: II

Let's include LCD color TVs among this summer's box-office hit sequels such as [\(Please turn to page 36\)](#)





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Материал, облицованный ацетатом целлюлозы

ELECTRONICS

(Continued from page 30)

Rambo III, Crocodile Dundee II and Billy Martin V. Two columns ago, in July ("Electronics," page 25), we explained how the new active-matrix drive system makes this current crop of color LCDs sharper and brighter than earlier passive sets, and gave our hands-on evaluation of the Magnavox Personal View model. Since then, we've had a chance to take Sharp's Crystaltron set into the field.

How does the Crystaltron work? Real good—on a par with the Personal View, with which it shares a 3-in. display com-

posed from 92,160 picture elements driven by a thin-film transistor active matrix. The main difference between the two brands is price and configuration. Personal View costs \$450 versus \$600 for Crystaltron—though this is likely to see discounting. The Magnavox sports a long, slim, paperback-book shape and a front-firing loudspeaker, whereas the Crystaltron we tried has a squarer, thicker profile and a side-firing speaker. More about configuration later.

Liquid crystals, such as those used in

calculator or television displays, change their alignment with the slightest application of electrical current. In a backlight display, the electrical charge can cause the crystals in an individual pixel to align themselves perpendicularly to the display to let light pass, or parallel to the display to block the light.

With more than 92,000 pixels on a 3-in. screen—each topped by its own color filter—it takes quite a system to tell each pixel what to do to create a motion video image. In the new active-matrix drive system, each of the pixels is linked to its own thin-film transistor (TFT). The TFT conveys the rapid voltage changes that correspond to changes in the moving TV picture. Rapid, in this case, could mean as often as every $\frac{1}{30}$ of a second, which is the image scanning rate of a television frame.

This direct-link, "active" matrix has a big and visible advantage over the passive-drive matrix used previously. In the passive system, pixels are not addressed directly. Instead, the picture information travels along the entire distance of the vertical and horizontal lines where the pixel might be located. Along the way, information meant for a particular pixel might spill into adjacent pixels. This condition, known as crosstalk, reduces the overall contrast of the picture, yielding a blurred appearance.

Other elements also contribute to the high quality of Crystaltron's display. Like the Magnavox unit, Sharp's uses a backlight whose color temperature emulates that of natural light from the sun, and a black grid etched around each pixel gives the overall image greater definition. As we pointed out in July, you'll pay the price for these improvements not only at the cashier's window, but in replacement batteries. Expect about 2 hours of play from five alkaline AA cells when using the built-in backlight (with the screen in the closed position) or accessory backlight (this allows you to flip up the screen for viewing at an angle). The same batteries will provide 4 hours of power with the screen flipped up to take advantage of ambient light, but you might find this way of viewing less than ideal. The backlight is the only way to go, and will justify your investment in rechargeable cells.

This brings us back to configuration, and why you might find the boxy, proletarian shape of the Crystaltron more practical than the Personal View's elegant profile. Simply stated, the Sharp's 1½-in. depth enables you to stand it on edge, in certain viewing situations. You can try that with the tall, slim Personal View, but it's a precarious undertaking as the center of gravity is high, and the business end of the TV is at the top. These TVs might be portable, but at \$450 or more they surely ain't disposable. **PM**

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People who work on buildings and people who work in them have the same problem: tired, aching feet.

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ONLY ONE INSOLE COMES WITH THIS SEAL.



OUTDOORS

BY JOE SKORUPA

Big-Boat Luxury In New Pocket Cruiser



Mark Twain MTX 228 has feel of a minicruiser in a 22-ft. hull.

WHEN I was wet behind the ears, I spent so much time at one tree-lined lake that I thought I knew it as well as my own backyard. But I never knew its vastly different nocturnal personality until I spent one memorable night in a family

friend's cuddy cabin boat.

On that night long ago, two high-school fishing friends and I made discoveries about wildlife, thermal patterns, water cycles and, not least importantly, the stars that kindled in us a deep appreciation of boating.

Yamaha's Year Of The Sterndrive

Hidden away in the heart of Louisiana's Cajun country is a facility rarely seen by the public. Yamaha Marine recently opened its test base here to unveil the product of nearly three years of designing and testing—a new line of stern-drive engines.

We were among a select group invited by Yamaha to test drive a fleet of boats

equipped with the brand-new drive systems, available in 4.3-liter V6 and 5.0- and 5.7-liter V8 models.

After a day of roaring through green-water bayous, I can report the engines have all the punch we've come to expect from Yamaha, as well as trademark, bells and whistles. Distinctive features include distributorless ignition, computer management system to adjust timing, color-coded fill caps and checks, multifunction instrumentation and an innovative warning system that drops engine speed to 2500 rpm in case of overtrimming, overheating and loss of oil pressure or coolant.

We'll take a closer look at these 205 hp to 260 hp engines in the months to come.



New Yamaha stern-drives have GM blocks and Japanese-built lower units.

While on assignment recently near Boca Grande, Florida, I recalled that experience. We were testing a fleet of enclosed-bow water-scoopers, but took time to test ride a different breed of boat, the Mark Twain MTX 228 mid-cabin cuddy.

Equipped with a Mercruiser 7.4-liter Bravo One stern-drive, it was slower and less agile than our similarly sized test fleet, but it has several impressive features.

Foremost among these is an immense cabin of 236.26 cu. ft. The designers of the MTX 228 managed to put the belowdecks space of a much larger boat in a hull 22 ft. 3 in. long. (Beam is very trailerable, at 8 ft. 4 in. wide, but the weight, 5050 pounds, may be daunting.)

Standout cabin features include a V-berth of 34 sq. ft., mid-cabin berth of 23 sq. ft.,

full galley, enclosed head and hanging locker. It's one of the few boats this size to sleep five. Stowage adds up to a huge 70.3 cu. ft. and the cockpit area, which seats six, is 33.9 sq. ft.

Top-end speed is a respectable 49 mph, as is the 0- to 35-mph hole-shot time of 13.5 seconds. But this boat has a high center of gravity and a tendency to roll. Hydraulic trim tabs are standard and necessary for control.

We ran the boat through a handling course and found MTX 228 is no roadster. It's best for straight-ahead running with gradual power delivery and sweeping turns.

The one area where it can't be beat, however, is belowdecks comfort. I haven't overnights in a secluded cove on a tree-lined lake in a long time, but a good boat to do it in is the MTX 228.

Letting The Boat Out Of The Bag



The Pisces folding, touring kayak can be assembled in 15 minutes.

If you've paddled folding boats before, you know that they're masters of the art of compromise. They trade a certain level of efficiency, comfort and style for easy assembly and portability. For some outdoorsmen, folding boats are an ideal, low-cost option. For others, they're unsuitable at any price.

The new touring kayak, by Folbot of Charleston, South Carolina, may go a long way toward winning new converts to the boat-in-a-bag philosophy.

The Pisces 2-person kayak comes in two luggage-size carrying bags, assembles in 15 minutes, and weighs 72 pounds. It handles 600 pounds of passengers and gear in its 16.5-ft. overall length. Beam is 36 in., height 16 in.

One standout feature of the Pisces is [\(Please turn to page 40\)](#)

You can tell Hardbody by

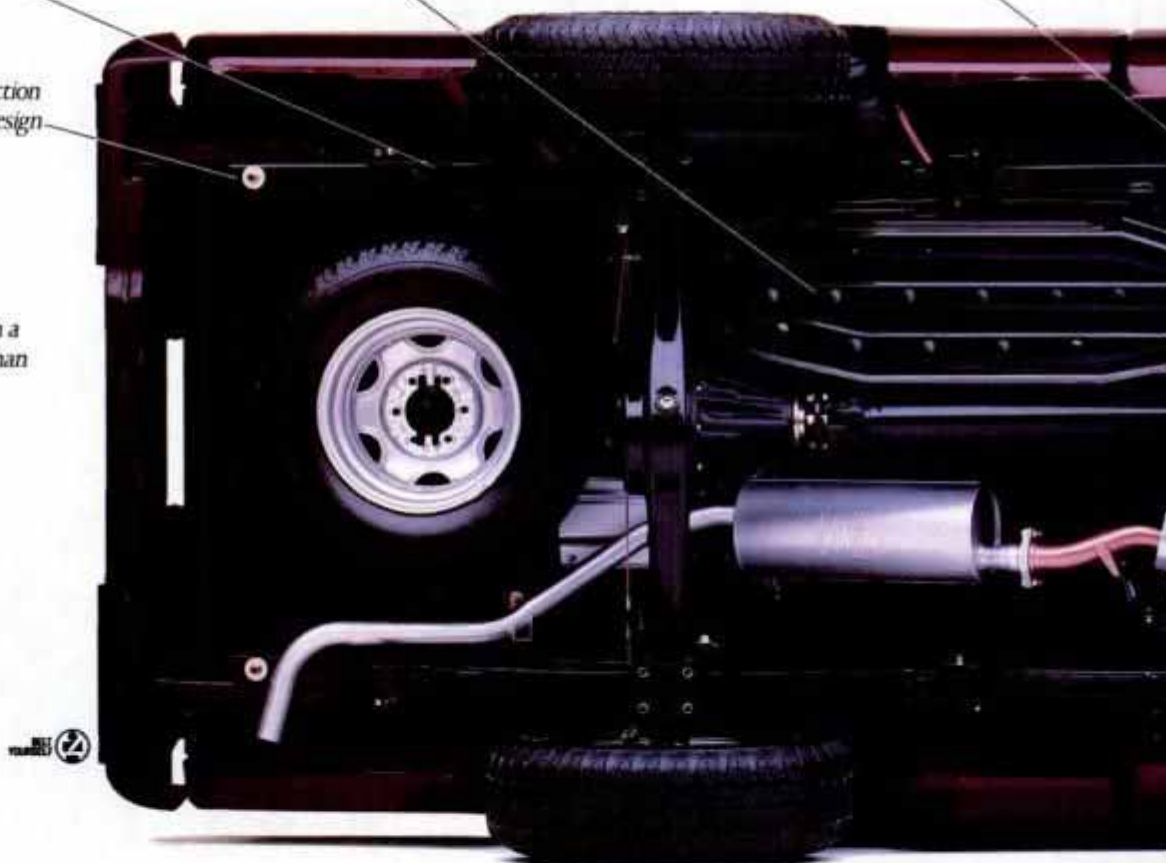
Semi-elliptical leaf springs let the Hardbody haul up to 2,000 lbs.

Skid plates under the fuel tank, engine and transfer case help ward off stumps and boulders.

A two-speed transfer case gives you a choice of gear ranges. From stump-pulling low to street-cruising high.

A welded ladder frame and box section design is about as strong a frame design as you can give a truck.

Nissan® Hardbody SE 4x4, in a slightly more precarious position than it normally appears.



First of all, don't try this at home. Instead, take a minute to read the rest of this page. And you'll see that underneath that tough exterior, the Hardbody™ is even tougher at heart.

Just take a look at that welded box ladder frame, for example. It's the strongest

possible frame design a truck can have. To handle rocks and ruts, we've given



Our Hardbody looks even better when you don't turn it over.

See your Nissan Dealer for specifications of each Hardbody truck model.

a lot about a turning it over.

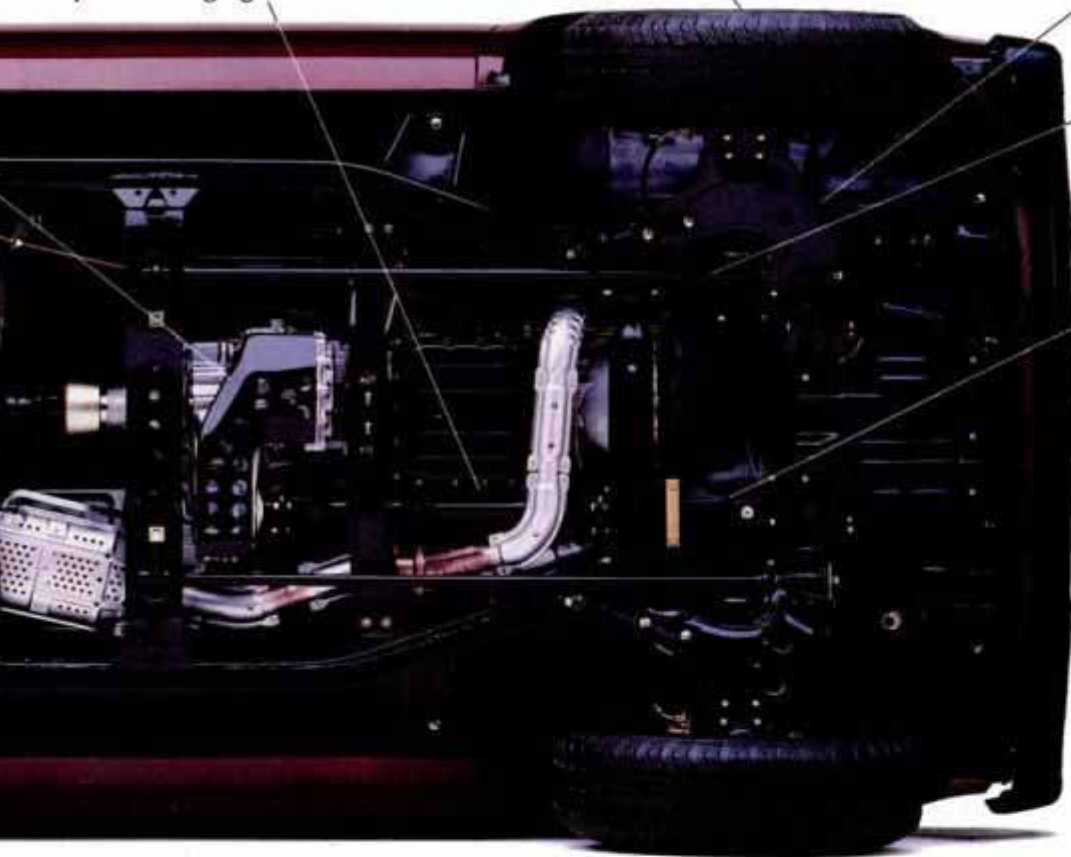
The new optional electronic 4-speed overdrive automatic transmission has computer-controlled shift points that put it in the right gear for the situation.

Auto-locking front hubs let you shift into four-wheel drive without getting out of the cab.

The front stabilizer bar reduces body lean when you're taking turns at speed.

The independent torsion bar suspension allows each wheel to deal with ruts and rocks without transferring the shock to the other wheel. Result, much better control.

Power-assisted rack-and-pinion steering makes the Hardbody as easy to handle off the road as on.



the Hardbody a torsion bar front suspension. For more civilized roads, there's a front stabilizer bar. And the semi-elliptical leaf springs let you load up the bed without overloading the suspension.

Of course, if you really want to know what kind of truck the Hardbody is, simply

take one out for a test-drive.

We think it'll make you want to turn over something else: Your money.



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STRONG ON CLOGS



Crystal Drano® powers through the toughest clogs. That's because its unique churning power cuts right through the grease, food and hair that cause those stubborn clogs! So even problem clogs are no problem with Crystal Drano.

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have a strong, firm grip as you sharpen knives or tools and allows your hand to maintain a safe distance from potentially harmful contact. The business end of the Diafold is made of monocrystalline diamond embedded in electroplated nickel with a brass core.

The Eyes Have It

It's not because my eyesight is going that I'm a fan of big, easy to read electronic displays. The reason is that I'm usually too busy rigging gear, studying the water and controlling the boat to scrutinize my electronic instruments.

Raytheon Marine Co., has an economical instrument for people like me, and it does much more than the normal sounder. It's the STN-24 LCD Fishfinder/Navigation Sounder, which features Supertwist—ultrahigh-contrast LCD technology that allows manual adjustment of screen brightness for improved visibility—and jumbosize readouts.

In addition to fishfinding, the STN-24 monitors boat speed and surface water temperature. In the navigation mode, digital depth, speed and temperature readouts fill the screen.

Other noteworthy features include five depth ranges, alarms, five sweep speeds and a freeze function for extended study. It measures 6 in. × 6 in. × 2 in., with a screen roughly 4 in. high × 2 in. wide. Cost is \$399.

FM



Bigger is better in digital readouts, as shown on Raytheon's STN-24.

OUTDOORS

(Continued from page 37)

that the hull and deck are separate elements. The first step is to position the Finnish birch keel and aircraft-grade aluminum longerons. Then insert the Finnish birch cross frames to make the gunwale sections rigid.

Finally, join the hull and Propex-fabric deck together by sliding the deck through a special double-tracked extruded gunwale. The outer skin is a PVC fabric covered by 2000-denier tire cord. Other interesting features include inflatable sponsons to tension the skin and provide flotation, and a Velcro closure that allows front and rear decks to open up for loading and unloading.

Standard equipment includes paddles and carrying bags. Cost is \$1150. With the Pisces there's no need to compromise.

Sharpen Up

A knife sharpener is such a basic tool that scant attention is paid to its fundamental design. DMT, a Marlborough, Massachusetts company, took a good look at the simple sharpener and came up with a clever new approach.

The Diafold Diamond Whetstone Sharpener features a unique folding design that combines a sharpener with a sturdy handle that swings back to form a storage case.

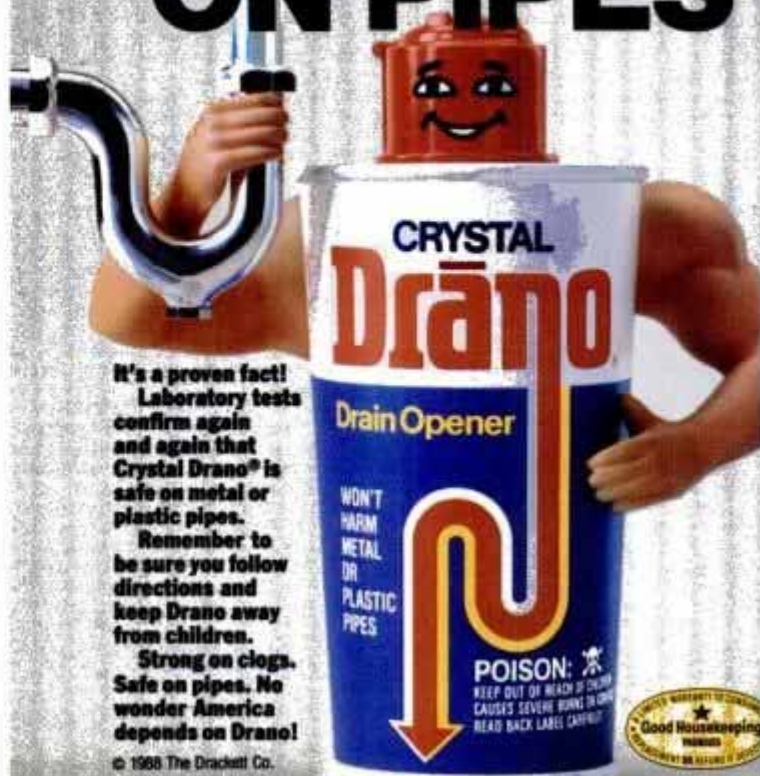
A whetstone with a handle allows you to



The Diafold Whetstone is a diamond-embedded, folding sharpener.

40

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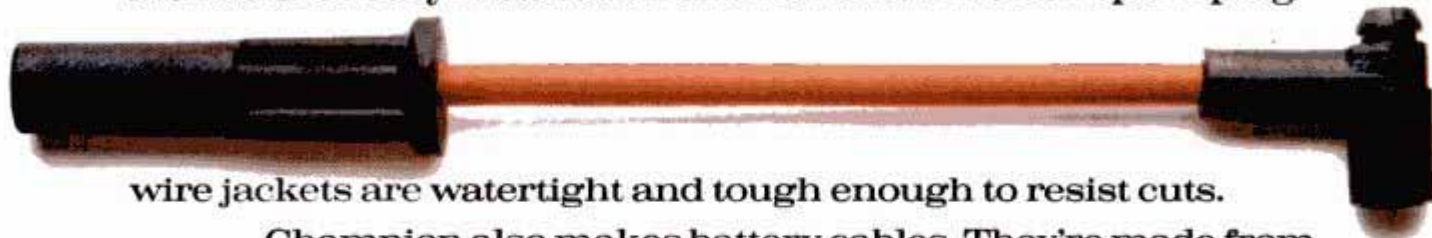
That's why our premium spark plug wire terminals are specially designed to snap in place to insure a tighter connection with the spark plugs. Or why our terminals, unlike others, are



made of stainless steel to avoid corrosion.

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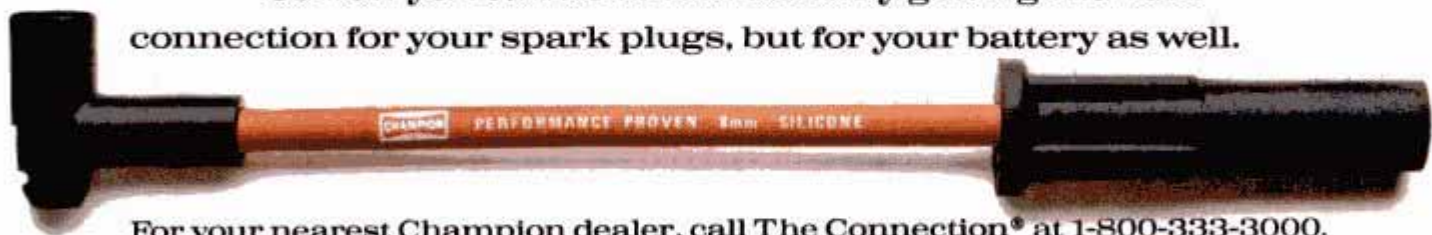
What's more, our spark plug wires have the largest boot available for easy installation and removal. And our spark plug



wire jackets are watertight and tough enough to resist cuts.

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OLD HOUSE RESTORATION

BY BOB VILA

Dealing With Old Windows

WHAT CAN I DO with my windows? This is a common lament of old-house owners, especially this time of year when the cold season looms. The way I see it, you've got two choices. You can make the best of what's there, sealing these energy wasters as tightly as possible, or you can replace them with new, energy-efficient units.

Many old-house owners shudder at the thought of replacing their old windows with new ones. After all, everyone knows that much of the character of an old house comes from the design and placement of its windows. Fortunately, you can retain the architectural integrity of your restoration and benefit from today's energy-efficient products as well.

Depending on the style and size windows you have, you may be able to find a stock window in a manufacturer's product line that fits the bill—and the space you've got. Or, you may have to go the custom route and have windows designed and/or sized to replicate and replace the originals. Like everything else, what you decide to do is largely dependent on two things: the condition of your present windows and, of course, your restoration budget.

Keeping the old

If the wood is sound and the frame and sash are in good condition, there's usually no reason why an old window can't be saved. In most cases, restoring it involves repairing the sash and trim, as well as replacing the putty around each pane of glass to prevent leakage. You'd be surprised how many old windows have

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



Replacement windows that yield better energy efficiency without sacrificing any architectural integrity are now available.

no weatherstripping. So be sure to check each window to ensure this material is in all the right places.

The old double-hung windows with weights and pulleys are real energy wasters. The cavities where the cords and weights operate are uninsulated, which means lots of cold-air infiltration—and lost heat. There really isn't too much you can do about this, unless your sashes are 1½ in. thick. If they are, it's relatively easy and inexpensive to replace the old cords and weights with new sash balances to help tighten things up and save energy. I prefer the spring-loaded aluminum balances. I think they do a better job than the vinyl ones that

work on friction. After you remove the old weights and pulleys, be sure to insulate the now-empty cavities. I always depend on fiberglass insulation, which can be tucked easily into these odd spots.

Although replacing pulleys and weights like this is not as good as buying a brand-new window, it is very effective for cutting down drafts. As an added bonus, those old windows will probably open and close easier, too. If you have a real antique, however, you'll want to maintain the authenticity of sash cords and weights. Under these circumstances, make sure your storms are in good shape and that they fit properly. If not, it's worth your while to get

new ones. You can still find wood-frame storms that blend well with the character of your home.

On with the new

If you're tired of sticky, leaky, inefficient windows—no matter what you do, an old window is never going to be as efficient as a new one—it may be time to talk replacement. If your sashes have deteriorated or rot has set in, you may not have any choice.

Of course, you'll want to replace your home's original windows with a similar product that not only will improve its overall energy efficiency, but will also retain the architectural integrity of the house. As I said earlier, this is possible to do today.

Several of the large window manufacturers, like Marvin Windows (Minneapolis, Minnesota) and Pella (Rolscreen Co., Pella, Iowa) offer a variety of wood-frame windows in their standard, ready-to-order lines that, depending on the age of your house, style and size of window, may fit the bill. Although many manufacturers offer the popular vinyl- or aluminum-clad wood windows today, I hesitate to recommend them for restoration work. True, these products are maintenance free, but I think sticking to wood is the more *authentic* way to service your old house.

Two of the most important things involved in choosing new windows are finding ones that replicate the style of the originals and that are the right size. If this isn't possible with a stock window, you'll have to go the custom route. Again, some of the major manufacturers, like Marvin and Pella, also offer this service.

Furthermore, there are a variety of millwork shops

(Please turn to page 44)



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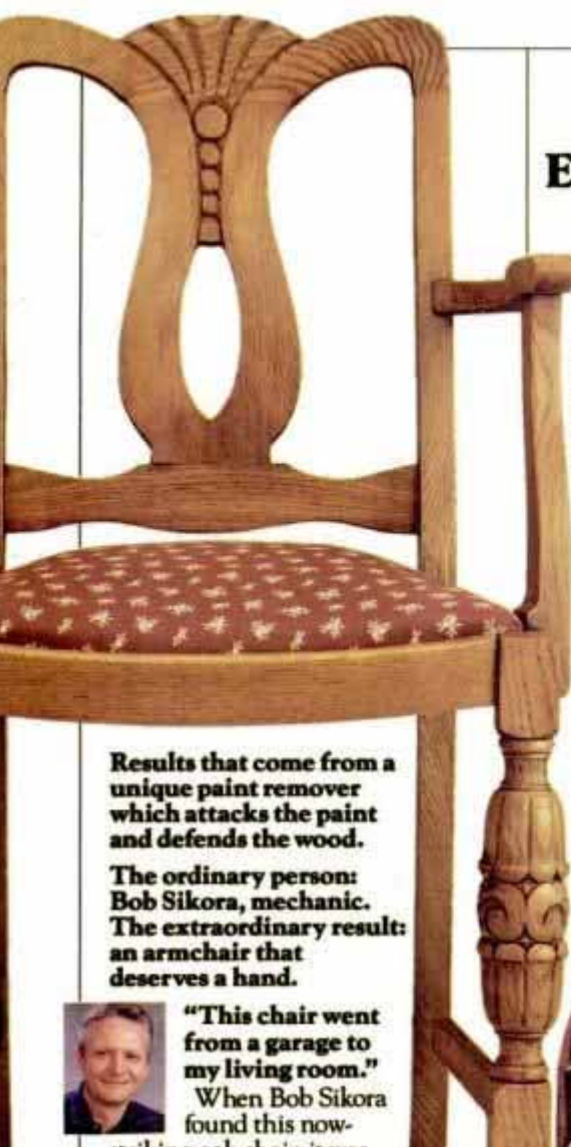
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Today's glass

Once you select a window that replicates the originals, or elect to have custom units made, you'll have some choices when it comes to selecting glass. Many restoration purists, or those with homes that are historic landmarks, stick with single-pane glass to retain a look as close to the original windows as possible.

But if you're restoring an old house for the pure joy of it, I see no reason why you have to take two steps backward when doing this replacement work. You can order just about any window, including true divided lights with wood muntins, with either double-glazed insulated glass or the new Low-E glass to increase your home's total energy efficiency.

Most of you are probably familiar with these products. Double-glazed glass, of course, consists of two panes sealed together with an air space in-between. The air acts as an insulator between your warm home and the outside cold. So the



Special-order windows to fit any style and size requirements are made by some big manufacturers—and smaller custom shops.

larger this air space is, the better.

The new low-emissivity, or Low-E, glass usually has a thin, metallic film on one of the panes or between them, that lets the sun's good rays enter your home, but won't let the radiant heat escape. This film works in the reverse, too, and helps keep your home cool in the warm months. By keeping ultraviolet rays out, Low-E glass eliminates some of the problems associated with the sun's rays: faded furniture, carpeting and window treatments. Different manufacturers offer different variations of this type of glass which can result in different R-values.

All in all, the *old-house* replacement window market is an encouraging one. If you can't find a suitable replica from the stock items in a manufacturer's catalog, it's a comfort to know there are enough folks out there willing and able to create custom windows just for you. **PM**

OLD HOUSE RESTORATION

(Continued from page 42)

scattered around the country that specialize in manufacturing historical or made-to-order custom windows.

Although giving average prices is never easy, it is particularly difficult when talking about windows.

There are just too many factors involved to be able to give ballpark figures here. Suffice to say you should expect to pay from 25 to 100 percent more for custom windows.

Don't be tempted, in the name of economy, to order standard-size units and try

to make them fit your openings with extenders. Many times, this involves reworking the wallpaper and interior trim to make things fit. This means that you're likely to pay more in the form of labor and materials trying to do this than if you had just ordered the custom replacements from the beginning. Also, when you start doing things like this, you're getting further away from retaining the architectural integrity of your house. This, of course, should be your prime objective throughout this replacement project.

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Stealth SLR Bridges The Gap

BY STEPHEN A. BOOTH, Photography Editor

OPTICS and electronics join for a marriage made in heaven in the new Olympus Infinity SuperZoom 300, one of the "bridge" cameras discussed in May (see "Photography," page 58). It offers sensible electronic automation for basic point-and-shoot photography, then adds several automated and manual functions for more sophisticated or creative applications.

The 300 is a comfortable camera to hold and use. The contoured, binocular-style grip places your trigger finger conveniently over the shutter release button. Camcorder-style controls for the powered 38-105mm zoom are located so that your left hand operates them when it's gripping the 21-ounce camera—half the weight of an autofocus SLR with comparable zoom lens.

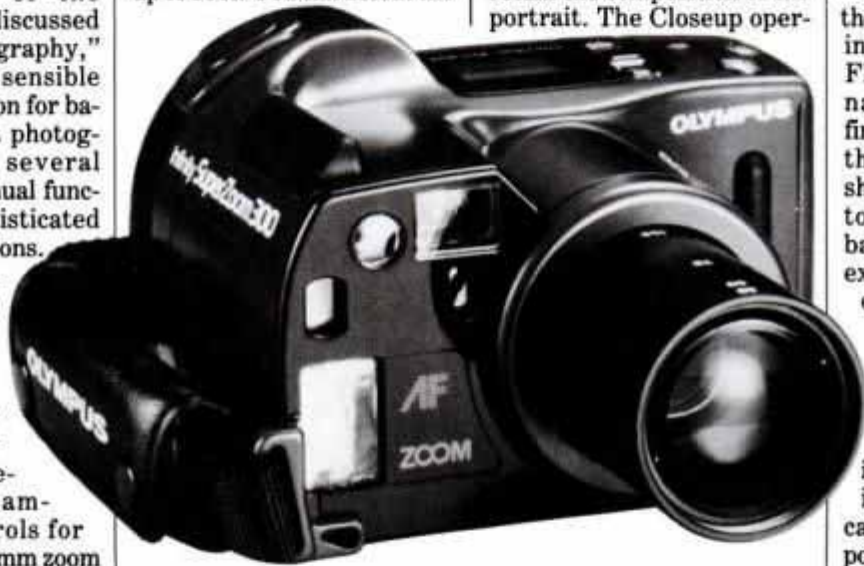
These power controls let you compose with the zoom anywhere from wide to telephoto in just 1½ seconds—while the autofocus (AF) lens keeps your target subject perfectly sharp.

