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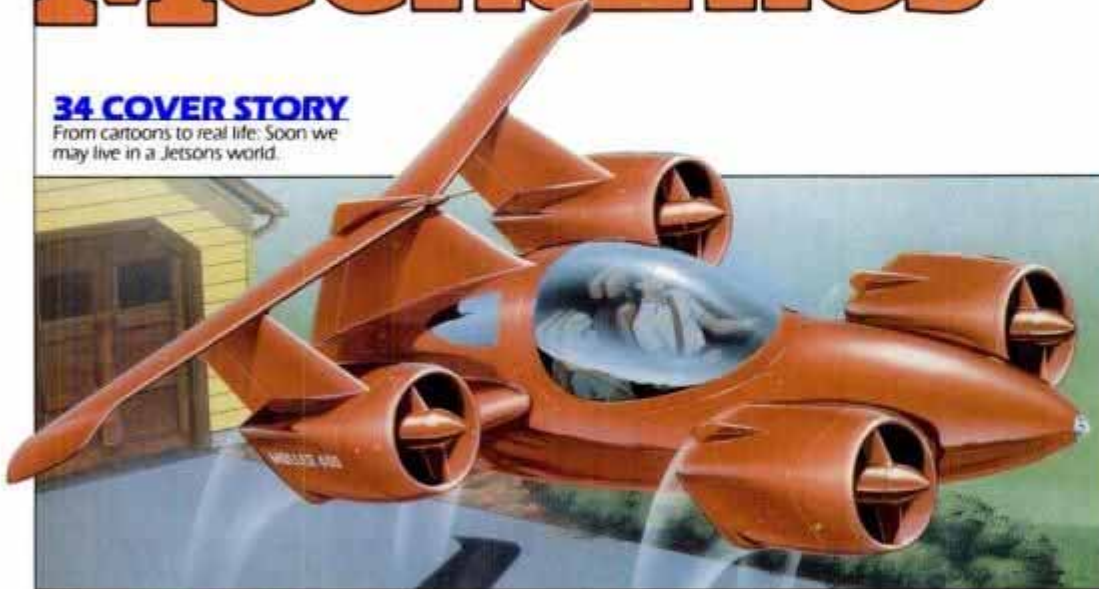
Buckle up for safety! © Plymouth/Chrysler Motors, 1990

Popular Mechanics®

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VOLUME 168
NO. 1

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—PM cover illustration by Mark McCandlish



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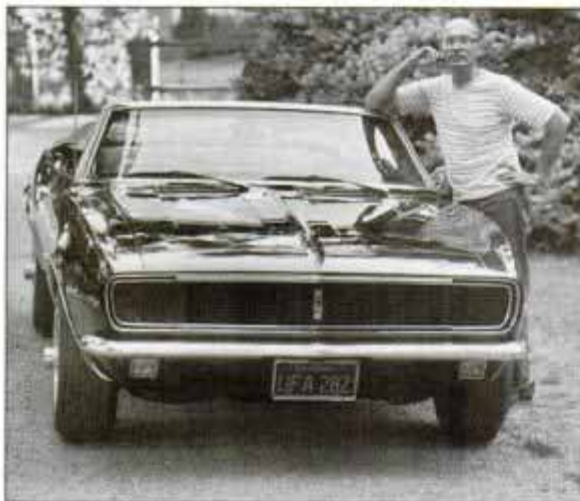
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EDITOR'S NOTES

● This month, we're very proud to announce the winners of our 1991 Design & Engineering Awards. You'll remember that we announced the awards program last March and asked for nominations from you, from industry and from anyone who wanted to nominate a new product or a good idea. *USA Today* ran a piece on our awards, and we subsequently received hundreds of nominations, ranging from new shop tools to the F-117A Stealth Fighter. Our own editors also made nominations. Out of all these nominations, we narrowed down the list to our final list of winners, which you'll find starting on page 23. This is going to be an annual event for us, and we'll call for new 1992 awards nominations in the March issue. I hope you'll participate in our awards program for next year. . . . It's almost impossible to believe, but facts are facts. This issue marks the 40th year that we've been printing Owners Reports. The concept was simple. If you want to know how good a car is, how it's holding up in daily use, and what's breaking and not breaking, ask



Contributing Editor Lamm and his 1967 Camaro convertible.

someone who owns one. That's what former PM Auto Editor Floyd Clymer did 40 years ago this month. He asked owners of the '50 Nash Rambler how they liked their car. The owners told him, and we printed the results. The cars are different today and the editors are different, but the results are just about the same—owners of particular cars telling you, the readers of POPULAR MECHANICS, how they like them. Today, Contributing Editor Mike Lamm compiles our Owners Reports, so we asked him to go back through all 40 years to come up with the highlights and lowlights, cars that were the best and worst. His report is on page 42. I think you'll enjoy it. . . . It has been a part of the American Dream for decades. Not only a chicken in every pot, but also a helicopter in every garage. Why waste time in traffic jams commuting to work by car when you can whisk over the traffic in your own personal helicopter? Up to now, that concept just wasn't practical for anyone who wasn't a millionaire. In reality, it still isn't. But with the Moller 400, it's getting closer, as we explain in this month's cover story which starts on page 34. The Moller 400 is part car, part helicopter, part hovercraft, and it's so simple to fly that just about anyone can do it—if you can afford the price of admission. Right now, that's about \$100,000. Not cheap, and not everyone can have one in their garage for this amount. But it's a step closer to realizing the dream. Till next time.

ask someone who owns one. That's what former PM Auto Editor Floyd Clymer did 40 years ago this month. He asked owners of the '50 Nash Rambler how they liked their car. The owners told him, and we printed the results. The cars are different today and the editors are different, but the results are just about the same—owners of particular cars telling you, the readers of POPULAR MECHANICS, how they like them. Today, Contributing Editor Mike


Joe Oldham

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Editorial Offices

224 West 57 St.,
New York, NY 10019

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Imagine yourself behind the wheel of a spirited open roadster as you cruise down your favorite twisty road. The sports car at your command is especially exciting because it's one you built yourself!

"I've had 5 Austin-Healey's, 2 Triumphs and 1 Corvette, none of which is anything close to my Classic Roadster. It was fun to build, but driving it is . . . awesome!"

— D. Fry, Maryland



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Steven Willson, editor (212) 265-7538
Tom Klenck, assoc. editor (212) 265-7570
Roy Berendsohn, asst. editor (212) 265-7572
 (building, home remodeling, shop design, tools, furniture making and design)

BOATING/OUTDOORS

Joe Skorupa, editor (212) 265-7596

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SCIENCE/TECHNOLOGY

Abe Dane, editor (212) 265-7740

ELECTRONICS/PHOTOGRAPHY

Frank Vizard, editor (212) 265-7581

GENERAL

Joe Oldham, editor-in-chief (212) 265-7503
Deborah Frank, managing editor (212) 265-7518

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ADVERTISING OFFICES

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Production Manager Carole L. Hartman
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 (212) 649-3164

READER SERVICE DEPARTMENT

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 (212) 649-3127

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606-342

LETTERS

Fueling America's Wants

Your recent issue featuring all of the latest technical achievements from Detroit certainly hit the jackpot for ironical timing. Your magazine comes out talking primarily about the new 200-horsepower engine from Detroit without a word regarding its fuel economy. The next week, we're on the verge of another energy crisis because of the Middle East situation. Why does the average person need a car that will go from 0-to-60 mph in 7 seconds? When will Americans learn to look beyond the day after tomorrow? Europeans are currently paying \$4 or more per gallon of gasoline. Maybe the best solution to resolve our federal deficit would be to slap on a buck or two in federal tax on gasoline and see what that does to driving habits and the direction of Detroit's technical efforts.

JAMES D. BUSHNELL
BERKELEY HEIGHTS, NJ

If you want to hit the panic button, that's up to you. If you want to drive a Yugo that gets 50 miles per gallon, that's up to you. The fact is, no one "needs" anything more than a box with a seat and an engine in it to get from point A to point B. However, I don't see too many of those around. Why? Because Americans don't want minimal transportation. America is about choice. And we, as Americans, choose to drive around in more than minimal transportation. By the way, in Europe, where gas is \$4 a gallon, they design and build Ferraris, Lamborghinis, Mercedes-Benz 500SLs and BMW 850i coupes, and all have more than 300 hp.

Highway Patrol

I was pleased that no self-righteous conclusions were



drawn about the use of radar detectors in your recent article. *Popular Science's* recent sanctimoniously written article about photo radar and similar Big Brother devices disgusted me so much that I didn't even bother to argue.

None of this detector nonsense would be necessary if the speed limits were realistic. Our uniformed policemen are misused as tax collectors. Speed limits are deliberately set low for tax-revenue opportunities. Go anywhere in the country and you will realize that, almost always, posted speed limits are 10 to 15 miles below the normal traffic speed, thus making us a nation of motoring criminals. The alternative, of course, is a tax increase elsewhere, such as property taxes. Misuse of the police results in public fear of policemen. They should be a normal and welcome part of our lawful society.

BARRY SYRETT
RANCHO PALOS VERDES, CA

Beautiful Bird

Wow! I about jumped out of my chair when I saw your "Shooting Star" article. I was one of the few workers who handbuilt the first XP-80 and am proud to have been a part of Lockheed's old Skunk Works. The XP-80

was one of the most beautiful planes ever built.

ART ROSSITER
DES MOINES, IA

"Shooting Star" is a great article about a beautiful airplane. As a high-school junior in the summer of 1945, I worked at WPAFB in Hangar No. 7 at Wright Field. This hangar is where they kept all the special planes—Japanese Zeros, German Messerschmitts and several experimental craft. We had the Northrop "Black Widow" twin-boomed fighter bomber, the Bell XP-59 and a very special plane kept undercover—the XP-80. It was the most beautiful thing I had ever seen. You could not see a rivet or a seam—just that last coat of lacquer.

HOWARD G. GILLETTE
LEBANON, TN

Totally Equipped

I think your "Death Valley To Pikes Peak" article was grossly misleading. In it, your Outdoors Editor, Joe Skorupa, states that they loaded up the Ford Explorer with a winch, tools, spare parts, camping gear, maps and supplies for a week. I did see a winch in the photos, but the Explorer looked otherwise empty. This suggests that you used a backup vehicle. Writing that the vehicle was loaded when it was not, and not mentioning the backup vehicle, is misleading to

readers. Also, why did Skorupa state that he had camping gear and a week's supply of food when he stayed in a motel every night?

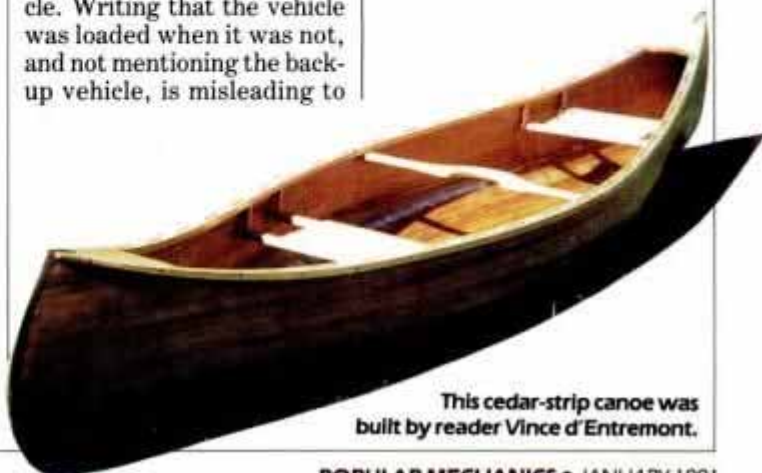
DANTON HEINEMANN
LA JOLLA, CA

First of all, there was no backup vehicle. Second, the gear was often taken out of the Ford Explorer while photographer Rich Cox shot photos. Third, virtually the entire trip was accomplished off pavement. You have obviously never been in Death Valley or some of the other regions crossed by Skorupa and Cox. If you had been, then you would have also had with you camping gear and supplies for a week. Sometimes, that's how long it is between contact with other humans in those areas. Lastly, all of Rich Cox's photography gear added another 150 pounds to the Explorer's load.

Shop Project

I was really intrigued by the cedar-strip canoe featured in the May '90 issue (page 73), especially when I learned that the builder was from my "backyard." Here's a picture of the canoe I built from those superb plans. I found them to be very complete and easy to follow.

VINCE d'ENTREMONT
ARMDALE, NOVA SCOTIA



This cedar-strip canoe was built by reader Vince d'Entremont.

The New Chevy Caprice Wagon.



Put on
5,000 pounds
and still
look good.



- The New Caprice Wagon. ■ 5.0 Liter V8 engine.
■ Rear-wheel drive for 2½-ton towing capability.* ■ Spacious accommodations for 8 people. ■ 92.7 cu. ft. of cargo room with rear seats folded down.
■ Four-wheel anti-lock brake system (ABS). ■ 3-year/50,000-mile Bumper to Bumper Plus Warranty.†

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WINNING WITH


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TODAY'S CHEVROLET™

It's in such great shape it can pull its own weight plus up to 2½ tons of boat, trailer or whatever to boot.* And look as smooth and lean as they come at the same time.

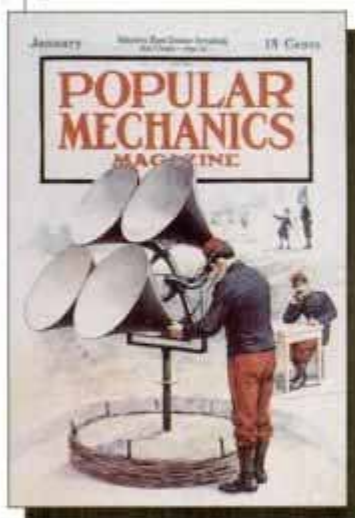
It's so well designed, it has the added safety of anti-lock brakes and a driver's-side air bag. So, no matter how you look at it, our full-size wagon has never looked better. Even with a few thousand extra pounds on it. Drive the new Caprice Wagon and feel why more people are winning with The Heartbeat of America.



*When properly equipped with optional trailer towing package. Maximum gross trailer weight including all passengers and cargo in the Caprice Wagon plus any cargo in the trailer. †See your Chevrolet dealer for terms of this limited warranty. Chevrolet, the Chevrolet emblem and Caprice are registered trademarks and Chevy is a trademark of the GM Corp. ©1990 GM Corp. All Rights Reserved. Let's get it together... buckle up. 

TIME MACHINE

75 YEARS AGO: JANUARY 1916



Zeppelin Busters

Inverting the passive listening techniques now used to hunt submarines, WWI anti-aircraft gunners turned megaphones toward the sky, hoping to detect marauding Zeppelins. The French, looked upon as the trailblazers in air defense, incorporated listening devices into a network of observation posts and batteries protecting Paris. Using high-angle machine guns, rangefinders, interceptor planes and searchlights, this network warded off attacks.

French Cleaning

Down in the trenches, French technology of a more homespun variety proved surprisingly important to the health and morale of front-line troops. Consisting of an unlikely looking system of water wheels, belts and tin cups, the streamside field shower clearly made use of whatever materials were at hand. But despite its peculiar appearance, the device delivered a steady stream of cleansing water, and was in heavy demand until cold weather set in.



50 YEARS AGO: JANUARY 1941



Megamapper

Photographic aerial reconnaissance was evolving from art to science—prompting us to place the Army's latest high-flying optics on our cover. Called "Big Bertha," the camera had a 40-in.-focal-length lens capable of snapping sharp pictures of 36 sq. miles at once. Flying aboard the latest photo plane at 25,000 ft., airborne shutterbugs went about their work in electrically heated comfort, while sipping oxygen through rubber hoses, rather than modern oxygen masks.



Nuclear Fever

The seductive glow of the atom held America in its thrall, and POPULAR MECHANICS reflected it no less than anyone. Our story "The Miracle Of U-235," by the physicist R.M. Langer, predicted flying wings propelled by jets of vaporized steel, lava highways melted into

the ground by nuclear heat, and plastic cars able to run 5 million miles without refueling. The social consequences for a world where no two points are more than 7 flying hours apart? "It is all one big community, and there is no excuse for differences in materiel welfare," wrote Dr. Langer.

25 YEARS AGO: JANUARY 1966



Return Of A Legend

Out of production since 1937, the magnificent Duesenberg was back for 1966. Built by Fred Duesenberg, son of one of the original builders, the Model D had an elegantly styled handmade steel body from Italy. In an era when size mattered, the 6000-pound Duesenberg was half a ton heavier than the Lincoln Sedan and a foot and a half longer than the Chrysler Imperial. Twenty-five well-heeled buyers had already put down \$5000 deposits on the \$19,500 car.

Supersonic Skepticism

American aerospace hubris was at its height, with Boeing and Lockheed locked in a federally subsidized race to build the first supersonic transport. Although the Anglo-French *Concorde* was expected to fly first, the American companies believed their more ambitious designs would dominate in the end. The titanium craft would fly at 1800 mph, whereas *Concorde's* aluminum structure was safe only to 1450 mph.

Boeing's swing-wing got the nod over Lockheed's double delta (above), but cost overruns eventually killed the whole project.

PM

Traffic radar doesn't say which car is being clocked, it merely flashes a number. The radar operator must then try to determine which vehicle produced the reading.



Why radar makes mistakes. How to protect yourself.

Although nine different errors have been documented for traffic radar, the most common source of wrongful tickets is mistaken identity.

It's hard to believe, but traffic radar does not identify which vehicle is responsible for the speed being displayed. It shows a number and nothing else. The radar operator must decide who is to blame.

Traffic Radar Is Blind

Traffic radar works differently from military, air-traffic-control, and weather radars. The others use rotating dish antennas in order to track many objects simultaneously.

Traffic radar uses a far smaller, far cheaper, antenna. This requires traffic radar to ignore all reflections but the strongest. The number displayed is the speed calculated from the strongest reflection.

The Best Guess

Remember, these reflections are invisible. Truck reflections can be ten times stronger than car reflections. How can the operator know for sure which vehicle is responsible for the number?

The truth is, he can't be sure in many cases. The result is mistaken identity. You can be ticketed for somebody else's reflection.

Self Defense

The only way to defend yourself against these wrongful tickets is to know when radar is operating near you. In his verdict upholding a citizen's right to use a radar detector, one judge wrote:

"If government seeks to use clandestine and furtive methods to monitor citizen actions, it can ill afford to complain should the citizen insist on a method to effect his right to know he is under such surveillance."

We Can Help

We specialize in radar warning. And PASSPORT, ESCORT, and SOLO do far more than simply find radar. Upon radar contact, the alert lamp responds and the meter shows radar signal strength. At the same time, you will hear an audio warning — pulsing slowly when the radar is weak, quicker as it strengthens, then constant as you approach close range. When you know exactly how strong the radar waves are, you'll know when the radar unit is near enough to actually have you under surveillance.

Expert's Choice

PASSPORT, ESCORT, and SOLO are the most advanced radar-warning instruments available. And the automotive experts agree.

Car and Driver called PASSPORT "A terrific radar detector." When *AutoWeek* tried our cord-free SOLO, they "fell in love at first beep." And when *BMW Roundel* tested our new ESCORT, they concluded "Nothing else even comes close."

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We sell directly 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 6:00 PM eastern time go out the same day by UPS. Overnight delivery by Federal Express is only \$14.50.

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"tar," 1.0 mg nicotine av. per cigarette by FTC method.

TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY ED VALIGURSKY

NASA's Taxi To The Space Station

HAMPTON, VA—The year is 2001. The completed Space Station *Freedom* floats 220 miles above Earth. Its first crew, facing exhaustion, is waiting to be replaced. But stubborn fuel leaks have once again grounded NASA's Shuttle fleet—indefinitely.

This kind of scenario has led NASA to consider an alternative manned-launch capability: a compact, reusable minishuttle for quick launch on a modified Titan IV booster. The Personnel Launch System, or PLS, would ferry eight passengers (plus a 2-person flight crew) to and from *Freedom* in 72 hours.

NASA's Langley Research Center proposes a lifting-body vehicle, designated

HL-20. At 11 tons, the spaceplane would be only a quarter the size of the Shuttle orbiter. Langley's design stresses safety. In case of a launch snafu, on-board emergency rockets would thrust the PLS away from the booster. Then parachutes would open to carry the craft to a safe splashdown. On return from orbit, the PLS would make a standard runway landing.

Though not yet approved for development, the HL-20 recently manifested itself in an engineering model built at North Carolina State University. It may face competi-

tion from a simpler configuration out of Johnson Space Center, a capsule recovered by parachute.

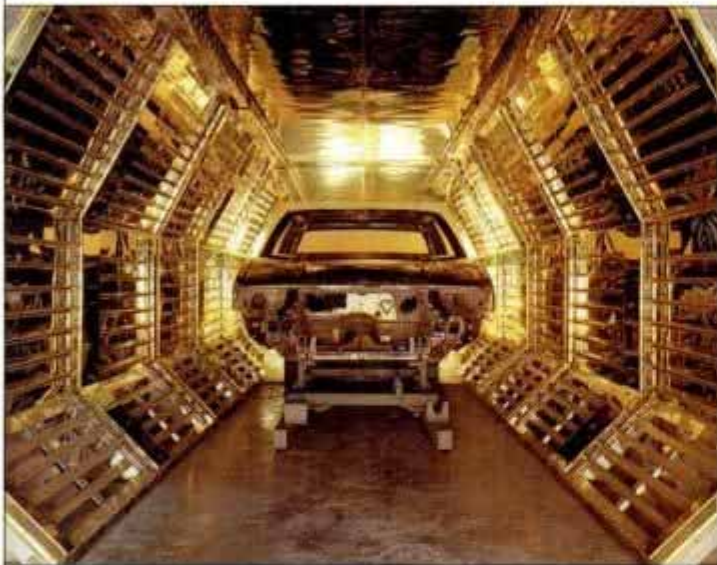
HL-20 maneuvers prior to reentry. Cutaway shows 8-passenger cabin flanked by propulsion bays.

Highlights This Month

- **Hermetically Sealed**—Eight begin 2-year sojourn in Biosphere.
- **Off The Deep End**—NASA's huge swimming pool to train astro-hardhats.
- **Light Workout**—Fiberoptics could flex manmade muscle.
- **Deadly Aim**—Laser automates helo gun night-targeting.
- **Businessman's Special**—NASA's bid to industrialize space.
- **Gas Station Automation**—Meet Sweden's robotic pump jockey.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Mike Fillon, Oliver Fultz,
Bob Scheier

THERMAL INNOVATIONS CORP. PHOTO



Gold-Plated Car Oven

TROY, MI—When a freshly painted car dries in an automobile factory oven, solvents that carry the paint pigments release hazardous fumes. The Environmental Protection Agency is nudging car-makers to switch to water-based paints, which are cleaner but need long drying times at lower temperatures.

Now, a gold-plated oven developed by DuPont and other companies speeds up

Superefficient gold-plated oven redirects paint-drying infrared energy at car body and away from oven walls.

the drying process by re-radiating infrared energy at wavelengths best absorbed by water. The gold coating, a product of Epner Technology, bounces 98 percent of the energy back at the car. Conventional oven walls soak up 40 percent of heat.

The oven bakes at 180° F, less than half the temperature of conventional car ovens and ideal for drying water-based paints.

GM has installed 18 of the new ovens, and European and Japanese carmakers are studying the process.

Home Sweet Biome

ORACLE, AZ—Never before have hardware and nature interwoven so closely as in Biosphere II, the man-made microcosm in which eight researchers will spend the next two years. The \$30 million venture, sponsored primarily by Texas oilman Edward P. Bass, is aimed at developing spinoff technologies for space exploration, agriculture and environmental monitoring.

An airtight greenhouse, covering roughly the acreage of a baseball field, houses the self-sustaining mini-world. Inside, 3800 species of plants and animals will populate five different hot-weather habitats or biomes. The human Biospherians will raise and live off vegetable crops, fish, chickens, dwarf pigs and goats.

Beneath all the bi-



ology, however, lies technology that keeps the ecosystems under control. A

battery of sensors monitors temperature, atmospheric composition, humidity and other factors. Meanwhile, computer-controlled pumps, valves and ducts stimulate wave and tide action in the coral reef biome, and controls air circulation elsewhere.

To keep heat-driven air expansions from blowing out the tightly sealed glass panes, Biosphere II will have lungs—twin geodesic domes

Glass-and-steel structure contains five ecological zones, an agriculture module and a human habitation section.

connected to the greenhouse by 150-ft. tunnels. Each dome, sealed off from the outside atmosphere, can hold 1.5 million cu. ft. of air (Biosphere itself holds 7 million cu. ft.). A rubber membrane stretched across the top of each dome will allow air volume to vary. The weight of a steel plate on the membrane maintains pressure to blow air outward if Biosphere leaks.

The eight Biospherians will live in a multistory module with a library, gym, laboratories, amphitheater, TV, stereo and VCR to keep them from going stir-crazy.

The scientific data that is amassed during the 2-year experiment will help solve environmental problems on Earth and run closed-loop ecosystems for long-duration space missions.



Rain forest, grassland, marsh, coral reef and desert will coexist under glass. Below left, domes act as lungs. Below right, plants are screened.

SPACE BIOSPHERES VENTURES ILLUSTRATION

SPACE BIOSPHERES VENTURES PHOTOS



HOLLYWOOD'S GREATEST PERFORMER



Shown approximately actual size of 9 1/4" in length. Scale 1:24.

The 1930 Duesenberg J Derham Tourster was one of Hollywood's greatest sensations. It was the most luxurious of all Duesenbergs ever and its rakish good looks and bold demeanor never failed to turn heads along Sunset Boulevard.

Now, Franklin Mint Precision Models has re-created this Hollywood legend in a superb 1:24 die-cast replica. With every fine detail authenticated by Gordon M. Buehrig, the legendary designer of the original. And officially authorized by the Heritage Plantation of Sandwich Antique Automobile Museum on Cape Cod, Massachusetts — where an original is maintained in perfect order.

Hand-assembled and ready to display, this fabulous show car is crafted of 136 separate die-cast components, to match the original inside and out. From the complete engine and undercarriage to the sparkling chrome-plated trim.

You'll find fully operable wheels and steering. Seats that "give." A top that snaps easily on and off. A replica as legendary as the Hollywood original. Yours for just \$120.



The name *Silvertown*, which appears on the tires, is a registered trademark of the B.F. Goodrich Co.

ORDER FORM

Please mail by January 31, 1991.

Franklin Mint Precision Models
Franklin Center, Pennsylvania 19091

Please send me the 1930 Duesenberg J Derham Tourster, fully assembled and ready for display. I need send no money now. Prior to shipment of my imported die-cast model, I will be billed for a deposit of \$24.* and after shipment, for the balance in four equal monthly installments of \$24.*

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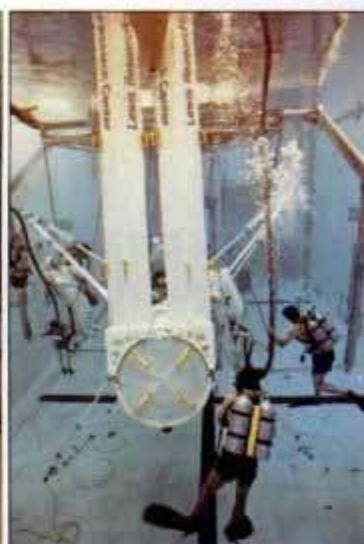
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THIRTY-DAY RETURN ASSURANCE POLICY

If you wish to return any Franklin Mint Precision Models purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

THE 1930 DUESENBERG J DERHAM TOURSTER.



NASA ILLUSTRATION AND PHOTO

Giant Zero-G Pool

HOUSTON, TX—The only way to prove you can construct a space station in orbit is to do it first in water, says NASA. So Johnson Space Center is building the world's largest dedicated neutral-buoyancy facility to

simulate weightlessness for space construction.

Weighing over a billion pounds, the building will demand some remarkable engineering. The pool will be 60 ft. deep and slightly smaller than a football field. Workers

must first drill 33 85-ft. wells to drain the water table around the site, since half the pool will be underground. Then builders will lay an 8-ft.-thick concrete floor and erect 12-ft.-thick concrete walls, which will incorporate special expansion joints to take the weight of 14 million

Cranes will lower mockups at Johnson (above left). At an existing tank (above), engineers already practice assembly.

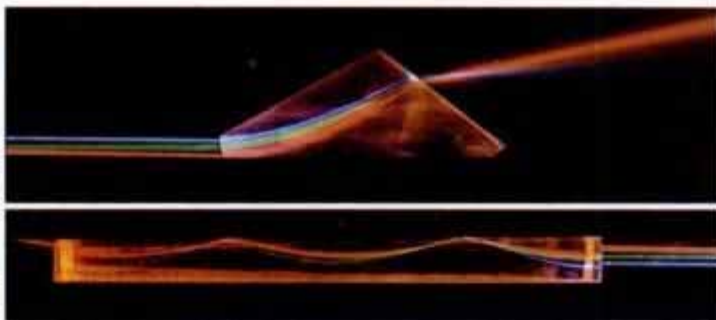
gallons of water.

Astronauts in training will enter the pool from the surface, but leave through an underwater exit leading to decompression chambers.

Glasses Look Smarter

TUCSON, AZ—Lenses with unheard of light-bending properties are the result of a new gradient refractive index technology.

By precisely controlled melding of materials, the technique allows a single lens to do the work of multiple lenses. In one configuration, for example, the edges of the lens bend light at a sharper angle than the center, mak-



Laser beams show Grin glass bending light at different angles.

ing a wide-angle lens that's only one block of glass.

Isotec, a leading manufacturer in the field, makes the

lenses by fusing several species of glass powder with differing refractive indexes. The outfit claims this tech-

nique allows for much bigger, cheaper and more rugged lenses than the processes of U.S. and Japanese competitors. Those rivals have made their lenses via chemical vapor deposition or by introducing dopants into hardening glass.

Beyond camera and multifocal eyeglass applications, Grin lenses could wind up in military night-vision goggles, solar-energy concentrators, optical computers and fiberoptic telecommunications networks.

ISOTEC PHOTO

Light Flexes Artificial Muscle

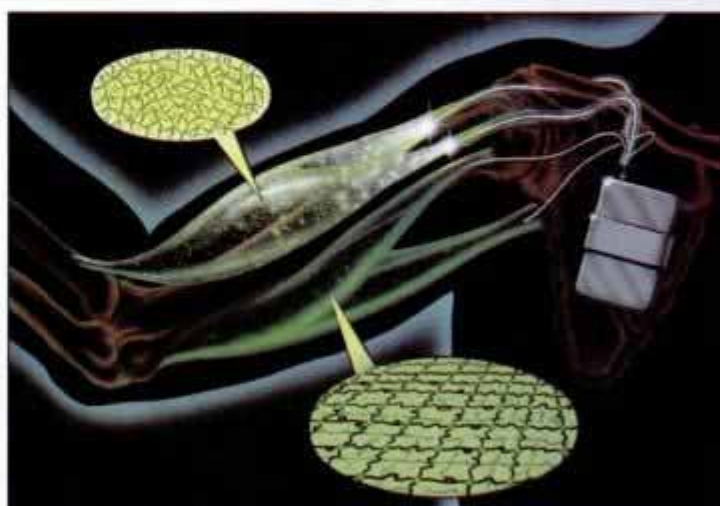
CAMBRIDGE, MA—A newly developed gel collapses when exposed to light and reexpands when the light disappears. The substance could form the basis of a synthetic muscle that contracts and relaxes under the control of a tiny light source implanted in the body.

Researchers at Massachusetts Institute of Technology and Japan's Yokohama University are working with the gel, which consists of a cross-linked network of long molecule chains, held apart by a

liquid that keeps the network from collapsing. When the light turns on, its heat melts an icelike layer of water molecules around the network, and the gel collapses.

In an artificial muscle, a light as weak as $1/100$ watt could trigger the contraction, which suggests fiberoptics might act as artificial nerves to control the gel.

Future research will focus on formulating gels that will expand and contract without suffering wear and tear over time.



Implanted powerpack sends light via fiberoptics to artificial muscles.

PM ILLUSTRATION BY THOMAS C. MOORE

Atlanta's Automated Athlete

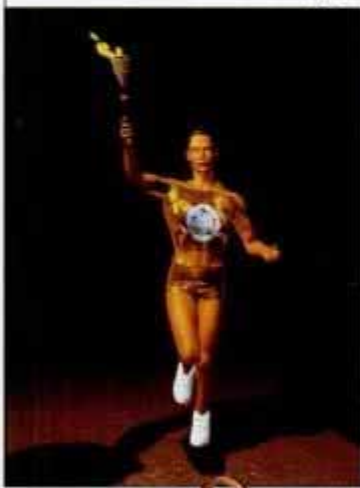
ATLANTA, GA—Pulling out all the stops in its winning bid for the 1996 Summer Olympics, the city commissioned a video presentation starring a computer-generated athlete with startlingly

lifelike movements.

To capture real-life motion, high-contrast cameras filmed silver targets fitted on an athlete running on a treadmill. Computers translated the targets' movements into numerical data. Then, digitizers traced the curvature of a clay model of a woman and built up an anatomical database. Software combined the two databases to create the Golden Athlete.

The technique could find uses in sports performance analysis and orthopedics.

Golden Athlete (left) was born of real-world motion capture, mated with data from clay athletic form (below).



Virtual-World Videogame

CHICAGO, IL—Billed as the world's first interactive virtual-reality sport, a game called BattleTech pits teams controlling 31st-century nuclear-powered robotic tanks against each other on a computer-created landscape.

Each player enters a cockpit where a dedicated computer generates a graphic display of the virtual battlefield. Thirty-two megabytes of RAM memory make possible real-time vision from the robot's point of view.

A local area network allows players, grouped in



Cockpit contains more than 100 controls and displays, a 25-in. color monitor and a radio to talk to teammates.

teams of four, to communicate and develop strategy to defeat their opponents.

The game illustrates the consumer potential of virtual-reality technology, first developed to enable tele-robotic activity in space.

Night-Flight Gunsight

EGLIN AFB, FL—The Air Force hopes to improve helicopter gunners' accuracy at

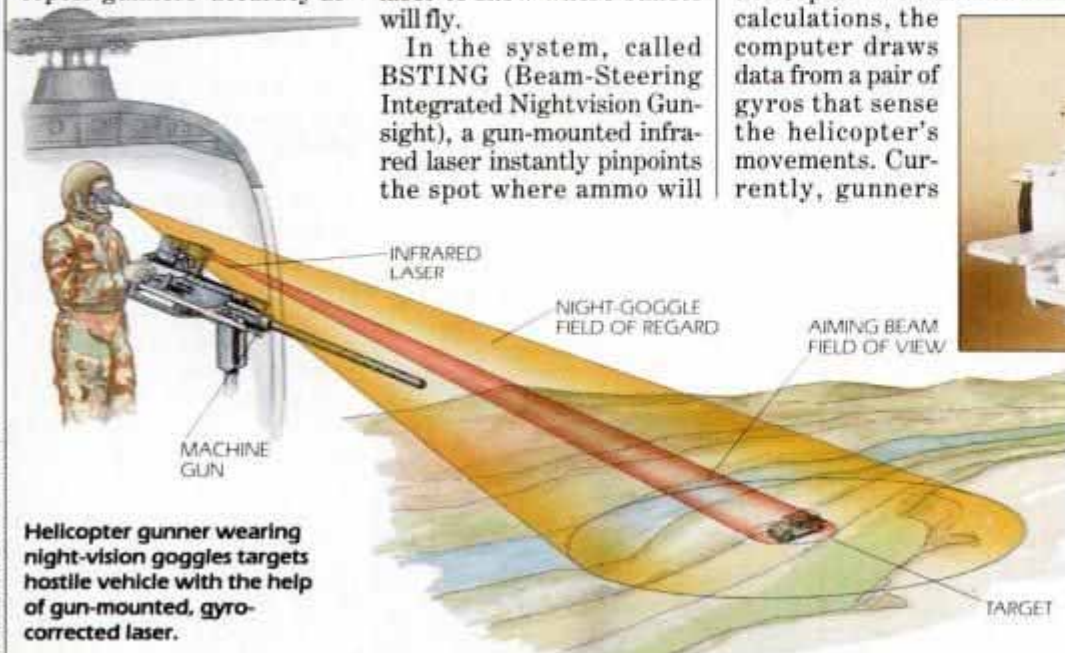
night with a new system that uses a computer-controlled laser to show where bullets will fly.

In the system, called BSTING (Beam-Steering Integrated Nightvision Gunsight), a gun-mounted infrared laser instantly pinpoints the spot where ammo will

strike. A computer adjusts the beam after making corrections for the bullets' trajectory and the motion of the helicopter. To make these calculations, the computer draws data from a pair of gyros that sense the helicopter's movements. Currently, gunners

must rely on watching tracer rounds and guesstimating corrections during battle.

And unlike tracers, the infrared beam doesn't give



Helicopter gunner wearing night-vision goggles targets hostile vehicle with the help of gun-mounted, gyro-corrected laser.

away the helicopter's position, unless it's aimed straight at troops wearing night-vision goggles. The beam can spotlight targets more than a mile away.

The Air Force hopes the system will put a sharper sting in future special operations endeavors.

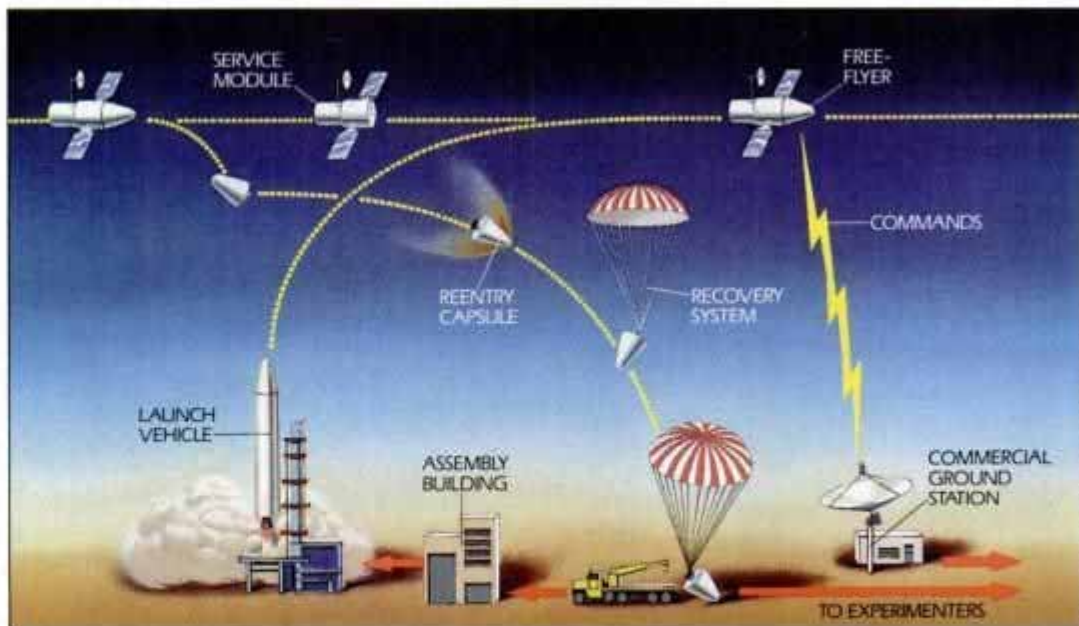


All-Business Orbiter

TULLAHOMA, TN—Hoping to jump start the stalled commercial sector of the nation's space program, NASA is organizing an all-commercial rocket system designed exclusively to loft payloads with profit potential.

Called COMET, for Commercial Experiment Transporter, the endeavor will feature an expendable launch vehicle that's tipped with an unmanned free-flyer, which houses the experimental package. The spacecraft will split into two parts after orbiting for about 30 days, dispatching a heat-shielded module back into the atmosphere for recovery.

The other section, known as the service module, will remain in space for up to a

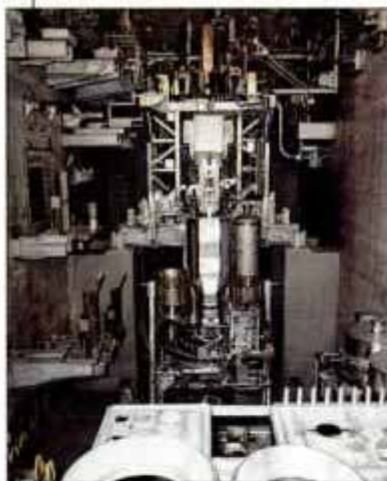


COMET will combine expendable rocket, reusable recovery capsule and long-term service module.

year for long-term remote-controlled experimentation before burning up on reentry into the atmosphere.

Teams are now vying to build and operate the COMET infrastructure and launch packages developed by the

16 Centers for Commercial Development of Space, which are co-funded by NASA and private industry.



Nuke-Waste Mortuary

AIKEN, SC—One-hundred million gallons of high-level nuclear waste lurk in aging tanks beneath Department of Energy plants. Now under way is the first effort to dispose of this hazard for good.

The Savannah River Defense Waste Processing Facility,

Melter (left) fills canisters. Canister transporter (right) rolls on 5-ft. tires.

scheduled to open in 1992, recently began testing equipment to glassify the waste.



In glassification, waste mixes with fine particles of borosilicate glass. The mixture feeds into a 2100° F melter and then into stainless-steel canisters. There it hardens into a long-lasting glass. A welded-steel plug seals each canister.

Glassed canisters from the plant may find their final resting place at the proposed Yucca Mountain, Nevada, repository.

Robotic Gas Station

DANDERYD, SWEDEN—Drivers in this suburb of Stockholm are filling up with

an experimental automatic refueling device known as Tankman.



The system depends on a driver replacing his gas cap with a special adapter/cap combo that mates with a robotic nozzle.

Activated by pushing a button or inserting a credit card, a sensor on the robot first searches for a radio-frequency ID tag on the adapter, then pushes the nozzle directly through a valve in the gas cap to fill the tank. An airtight rubber seal muffs the nozzle to prevent fumes from spreading. When it's finished, the nozzle withdraws and locks the adapter.

Sensors monitor and halt refueling if the car moves or someone interferes with the robot.

Tankman's inventors suggest that the next step is to put credit card information on the adapter's ID tag, for automatic payment of tolls and parking fees.

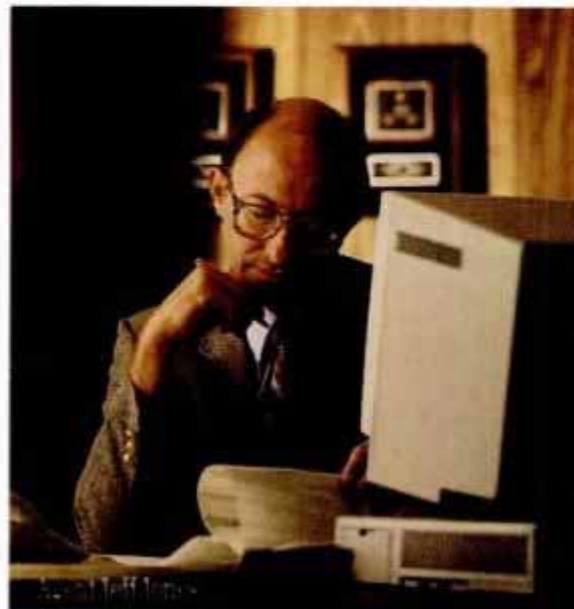
TRANSCBOT PHOTOS

FM ILLUSTRATION BY ADOLPHE BROTHMAN

DEPARTMENT OF ENERGY PHOTOS

Paoli, Indiana since 1972:
3,650 people,
1,260 babies,
2 floods,
2,647 auto claims

...and 1 State Farm agent.



Paoli's not a big city by any stretch. But even in a small town like this, things keep changing. They put up a new church not far from the courthouse last year. Families are building houses. Babies are being born. And every time something changes, someone's insurance coverage needs reviewing. That's where Jeff Jones, Paoli's State Farm agent for the last 18 years, comes in.

Like State Farm agents across the country, Jeff offers all his policyholders a free State Farm Family Insurance Checkup. That helps them make sure that no matter what's changed, their insurance coverage won't be out-of-date. Whether it's auto, home, life or health insurance.

In 18 years, about the only thing in Paoli that hasn't changed is Jeff. And that's the way folks in Paoli like it.



Like a good neighbor,
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State Farm Insurance Companies
Home Offices: Bloomington, Illinois



The Latest Fast-Braking News From Pontiac.



Bonneville LE.

It's called ABS.

A sophisticated computer-controlled braking system, designed to help prevent wheel lock-up under braking... keeping you in control. And it's available on LE. But there's more built into Pontiac Bonneville* than just sheer stopping power.

For instance, its powerful 3.8 liter "3800" V6 engine has sequential-port fuel injection to maximize output at 165 hp and 210 lbs.-ft. of torque.

All this power can be fully appreciated from the friendly confines of an acoustically insulated interior complete with air conditioning and seating for six passengers. There's even an available AM/FM stereo cassette with a 6-speaker sound system.

The Bonneville LE sedan. Performance, excitement and an uncompromising commitment to quality are what this agile American sedan is all about. And news like this is bound to travel fast.

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DESIGN & ENGINEERING AWARDS 1991

● For almost 90 years, POPULAR MECHANICS has served as a mirror for the technological achievements of our century—a contemporary chronicle of design and engineering. From the dawn of aviation to the dawn of space travel, PM has been on the forefront, telling five generations of Americans what's new and how it works.

While this continues to be our basic mission, we also feel it's time to amplify our efforts. And that's what the new POPULAR MECHANICS Design & Engineering Awards are all about. We want to highlight the best of the hundreds of new designs and ideas that come our way each year.

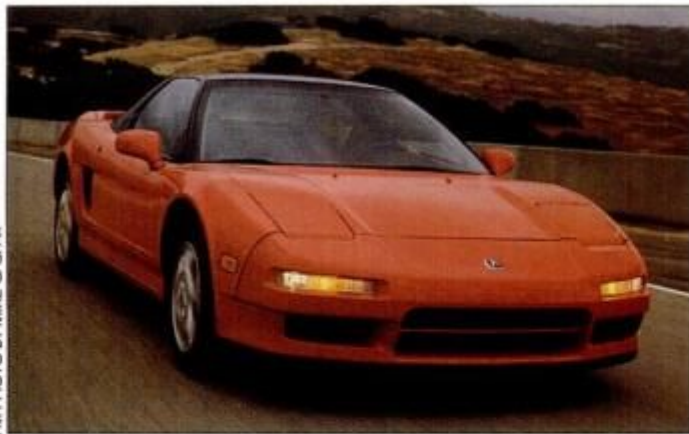
Our ground rules are simple. We have no preset categories, aside from our five basic editorial topics. The winners are selected by PM's editors, and represent our recognition of outstanding achievement in their respective areas.

We hope you enjoy this new tradition, and join us in congratulating the winners.

—Joe Oldham

DESIGN & ENGINEERING AWARDS

PM PHOTO BY MIKE GASPAR



ACURA NSX
Acura Division
American Honda Motor Co.

From its 270-hp 24-valve 3.0-liter dohc aluminum V6 to its innovative suspension, the new NSX is a techno tour de force and just about the most exciting new sports car we've ever driven. Rarely does a car come this close to perfection.



PM PHOTO BY RON HUSSEY

TOYOTA PREVIA
Toyota Motor Sales USA

Not only is Toyota's new Previa a major leap forward in design compared to its predecessor, it's also unique in a hotly competitive market segment—the only midengine minivan, and arguably the best-looking.



PM PHOTO BY RICH COX

OLDSMOBILE CUSTOM CRUISER
Oldsmobile Division
General Motors Corp.

CHEVROLET CAPRICE WAGON
Chevrolet Division
General Motors Corp.

BUICK ROADMASTER ESTATE WAGON
Buick Motor Division
General Motors Corp.

In this new marriage of rugged body-on-frame construction and contemporary aerodynamic exterior design, GM has successfully revitalized the concept of the traditional American station wagon—big, comfortable and stylish.

PM PHOTO BY RICH COX



DODGE STEALTH
MITSUBISHI 3000GT
Dodge Division
Chrysler Corp.
Mitsubishi Motor Sales

Manufactured by Mitsubishi, these two nearly identical sporty twins embody more gee-whiz high technology than any cars on the market today. Add seductive shapes and the availability of as much as 300 hp, and you've got a pair of winners.



FORD EXPLORER
MAZDA NAVAJO
Ford Division
Ford Motor Co.
Mazda Motors of America

Developed jointly by Ford and Mazda, these new compact sport/utility vehicles have already gone to the head of a very tough class. The Navajo and Explorer offer a rare combination of interior volume and tough 4wd off-road capability.



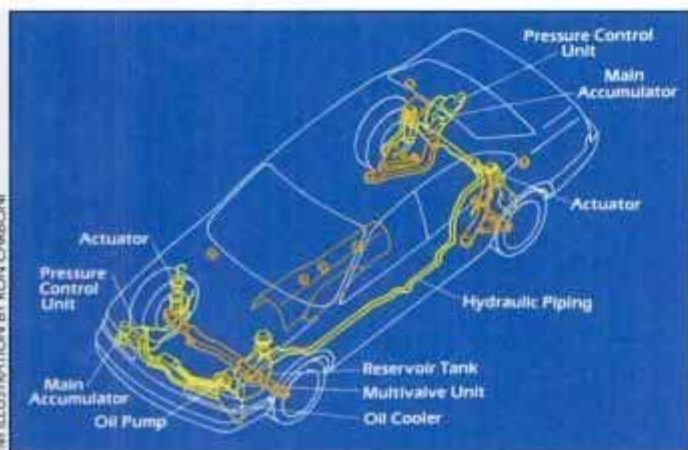
SATURN MANUFACTURING

Saturn Corp.
General Motors Corp.

While we recognize the general competence of the new Saturn automobile, we're even more impressed with the well-conceived manufacturing process that produces it. The all-new Saturn plant in Spring Hill, Tennessee, employs a number of



innovative techniques, such as the lost-foam casting process (above left) for engines and transmissions, as well as state-of-the-art assembly processes and a hand-picked labor force. The result is exceptionally high quality for an all-new vehicle.

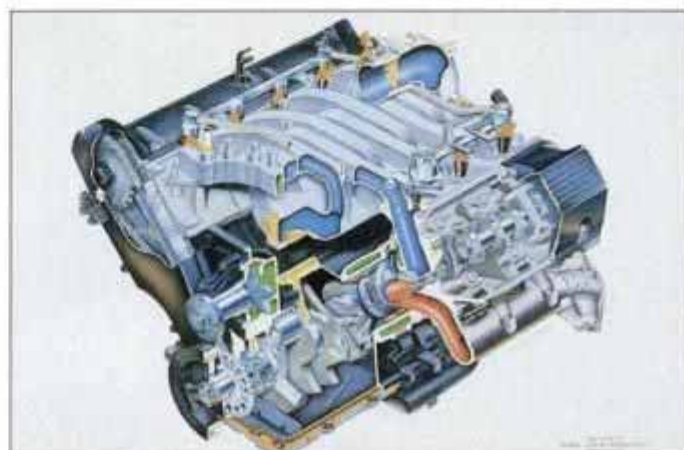


PM ILLUSTRATION BY IRON CARBONI

Q45 ACTIVE SUSPENSION

Infiniti Division
Nissan Motor Corp. USA

Active suspension—a system that instantly adjusts components to cornering forces—has been anticipated for years. Nissan's electro-hydraulic system is the first on the market and is also an impressive performance enhancer.



FORD MODULAR V8

Lincoln-Mercury Division
Ford Motor Co.

Smooth and potent, Ford's all-new sohc 4.6-liter V8 engine is the first arrival in a family of V8 and V6 powerplants that will share common production tooling. The 4.6-liter makes its first appearance this year in the Lincoln Town Car.