Unlike AF compacts, which use an infrared beam for focusing, the 300 uses a chip-based, phase-difference detection system similar to that in AF SLRs.

When it's too dark for the CCD sensor to focus on its own, the 300 automatically activates a near-infrared illuminator to assist autofocus on subjects within 13 ft. Flash is fired automatically in these circumstances, or

when the 300 senses a backlit subject, and the range of the flash is keyed to the focal length of the lens, up to 56 ft. You can defeat the

rect focal length when you focus your subject. Then, the Servo AF tracks the subject both to keep it in focus and retain the composition of the portrait. The Closeup oper-



The Olympus Infinity SuperZoom 300 bridges the gap between compacts and SLRs with full automation plus creative options.

flash, or activate it manually for fill light to eliminate shadows. The flash recycles in 2½ seconds.

In its Continuous mode, the 300 will fire one frame per second as long as the shutter release is depressed. In the Servo AF mode, and with the shutter release depressed halfway, the lens will track moving subjects, refocusing once a second.

A variation of the latter feature makes portrait taking almost foolproof—especially when the subject is moving. In the Portrait mode, you can set the 300 for Closeup (head and shoulders) or Full Portrait (head to feet) composition. The lens automatically zooms to the cor-

rect focal length when you focus your subject. Then, the Servo AF tracks the subject both to keep it in focus and retain the composition of the portrait. The Closeup oper-

ates at distances 4 to 10 ft. from the camera, Full Portrait from 10 to 26 ft. Among the 300's other tricks is Auto Program Shift: The camera automatically optimizes shutter speed and aperture according to the focal length at which the lens is set. This, for example, would compensate for camera shake at telephoto lengths. Another neat trick is the Infinity mode. Normally, AF cameras are stumped when asked to focus on objects in the sky, such as fireworks or clouds, because there's really nothing to focus on! Here, the 300 fixes focus at infinity so you can capture those ethereal and ephemeral objects on film. When the sky's

dark, the 300 allows a maximum exposure time of 2 seconds—a necessity for good images of fireworks.

By the way, you can use the manual fill flash at night in the Slow Speed Synchro Flash mode to create fascinating images. The flash fires just long enough to light the main subject, then the shutter remains open for up to 2 seconds to expose the background properly—for example, when there are colorful marquees, neon signs or automobile taillights in the background.

Other creative functions in the Olympus Infinity SuperZoom 300 include spot light-metering and double-exposure capability. For critical exposure, the spot meter measures an area that is 5 percent of the total frame. The double-exposure feature lets you combine two images on the same frame of film. To meld the images just right, the 300 offers exposure compensation, manually adjustable up to 1½ stops plus or minus in half-stop increments.

The 300 advances and rewinds film automatically, and sets film speed for DX-coded films from ISO 25 to 3200. The camera also autofocuses for macro photos of subjects within 2.6 to 4.3 ft. Aperture range is f/4.5 to f/32, shutter speeds are 1/500 second through 2 seconds. The camera is powered by two 3-volt lithium batteries, and costs \$550. Optional accessories include a polarizing filter and a variety of special-effects filters.

New And Noteworthy

■ Kodak has had a busy summer. In the amateur photography category, Father Yellow has cooked up two new slide films, a trio of how-to books, and even a Mickey Mouse camera—that is, a snapshooter for kids. Let's deal with age before beauty.

At last, Kodachrome in the ISO 200 speed has filtered down from the professional level. In practical terms, this means you'll be able to find it in your neighborhood pharmacy or convenience store, instead of having to make a special pilgrimage to a pro shop.

In photographic terms, the amateur film compromises nothing found in the professional version, except the need for refrigeration. It's useful when you want classic Kodachrome color for low-light, telephoto or action photography.

Kodak's other entry in the transparency film category is Ektachrome 100HC, with a medium-speed rating of ISO 100. Kodak doesn't say what the HC means, but you can bet it signifies heavy color—as in more highly saturated reds, greens and yellows than obtainable from earlier Ektachromes.

Meanwhile, Kodak promises whiter whites and none of the blue-tinted flesh and neutral tones that previously attracted criticism to Ektachrome.

To help you use the new amateur films more professionally, Kodak has published a new title in its excellent series of how-to books. *How To Take Good Pictures* (\$8) offers 192 pages of tips and photos for the casual snapshooter.

To try and grab 'em while they're young, Kodak offers its Mickey-Matic camera—12-bucks-cheap for kids, and a real bargain for collectors of potential nostalgia (remember those Mickey Mouse watches?). The Mickey-Matic uses 110-size ISO 200 or 400 print film. For indoor photos, the camera accepts flip-flash packs. Mickey-Matic comes in blue or rose, with the Disney character emblazoned on its front panel.

■ Polaroid hasn't forgotten the children, either. In fact, the instant photography guys might have remembered something about kids that Father Yellow forgot—namely, the temper tantrums that occur when he or she "wants it now."

The answer is Cool Cam (\$69 minus \$10 rebate), a fixed-focus instant film camera for instant gratification. It comes in hot red-and-black or cool pink-and-gray, with color-coordinated fashion sunglasses and shoulderbag. For film, Cool Cam uses the new 600-Plus, which incorporates the sharp, saturated color chemistry of Polaroid's rectangular Spectra film in the square 600 format. That's good news for grown-ups, too: The new film can bring new life to all pre-Spectra, 600-format Polaroid cameras, such as the Sun series. **PM**

The Weed Eater Blower/Vacs.

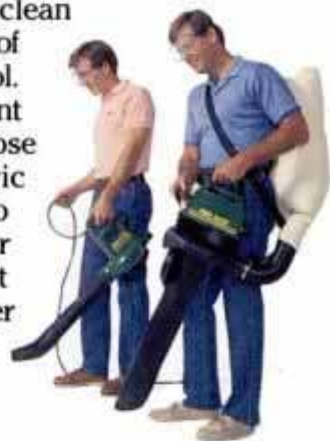
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New-Age Singles: The Mini CD

BY FRANK VIZARD, Contributing Editor

ALTHOUGH the 3-in. compact disc is still a new format, it is clear that CD-3 (as it shall be called forevermore) will be used in a variety of ways by the numerous record labels now supporting the format.

CBS, for example, is adopting a 3-pronged approach. The company will issue new hit singles, oldies and extended-play dance selections on the midget disc. While CD-3 is capable of storing 20 minutes of music, don't expect it to be used to its full capacity. CD-3 is to be the reincarnation of the old 7-in., 45-rpm vinyl single.

Early promotional titles from CBS illustrate the trend. A Bruce Springsteen CD-3 containing *One Step Up* and *Roulette* amounts to 8 minutes and 12 seconds of music. Michael Jackson fans get 10:10 of both a vocal and instrumental version of *Man*

In The Mirror. And in an example of under-utilized capacity, Gloria Estefan and the Miami Sound Machine sing both the English and Spanish versions of *Anything For You* for a total of 7:46. CBS says list price for its CD-3 hit singles is \$2.49 while dance versions—the heir apparent to vinyl 12-in. singles—list for \$5.98.

Teen tunes

A&M, meanwhile, is offering CD-3 samplers with six songs for about \$5. Much of the material on its CD-3s will be new selections or new versions of older songs by popular artists, promises A&M. Don't look for too many classical or jazz titles from any of the record labels. CD-3 is being targeted at an adolescent audience.

CD-3s require the use of an adapter before they can be played on older compact disc

players. Some new CD players have specially molded drawers that will accept both the regular 5-in. CD and CD-3 without using an adapter for the latter.

Home players that accept both disc sizes soon will be the norm, but just how far the CD-3 format might go is demonstrated by Sony's introduction of a personal CD player sized expressly for CD-3 use.

Dubbed the Pocket Discman, Sony's player measures less than 4 in. sq. × 1½ in. thick. Within this small space are more than 400 parts that represent a triumph of miniaturization. The optical pickup assembly, for example, uses a new single-lens design that weighs one-tenth of a gram and is only one-fifth the size of typical multiple-lens assemblies. The machine weighs just 10.6 ounces, or 14.1 ounces with its rechargeable 2-hour battery.

Although normal size CDs don't fit inside the Pocket Discman, the machine can play them. Both the optical assembly and the center spindle can be adjusted to accommodate the larger CDs.

Yes, the 5-in. CD does stick out of the machine. But don't think of it as a bologna slicer. Playback stops harmlessly at the slightest contact with flesh or any other material. For nonportable use, a plug-in AC adapter is supplied with the machine. For car or boat use, a DC adapter is available as an option.

The Pocket Discman has a list price of \$360. That's certainly expensive but Sony notes that its personal cassette player, the Walkman, was a high-ticket item when it was introduced. Now personal cassette players are inexpensive and owned by millions. Time will tell if the Pocket Discman has the same future ahead of it.

Lyrics, too

Meanwhile, CD-3 represents a new size, but the compact disc medium is also gaining a new capability. JVC and Warner New Media plan to use the subcodes already on the CD to carry digital graphics material for display on video screens. The graphics won't be moving images. They will include material such as liner notes, lyrics or guitar fingering diagrams.

Warner hopes to introduce 50 CD+G titles before the year is out and JVC plans to debut a CD player with the necessary decoding circuitry this fall for about \$399. An outboard adapter to retrofit older CD players with digital graphics outputs should cost about \$150. CD+G discs are likely to be priced higher than standard CDs.



Sony mini CD isn't much bigger than a cassette.



Denon's DR-M10HX \$280 cassette deck performs like units twice its price.

Stacked Deck

Audio manufacturers introduce new products every year or so, but some products become perennial best sellers. These models stay in a manufacturer's line year in and year out because they offer superior performance at a very good price.

One of the newest products to join my list of perennials is Denon's DR-M10HX cassette deck. This machine costs \$280 and at that price it is hard to find a better performing deck. Frequency response is rated at 25 to 18,000 Hz plus or minus 3dB—a range that should accommodate all but the most demanding recordings. Wow-and-flutter and signal-to-noise ratio challenge more expensive decks. To find better specs, in fact, you'd generally have to spend twice the money.

The DR-M10HX includes most of the features expected in a top-flight tape deck, such as Dolby B and C noise reduction. Less common is the inclusion of Dolby HX Pro circuitry.

Dolby HX Pro works only during the recording process. When the HX circuitry detects high-level, high-frequency music, it automatically lowers the deck's recording-bias current. Bias is an inaudible superhigh frequency recorded onto the tape to keep tape noise and distortion levels low. Unfortunately, music with a lot of intense high frequencies can often act as a bias signal as well. When both bias signals collide, the result is tape saturation, which manifests itself as a dull-sounding recording. What happens is that the natural high frequencies that lend brightness to the music are canceled out—and don't get recorded. The Dolby HX Pro circuit automatically lowers the recorder's bias to prevent this cancellation.

Recordings made with Dolby HX Pro stand a better chance of retaining the natural sound of the original—especially if the original is a digital source. For this reason alone, the DR-M10HX commends itself.

Private Studio

Each time I travel to Japan to view the latest audio products, I spend at least one evening enjoying the *karaoke* experience. Upon entering the appropriate establishment, my hosts and I take turns singing the lyrics to a variety of songs recorded as instrumentals.

While enormously popular in Japan, *karaoke* has not caught on in the United States. Americans, perhaps, realize

that singing in public bars is likely to lead to a run-in with some very vocal critics. Sansui, however, is offering a machine that lets you enjoy the sound of your own voice in private.

Sansui's EM-P2 is basically a full-featured personal cassette player equipped with a headphone/microphone attachment. As you sing into the microphone, the headphones let you hear your own voice as it accompanies the background instrumentals prerecorded on the cassette. The EM-P2 has an echo control that is effective for both vocals and instruments. There's also a pitch control that alters the key and tempo of the mu-

sic by as much as 15 percent, to let you re-tune the instrumental or to bring a song into your vocal range. You can record your crooning along with the background instrumental by connecting the EM-P2 to a second tape recorder.

While a machine like the EM-P2 promises lots of fun for the average closet singer, it can also be used by the more serious musician. The 1/4-in. headphone jack accepts plugs from electric guitars, keyboard synthesizers and other instruments so the EM-P2 can function as a portable rehearsal studio, enabling a musician to practice without disturbing others. The EM-P2 costs \$149. **PM**

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THE CAPTAIN COMES HOME



Thirty years ago, William Robert Anderson took *Nautilus*, America's first nuclear-powered submarine, on a history-making voyage under the North Pole. Today, Anderson returns to find a changed and changing underwater Navy.

BY TIM COLE, Science/Technology/Aviation Editor; PM Photos by Brian R. Wolff

IT WAS AN UNEASY time in America 30 years ago. A series of *Sputnik* satellites had just made an all-too palpable demonstration of Soviet astronautics. Visions of space-based ICBMs haunted an unprepared nation. And even though America's rudimentary *Vanguard* satellite had given us a tenuous toehold in low-Earth orbit, President Eisenhower needed a means of demonstrating America's technological prowess.

Indeed, technology was emerging as the high ground of the '50s, prime real estate on

the intellectual battlefield of the Cold War.

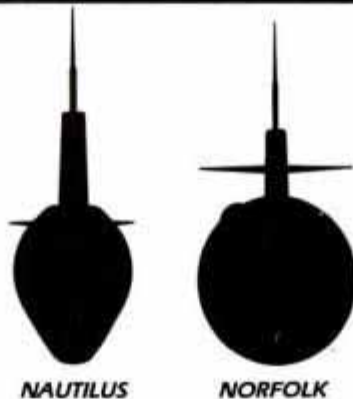
But President Eisenhower had a very significant card up his sleeve—a means of exhibiting American know-how tinged with the kind of military overtone that would make the world, and particularly the Soviet Union, stand up and take notice.

Ike had *Nautilus*, the world's first nuclear-powered submarine, the work of that irascible genius Hyman Rickover. And he had William Robert Anderson, a country gentleman from Waverly, Tennessee, one of the most experienced skippers in Ameri-

ATTACK SUBS



Nautilus (top) cleared the icepack in just under six days with the help of Navy sea-ice expert Waldo Lyon (left) seen conferring with skipper Anderson. The cross section of a 688-class sub (right) has expanded in comparison with *Nautilus*'s early reverse-teardrop design.



NAUTILUS

NORFOLK

ca's "silent service." This cool-tempered professional would command this remarkable machine on a voyage beneath the North Pole—electrifying the world by sailing where no ship had ever sailed before.

"At first, Rickover didn't want us to go up there," Anderson recalled 30 years later as I joined him on a tour of *Nautilus*, now a museum ship berthed in Groton, Connecticut. "The admiral told me, 'You're going to take that submarine up there and lose it and wreck our nuclear program.' But Eisenhower wanted it to happen. And Rickover eventually became a supporter, too."

With that presidential impetus, *Nautilus* completed a journey that to this day affects the disposition of America's nuclear-submarine forces. The Arctic Sea was deemed completely inaccessible back then. Now, it is considered a highly prized theater of engagement, where Soviet and American submarines play a high-stakes game of hide and seek.

Following Anderson's polar gam-

ble, America's fleet of nuclear submarines built upon *Nautilus*'s early advancements in propulsion, life support, sonar sensing, weapons delivery and ship's quieting—the nuts and bolts of nuclear deterrence.

To develop a sense for the changes that have taken place in America's nuclear-submarine fleet, I visited *Nautilus* with Anderson, a former 4-term congressman from Tennessee and now a Washington, D.C., business executive. We then shifted the scene 30 years to the present with a tour of *Nautilus*'s direct descendant, the *Los Angeles*-class attack submarine *Norfolk*.

These separate views of two highly sophisticated weapons-delivery platforms illustrate the enormous strides that have taken place in nuclear-submarine technology—and highlight the logical development of concepts *Nautilus* pioneered.

Past glories

"It seems like everything is in place," Anderson said as we entered

Nautilus's wardroom—virtually unchanged after three decades. *Nautilus* was a tangible product of the nuclear age when construction was completed in 1954 at General Dynamics' Electric Boat Co., in New London. Subtle changes in appearance included retractable bow planes forward, and a reverse-teardrop shape to reduce drag. But the real differences were inside.

Rickover had selected a pressurized-water reactor for *Nautilus*. Like later versions of this remarkable engine, the heat from the uranium-fueled powerplant was removed through a closed loop, which turned water from a separate loop into steam. The steam spun a turbine that turned a propeller shaft through a reduction gear. The steam then traveled to a condenser, where it reverted to a liquid state for recycling.

Demineralized water generated by the on-board desalinators operated through this closed system. *Nautilus* lacked the oxygen-generating ability found aboard today's nuclear submarines—systems that separate hydrogen from purified water by electrolysis to produce oxygen.

While nuclear power meant the boat could remain submerged indefinitely, it had to surface at least once every 10 days to ventilate.

Designers positioned *Nautilus*'s reactor and engine spaces in the after half of the vessel. The boat's two decks forward contained crew accommodation, galley and control stations—an arrangement considered palatial in 1954. The attack center was on an island on the top deck under the sail, surrounded by navigation equipment and fire-control stations.

Controls for the planes and dive stations were located on the lower deck. The two spaces were connected by intercom and an elaborate brass communication funnel more appropriate for a Mississippi riverboat.

Nautilus's World War II-vintage Mark 14 unguided torpedoes were fired from six 21-in. tubes under the direction of a rudimentary electro-mechanical fire-control computer. Surface search radar and communications sets were also fairly basic. For an ice-thickness recorder, designers aimed a set of sonar transducers upward to read topographic variations in the bottom of the ice. *Nautilus*'s leading-edge inertial navigation system, designed by North American Rockwell for an early guided missile, meant the boat could navigate precisely while submerged for extended periods.



Shift the scene 30 years forward to today's sub, the *USS Norfolk*, SSN-714. A *Los Angeles*-class attack sub and *Nautilus*'s direct descendant, she boasts significant improvements in operations, quieting and weapons management. While dive stations have undergone subtle enhancements, like two controls instead of the *Nautilus*'s three (above right), principal upgrades are in sonar (near right) and the wire-guided advanced-capability Mark 48 torpedos (far right), which are more acoustically sensitive and have a greater range.



ATTACK SUBS

At the helm

Rickover needed a consummate submariner to command the nation's first nuclear boat, and William Anderson was a natural choice. Anderson graduated from the U.S. Naval Academy in June of '42, and trained in Groton aboard World War I-vintage O-boats.

His first war patrol was aboard the *Tarpon* out of a shattered Pearl Harbor. He'd later serve as an officer aboard the *Narwhal*, a *Nautilus*-class diesel sub. Anderson and the men he served with preyed on Japanese commerce, acted as lifeguards for B-29 pilots returning from raids on the Japanese homeland, and resupplied Filipino guerrillas.

Anderson remained in the Navy after World War II, advancing to command a conventional submarine named *Wahoo*. He took command of *Nautilus* on June 18, 1957, and was her second skipper.

Try and try again

It took Anderson and his crew of 111 seamen, chiefs, officers and four civilian scientists three attempts before they finally cruised under the pole.

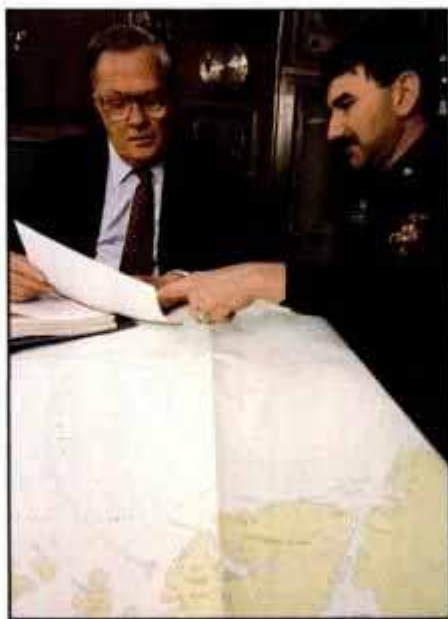
The first time was from east to west, going under the ice pack between Greenland and Spitzbergen. Peering through the Kollmorgen periscope situated in the attack center, he could angle the instrument high above the sail of the submarine so he could see the intricate and fractured patterns the ice created as the submarine surged ahead. No one had ever gazed out over this otherworldly icescape.

But the spectacle was muted by harsh realities. "We had a lot of trouble on that first try. At one point, we attempted to surface in an open area. But we rammed the ice pack with our sail because of a blind spot in our under-ice sonar. We damaged both periscopes. But we managed to make it out from under and resurface to complete repairs."

That same trip, *Nautilus* again attempted to transit the pole, sailing 450 miles inside the ice pack to 87° north latitude. *Nautilus's* goal was now only 180 miles away.

Suddenly, a circuit breaker feeding a trim pump kicked out. The power to the gyrocompasses was on the same circuit. *Nautilus* was blind, and magnetic distortions were causing wild fluctuations in conventional compasses. Using a lot of trial and error navigation, Anderson worked *Nautilus* out from under the ice to resurface.

"We'd had a dead reckoning error of more than 100 miles. Even Columbus did better than that."



Nautilus's Anderson (left) goes over Arctic Sea charts with *Norfolk's* Ponessa.

Slow going

A commitment to participate in a NATO exercise forced *Nautilus* to discontinue the polar attempt. Anderson also had a plan.

"We'd been on the east side and knew the area a little better. I wanted to try the hard part first through the Bering Strait when I knew our nav gear would be up and running. Besides, maybe our luck would change." Prior to this western attempt, Anderson and sea-ice expert Waldo Lyon from the Naval Electronics Lab reconnoitered the Bering Strait from a chartered bush plane—the pair posing as a geological survey team.

"There was a good reason for going up there. We wanted to study the ice and see if we could spot some way through. If there was some pattern to it, we wanted to find out what it was."

But, after departing Seattle, *Nautilus's* third attempt to reach the pole was thwarted off Alaska when she ran into unexpectedly thick pack ice in shallow water. Anderson prudently called retreat.

In the end, time served *Nautilus* better than advanced scouting. Spring turned to summer and the ice pack receded northward. Departing Pearl Harbor on July 23, 1958, *Nautilus* ran submerged to the Bering Strait, then surfaced for a topside cruise as far north as Point Barrow. Submerging 10 miles north of the Alaskan coast, *Nautilus* slowly crept north, careful for any indication of rapid shoaling.

"We had no idea what we'd find. For all we knew, there was a huge sea mount under the pole and we were heading right for it."

But *Nautilus* sailed on—reaching the pole on August 3, 1958, after a two-and-a-half day sail. Anderson recalls peering through the attack center periscope as the ice changed shape, diffusing and refracting the light like a bank of clouds. Two days later *Nautilus* exited the pack ice in the North Atlantic and sailed into the history books.

Fast forward

Under-ice operation is more commonplace these days, as Anderson and I learned from Cmdr. Alfred E. Ponessa, captain of *USS Norfolk*. But it's still not taken for granted. Some, but not all, of the nuclear subs in the fleet are "under-ice capable," having special up- and forward-looking navigation sonars, strengthened sail and rudder caps, and sail-mounted diving planes that rotate 90° to cut through ice. Subs today can also safely surface in open polynyas.

After a full-dress lunch in the wardroom, Ponessa took us on a tour of *Norfolk*, highly proud of the enhancements represented by the *Los Angeles* class.

An S6G nuclear reactor powers *Norfolk*, an improvement in noise reduction over *Nautilus*.

"That's one of the main developments," Anderson told Ponessa. "*Nautilus* sounded like a freight train coming down the tracks."

Subsurface sensing has also changed dramatically. *Norfolk's* sonar suite includes a bow-mounted phased-array system forward of the four torpedo tubes, a towed-array sonar that's mounted alongside the hull, and an active sonar, in addition to an updated version of the ice-thickness recorder that *Nautilus* carried.

Norfolk and her sister ships have a combined control/attack center amidships on the top of three decks, which aids communication during firing exercises. The captain can monitor the dive and maneuvering stations while directing fire-control teams. *Norfolk's* \$7.3 million Kollmorgen periscope is a remarkable instrument with a TV camera that feeds to a monitor, and a 70mm still camera. *Norfolk's* other retractable masts send and receive messages, take position fixes from orbiting satellites, or monitor and evaluate the radio-wave environment around the sub.

Down on the bottom deck, Ponessa showed us the torpedo room, huge by *Nautilus's* standards, filled with Mark 48 wire-guided torpedoes. Teleoperated by the sub's fire-control team, the torpedoes can home in on

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TECHNOLOGY

WINGING IT

Radical breakthrough in rigid-sail aerodynamics expands the envelope in the search for wind-powered speed.

BY JOE SKORUPA, Boating/Outdoors Editor

THE WORLD'S two fastest sailboats have already clashed in the upcoming America's Cup race at least a thousand times. Dennis Conner's radical new wingmasted catamaran, *Stars & Stripes*, and New Zealand's equally high-tech monohull, *Kiwi Mischief*, have battled through heavy wind and light, fought through extreme shifts in weather and current, and suffered unforeseen breakdowns. Men have gone overboard. Boats have pitched and dismasted. And everything, even human error, has occurred—on computer.

The quest to build *Stars & Stripes*, the boat that will defend the San Diego Yacht Club's possession of the America's Cup, has brought together the greatest gathering of minds and technology ever united for a Cup defense.

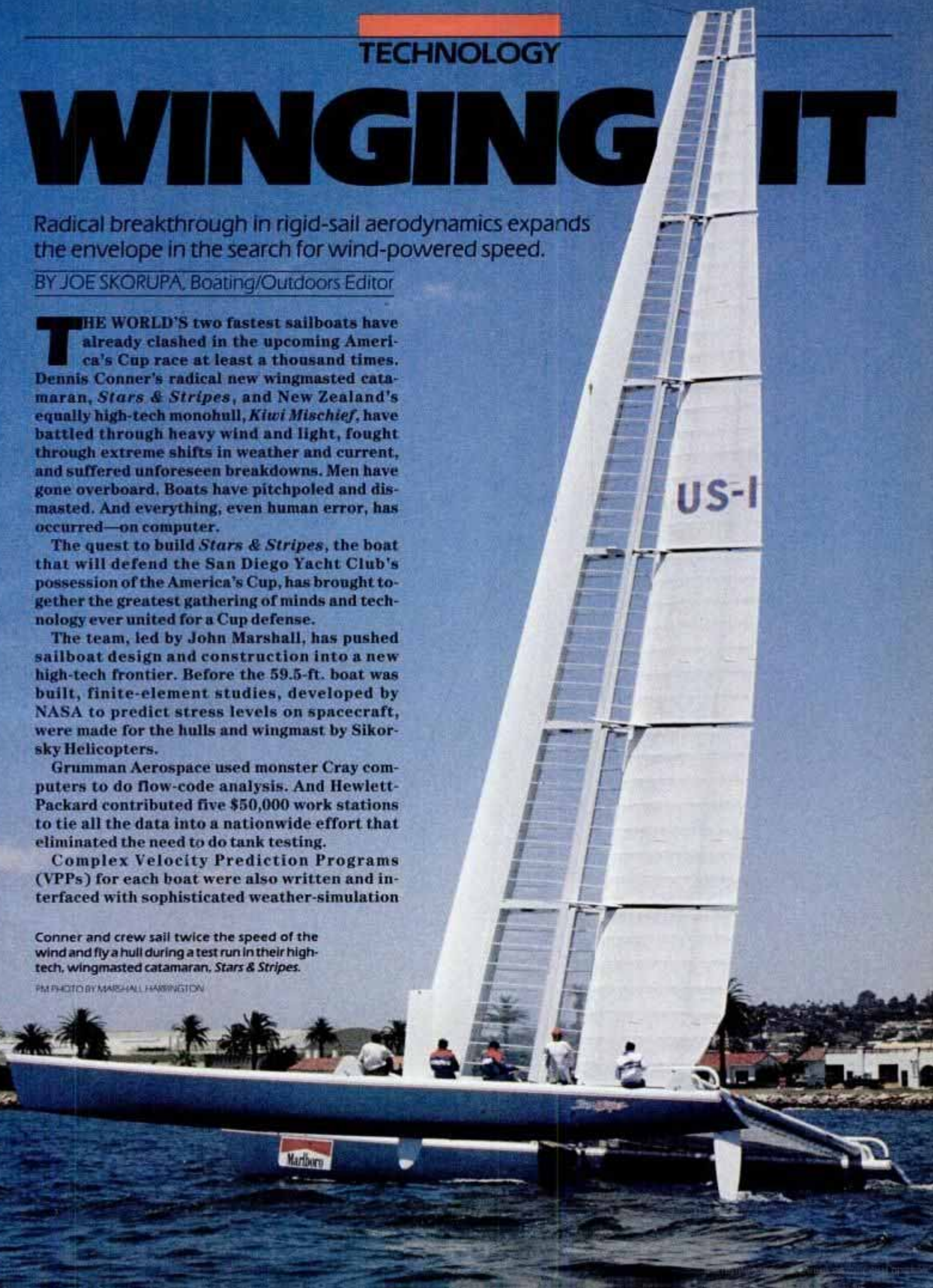
The team, led by John Marshall, has pushed sailboat design and construction into a new high-tech frontier. Before the 59.5-ft. boat was built, finite-element studies, developed by NASA to predict stress levels on spacecraft, were made for the hulls and wingmast by Sikorsky Helicopters.

Grumman Aerospace used monster Cray computers to do flow-code analysis. And Hewlett-Packard contributed five \$50,000 work stations to tie all the data into a nationwide effort that eliminated the need to do tank testing.

Complex Velocity Prediction Programs (VPPs) for each boat were also written and interfaced with sophisticated weather-simulation

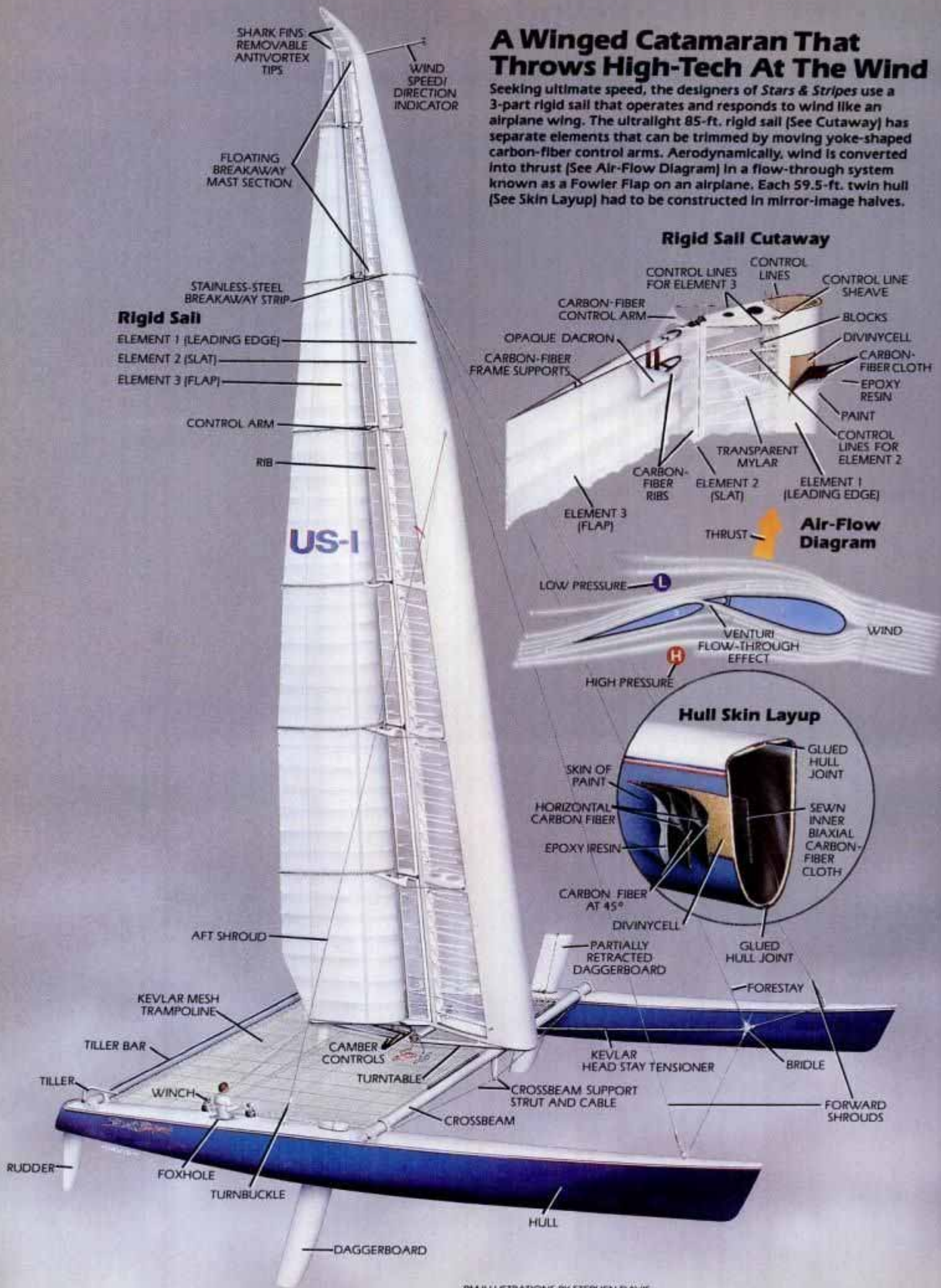
Conner and crew sail twice the speed of the wind and fly a hull during a test run in their high-tech, wingmasted catamaran, *Stars & Stripes*.