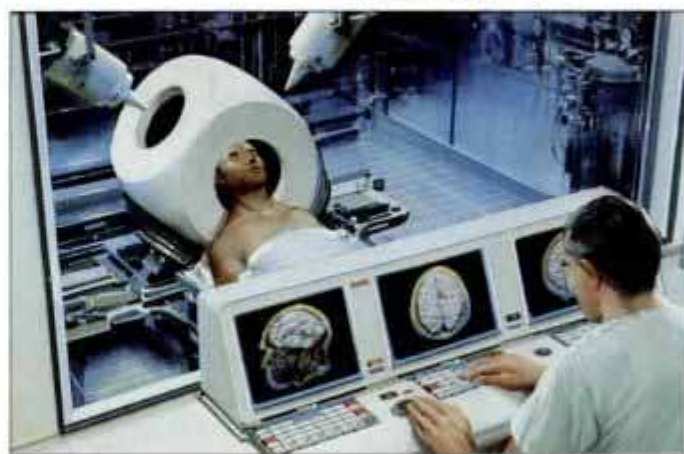


PM PHOTO BY BILL A'HE

DIACOM

Rinda Technologies

This new PC-based software system turns basic laptop computers into auto-diagnostic systems. Diacom interfaces with your car's fuel-injection computer to access error codes, and it can also monitor and record performance in real-time.



PM ILLUSTRATION BY JOHN BERKEY

VIDEO TUMOR FIGHTER

University of Washington
(School of Medicine)
University of Virginia

This breakthrough medical technology allows treatment of brain tumors without the trauma of traditional surgery. The core of the system is a metallic pellet maneuvered into place by electromagnets, then heated by RF radiation to kill the tumor.

PM PHOTO BY ERIC SCHULZINGER



F-117A STEALTH FIGHTER

**Aeronautical Systems Div.
Lockheed Corp.**

Although radar-evading technology isn't new, the F-117A Stealth fighter plane takes this black art well into the future—as well as years ahead of America's global competitors. Proof: The F-117A flew for nine years in total secrecy.



ENERGY ADVANTAGE LOW-E GLASS

Libbey-Owens-Ford Co.

This latest addition to the low-E glass market does its predecessors one better by combining impressive solar heat gains and very low heat loss values. The result is a product with great solar performance and energy-saving potential.



PICQUIC MULTIPURPOSE SCREWDRIVER

PR Innovations Inc.

This extremely well-designed tool may not be a completely new idea, but it still deserves plenty of praise. It's comfortable, works well and even keeps you from losing the bits. To get a new bit, you must first store the old one in its place.



ABSE 15 CORDLESS DRILL

AEG Power Tool Corp.

Cordless convenience all too often means poorer features. But that's not true of this 12-volt tool. It has 10 clutch settings, a motor brake, clamp-on light and even converts easily into a screwgun by simply pulling off its standard 1/2-in. chuck.



M300 ELECTRIC MOWER

**U.S. Power Tools Group
Black & Decker**

By designing an electric lawnmower that is simultaneously durable, powerful and eye-catching, B&D has set a new standard. You can even adjust the cutting height of all four wheels at once, by simply squeezing a single handle.



PRO FLEX CAULKING SEALANT

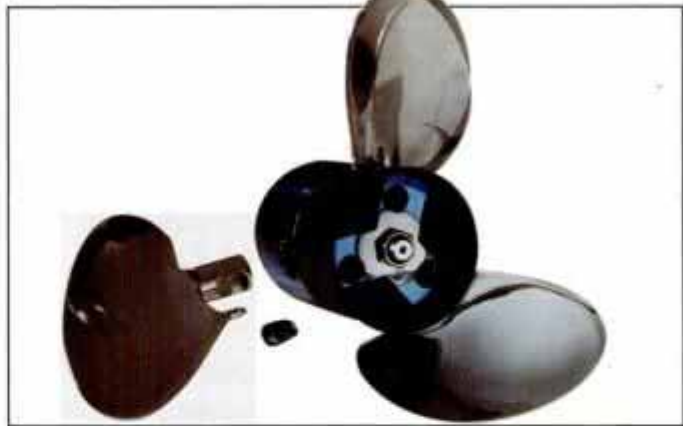
Geocel Corp.

Pro Flex is the next best thing to a universal caulking compound. It's paintable, flexible, works on wet surfaces and in freezing temperatures, adheres to just about anything and even comes in several colors. What more could you ask?



GENESIS SERIES
Wellcraft Marine

Using CAD/CAM technology, Wellcraft's designers threw out the rulebook when they created an American original with the new Genesis miniyacht—a design certain to inspire numerous imitators. Deck area is studded with industry firsts.



TORQUE SHIFT PROPELLER
Land & Sea Corp.

The Torque Shift prop, a continuously variable-pitch design, enables marine engines to generate maximum torque at all speeds. This feature is radically new to the world of pleasure boating and will undoubtedly see widespread application.



SILVERSTAR/SPITFIRE OUTBOARDS
Outboard Marine Corp.

There are so many innovations in this new cutting-edge outboard engine series—extensive use of lost-foam casting, compact design, modular componentry—that OMC had to file 43 new patents to cover them all.



PHOTURA 35MM CAMERA
Canon USA

Boasting a unique tubular design, the radical new Canon Photura also features a 35-105mm zoom lens, drop-in loading, autofocus and 1-hand operation. The camera's built-in strobe flash nestles neatly in the fold-off lens cap.

PM PHOTO BY MICHEL TCHERKOFF



TR CAMCORDERS
Sony Corp.

Beginning with the TR5 model, Sony's miniaturization of its camcorder line has spawned a new breed of videomakers, amateur and otherwise. New minis pack most maxi features and are palm-sized. TR4 model shown here is smallest of lineup.

PM PHOTO BY BILL ASHE



LIFESTYLE AUDIO SYSTEM
Bose Corp.

Miniaturization is also revolutionizing home audio. Tiny, but potent, new Lifestyle system includes radio/compact disc player, subwoofer/amplifier, two satellite speakers, two amplified speakers and RF remote-control module.



FAST FOUR

BY TONY SWAN, Automotive Editor
PM Photos by G Photo

● So where does it say that having a use for more than two doors automatically excludes you from the fun of high performance? Not in Detroit. Not anymore. Ford, Chrysler and General Motors are all offering sedans designed to satisfy the family man's occasional lust for go-power, as well as his ongoing need for extra doors and plenty of seating. Not to mention civilizing amenities like pile-cut carpeting, cruise control and a premium sound system.

These hot-rod sedans also pay tribute to the realities

technoflash of the Pontiac Grand Prix STE, the go-for-it dash of the Dodge Spirit R/T. And each represents good value versus imported competition.

Bottom line: We don't think it's possible to pick the wrong car here.

Ford Taurus SHO

This top-end variant of a very, very good basic family sedan is the roomiest car in this test. It's also, by a few pounds, the heaviest.

It comes from the factory with big-ticket items like air conditioning, antilock braking (ABS) and cruise control baked into its base price of \$21,633, along with vari-



of family finance. There's BMW 535 performance here for a fraction of the regular cost. And they'll smoke just about any comparably priced automobile from the far side of the Pacific.

Which one's best? Ultimately, that gets to be a subjective choice. Test track data notwithstanding, we think one member of this trio does a little better job of blending sporting performance with sedan comfort and contemporary high style.

But each of these cars has its own distinctive character—the subtle polish of the Ford Taurus SHO, the

able-assist power rack-and-pinion steering, power locks and windows, lots of interior lights, its own special appearance items, a big 18.4-gallon fuel tank and a pair of excellent driving seats, which we think are among the best in the business.

Our 1990-model test car also carried a discounted package of options—including leather upholstery, an autolamp system, keyless entry, automatic climate control, JBL audio system, power antenna, power moonroof and \$491 worth of compact disc player—for a grand total of \$24,962.



DOORS

Detroit's new breed of super sedans makes high performance a family affair.

In short, our Ford Taurus SHO was about as well-equipped as any modern American luxury car, with the added bonus of plenty of smooth horsepower and handling to match. (The 1991 Taurus SHO gets 6-spoke, 16-in. aluminum wheels and 215/60R16 Goodyear performance tires, as well as a new taillight design.)

The SHO gave a very solid account of itself during the instrumented testing portion of our 3-way shootout. Hauled by Yamaha's wonderful 3.0-liter 24-valve dohc V6, it showed us consistent 0-60-mph times of just over 7 seconds, with a quarter-mile run of 15.4 seconds at 91 mph. It snaked through the slalom pylons in 8.6 seconds and stopped repeatedly from 60 mph in 125 ft. or less,

and its 4-disc ABS braking system controlled lockup.

Back in the real world, the Taurus SHO was a very easy car to live with and reflects quality throughout. There's all sorts of storage space and even more space for people. Though the optional sunroof subtracts from rear headroom, we found that a 6-footer can still be comfortable back there, even with another 6-footer in front of him.

There have been complaints in the past that the clutch and transaxle are not wonderful, and they aren't—the clutch is a little heavy and the shifter is stiff and notchy. Aside from that, though, we think it's very difficult to find fault with this understated super sedan.



FORD TAURUS SHO

Roomy interior of Taurus SHO (above left) was subdued but posh. Yamaha 3.0-liter 24-valve dohc V6 delivers 220 horsepower and wheelspin on demand. Ford's SHO turned in consistent 0-60-mph runs in the low 7-second bracket.

FAST FOUR DOORS



PONTIAC GRAND PRIX STE



Slowest at the strip, STE still ran mid-7-second 0-60-mph times. Interior has more flash and gadgets than SHO. New GM 3.4-liter dohc 24-valve V6 makes 210 hp and seductive noises.

Agile, spiffy and fast, the SHO is the best of this new breed.

Pontiac Grand Prix STE

However, as this new Grand Prix variant ably demonstrates, spiffiness isn't confined to the Ford Motor Co. Built around GM's excellent new 3.4-liter dohc 24-valve V6, the STE was conceived specifically to compete with the Taurus SHO and is the *only* GM 4-door offering the new engine. There's also a new M27 Getrag 5-speed manual transaxle to go with it or an optional electronically controlled 4-speed automatic, something neither the Taurus SHO nor the Spirit

R/T offer. Score an extra point for Pontiac here.

Besides the 3.4-liter V6's 210 hp, there's plenty more to support the STE's sports sedan status: Pontiac's successful Y99 sport suspension, 215/60R16 Goodyear Eagle GT+4 tires, body-color alloy wheels, power windows and locks, air conditioning, cruise control, a remote keyless entry system and an upgraded AM/FM cassette system with STE-only 8-speaker sound and steering-wheel-mounted system controls, power bucket seats with power lumbar and thigh supports (in cloth or optional leather), and an elaborate electronic

information system. Our test car was also equipped with optional ABS brakes and the second-generation head-up display (HUD) unit.

In our empirical data-gathering sessions, the Grand Prix ran solid 7.6-second 0-60-mph times, pretty much as the engineers told us it would, with quarter-mile runs averaging 15.75 seconds at 87 mph. That's much quicker than the basic 3.1-liter V6 ever thought of delivering. The new 3.4-liter is an impressive combination of quick response, midrange torque, 7000-rpm screams and a terrific exhaust sound with a generally better low-end response than the SHO V6.

We measured 60-0-mph stopping distances at an impressive best of 129 ft., nearly equal to the SHO, and slalom times a couple of hundredths of a second quicker.

The STE was also very close to the SHO in the cargo-volume derby, which isn't surprising since it's actually a bigger car—6.4 in. longer, a tick wider and a tick taller. The STE seems to have a more open feel than either the Ford or Dodge.

There's also plenty of room for big



FORD TAURUS SHO



DODGE SPIRIT R/T

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)	CURB WEIGHT (lb.)
Dodge Spirit R/T	\$17,900/ \$19,400 (est.)	L4 DOHC 16V T 135.0/2212	224 @ 6000 rpm/ 217 @ 2800 rpm	front/ front	5-speed manual	103.3	181.2	68.1	57.6/57.2	3060
Ford Taurus SHO	\$21,633/ \$24,962	V6 DOHC 24V 182.0/2997	220 @ 6200 rpm/ 200 @ 4800 rpm	front/ front	5-speed manual	106.0	188.4	70.8	61.6/60.5	3463
Pontiac Grand Prix STE	\$20,479/ \$21,500	V6 DOHC 24V 207.0/3352	210 @ 5200 rpm/ 215 @ 4000 rpm	front/ front	5-speed manual	107.5	194.8	70.9	59.5/58.0	3436

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



DODGE SPIRIT R/T

people front and rear, and a fair amount of small-object storage. The rear compartment uses bucket-style backs on bench-style cushions for an unusually sporty interior look. Our white test car was fitted out with gray cloth interior and seat trim that felt and looked like quality goods.

The STE's sound system (eight speakers) gets top marks, as do the seating, shifter and powertrain in general. While we give the Taurus a small edge in overall execution and use of interior space, there's not really much to choose between the Ford and the Pontiac other than style. This is unquestionably the best STE yet.

Dodge Spirit R/T

The Spirit R/T's hot new Lotus-developed twin-cam 4-valve intercooled balance-shaft 2.2-liter turbomotor makes more horsepower and torque than the SHO engine from 26-percent less displacement and 33-percent fewer cylinders.

This potent 4-banger is available only in this car and only with a 5-speed manual transaxle.

As the test numbers indicate, this one can definitely run and shoot. We actually got one 0-60-mph run of less than 6 seconds, with the others all fall-



Spirit R/T was quick through the cones and even quicker straightahead, with 0-60 mph in low 6-second area. Interior is snug. New 24-valve dohc 2.2-liter turbo makes 214 hp.

ing into the low 6-second range, a bit quicker than even Chrysler engineers who forecast 0-60 mph in 6.5 seconds expect of their new car.

In the quarter mile, the little R/T ran nearly a second quicker and 5 mph faster than the SHO—same day, same driver, same conditions. It was very close to the other cars in the slalom exercise, and the all-disc ABS brake system provided 60-0-mph stops in 128 ft.

Pretty sensational performance all around, we thought.

Now for some perspective. The Dodge Spirit R/T is the smallest, shortest, lightest car in this trio—good in the realm of performance, not so good when it's you, Madge, three kids and cargo. Dodge calls the R/T a 5/6-passenger midsize, and its EPA passenger volume index is surprisingly high, but we don't believe for a minute that five adults can travel in it comfortably.

Leg and elbow room notwithstand-

ing, the interior of the R/T, done up in a tasteful mix of gray cloth with black and red accent stripes, was more comfortable and quieter than we anticipated, with a surprisingly high level of fit and finish. Air conditioning and a driver's air bag are standard. ABS is optional, as are power seats, windows and locks. Although not so well-appointed as the SHO or the STE, there's a lot here for the money.

Like the other two entries in this showdown, the Spirit R/T is bags of fun to drive on the street. There are quirks, to be sure. Chrysler still hasn't cured the cable-shifter 5-speed of vagueness, although it's much improved. The engine is a trifle peaky, and turbo lag is still a problem, whatever the engineers may say. But zing it up into the powerband, and it'll simply run off and hide from anything in its class.

In fact, viewed strictly in terms of bang for the buck, the Spirit R/T has all the earmarks of a definite winner. If your sedan needs are skewed more toward vroom than volume, this one looks like the most tempting ride of them all.

PM

PONTIAC GRAND PRIX STE



TEST RESULTS

STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/PM test)	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING ¹ ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. ² SLALOM (mph)	200-FT. ³ SKIDPAD (G)	EPA CARGO VOLUME (cu. ft.)	INTERIOR VOLUME (cu. ft.)
Power rack & pinion/ 2.5	F: 10.2-in. vented disc, ABS/ R: 10.5-in. disc, ABS	19/ 14	6.2 14.5 @ 96	4.9	128	8.74	.83	14.4	111.2
Power rack & pinion/ 2.5	F: 10.2-in. vented disc, ABS/ R: 10.1-in. vented disc, ABS	18/ 14	7.2 15.4 @ 91	5.7	121	8.63	.84	18.4	100.1
Power rack & pinion/ 2.3	F: 10.5-in. vented disc, ABS/ R: 10.1-in. disc, ABS	NA/ 16	7.8 15.8 @ 87	6.1	129	8.61	.81	15.5	115.3

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

Comfort And Value Come So Does A Precision Built



*"Best-Built" claim based on an average of consumer-reported problems in a series of surveys of all '81-'90 models designed and built in North America. Sales by Division. **Retail Deliveries by Division, 1990 vs. 1989.

Standard With Ford Ranger. Truck.



It's no wonder Ranger owners always feel so comfortable. They drive a solid value. And Ford is determined to make it a lasting value.

Ford Trucks. The Best Never Rest.

People who *build* Rangers never forget that people who *drive* Rangers just won't tolerate imprecise sheetmetal fits, blemishes in the paint finish—unsatisfactory workmanship of any kind.

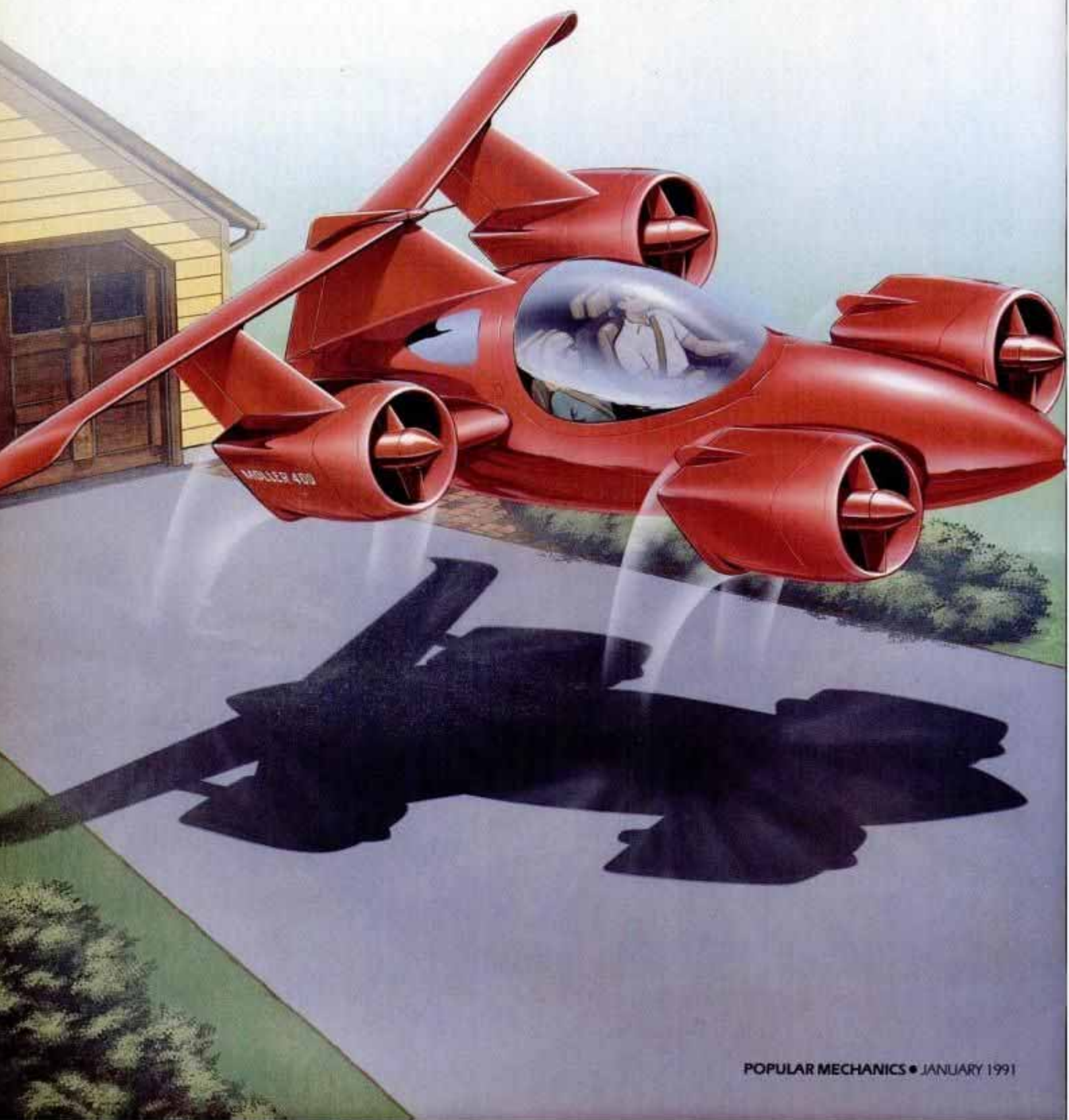
And even though Ford is already the best-built line of American trucks,* we never stop asking: Can we build them tougher? Could a fit be even thousandths of an inch tighter?

Because we never rest, Ranger's sales lead over the competition just keeps growing wider:**



THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS
ARE BUILT FORD TOUGH.

Buckle up—together we can save lives.



SKYCAR

It is 1999. You can leave for work a little later than you did just a few years ago because you own a Moller 400 volantor.

BY BOB McCAFFERTY

● You enter your security code on the vehicle's external keypad. The clear canopy rises silently while an on-board computer initiates its preflight review sequence. Easing into the pilot's seat, you secure your inertial safety harness and scan the systems monitor—one of two CRT screens that replace dozens of dials in earlier aircraft. It shows all systems up and ready, then responds to your verbal command to check each item. Fuel level and pressure—check. Stability computer—check. Battery—check. Ignition—check.

Another voice command, combined with your operation of a microswitch on the throttle, starts all eight engines. Hardly a sound comes from the rotary powerplants, but the full-color monitor verifies engine temperatures established and pre-lift-off power attained. Your three self-checking, cross-checking computers confirm all systems ready. Your pulse quickens as you roll forward out of your garage.

With a nudge to the throttle, your volantor (a European term meaning to hop nimbly about) rises to 3 ft. Scanning the CRTs, you complete your hover check. All okay. An easy forward motion on the righthand joystick and you're accelerating, engines humming quietly at 65-percent power. The computer assumes control to attain the rate of climb and altitude you've preset. A quick glance at the flight monitor shows an airspeed of 160 mph and a 4800-ft.-per-minute climb. Slightly more than a minute after liftoff, you are 1 mile up and traveling five times faster than the highway traffic below. Welcome to 21st-century commuting.

A different dreamer

That scenario could be just the pipe-dream of yet another of the dozens of post-World War II inventors who

promised us our own personal commuter plane. But ex-boy genius, hummingbird admirer, aircraft welder, aerodynamics engineer, University of California professor, backyard inventor and true believer Paul Moller is different.

So say state of California future transportation planners and a top vertical-takeoff-and-landing expert at NASA. "This is extremely significant," says Dr. John Zuk, chief of NASA's Office of Civil Technology. "It's really a breakthrough for the type and concept, and it has merits from a cost standpoint that show promise to be a future personal transportation system."

What Moller has done, after an estimated \$25 million, 500,000 hours and

have enough engines that it can tolerate a failure on one during some critical mode of operation and still get back down. Finally, and probably the most important thing, it has to be fundamentally inexpensive."

A custom-designed Wankel rotary engine is one reason why Moller may succeed where others have not. It provides the power-to-weight ratio vertical takeoff demands, yet is inexpensive to produce. Moller bought technology information on a single rotor engine from the Outboard Marine Corporation (OMC)—which had used it to propel snowmobiles. Then he upgraded it into an air-cooled, 2-rotor, mostly aluminum powerplant that weighs just 72 pounds. Moller is nearing his production vehicle goal of a



Moller's first M400, shown at his Davis, California, plant, should fly this year.

25 years of single-minded effort, is to fly a 2-man, saucer-shaped, 8-engined, vertical-takeoff-and-landing craft at an altitude of 40 ft. for more than 3 minutes. "It's a true first," Zuk says.

Practical transport

Today, Moller's goal is to build a practical transportation vehicle of the air. "There are three really clear-cut criteria," says the 53-year-old inventor. "It has to be easy to fly. It has to be extremely safe—for example, it's got to

1.3-liter engine that cranks out more than 150 horsepower. That's more than 2 horsepower per pound. Durability will be enhanced with a NASA-developed plasma-sprayed ceramic coating on the engine's interior.

Next, Moller invented a system of variable-camber exit duct vanes (see illustration on page 37). These direct thrust from 7-bladed, variable-speed fans mounted on each engine to produce lift for vertical takeoff and hover. Computers reconfigure the vanes in flight to replace lift with forward

thrust. "We do with software what helicopters do with hardware," Moller says. Moller holds the worldwide patent on this combined system, as he does on six of the 70 changes he built into the engines.

Two engines are to be mounted in each of four nacelles. The synchronized, counterrotating fans face toward each other to confine prop-tip noise to the center of each nacelle. The engines themselves are muffled with another Moller invention: the Supertrapp muffler, which will keep noise down to less than 30 percent of that from a Cessna on takeoff, according to Moller.

Moller created the muffler technology years ago. It evolved into the world-renowned Supertrapp motorcycle muffler, which, as a \$4-million-a-year company, helped finance his commuter vehicle work.

The Moller 400

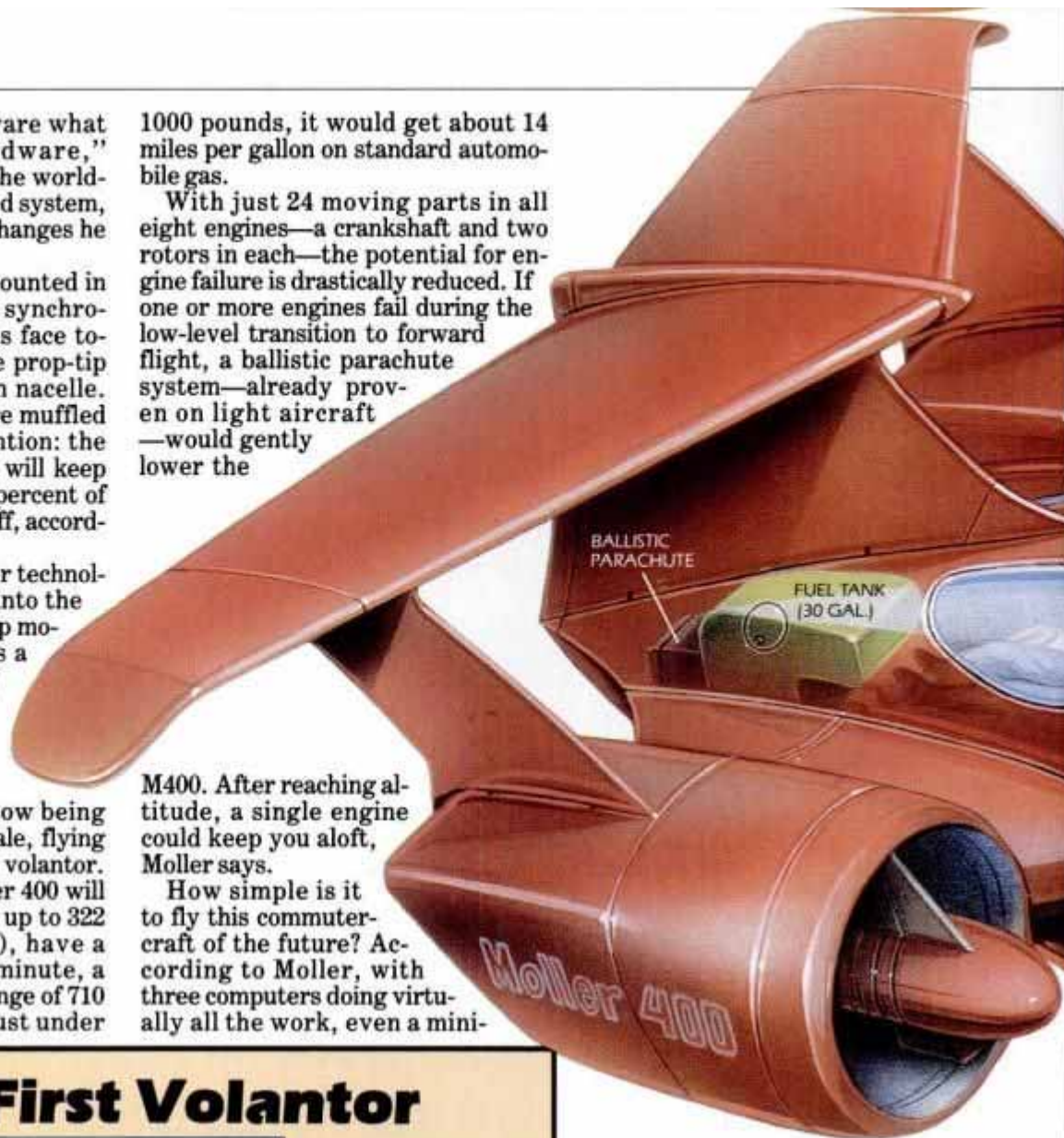
Moller's innovations are now being combined in the first fullscale, flying prototype for a production volantor. The nearly completed Moller 400 will carry four people, cruise at up to 322 mph (top speed 420 mph), have a climb rate of 6300 ft. per minute, a ceiling of 40,000 ft. and a range of 710 miles. With a payload of just under

1000 pounds, it would get about 14 miles per gallon on standard automobile gas.

With just 24 moving parts in all eight engines—a crankshaft and two rotors in each—the potential for engine failure is drastically reduced. If one or more engines fail during the low-level transition to forward flight, a ballistic parachute system—already proven on light aircraft—would gently lower the

M400. After reaching altitude, a single engine could keep you aloft, Moller says.

How simple is it to fly this commuter-craft of the future? According to Moller, with three computers doing virtually all the work, even a mini-



The First Volantor

● Three years ago, Paul Moller climbed aboard the saucer-shaped XM-4 and achieved his first manned flight. Only a handful of technicians, investors, friends and a photographer witnessed the event.

Fifteen months later, he was ready to give the public a glimpse. After donning his motorcycle helmet, he began flipping switches to kick each tiny but powerful engine to life. One after another—Bbbr-rup-bbrrup-hhmmm. Within a matter of seconds, he lifted off. With only a crane-operated safety tether (insurance company required) connecting him to the rest of the world, he rose evenly, firmly a few feet, paused, turned slightly, then moved slowly up and over a grassy area behind his plant, reaching an altitude of 40 ft. The flight lasted just over 3 minutes. "It's



The M200X tests volantor concepts—and offers hope to frustrated commuters everywhere.

exciting, but scary," he said after landing. Especially since there were some stiff winds he had to adjust for manually. The Moller 400, he believes, will be almost insensitive to such buffeting because of its small wing surfaces.

Moller's present test-bed craft—the M200X—is the third he has built. The first, a marginally stable contraption that delighted neighborhood kids on an otherwise quiet Davis, California, street, had two huge fans, but never managed more

than 36 in. of altitude. The later XM-3 drove on a single fan with eight engines. This tester reached just 2 ft. of altitude in 1968.

But the M200X, which evolved from the XM-4, flies. Not far, nor high, nor fast—but enough to cause the hopes of commuters to soar. **PM**

mally skilled pilot shouldn't have any trouble. "I could put you on a simulator for 2 hours, maybe less, and be 100-percent confident that you'd be able to fly the craft satisfactorily," he says.

The pilot has to be familiar with only two controls. "You've got a lever on your left which selects altitude and rate of climb," Moller says. "The joystick on the right determines where you want to go. You turn it, and it points the aircraft in that direction. That's it. How do you get in trouble with that? There's no real skill involved at any point of this operation, aside from familiarization with what those levers do."

Why is Moller so confident that all of this will work? Because he has flown more than 200 manned and unmanned flights with the XM-4 and M200X since 1970, and performed 3500 hours of flight tests with both powered and unpowered vehicles in his own 200-mph wind tunnel.

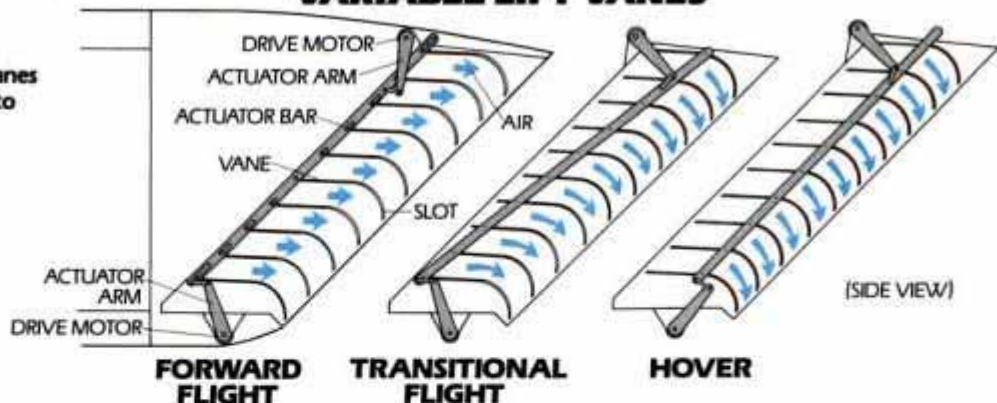
Gridlock buster

When the M400 gets off the ground, it will mean more than just the realization of a dream. It may be the solution

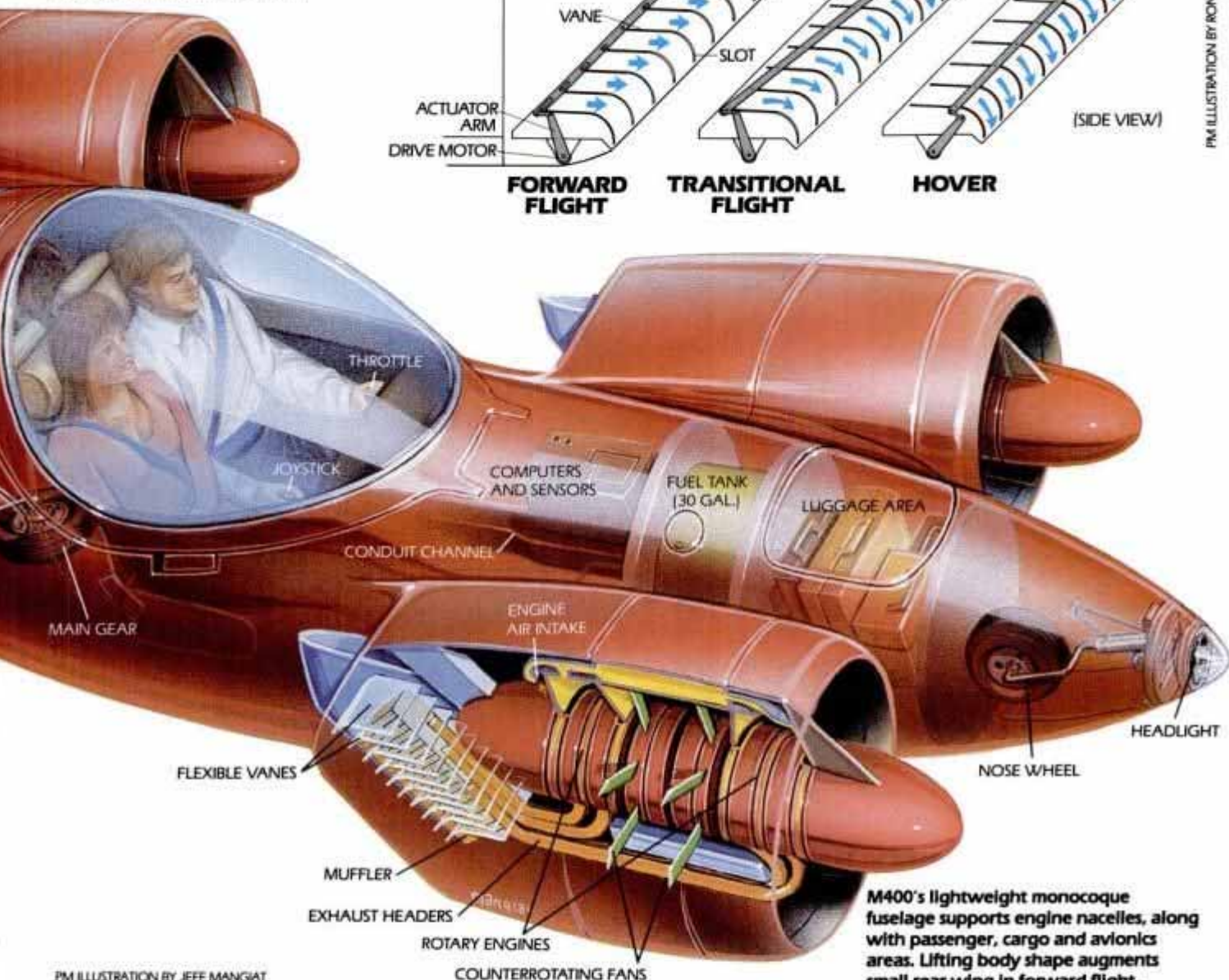
INSIDE THE MOLLER 400

Moller's patented variable-exit guide vanes (right) slide in slots, like a rolltop desk, to change the direction of thrust.

VARIABLE LIFT VANES



PM ILLUSTRATION BY RON CARBONI



M400's lightweight monocoque fuselage supports engine nacelles, along with passenger, cargo and avionics areas. Lifting body shape augments small rear wing in forward flight.

PM ILLUSTRATION BY JEFF MANGIAT

to an impending crisis in American transportation. James Pitz, president of the American Association of State Highway and Transportation Officials and Michigan's transportation director, says, "We know traffic is probably going to double by 2010." In California, the state department of transportation's Office of Technology and Research Chief John Vostrez says, "Demand is going up something like 6 percent a year."

As the chief planner of traffic solutions for the nation's largest state, Vostrez is working on such futuristic concepts as "smart highways" with automated spacing between vehicles and on-board computers linked to a central information source. But after visiting Moller's plant, he says Moller's work "makes the technology

we're working on look fairly mundane."

Moller's unique craft also fuels the imagination of the chief of California's State Aeronautics Division, Jack Kemmerly. He is excited to see Moller combining advances in VTOL technology with fly-by-wire control. "If and when that accomplishment takes place—and in my mind I know that it will—Paul Moller will have struck gold with a technology that has real applications," Kemmerly says.

"The biggest drawback would be perhaps how we are going to utilize the airspace if we have a large number of small flying commuter vehicles. Of course, that can be handled," Kemmerly says.

Moller says all of the technical problems have been solved. Product liabil-

ity pressure—which he thinks is outrageous in this country today—and money are the only limiting factors now.

"If sufficient funds were available," he says, "we could have this thing through the transition phase and be demonstrating it three months from now." He says he could be producing several thousand a year by 1995.

At that level, each would cost about \$100,000. But if he could produce 40,000 a year, they would carry a price tag no greater than a luxury car.

So far, 65 \$5000 deposits have been made by those who share the M400 dream. They may not have long to wait. Having proven his concepts with a flying saucer, Moller says of his M400 prototype: "I'll fly it this year. I have no doubt of that." **PM**

VIDEO TO GO

Take them anywhere. Camcorders are smaller and lighter than ever.

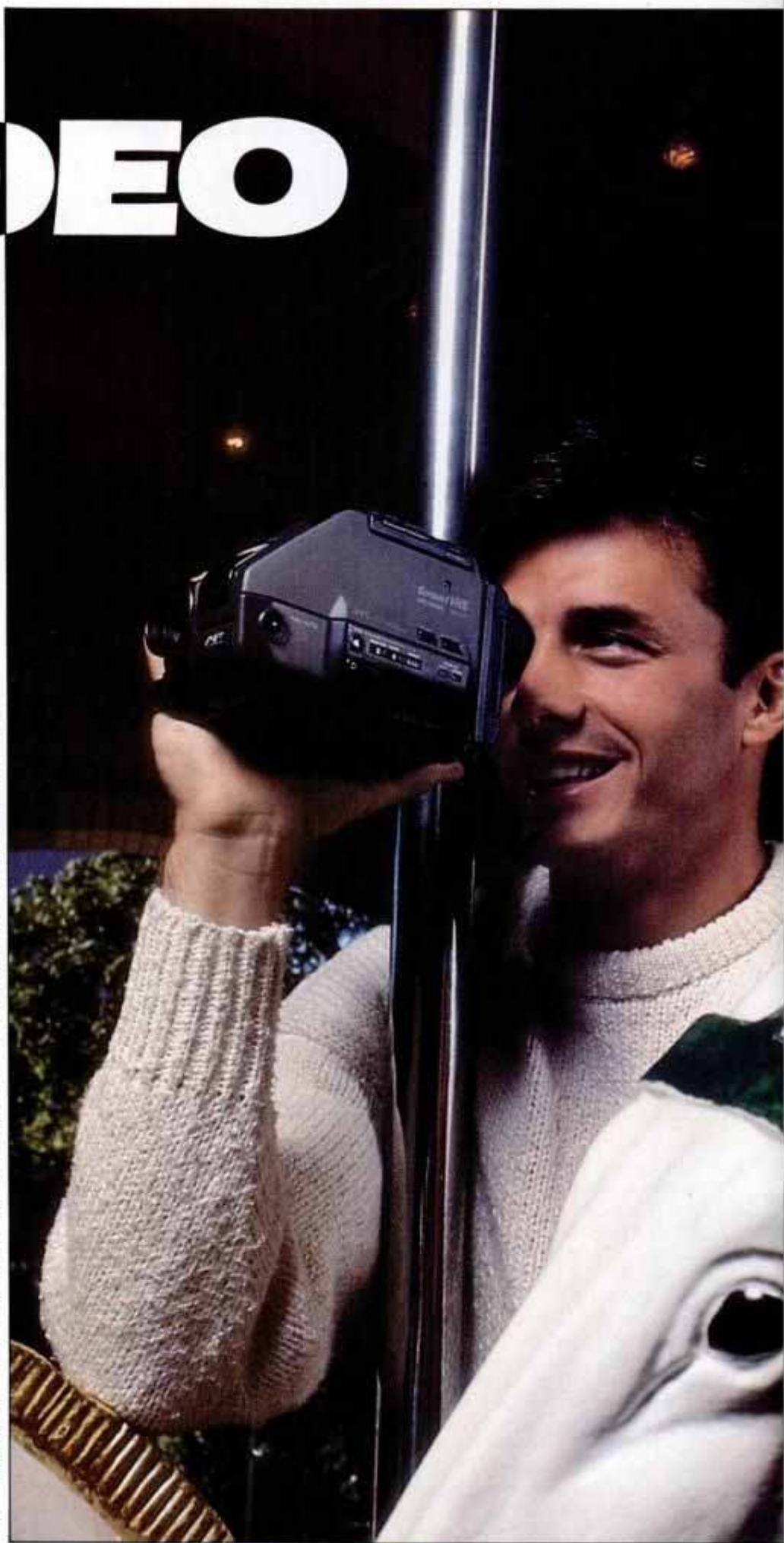
BY STEPHEN A. BOOTH,
Contributing Editor

● Small and light describes what's on tap for the new breed of camcorders that is ringing in the 1991 model year. They're small enough to nestle comfortably in the palm of your hand and, weighing in below 2½ pounds, won't put undue stress on your wrist. Most important, small and light doesn't mean stripped down—either in performance or features.

The pacesetters in subcompact camcorders can be found in both the 8mm and VHS-C video formats. The 8mm format permits up to 2 hours of recording on a tape about the size of an audio cassette. VHS-C cassettes—the C stands for compact—are miniaturized versions of the VHS cassettes used in home VCRs. They hold enough tape for either 30 minutes of recording in the standard-play mode or 90 minutes in the extended-play mode (at some sacrifice of image and sound quality). Because they use the VHS recording system, VHS-C cassettes can be played back in VHS home VCRs when inserted in an adapter shell. And since 8mm tapes are thinner and use a different recording system, it's necessary to connect the camcorder to a TV or VCR via cables to view the cassettes.

For making smallness a big feature in camcorders, credit must go to the 8mm video format—in particular, the Handycam line of handheld movie-

At left is JVC's GRAX7U VHS-C sharing a ride with RCA's Pro850 8mm camcorder.





PM PHOTO BY ROY ATTAWAY



**CHINON
CB-SC96**

makers from Sony. Increasing demand for this diminutive format has prompted major companies such as RCA, Zenith, Fisher and Hitachi to introduce their first 8mm camcorders.

Meanwhile, the VHS-C format still manages to keep pace with 8mm in the trim-and-slim category. The very name of Panasonic's new camcorder line sums it up nicely: Palmcorder. And Quasar's name for its subcompact line—QuarterBack—uses football imagery to convey the concept of maneuverability and a 1-handed grip.

Based on PM's firsthand evaluation of the subcompacts, performance does not suffer in the areas of sharpness, resolution, low-light sensitivity and sound. Nor do the subcompacts lack the amenities found on larger camcorders. These include multiple high-shutter speeds for freezing action, continuous white balance for adjusting to variations in lighting and flying erase-heads for noise-free transitions between different scenes in your movies. Zoom ratios are either 6x or 8x—only a handful of larger camcorders boast more.

Moreover, the subcompacts frequently incorporate creative functions such as digital superimposers, character generators and time-lapse recording. Digital superimposers let you shoot artwork, lettering or other graphics material, then overlay it on the video image. Character generators permit you to type out letters and numbers to create titles for your videos. Time-lapse recording opens up a world of creative possibilities, such as cartoonlike animation. Finally, some subcompacts permit you to execute wipes, fades and other professional-like special effects.

How they do it

Instead of chintzing on performance and features, the subcompacts achieve their economies in size and

weight through new designs in lenses, autofocus systems and tape transports, and also by paring down power requirements.

For example, the lenses no longer protrude from the camcorder body, nor do they rack forward and back as they zoom. Instead, the lens remains flush with the front of the camcorder body, thanks to lens elements that alter focal length internally.

Further reductions in size and weight have been achieved by shrinking the volume of the tape-transport mechanism—the part of the camcorder that handles the cassette and feeds tape to the recording heads. As often as not these days, the already-tiny head drum houses micromotors and other circuitry in its hollow core.

If camcorders are smaller and lighter than ever, so too are the rechargeable batteries that power them. The smaller size of the power source doesn't mean less juice and less running time. If the battery pack is smaller, it's because the new models boast more-efficient motors, low-voltage circuitry and fewer moving parts (such as the lenses) which require less power than before.

Also contributing to the smaller size of camcorders is the autofocus (AF) system. Some models now use through-the-lens (TTL) AF, instead of an outboard (usually infrared) mod-

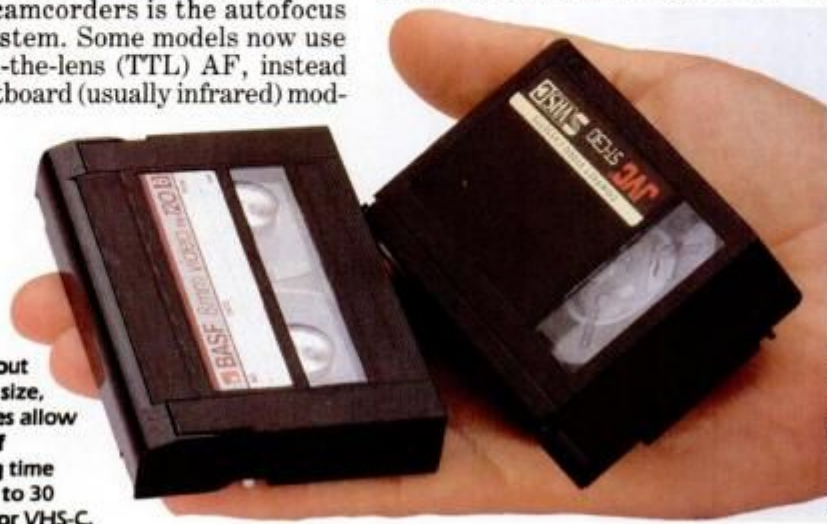
ule mounted elsewhere on the camcorder. This was a cause for concern in the earliest subcompacts.

Camcorders use one of three kinds of autofocus systems. Infrared (IR) rangefinding is the simplest. Basically, from a module mounted on the camcorder body, a transmitter bounces an IR beam off the subject, and a receptor in the same module picks up the reflected beam to measure distance to the subject. This information is constantly passed along to the lens motor to maintain focus.

TTL-AF systems are more complex but more compact because they do not take up the real estate required for a separate module. There are two kinds of TTL systems: phase detection and blur reduction. Instead of performing simple rangefinding, they monitor the quality of the incoming video image—either the amount of light or the degree of contrast.

Phase detection measures the amount of light passing through the zoom lens. A splitter trains images from the extreme left and right points of the lens onto a detector chip. A comparator here signals the lens motor to make adjustments so that left/right images are identical. Blur-reduction measures video frequencies. A sharply focused image will have more high-frequency information than a blurry one. A microprocessor directs the lens motor to move in such a way as to track the highest-frequency signals.

Judging by the latest models, TTL-AF systems have improved considerably compared to their application in the first subcompacts—namely Sony's Handycam CCD-TR5 and its derivative versions. As reported in *POPULAR MECHANICS* (Home Video, April '90, page 127) and elsewhere, the TTL-AF system appeared slow and indecisive in coming to focus when asked to track moving subjects to the extreme (6x telephoto) focal



While about the same size, 8mm tapes allow 2 hours of recording time versus 20 to 30 minutes for VHS-C.

PM PHOTO BY BILL ASHE

SONY TR4



PANASONIC PALMRECORDER



length of the zoom lens. This shortcoming was not apparent in any of the TTL-AF subcompacts evaluated for this article. Despite the improvements in TTL-AF, companies such as Hitachi and RCA have chosen to stick to the tried-and-true IR rangefinding autofocus, with excellent results.

What's available: 8mm

Of the many 8mm camcorders introduced recently, a dozen that qualify as subcompacts hail from Canon, Chinon, Fisher, Hitachi, Minolta, Nikon, Olympus, Pentax, RCA, Ricoh and Sony.

Sony's three newest models carry on the tradition established last year with the Handycam CCD-TR5—at the time, the smallest, lightest camcorder available. The new CCD-TR4 (\$1100) now holds the smallest/light-

est title, measuring only 4 3/8 in. wide x 4 1/8 in. high and 6 5/8 in. from lens to viewfinder. It weighs just 1 pound 9 ounces without tape and battery—under 2 pounds in any case. Among other features, it packs a 6x variable zoom lens and four shutter speeds, the fastest being 1/4000 second.

Ricoh's R-66 (\$1099) and Nikon's VN-300 (\$1100) are similar to the TR4. Ricoh's R-66 offers six shutter speeds. So does Sony's CCD-TR6 (\$1200), but this model ups the ante with an 8x zoom and a studio full of features at an infinitesimal increase in size and weight. At the top of Sony's subcompact line is the CCD-TR7 (\$1400), which adds hi-fi stereo sound recording and a higher-resolution image pickup with no appreciable increase in bulk.

Also light in weight but heavy on

features are the RCA Pro850 (\$1299), Hitachi VM-E10A (\$1100), Minolta Master 8-406 (\$1270), Pentax PV-909A (\$1299) and Chinon's C8-SC96 (\$1595) and C8-SC98 (\$1795).

The Chinon C8-SC98 is particularly noteworthy due to its 8x zoom and a long list of digitally generated creative features. These include the ability to trigger scene transitions with eight different patterns for wipes and fades—including diamonds, squares and stripes, either soft or sharp.

Perhaps the most novel styling among the new handheld 8mm camcorders can be found in models from Canon, Fisher, Olympus and Pentax.

The Fisher FVC-880 (\$1300), Olympus VX81 (\$1999) and Pentax PV-EM100A (\$1299) share a binocular-like shape and are held in the same fashion. They're also offbeat in their use of "fuzzy logic" or artificial intelligence for autofocus—a technology that claims to evaluate focus and exposure conditions more thoroughly than other systems, and more quickly. Despite their unconventional design and technology, these models weigh in around 1 pound 9 ounces (without battery), boast a 6x variable-speed zoom and six shutter speeds.