PHOTO BY MARSHALL HARRINGTON



A Winged Catamaran That Throws High-Tech At The Wind

Seeking ultimate speed, the designers of *Stars & Stripes* use a 3-part rigid sail that operates and responds to wind like an airplane wing. The ultralight 85-ft. rigid sail (See Cutaway) has separate elements that can be trimmed by moving yoke-shaped carbon-fiber control arms. Aerodynamically, wind is converted into thrust (See Air-Flow Diagram) in a flow-through system known as a Fowler Flap on an airplane. Each 59.5-ft. twin hull (See Skin Layup) had to be constructed in mirror-image halves.



Rigid Sail

- ELEMENT 1 (LEADING EDGE)
- ELEMENT 2 (SLAT)
- ELEMENT 3 (FLAP)

- CONTROL ARM
- RIB

Rigid Sail Cutaway

- CONTROL LINES
- CONTROL LINE SHEAVE
- BLOCKS
- DIVINYCELL
- CARBON-FIBER CLOTH
- EPOXY RESIN
- PAINT
- CONTROL LINES FOR ELEMENT 2
- TRANSPARENT MYLAR
- ELEMENT 2 (SLAT)
- ELEMENT 1 (LEADING EDGE)
- THRUST
- AIR-FLOW DIAGRAM
- LOW PRESSURE (L)
- HIGH PRESSURE (H)
- VENTURI FLOW-THROUGH EFFECT
- WIND

Hull Skin Layup

- GLUED HULL JOINT
- SEWN INNER BIAxIAL CARBON-FIBER CLOTH
- GLUED HULL JOINT
- SKIN OF PAINT
- HORIZONTAL CARBON FIBER
- EPOXY RESIN
- CARBON FIBER AT 45°
- DIVINYCELL

programs. All of this culminated in the breakthrough electronic races.

"We actually do war games in the computer," says Clay Oliver, a naval architect on the *Stars & Stripes* design team. "Our boat and the enemy boat [*Kiwi Mischief*] run the race course in different light-air/heavy-air conditions, and we find the probability of winning or losing. We make it interesting by programming a factor of breakdown, which is catastrophic, or of the skipper's tactical skill, which is difficult to figure. Is it an advantage or a disadvantage? We're not sure."

Look, ma, no sail

To yachtsmen, the most radical elements of *Stars & Stripes* are its carbon-fiber reinforced twin hulls. No catamaran has ever raced for the America's Cup in its 137-year history.

But to those who value technological advancement, the most radical element is the 3-part rigid sail, which responds to wind like an airplane wing.

Wingmasts have been used for at least a decade in catamaran racing, most notably in the Dave Hubbard/Duncan MacLane-designed *Patient Lady* series of C-Class cats. But, according to Dave Hubbard, no naval architect or sailboat designer has ever before worked with the country's top aeronautic minds and technologies.

In addition to Marshall, Oliver, Hubbard, MacLane and others, the design team enlisted the aid of aerotech whiz Burt Rutan, the man behind the ultralight, round-the-world-on-one-tank-of-gas aircraft *Voyager*. Rutan built the space-age 1300-lb. rigid sail, which is larger in area than that of a Boeing-757 wing, in his high-tech plant in the Mojave Desert.

The 90-ft. wingmast is comprised of three independently movable compo-



PM PHOTO BY MILES ARCHER

Half of the 40-member crew of New Zealand's *Kiwi Mischief* act as a live ballast.

nents made of carbon fiber/epoxy resin, carbon-fiber ribs and Mylar and Dacron skins. The components, referred to as Elements 1, 2 and 3, are analogous in function to an airplane wing's leading edge (Element 1), slat (Element 2) and flap (Element 3).

The true breakthrough here, according to Hubbard, is the concept of airflow between Elements 2 and 3 achieved by Element 2's remarkable maneuverability. Known as the Fowler flap in aeronautics, this adjustable gap creates a venturi effect in airflow across the wing. A stream of

air is forced from the high-pressure side to the low-pressure side of the wing to increase lift or thrust, similar to that of an airplane with its slats deployed during takeoff.

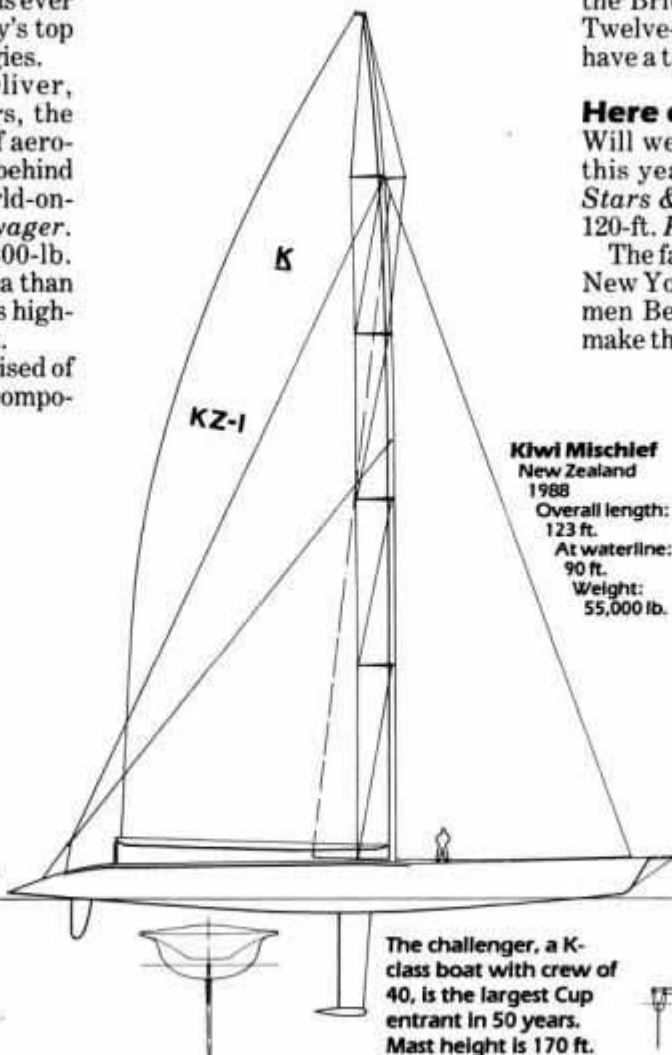
The knowledge gained in aeronautics and construction technologies, which cost the designers and builders of *Stars & Stripes* about \$3 million, will give the boat a 5- to 10-percent speed advantage over previous wing-masted cats, according to Hubbard. This will put the big cat in the 35-mph range. The current speed record for a wind-powered boat is 41 mph, held by the British catamaran *Crossbow II*. Twelve-Meter boats, by comparison, have a top speed of about 11 mph.

Here comes the judge

Will we see an America's Cup race this year between the wingmasted *Stars & Stripes* catamaran and the 120-ft. *Kiwi Mischief* monohull?

The fate of the race is in the hands of New York Supreme Court Judge Carmen Beauchamp Ciparick, who will make the final ruling sometime before

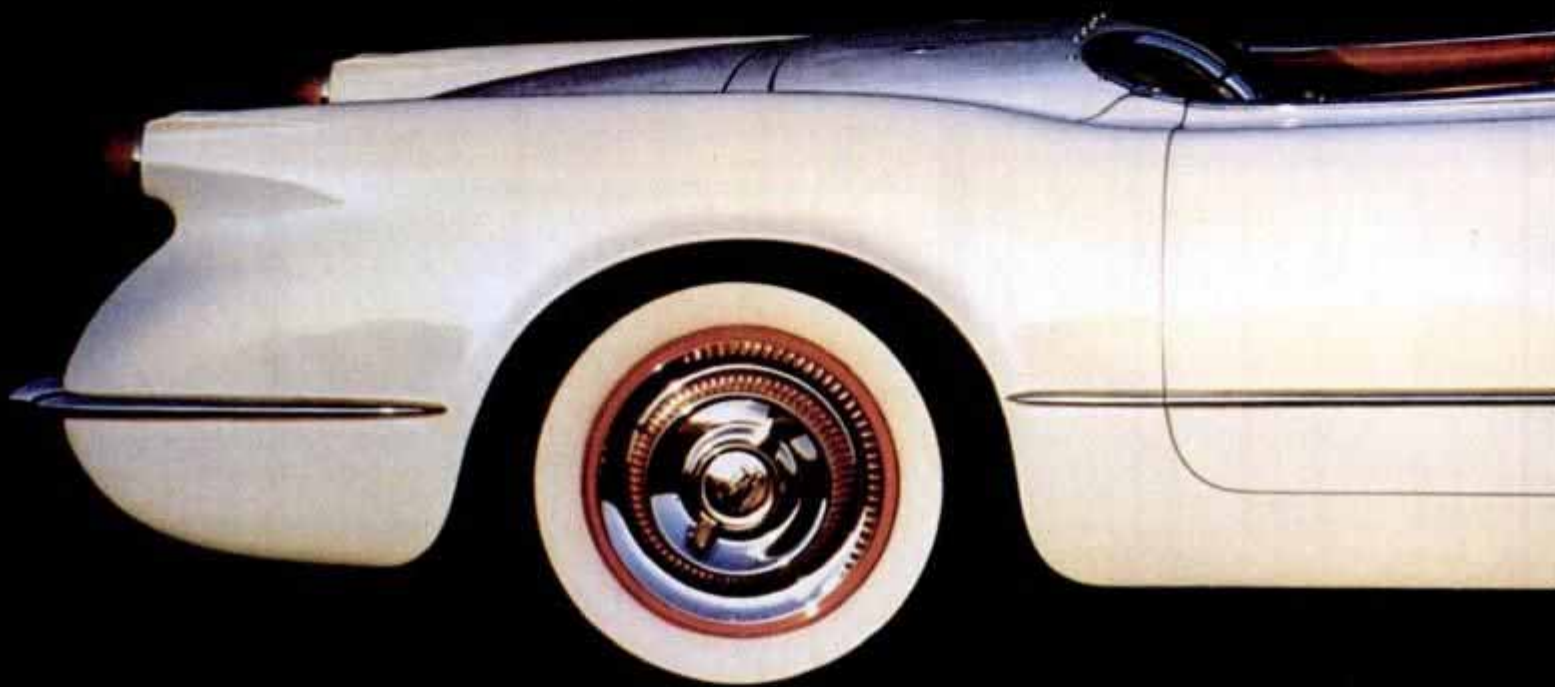
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HAPPY BIRTHDAY, CORVETTE!

The car America has loved for 35 years.



BY CLIFF GROMER
PM Photos by Cliff Gromer
and Bill Erdman

FOR 35 YEARS it's been the Great American Dream Machine, a seductive 2-seater with a spirit of adventure unlike that of any other automobile. It's called Corvette, and it has everything—power, speed, agility and a healthy dollop of raw sex appeal.

But it wasn't always smooth sailing for Chevy's Plastic Fantastic, and the car suffered a survival crisis before it entered its third year of production.

The whole Corvette phenomenon started in the early '50s when General Motors styling chief Harley Earl looked at some of the fiberglass-bodied sportsters of the day, mostly products of southern California hot-rod shops. He saw the material as an easier way to experiment in styling.



The original '53 Chevrolet Corvette was a near carbon copy of the Motorama show car. The split window coupe of '63 was the first in the Sting Ray series. Model year '57 saw the first real sales jump, almost double that of '56. In 1967, big-block fever—427 cu. in. and up to 435 hp—was hot, and in '68 the Vette got its second major redesign.



Earl came up with a concept for a low-priced, sporty 2-seater that would use a lot of Chevrolet hardware and sell for about \$1850. GM President Harlow "Red" Curtice liked Earl's car so much he wanted it for the GM Motorama Show, which at that point—April, 1952—was barely seven months away.

Chevy chief engineer Ed Cole and suspension engineer Maurice Olley came up with a 102-in. wheelbase. The design was very close to the actual production Corvette and used front and rear suspension pieces from a '52 Chevy sedan. The completed car, as shown January 1953, was a clean, rounded design free of frills and doodads. The only eyebrow-raising feature was the jet-pod taillight.

Engine-wise, the biggest gun in Chevy's arsenal at the time was a 105-hp, 235-cu.-in. Six—fine for a Chevy sedan, but not for a hot sports car. Chevy engineers turned to the hot-



rodger's notebook and by bumping compression, adding three side-draft 2-bbl. carbs, a solid-lifter cam, heavier valve springs and dual exhausts were able to squeeze out 150 hp. Chevrolet then compromised this achievement with a 2-speed Powerglide automatic.

The Corvette knocked 'em dead, and the car was rushed into production—300 copies, all in Polo white. Base price was \$3498, a tenth of what the originals are worth today.

The original body design was carried through the '55 model year, and the car picked up its first V8 and its first manual (3-speed) transmission. But sales were dismal. Poor handling and the automatic transmission turned off serious sports-car buffs while the boulevard set scoffed at leaky side curtains and lack of exterior door handles.

Nudged to the brink of extinction by poor sales, the Vette was rescued in '56 largely by the efforts of a brilliant Belgian-born Chevrolet engi-



neer, Zora Arkus-Duntov. Heading up a full-bore Corvette racing program, Duntov helped develop special engine, chassis, suspension and brake hardware that earned the car true respect on the track and true sports-car status on the street. Convenience and comfort items weren't ignored either, with real roll-up windows, power-operated ragtop and optional hardtop. Sales jumped to a record level.

While the Corvette was evolving from '58 to '62, a separate project was unfolding in styling that would radically alter the basic concept. The project, code-named XP-720, was started in 1959 as a redesign along the lines of Bill Mitchell's Sting Ray racer, and hit the showrooms for 1963.

The new Corvette had a brand-new body and rode on a brand-new chassis that featured a fully independent rear suspension. Among the significant number of firsts for the '63 was the availability of a closed-coupe model (with the distinctive split rear window). Performance options included a 360-hp fuel-injected engine and a road-race package—option code Z06.

The boulevard set also got their share—better road manners and comfort, plus luxuries like a/c, power brakes and steering.

Performance was at its zenith during this period with big blocks (396 in. starting in '65) available with up to 435 hp. A special L-88 option designed for race use was rated at 430 hp, but the real output was well over 500.

In 1968 the Corvette was totally redesigned inside and out. Longer, narrower and with a Kamback tail section and removable rear window, the new body was styled after the Mako Shark show car. The Vette also gained weight, scaling in as high as 3600 pounds.

The Stingray (one word this time) returned in '69 as did massive power in the form of tricarb 427s and two L-88s, one cast iron, the other the \$3000 all-aluminum ZL-1.

The power parade continued in 1970 but on a lesser scale. Gone was the powerhouse 3-deuce 427. In its place was a 4-bbl. 454 big block rated at 390 hp. A 460-hp version—the LS-7—was available over the counter. Emissions regulations rolled in and squeezed the life out of performance and the '70s saw a number of lasts for the Corvette. The LT-1 vanished from the option sheet after '72, dual exhausts died after '74 as did the last of the big blocks—an emasculated 270-hp 454. Roadster models disappeared in '75 and the Vette was pumped full of luxury and comfort features. Still, in 1979 the Corvette set an all-time sales record of 53,807.

Weight reduction was the priority of the '80s. Everything that could be lightened was. Windshield and roof panels were thinned, as were hood and doors. Aluminum was used for the crossmember and differential case and the frame was lightened.

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Prime Movers: The Vette Engines



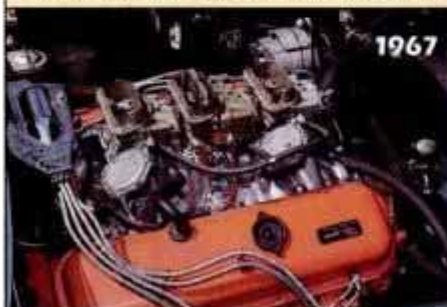
Original Blue Flame Six of '53-'55 (left) gave way to versatile small-block Chevy V8 (right).

THOUGH THE CORVETTE began life with a 6-cylinder sedan engine, this car's power heritage dwells on one quantity only: the massive thrust of an all-American V8. When the Chevy small-block V8 came along in 1955, the Blue Flame Six was quickly forgotten. Initially available in 265-cu.-in. trim (195 hp), the small block has since been through several capacities—283, 327 and 350. Tops was the injected

327 of 1964, capable of 375 hp.

The true thunder years, though, were '65 through '74—the big-block era. Ranging from 396 cu. in. to 454, the big-block V8s were capable of gross hp as high as 500-plus.

The big blocks are long gone, but the small-block V8—whether it's the port-injected base engine or the new Lotus 32-valve twin-cam LT-5—will continue to be the heart of the Corvette saga.



Big-block era was typified by tripower 427 (left). Current 350 (right) uses port injection.



CORVETTES AT SPEED



Chevrolet engineers use the world's race tracks to forge leading-edge automotive technology.

BY LEN FRANK,
West Coast Editor
PM Photos by Taylor-Constantine

THEN: THE FIRST Corvette was crude—not very promising as an instrument to take on the best production sports cars in the world. In fact, it looked as if it might have a rough time surviving at all.

NOW: After a Corvette won the

last race of the SCCA's Escort Endurance Series in 1987, completing a 3-year clean sweep, the SCCA changed the rules to exclude Corvettes.

What happened between the first Blue Flame Six/Powerglide Corvette of 1953 and the last SCCA-eligible Z-51 Corvette of 1987 can be broken down into a few experimental cars, a handful of racing cars and a stream of improving production hardware.

Two secret weapons were the all-conquering Chevy small-block V8,

and a European emigré named Zora Arkus-Duntov. The V8 was installed in 1955—a passenger-car engine that was designed to be potent and inexpensive to build. It now makes well over 100 hp/liter in racing trim, and shows no signs of ending its development. It is the one element that runs throughout the Corvette saga.

The Hardware

■ **Small-Block V8**—It combined short stroke, low reciprocating



weight, very light (for a pushrod engine) valve gear, and low overall weight with good breathing and constant development. The first Duntov-cammed versions were good for 7000 rpm and 250 bhp (SAE gross) from 265 cu. in. A current 366 small block built for racing has 600 to 700 net hp, normally aspirated, on racing fuel.

■ **Fuel Injection**—This was really intended to improve volumetric efficiency, increase fuel economy and reduce air pollution. Chevy's (and Pontiac's) Rochester injection was constant flow rather than the timed Bosch mechanical injection used by Mercedes, much better suited to volume production. The ultimate fuel-injected small block was good for 375 hp from 327 cu. in. in 1964-65.

■ **SS**—The Corvette's debut in international racing was at the Sebring 12-Hour in late March, 1957. Three were entered. They didn't win, or even come close, but the potential was impressive, even to seasoned veterans like Juan Manuel Fangio and Stirling Moss.

The space-framed car weighed in at a competitive 1850 pounds and featured exotica like magnesium bodywork, a bubble top, DeDion rear suspension, twin A-arms up front and a 315-hp small-block sporting aluminum heads with oversize valves.

Duntov actually produced two SSs—one mule and one finished racing car. The racing car was built with full Motorama finish, but no time left for sorting or practicing, and, predictably, it failed to finish.

■ **Sting Ray**—Mitchell and GM Styling were able to obtain the refurbished mule SS chassis. He had Larry Shinoda design a new body for it based on a very advanced production proposal, and the Sting Ray was born.

Disproving the adage about there being nothing as old as last year's racing car, the Sting Ray remained competitive through 1960, running against Reventlow Scarabs, Lister Jags and Lister Corvettes, Birdcage Maseratis and the latest Porsches. It was a private entry and got precious little official help from Chevrolet or GM even though Bill Mitchell was a VP. After its racing days, the Sting Ray became a show car.

■ **Production Racing**—The Corvette had a few high-tech touches—Rochester fuel injection, the close-ratio Borg-Warner T-10 4-speed transmission, Bendix Cerametallic brake linings—but it was crude when compared to its principal adversaries. The ladder frame, iron engine, sedan front



Bill Mitchell's portentous Sting Ray racer of 1959 (top) rode on the same chassis used in the pre-Sebring development of the SS (opposite page, top and insets), two years earlier. Though disappointing in the Sebring race, SR-2 (left) showed vast potential. Be-finned SR-2 was another Mitchell product. Grand Sport Corvettes (above and below) were conceived to combat Ford's Cobra in the mid-'60s, though only five were built.





suspension, iron drum brakes, solid rear axle and excessive weight were far from state-of-the-art.

Nevertheless, from 1957 until 1962, when the Shelby Cobra came along, Corvettes kicked the daylights out of assorted Jaguar XKs, Mercedes 300SLs, Porsche Carrera Speedsters and Ferraris all over the country.

■ **CERV I**—The Chevrolet Experimental Research Vehicle I was *not* a racing car. It was only a coincidence that it was built to fit all of the Indianapolis specs. Indy was just the barest possibility. Pikes Peak (where Duntov set a record in 1956) was the real target.

The next target was the new Daytona Motor Speedway, where the record was held at 176-plus by an Indy car. The CERV I engine was a very special (high-silicon alloy block, alloy heads, ram tuning on the Rochester injection, magnesium clutch housing) small block rated at 353 hp. It went 167 mph.

Duntov turned to further engine development and a dual-turbo version of the light-alloy engine was produced with 500 hp. No record fell to this pioneering effort but a later 366 small block ran 206 mph at GM's Milford test track.

CERV I gave Chevy experience

with mid-engined design, transaxles, high-speed aerodynamics, the Reynolds 390 high-silicon light-alloy block casting technique, ram tuning and the rear suspension used in production cars from 1963 through 1982.

■ **CERV II**—Chevy General Manager "Bunkie" Knudsen wanted to get back into racing so the CERV II was planned for the international prototype class with a 4-liter version of the small block using special 3-valve sohc heads (run by Mickey Thompson at Indy). Titanium was to be used for hubs, connecting rods, valves and exhaust manifolds.

The car was to weigh under 1400 pounds. At the same time, an automatic racing gearbox was designed with no power-wasting hydraulic coupling. Construction was started almost at the same

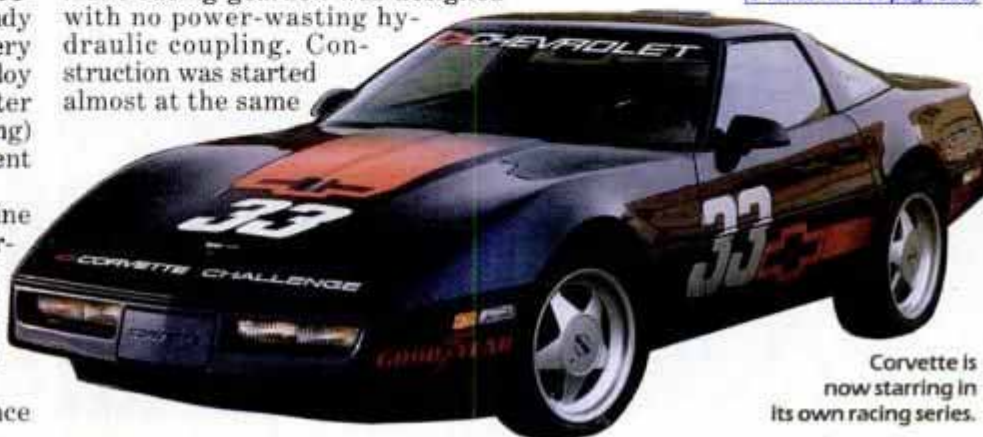
time Knudsen was ordered to stay out of racing.

The CERV II was eventually built with an advanced 4wd unit, using two torque converters, a glued-together steel and aluminum monocoque, very wide wheels, low-profile tires and body by the team of Shinoda and Lapine again. It finally used an injected, alloy, sohc 377-cu.-in. V8.

The plan was modified to use the CERV II as a response to Ford's GT-40. GM management killed that, so the car was used as a research tool for a mid-'60s super-Corvette that also failed to reach production.

■ **Grand Sport**—When corporate management forced Knudsen to turn

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Corvette is now starring in its own racing series.



THAT WAS THEN,

Hot-rod muscle versus high-tech finesse.

BY RICH TAYLOR
Contributing Editor

TALK ABOUT tough assignments. I've just spent 8 hours at Englishtown Raceway Park, Englishtown, New Jersey, on a cloudless 75° day, alternating between a brand-new Z-52

Corvette roadster and a 60,000-mile, all-original 1966 327/350. The idea is to decide which car I like better, flogging them around the skidpad, weaving through the slalom, and smoking down the quarter-mile. Ed Fischer, who owns this Sunfire Yellow '66, asked, "You get *paid* to do this?" Then he shook his head in disbelief.

The plan was to compare two Corvette roadsters, two decades apart, but roughly the same in price and performance. Ed's roadster had a base price of \$4084, and cost \$5100 with a

long list of options in 1966. It's just been appraised at \$35,000, which if anything is a little bit low. Our '88 roadster has a base price of \$34,820, but the inevitable extras brought the list price up to \$38,013.

The '88 has the Sport Handling Package (RPO Z-52), which means it has Delco/Bilstein gas shocks, 13:1 steering, heavy-duty suspension, an engine oil cooler and, most importantly, P275/40ZR-17 Goodyear Eagle GTs on 9.5-in. × 17-in. cast-alloy wheels. The engine is Chevy's classic



Current Corvette gets exceptional sticking power from massive 275/40ZR-17 Goodyear Eagle Tires. Port-injected, 350-cu.-in. small block makes 245 hp and 345 lb.-ft. of torque.



THIS IS NOW

350-cu.-in. (5.7-liter) V8, with aluminum heads, Tuned Port Injection and roller valve lifters.

This hot V8 is rated at 245 hp (SAE net) at 4000 rpm and 345 lb.-ft. of torque at 3200 rpm. Our rough conversion table gives an equivalent of about 317 hp under the old SAE gross horsepower rating system in use back in 1966. The transmission is a Doug Nash 4-speed manual with overdrive on the top three gears. Differential ratio is 3.07:1. ABS 4-wheel disc brakes are standard, and curb weight

of the car is given as 3229 pounds.

Ed Fischer's '66 is totally stock, with the original hydraulic-lifter L79 327-cu.-in. V8, rated at 350 hp (SAE gross) at 5800 rpm, 360 lb.-ft. of torque at 3600 rpm. Running our conversion the other way gives an equivalent of about 270 hp (SAE net). The transmission is the M20 4-speed manual, driving a 3:36:1 differential. It has 4-wheel disc brakes, and a curb weight of 3230 pounds.

The single greatest automotive advance in the past 20 years has been in

tire design and construction. So, since Ed Fischer's '66 was wearing its stock Gold Line 7.75-15 bias-plys on knock-off alloy wheels, we replaced them for our performance testing with 225/70VR-15 Goodyear Eagle GTs—the fattest tires we could fit under the fenders without rubbing.

On paper, these two Corvettes are about as evenly matched as they could be, despite their age difference—the same size, the same power, the same weight. The new Corvette's immense

(Please turn to page 103)



Ed Fischer's 1966 roadster is propelled by a 327-cu.-in., small-block V8 rated at 350 hp (SAE gross) and 360 lb.-ft. of torque. Narrow tires hampered the car's handling.





CORVETTE INDY

A PM exclusive: Our hands-on encounter with the future.

BY TONY SWAN, Automotive Editor
PM Photos by Martyn Goddard



ULTIMATE CORVETTE. In 35 years, those two words have had plenty of exercise. The SS. SR-2. Grand Sport. Mako Shark. XP-880. Contenders have been plentiful.

But surely *this* car puts all previous claimants in the shade. Surely the Corvette Indy will elevate Chevy's sacred nameplate beyond mere world class into the rarefied regions of the Porsche 959, Ferrari Testarossa and Lamborghini Countach.

If it ever reaches production.

And this is not beyond the realm of possibility. Although GM normally resists low-volume exotics, the Corvette Indy has gone well beyond its original scope. What began

as a concept car for the 1986 Detroit Auto Show has expanded into a full-scale prototype program. The car shown here is Phase II. Phase III, already in the works, will be a preproduction edition.

Phase I, which went from clay model to finished show car in six weeks, was not a runner. Ramrodded by Jack Schwartz, ex-PPG pace-car maven, currently with Chevrolet Special Vehicles, the show car had no underpinnings—only an Ilmor-Chevy Indy car motor plunked into the engine bay.

But the shape was enough to light the not-readily-flammable imaginations of GM's decision makers, and Schwartz moved on to development of the car you

see here. At this point, Lotus entered the picture, partly because GM's new subsidiary was already at work on the aluminum LT-5 32-valve dohc V8, partly because mid-engine supercars are this firm's stock in trade.

Schwartz and Lotus worked out an impressive hardware list—fully active suspension, full-time 4wd and a filament-wound carbon-fiber backbone chassis with a load capacity of 83 tons per square inch, compared to about 18 for a comparable steel structure. (ABS braking and 4-wheel steering will wait for Phase III.)

The car's front and rear suspension—a maze of A-arms and power rams—are bolted to subframes rigidly mated to the central tube, rigidity being the key to an active system.

The LT-5 engine, its intake runners exposed as part of the car's design, sits crossways behind the passenger compartment. It's mated to a modified Olds Toronado transaxle.

There are also interesting items inside the car. Schwartz insisted on multiplex wiring, rearview TV, electronic instrumentation and ETAK-satellite navigation.

The car rides on huge tires specially developed by Goodyear—275/40ZR-17 front, 315/35ZR-17 rear—which give the car plenty of stick, with or without active suspension. Those wheels—12 in. wide—were machined from solid aluminum billet.

We picked up plenty of information when we visited the Lotus facilities, near Norwich, England. But what we really wanted to do was drive the car. And finally we did, on the Lotus test track. With the plastic canopy cinched down and the LT-5 grumbling at idle, the Corvette Indy feels more like a fighter plane than a car, pretty much what its designers had in mind.

There's quite a bit of noise, some from the engine, more from the active-suspension pumps, but Schwartz and his Lotus compatriots will have this under control in Phase III.