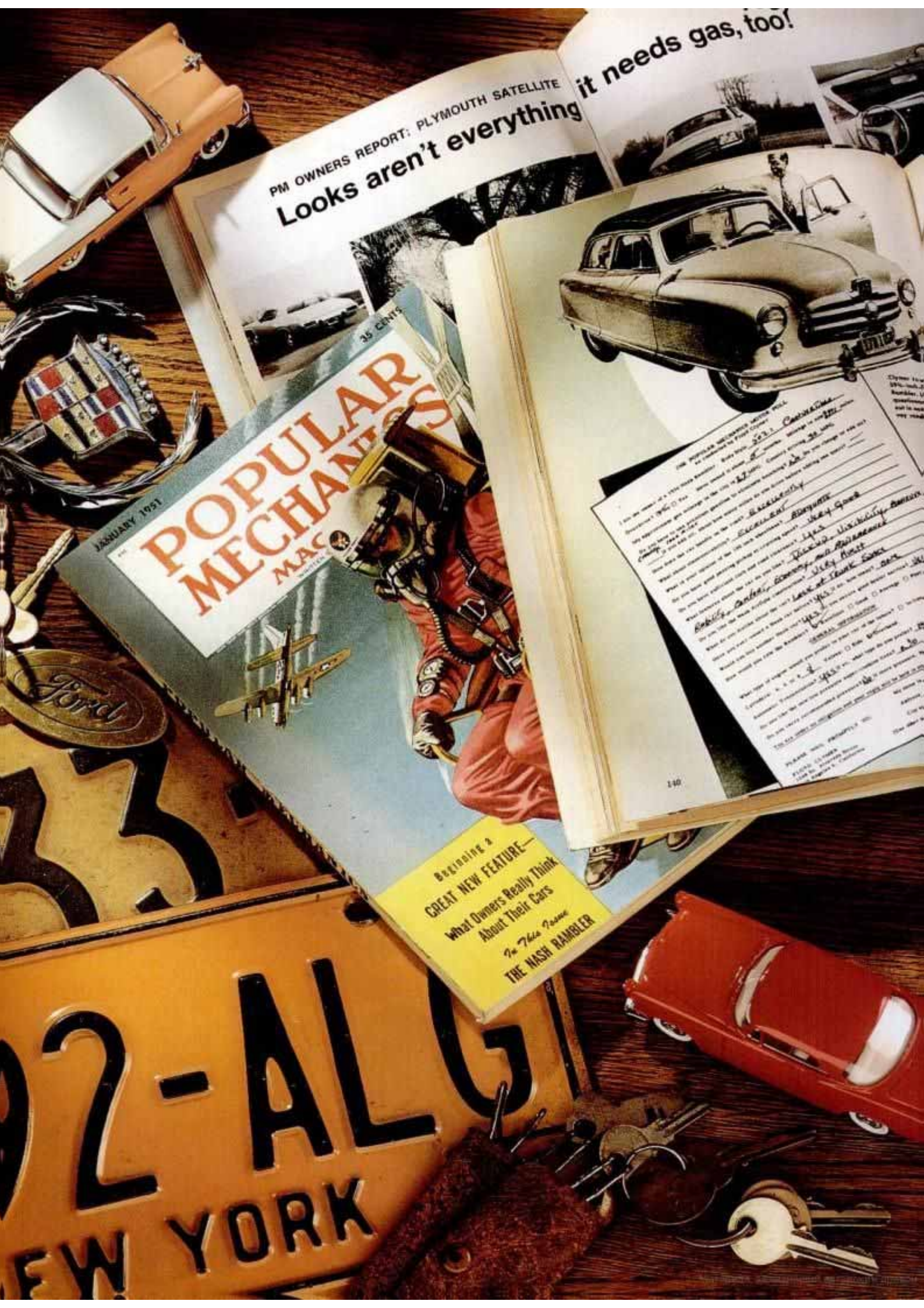
Canon's E08 (\$1549) also uses fuzzy-logic TTL-AF. But the 2-pound moviemaker shares the triangular styling of Canon's top-of-the-line A1 Series camcorders and shoehorns the A1's studio-full of special effects into a more compact package. These effects include hi-fi stereo sound, digital superimposer, 8x 2-

(Please turn to page 86)

OLYMPUS VX-81



PHOTOS BY BILL ASHE



PM OWNERS REPORT: PLYMOUTH SATELLITE
Looks aren't everything

it needs gas, too!

JANUARY 1951

POPULAR MECHANICS

35 CENTS

Beginning a
GREAT NEW FEATURE—
What Owners Really Think
About Their Cars
In This Issue
THE NASH RAMBLER

2-ALG
NEW YORK



THE NASH RAMBLER SURVEY FORM

Do you own a 1951 Nash Rambler? Yes No
If you own a 1951 Nash Rambler, please answer the following questions. If you do not own a 1951 Nash Rambler, please check the appropriate box.

What is your age? 32 years
What is your occupation? Business
What is your annual income? \$3,000
What is your highest grade of schooling? High School
What is your present car? Nash Rambler
What is your present car's make? Nash
What is your present car's model? Rambler
What is your present car's year? 1951
What is your present car's color? Light Blue
What is your present car's engine? 4-Cylinder
What is your present car's transmission? Manual
What is your present car's drive? Front
What is your present car's fuel? Gasoline
What is your present car's horsepower? 50
What is your present car's top speed? 70 mph
What is your present car's acceleration? Good
What is your present car's handling? Good
What is your present car's steering? Good
What is your present car's braking? Good
What is your present car's visibility? Good
What is your present car's ride? Good
What is your present car's noise? Low
What is your present car's maintenance? Easy
What is your present car's economy? Good
What is your present car's fuel economy? 25 mpg
What is your present car's overall rating? Very Good

PLEASE MAIL THIS FORM TO:
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ASK THE MAN WHO OWNS ONE

riences, and put the data in order and attempt to interpret the results.

Mileposts

Culling through 40 years of Owners Reports has produced some interesting sidelights. Did you know, for example, that early 1955 Chevy V8s burned oil? When Floyd Clymer asked Chevy for an explanation, the engineers said the chromed piston rings in early small blocks seated slowly. And sure enough, as they put on more miles, owners did note that oil consumption went down.

The first import we surveyed was the 1952 MG-TD. As was the custom at the time, Clymer asked all respondents to give their cars an overall rating—either Excellent, Average or Poor. In the MG survey group, a surprising 74 percent saw their quirky little cars as Excellent.

In January 1954, Clymer polled owners of three rear-engined cars—the VW Beetle, the Porsche 356 and the Renault Dauphine. People generally hated the Dauphine, but loved its fuel economy—37.1 mpg city/43.9 mpg highway. Those figures stood as an O.R. record until the VW diesel Rabbit finally beat them in 1979. It took 31 years for a gasoline car to beat the Dauphine. That honor fell to the '84 Honda CRX at 43.1/52.2 mpg, marks that still stand.

The worst fuel economy ever recorded was for the 1970 Plymouth Barracuda 440 6-Pack V8—8.7 mpg around town. Others with an impressive thirst were the '72 Cadillac Eldorado (9.2/11.6 mpg) and the '71 International Travelall (9.7/11.5).

Sometime during 1954, Art Railton took over the Owners Report desk and supervised surveys of two early American sporty cars—the '54 Corvette and '55 Thunderbird. Corvette buyers said the fiberglass roadster leaked a lot, but liked its styling. Most of them also praised the Vette's 6-cylinder performance, despite the car's 2-speed Powerglide transmission.

Owners of the T-Bird, meanwhile, rated their car's power, performance and handling above its styling, and found the convertible top to be its biggest headache.

Another import that won hearts was the '56 Mercedes-Benz 300-SL. The elegant Gullwing coupe cost \$7500 back then, and 99 percent of the owners surveyed called it Excellent—the highest overall rating for any car through 1966, when the overall rating system was discontinued.

Before leaving the era of overall ratings, we should note that the 1955 Packard finished right behind the Gullwing at 97-percent Excellent.

ALL-TIME BEST

OVERALL RATING

The classic Gullwing coupe cost only \$7500 in 1956, much less than a Lincoln Continental Mark II. Of owners in survey, 99 percent gave the 300-SL an overall rating of Excellent, 2 percent more than the 1955 Packard.



MECHANICAL PROBLEMS

Only 10 percent of LS400 owners were able to list any mechanical problems with their new cars, and complaints were too scattered to suggest any pattern. Ford Probe (1989) and Honda Prelude (1988) also scored high marks.



WORKMANSHIP

Consistent with LS400's mechanical excellence, owners also gave their cars highest-ever scores for fit and finish—almost 98 percent of survey group rated the car's workmanship as Excellent. Runners-up in this category were 1975 BMW and 1972 Toyota Celica.



FUEL ECONOMY

CRX delighted its owners with exceptional fuel economy—43.1 mpg city, 52.2 highway. Renault Dauphine set a long-standing gas mpg record in 1953 at 37.1/43.9. Dauphine's mpg record stood until the diesel Rabbit.



DEALER SERVICE

Toyota's new Lexus division narrowly edged Honda's Acura organization for all-time best rating in dealer service. Other highly regarded dealer services over the years belonged to Pontiac, Chrysler Corp. and Studebaker.



FM PHOTO BY HUMPHREY SUTTON

ALL-TIME WORST

OVERALL RATING

Ford Motor Co. quality was in question in the late '50s, according to surveyed owners. The 1958 Lincoln drew the worst overall rating in O.R. history—almost 17 percent called it Poor, followed closely by the 1957 Mercury and the 1957 Ford.



MECHANICAL PROBLEMS

Problem-plagued Fiat 131 won the dubious distinction of the most trouble-prone car in Owners Report history. Runners-up for this distinction were the sporty 1969 American Motors AMX and the early (1975) edition of the VW Rabbit.



WORKMANSHIP

Although owners have been uniformly enthusiastic about their Corvettes since the first Vette survey (1954), the 1980 model scored the worst-ever mark for workmanship: Almost 28 percent of the owners surveyed called workmanship in their cars Poor.



FUEL ECONOMY

Propelled by a fire-breathing 440-cu.-in. Hemi V8, the 6-Pack Cuda had prodigious performance—and the thirst to go with it: 8.7 mpg around town. The '72 Cadillac Eldo and the '71 International Travelall were almost as bad.



DEALER SERVICE

Although the car itself didn't show up in any of the All-Time Worst O.R. ratings, Yugo dealers took a beating from the owners: 22 percent rated Yugo dealer service departments as Poor, the lowest service rating ever.



Our worst overall rating went to the '58 Lincoln—16.9 percent rated it as Poor. Then came the '57 Mercury, followed by the '57 Ford.

Turning to the other end of the price spectrum, the VW Beetle was well on its way to fame and fortune when we ran a survey in 1956. Built to last, with a good dealer network, it was not surprising that 95.8 percent rated the Bug as Excellent.

When the Corvair came along in 1960, owners, who had yet to hear of Ralph Nader, had high praise for their cars' handling.

Import invasion

Led by the spiffy Datsun 240Z, Japanese cars were really coming into their own. Our survey on the 1972 Z-car reflected enthusiasm for performance and criticism for the air-conditioning system.

Then the first oil crunch came along, and Japanese cars were on the board in a big way. Over 92 percent of 1974 Honda Civic owners said they'd buy again, and 91 percent of 1977 Honda Accord owners said the same.

During the same period, 43.7 percent of Mustang II owners said they would not buy again, as did 44.4 percent of Pontiac Sunbird owners.

Winners and losers

Back in the '50s and '60s the "would-buy-again" favorites (in order of percentages) were: the '66 AMC Rambler, '54 Buick Roadmaster, '66 Pontiac Tempest and '65 Ford Falcon.

In the '70s, top buy-again cars were the '78 Olds Diesel, '79 Mazda 626, '70 Mercedes and the '72 Saab 900.

In recent times, top buy-again picks were the '90 Lexus LS400, '83 Ford T-Bird and '87 Acura Legend.

The Lexus also had fewer mechanical problems than any car we've ever surveyed—89.9 percent reported their cars as troublefree. The Ford Probe is second with 87.3 percent reporting no problems. Another accolade for Lexus: 97.7 rated its workmanship as Excellent.

The most trouble-prone car we've ever recorded was the '79 Fiat 131, followed by the '69 AMC AMX and '75 VW Rabbit. The worst workmanship score, at 27.6-percent Poor, went to the '80 Corvette.

As for dealer service ratings, Yugo owners were the most dissatisfied as a group, 22 percent rating their dealers as Poor. Lexus was tops in this category, too, with Acura close behind.

What all this proves is that owners aren't often fooled after they've lived with their cars for a while. And that's why we plan to keep asking the men—and women—who own them. **PM**



**IMPULSE
600H**

**STANDARD
HORIZON HX220S**

**KING
7500**

**SMR
SEA LAB 9600**

**RAY JEFFERSON
987**

SLIGHT OF HAND

Lab testing the new breed of inexpensive marine VHF handheld radios.

BY JIM YOUNGS AND FRANK C. BARR, President,
Advanced Product Evaluation Laboratory

● Even a seasoned skipper is put to the test on a day that starts out calm and suddenly turns blustery. The biggest fear is equipment failure. You could wind up far from shore and dead in the water. What then?

At a time like this, a VHF radio is a lifeline connecting you to other boats, marinas, weather channels and the Coast Guard.

The good news for skippers of small, trailerable boats is that handheld VHF radios have come a long way in recent years. They're compact, lightweight and loaded with features. They're affordable, too.

Test Parameters

We wanted to see how far these mini-marvels have come, so we decided to put five units in the 6-watt power range to a comparison test. We turned them over to our test partner Advanced Product Evaluation Laboratory (APEL) for analysis and then used them in real-world applications.

Lab testing was conducted in a certified radio-frequency (RF) shielded room, using constant power sources and monitoring equipment.

Transmitter tests included: 1. RF output power, which is the power delivered to the antenna; 2. Battery current drain, at both high- and low-power settings; and 3. Spurious (unwanted) signal suppression, which is measured in decibels down from the carrier signal.

Note that the higher the RF output power, the stronger the transmitted signal. Strength is good for open-sea use, but in the harbor, FCC regulations limit output to 1 watt on the low setting. As far as battery current drain goes, the lower the better. Receiver tests included the following:

Sensitivity—The minimum input signal at the antenna that will cause background noise to be reduced by 12 dB. The smaller the better. All units scored well here.

Squelch Threshold—The minimum signal that will cause the receiver to switch from a quiet state to an open state. Again, the lower the better. And, again, all were comparable.

Adjacent Channel Rejection—The ability to differ between a desired signal and an undesired one. It's expressed in negative decibels below the carrier signal. The greater the better. All units performed well.

Noise—The signal-to-noise ratio measured in decibels. The larger the better. Differences were evident.

Audio Output Power—The electrical output rating of the receiver. It's an electrical measurement shown in watts. Again, there were differences.

Acoustic Output—The measurement of sound taken at 1 meter using the A-weighted (attuned to the human ear) sound scale. This is an important category, especially aboard a boat on a stormy sea. The louder the better.

Each radio was also subjected to a

vibration test that shook the units for 15 minutes in three planes. The units were then dropped several times from a height of 2 ft. onto concrete. All units passed both tests.

The final test put the units through temperature extremes. After 12-hour intervals at 122° F, 68° F and -5° F, each radio was removed from the environmental chamber and tested for performance. All units passed the test except the King radio, which required 8 minutes to warm up after the low-temperature interval.

Impulse 600H

Our comparison test champ, the Impulse 600H, also turned out to be our least expensive unit. Most impressive was the fact that it had the loudest level with the least amount of noise. It also had the highest battery voltage and was among the lowest in current drain, which translates into long battery life between charges.

The controls on this 6-watt radio are simple and easy to use. The thumbwheel channel selector, squelch knob, volume control and battery indicator are on top for easy access. The switches for high/low output and instant Channel 16 are on the front. Perhaps the only drawback is size. It's the largest of the test units and among the heaviest.

The unit has 82 channels, nine of which are for weather information. One of the things we especially liked

SLIGHT OF HAND

was that it was the only unit to deliver more power than it was rated for. Superior performance, low price. It's a combination that's hard to beat.

Standard Horizon HX220S

The Standard Horizon, our second-rated radio, is the test's most compact unit. It has a large LCD display that shows huge numbers and prompts. Big knobs and smooth operating controls facilitate use with gloved hands.

To compensate for the test's weakest battery, the Standard measured among the lowest in battery drain in the receiver mode. It was the clear leader in audio output power, but trailed in acoustic volume.

The 6-watt Standard has a whopping 160 channels plus 10 weather channels. It's also expandable. One of the handiest features is a programmable scan mode that enables monitoring of several channels at once. Among our favorite options is a quick battery charger.

Compactness and extensive features don't come cheaply, and the Standard is the most expensive unit. This is an important factor considering it has the smallest battery and came up shy of its 6-watt rating.

King 7500

The King transceiver, our third-rated model, scored top marks in spurious signal suppression and current drain in the receiver modes. It also scored

well in audio output power, ease of use and squelch threshold.

This model, however, was the only unit that had trouble with our low-temperature test, so if you're boating in the Arctic Ocean, keep it warm. It required 8 minutes at room temperature before functioning properly.

The controls are well-marked and easy to use, but we found the display numbers somewhat thin. Quick access to Channel 16 is provided by a red button on the keypad. And a handy cheat-sheet label lists important functions. It's equipped with the second-most-powerful battery.

The premium-priced 6-watt King has 135 channels plus 10 weather channels. Optional accessories include a spare battery pack, a remote speaker/microphone and an external antenna adapter.

SMR SL 9600

The SL (Sea Lab) 9600 came out on top in sensitivity, squelch and current drain in the transmit modes. It finished middle of the pack in most other categories.

Like the Impulse radio, it's an analog unit equipped with thumbwheel channel selectors. Unlike the Impulse, the Sea Lab has an awkward protective cover on the controls, which keeps everything watertight, but somewhat hampers operation.

The Sea Lab features a handy dual-watch position that enables you to monitor Channel 16 and one other

channel at the same time. It has 78 channels and eight weather channels.

Ray Jefferson 987

The 5.5-watt Ray Jeff took top honors for adjacent channel rejection. It scored well in sensitivity and tied with the leaders in current drain in the receiver modes.

It has a complex 10-button keypad that enables you to enter channel numbers without having to scroll through them. Also included are buttons for seek, scan and instant access to Channel 16. The unit comes with a range of 55 transmit channels and 90 receive channels.

The LCD display is somewhat small, but the numbers are big. Compactness is the Ray Jeff's hallmark. It ranked second in size and first in weight, a mere 1.21 pounds. It was second lowest in price, too.

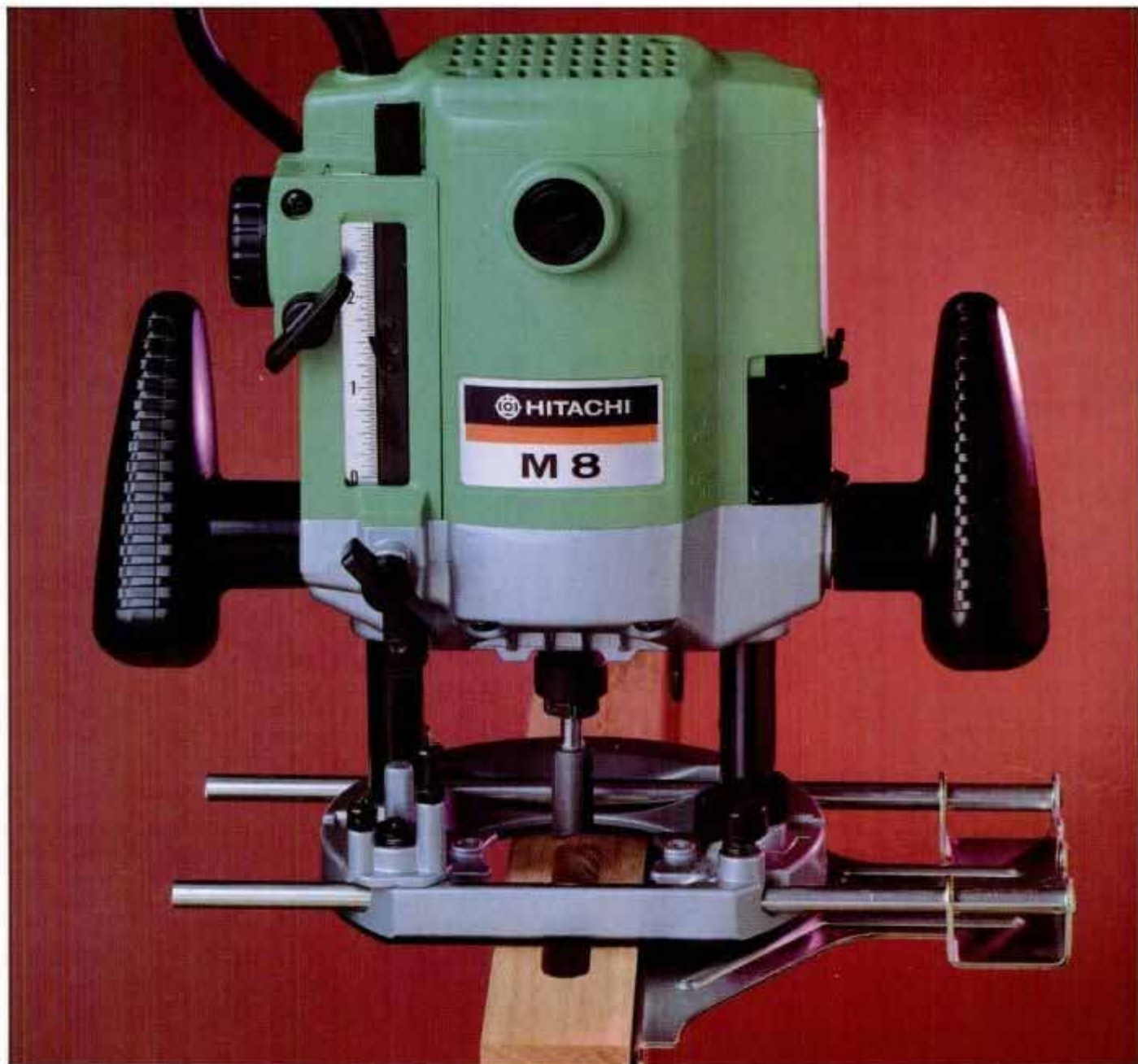
With such divergent approaches to VHF technology, we were impressed at how close these transceivers came out in lab tests. The main differences were found in areas that most comparison shoppers would check first: size, weight, ease of operation, speaker loudness, battery strength and price—which is often lower than the suggested figures listed here.

The next time you venture out on a calm, clear day, remember that one of these minimarvels may just be your lifeline to shore. Our VHF radio test proves they're dependable, so don't leave the marina without one. **FM**

MARINE RADIO TEST RESULTS					
MAKE/MODEL*	1. IMPULSE 600H	2. STANDARD HX220S	3. KING 7500	4. (tied) RAY JEFF 987	4. (tied) SMR SL 9600
DIMENSIONS (in.)/ WEIGHT	5. 2.7 × 1.7 × 8.3/ 3. 1.31 lb.	1. 2.6 × 1.6 × 7.2/ 2. 1.24 lb.	3. 2.6 × 1.6 × 8.2/ 4. 1.38 lb.	2. 2.7 × 1.8 × 7.4/ 1. 1.21 lb.	4. 2.9 × 2.0 × 8.1/ 5. 1.39 lb.
BATTERY	1. 13.6 volts	5. 10.0 volts	2. 13.2 volts	4. 10.8 volts	3. 12.0 volts
TRANSMIT POWER HIGH/ LOW	1. 7.0 watts/ 2. 1.1 watts	4. 5.5 watts/ 5. .325 watts	2. 6.0 watts/ 3. .9 watts	5. 5.1 watts/ 4. .8 watts	3. 5.8 watts/ 1. 1.15 watts
TRANSMIT CURRENT DRAIN HIGH/LOW	2. 1.1 amps/ 2. .46 amps	5. 1.7 amps/ 4. (tied) .55 amps	3. 1.2 amps/ 3. .49 amps	4. 1.4 amps/ 4. (tied) .55 amps	1. .75 amps/ 1. .39 amps
SPURIOUS SIGNAL	2. (tied) -68 dB	3. -65 dB	1. -69 dB	2. (tied) -68 dB	4. -61 dB
CURRENT DRAIN RECEIVE/ IDLE	2. .18 amps/ 4. .092 amps	1. (tied) .15 amps/ 2. .062 amps	1. (tied) .15 amps/ 1. .048 amps	1. (tied) .15 amps/ 3. .065 amps	3. .21 amps/ 5. .093 amps
SENSITIVITY/ SQUELCH THRESHOLD	3. .23 microvolts/ 4. .26 microvolts	2. (tied) .20 microvolts/ 3. (tied) .22 microvolts	4. .30 microvolts/ 2. .20 microvolts	2. (tied) .20 microvolts/ 3. (tied) .22 microvolts	1. .19 microvolts/ 1. .19 microvolts
ADJACENT CHANNEL REJECTION	2. (tied) -67 dB	4. -65 dB	3. -66 dB	1. -69 dB	2. (tied) -67 dB
NOISE	1. 49.5 dB	2. 48.5 dB	5. 44 dB	4. 47.5 dB	3. 48.0 dB
AUDIO OUTPUT POWER/ ACOUSTIC OUTPUT	4. .245 watts/ 1. 89.3 dB	1. .475 watts/ 5. 82.1 dB	2. .405 watts/ 4. 83.3 dB	3. .320 watts/ 3. 84.2 dB	5. .211 watts/ 2. 87.4 dB
EASE OF USE	1. (tied) Best analog	1. (tied) Best digital	2. Quick, easy access	3. Complex keypad	4. Analog, but awkward
CONSTRUCTION	2. Large, but solid	1. Super compact	3. (tied) Good overall	3. (tied) Good overall	4. Sufficient
PRICE	\$329	\$659	\$629	\$399	\$499

* Bold numbers denote comparison rank.

JOURNAL



COMPARISON TEST

PLUNGE ROUTERS

Six leading-edge routers in a bit-spinning test of power and versatility.

BY THOMAS KLENCK, Associate Home Improvement Editor
PM Photos by Stan Silver

● If you're like most woodworkers, you bought your first router for one reason—to create custom moldings and decorative edges that give your work a finished, professional look. However, that's not all that this miniature milling machine is capable of. It excels at shaping dadoes, grooves, rabbets and dovetails; following templates for consistent production work; and performing hundreds of other special tasks. And, when it's installed upside down in a router table, you have a scaled-down shaper at a fraction of the cost.

You probably discovered, however, that the standard router isn't well-

suited to cutting mortises, stopped grooves or other blind cuts where the bit must enter the wood away from the edge. In some cases, you can lean the router into the work, but this method isn't precise and has depth limitations.

The solution is the plunge router. It features a motor/collet assembly that's mounted on a base by means of two spring-loaded columns. With the base positioned firmly on the work, the cutter can be plunged straight down to accurately shape mortises or other internal cuts.

Our comparison test focuses on plunge routers in the 1- to 2-horse-



PORTER-CABLE 693

power range. These medium-duty tools are easy to handle, with power and features well-suited to the average woodworking shop. (For a look at how these routers compare with the standard variety, and with the super heavy-duty models, see page 53.)

Tool features

All plunge routers have certain common features (see drawing on page 51). In addition to the spring-loaded columns, they have a locking mechanism for holding the bit at a specific depth of cut. This is essential for edge-trimming jobs, as well as the usual plunge cuts. Most tools have a lever near one of the handles for locking the plunge action.

Plunge routers also have an adjustable depth-stop system that controls plunge depth. This is comprised of a depth-adjustment post that contacts the depth stop at maximum plunge. Most units feature a pivoting, adjustable depth-stop assembly that allows you to preset several depth positions. The top of the depth post references against a scale for easily measuring the plunge depth. The best systems have a scale-reset feature for setting the depth post indicator at a convenient position on the scale.

Only some of the routers that we



HITACHI M 8

tested have a fixed-depth adjustment rod. This enables you to adjust the height of the plunge stroke. Although it's not a requirement for ordinary plunge routing, it's useful for adjusting bit depth when edge trimming, or when using the router in a router table.

Our selection of routers uses three distinct collet designs (see illustration on page 54). In all cases, the tapered collet has split or notched sides and compresses around the bit shank as it's tightened. We found that the threaded collets (type A in the illustration) tend to tighten on the bit in use, making the collet difficult to unloosen. However, once the collet is loose, the bit is immediately free. The separate collet/nut design (type B) often requires tapping on the collet nut to free the bit after loosening the nut. Our favorite design (type C) features an annular spring that holds the collet in the collet nut. This design pulls the collet free from the bit shank when the nut is loosened.

Most of our plunge routers have combination round- and straight-sided bases. The straight edge is useful for accurately guiding the router against a guide strip. You can handle this job with a round base—however, our measurements revealed that



RYOBI R-151

these router bases can be as much as .016 in. off-center.

All of the tools can be fitted with guide bushings or a guide fence. In most cases, though, these are optional accessories (see specifications chart on page 54).

Elu 3303

The Swiss-made Elu represents Black & Decker's investment in the world of fine woodworking power tools. And, the model 3303 is indeed a well thought out and carefully made tool. It features polished steel columns that fit precisely in the housing for a smooth plunging action. And, the Elu uses an annular-spring-type collet design that makes bit removal effortless.

However, the Elu's most notable feature is its design. With one upright handle and one knob-type handle, this tool is equally at home with 1-handed edge trimming or 2-handed plunge routing. Plunge locking is handled with the knob—a simple twist of the wrist locks or loosens the plunge mechanism.

Needing improvement are the slot-head adjustable depth-stop screws—they look prone to damage if they're used often. The depth adjustment doesn't have a scale reset, and the



ELU 3303



MAKITA 3620



SKIL 1835

sliding switch is a little too far out of reach. Our biggest gripe is the lack of a fixed-depth adjustment rod, which would make this tool easier to use in a router table. This feature is available as an accessory, however, and takes the place of the adjustable depth post.

Elu delivers this tool with a guide fence and guide bushing adapter. A similar model with electronic variable speed (Elu 3304) is also available.

Hitachi M 8

The 1½-horsepower M 8 is the most full-featured of all the medium-duty plunge routers we tested. In fact, it's

almost a scaled-down clone of Hitachi's big 3-plus-horsepower models.

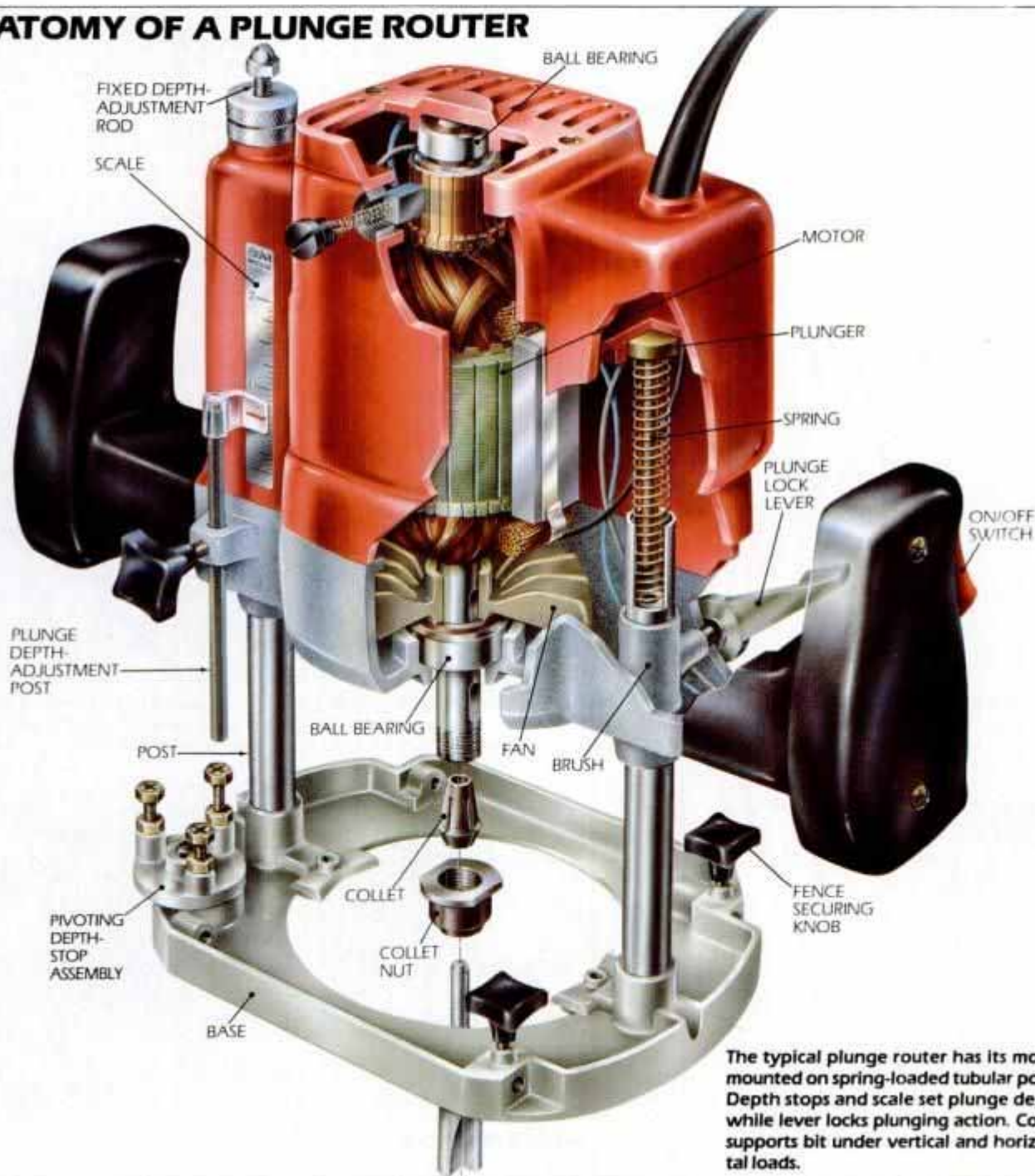
This very comfortable tool has a few special surprises that aren't evident at first glance. First, the angle of the handles can be adjusted to any of three positions by loosening the handle screws. Next, the depth-adjustment post/scale mechanism features a rather novel, and almost overly complicated, scale reset. Although you'll need the instruction manual to figure it out, you'll find that it's convenient and very precise.

The oversize ON/OFF switch mounted on the right of the housing is far

enough away to prevent accidentally switching on the tool, but large enough for fast operation. The tool has a shaft lock so only one wrench is required to remove the bit. However, Hitachi can improve this feature by either designing more stop positions on the shaft lock or using a hexhead on the collet. The tool has a no-frills, fixed-depth rod—a threaded rod with a few nuts—at the back.

On the down side, performance wasn't as smooth as the Elu, and the columns needed lubrication to improve plunge action. And, Hitachi should include a guide fence and bush-

ANATOMY OF A PLUNGE ROUTER



The typical plunge router has its motor mounted on spring-loaded tubular posts. Depth stops and scale set plunge depth while lever locks plunging action. Collet supports bit under vertical and horizontal loads.

PH ILLUSTRATION BY DON MANNING

ing adapter with a tool of this caliber and price.

Makita 3620

Like many other major manufacturers, Makita offers a heavy-duty plunge router that's gained wide acceptance in the professional wood-working community. The smaller model we tried suggests that Makita may have put all of its eggs in just one basket.

This tool is definitely not a multi-purpose router—it's a light-duty plunge router. It has the shortest plunge stroke (1 $\frac{3}{8}$ in.) of all our test tools. We were unable to use a $\frac{3}{8}$ -in.-dia. pattern bit (straight with bearing on top) because the bit end couldn't be retracted above the base.

Unlike most of the other tools, the Makita has a trigger switch that can't be locked on, making the tool impractical in a router table. It also lacks a fixed-depth rod. Plunge action was sloppy, and the tool tended to jam—even after oiling. Most annoying is the plunge lock lever. It clamps the motor housing to a column through a screw and a nut on the opposite side. We

found the lever continually needs adjustment, and the nut frequently falls off the housing.

The Makita is a very comfortable tool, however, and does have a simple and effective scale-reset marker on the depth post. It comes in a case with three wrenches.

Porter-Cable 693

To be fair, P-C is solving a few problems with this tool that puts the 693 in a class by itself. This isn't a plunge router designed from the ground up, but rather the combination of two distinct products—the P-C 6902 1 $\frac{1}{2}$ -horsepower router motor and the innovative 6931 plunge router base. The base not only gives a new lease on life to a standard Porter-Cable router, but turns many competitors 3 $\frac{1}{2}$ -in.-dia. tools into potential plunge routers.

It's a great idea, and P-C has done a fine job. However, the tool is a compromise—it's heavier and larger than the other tools in this power range. The standard base plate is round and ready for guide bushings, but limits bit diameter to about 1 in. To use

larger bits, you'll need a special base plate.

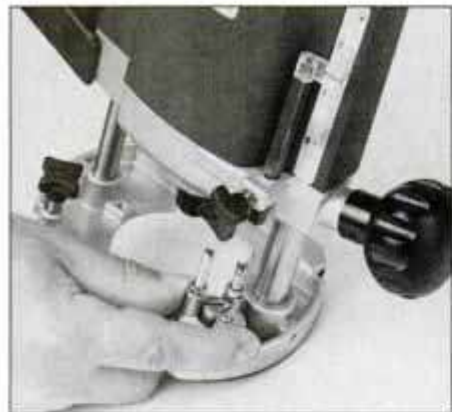
The 693 has all the features of a good plunge router. Plus, it's the only tool in this range that handles $\frac{1}{2}$ -in. bits as well as the $\frac{1}{4}$ -in. size. It has the largest plunge stroke, and the depth stop features six positions (three adjustable and three fixed).

We particularly like the round handles, and the plunge lock lever is spring loaded—the plunge is always locked until the lever is pulled open. The fixed-depth rod is controlled by two knurled wheels that are much handier to use than the double hexnut arrangement on most other tools.

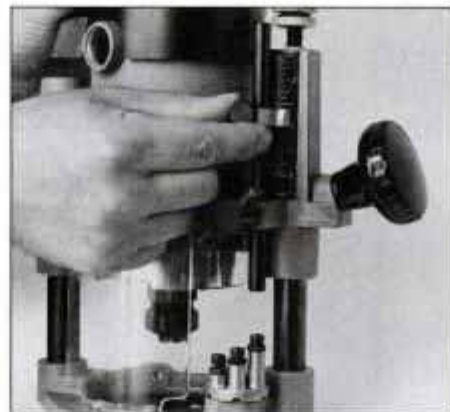
Ryobi R-151

Ryobi's entry in this plunge router class is patterned after the larger tools, and has many of the standard features. While its plunge depth adjustment doesn't have a scale reset, it does have a fixed-depth rod and the tool comes with a fence and guide bushing (the only tool with a guide bushing included).

What it also has is one of the most awkward and debilitating trigger



Many tools have a pivoting depth stop with three stops. Skil 1835 has single adjustable stop, and Porter-Cable 693 has six positions.



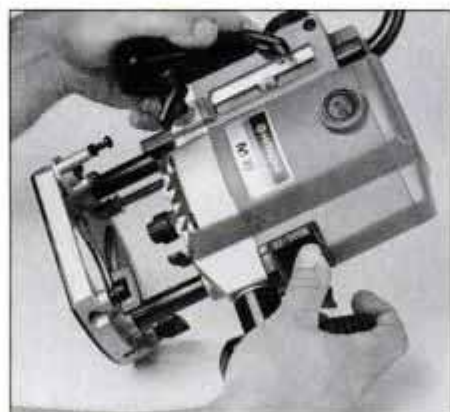
Scale-reset feature (Porter-Cable shown) simplifies measuring plunge depth. Hitachi and Makita routers have a similar system.



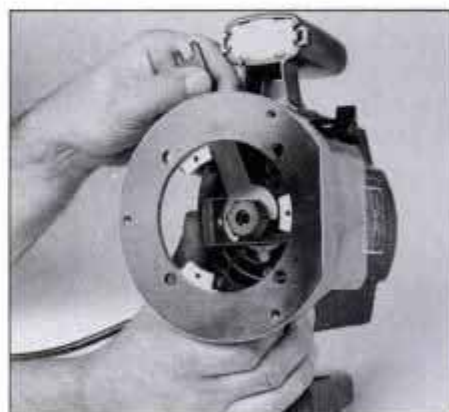
A lever is used to lock plunging action. P-C lever is spring loaded in the lock position. Elu incorporates lock in the right handle.



Set bit depth for edge trimming or router table work with threaded rod and nuts at back of Ryobi tool. Hitachi and P-C are similar.



The ON/OFF switch should lock in the ON position so hands are free to control tool and to enable it to be used in a router table.



Shaft lock on Skil and Hitachi (Skil shown) simplifies bit changing. Thumb holds lock in place while wrench loosens collet nut.

Router Alternatives

● Today, manufacturers offer a wider range of routers than ever before, and choosing one model over the rest takes some serious research and product comparison. You can buy a router as small as ½ horsepower or as large as 3½ horsepower. And, more power doesn't mean a better tool. A 2-horsepower unit isn't only excessive for trimming plastic laminate, but the extra weight of the larger tool can be unwieldy and unsafe. On the other hand, a small homeowner tool will be a real disappointment if you expect it to handle heavy mortising. A major advantage of the bigger tools is the ability to handle ½-in.-dia. bits. These bits match the cutting capabilities of the more powerful tools, and come in a wider range of styles and sizes than ¼-in. bits. If you're moving up to a heavy-duty tool but still want to use your ¼-in. bits, check to see that the large model comes with an adapter to handle the smaller bits. With some models, this is an additional accessory.

Our plunge router comparison test highlights the differences between six medium-duty machines—the kind that will satisfy the needs of most home workshops. However, you may need one of the high-horsepower models or perhaps only require a modest standard unit. Here are some of the important differences.



Standard, nonplunging routers such as the Sears 17445 (left) and the Milwaukee 5620 (right) are available for light- and heavy-duty edge trimming, template work and router table applications.

The standard router

This time-honored design features a bit depth adjustment that's set and locked in place while the router is turned off. Most popular models have a screw-type depth adjustment. The motor body slides through the base/handle assembly and can be locked in place by a clamp at the back of the router. For fine tuning, the body has an adjustment ring that works through a helical groove in the motor housing. Turning the ring raises or lowers the motor and cutter. Other models may have a rack-and-pinion adjustment mechanism.

The standard router is ideal for all edge work and is the tool of choice for router tables. It also handles template work—either with a guide bushing or ball-bearing-piloted straight bit. For in-

ternal work, however, a starter hole is required to position the tool. For light-duty applications, it's available in inexpensive homeowner models such as the Sears 17445 (about \$45, shown upper left). For more demanding work, models such as the Milwaukee 5620 (about \$325) are suitable. For heavy-duty applications and use in router tables, standard routers up to 3 horsepower are becoming commonplace. These hefty tools handle large bits, and some feature electronic variable-speed control. Variable speed enables you to handle

larger bits and work in different materials. Because the high torque of the big routers can almost wrench the tool from your hands during startup, the electronic models are often equipped with a soft-start feature that slowly brings the tool to running speed.

Big plunge routers

If you've decided that you need a plunge router, the next question is: How big? The 3½-horsepower Freud FT2000 and the 3-horsepower Bosch 1611EVS shown are two examples of the large tools offered by most manufacturers today. (Bosch also offers its unit in a 3½-horsepower, 220-volt version.) Other models are available from Elu, Hitachi, Makita, Porter-Cable, Ryobi and Sears. Although you can use an adapter and ¼-in. bits, you won't be taking full advantage of the power and capability of these tools until you switch to the ½-in. shank. If your experience is limited to 1- or 2-horsepower models, you may find these professional versions somewhat awe-inspiring. Whether it's 2-in.-deep mortises in oak or pattern-cutting shapes in ¾-in.-thick plywood, you can expect results.

However, these powerful plunge routers are big and heavy. To get a plunging capacity of up to 3 in., a typical unit can stand up to 14 in. tall when fully extended. And, at roughly 12 pounds, you don't want to use one in an awkward position. Like the large standard models, the big plunge routers are offered with electronic variable speed and the soft-start feature.

And they're expensive, costing about 75 percent more than the medium-duty versions. The suggested list price for the electronic Bosch, for example, is \$435 and the Freud is about \$100 less.



Heavy-duty plunge routers are offered by most manufacturers, and combine power and versatility. The Freud FT2000 (left) boasts 3½ horsepower, and the 3-horsepower Bosch 1611EVS (right) has electronic variable speed with soft start to reduce starting torque.

switch/plunge lock arrangements. Like the Makita, the Ryobi handle-mounted switch must be held in the ON position to keep the tool running. However, the plunge lock lever is next to the handle that contains the switch. In order to reach the lever, we had to let go of the trigger, which, of course, stops the motor—in the middle of the cut.

Like other tools, the Ryobi R-151 requires two wrenches to loosen the collet. However, its threaded collet tends to tighten during use, and to loosen it is a chore.

Skil 1835

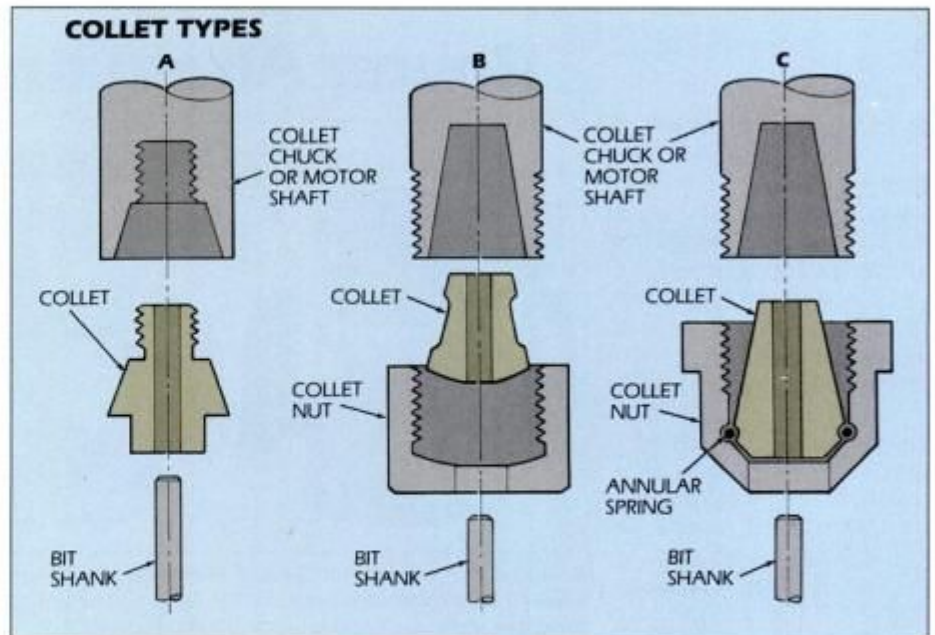
It doesn't look fancy, lacks a few features and is certainly much too loud—but in terms of plunge router performance for dollars spent, this may be the best tool in the group.

The Skil tool is rated at 1 3/4 horsepower, making it the most powerful tool that we tested. It's comfortable to hold and features a shaft lock so only one wrench is required to operate the collet. And, the wrench has its own storage clip in the top of the housing. Perhaps a little less useful is the bit storage compartment in one of the handles—it holds up to three narrow bits.

Plunge depth adjustment features a minimal, single-screw stop and a post without a scale reset. Frankly, we didn't miss the multistop system found on the other tools. On the negative side, the Skil tool has no fixed-depth rod, and the rocker-type ON/OFF switch has a dust cover that interferes with operation. This tool also has external plunge springs—the system looks simple, but you may have to clean the springs and columns periodically.

Taking the plunge

We like the Elu 3303, Hitachi M 8, Porter-Cable 693 and Skil 1835 medium-duty plunge routers—all for dif-



The models we tested use three types of collets to hold bits. Type A (Hitachi M 8 and Ryobi R-151) is threaded. During use, bit rotation can increase tightness. Type B (Porter-Cable 693, Makita 3620, Skil 1835) uses a collet nut to tighten collet. Bits may remain locked in collet after loosening. Collet type C (Elu 3303) is held in nut with an annular spring. Loosening the nut draws the collet away from the shaft to free the bit.

ferent reasons. The Elu and Hitachi models are clearly the high scorers. The Hitachi comes closest to packing all the big plunge router features in a compact product. On the other hand, the Elu is carefully made, innovative and a smooth-operating tool.

Porter-Cable's hybrid is just a little too bulky for this power class, although some might find the extra weight an asset. Its spring-loaded plunge lock and 1/2-in. capacity are great features.

At about \$70 less than its nearest competitor, the Skil tool is the economy entry in this test—if you can live without the bells and whistles, this tool does the job.

We didn't like the medium-priced Makita 3620 and Ryobi R-151 plunge routers. While the Makita is very comfortable to hold, its capabilities are clearly limited, and we can't abide

the lock-lever nut that won't stay in place. And, until Ryobi recognizes that the plunge-lock lever must be easily accessible when the tool is running, we'd just as soon pass on this model as well. **PM**

MANUFAC/ MODEL	NOISE LEVEL	
	84.5	95
ELU 3303	[Bar chart showing noise level]	
HITACHI M 8	[Bar chart showing noise level]	
MAKITA 3620	[Bar chart showing noise level]	
PORTER-CABLE 693	[Bar chart showing noise level]	
RYOBI R-151	[Bar chart showing noise level]	
SKIL 1835	[Bar chart showing noise level]	

Chart shows relative sound levels as measured on dbA scale. Tools are tested running free without router bit installed.

PLUNGE ROUTER SPECIFICATIONS

MANUFACTURER	MODEL	PRICE ¹	AMPS	HP	RPM ²	COLLET SIZE	PLUNGE DEPTH	SHAFT LOCK	SWITCH ³ TYPE	PLUNGE ⁴ STOPS	FIXED DEPTH ⁵ ADJUSTMENT	DEPTH SCALE ⁶ RESET	WEIGHT (lb.)	STANDARD ⁷ ACCESSORIES
Elu	3303	\$235	6.5	1	24,000	1/4"	1 15/16"	NO	SLIDING	3	NO	NO	6	A, B
Hitachi	M 8	\$258	7.3	1 1/2	25,000	1/4"	2 1/8"	YES	SLIDING	3*	YES	YES	6.9	
Makita	3620	\$192	7.8	1 1/4	24,000	1/4"	1 3/8"	NO	TRIGGER	3	NO	YES	5.7	D
Porter-Cable	693	\$285	10	1 1/2	23,000	1/4", 1/2"	2 1/2"	NO	TOGGLE	6*	YES	YES	11.5	
Ryobi	R-151	\$183	6.5	1	24,000	1/4"	1 15/16"	NO	TRIGGER	3	YES	NO	6.1	C
Skil	1835	\$116	9	1 3/4	25,000	1/4"	2"	YES	ROCKER	1	NO	NO	7	B

1. Suggested retail price, tools often sell for less. 2. No-load speed. 3. Switches lock on except Makita and Ryobi. 4. Plunge stops are adjustable except where indicated. 5. Fixed-depth feature controls bit depth for edge trimming and router table use. 6. Depth scale reset simplifies measuring plunge depth on

scale. 7. A=guide fence; B=1 3/16-in.-dia.-hole guide bushing adapter, P-C base accepts guide bushings; C=guide bushing; D=case. 8. Fixed middle stop. 9. Low three stops are fixed.

HOME IMPROVEMENT

HOW TO BUY A FURNACE

BY MERLE HENKENIUS
PM Illustrations by
Eugene Thompson

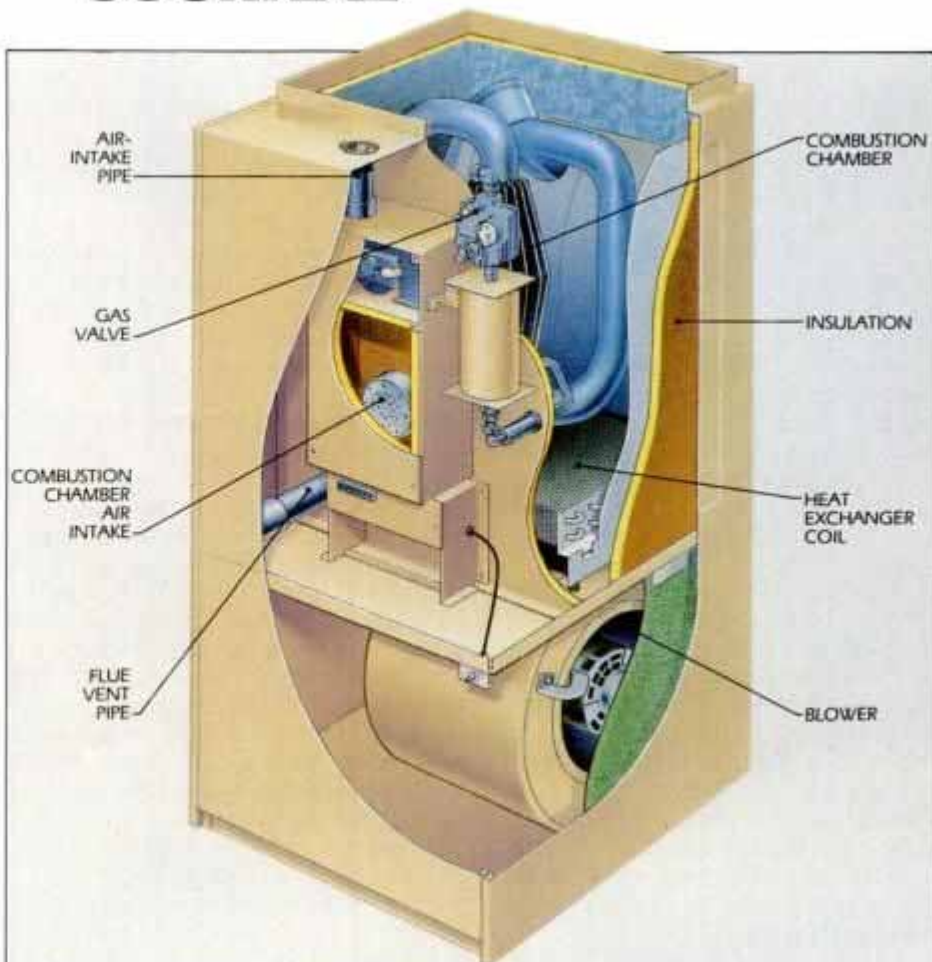
● The middle of winter isn't the time to start taking apart your home heating system. It is the time, however, when you may find yourself overhauling the household budget (and lowering the thermostat) to compensate for rising energy costs. And, if your furnace has seen better days, now is the time to check out the new models. You may find that replacing your furnace is one of the most economically sound improvements you can make.