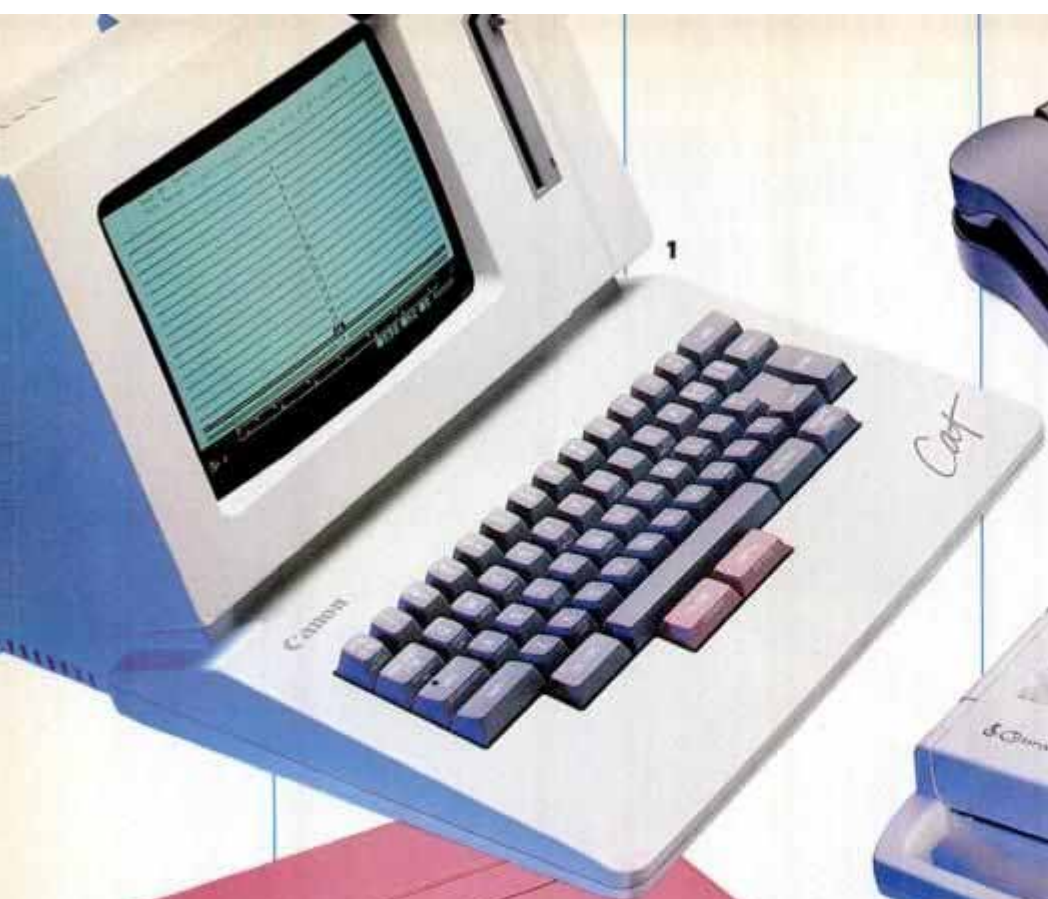
The LT-5 in the Corvette Indy bore a very early serial number—002—but it still made plenty of torque and, once rolling, stirred the 3300-pound prototype along with zeal.

As you'd expect with a half-million-dollar prototype, we were cautious, particularly with the active system ailing. A couple of transducers had been damaged in shipment, which led to a bit of oscillation in cornering.

On the other hand, with double A-arms all around and massive rubber, the Corvette Indy behaves very much like a good-riding race car. Again, precisely what they had in mind. We can hardly wait for Phase III. **PM**



Corvette Indy doors [top] are of scissor-type favored in some Lamborghini designs. Interior emphasizes high tech, with rearview TV and ETAK satellite navigation. Overall styling is pure exotic, but clean and subdued. Small side windows and/or variable-opacity canopy glass are planned for Phase III edition.





HOMework

Office electronics scaled to the home
can let you work where you live.

BY RON SCIBILIA
PM Photos by Hing/Norton

A WAVE OF NEW technology in office electronics promises to change the lives of millions of workers who collect, analyze or communicate information. One immediate consequence of this desktop revolution is the potential for greater flexibility in choosing where to work.

Expressways got you down? For the price of a commuter car you can set yourself up to telecommute—not at freeway speed, but at *electronic* speed—taking care of business from an office at home or on the road.

Advances in personal-computer hardware and software continue to put even greater power into the hands of more and more people—and *what* power! The new generation of 32-bit microcomputers exemplified by Apple's Macintosh II, IBM's Personal System/2 Model 80, Compaq's Deskpro 386 and numerous others offers processing speed and memory-handling

capabilities that make earlier PCs look like Model T Fords. Useful computing power is also arriving in smaller packages these days, whether it's in mobile portables or down-sized desktop models.

No matter how accessible computers become, though, not everyone needs—or wants—the full functionality of a modern PC. Accordingly, a growing number of manufacturers, including Smith-Corona, Magnavox, Brother, Panasonic, Canon and Epson are wooing computer-shy consumers with personal word-processing systems. These systems barter the broader versatility of the PC for the simplicity of dedicated writing machines. Some of these are termed turbo typewriters, built on what is essentially a typewriter chassis. Others are really pared-down computers.

In the former camp is Smith-Corona's 1-

- 
- 1 Canon Cat word processor
 - 2 Sony ITA-650 phone/answering machine
 - 3 Canon PC-3 portable copier
 - 4 Cobra PP-110 Print-Phone facsimile transceiver
 - 5 Sharp UX-80 telephone/facsimile
 - 6 Panasonic Apogee copier
 - 7 Magnavox Videowriter 450 word processor
 - 8 CD-ROM disks



HOMEWORK

piece PWP 7 (\$699), one of four word processors offered by the company. The PWP 7 is a sleek, under-20-pound carry-along that can run on batteries. It features a flip-up, backlit liquid-crystal display, daisywheel printing and a built-in, 100 KB (kilobyte) 3-in. floppy-disk drive. Like its word-processor rivals, Smith-Corona's unit keeps its word-processing software on a ROM (read-only memory) silicon chip for faster, easier access. The PWP 7 also includes a 75,000-word spelling dictionary.

Televised typing

Epson's Elite 400 Plus (\$500), which uses a dot-matrix print head and nonbacklit LCD screen, incorporates a built-in thesaurus, and takes small battery-backed RAM (random-access memory) cartridges for data storage. The Epson unit has connectors for both an optional internal modem and a full-size external video monitor for extended desktop use at home.

Magnavox, first on the scene with an everything-in-one-piece machine, now markets several word-processor models, starting as low as \$400. Its Videowriter 450 (\$899) features a computer-like CRT (cathode-ray tube) display instead of a harder-to-read LCD. The 450 boasts a 3.5-in. microfloppy disk for storage, a

60,000-word spelling-checker dictionary, 50,000-synonym thesaurus and mailmerge capability. Also built-in is a quiet and fast thermal-transfer printer (with sharp 24 x 36 dot resolution) that prints on bond paper. There's also a parallel interface for attaching a different printer, if you desire. A new model, the Videowriter 4500, set to hit the market shortly at a projected price of \$999, adds an RS-232C serial port for interfacing with an outboard modem or a facsimile transceiver.

Brother International's WP-500 word processor (\$1199) adopts Magnavox's 1-box approach with a built-in CRT, but uses a 15-character-per-second, daisywheel printer for typewriter-like print quality on any paper. Panasonic's KX-W1500 (\$900) closely resembles Brother's in offering a 9-in. built-in monitor, disk drive and daisywheel printer for letter-quality output.

The Canon Cat "work" processor—as Canon calls its intriguing venture into this area—is the brainchild of computer designer Jef Raskin, touted as the original "Man Behind The Macintosh." Canon's unit shares surprisingly little with that computer except for a 9-in., high-resolution, black-on-white CRT display.

Unlike the graphics-oriented Macintosh, the Cat (\$1495) is text-based,

with both word processing (including a 90,000-word dictionary) and telecommunications software stashed in ROM for snap-your-fingers accessibility. Additional software is available on disk for generating forms and customized mailings. As standard equipment, there's also a 3.5-in. microfloppy-disk drive, on-board 1200-baud modem, and serial and parallel interfaces. A printer is separate.

Phone etiquette

Impressive as these computers and word processors are, perhaps the most exciting developments are in communications and new data-access applications.

Telephone-answering devices (TAD) have been a key element in the development of the desktop revolution. In addition to stand-alone TADs, most manufacturers now offer integrated devices that combine the phone and TAD in a single chassis. Most models, such as Sony's ITA-650 (\$250), incorporate convenience features such as speakerphone, beeperless remote control, and multiple memory banks for 1-touch dialing. Now, you can even use your computer as a TAD. Several add-on accessories will enable your computer to send and receive voice messages over the telephone. Products such as Natural MicroSystems' Watson (\$149) and The

(Please turn to page 94)

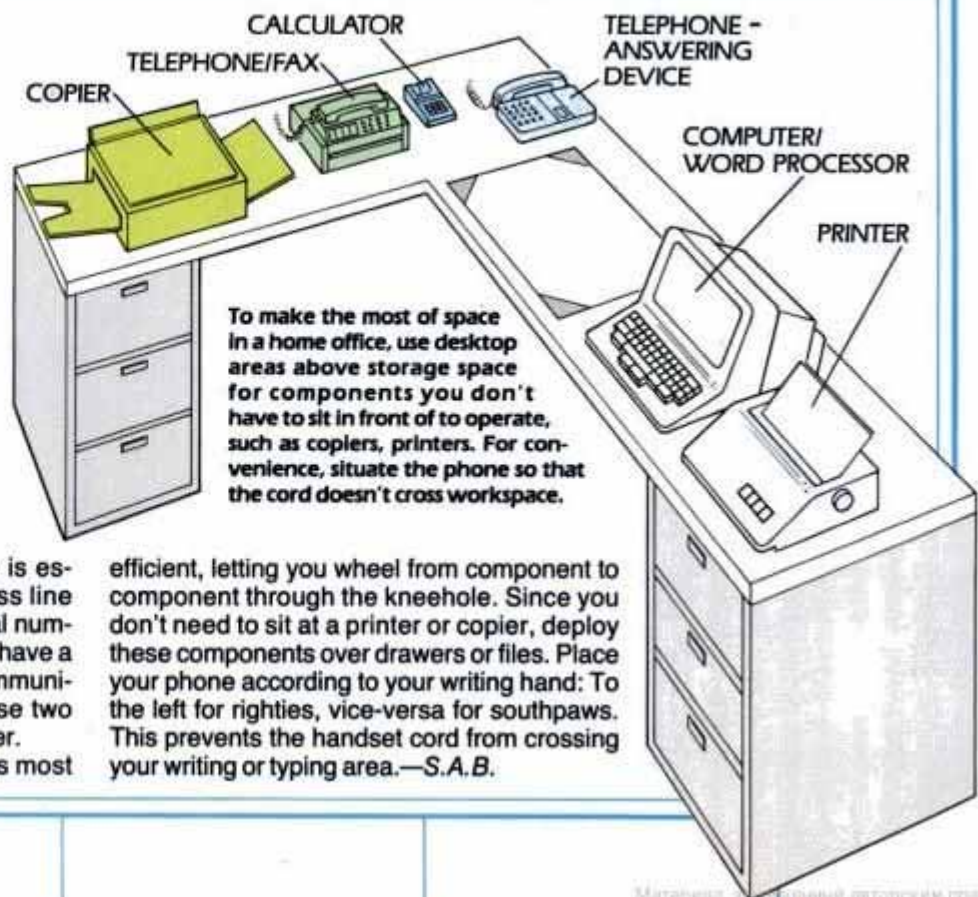
Set Up Your Office-At-Home

THE NICEST THING about today's home-office electronics is the flexibility of the hardware. Some components will perform double-duty, enabling you to expand when needed.

For example, a telephone/fax machine can double as a convenience copier until you're ready to invest in a regular plain-paper copier. Meanwhile, your computer (or word processor), through its communications modem, will let you access on-line data banks until you're ready to add a CD-ROM reference library.

Telecommunications is the linch-pin of any business, including an office-at-home. A telephone-answering device is essential. Ideally, the incoming business line should be different from your residential number. Ideally too, your computer ought to have a separate, dedicated line for modem communications. Ditto for the fax—though these two might share if you don't use both together.

Physically, an L-shaped worktable is most



efficient, letting you wheel from component to component through the kneehole. Since you don't need to sit at a printer or copier, deploy these components over drawers or files. Place your phone according to your writing hand: To the left for righties, vice-versa for southpaws. This prevents the handset cord from crossing your writing or typing area.—S.A.B.

New WAVE WATERCRAFT



We carve chop, glide glass and go airborne to test the best of the new jet-powered, personal watercraft.

BY JOE SKORUPA, Boating/Outdoors Editor
PM Photos by Skip Gandy

YOU CAN TEACH an old hotdogger new tricks. Climb aboard a jet-powered personal watercraft and you'll be surprised at how soon you'll hammer the throttle and whip it into high-speed power slides, carve tight turns, skitter backward and spin complete donuts. Before long you'll be crashing the surf and jumping waves like a frisky dolphin.

At least that's how it went with the PM test team recently in the crystal-line waters of Florida's Captiva Island where we assembled a fleet of five 2-person watercraft and put them through a battery of tests.

The personal-watercraft scene has exploded in the past two years with more than 100,000 units sold annually and new designs and models popping up like umbrellas in a rainstorm.

We decided it was time for PM's no-holds-barred comparison test treatment. A winner was selected after a series of speed and handling tests and observations made during three days of hard running. But our ultimate criterion was ridability, a combination of performance and operational ease that allows an average person to do what these exhilarating machines were designed to do—have fun.



BOMBARDIER SEA-DOO

FAZER FAZE II

Bombardier Sea-Doo

Built with a unique blend of rider-friendly design and high-performance power, the Sea-Doo was the test fleet's most consistent finisher and the personal watercraft we would most like to own.

The newly introduced Sea-Doo beat the fleet in cornering/handling, and tied for first in fun factor and riding double. It finished second in all other categories, except on the performance course where it came in a close third.

The hull, similar to a modified-V, is flat in the stern for mounting stability and knifed in the bow for slicing chop and carving tight turns.

Features we especially liked were self-righting flotation, stowage compartment forward of steering column, soft seat, padded steering column, nonskid footwell and bumper rail.

The winner displayed an interest-

ing split personality unique among our test fleet. It was a pussycat in ease of operation, shortness of learning curve, riding double and level of athletic skill and fitness required. But its mod-V hull and spunky Rotax engine gave it surprising handling and high-performance punch.

At first, Sea-Doo's high-torque throttle response may seem intimidating, but as you gain experience it becomes a performance advantage.

Yamaha WaveRunner

The fleet's clear winner in overall ease of operation, with first-place rankings in rider friendliness, stability at speed and rest, fun factor (tied) and riding double (tied) was the WaveRunner.

Novice riders will feel total confidence right from the start. A flat hull makes the craft ultrastable for mounting, a solid platform for riding double, and unsurpassed in spinouts.

Despite back-of-the-pack speed and acceleration marks, the craft is more than fast enough for thrills. It can, in fact, pull a waterskier.

Features we liked were a padded steering column, bow and stern lifting hooks, padded knee rest, rub rail, bow bumper and a visibility spout that shoots a thin geyser 10 ft. high as an eye-catcher to alert bigger boats.

Of special note are two stowage areas, a rarity among the fleet. One is a self-draining compartment beneath the seat that can be used as an ice chest, and the other is a smaller rear porthole compartment.

A slight deviation from the craft's overall high-tech user-friendliness is the necessity to premix fuel and oil (50-to-1 mixture).

The WaveRunner isn't the fastest craft in the water, but it is the least intimidating and an ideal minijet for riders of all skill and fitness levels.

TEST PARAMETERS

All models were stock 2-person, jet-powered personal watercraft. Top-end speed (solo and double), acceleration and performance course figures are the result of averaging four test runs for each watercraft. Acceleration figures represent the time it took each craft to cover a 100-ft. course from a dead stop. Quarter-mile performance course began from a dead stop and included two short sprints and three 180° turns.



OVERALL RANKING/MAKE/MODEL	1. BOMBARDIER SEA-DOO	2. YAMAHA WAVERUNNER
Length/Beam/Height/Weight	96"/41.5"/36.2"/365 lb.	109"/40"/34.5"/346 lb.
Engine Displacement/Hp Rating/Fuel Capacity	580 cc/55 hp/8.7 gal. (2.2 gal. reserve)	496 cc/32 hp/5.8 gal. (1.06 gal. reserve)
Top End Solo, Double (mph)/Ranking	38.13 mph, 35.5 mph/2	32.88 mph, 31.0 mph/4
Acceleration 0-100 ft. (sec.)/Ranking	3.61 sec./2, high-torque throttle response	4.06 sec./5, fast enough for thrills
Performance Course (sec.)/Ranking	27.04 sec./3, best of the easy sit-down craft	27.13 sec./4, whips through turns if rider stands
Rider Friendliness/Ranking	Minimum learning curve required/2	Inspires total confidence right from the start/1
Stability At Speed, Rest/Ranking	Solid at speed, some balance necessary at rest/2	Most stable platform in the fleet/1
Cornering, Handling/Ranking	Mod-V hull pays off in tight turns/1	Flat hull rounds out turns, but still superb/2
Riding Double/Ranking	Good ergonomics and superior power/1 (tied)	Easiest to control, comfortable/1 (tied)
Fun Factor/Ranking	A pussycat starting, but a tiger when pushed/1 (tied)	Low on physical demands, great spinouts/1 (tied)
Price As Tested	\$4199	\$3905
Address	Bombardier, 1850 32nd Ave., Lachien, Quebec, H8T 3J7, Canada, (514) 636-5994	Yamaha Marine, 6555 Katella Ave., Cypress, CA 90630, (714) 761-7821



YAMAHA WAVERUNNER

KAWASAKI JET SKI X-2

WETBIKE TOM CAT

Wetbike Tom Cat

The Tom Cat is the motorcycle of the waterways. Its ergonomics, profile, handling characteristics and level of skill required make it feel more like a street machine than a watercraft.

It scorches the water like a hot street machine, too. The Tom Cat whipped the fleet in top-end speed (solo and double), hole-shot and performance course times. It left the water practically steaming.

But raw power and speed don't tell the whole story. Novices have a difficult time mastering the Tom Cat: Its high-off-the-water profile makes you do a balancing act simply to sit still. Then you have to crank the throttle to get it planing, forcing you to zip along faster than most beginners wish to go.

Once you learn to get going in a straight line, the next intimidating experience is turning. This is done not by using the handlebars, but by lean-

ing hard into the turn. All of this takes practice, patience, skill and strength.

Noteworthy features include self-righting flotation, bilge pump, gas gauge and the Hydro-Link suspension system that keeps the front ski in contact with the water at all times.

Despite its high degree of difficulty, the Tom Cat was surprisingly forgiving when riding double and clearly the fleet leader in pure performance thrills. Once you pay your dues, the Tom Cat rewards you with a true wet-and-wild personal-watercraft ride.

Kawasaki Jet Ski X-2

The most agile craft in the fleet was the venerable Jet Ski, which was equipped with a removable X-2 nose and pontoon set to increase stability and allow riding double.

Unlike other manufacturers, which are designing 2-person, sit-down models, market-leader Kawasaki of-

fers a removable system that alters the basic craft's flotation and performance characteristics. The result is a slight loss of speed and cornering ability that's offset by a gain in rider-friendliness.

The nimble Jet Ski, which can turn on a dime and give 9 cents change, finished a solid second on the performance course and third in hole shot. It finished last in top-end speed categories, but hit a respectable 32 mph solo.

Because of its narrow 27-in. beam, the craft requires a better-than-average sense of balance. However, once you're up everything else comes easily, especially if you attempt them at beginner speeds.

Several Jet Ski features were unique among the fleet, especially handlebars that adjust to three driving positions, adjustable trim nozzle and automatic circling at idle speed

(Please turn to page 106)



3. WETBIKE TOM CAT	4. KAWASAKI JET SKI X-2	5. FAZER FAZE II
96"/26"/42"/318 lb.	88"/39"/35"/276 lb.	95"/42.5"/25"/250 lb.
798 cc/60 hp/9 gal. (no reserve)	650 cc/52 hp/4.2 gal. (1 gal. reserve)	430 cc/40 hp/3.5 gal. (no reserve)
38.62 mph, 36.5 mph/1	32.0 mph, 29.0 mph/5	36.75 mph, 32.0 mph/3
3.58 sec./1, leaps at touch of throttle	3.87 sec./3, within a fraction of the leaders	3.98 sec./4, near the back in a very quick fleet
25.41 sec./1, like riding a rocket	26.52 sec./2, agility makes up for slower speed	27.38 sec./5, best as a straight-ahead scorcher
Tires out experts, beats up novices/5	Erect riding position contributes to fatigue/4	Quick learning curve, unintimidating/3
Superb balance necessary at rest, less at speed/5	Narrow beam requires balancing act/4	Hard to tip, but chop can come over bow at idle/3
Experts use balance and muscle, novices wipe out/5	Can turn on a dime with practice/3	Lean hard and use muscle for turns/4
Relatively easy once you learn how/2	Stern is buried, ergonomics are tight/3	Low and cramped seating position/4
Challenging, and high-performance champ/2	Nimbleness a blast when you can use it/3 (tied)	Fine slides and donuts, superb straight-ahead/3
\$4339	\$3750	\$3795
UltraNautics Wetbike, 620 W. Hueneme Rd., Oxnard, CA 93033, (800) USA-WETT	Kawasaki Motors, Dept. TBM, P.O. Box 25252, Santa Ana, CA 92799, (714) 541-5217	Werks Fazer Marine, 3552 St. Johns Indus. Pkwy., Jacksonville, FL 32216, (904) 641-7167

Wonderbed

Make your child's dream a reality with our fun-to-build superbed.

BY NEAL BARRETT



HAVE YOU EVER noticed how a large cardboard box or an old sheet draped over a few chairs will keep a child occupied for hours on end? Imagination goes into high gear as the real world becomes magically transformed into a scaled-down fantasy environment. Too often, however, a child's impromptu play takes over the entire living room prompting parents to occasionally wonder if they're loosening their *own* hold on reality.

Our solution is to give the kids the space they need to play *and* solve a few grown-up problems. By combining our fantasy structure with a bed and incorporating much needed toy storage space, the kids can have their fun without turning the rest of the house upside down.

You may be wondering, however, whether your skills and equipment are up to handling such a project. Well, we've worked out the construction details with the do-it-yourselfer in mind. While fancy equipment will make the job go faster, all that's required are a circular saw, drill, a few clamps and the most ordinary hand tools.

The choice of material is No. 2 common pine. This wood is available at most building supply outlets. However, there is a trade-off with using this grade of pine. It *can* shrink, cup or warp after it's been in your home for a while.

Be sure to let it adjust to indoor humidity for at least two weeks before starting the project.

Stack the wood with evenly spaced $\frac{3}{4}$ -in.-sq. sticks placed in between for good air circulation.

Because this piece is so large, it must be built in subassemblies which

can then be brought to the room for final assembly. Make sure that you use screws during the final assembly so it will be easy to remove the bed at a later date.

This project is just one of the many great ideas offered in *The Breathing Room Book* available from Western Wood Products Assn., 522 S.W. Fifth Ave., Portland, OR 97204. It costs \$1.95 ppd. and separate plans for most of the projects are available for 75 cents.



A child's bed is a castle. And, surrounded by favorite toys, what better place to nestle down for a nap.

Building the base

Begin by cutting the $\frac{5}{4}$ stock to size for the base frame parts. Make sure that the cutting lines are marked square and positioned accurately. Use a ripping guide with your circular saw for ripping the frame pieces to the specified width.

Lay out equally spaced positions for

Color photo: J.R. Rost
Black-and-white photos: Neal Barrett
Technical art: Eugene Thompson
Design: Czopek and Erdenberger
Photo stylist: Gabe Herrick



1 Lay out assembly lines on base frame sides. Fasten sides to cross blocking with 8d common nails. Use three nails per joint.



2 Temporarily secure the four base frame subassemblies with clamps. Then, join the frames together with 2-in. No. 8 fh screws.

the cross blocks on the long frame sides and use 8d finishing nails to assemble the four frames (Fig. 1). Clamp the frames together (Fig. 2) and secure them with 2-in. No. 8 fh screws.

Next, cut the $\frac{3}{4}$ -in.-thick birch plywood platform to size and lay it in place on the frame. Bore and counter-sink pilot holes for 1 $\frac{1}{4}$ -in. No. 8 fh screws and secure the plywood.

Cut the long 1x12 frame caps (G) to length and nail in place with 8d finishing nails (Fig. 3). Then, measure and install the short end cap. Cut the 1x12 trim boards for the head and foot of the bed, nail in place and then install the side trim boards. Check to make sure that the edges of the trim boards are flush with the cap boards and plane if necessary (Fig. 4). Install the narrow inside trim boards as shown in the drawing (Fig. 5).

Module construction

The majority of the bed structure is comprised of stacked box-type modules, as shown in the drawing.

It's a good idea to cut all the parts for the modules before beginning to assemble them.

Assemble the modules with 6d finishing nails (Fig. 6). Note that modules 1 and 3 have interior partitions. Attach these partitions to the tops and bottoms and then nail the remaining pieces in place. Cut the $\frac{3}{4}$ -in.-sq. strips (R) and install on modules 1 and 3 as shown in the drawing (Fig. 7).

Begin joining the modules into groups by attaching pairs of No. 2 modules side-to-side with 1 $\frac{1}{4}$ -in. No. 8 fh screws. Note that the module openings face in the opposite direction (Fig. 8). Then, join each pair of No. 2



3 After attaching the plywood platform, secure the two long top caps followed by the short top cap. Then attach the 1x12 side trim.

modules to a No. 1 or No. 3 module as shown in the drawing. Pay close attention to the orientation of the openings. Finally, attach one No. 5 module to the end of module No. 4. Sand all of the subassemblies with 120- and 220-grit sandpaper.

Preparing the spacers

The spacers and shelves are painted to contrast with the overall natural finish of the bed. We used Eaglo semi-gloss Pale Magenta No. Q15-44D after priming with a quality latex primer. It's best to paint them before assembly. The spacers need only be painted on the edges that will be exposed when the bed is completed.

Use a miterbox to cut 1x3 stock to length for the spacers. Install the first

layer of spacers to the base with 3d finishing nails. Note that all of the spacers are set back $\frac{3}{4}$ in. from the outside of the bed (Fig. 9).

Cut 1x12 stock for the shelves and wide spacers. To lay out the wide miters on the spacers and shelves that cover the top set of modules, lay a framing square on the stock so the same number on each leg lines up with the stock edge (Fig. 10). Carefully cut to the line with a circular saw.

Preparing the top

Cut the top band cross blocking to size from $\frac{3}{4}$ stock and crosscut the 1x12 boards for the top band assembly to length. Note that the end cross blocks (II) are shorter to accommodate the keystone base (KK & JJ). Lay out the

block spacing on the inside and outside top band trim boards. The outside blocks (HH) are placed $11\frac{1}{4}$ in. in from the ends of the boards. Then, assemble the two long top band frames.

The four truss support keystone shapes are made by gluing and nailing five pieces of $\frac{5}{8}$ stock that have been cut to shape. The center layers of the blocks are longer and shaped to accept the lower truss corners.

Cut patterns for the keystone shapes (LL & MM) and trace the shapes onto the stock. Cut the shapes with a sabre saw. Also, cut the two keystone gussets that secure the truss peaks.

After the glue has dried, use a belt sander to dress the faces of each keystone (Fig. 11). Then, construct the

MATERIALS LIST — CHILD'S BED

Key	No.	Size and description (use)	R	12	$\frac{3}{4}$ x $\frac{3}{4}$ x $11\frac{1}{4}$ " pine (modules 1,3 strip)	LL	16	$1\frac{1}{2}$ x $7\frac{3}{4}$ x 9" pine (keystone component)
A	4	$1\frac{1}{2}$ x $10\frac{1}{2}$ x $77\frac{1}{4}$ " pine (base side)	S	6	$\frac{3}{4}$ x $11\frac{1}{4}$ x 24" pine (module 3 face)	MM	4	$1\frac{1}{2}$ x 9 x $11\frac{1}{4}$ " pine (keystone component)
B	2	$1\frac{1}{2}$ x $10\frac{1}{2}$ x $64\frac{1}{2}$ " pine (base side)	T	11	$\frac{3}{4}$ x $11\frac{1}{4}$ x $11\frac{1}{4}$ " pine (modules 3,4,5 face)	NN	2	$1\frac{1}{2}$ x $6\frac{1}{4}$ x 6" pine (gusset)
C	14	$1\frac{1}{2}$ x $10\frac{1}{2}$ x 9" pine (cross blocking)	U	24	$\frac{3}{4}$ x $11\frac{1}{4}$ x $12\frac{3}{4}$ " pine (modules 2,5 face)	OO	4	$1\frac{1}{2}$ x $3\frac{1}{2}$ x 66" pine (cross tie)
D	2	$1\frac{1}{2}$ x $8\frac{3}{4}$ x $77\frac{1}{4}$ " pine (frame side)	V	2	$\frac{3}{4}$ x $11\frac{1}{4}$ x 39" pine (module 4 face)	PP	4	$1\frac{1}{2}$ x $3\frac{1}{2}$ x $37\frac{3}{8}$ " pine (rafter)
E	5	$1\frac{1}{2}$ x $8\frac{3}{4}$ x $40\frac{1}{2}$ " pine (cross blocking)	W	2	$\frac{3}{4}$ x $11\frac{1}{4}$ x $40\frac{1}{2}$ " pine (module 4 face)	QQ	1	$1\frac{1}{2}$ x $5\frac{1}{2}$ x $78\frac{3}{8}$ " pine (ridge)
F	1	$\frac{3}{4}$ x 42 x $77\frac{1}{4}$ " birch plywood (platform)	X	1	$\frac{3}{4}$ x $1\frac{1}{2}$ x $54\frac{3}{8}$ " pine (spacer)	RR	*	4" No. 14 fh screw
G	4	$\frac{3}{4}$ x $11\frac{1}{4}$ x $88\frac{1}{2}$ " pine (base cap/top band side)	Y	8	$\frac{3}{4}$ x $1\frac{1}{2}$ x $49\frac{1}{2}$ " pine (spacer)	SS	*	2" No. 10 fh screw
H	1	$\frac{3}{4}$ x $11\frac{1}{4}$ x 42" pine (base cap)	Z	20	$\frac{3}{4}$ x $1\frac{1}{2}$ x $11\frac{1}{4}$ " pine (spacer)	TT	*	$1\frac{1}{4}$ " No. 8 fh screw
I	4	$\frac{3}{4}$ x $11\frac{1}{4}$ x $64\frac{1}{2}$ " pine (base end/band end)	AA	1	$\frac{3}{4}$ x $1\frac{1}{2}$ x $64\frac{1}{2}$ " pine (spacer)	UU	6	$\frac{3}{16}$ x 6" lagscrew and washer
J	4	$\frac{3}{4}$ x $11\frac{1}{4}$ x 90" pine (base side/band side)	BB	4	$\frac{3}{4}$ x $1\frac{1}{2}$ x $38\frac{3}{4}$ " pine (spacer)	VV	4	$\frac{3}{16}$ x 3" lagscrew and washer
K	2	$\frac{3}{4}$ x $1\frac{1}{4}$ x $76\frac{1}{2}$ " pine (base trim)	CC	9	$\frac{3}{4}$ x $1\frac{1}{2}$ x $9\frac{3}{4}$ " pine (spacer)	WW	8	$\frac{3}{16}$ x 4" bolt, washers and nut
L	1	$\frac{3}{4}$ x $1\frac{1}{4}$ x 42" pine (base trim)	DD	3	$\frac{3}{4}$ x $11\frac{1}{4}$ x 45" pine (shelf)	XX	*	8d finishing nail
M	6	$\frac{3}{4}$ x $11\frac{1}{4}$ x $24\frac{1}{4}$ " pine (module 1 face)	EE	2	$\frac{3}{4}$ x $11\frac{1}{4}$ x $64\frac{1}{2}$ " pine (top shelf)	YY	*	6d finishing nail
N	66	$\frac{3}{4}$ x $11\frac{1}{4}$ x 12" pine (modules 1,2,3,4 face)	FF	2	$\frac{3}{4}$ x $11\frac{1}{4}$ x $88\frac{1}{2}$ " pine (top spacer)	ZZ	*	3d finishing nail
O	6	$\frac{3}{4}$ x $11\frac{1}{4}$ x $25\frac{1}{2}$ " pine (modules 1,3 face)	GG	2	$\frac{3}{4}$ x $11\frac{1}{4}$ x $66\frac{1}{2}$ " pine (band cap)			
P	6	$\frac{3}{4}$ x $11\frac{1}{4}$ x $13\frac{1}{2}$ " pine (modules 1,3 face)	HH	10	$1\frac{1}{2}$ x $10\frac{1}{2}$ x $11\frac{1}{4}$ " pine (cross blocking)			
Q	6	$\frac{3}{4}$ x $11\frac{1}{4}$ x $9\frac{3}{4}$ " pine (modules 1,3 partition)	II	16	$1\frac{1}{2}$ x 9 x $11\frac{1}{4}$ " pine (cross blocking)			
			JJ	8	$1\frac{1}{2}$ x $11\frac{1}{4}$ x $11\frac{1}{4}$ " pine (keystone blocking)			
			KK	4	$\frac{3}{4}$ x $11\frac{1}{4}$ x $11\frac{1}{4}$ " pine (keystone blocking)			

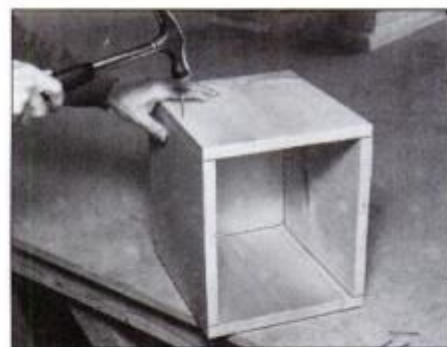
Misc: Glue, 120- and 220-grit sandpaper, satin polyurethane varnish, latex primer, Eaglo paints: Pale Magenta No. Q15-44D, Diana No. Q14-44D. * As required.