Manufacturers have been hard at work on new, more efficient furnace designs. This rush to greater efficiency is an attempt to satisfy a buying public that is more energy and ecology conscious than ever before. And, the U.S. Department of Energy is requiring substantial improvements by 1992. While it's possible to buy a 65-percent efficient gas furnace today, the 1992 cutoff will be 78-percent efficiency.

Oil-fired furnaces and heat pumps have also seen improvements—to-day's least-efficient models are more efficient than comparable units made just 10 years ago. What's more, the designs developed a few short years ago are fast being eclipsed by a completely new generation of technology.

There's also a good chance that your older furnace is actually too large for your home. Any furnace will cost more to operate if its BTU output is higher than the home requires. In addition, new, efficient replacement windows or a recent insulation upgrade might mean that a smaller furnace is appropriate. The best way to know for sure is to have a certified heating contractor perform a heat-loss analysis on your home and determine the optimum BTU rating for your replacement unit.

Smaller furnaces and higher efficiencies are good for the consumer, of course. But, more options also make for a more difficult buying decision. What may be right for some homes, may not be right for yours. And, it's



Advances in technology have helped to create furnaces in the 90-plus efficiency range. The Lennox Pulse furnace, depicted here, utilizes internal combustion and spark-plug ignition. Exhaust gases are cooled to about 130° F before leaving through 2-in. PVC vent.

difficult to keep specific needs in focus when sorting through the blizzard of claims, technical details and aggressive advertising campaigns.

Tools for comparison

The three primary considerations for making a decision are the efficiency rating of the unit, the cost of energy (fuel and electricity), and the purchase price (including installation).

The yellow DOE tag on each unit will tell you how efficient it is and what one year's operating cost would be given a specific operating time and cost of energy. While it's not likely that your energy bill will match the figure that's on the tag, the stated cost is useful for comparison as all manufacturers use the same testing profile. With this information, you can estimate the payback period of a very efficient but expensive unit and compare the relative economies of different systems.

In addition to comparing costs and efficiencies, it's important to have a general understanding of the various systems available, how they work and how their efficiency is designated and determined.

Efficiency designations

Gas- and oil-furnace efficiencies are the easiest to understand. With each heating cycle, a furnace burns a certain amount of fuel. Some of the heat produced is transferred into the home through the airflow in the forced-air system, and some escapes through the chimney with the exhaust vapors. The heat that escapes is subtracted from the total amount produced to reach an efficiency rating. This standard is known as the Annual Fuel Utilization Efficiency (AFUE) and is expressed as a percentage.

A home with a standard builder's-grade furnace is able to benefit from only 64 to 65 percent of the heat that's produced at the furnace burner. This means that for every fuel dollar spent, as much as 36 cents is lost through the flue. By contrast, some new gas- and oil-fired furnaces have AFUE ratings of 94 percent, or better.

The AFUE standard is less revealing when applied to electric heat. Because electric-resistance heating requires no flue, none of the heat is lost and the AFUE rating is 100 percent. As such, you get a dollar's worth of heat for every dollar's worth of

electricity used. The fact that less-efficient fossil fuel systems may deliver more heat per dollar is related to the cost of those fuels versus the cost of electricity—not the efficiency of the systems.

Heat pumps, by contrast, have two rating designations: one for cooling and the other for heating. In the cooling mode, the Seasonal Energy Efficiency Ratio (SEER) is applied. In the heating mode, it's called the Heating Seasonal Performance Factor (HSPF). Both the SEER and the HSPF compare wattage input to BTU output. In each case, a larger number indicates greater efficiency. Heat pumps also have a Coefficient Of Performance (COP) rating that's measured in the laboratory. For typical air-to-air heat pump installations, the HSPF is the more useful indicator because it's the result of field testing under real-world conditions.

The heat pump is a real problem solver in the Sun Belt states where winter temperatures are moderate. In the right situation, you'll get several dollars worth of heat for each dollar of electricity used, in comparison to electrical heating.

When winter temperatures drop below 20° F, however, the heat pump advantage is substantially reduced. In this case, a gas-, oil- or electric-heating system is usually required to supplement the heat pump output. Because heat pumps also serve as air conditioners, many units are sold as replacement air conditioners that then function during the winter to reduce operating costs of the existing furnace.

While, in terms of efficiency, heat pumps beat conventional electric fur-

naces hands down, they do have their shortcomings. They are more expensive to install and maintain, and often require conventional backup heating systems. (Some electric utility companies offer rebates to offset this part of the expense.) Heat pumps also tend to start each heating cycle with a surge of cool air, which can affect comfort. And until recently, their outdoor components have been fairly noisy.

How the equipment works

A standard gas- or oil-fired furnace has a series of burners and a set of hollow metal tubes above the burners called the heat exchanger (see furnace diagrams below). When the burners are ignited by the pilot, the heat and exhaust passes through the heat exchanger tubes on the way to the flue. The furnace blower pulls in house air through the cold-air return duct and sends it around the heat exchanger cells to be warmed. The warm air is then cycled to warm-air ducts throughout the house.

An electric-resistance heat system accomplishes the same end result with a simple heating coil that replaces the burner assembly and heat exchanger.

A heat pump is really just an air conditioner or refrigerator that's capable of working in reverse. In the heating mode, heat in the outside air is removed and transferred to the interior of the home, much in the same way that a refrigerator removes heat from the cold air inside.

Improvements in gas- and oil-fired furnaces

Today's gas- and oil-fired units are commonly available in three levels of

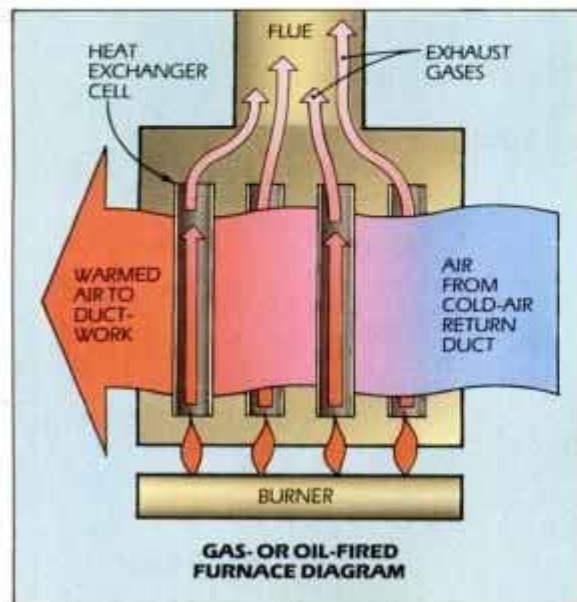
efficiency. At present, you can buy a \$500 low-efficiency (65-percent) furnace, an \$800 midrange-efficiency (78- to 83-percent) unit or a \$1500 high-efficiency (88- to 97-percent) model.

These are raw figures, of course, and installation costs will vary widely. A completely new duct system would add at least \$1000 to the ticket. All new furnaces are designed to slip easily under already existing ductwork, however.

The simplest way that engineers improve furnace efficiency is to remove the pilot light. By substituting an electric, spark ignition, an immediate 3-percent improvement is realized—all for roughly \$50 more per unit. In fact, a spark ignition will earn its keep in one to one-and-a-half years. Assuming a 10-year lifecycle, at a savings of \$30 to \$50 per year beyond the payback year, a spark ignition could save \$270 to \$450, with the added benefit of improved reliability.

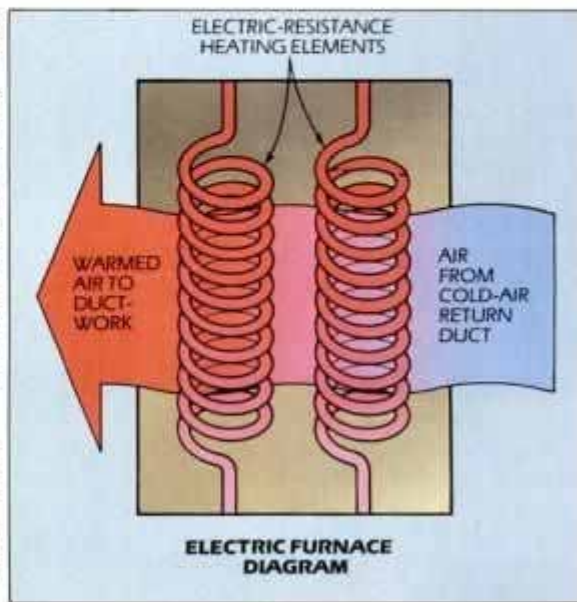
To achieve greater gains in efficiency without undue expense, manufacturers add flutes and bends to the heat exchanger cells that maximize the exposure of hot gases on the heat exchanger walls. Most units also have modified burner assemblies and exhaust collection points. Along with spark ignition, these models can achieve energy efficiency ratings in the low 80s.

As for the super furnaces in the 90-plus efficiency range—commonly called condensing furnaces—proprietary differences are more pronounced. Some models boast radically altered heat exchangers and burners, and powered exhaust fans with electronic sensors to monitor exhaust



Left: Conventional oil- or gas-fired furnaces utilize a burner placed below the heat exchanger. Hot exhaust gases move through heat exchanger on way to flue and transfer heat to house air through cell walls. Heat lost through flue is wasted. Furnace efficiency indicates amount of burner heat transferred to house air.

Right: Electric furnaces transfer all of their heat from heating coil element directly to house air and are 100-percent energy efficient.



flow. Others, like the Lennox Pulse furnaces, bring an entirely new treatment to the problem.

Instead of a conventional burner assembly under an open-bottom heat exchanger, Pulse units rely on internal combustion—combustion actually takes place inside the heat exchanger. An automotive-type spark plug is used to ignite bursts of gas at a rate of 60 to 70 times per second. Exhaust temperatures that can reach 1200° F are cooled to about 130° F before they leave through a 2-in. PVC plastic vent pipe. Small Pulse units are up to 97-percent efficient, and larger units reach 92 to 93 percent.

Improvements in heat pumps

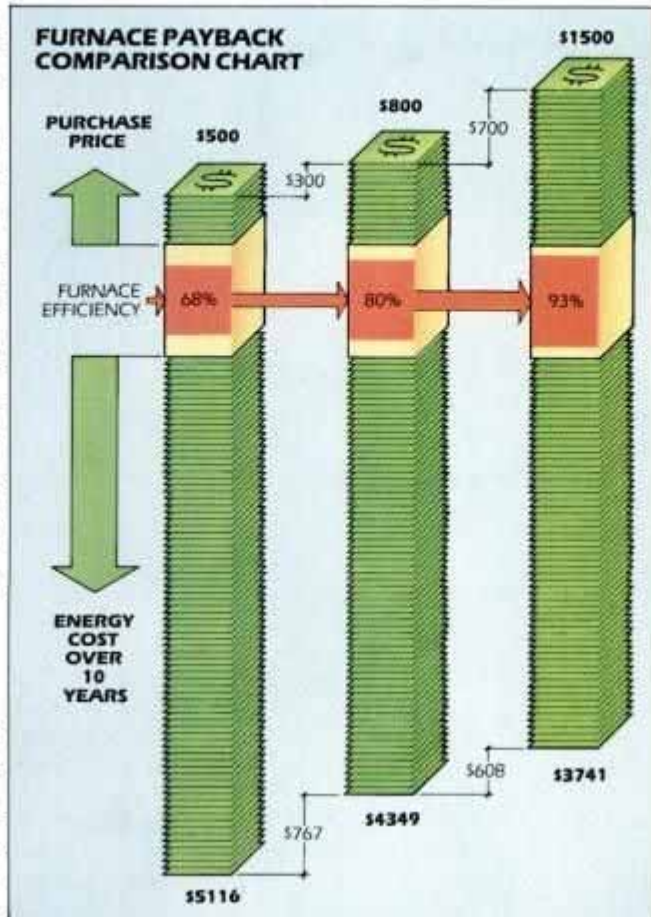
While a standard heat pump of 10 years ago might have an HSPF in the 5.9 to 6.3 range, it's not uncommon to find today's models boasting HSPFs of 7.0 to 9.0. Impressive strides in compressor technology are gradually replacing the traditional reciprocating-piston units with very efficient scroll compressors. And, modern heat pumps are likely to have the external coil wrapped around the blower fan so that air is pulled over the coil from all directions and heat transfer is maximized.

The big news, however, is in variable-speed heat pump compressors such as those made by Carrier and Trane. There are only a few of these units on the market today, but more are sure to follow. While a single-speed compressor must run at full power each time it kicks in—no matter how small the load—a variable-speed compressor can match its operation and output to the demand. These new compressors may improve efficiency by 80 percent or more over standard models and reduce the start-up surge of cold air common to single-speed models.

Unfortunately, units with multi-speed compressors can cost up to twice the \$1800 to \$3000 price tag of a standard unit. The average cost of a standard unit with installation ranges from \$2500 to \$4400.

Comparing lifecycle costs

If it's time to replace your old furnace, should you upgrade to an 80-percent



Using approximate figures, this chart illustrates savings realized through efficiency that can offset initial cost over a 10-year period. Variations in fuel cost, maintenance schedules and furnace life also affect long-term furnace economy.

unit or reach for one of the super-efficient models? The answer depends on several factors. Aside from the environmental bonus, a more efficient furnace will cost less to operate on a month-to-month basis. Whether it will pay sufficient dividends to offset its higher purchase price depends on how long you plan to stay in your present home. To get a rough idea of the payback potential of a particular furnace, you'll need to know your area's energy rates and the average number of heating hours per season. These figures are available from your local utility companies.

Using a 10-year lifecycle, 2250 heating hours per season and a natural gas rate of 50 cents per therm (100,000 BTUs), here's how an 80-percent furnace compares to a 68-percent unit, and a 93-percent furnace compares to the 80-percent model. All figures reflect a 40,000 BTU/hr-capacity furnace for a small, well-insulated home. Larger homes may require a unit with a greater BTU output.

With the above figures, a 68-percent furnace would have a first-year

energy cost of \$511.60, while an 80-percent unit would cost about \$434.90—for a net savings of \$76.70. Assuming all other factors remain unchanged for 10 years (they won't, of course), we'll see a total energy savings of \$767. Subtract the \$300 extra that the 80-percent model costs, and we're still \$467 to the good after 10 years.

A 93-percent efficient model would have a first-year energy cost of \$374.10. Subtract this figure from the 80-percent unit's \$434.90, and we get a first-year savings of \$60.80—\$608 over 10 years. When we subtract the \$700 higher purchase price of the super-efficient unit, however, we're \$92 shy of a full payback. We'd also have a larger electricity bill from the exhaust fan operation.

To see these figures in perspective, remember that most furnaces will last longer than 10 years. And, while the 80-percent unit's heat exchanger may only be warranted for 10 years, the 93-percent efficient furnace will come with a 20-year or limited lifetime heat exchanger warranty. Add to this the ecological advantage

of burning less fuel, and the balance may shift toward the high-efficiency side. On the down side, more complex high-efficiency equipment is likely to require more frequent service.

Heat pump comparisons

A qualified HVAC (Heating, Ventilation and Air Conditioning) specialist in your area will be able to tell you how heat pumps stack up against fossil fuel systems and electric furnaces. The easiest comparison to make is between heat pumps and electrical-resistance heating.

Assuming a heating load of 40,000 BTUs, a -15° F projected low temperature, 2250 heating hours and an inexpensive electric rate of 5 cents per kwh, the seasonal operating costs of a standard electric furnace would be \$1015.53. When the same figures are applied to a heat pump with a COP of 3.40, first-year operating costs total \$535.50. A difference of \$480.03, multiplied by a 10-year lifecycle, adds up to a savings of \$4803. Subtract the \$1000 higher purchase price of a heat pump, and there's still a net gain of \$3800. **PM**

TOOL TEST

NEW LIGHT-WEIGHT AIR COMPRESSOR

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor

● I tried Thomas Industries' new lightweight (19 pounds) air compressor/vacuum pump and found it quite capable of providing power for a variety of air-driven accessories.

Its 10.5-amp motor is permanently lubricated and never needs oiling. The compressor is a 3/4-hp oilless piston type. Its pressure is infinitely adjustable between 10 and 100 psi simply by turning a knob (Photo 1).

The Model 1020 compressor doubles as a vacuum pump. I always found it a nuisance to empty the dirty oil from my lawnmower, but the job is quick and clean with this machine.

To vacuum out oil, remove the compressor's air filter and connect a tube in its place that runs into the collecting jar. Run another hose from the jar



Although it's lightweight, compressor can handle a wide range of jobs. Oil-Vac (inset) is easy to use.

to the oil reservoir. Start the compressor and fill the jar (Photo 2).

The Oil-Vac kit includes a 40-ounce collecting jar, plastic lid and overflow shutoff valve, two 6-ft. connecting tubes, and two pickup tubes—one 15 in. long and the other 36 in. long.

The compressor's thermal overload switch shuts off the motor if it overheats. I expected to trip the switch while blowing water out of a sprinkler system, but didn't (Photo 3).

I used the compressor to spray paint, inflate tires and drive a caulk gun (Photos 4, 5 and 6). Each use worked out just fine.

The Model 1020 3/4-hp compressor costs about \$160. The Oil-Vac kit costs about \$35; the caulk gun, spray gun and blower kit costs about \$30. All are sold at hardware stores. Contact Thomas Industries, Power Air Division, 1419 Illinois Ave., Sheboygan, WI 53082-0029. **FM**



1 Adjust output pressure by turning the knob on top of compressor. Pressure is infinitely adjustable between 10 and 100 psi.



2 Oil-Vac is quick, easy and clean to use. Compressor draws vacuum through 40-ounce jar and sucks oil out of 4-cycle mower.



3 Set at 100 psi, compressor made short work out of the annual chore of blowing water from underground sprinkler lines.



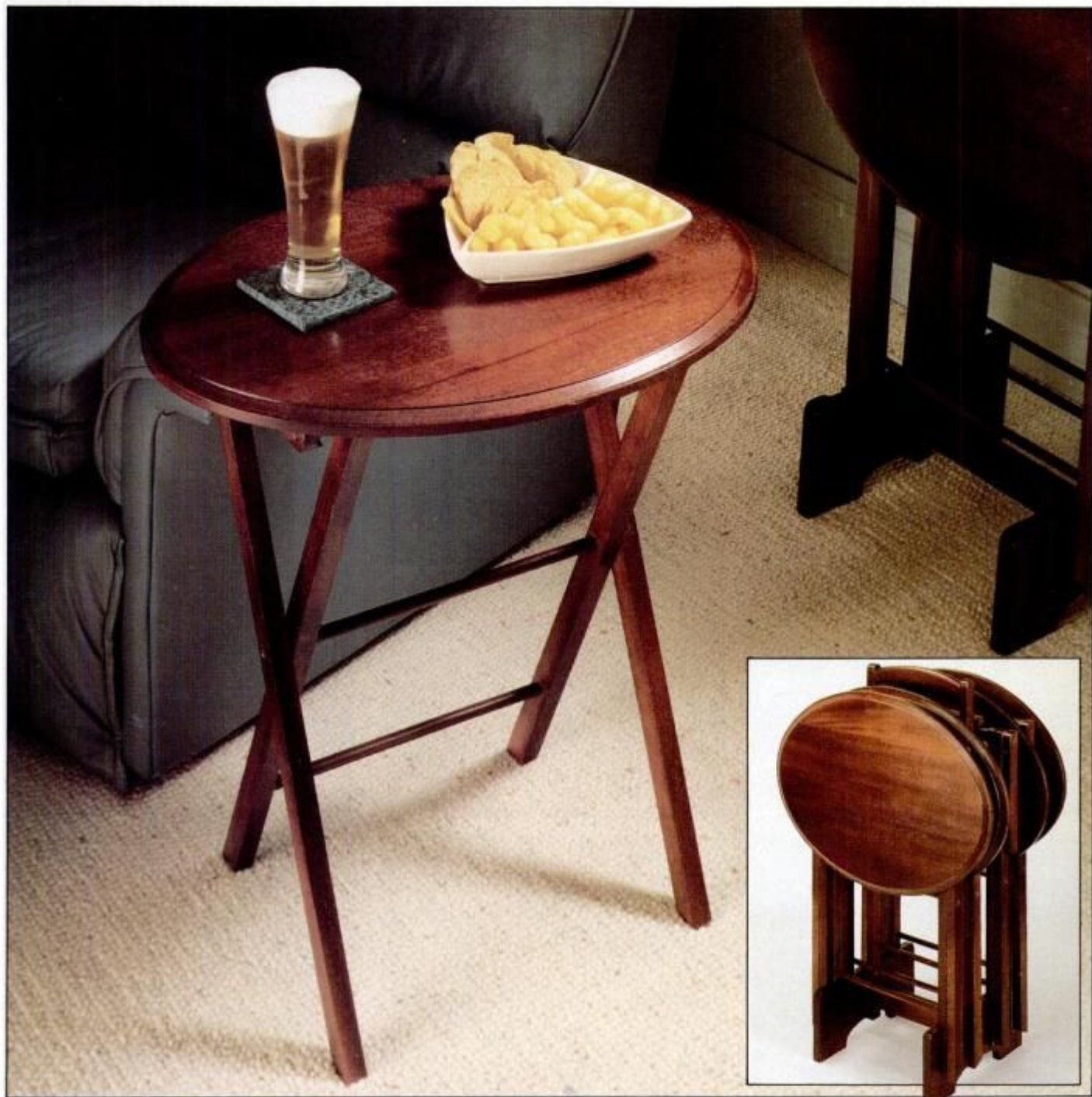
4 Air delivery was smooth and steady for spraying paint, even heavy-bodied materials such as rust-inhibitive primer.



5 The compressor has plenty of power to inflate car tires. It comes with a 15-ft.-long air hose and a brass-plated air chuck.



6 Set at 10 psi, the compressor steadily pushed a smooth bead of exterior latex caulk. The caulk gun proved easy to use.



SHOP PROJECT SPARE ELEGANCE

Build these mahogany folding tables and stand.

BY NEAL BARRETT

● Most households need extra table space when company comes. Typically, folding card or tray tables are pressed into service and are later put

away in the closet. Our folding tables, however, are attractive enough to be stored out in the open. Considerably more elegant than a card table or sheetmetal tray tables, these are made from mahogany, although other hardwoods, such as cherry, walnut or oak will also look attractive.

Being able to store these in the open not only frees up closet space, but makes them more convenient. You'll never have to dig in a closet again to get at a folding table.

The Top

Begin by making a template of the top from ¼-in.-thick plywood. Saw out

the template, then smooth it to final shape by filing, sanding or using a block plane. Then, rip and crosscut four pieces of plywood, one for each top, measuring 4¼ in. wide by 24¹³/₁₆ in. long. Joint their edges to form a good glue joint.

Lay out the pieces for each top and trace the oval shape from the template on them. We used joining plates (also called biscuits) to align the pieces during glueup, but dowels serve just as well. Lay out the loca-

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

tion of the plates, keeping them at least 3 in. from the top's edge (Photo 1) and about 6 to 8 in. on center. Cut the slots with a plate joiner, making sure that joiner and workpiece are held firmly to the bench (Photo 2). The bench should be free of debris to ensure the joiner and workpiece are on the same plane.

Apply glue to the edges of each piece, to the plates and the plate slots (Photo 3). Pull the pieces together with pipe clamps (Photo 4), and scrape off glue squeeze out after 20 to 30 minutes, while it's firm but still soft enough to remove easily.

When the glue is dry, smooth the surface with a cabinet scraper. Retrace the top outline on the blank and cut out the top with a band saw or jig-

saw. Cut on the waste side of the guideline and remove saw marks and refine the outline with a sharp block plane. Sand the edges smooth using 120- and 220-grit sandpaper.

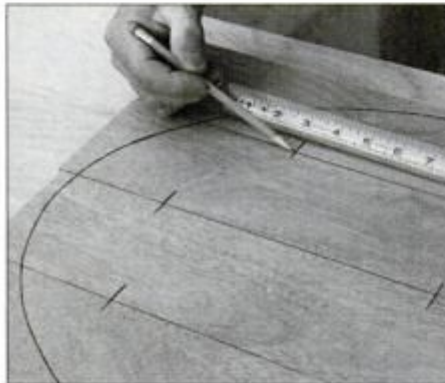
We cut the top's decorative edge with a Bosch panel raising router bit (#85480M) and an edge guide in our router. Clamp the top so half its edge overhangs the bench. Cut the molding on half the top, then reclamp as before and finish routing the edge. Be sure the bit is razor sharp and advance the router slowly to avoid tearout.

Rip and crosscut the legs and cleats. Plane or sand away any saw marks, then cut the radiused ends on them and rasp each piece to shape. Sand them smooth with 120- and 220-grit sandpaper.