4 If the upper edges of the side trim are not flush with the faces of the caps, carefully trim the edges with a sharp hand plane.



5 Cut the inside trim pieces to size and apply to base frame around the plywood. Plane edges if necessary so they're flush with caps.



6 After cutting components to size for all modules, begin assembling modules with 6d finishing nails. This is module No. 2.



7 Modules 1 and 3 require $\frac{3}{4}$ -in.-sq. strips on side opening edges to bring edges flush with top. Nail with 6d finishing nails.



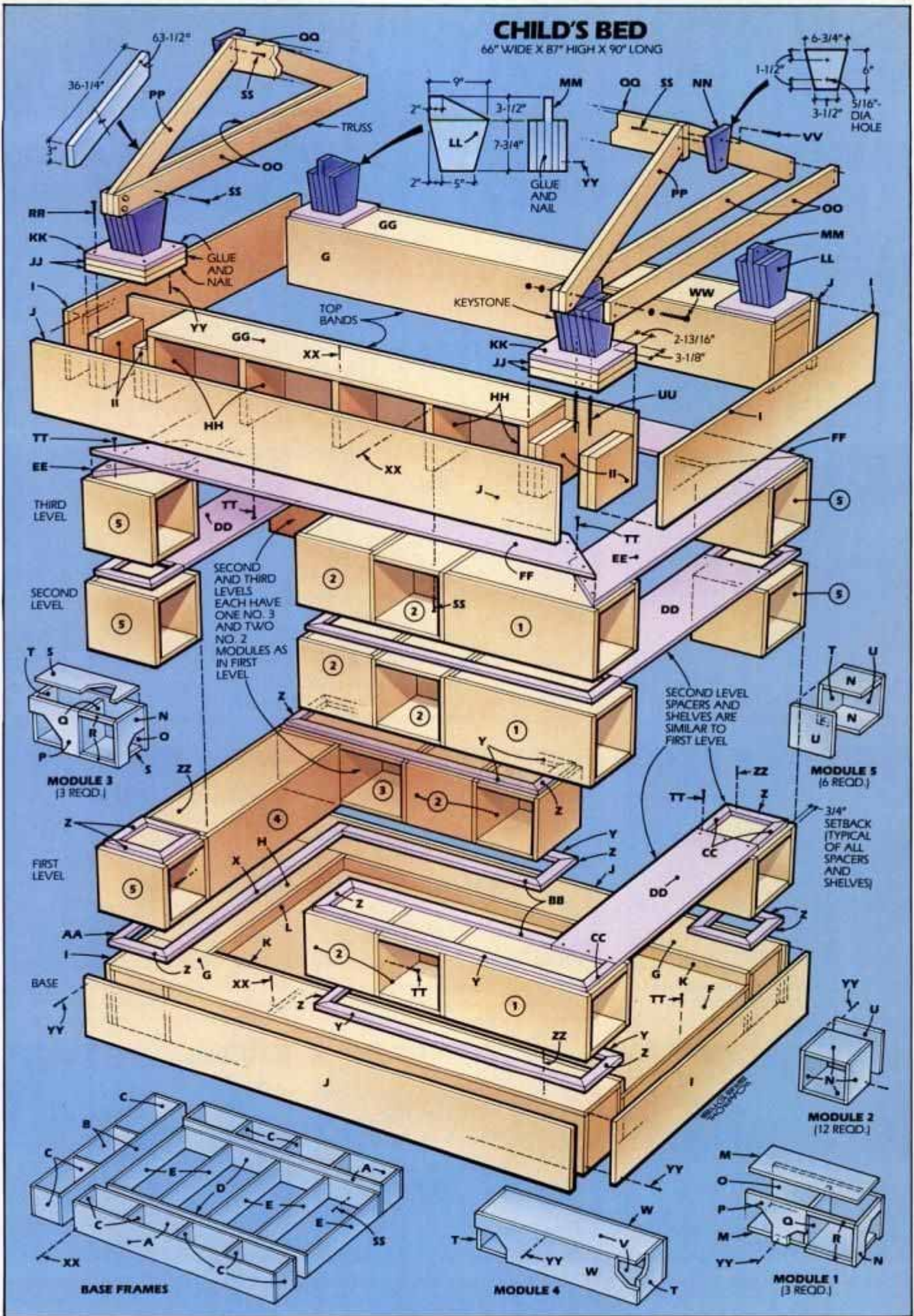
8 Fasten adjacent modules together with $1\frac{1}{4}$ -in. No. 8 fh screws. Notice the orientation of the openings as shown on drawing.



9 Cut all spacers and shelves to size and secure first row to base with 3d finishing nails. Spacers are set back $\frac{3}{4}$ in. from edge.

CHILD'S BED

66" WIDE X 87" HIGH X 90" LONG



four keystone bases. Each base is made by gluing and nailing three layers of 1 1/4-in.-sq. boards—one from 5/4 stock and two from 3/4-in.-thick stock. Prime the keystones and bases, and paint any color you'd like. We used Eagle Diana No. Q14-44D semi-gloss paint. Lay out the position of each keystone on its base and join them with 5/16 x 6-in.-long lagscrews with washers.

Next, cut the parts for the trusses and ridge beam from 5/4 stock. To get a good fit between the trusses and keystones, temporarily assemble the entire top band section and clamp the truss components in place. Use a piece of 5/4 scrap to space the rafters at the peak where the ridge will be installed. Then, secure the lower truss

corners with 5/16 x 4-in. bolts as shown in the drawing. Screw the peak gussets to the rafters (Figs. 12 & 13).

Final assembly

Position the first layer of modules on the base and secure to the spacers with 1 1/4-in. No. 8 fh screws. Attach the closed ends of modules 3 and 4 by toenailing through the top of module 3 into module 4 (Fig. 14).

Attach the next layer of spacers on the first row of modules as shown in the drawing (Fig. 15). Note that the spacers on one end stop short to allow the shelf (DD) to be installed.

Assemble the next two tiers of modules in the same way. After installing the third level, lay the mitered 1x12 spacers and shelves in

place. Secure with screws (Fig. 16).

Position the two long top band frames over the 1x12 spacers and screw in place from below. Install the keystone supports (Fig. 17) at the corners with 4-in. No. 14 fh screws and attach the end trim boards (I). Finally, position the trusses over the keystones and secure with 2-in. No. 10 fh screws (Fig. 18). Install the ridge with 5/16 x 3-in. lagscrews.

Finishing the bed

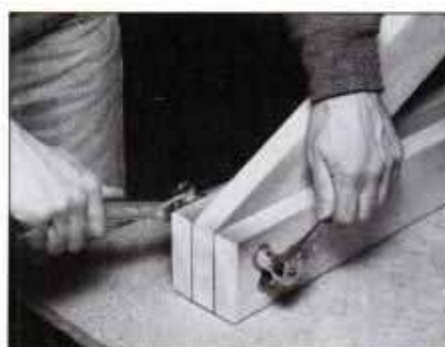
Fill all nail holes and sand. For a clear, durable finish, we used three coats of McCloskey's Satin Polyurethane Varnish, thinning the first coat 30 percent with mineral spirits. Let each coat dry overnight and sand lightly between coats. **PM**



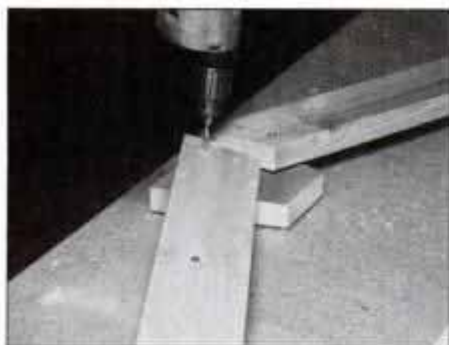
10 To lay out large top spacer miters, align a large steel square so the same number on each leg lines up with edge of stock.



11 After cutting the keystone shapes for supporting the truss, nail and glue pieces together and smooth sides with a belt sander.



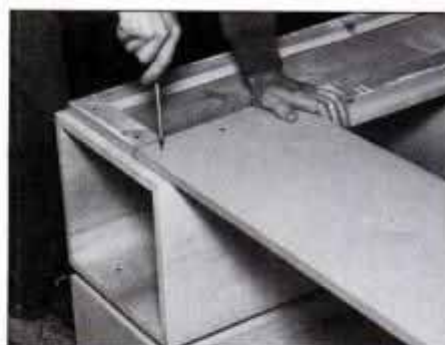
12 Lay out truss components and bore holes for the 5/16 x 4-in. bolts that secure rafters to cross ties at lower corners of truss.



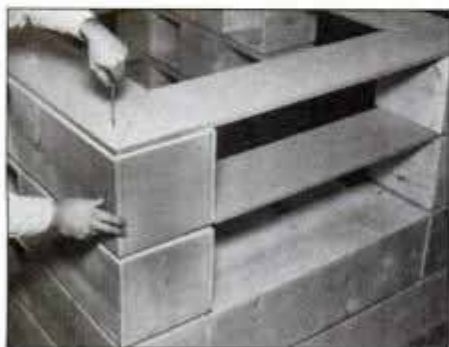
13 The upper corner of each truss is secured by screw fastening the rafters to keystone gusset. Use 2-in. No. 12 fh screws.



14 With components completed, join the first tier of modules to base with 1 1/4-in. No. 8 fh screws. Toenail modules 3 and 4 at corner.



15 The second row of spacers incorporates a shelf across the open end. Screw-fasten shelf to modules for easy disassembly.



16 The last level of modules is capped with mitered 1x12 spacers and shelves. Install with 1 1/4-in. No. 8 fh wood screws.



17 After the top band assembly has been secured to the top spacers, secure keystone supports in recesses at band frame ends.



18 Place trusses over keystone supports and secure with 2-in. No. 10 fh screws. Install ridge with 5/16 x 3-in. lagscrews.

TURNING TOOLS



A woodturner's guide to gouges, chisels and scrapers.

BY JOSEPH TRUINI,
Shop And Tools Editor
PM Photos by Brian Kosoff

A

little free time spent at the wood lathe is, for many woodworkers, heaven. And the reason is simple: Woodturning is fun, easy to learn and very satisfying.

With a little practice and patience, even a novice turner can create an intricately shaped spindle, a perfectly proportioned bowl or fanciful finial. Also, wood lathes are available in a wide variety of sizes and styles to satisfy nearly everyone's budget and workspace.

While the lathe provides the power, the actual shaping of the wood blank is done with various turning tools. Here, we've gathered together 24 tools that every woodturner should know about. Some of the tools are essential to basic woodturning while others are more specialized. It's worth mentioning that while a few of the turning tools shown are sold in sets, they are usually available individually, as well. All the tools shown can be purchased through the mail.

Most turning tools look pretty much the same – sharpened steel blades fitted with large hardwood handles. There are three basic types of turning tools: gouges, chisels and scrapers. The size and shape of a tool's blade determines how it's used. Most of the tools

R. Surby Sheffield England

Robert Goff



shown here are standard-strength turning tools—the most commonly used woodturning tools.

Heavyweight turning tools with thick blades and oversized handles, known as long-and-strong tools, are available for turning very large, heavy projects.

Conversely, small-scale tools are designed for shaping fine, intricate details and for turning miniature parts such as chess pieces and dollhouse furnishings.

Tool selection

There's no hard-and-fast rule regarding which turning tools you should own. This depends on the type of woodturning you do, size of the lathe and your budget. For a novice woodturner, it may be best to begin with a starter set of turning tools. Then, add tools of various sizes and styles as your skills increase. More experienced turners will be interested in the specialty tools shown, such as the spiral turning tools (No. 1 and No. 2) and

Glaser/Stocksdale gouge (No. 6).

Most woodturning tools are made with carbon-steel blades. Newer, more expensive tools with blades of high-speed steel (HSS), will hold a sharpened edge about six times longer than carbon steel. For most turners, carbon-steel tools suffice nicely. However, if you turn hard, exotic woods, burls, resinous woods or laminated blanks, consider the advantages of HSS tools. Now let's take a look at each of the tools shown.



1. Eye-style spiral tool—This odd-looking tool is used to make bowls in the traditional Swedish technique known as spiral turning. The tool's 25-mm-dia., ring-shaped cutting edge is designed primarily for shaping the sides of the bowl. To use, set the lathe at a slow speed and hold the tool at an acute angle to the spinning bowl. Don't force the cutting edge into the work. When used properly, the tool will shear off corkscrew- or spiral-shaped wood shavings. The 16-in.-

long tool has a 9½-in.-long hardwood handle and costs \$27.50 postpaid from Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

2. Hook-style spiral tool—To complement the eye-style tool above, Woodcraft also offers this hook-shaped spiral turning tool. The curved edge is designed for shaping the bottom of the bowl. It's available from Woodcraft for \$37.70 postpaid. The pair of spiral turning tools costs \$61.95. Both tools have carbon-steel blades and

must be honed before use.

3. Detail turning set—These three tiny turning tools represent a set of eight 7-in.-long tools that are ideal for shaping intricate details that would be impossible with standard-size tools. Use them to turn miniature parts or to create embellishments on larger turnings. Shown are: a ¼-in. parting tool, ⅜-in. skew and ⅜-in. gouge. The set also includes a ¼-in. gouge, ⅜-in. round nose, ⅜-in. square nose, ⅜-in. diamond point

12

PARTING
TOOL

SKEW

ROUND
NOSE

SQUARE
NOSE

ROUGHING
GOUGE

SPINDLE
GOUGE

BOWL
GOUGE

SPINDLE
GOUGE



and a $\frac{9}{64}$ -in. beading tool. It's \$39.50 ppd. from Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

4. Side scrapers—This pair of specially shaped tools is designed to make internal, finishing cuts on bowls, trays and similarly shaped pieces. The two different blade profiles allow you to form round-bottom or square-bottom bowls. Both the left edge and tip of each tool is ground for use. The dual-edge tips permit you to undercut recesses and shape hard-to-reach areas safely. The 17-in.-long tools have $9\frac{1}{2}$ -in.-long hardwood handles. They cost \$24.50 each or \$42.95 per pair postpaid from Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

5. Universal scraper—Here's a unique turning tool that is actually five tools in one. It consists of a blade fitted to a large ash handle and three interchangeable cutters—skew/full round, square and round nose/square. The cutters are made of high-speed steel and are held securely to the blade with a hex-socket machine bolt. A hex-key wrench is provided. This British-made tool costs \$45.95 postpaid from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

6. Glaser/Stocksdale gouge—Developed by two accomplished American woodturners, this 1-in. spindle gouge is the Rolls-Royce of turning tools. It features a $19\frac{1}{2}$ -in.-long black-anodized aluminum handle fitted with a 6-in.-long blade made of supertough vanadium carbide. The blade will hold its edge eight to 12 times longer than a HSS blade. The hex-shaped handle, machined from 1-in. bar stock, provides a comfortable grip. This handsome, well-balanced tool is designed for the serious turner. The 1-in. gouge shown costs \$112.50. A $\frac{5}{8}$ -in. bowl gouge costs \$82.50. Both are available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

7. Fluted parting tool—A parting tool is used primarily to make parting-off (severing) cuts and diameter-sizing grooves. The improved parting tool shown features a HSS blade that has a shallow flute machined along its cutting edge. This forms two sharp cutting spurs that score the cross-grained fibers to ensure smooth, clean cuts. The blade is also thinner at its top edge than at the bottom fluted edge to prevent binding in the cut. It's \$33 ppd. from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

8. Diamond-point parting tool—Machined from the finest Sheffield high-speed steel, this British-made tool features a 7-in.-long blade and 10-in.-long ash handle with brass ferrule. Use it to make parting-off cuts, diam-

eter-sizing grooves and for beading work. The HSS blade not only keeps an edge longer than a carbon-steel blade, it also retains its hardness at higher temperatures. This is important when there's a significant heat buildup while turning. This parting tool costs \$36.80 postpaid from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013. Contact Garrett Wade for information on its entire line of HSS turning tools.

9. Micro turning set—These three tools represent a set of five small-scale turning tools offered by Constantine's, 2050 Eastchester Rd., Bronx, NY 10461. The 10-in.-long tools feature HSS blades and ash handles with brass ferrules. These tools are slightly larger than the detail turning set shown (No. 3), but they can be used in much the same way—to turn intricate details. The 5-piece set includes a $\frac{1}{4}$ -in. roughing-out gouge, $\frac{1}{8}$ -in. spindle gouge, $\frac{1}{4}$ -in. round-nose scraper, $\frac{1}{4}$ -in. skew chisel and $\frac{1}{16}$ -in. parting tool. It costs \$54.50 postpaid.

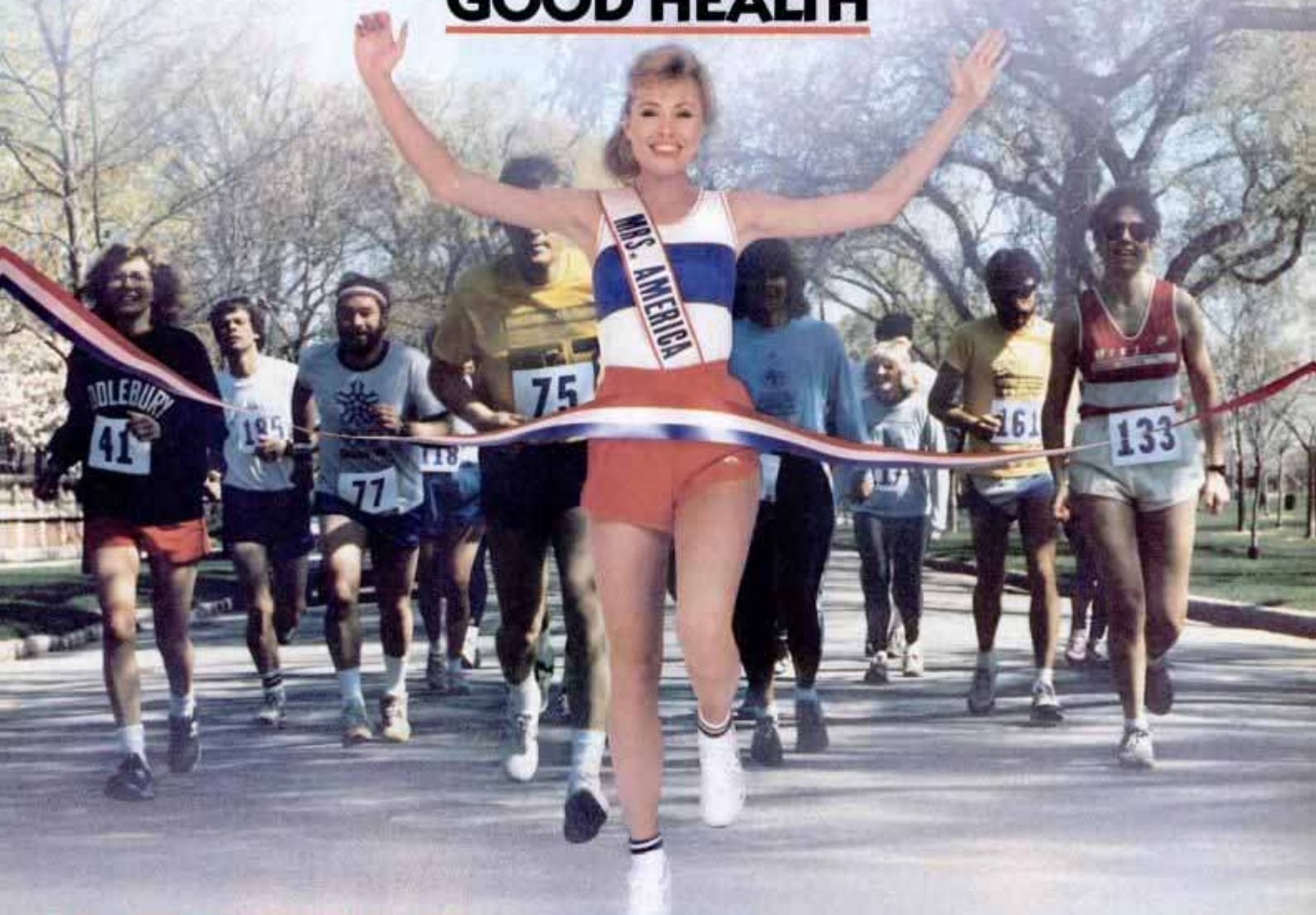
10. Oval-skew chisel—Here's an improved version of a common skew chisel. This skew features rounded sides that allow it to slide smoothly across the toolrest without hanging up on any surface imperfections, nicks or scratches. The upper edge of the blade is ground flat to provide greater control when cutting square shoulders and ends. It features a 1-in.-wide HSS blade and a 12-in.-long ash handle. It costs \$25.95 postpaid from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461. A $\frac{3}{4}$ -in.-wide oval-skew chisel costs \$22.75.

11. Roughing-out gouge—Gouges come in various sizes and are essential to all levels of woodturning. Use this large $1\frac{1}{4}$ -in. roughing-out gouge to quickly cut a square turning blank into a cylinder. The roughing-out gouge is often the first tool a turner uses. The $18\frac{1}{2}$ -in.-long tool (\$53.75) has a HSS blade and a large ash handle. A $\frac{3}{4}$ -in. roughing-out gouge is also available for \$37.25 postpaid. Contact Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

12. Standard set of turning tools—Here's a standard set of tools that any woodturner would be proud to own—novice or expert. The 8-piece set includes a $\frac{3}{4}$ -in. skew, $\frac{1}{2}$ -in. round nose, 1-in. square nose, $\frac{3}{4}$ -in. roughing-out gouge, $\frac{1}{2}$ -in. spindle gouge, $\frac{3}{8}$ -in. bowl gouge, $\frac{1}{4}$ -in. spindle gouge and $\frac{1}{4}$ -in. parting tool. Each tool features a carbon-steel blade and ash handle with brass ferrule. The set costs \$117.50 ppd.—less than \$15 per tool—from Woodcraft, 41 Atlantic Ave., Box 4000, MA 01888. **PM**

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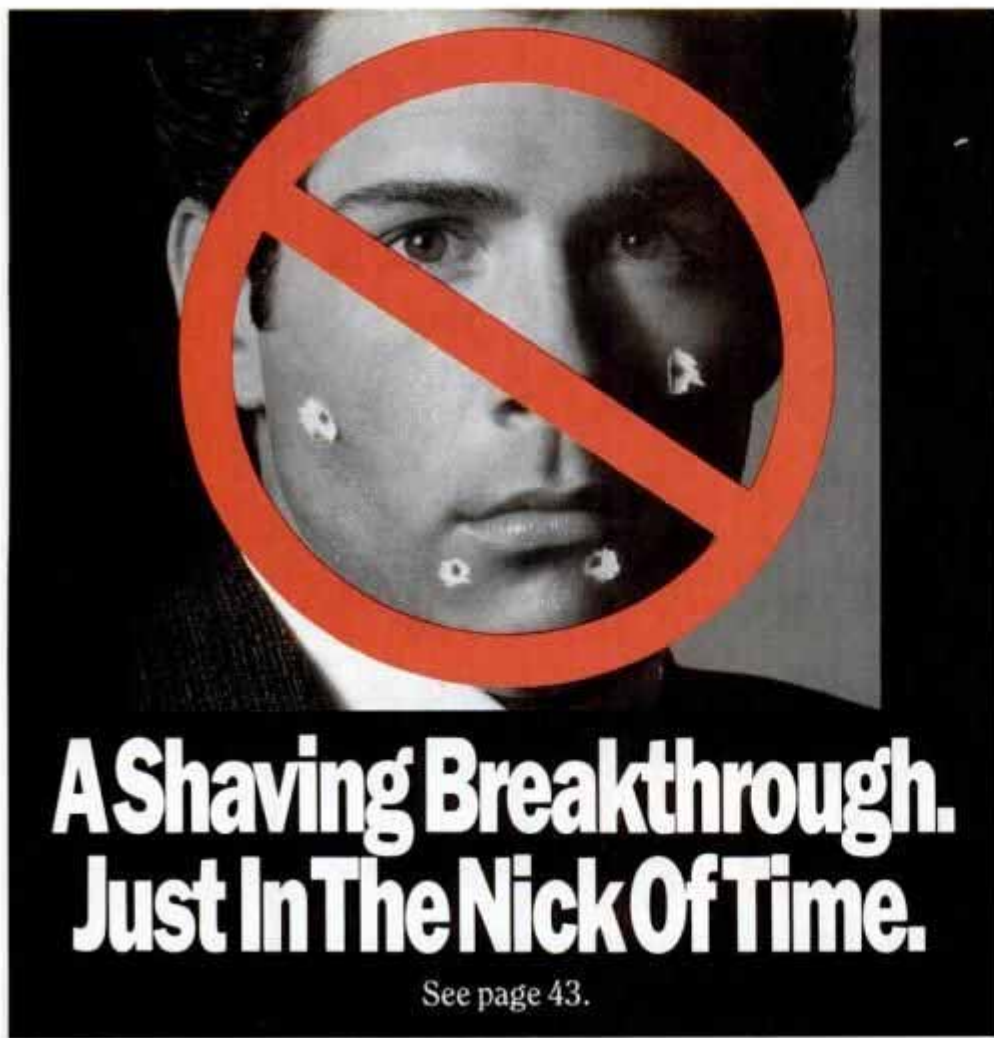
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A Shaving Breakthrough. Just In The Nick Of Time.

See page 43.

HOMWORK

(Continued from page 78)

Complete PC's Complete Answering Machine (\$349) digitize the incoming or outgoing vocal information and store it in disk-based memory.

Even more exciting is the outreach capability available today. With an inexpensive telephone modem, you can transform your personal computer into a vast research library.

Fingertip facts

Instead of trekking to the nearest library, you can flick on your modem. With a subscription (\$25 per year) to Dialog Information Services, the most comprehensive of the major electronic information services now available, you can scan thousands of sources from the comfort of your desk chair. Dialog claims to have well over 100-million items in its constantly updated on-line archives, and at last count offered nearly 300 separate databases, ranging from general interest to esoteric journals.

What does a trip into this treasure trove of information cost? About \$60 per hour is typical, a figure that might sound high until you begin to tally the time spent traveling and data-searching—and the possibility that many libraries won't match Dialog's range of sources. For the more casual user, the

company also has another service, Knowledge Index, which offers about 60 of Dialog's databases and is available evenings and weekends for a flat \$24 per hour.

Finally, when you're writing that report, if you'd like to have a collection of reference works you can thumb through without having to ever take your eyes from the computer screen, software supplier Microsoft might have the answer to your prayers: It's called Bookshelf, a set of 10 complete reference books housed on a single CD-ROM—a compact disk that stores computer data instead of music. The volumes include a dictionary, thesaurus, almanac, compendium of quotations, business information source book, style manual, English usage guide and zip-code directory.

Where Bookshelf sets itself apart from the traditional ink-on-paper reference library is in providing near-instant access to any item, plus the ability to cut and paste information into a document for note-taking purposes. Because CD-ROM technology is still a new concept to most people, Microsoft is bundling the program, priced at \$295 by itself, with all the necessary hardware for \$1095.

CD-ROM players are also now available from Apple, Hitachi, Panasonic, Sony and NEC, while CD-ROM

software, for both MS-DOS and Macintosh computers, includes medical databases, business statistics, book catalogs, custom map-generating programs, encyclopedias, dictionaries and art libraries.

Info to go

Once you've completed your report—or any other type of document—you'll want to get it to the right people quickly. You don't necessarily need a PC to transmit graphics and text. Facsimile machines, which use a high-speed modem to transmit digitally scanned images through telephone lines, can do the job, too.

In contrast to computer communications, faxing is a no-muss, no-fuss affair. Group III is the current general standard. This type of fax lets you send a full page of text or graphics in as little as 15 or 20 seconds. The older, analog Group II standard takes about 3 minutes. A side benefit: Your machine can double as a copier making dupes on thermal paper.

Among the rapidly growing ranks of suppliers now bringing affordable personal fax machines to market are Ricoh, Canon, Toshiba, Panasonic, Brother, Sharp, PacTel, Northwestern Bell, Cobra and Murata. Panasonic is stressing space-saving integrated units, offering two combination fax-telephones with built-in answering machines. The KX-F120 (\$1695) is a Group III/Group II-compatible machine, the KX-F100 (\$1195) a Group III-only unit. Each unit allows a caller to leave you a voice message or a fax message, and lets you send a fax in the middle of a call.

Sharp Electronics' UX-80 (\$1499) includes a telephone, plus reduction and enlargement-copying capability, along with the unique ability to transmit pages from a hardback volume.

While the \$1000 to \$2000 price range is where most of the fax action is, some suppliers are attacking both the low and high ends of the price spectrum. Murata's M-1200 (\$899) and Sharp's UX-30 (\$899) target the cost-conscious fax fancier. At the top rung of the personal fax ladder is Canon's FaxPhone 25 (\$2695), which adds to its wide range of fax features a serial interface for using the unit as a scanner or printer with a personal computer. Portable faxes—from Cobra, Comet, Medbar, CBM (Citizen) and Northern Telecom—are also proliferating. Cobra's PP-110 Print Phone (\$1399) weighs 8 pounds.

The latest chapter in the fax story, and one likely to gain in popularity, is the PC-fax board. This add-in expansion card lets you use your personal computer as a facsimile device. Prices

(Please turn to page 96)

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HOMEWORK

(Continued from page 94)

range from as low as \$395 to well over \$1000, depending on features.

Copiers go digital

There's new action, too, in that cornerstone of home-office products, the personal copier.

Though prices haven't dropped as quickly as once expected, you can find a larger selection of units at more affordable cost than ever before. For example, Canon's series starts at \$745 list, with street prices often below \$500 for the basic PC-3.

Other major companies marketing personal copiers include Sharp, Ricoh, Xerox and Packard-Bell. A newcomer on the scene is Panasonic, whose slim, lightweight (12-pound) Apogee (\$799) underscores the way digital technology is integrating office electronics products.

Plain-paper models from Canon and other suppliers employ electrostatic technology for copying. The desired image is first focused by a light source onto a photosensitive drum, toner powder is applied to adhere to the electrically charged image area, and the image is finally fused onto paper by rollers with pressure and heat.

Panasonic's Apogee also uses plain paper, but avoids drums, toners, heat rollers and chemicals. Borrowing instead from the scanner technology used by fax machines, the Apogee's scanner translates a document into light and dark signals, then reproduces it by heating an ink ribbon to transfer that image onto the copy paper. Panasonic concedes the thermal-transfer print quality doesn't quite match the electrostatic method, but argues that its approach has distinct advantages for the casual or light-volume copier, notably the convenience of avoiding messy chemicals. This is a problem that companies such as Canon have shrewdly tried to circumvent by using easy-to-replace but costly cartridges (about \$90) that contain the copier's vital mechanisms.

If you also own a PC or a VCR you might find an intriguing and potentially useful bonus in the Apogee. When coupled with an accessory interface, the Panasonic machine can copy directly from a composite video signal. This means you can use the Apogee to render an image from either your VCR, video camcorder or computer screen. Much like the use of CDs for data storage, this type of versatile capability points to the future integration of electronic entertainment and electronic-information products—all nestled compatibly in the same cozy electronic cottage. **FM**

Save Gas, Save Engine with 'POLY'

GUARANTEED LOWEST PRICE (see details below)

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

The Secret is "Poly"

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

Years of Testing and Use Have Proved it True!

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

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

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

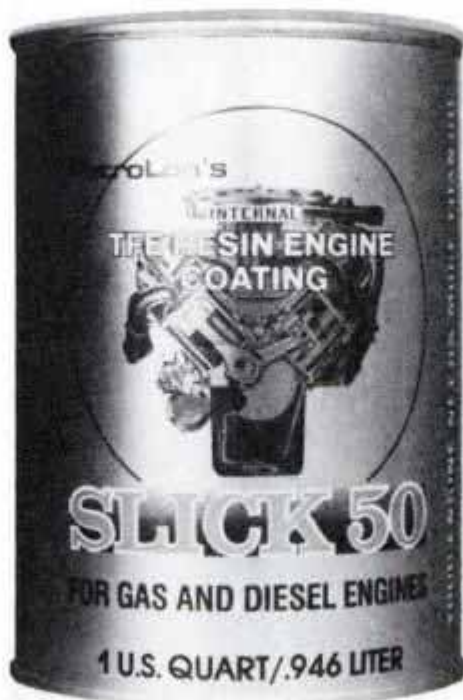
TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

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

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

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

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



It's Easy to Treat Your Engine

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

Only One Treatment Necessary

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

Works with Most Oils

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

4 Ways Slick 50 Saves You Money

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

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

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

Slick 50 Will Not Affect Your Warranty

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

There's No Risk with Our Money Back Guarantee

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

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

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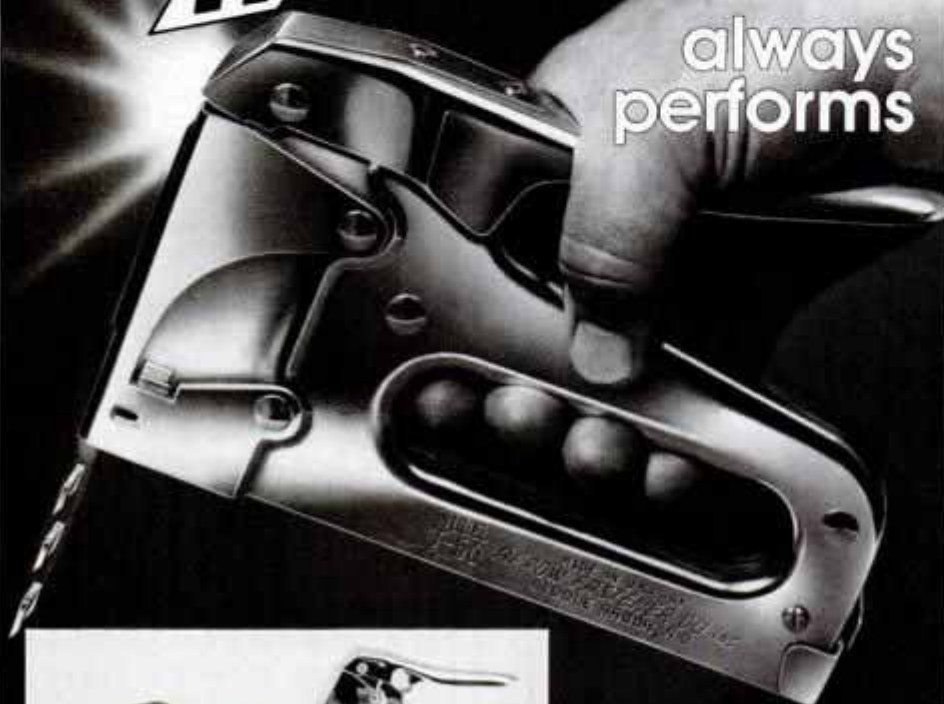
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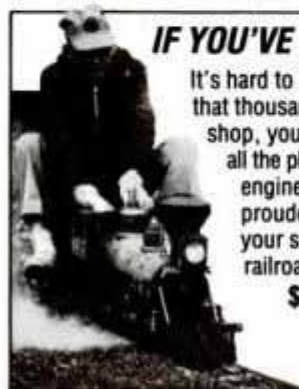
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ATTACK SUBS

(Continued from page 54)

the sound of a ship or submarine. The new advanced-capability Mark 48 torpedo (or ADCAP) is more acoustically sensitive and has a greater range. Ponessa pointed out that *Norfolk* can fire *Harpoon* antiship missiles, and *Tomahawk* land-attack cruise missiles from its 21-in. torpedo tubes.

Later versions of the versatile *Los Angeles*-class carry 12 vertical-launch missile tubes that accommodate the *Tomahawk*.

All of these weapons and sensing upgrades have naturally taken up precious volume aboard *Norfolk* and other subs in the *LA*-class. But life aboard ship has always been somewhat cramped for the submariner.

"*Nautilus* was considered a training ship, so we had a lot of crew rotation and it got pretty crowded," Anderson told Ponessa.

Norfolk's crew, like the crew of *Nautilus*, sleep in 3-tier bunks and keep their meager possessions in flat trays under their bedding. Off-watch hours are spent reading, or performing "quals," qualification lectures and assignments that continually teach the officers and crew the functions of the ship. Constant study under way is a Rickover legacy.

Essential life-support functions have clearly improved since Anderson's time aboard *Nautilus*, with reliable oxygen generators and lithium-hydroxide CO₂ scrubbers constantly replenishing and cleansing on-board air supplies. Fire suppression and proper placement of emergency breathing apparatus has gotten plenty of attention in recent years.

All of these sophisticated functions occur aboard a ship able to cruise well in excess of 20 knots and dive much deeper than 400 ft. Actual performance remains highly classified.

Subs of tomorrow

As Anderson pointed out, for a sub skipper who started his career in World War I O-boats, things have certainly changed. The next generation SSN-21 represents further submarine advancements. Ultra-quiet torpedo tubes will carry longer-range weapons. Studies are under way for satellite-based real-time laser communication. Retractable bow planes and hardened sails will make under-ice operations more routine.

The advent of this great age of submarine technology can be traced to a day in August 30 years ago, when William Robert Anderson and his determined crew sailed a revolutionary ship called *Nautilus* to the top of the world.

PM

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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HAPPY BIRTHDAY, CORVETTE!

(Continued from page 60)

Corvette met the computer in '81 with Chevy's Computer Control Command engine management system, though the system had only one engine to manage—a 190-hp 350.

The '82 model represented the last of a breed—a body design that originated in '68 and a chassis dating to 1963. A new version of the 350 engine featured twin throttle-body fuel injectors. The 200-hp mill was backed by a new 4-speed automatic.

The late introduction of the new Corvette during the '83 model year prompted Chevrolet to label the new Corvettes as '84s. Officially, no '83 models were ever sold.

The '84s were completely new with a spine-type chassis in sleek styling that resembled GM's Camaro and Firebird. There was a 1-piece liftoff roof panel, lift-up glass hatch and arcade-like electronic instrumentation. The cross-fire engine was carried over, but a Doug Nash 4-speed was available with automatic overdrive.

A new level of lateral acceleration was achieved with the redesigned suspension that featured single-leaf plastic springs front and rear. It all came together on fat 255/50-16 in. tires. The optional Z-51 suspension made the car race-ready but next to unbearable on the street.

Following the evolutionary course of its predecessors, the new model was refined. By '85, the price of a base Corvette was close to \$25,000. The car now had a new port-injection system—the first true injection since '65. It upped horsepower to 230 and improved economy. Ride harshness was also eased.

New braking standards were set in '86 with an antilock brake system (ABS). The same year saw the advent of the first convertible since '75.

A third suspension level—Z-52—was added in '87, midway between the base and superstiff Z-51.

Interesting options packed the order form in '88. First there was the big-wheel option—17 in. big, wearing huge P275/40ZR-17 Goodyears. Twin turbo power continued to be available, via Callaway, and there was also a heavy-duty brake package.

Closing out the '80s in style, 1989 will offer one of the most exciting options since the old tripower big-block days: An LT-5 engine, with a Lotus-built 4-cam 350 cranking out close to 400 horsepower—combined with a 6-speed manual transmission—will give the Corvette true 200-mph capability and a price tag close to \$60,000. And that, friends, should put the Corvette at the top of anyone's wish list. **PM**

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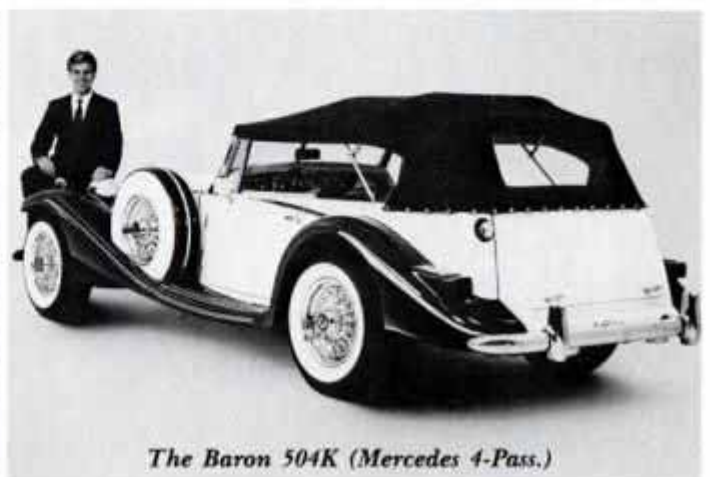
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CORVETTES AT SPEED

(Continued from page 63)

off the anti-GT-40 project, he and Duntov planned a lightweight anti-Cobra Corvette.

The idea was to build 125 GT cars loosely based on the 1963 Sting Ray production coupes. It had a new ladder-type frame made up of large tubing, a 1-piece hand layup glass-fiber body, lightweight front suspension and a version of the Sting Ray's independent rear suspension.

The homologated weight was 1908 pounds. The engine was to be a hemi V8 with alloy block, dual plugs, ram-tuned fuel injection and displacement between 377 and 402 cu. in.

Once again, GM corporate policy turned off the tap, but this time after five GS Corvettes had actually managed to emerge. Using production-based small blocks, the GS ran as a modified car against Coopers, Chaparrals, Scarabs. In the hands of Texas-based Mecom Racing, three of the cars—running 377-cu.-in. aluminum small blocks with Weber carburetors and 485 hp—ran the Cobras and Ferrari GTOs into the ground.

The last two Grand Sports were bodied as roadsters using targa-style roll bars, to run at Daytona (the lower frontal area of the roadster allowed a higher top speed). Once again, GM management came down on Knudsen and the program was scrubbed.

The Grand Sports have changed hands many times since the mid-'60s, but all five (some say six) still exist and are very highly prized today. And yes, they were faster than the Cobras, including the Daytona Coupe.

■ **MARK IV**—There have been only three engines used in production Corvettes since 1953: the Blue Flame Six, the small block and the mighty Mark IV (396, 427, 454 cu. in.). The Mark IV was originally a secret weapon for NASCAR to allow Chevy to compete with Ford and Chrysler.

The ultimate version, the L88, reportedly had 560 bhp, although the factory never admitted it. It was available only with the Muncie Rock Crusher M22 gearbox, heavy-duty suspension, heavy-duty cooling, heavy-duty everything. With 12.5:1 compression, optional aluminum heads, standard tripower carburetion, it was for racing only, and was effective in long-distance competition.

The L88-powered production-based Corvette won the GT class at Daytona and Sebring in 1966, at Sebring again in 1967, and managed 171.5 mph—22 mph faster than the winning Ferrari GTB—down the Mulsanne straight at LeMans. Only about 500 were built in three years. **FM**

OLD VERSUS NEW

(Continued from page 65)

tires constitute its only unfair advantage. And that's the way it worked out at the track. Ed's old yellow Vette ran wheel-to-wheel with our new Z-52 everywhere except the slalom.

It's off the track where the differences show up most. The '88 Corvette, particularly in Z-52 form, is just about the most balanced all-rounder in the world, circa 1988. It does *everything* well.

On the other hand, put the top down and the stereo on, and the Z-52 will happily cruise down to the Dairy Queen with never a hint of thoroughbred temperament.

Ed's '66 has a disposition as sunny as its bodywork. By comparison to the intensely serious Z-52, everything about it seems happy and friendly. There's lots of room behind the big mahogany steering wheel, much more room than in the tight-fitting '88. There's also more trunk room. The big white-on-black gauges are as functional as the elaborate electronic display in the '88.

In 1966, *Road & Track* wrote "the 4-speed all-synchro gearbox is about as near faultless as any we've ever encountered." That's still true. Surprisingly, Corvette engineers gave away that great shift feel on the current model, when they moved the shifter mechanism inside the gearbox.

Which is the better car? Well, judged for what it can do, as a machine, as a total package, the 1988 Corvette is it. No contest. It's benefited from 20 years of development by some of the savviest engineers in the car business. It's one of the two or three hottest cars built anywhere.

However, if I personally had to choose either the Z-52 or Ed's '66 to actually live with, to drive, to own, I'd choose the '66. To my mind, it's more exciting to look at, it's far more comfortable to be in and it's just as rewarding to drive. I was prepared for the '66 to be awkward and old-fashioned compared to the new car, but that's simply not the case. It's a well-balanced package that shows its age only in extreme situations—and when was the last time you plunged into a 100-mph, off-camber decreasing-radius sweeper on the way to the office?

Last but not least, 10 years from now, a 1988 Corvette will be at the very bottom of its price cycle, worth perhaps \$15,000-\$20,000. By comparison, Ed Fischer's '66 will be a \$75,000 car. If you're going to spend \$35,000 for an automotive artifact like a Corvette, it's certainly nicer to be making money rather than losing it as you drive in style. **FM**

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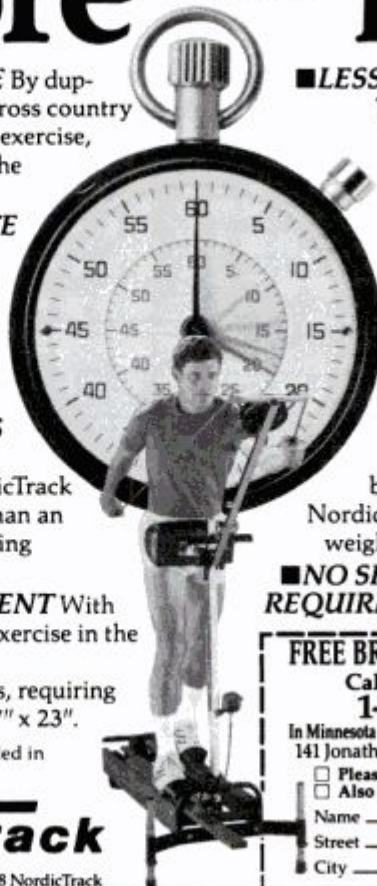
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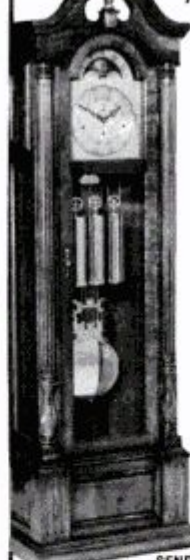
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HIGH-TECH OIL CHECK

Oil analysis can save you money
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TEXT AND PHOTOS BY MIKE ALLEN
Assistant Auto Editor

WHEN YOU change your own oil you probably run your fingers through the drain pan, examining the dirty oil for consistency, particles or the occasional stray piece of timing gear or piston skirt. Does it smell burned? Is it thin and runny with raw, unburned gasoline? Or so thick and oxidized it won't run out of the pan without help, like a new bottle of ketchup?

Proper *scientific* oil analysis has been around since WWII, starting with the military and later with the railroads. By quantifying contaminant parts-per-million, abnormal component wear can be pinpointed without disassembling the engine. High levels of, say, chromium point to abnormal ring wear, while tin and lead make the bearings suspect. Copper means that the bearings have worn all the way through to the brass backing, and failure is imminent. High concentrations of iron would come from worn cylinder walls or camshafts.

Sodium is one of the additives in anti-freeze, and high levels of sodium can mean either a bad head gasket or a leak in the block or head. Or maybe just some road salt getting in through the air cleaner.

Silicon (sand) usually means the air cleaner or PCV system is leaking or (more likely) the air filter needs to be replaced. Silicon is very abrasive, and high levels of other contaminants in the presence of silicon will probably go away after a fresh air filter and an oil change.

Spectroscopes, the only machines sensitive enough to detect such small



This \$165,000 emissions spectrophotometer automatically checks tray of 100 oil samples and gives concentrations of contaminants in parts-per-million in 30 seconds per sample.

concentrations, are expensive, requiring the ministrations of a highly skilled staff, as well as trained oil analysts to interpret the results. Commercial oil analysis has always had these limitations, making it impractical for the average Joe.

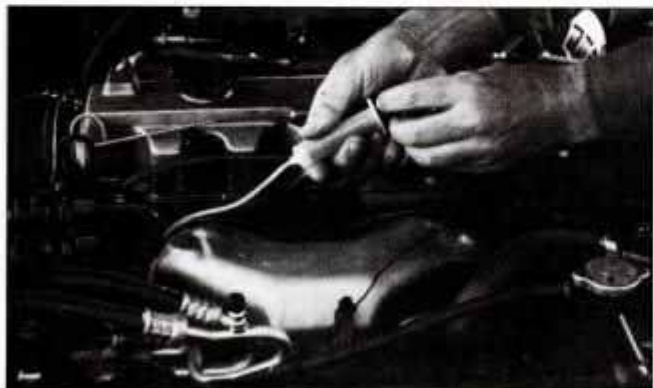
Detect Auto Labs, a large oil-analysis firm that's been involved with the fleet market for a long time, has automated, computerized and reduced the price to less than \$10. The report is written in plain, easy-to-understand English, so you won't need to interpret the raw

numbers in parts-per-million generated by the spectroscopes.

The Detect system is so accurate it can pick up differences in wear rates between different types of engines. They'll need the VIN (vehicle identification number) from your registration so their computer will know what's in your vehicle. It then compares your oil with samples from thousands of other engines like yours before interpreting the results.

You can buy Detect's prepaid analysis kits from J.C. Whitney's mail-order catalog, Canadian tire dealers, many retail outlets and fast-lube franchises by the time you read this, but if you can't find one, you can contact Detect for the name of a retailer near you: Detect Auto Labs, 122 E. 42nd St., Suite 2100, Department PM, New York, NY 10168, (212) 682-6859.

Manufacturer recommendations to the contrary, we change the oil in our long-term test cars at 3000-mile intervals, 2000 for turbo cars. So should you. We've added Detect's oil analysis to our long-term test program, and we'll be reporting the results in our coverage. **PM**



Plastic tube and syringe included in Detect kit allow oil sampling through dipstick tube (left), although sampling while changing oil is preferred.

WINGING IT

(Continued from page 57)

September 3—the earliest possible starting date. However the judge decides to interpret the Cup's original Deed of Gift, appeals are likely.

Judge Ciparick stunned yachtsmen last summer by ruling that New Zealand could force an early, 1-on-1 Cup defense in boats with a maximum waterline length of 90 ft. The previous race format, in place since 1958 and open to all challengers, called for 60-ft.-long 12-Meter boats meeting in 3- to 4-year intervals.

Rather than asking will the race be run, the better question is: Will it be a true sporting event? Monohulls never meet catamarans in head-to-head racing. Why? Because the monohull is to the catamaran as the Boeing 747 is to the Concorde. Each is a superb craft, but in speed there's no comparison.

However, a case can be made that such a race can be close. *Kiwi Mischief* has an immense sail area of 15,000 sq. ft., five times that of 12-Meter boats. A narrow innovative hull—14 ft. wide at the waterline flaring out to a maximum of 26 ft.—plus an extremely low-drag keel may push this radical monohull to the threshold of 30 mph.

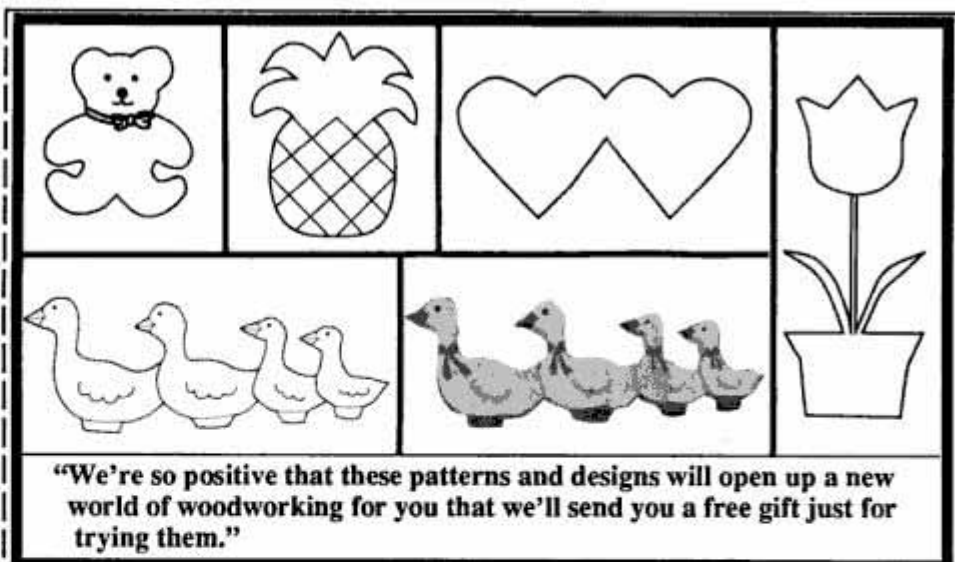
Stars & Stripes, on the other hand, may never actually run to its full potential during an America's Cup race. Dennis Conner and crew are inexperienced catamaran sailors. They've already had catastrophic accidents in training, capsizing one Formula-40 cat and dismasting another. There is even talk that Conner may scrap the rigid sail in favor of a conventional sail.

Despite the cloud of courtroom wrangling over the 1988 race, the future of the America's Cup has never looked brighter. By throwing out the restrictive 12-Meter rulebook, competitive boats will now be able to use the latest high-tech advancements and more than double the speed of previous races.

Experts are already predicting that *Stars & Stripes* and *Kiwi Mischief* are the fastest catamaran and monohull, respectively, in the world.

"Once we get the America's Cup settled and don't have to worry about breaking up," said John Marshall, when the big cat was launched in San Diego, "we're convinced we could lift the world record for speed under sail. I think we have enough interest to attempt it and it would be fun to try."

Cup race or no Cup race, the *Stars & Stripes* wingmast will sail into history and, more than likely, the record books. The high-tech, high-speed genie has been let out of the bottle and America's Cup racing may never be the same. **PM**



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NEW-WAVE WATERCRAFT

(Continued from page 81)

when the driver falls off.

Despite the pontoon set's obvious benefits, this is clearly a halfway measure. The Jet Ski is fundamentally a 1-person machine meant to be driven standing up. Weight and load distribution when riding double virtually buries the stern.

However, the craft is an outstanding wavejumper with a relatively swift learning curve, and it's easily stripped down, once you've mastered the fundamentals, to become a solo hotdogger's dream machine.

Fazer Faze II

With a low-to-the-water, pickle-fork hull, it's not surprising the Faze II is ultrastable and a straight-ahead screamer. Beginners can sit down on the Faze II for the first time and roar away with confidence.

Although the craft maneuvers like a snowmobile, requiring the rider to shift weight and lean hard into the turn, the technique can be practiced in slow motion and swiftly learned.

The Faze II's well-designed strengths allowed it to finish third in top-end speed, overall stability at speed and rest, rider-friendliness and fun factor. However, as a relatively difficult machine to maneuver, it finished behind the fleet on the performance course.

A number of features were stand-outs such as a hinged forward engine hatch, rubber footwells, underseat stowage and low-pressure ducts for increased engine ventilation.

But others were less satisfying, especially the low seat and handlebars. You don't know how to position your legs—straightforward with locked knees or bent backward in an uncomfortable crouch. Equally annoying is the forward-mounted exhaust that maximizes noise and fumes.

Despite certain glitches, the Faze II is a unique waterscorcher with a gutsy engine and nearly tip-free hull that provides a stable platform, relatively dry ride and short learning curve. Its low price also makes it one of the fleet leaders in value.

Overall, our test proved that these craft are basically idiotproof. Wear a flotation vest and sneakers, operate at controllable speeds, follow basic boating rules of the road, use throttle power throughout a turn, leave at least 100 ft. for stopping, and you'll have the most exhilarating ride of your life.

It's easy to see why interest in jet-powered personal watercraft is booming. They bring out the hotdogger in everyone.

PM

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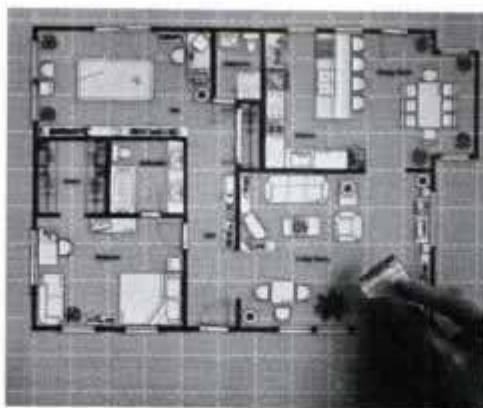
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Bathroom Designer Kit

This 3-dimensional kit shows you two 3-D views and an overhead look of a remodeled or new bathroom. The colorful vinyl pieces include track lighting, sliding glass doors, modern vanities and sinks; even a Jacuzzi. (PM-2030—\$26.45, includes shipping)

Landscape Designer Kit

Renovations to your property can be costly and highly noticeable. Before you sink in a lot of money, plan your design with this comprehensive kit. It shows the location of trees, shrubs, walkways, fencing, patio furniture, pool, sprinklers, lighting, even a basketball net. The blueprint grid can show property up to 144 by 288 feet. (PM-2040—\$31.45, includes shipping)

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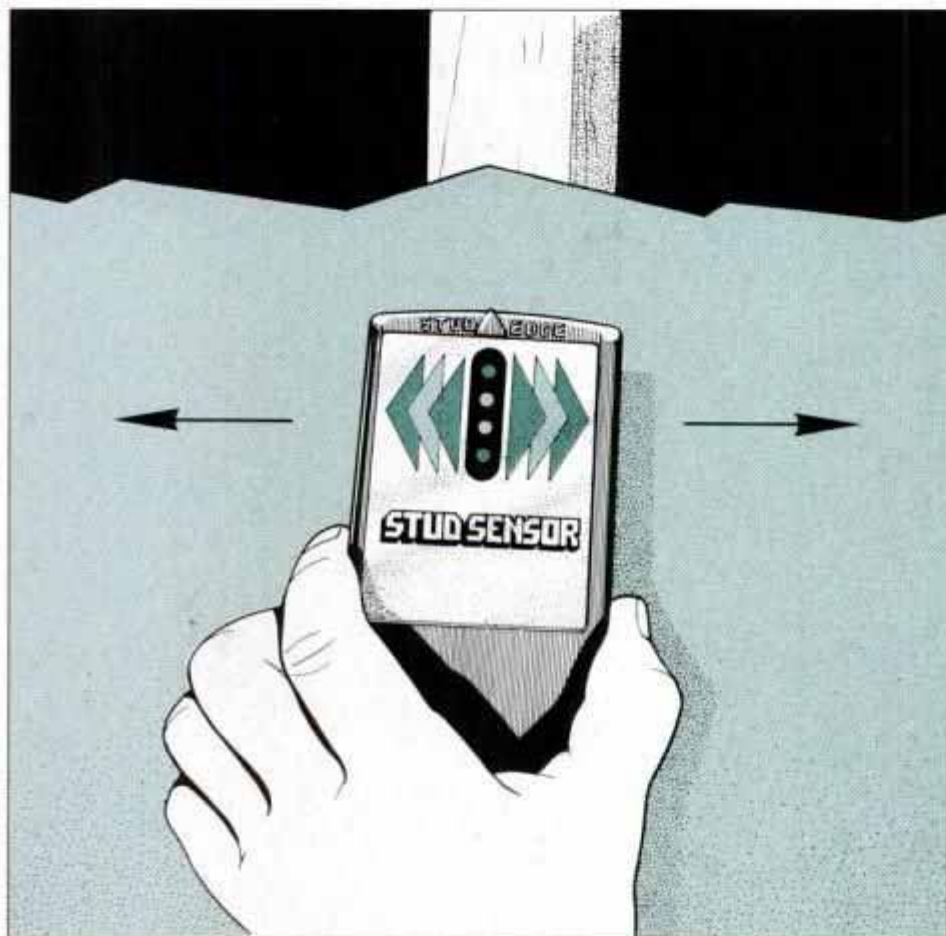


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BUCKLE UP FOR SAFETY.

How To Locate FRAMING STUDS

BY ROSARIO CAPOTOSTO, Contributing Editor; PM Illustrations by George Retseck



1 An electronic stud finder is a great tool for locating the exact position of wall studs. As you move the tool across the wall, the lights indicate the stud edges.

MOST HOUSE WALLS are built using vertical 2x4 studs. And as long as they serve their primary purpose—namely, holding up the house—we rarely think about them. But when we do work on the walls, whether putting in a new window or simply hanging a heavy painting, we need to know the precise location of these framing members. And, we want to find them without tearing the wall apart. Fortunately, every wall carries some tell-tale clues that make this job easier.

If you do a lot of remodeling and repair work, your best bet is to invest about \$20 in an electronic stud finder.

The one shown on this page is made by Zircon International and is available in hardware stores, home centers and through mail-order tool catalogs. All you do is move the sensor across the wall and when it passes over the stud, the lights on the unit come on. It operates on a simple 9-volt battery and will accurately establish both outside edges of the studs. This device was designed primarily for working on drywall or wood-paneled walls. But it also functions well on plaster walls as long as wood lathe was used. Apparently, metal lathe confuses the instrument.

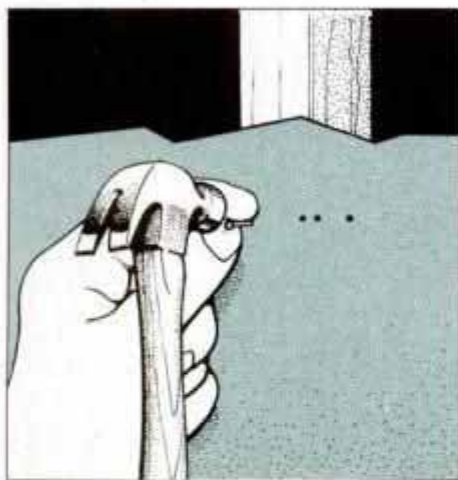
If you'd rather take a lower-tech



2 Using your knuckles, lightly tap along a wall and listen for a change in sound. A solid thud will be heard over a stud.

approach, Figures 2 through 10 give you some sensible options. The easiest of these is simply tapping your knuckles across the wall and listening for a change in sound. While this will generally yield the rough location of a stud, it will not clearly define both edges. To find the center of the stud, you can probe the wall with a small nail. Usually, I use a 4d finishing nail and repeatedly drive it into the wall until it hits the stud. Then I measure over 1½ in. to find the other edge of the stud. (Studs are called 2x4s but their actual width is generally 1½ in.) Drive the nail again to make sure you have found the other side of the stud and then lightly mark the wall. These small holes can be easily repaired with caulk and touchup paint.

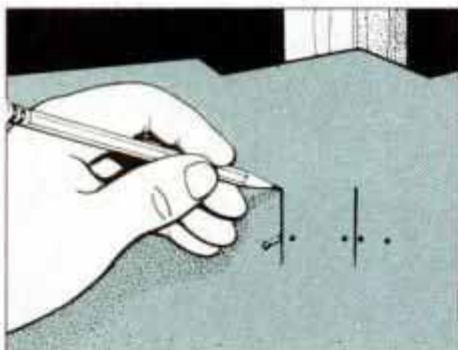
This method works on plaster walls too, but you do run the risk of cracking the brittle plaster. A better option is to drill repeated 1/16- to 1/8-in.-dia. holes across the surface. When the bit meets resistance beyond the depth of about 1 in., you'll know you've found a stud. You should, however, remember two important cautions when drilling into any wall: Be sure to use a double-insulated drill, and avoid drilling in any areas where there may be



3 After sounding out general stud location, find precise position by driving a small nail into wall until it meets resistance.

concealed electrical wires or water and gas pipes.

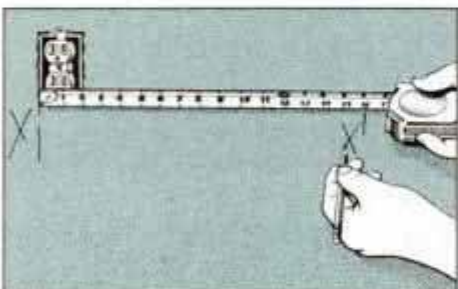
If you'd rather not put small holes in your walls, careful visual inspection may do the trick. By shining a light at a low angle across drywall, you can often see bumps or depressions where



4 Continue driving nail across wall until you pass over other edge of stud. Mark both edges on the surface with a pencil.

nails are driven into the studs. You'll get the best results if you work in a dark room.

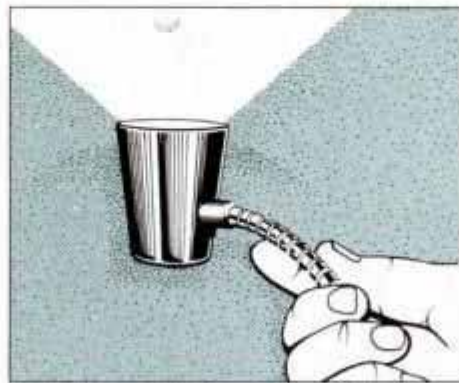
Visual inspection of the baseboard can also reveal depressions over finishing nail heads. Often this filler will shrink and be noticeable. Of course, you can also carefully remove the



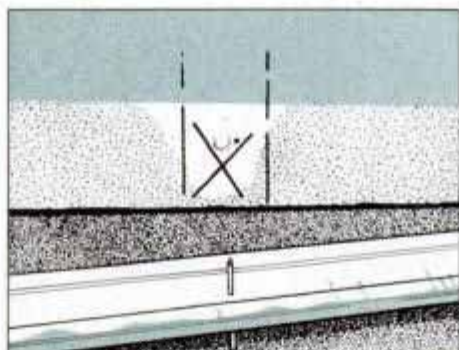
5 Outlet boxes are usually nailed to studs. Remove cover plate to see where stud is, then measure and mark 16 in. to next stud.

baseboard and check for stud markings or nails underneath.

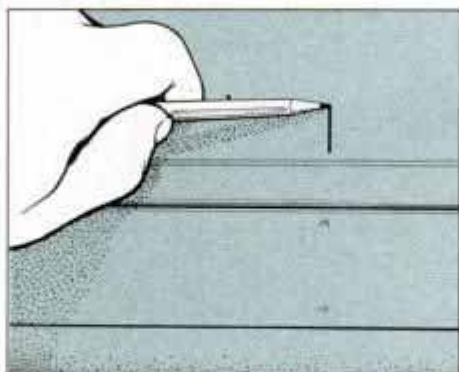
Another good option is to remove outlet cover plates. Generally, the boxes underneath are nailed to studs. Once the cover is off, you can see which side the stud falls on and then measure over in increments of 16 in. to find where other studs fall. Remember that these stud locations



6 A low skim light used in a dark room will often reveal depressions or bumps where wallboard nails are driven into studs.



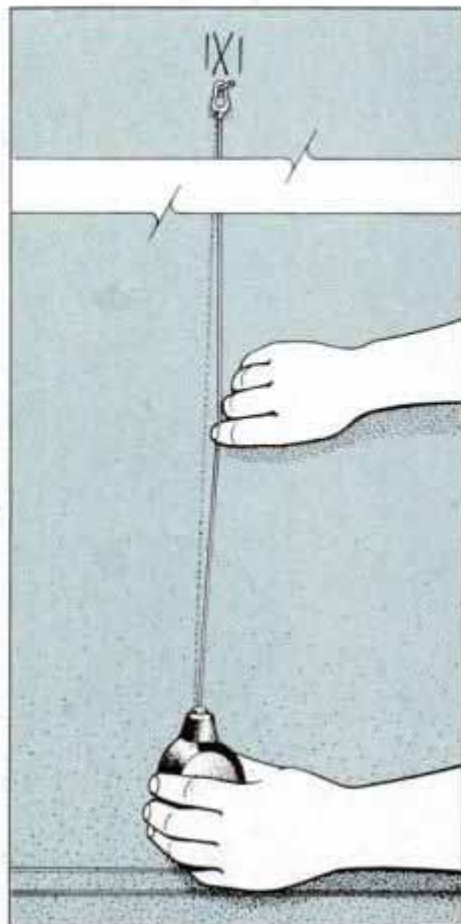
7 Clues to stud locations are found when baseboard is removed. Wall may be marked or have exposed nails over studs.



8 Baseboard nails are usually driven into studs. Look for nail-head depressions. Confirm location by probing with small nail.

must be confirmed—by probing with a nail—because you cannot depend on all studs being on the typical 16-in. centers.

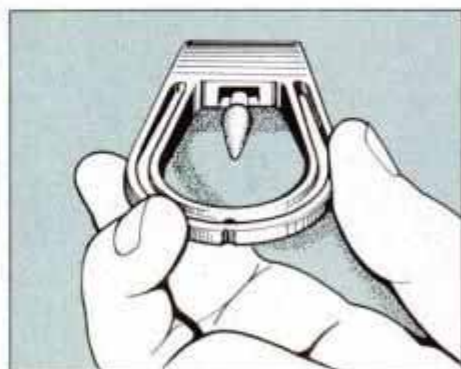
One last option is a simple magnetic stud finder. This inexpensive device



9 When stud location is pinpointed at top and bottom of wall, snap a chalk line between the two to mark length of stud.

has a pointer that reacts when the tool passes over the nails used to install drywall panels. These finders will work well if the nails are close to the surface and if you have the patience to thoroughly scan the wall inch by inch. They will not, however, work on paneling that is installed with adhesive or on plaster walls.

Using any one of the above methods should help you locate your wall studs. But keep in mind that many will also work well if you want to find joist locations in the ceiling. **PM**



10 A simple magnetic finder has a built-in pointer. This indicates the hidden location of nails used to attach wallboard.

Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Drafty Folding Stairway

The article on installing a folding stairway ("Homeowners' Clinic," page 121, Feb. '88) encouraged me to write about a problem I have with my folding stairway. My furnace thermostat and return duct for the furnace and air conditioner are located in the same hallway as the stairway. In the winter, a cold draft comes down through the cracks around the stairway and causes the furnace to come on even though the rest of the house is warm. In the summer, the reverse is true.

DICK LEURIG
ARLINGTON, TX

An easy and effective solution is to construct a rigid insulation cover for the stairway. In addition to reducing the draft, the cover will reduce the heat loss through that area.

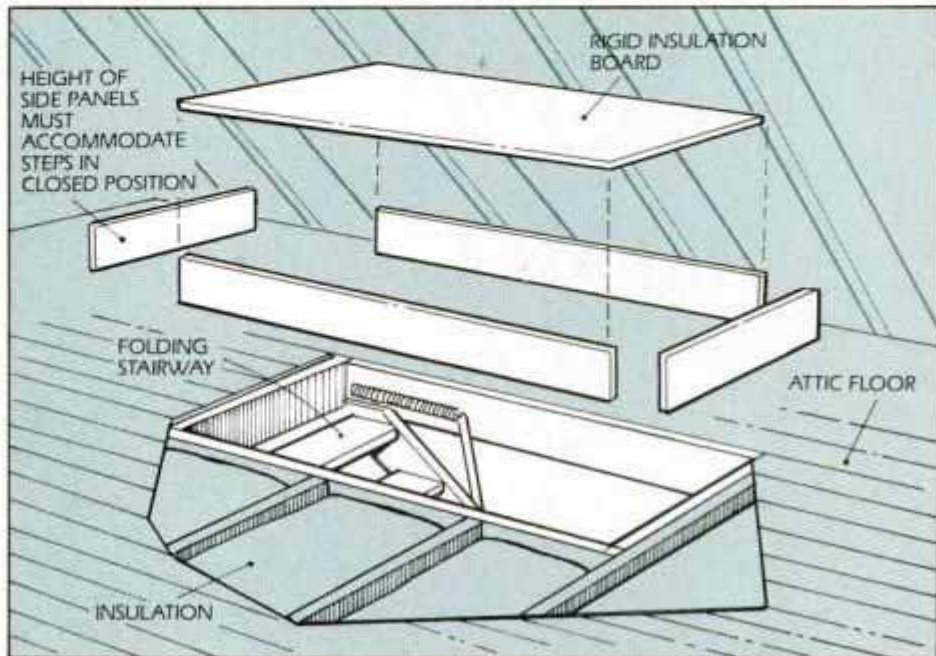
The problem that you describe is quite common. I've inspected thousands of homes with folding stairways used for attic access and over 95 percent of them did not have insulation over the stairway opening.

You can use an easily available rigid foam-insulation board, such as Styrofoam, to construct your insulation cover. The top of the cover should be large enough to overlap the perimeter of the stairway opening by a couple of inches. The sides must be deep enough to accommodate the folding stairway in its closed position. Once the top and four sides are cut to size, they can be attached to one another with an adhesive.

One such adhesive, generally available in cartridge form, is PL300 Foam Board Adhesive, manufactured by Contech Brands, a division of Rexnord Chemical Products, Inc. The solvent in some adhesives will react with Styrofoam. Be sure that the product you buy is compatible with the material you're gluing.

A 1-in.-thick Styrofoam board has a thermal resistance (R-factor) of about 5. If you'd like greater thermal resistance, then either double up on the Styrofoam or insulate the cover with Fiberglas batts.

Since the cover will only weigh a few pounds, it can easily be moved around when you use the stairway.



Heat loss and drafts through a folding-stairway opening can be greatly reduced by using a cover made from rigid insulation board. Use an appropriate adhesive to assemble panels.

Replacing Window Tracks

The plastic inside tracks of our double-hung windows have begun to crack and break. The windows are very difficult to raise and lower and there are drafts coming in through the broken tracks. Can you tell us how to fix the windows ourselves or who manufactures replacement tracks?

STEVEN HALL
ARLINGTON HEIGHTS, IL

You can replace the plastic inside tracks with metal pressure channels. These are generally available at hardware stores and home centers. They usually have spring-action strips on both side joints to hold the window snugly and eliminate drafts. Some window-channel kits feature adhesive-tape weatherstripping to further reduce cold-air infiltration. This is installed where the upper rail of the bottom sash and the lower rail of the top sash meet.

One brand of easy-to-install channels is Window Fixer Pak which is made by the Quaker City Manufacturing Co., 701 Chester Pike, Sharon Hill, PA 19079. The cost is about \$17 to \$23 per set depending on the window dimensions.

Spots On Ceiling

The painted ceiling in my bathroom has developed brown spots. I know that the spots are not caused by a water leak from the room above and they are not caused by mildew. Do you know what they are?

JEFF PAZONA
SUFFERN, NY

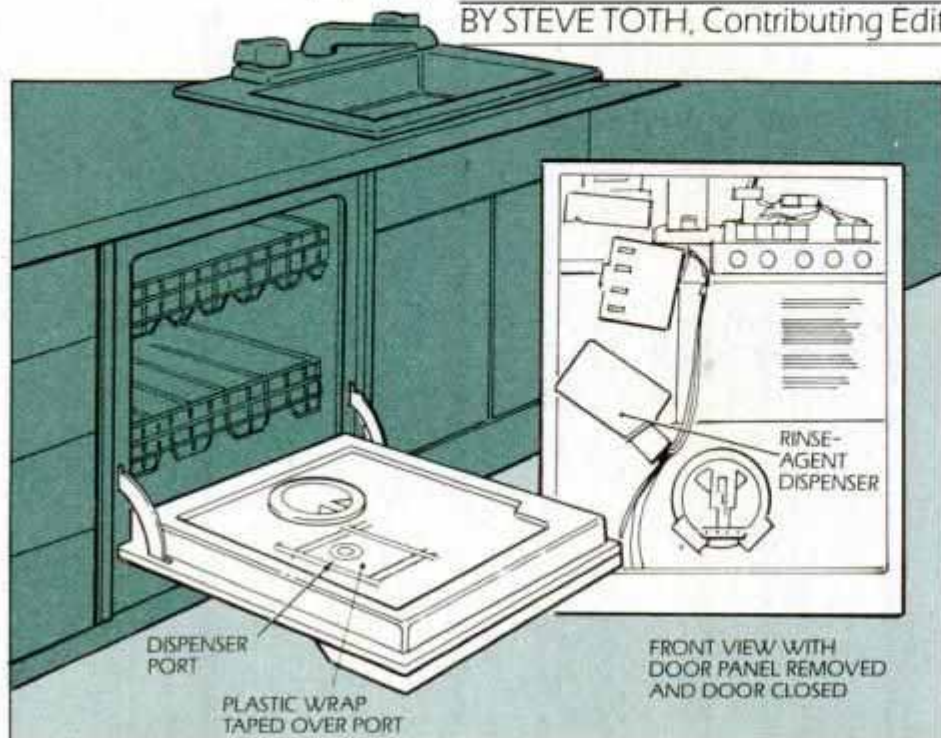
Latex paint contains a number of components, many of which are water soluble. When a surface coated with latex paint is exposed to very high humidity, the water-soluble components in the paint tend to leach out and appear as brown spots. These can usually be removed by scrubbing them with a water-dampened sponge. You don't need an abrasive cleaner. It may take a couple of applications with the sponge but, once the spots are removed, they shouldn't come back.

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



To check a rinse-agent dispenser, tape plastic wrap over the port to collect the rinse agent. If none is being dispensed, remove the outer door panel and replace the dispenser.

Not Dispensing

I have a KitchenAid dishwasher model No. KDS18, serial No. 230391741 (Superba). The automatic rinse-agent dispenser stays full and will not dispense. How can I repair or replace this part?

ALLEN E. WILSON
MARINA DEL REY, CA

The rinse-agent dispenser is only activated for a short time during the last rinse cycle and only dispenses about $\frac{1}{8}$ -tsp. of fluid at that time.

To check the dispenser, first dry the area around the dispenser port and tape a piece of clear-plastic wrap over the outlet.

Now, close the door and latch it. Press the CANCEL button and let the dishwasher advance to the rinse cycle. As soon as the RINSE light comes on, stop the machine by unlatching the door. Then relatch the door and press the NORMAL CYCLE button. Let the machine run through the rinse cycles. The moment the DRY light comes on, open the door and inspect the plastic wrap. If you see a small amount of rinse agent under the plastic, then the dispenser is operating properly. If not, you'll have to replace it.

To remove the dispenser, unplug the dishwasher. Remove the two screws on each side of the inside of the door and slip off the outer door panel. Remove the two wires from the dispenser solenoid and remove the ground wire. Unscrew the dispenser securing nuts and remove.

The replacement unit is part No. 4160649 and it can be purchased at any authorized KitchenAid parts distributor for about \$35.

Doesn't Heat Properly

I recently moved into a house with a lovely O'Keefe and Merritt oven. Most of the time, however, the oven doesn't heat properly. The factory repairman told me that the oven needs a sensor unit which is no longer manufactured. Can a substitute be used? My oven is model No. N-22, serial No. D11313 and the part number for the sensing unit is 355T202S01.

GWEN DUNAVANT
LAKE ELSINORE, CA

You can keep your vintage range working by substituting a 2-wire sensor. The new unit will allow you to use your oven and broiler, but you won't be able to use the AUTOMATIC ROAST control and the KEEP WARM

temperature-holding feature of the oven. The 2-wire sensor is part No. 355T202S02 and costs about \$70. To locate the nearest O'Keefe and Merritt parts distributor, call the Tappan Co., at (800) 537-5530.

To replace the sensor, first disconnect the power to the range. Open the oven door and remove the racks. Then, remove the single screw that holds the sensor to the top of the oven cavity. Pull the sensor down slightly. You'll see two white, and two yellow wires attached to it. Next, remove the control panel and tip it forward. On the back of the control panel you'll see the two white wires connected to terminals marked S on the oven thermostat. Disconnect these wires. Follow the two yellow wires to their contact points and disconnect them or cut them and tape the ends. The yellow wires will no longer be used.

Tie a length of string to the ends of the four wires and slowly pull the sensor unit from the oven until you see the string. Disconnect the string and tie it to the ends of the two wires on the new sensor. Go back to the control panel and gently pull the string and wires through. Attach the two wires to the terminals marked S on the thermostat and reassemble the control panel. Attach the sensor to the oven, reconnect the power and try out the oven.

Needs Needles

Do you know where I can find needles (part No. CC1221) for my 33-year-old Westinghouse sewing machine? I've been having needles cut to fit, but they don't work that well.

EVELYN M'GEHEE
SULPHUR, OK

Needles for your vintage sewing machine are available from the Tacony Corp. This company is a wholesale sewing-machine parts distributor. To get the needles, ask any sewing-machine repair center in your area to order them from Tacony Corp., 1760 Gilsinn Ln., Fenton, MO 63026. **PM**

If you have a problem with any appliance, send your question, with the model and serial numbers to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

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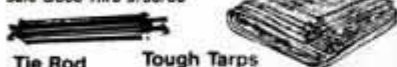
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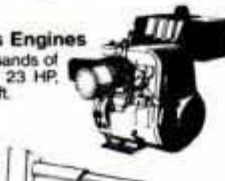
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Firsthand Drive Report

Pontiac STE AWD

BY TONY SWAN, Automotive Editor

AT FIRST GLANCE, GM's first venture into the realm of full-time 4-wheel-drive passenger cars seems curious. Why make the massive investment entailed in a 4wd option for a vehicle that's slated for a 1988 production run of about 2000 units?

In an organization that makes a religion of economies of scale, a 2000-car run is an anomaly.

But that's only the first-glance assessment. A second glance—along with a few questions in the right quarters—reveals that the new Pontiac 6000 All-Wheel Drive STE is actually a sort of production mule for a 4wd system that's going to see wide application in a number of GM car lines.

The system itself is a tidy job that makes maximum use of existing resources. The new rear end, which is decidedly more advanced than the familiar beam axle, employs a modified Chevy S-10 pickup front axle.

The design team retained the STE's standard THM 125 automatic transaxle, but bolted up a new transfer case in place of the regular front-drive differential.

The revised power delivery system also uses equal-length halfshafts, the traditional cure for torque steer.

There are two planetary gear differentials crammed into the transfer case, one for the front axle and one, with a vacuum-actuated lock, for the center differential.

The rear differential is a straight-forward ring-and-pinion arrangement, although the front-axle final drive ratio is 2.84:1 while the rear is 3.42:1. The disparity is corrected

through intermediate gear sets. Torque split front-to-rear is 59/41. Stirring all these gears and extra weight around called for more muscle, and Pontiac responded by creating a long-stroke 3.1-liter version of GM's corporate 2.8-liter V6. Another element of the STE All-Wheel Drive (AWD) powerteam that's going to see wide application, the 3.1 makes 138 hp at 3600 rpm and 183 lb.-ft. of torque at 4800, versus 125 hp and 160 lb.-ft. for the regular STE.

The extra muscle is clearly needed, and there's no danger of it being too much. At 3397 pounds, the STE AWD is 296 pounds heavier than the 2wd STE, and acceleration is far from nose-flattening.

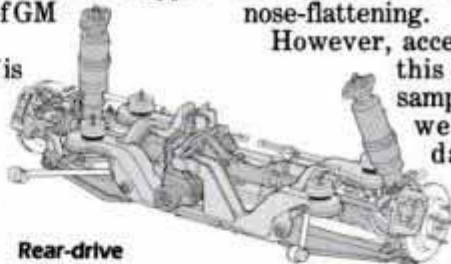
However, acceleration isn't what this car is all about. To sample what it is about, we spent a couple of days last winter sloshing around on snow-covered highways near Mount Rainier in Washington state—4-wheel-drive country made to order.

And we emerged impressed. Although the 4wd STE will exhibit mulish understeer when it's pushed hard in sloppy going, it's tidier than the front-drive version. More important, big mistakes are hard to make.

This impression also extends to dry-pavement performance, although this requires substantially higher speeds. Don't confuse 4-wheel drive with increased adhesion—that's not the benefit.

But in terms of balanced power delivery and improved weight distribution, the 4wd STE does its job double in spades—all for a mere \$22,000.

Now when do you suppose we'll see the turbo version?



Rear-drive unit employs ring-and-pinion from S-10 Blazer 4wd front axle. Independent-suspension components are unique.

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Mazda 626 4ws

Picture this—you sit down in the car and close the door. You twist the key and the engine springs into life. Immediately, the passive seatbelt mount whirs from the corner of the windshield and over behind your shoulder.

At the same time, the antenna automatically slides out of the driver-side A-pillar. In about 2 seconds, the hydraulic system gets up to pressure, and the rear wheels steer themselves away from the curb, rocking the car slightly.

It's a busy little beast, alright, as it rouses itself almost without human intervention. We call it Robocar.

The 4-wheel-steering system, with its microprocessor and speed sensor, steers the rear wheels in the same di-

rection as the fronts (but just a couple of degrees) at speeds above 22 mph. This supposedly enhances high-speed handling by making the back end of the car steer immediately, rather than after the front wheels have made the car yaw into the turn. At lower speeds, they steer in the opposite direction to reduce the turning radius.

Does it work? Well, the 626 does have excellent high-speed road manners, and the 12-valve turbo motor encourages the kind of rapid pace that places a premium on that sort of behavior. Even with the auto trans mandated by the 4ws option, here's one innocuous little box that will thoroughly embarrass big American iron out on the interstate.

Steering the rear wheels in the opposite direction makes the back end of the car go left before it goes right—into an adjacent wall if you're too close. Our 626 has acquired several scrapes from Manhattan's inescapable valet parking, where the attendants haven't heard about 4ws yet.

We've put almost 6000 miles on our 626 already. Mileage has varied from 17 mpg in heavy urban traffic, to 25 on long trips with the cruise control set.

The car was delivered to us in Jacksonville, Florida, and it had a subtle but persistent pull to the left, most annoying on a long drive. Repeated trips to Mazda's 4ws alignment wizard ultimately resulted in the front tires being replaced, which cured the problem.

Our only mechanical trouble came late one night, as a cloud of steam followed me into the driveway. The cold light of dawn revealed that a small water line had worked itself loose, with one of those permanently crimped hose clamps dangling from a fitting on the back of the intake mani-

(Please turn to page 120)



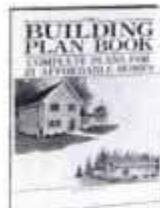
Mazda 626 Turbo with 4-wheel steering (top) is quick and handy for parking. Our Buick Regal (above) has had several minor problems, but rates positive with drivers.

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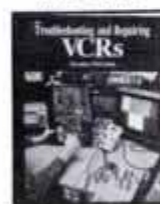
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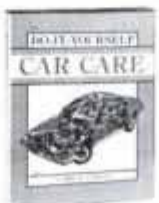
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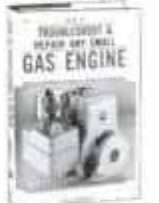
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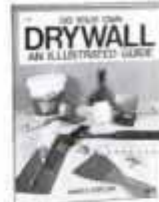
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LONG-TERM TEST

(Continued from page 118)



Ford's tiny Festiva thrives on diet of Manhattan traffic and is getting 34.3 mpg.

fold. Easy enough for a Saturday mechanic to fix—except it took us 30 minutes to wrestle it back together with a new hose clamp. Crowded in there.

Our 626 4ws (the 4ws package includes the cast-alloy wheels, automatic transmission and more) delivered for \$18,789.—Mike Allen

Buick Regal Custom

I flew into Detroit to pick up our Regal with its \$16,125 sticker on the window. With only 46 miles on the odo, I knew that it hadn't been given the official prep that long-term-test cars are sometimes given. We prefer to do it that way, rather than accept a car that has been lovingly broken in and debugged by proving ground staff.

So, I looked at the 700-mile drive back to New York with some trepidation when I noticed that the coolant temp gauge didn't move off the peg as I headed toward Toledo, and the semiarid plains of central Ohio. But the engine ran smoothly. I took out my trusty bent paper clip and used it to interrogate the engine computer, which revealed no faults. The trip was uneventful and the Buick a joy to drive. Later I traced the gauge problem to a connector in the engine compartment that hadn't been installed.

The Regal has given 22 mpg in commuting, touching 25 on trips, especially after 1500 miles of engine break-in. It went back to the dealer for a broken hood release, and aside from a single mysterious, unrepeatable instance of flat-battery syndrome, our only problem during the first part of the get-acquainted period was the right-side remote-control mirror that wouldn't

adjust properly. We won't count the nail in the tire as Buick's fault, although we did have some difficulty finding a replacement Goodyear GT+4 in the correct size.

Buick's passive-restraint system is eminently more practical than the Mazda's. The lap and shoulder belts attach to the door—if you want to use the passive system, just open and close the door and the belts will fall into place naturally (if the door flies open in an accident, though, you could be thrown out). Or, you can just unbuckle the belt in the center like a conventional pillar-mounted active system, which is our preference.

The 3.8-liter V6 has adequate acceleration, but the 4-speed automatic transmission will hunt considerably in traffic. I usually use the gear-sector position that locks out the overdrive any place but on the open road.

The fuel gauge switches to a different display at the ¼-full point. Unfortunately, the owner's manual is impenetrably vague about this, as we have the optional digi-analog instrument panel. On the display, it looks like you've run out of gas, but we've never needed more than 10 gallons to fill up the 16-gallon tank, even after the low-fuel light has come on.

Just as we go to press, Bill Hartford, PM's managing editor, reports that the Buick stranded him on New York's Brooklyn-Queens Expressway, quitting suddenly in traffic. Help should have been just a tow-truck ride away, but the dealer reports that replacement parts for a bad coil assembly should be in "real soon now." Stay tuned.—Mike Allen

Ford Festiva LX

Unlike many of Ford's recent new cars, the Festiva is neither innovative nor visually distinctive. Though Ford has managed to give it a front-end look that's consistent with the rest of the family, it's hard to pack a lot of character into a 140.5-in. package.

However, even though the Festiva is low on flash, it's high on function—particularly when that function is assessed in one of the world's more hostile automotive environments. New York City sorts out a car's soft points as though it has a blueprint, leaving the weak to be stripped by the car vultures who lurk everywhere, round-the-clock.

In the four months since it joined our long-term test stable, our Festiva LX has not only measured up to the daily challenge of Manhattan, it seems to have thrived. It's quick enough to hold its own in the taxicab wars, roomy enough to accommodate two king-size adults (rear seating requires a cooperative spirit on the part of all hands), small enough to make use of the tiniest parking remnants, and thrifty enough to turn in excellent fuel economy—34.3 mpg over 4230 miles, almost all of them accumulated in Gotham.

Our test car, a top-of-the-line LX model (5-speed, AM/FM/cassette, cloth upholstery, alloy wheels, full instrumentation, remote mirrors) has held up well against the subdued violence that passes for normal traffic in New York. Although its 12-in. wheels don't really like some of the potholes that pepper Manhattan's streets, and avenues, no squeaks or rattles have shown up so far.

About the only consistent complaint turned in concerning the car has to do with its part-throttle response. Our Festiva is fed by a 2-bbl. carburetor, and this seems to be the culprit in its balky behavior when the throttle is depressed. These hitches and hiccups can be overcome by nailing the throttle hard, but it's an irritating trait nonetheless.

Ford and Korean partner Kia will eliminate this problem entirely when electronic port fuel injection—currently limited to cars equipped with automatic transmissions—comes on-stream across the model line for the 1990 model year.

But even with this irritation, we're impressed—so far—with the character of this 1.3-liter mini from Korea. The quality is solid, the performance is lively, the accommodations better than adequate, and the price—\$8280 as equipped—marginally acceptable. This may not be the ultimate urbocar, but it's a good role model.—*Tony Swan*

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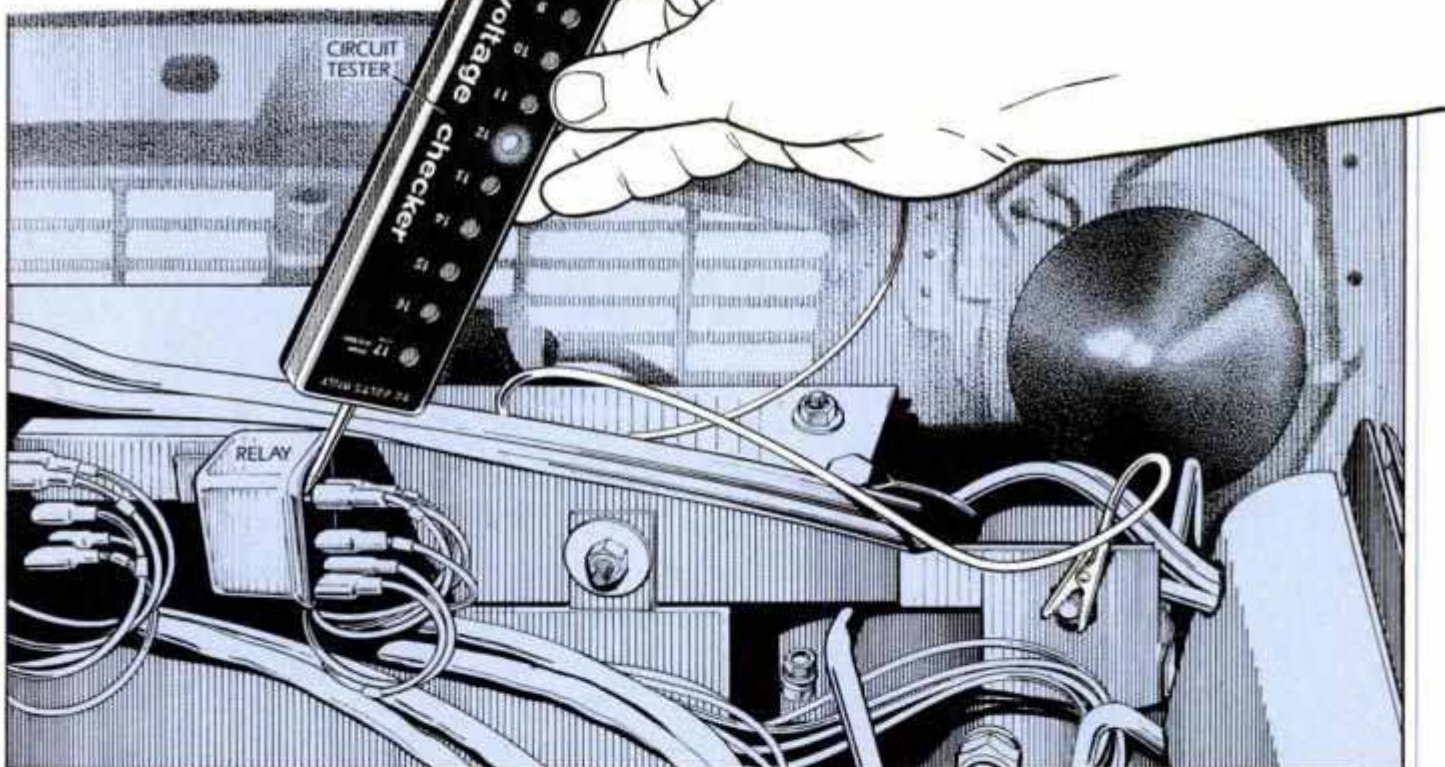
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Troubleshooting ELECTRICAL SYSTEMS

BY MORT SCHULTZ, Contributing Editor

PM Illustrations by Fred Wolff

Chasing electricity around a car's wiring system requires only a few specialized tools. You'll need a voltmeter and a test light, the functions of which are combined in the instrument shown.



ELECTRICITY isn't really much more mysterious than mechanical things. Unfortunately, you can't see the electrons flowing in the same way you can look at some mechanical systems.

An electrical circuit's state of health is inferred from diagnostic instruments, and to perform the diagnosis you have to be able to read a schematic diagram.

Basic terms

The amount of electricity that flows through a conductor or circuit is mea-

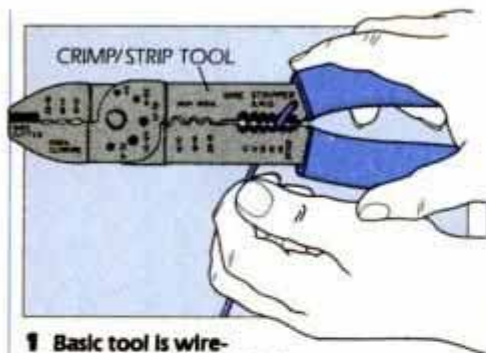
sured in *amperes* or amps. The force pushing it through is measured in *volts*. In an automobile, voltage is supplied by the battery and alternator. Voltage is needed to overcome the resistance of a circuit—the resistance the various conductors exert on the flow of free electrons. Resistance is measured in *ohms*.

Legalese

This brings us to the basic law of electric circuits: Ohm's Law. It says that if a force of 1 volt is required to push 1 ampere of current through a circuit,

the circuit resistance is 1 ohm. An understanding of this relationship between resistance (ohms), force (volts) and current flow (amps) is central to any troubleshooting.

Laws are useful only in the way they're applied, so let's spend a minute demonstrating how Ohm's Law is used in troubleshooting. Basically, it's a way of determining the third property of an electrical measurement when you know the other two. If you know how many amps are flowing and what the resistance is in ohms, you find volts by multiplying the amps



1 Basic tool is wire-cutter/stripper/terminal crimper.

times the ohms: Volts = amps \times ohms. If you know how many volts and at what amperage, you can determine resistance: Ohms = volts \div amperes. For example, a rear-window defroster that draws 10 amps from a 12-volt supply would have a resistance of $\frac{12}{10}$ or 1.2 ohms. If you know the resistance and the voltage, you can find amperage: Amperes = volts \div ohms.

If you think about these relationships, you'll see that they can help you determine why something doesn't work. For example, if voltage at the battery is adequate to run a particular device, but at the accessory itself voltage is inadequate, the resistance in the circuit between the device and source must be too high.

In other words, the voltage drop is excessive. You can measure voltage drop over a part of a circuit by connecting a voltmeter across that part of the circuit. Then, if you know the amperage, you can calculate the resistance.

On the other hand, if you measure resistance and amperage, you can calculate the voltage drop.

Circuits

Applying the conventional theory of electricity to automotive circuits, let's say that current flows from the positive post of the battery through the various wires, switches and electrical components that constitute a circuit to the negative post of the battery. Because a circuit must be complete from the battery's positive to the negative post before current will flow, the common high-voltage components in an automobile electrical system use the conductive chassis and engine block as part of the circuit. This is called a common ground. You could accomplish the same thing by wiring every circuit back to the battery, but you'd have twice as many wires.

The various components in the circuit are turned on and off by the switches, which cut off the flow of current by opening or breaking the circuit. For many accessories, the switch is wired in between the electrical device and the positive side of the battery. On other circuits the switch is between the component and the common ground—the chassis.

But it's not quite that simple: Not every circuit follows a single straight path from positive to negative. Those that do are called series circuits. Electrical devices in a series circuit must all be switched on and working or the other devices in the circuit won't work. And, because there is only one current path, amperage is the same anywhere in the circuit. Voltage at any point in the circuit is dependent on the resistance between that point and the source.

A circuit that provides more than

one path for current is called a parallel circuit.

Because a parallel circuit provides more than one conductor, the total resistance is less than the resistance within a single branch of the circuit.

If you have to determine amperage in a branch (or shunt) of a parallel circuit, you have to consider that branch as though it were a series circuit, since different amounts of current flow in each branch. But because voltage is equal at each branch junction, the source voltage can be divided by the resistance within a branch if you have to determine amperage through the branch.

Many automobile circuits are series/parallel circuits, a type that wires some loads in series and others in parallel. Some automobile lighting circuits—headlight and taillight, for example—are of this type. The switch is wired in series with the battery and each lamp. But the lamps are wired in parallel so that the others will continue to provide illumination if one should fail.

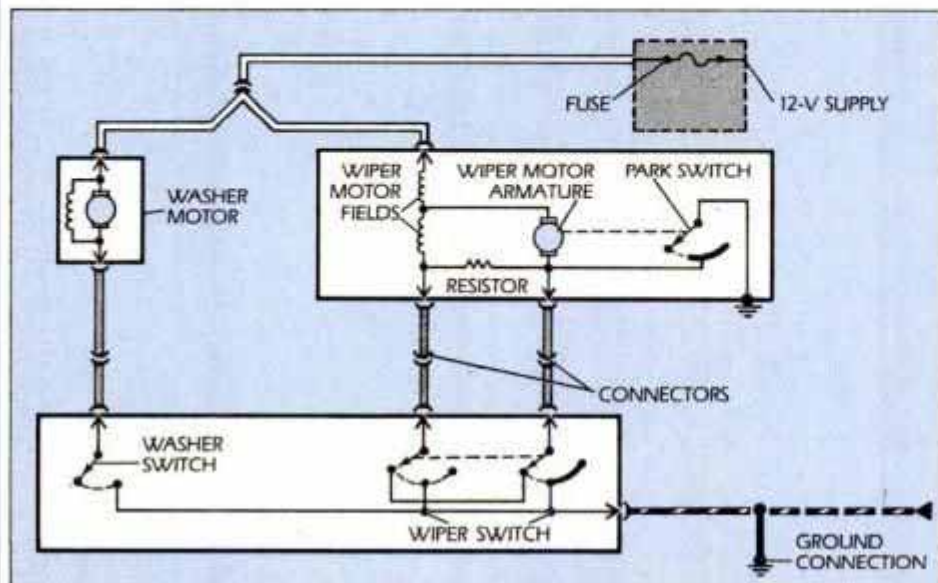
Almost all circuits are fused, either at the fuse box or by means of a fusible link in the wiring. The fuse is there to break the circuit should a short occur, overloading the wires and causing a heat buildup that could lead to a fire. The fuse will melt before this heat buildup occurs, breaking the circuit and shutting off the flow of current.

Troubleshooter tools

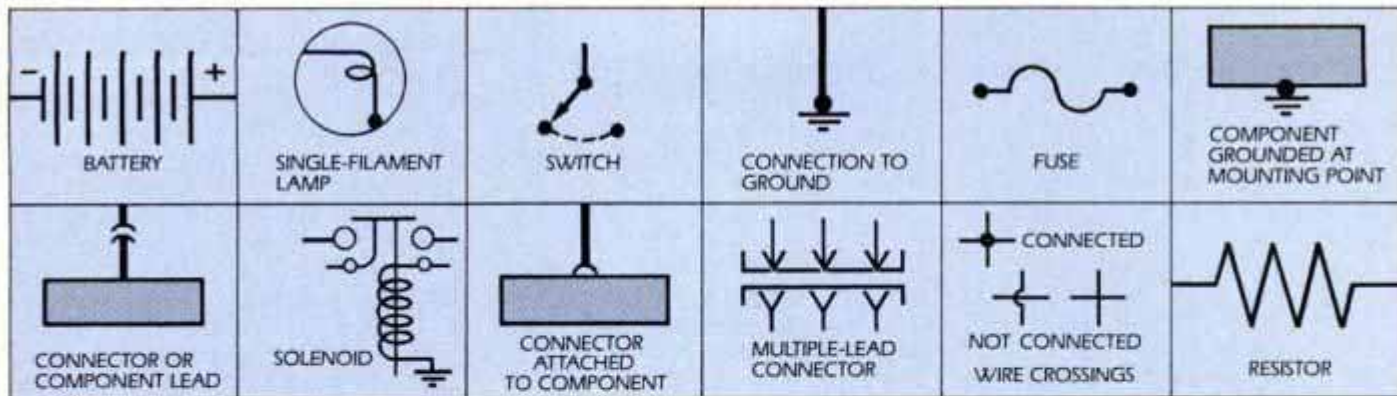
You'll need a few special tools to troubleshoot electrical circuits. Most basic is a test lamp—a 12-volt bulb with two leads that can be connected between common ground and any point in the positive side of the circuit to see if voltage is available. You'll also need a multipurpose electrical test instrument. Our favorite tool of this type is an analog meter that has different switch positions for ohms \times 1, 10, 100 and 1000; volts in a 20-volt scale; a distributor pickup output test range and 1- and 10-amp current scales.

Another nice tool is a voltage checking device that is used like a test light but provides an approximate voltage readout, shown in our lead illustration. You should also have a multipurpose wire stripper/terminal crimper tool (Fig. 1). For wiring repair, you'll need a soldering gun, resin-core solder and electrician's tape or heat-shrink tubing. An assortment of terminal ends is also necessary.

The most important tool is the wiring diagram for the circuit you wish to test. These are found in most service



2 Schematic of headlight washer/wiper circuit shows basic components and wiring.



3 Schematic diagrams use symbols to represent electrical components. Symbol usually, but not always, resembles component physically.

manuals. In some service manuals, you'll find a big foldout diagram for the entire electrical circuit in the back of the book. In most books, these are augmented by more detailed and easy to understand diagrams for individual systems, such as the windshield wiper or headlamp circuits (Fig. 2).

All wiring diagrams use symbols to represent different components and connections within a circuit. Some of the more common symbols are shown in Fig. 3.

Troubleshooting strategies

Armed with your wiring diagrams and your test equipment, you're ready to track down the source of an electrical failure. The first step is to logically analyze the failure. Is there more than one accessory that isn't working? Did smoke or the unmistakable odor of an electrical fire precede the condition?

Now dig out that circuit diagram. If it's a full-car diagram, components and the wiring will probably be arranged in a manner that corresponds to the physical layout of the car, from front to rear.

Study the system diagram and look for possible causes. For example, the very common problem of a fuse that burns out repeatedly might be caused by a short in any of the circuits that share that fuse.

By carefully examining the diagram, you can determine exactly which circuits and components are wired into that fuse.

No voltage

Another common problem is simply a component or components that won't work. If more than one is inoperative, you should begin troubleshooting at the beginning of the circuit that these parts share—the point where the circuit is supplied with power. If only a single part is out, you should start troubleshooting at the part.

In this case, the obvious strategy is to test for voltage supply. In the case of a single component, you would first test for voltage at the point where the circuit connects to the part. To do this, simply attach the positive lead of your voltmeter or test light to the terminal where power is supplied and attach the negative lead to common ground. In the lead illustration, a technician is using a test light that provides a voltage indication.

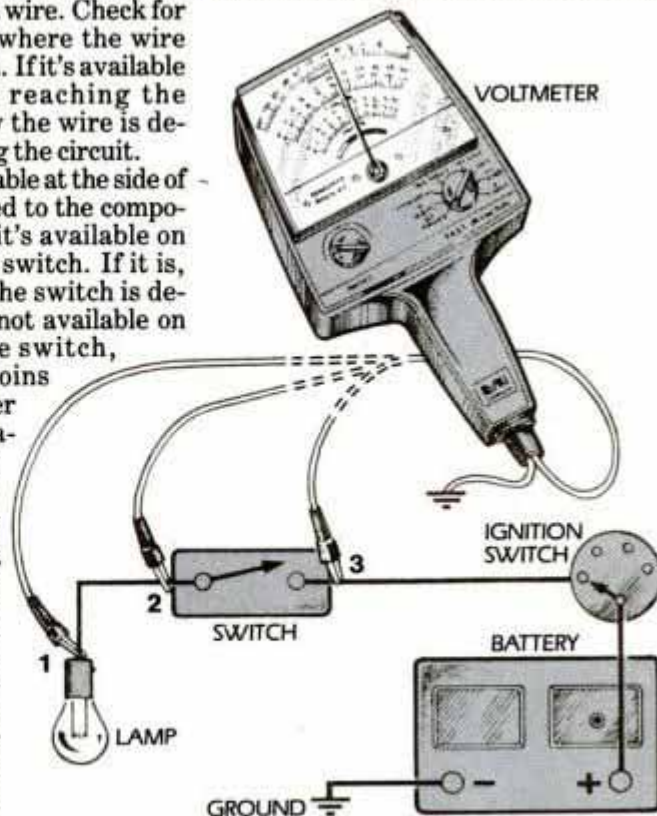
If you find that voltage is available, then you know that the part has failed and that the circuit is okay. On the other hand, if voltage is not available, start working back through the circuit toward the point of power supply (as shown by meter lead positions 1, 2 and 3 in Fig. 4). The part may be joined to a switch by a wire. Check for voltage at the point where the wire connects to the switch. If it's available there—but wasn't reaching the part—then you know the wire is defective and is breaking the circuit.

If voltage isn't available at the side of the switch that's wired to the component, check to see if it's available on the other side of the switch. If it is, then you know that the switch is defective. If voltage is not available on the input side of the switch, trace the wire that joins the switch to its power supply. You'll probably need the circuit diagram for this, as the wire may disappear into a loom. (A loom is a group of wires wrapped with tape or sleeved in plastic.) But by combining the information in the diagram with the color coding of the wire, you should be able to find its other end. If voltage is available at the

other end of the wire, then you know that it's defective. If it's not, continue checking back through the circuit toward the battery.

Insufficient voltage

If the voltage is present at a particular component, but is lower than the amount needed, then high resistance in the circuit is causing a voltage drop. The high resistance that causes voltage drop is usually the result of corrosion, a damaged wire, a bad part or a loose connection. You can locate the point of high resistance with your voltmeter/ohmmeter. If the voltage drop across one terminal is much higher than across a similar terminal, then you can surmise that either corrosion or a bad connection is causing



4 Check progressively closer to power supply (l. to r., above).

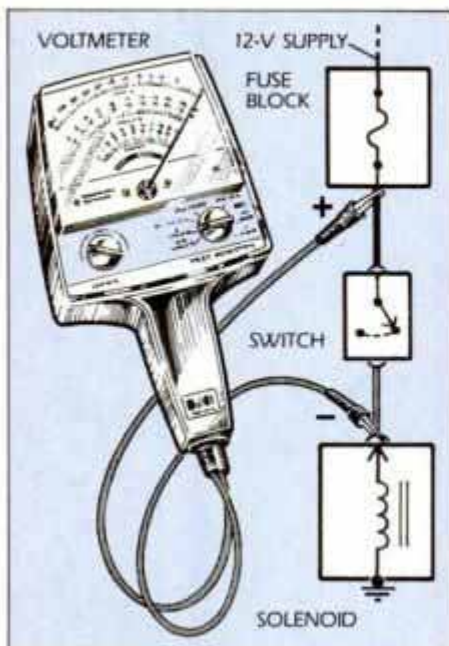
high resistance. In general, voltage drop across a wire, connection or switch should not exceed 1 volt. Your service manual provides specific voltage-drop figures for some circuits.

To measure voltage drop across part of a circuit, connect the positive lead of your voltmeter on the side of the circuit section closest to the battery positive terminal and connect the negative lead on the side of the circuit section that is nearest to ground (Fig. 5). The voltmeter will then show the voltage drop across the part. A good switch or connection should show virtually no voltage drop.

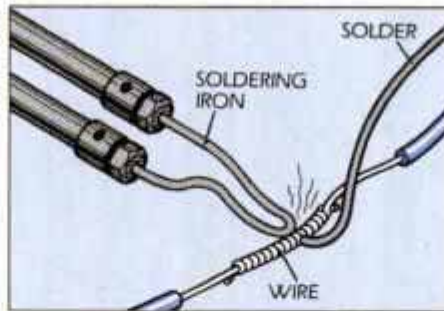
Help from your maker

When troubleshooting more complicated circuits, such as a/c controls or even windshield wipers, be sure to check your service manual for hints. If the job goes beyond what most technicians can figure out based on common sense and a knowledge of electricity, the book will probably provide some help.

To cite one example, our 1985 Chevette manual includes a section in the back that discusses the troubleshooting of various systems in detail. The directions are accompanied by a circuit diagram. A subheading "Troubleshooting Hints" provides specific strategies. For example, on the windshield wiper page, the Chevette manual tells you that if the wipers operate only in the low-speed position, check for an open circuit in the gray wire. If the wire is okay, you're to check the WIPER-WASHER switch. Similar in-



5 Use voltmeter to meter across suspect component for voltage drop, not to ground.



6 Soldering wire splices is the only fool-proof way to prevent corrosion.

structions tell you what to do if the wipers won't go on, if they operate at high speed only, if they won't shut off, if they won't park at the base of the windshield, and if the washer pump doesn't run. The wiring diagram shown in Fig. 2 is for the 1985 Chevette windshield-wiper circuit.

Simple repair techniques

Once you've pinpointed the source of an electrical problem, you may have to make some basic repairs other than simple replacement of parts. In most cases, these involve splicing in a new section of wire, attaching a terminal or insulating a wire.

Insulating a wire that is shorting to ground but is otherwise undamaged is the easiest of these three. You simply wrap it tightly and completely in electrician's tape. But there's a neater, more professional way to accomplish the same thing: heat-shrink tubing, available at most auto parts stores. You simply slide the tubing over the wire, position it at the point where insulation is needed, and heat it with a match. The tubing will shrink tightly around the wire, providing a nice, permanent repair.

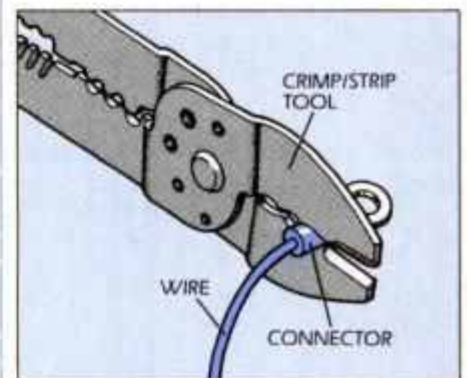
When replacing a wire or section of wire, use a same-size piece of wire as the original, or a bit larger.

The splicing of wires is a job that must be done right. Don't simply twist the two ends together and wrap with tape. This incomplete connection can cause a buildup of resistance and loss of voltage.

To properly splice the multistrand wire used in most automotive circuits, strip an inch of insulation from each wire end. Check the stripped wire for nicks or other damage and restrip if necessary. If you're going to use heat-shrink tubing to insulate the finished splice, slip a piece over one of the wire ends. Then braid the bare wire strands together and twist the wire tight. Position the broad tip of your hot soldering gun on the wire strands and touch the resin core solder to the

top of the bare strands—not to the soldering iron (Fig. 6). When the wire is hot enough to melt the solder, it will flow into the strands. Apply just enough to fill the area between the strands, don't pile it on. Insulate the spliced area completely with electrician's tape or heat-shrink tubing. Remember that a splice must be at least 1½ in. away from any other splice, harness branch or terminal.

If a simple blade or eyelet wire terminal must be replaced, make sure the new one is of the correct size for the wire gauge. Most terminals are designed to fit a narrow range of sizes. Strip only enough insulation from the wire to fit into the terminal sleeve. Insert the wire and use a crimping tool to squeeze the sleeve (Fig. 7). There are two types of crimping tools. One type is for insulated terminals, the other is for non-insulated. Our multipurpose wire stripper tool includes both.



7 Install new connectors onto wires with the correctly sized dies on your crimper.

GM aluminum wiring

To apply terminals or splice the aluminum cable used in the front-body wiring harness of most late-model GM cars, purchase the special repair kit available from your GM dealer parts department (Chevrolet part number 1684873-GR.2.530-Kit-Alum-Wire Terminal Repair).

This kit contains special metal sleeves for splicing, a tube of petroleum jelly, 14-gauge leads with terminals and 16-gauge leads with terminals. Splices are accomplished by crimping the sleeve-type connector to each end of the wire with 10-in. slip-joint pliers. Don't attempt to solder this wire. After joining the wire ends, the splice (and, if applicable, the terminal's crimp area) must be coated with the petroleum jelly. Electrician's tape should then be applied over the splice clip and petroleum jelly. The terminal crimp is insulated by its connector body.

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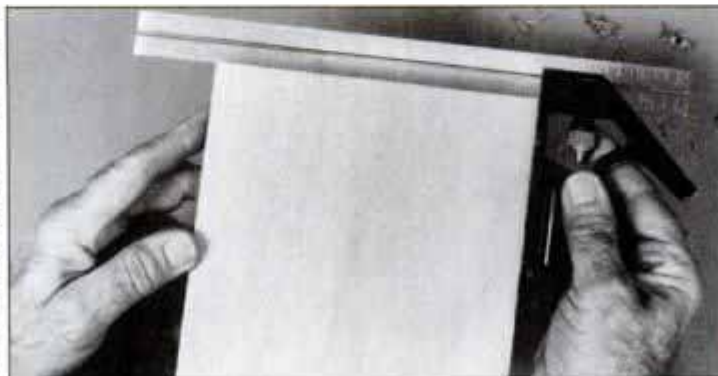
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Combination Square Know-How

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor

NO TOOLBOX or workshop is complete without a combination square. This requisite tool is most often used to mark and check square (90°) and 45° angles. However, the versatile combination square can also be used as a marking gauge, depth gauge, level and straightedge rule. Most squares also come with a miniature scratch awl, called a scribe, housed in the handle. Use the scribe as a fine-line marker and to pinpoint exact positions. A small level vial, used to determine level (horizontal) and plumb (ver-

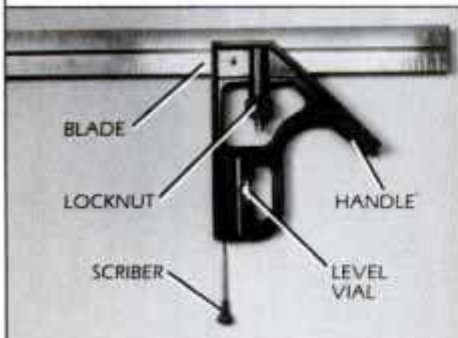


A combination square can be used like a try square to check the end of a board for squareness. Hold the handle against board's edge.

tical) alignment, is also housed in the handle. A typical combination square consists of a handle, or head, and a 12-in.-long steel blade, or rule. The han-

dle slides along the blade and can be locked by tightening the locknut. The handle has two working edges—90° and 45°—that are used in conjunction with the blade. On most squares, the blade can be removed and used as a ruler or straightedge.

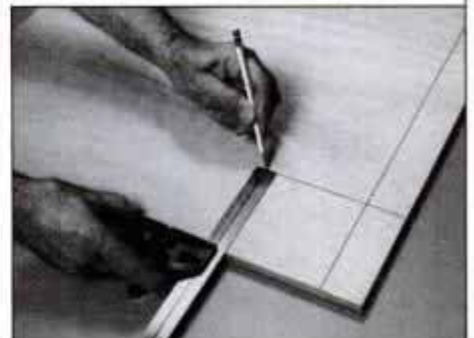
Another common technique is to use the square as a marking gauge. Lock the handle in place at the desired distance from the end of the blade. Then, slide the handle along the edge of the board while holding a sharpened pencil point against the blade's end. **PM**



Here's a typical combination square. Use it as a try square, miter square, marking gauge, depth gauge, level and straightedge rule.



To mark 45° angles, hold the angled surface of the handle against the board's edge. Use this method to check miter and bevel cuts.



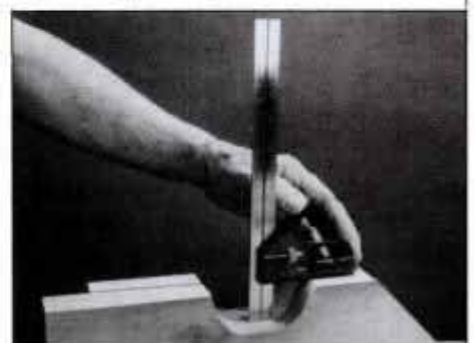
To mark a line parallel to the board's edge, slide the square down the board while holding a sharp pencil against the blade's end.



Use a combination square to check for square inside corners. Lock the blade so that its end is flush with the edge of the handle.



On most combination squares, blade can be removed from handle for use as a straight-edge rule. Use the scribe as a scratch awl.



Adjustable blade allows the square to be used as a depth gauge. Slide blade down, tighten the locknut and read the blade.

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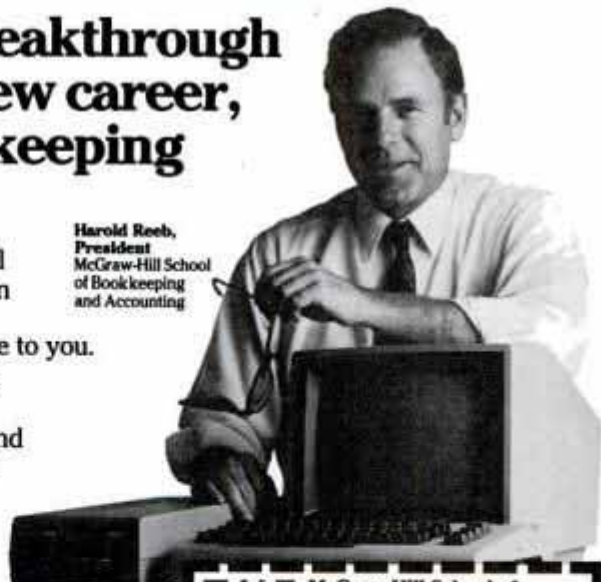
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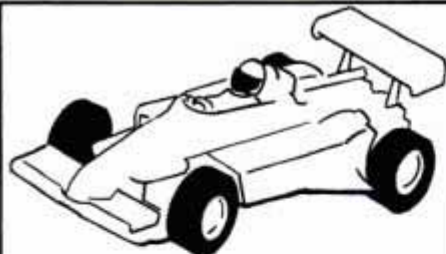
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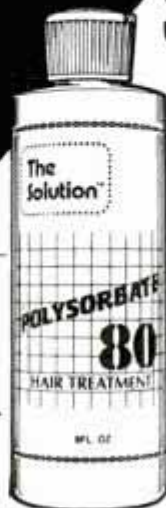
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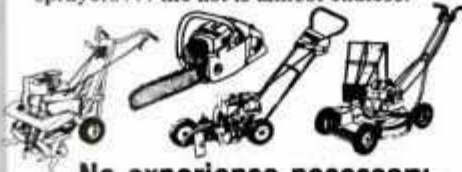
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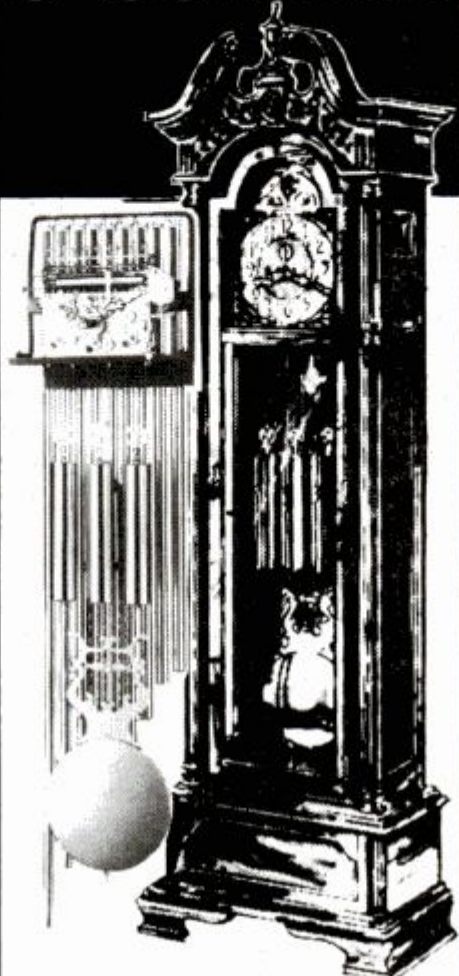
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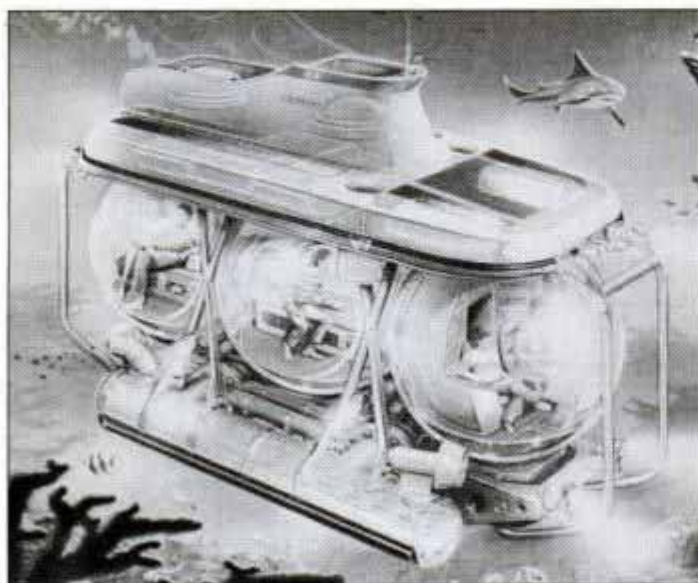
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