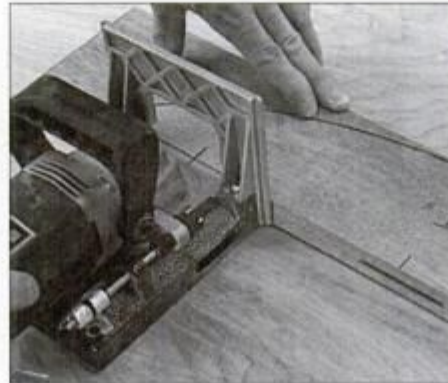
The two cleats which run cross-grain under the top are attached with three screws each. One screw fits in a round hole, while the other two fit into elongated holes to allow for expansion and contraction of the top with changes in humidity. Without the slotted holes, the cleats would restrict the top's movement and it would split in time.

Form the elongated holes by boring two holes side by side and chisel out the waste. Then counterbore each hole for the screwhead. Bore a $\frac{5}{16}$ -in.-dia. hole in the side of each cleat as shown, and tap in a $\frac{1}{4}$ -in. threaded insert (Photo 5).

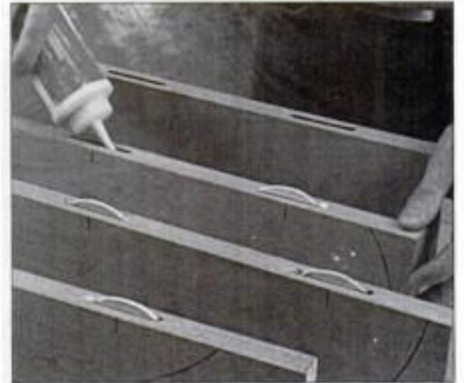
Place a top upside down on the bench, bore the pilot holes (Photo 6) and attach the cleats.



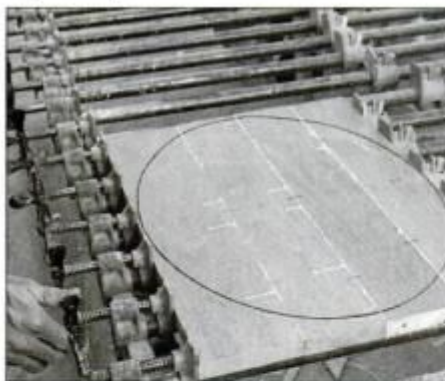
1 Lay out the joining plate positions on top. Keep the plates 3 in. back from top's edge and space them 6 to 8 in. on center.



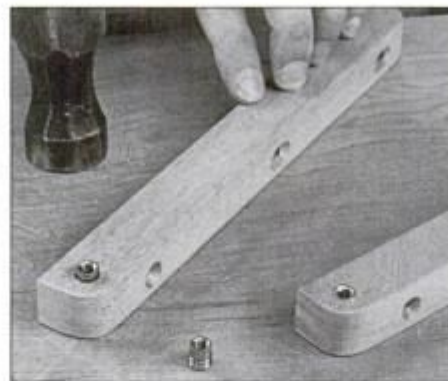
2 Cut plate slots in boards. To ensure joiner and boards are on the same plane, the work surface should be free of debris.



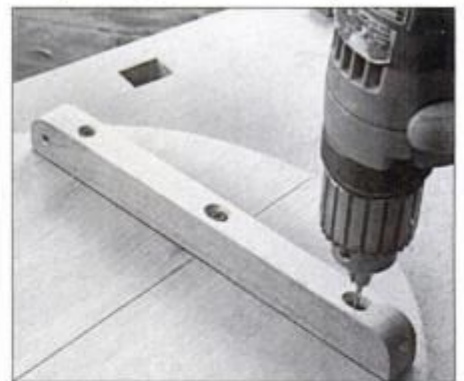
3 Apply glue sparingly to the plates and plate slots. Insert plates in slots and bring the pieces together with hand pressure.



4 Bring the edge joints tight with bar or pipe clamps. Scrape off the excess glue after 20 to 30 minutes, before it hardens.



5 Tap the threaded inserts into $\frac{5}{16}$ -in.-dia. holes in top cleats. Inserts allow the folding leg assembly to screw to the top.



6 Bore pilot holes into the top. Elongated screw holes in cleats allow top to expand and contract without cracking.

Leg Assembly

The inside pairs of legs are joined together with $\frac{1}{2}$ -in.-dia. mahogany dowels (see Misc. section of Materials List). To seat the dowels, bore $\frac{1}{2}$ -in.-dia. holes, $\frac{3}{8}$ in. deep in each leg at the locations in the plan. Crosscut the dowels to length, and presand them with 120- and 220-grit sandpaper.

Cut a 25° angle at each leg bottom, arranging the legs in pairs so the angles match properly.

Spread glue in the dowel holes and on the dowel ends, and join them to the inner legs. Pull the assembly tight with clamps, and cross measure it to check it for square (Photo 7).

Clamp the outside legs to the inside legs (Photo 8) and bore a $\frac{1}{8}$ -in.-dia. pilot hole into the inner leg. Attach the legs with a washer between them.

With the tabletop upside down, screw the leg assembly to the top, driving the machine screw into the

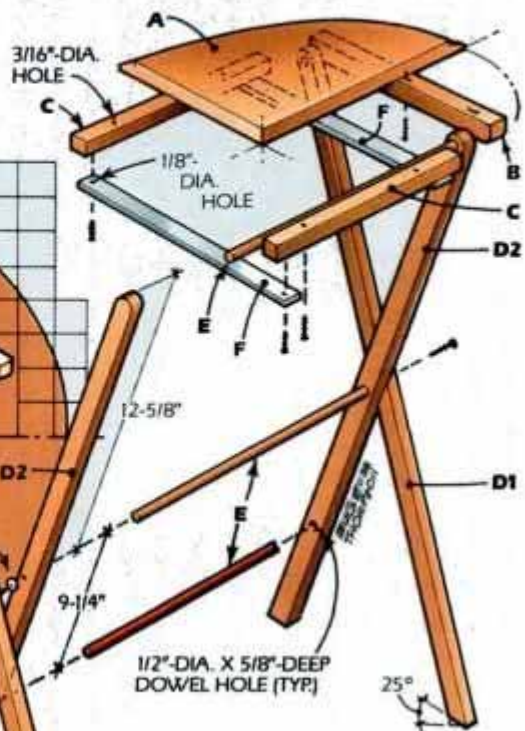
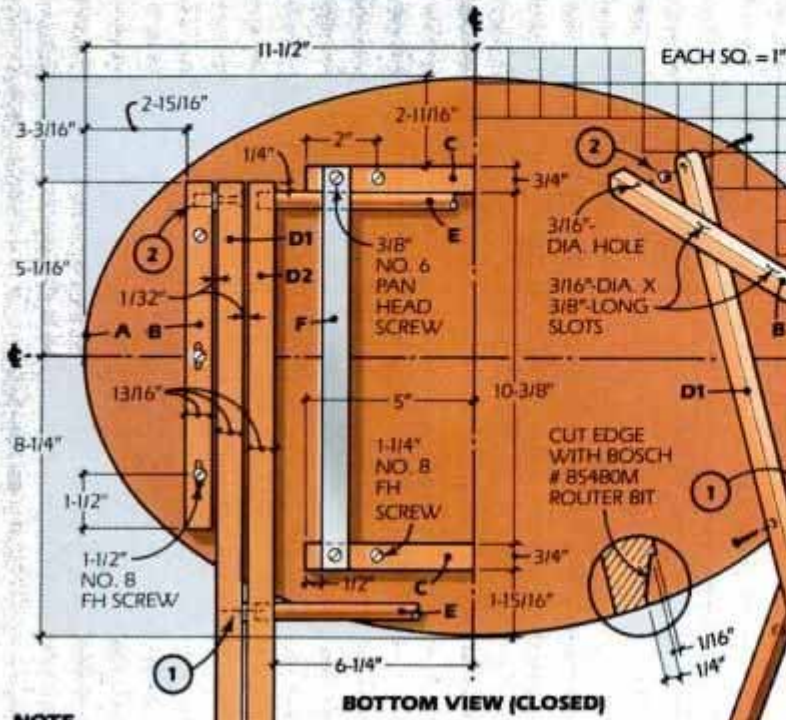
cleat's threaded insert (Photo 9). Separate the leg and cleat with a washer.

Bore and counterbore pilot holes in the cleats that run with the grain and attach them to the top. Cut strips of sheet steel to length using tin snips, debur them with a file and bore a $\frac{1}{8}$ -in.-dia. pilot hole in the end of each strip. Attach strips to the cleats.

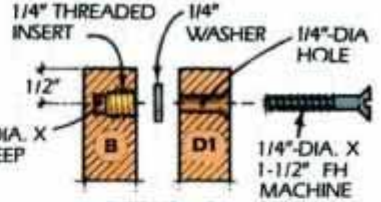
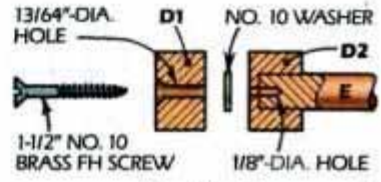
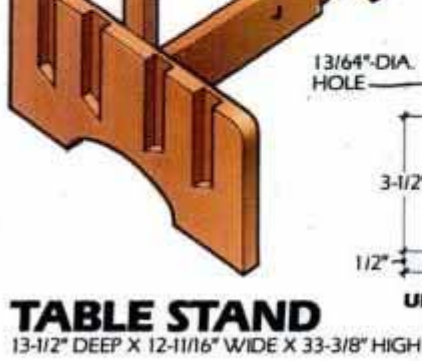
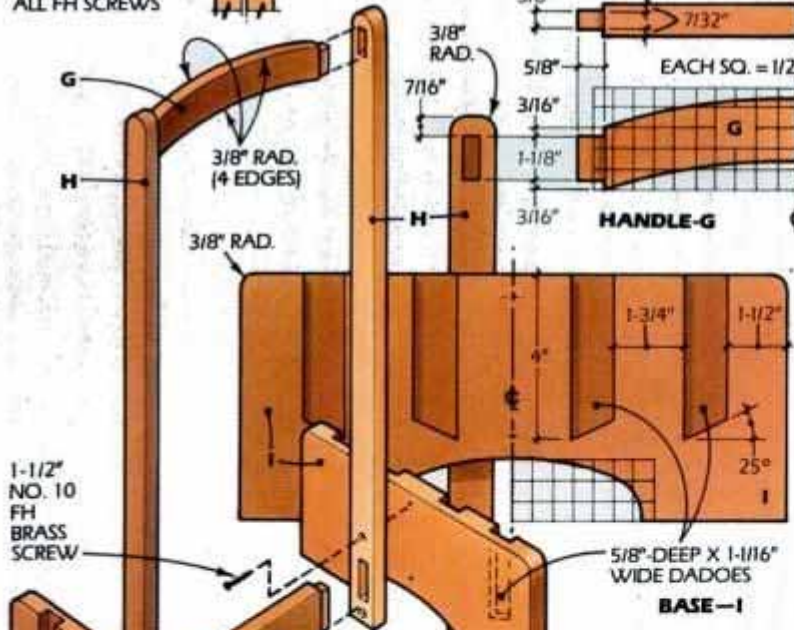
Open and close each table to check for smooth action and sand parts to eliminate friction between them.

FOLDING TABLE

16-1/2" DEEP X 23" WIDE X 25-1/2" HIGH (OPEN)



NOTE
COUNTERSINK
ALL FH SCREWS

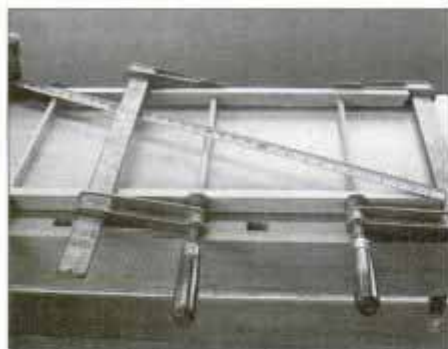


MATERIALS LIST—FOLDING TABLE STAND

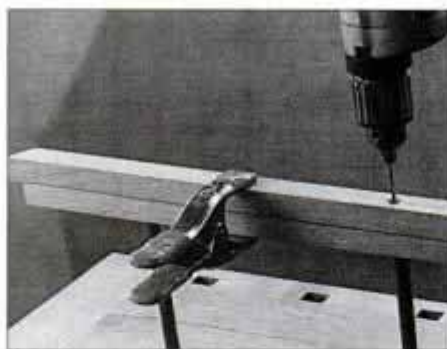
Key	No.	Size and description (use)
A	1	13/16 x 16 1/2 x 23" mahogany (top)
B	2	13/16 x 1 x 10 1/2" mahogany (leg cleat)
C	2	3/4 x 13/16 x 10" mahogany (stop cleat)
D1	2	13/16 x 1 x 27" mahogany (outside leg)
D2	2	13/16 x 1 x 27" mahogany (inside leg)
*E	3	1/2"-dia. x 13 3/4" mahogany dowel (stretcher)
F	2	.028-gal. x 1/4 x 11 1/8" steel (restraint)
G	1	13/16 x 2 1/4 x 10 11/16" mahogany (handle)
H	2	13/16 x 1 1/8 x 31 1/2" mahogany (upright)
I	2	13/16 x 6 x 13 1/2" mahogany (base, stand)
J	1	13/16 x 2 x 10 11/16" mahogany (stretcher)

Misc: 2, 1/4"-dia. threaded inserts (Available from Rensen Products, 6307 E. 18 Mile Rd., Sterling Heights, MI 48078, part No. PF-2520); 2, 1/2"-dia. x 1 1/2" fh machine screws; 2, 1/4" washers; 6, 1 1/2" No. 10 fh brass screws; 2 No. 10 washers; 6, 1 1/2" No. 8 fh screws; 4, 1 1/2" No. 8 fh screws; 4, 3/4" No. 6 panhead screws; 120- and 220-grit sandpaper; glue; tack cloth; Behlen's Solar-Lux Stain, Medium Brown Mahogany No. B503-3A136; Solar-Lux Retarder, available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013; varnish.

* Available from Woodworker's Supply of New Mexico, 5604 Alameda Place N.E., Albuquerque, NM 87113; part No. 203-021.



7 Glue and clamp together legs and dowels. Measure diagonals to ensure that leg assembly is square, and let glue dry.



8 Use spring or C-clamps to hold the outside legs to the leg assembly. Bore the pilot hole for the screw at the pivot point.



9 Attach the legs to the top with a machine screw. Place a washer between the leg and the cleat to reduce the friction.

Table Stand

Rip and crosscut the pieces for the stand base, and lay out the dadoes and curved bottom edge. Cut the curved bottom edge with a jigsaw, and smooth the cut with a rasp (Photo 10). Rout the dadoes in them using an edge guide and a $\frac{3}{4}$ -in.-dia. straight bit (Photo 11). Guide the cut with a straightedge clamped to the workpiece, and chisel the cut square.

Rip and crosscut a block 6 in. wide by $10\frac{11}{16}$ in. long. From this, cut the handle and bottom stretcher. Use the dado blades in the table saw to cut the tenons on this (Photo 12).

Rip the stretcher off the block, then

cut out the handle (Photo 13). Smooth saw marks off the handle, and cut the shoulders at the top and bottom edge of each tenon with a backsaw. Round the handle's edges with a $\frac{3}{8}$ -rad. rounding-over bit and router.

Rip and crosscut the uprights to size and cut their curved ends. Bore out the bulk of the stretcher mortises on the drill press. Chisel the mortise ends square and smooth their walls (Photos 14 and 15). Bore and counter-bore pilot holes in the uprights for attaching them to the base. Sand the base parts with 120- and 220-grit sandpaper and wipe with a tack cloth.

Glue and clamp together the up-

rights, stretcher and handle, and check for square. After the glue sets, screw the uprights to the base.

Finish the stand assembled, but do remove the leg assembly from the tops and separate the outer legs from the inner leg assembly. Finish sand the parts, wipe them with a tack cloth and apply stain. We used Behlen Solar-Lux Stain. If you apply this stain by brush or rag, use Solar-Lux Retarder to prevent lap marks caused by rapid drying. When the stain has dried, wipe each part with a tack cloth and finish it with a good quality varnish. Reassemble the tables when finishing is completed. **PM**



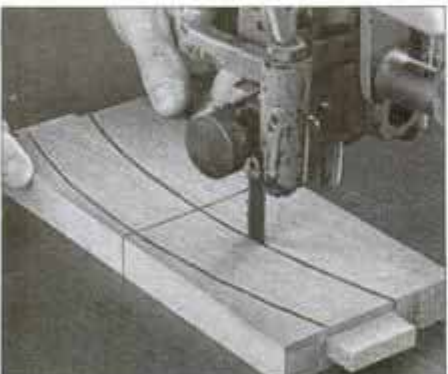
10 Lay out dadoes and curved cutout on stand base. Make curved cut with a jigsaw. Remove saw marks with rasp, then sand.



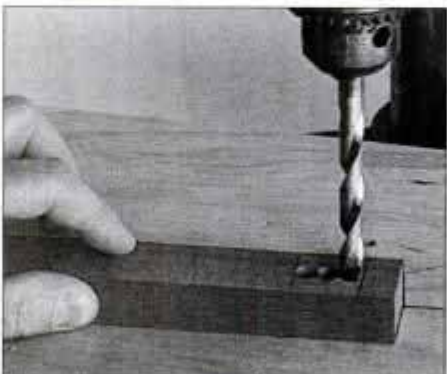
11 Clamp base pieces to bench and run router against a fence clamped to base. Finish dadoes by chiseling them square.



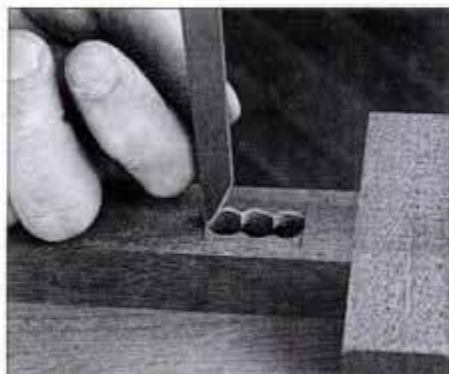
12 Rip a 6-in.-wide x $10\frac{11}{16}$ -in.-long piece and cut the tenons on both ends. From this, rip the stretcher and handle.



13 Cut out curved handle on band saw or with jigsaw. Smooth away saw marks with rasp or spokeshave, then finish sand.



14 With a $\frac{3}{8}$ -in.-dia. bit in the drill press, bore overlapping holes to remove waste from the mortises in the stand uprights.



15 Use a sharp chisel to square the mortise ends and smooth its walls. Test fit mortise-and-tenon joints for a snug fit.

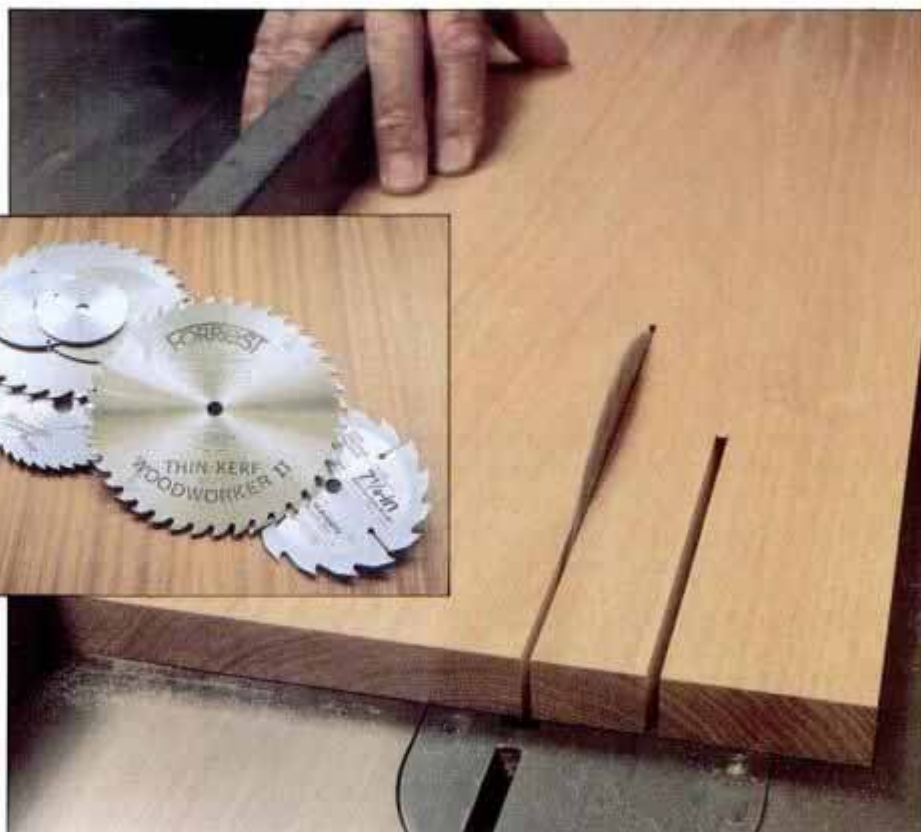
TOOL REVIEW
**THIN-KERF
BLADES**

TEXT AND PHOTOS BY
ROSARIO CAPOTOSTO
Contributing Editor

● Sometimes it seems as if each new product is bigger than last year's model, offers more for your money and has so many extra features that your life will forever be easier. Well, it's heartening to note that one of the latest trends in woodworking equipment claims to produce more—by actually doing less. This new development is the thin-kerf circular saw blade, and we decided that it was time to check out its merits.

Actually, thin-kerf blades have been around for several years, and my first experience with one came during a cordless circular saw test. I was impressed by the saw's ability to zip effortlessly through stock in spite of the relatively low power of its battery-operated motor. The secret, of course, lies in the remarkably thin, $\frac{3}{64}$ -in.-kerf blade.

Easy feeding and minimal strain on the motor are the most apparent advantages of using a thin-kerf blade. Since it's taking a bite that's about $\frac{1}{4}$ to $\frac{1}{2}$ the size of a conventional blade, it requires less energy to get the job done. However, this only holds true if the blade runs true and is free from wobble. Otherwise, the side-to-side motion of the blade will produce a wide and rough kerf—two conditions that negate the thin-kerf advantage. If you're using a thin-kerf blade on a radial-arm or table saw, it's best to



Sawing with a thin-kerf blade produces a kerf that's $\frac{1}{2}$ to $\frac{1}{3}$ the size of a standard blade kerf (right). Inset photo shows types available for radial-arm, table and portable saws. Blade stabilizers (upper left corner) stiffen thin blades to reduce vibration.

use a blade stiffener or stabilizer to hold the blade rigid and reduce vibration that might otherwise occur.

A blade stabilizer is a precision-ground steel disc that's mounted on the outside of the blade. They're available from $3\frac{1}{2}$ to 6 in. in diameter to suit a wide range of circular saw blade sizes and applications. In situations where a minor runout persists, paper shims inserted between the blade and stabilizer disc can help to eliminate the problem.

We tested a Forrest 40-tooth, $\frac{3}{32}$ -in.-wide-kerf blade on the table saw. With the rip fence properly aligned

parallel to the blade, but opened about $\frac{1}{64}$ in. at the rear to avoid friction, cuts in $5/4$ oak are quiet, smooth and effortless. This blade also performs well in crosscutting operations. For ripping hefty $8/4$ stock, we switched to a faster cutting 30-tooth, $\frac{3}{32}$ -in. blade. Both blades produced smooth-as-sanded edges without any noticeable strain on the saw's $1\frac{1}{2}$ -horsepower motor.

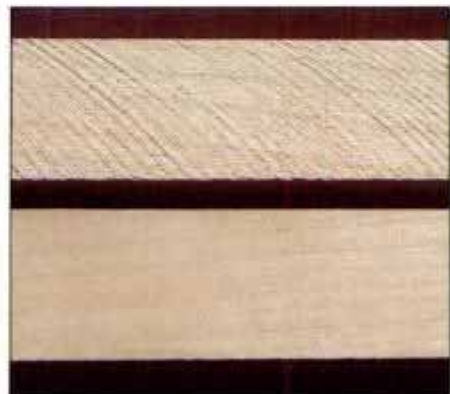
The lack of bulk in a thin-kerf circular saw blade makes it prone to overheating when cutting hardwood. To avoid this problem on the table saw, it helps to raise the blade at least 1 in.



When ripping hardwood, blade stays cooler if it's raised at least 1 in. above stock. The saw guard is removed for photo clarity.



Blade stabilizers reduce vibration to help produce a finer cut. When cutting thick stock, a smaller diameter stabilizer is necessary.



Blade with severe runout causes rough edge on top board. Smooth edge of lower board was cut with blade that ran perfectly true.



To help correct a blade that has a slight wobble, carefully positioned paper shims are placed between blade and stabilizer.

above the stock surface to minimize the length of the arc that each tooth makes as it passes through the wood. This also applies to portable circular saws. (The photos show the table saw safety guard removed for clarity. It should always be in place during normal operation.)

For portable circular saw work, the Sears 16-tooth, $\frac{3}{32}$ -in. blade, and the really thin $\frac{3}{64}$ -in. Milwaukee blade proved effective in cutting $\frac{3}{4}$ -in. plywood and nominal 2-in. lumber. However, freehand diagonal cuts in 2 x 10



Ripping very thin strips for edge banding produces a slightly greater yield and less waste with a thin-kerf blade.

stock showed less-than-perfect edges due to blade flexing and wobble.

In addition to effortless cutting, thin-kerf blades have a second advantage—they waste less wood. Because the kerf is thinner, less wood ends up as sawdust. While you won't realize any significant savings in normal day-to-day sawing operations, you will see a difference when ripping many thin strips from a wide board. Switching to a thin-kerf blade for ripping $\frac{1}{4}$ -in.-thick edge banding gave us one bonus strip for each nine strips that were



Portable saws with thin-kerf blades cut with much less effort. Rough diagonal cuts show evidence of blade wobble.

cut. While this isn't a great savings, it can add up.

Thin-kerf blades won't handle every sawing situation—I still prefer my standard blades for heavy-duty work. However, if you want to effectively increase the cutting power of your radial-arm, table or portable circular saw, the easiest way is by installing a thin-kerf blade. Some dealers and manufacturers of thin-kerf blades include Forrest, Sears, Milwaukee, DML, Freud, Systi Matic and Vermont-American. **FM**

REVIEW

NEW STAIRBUILDING BOOK/TAPE

BY ROY BERENDSOHN, Assistant Home Improvement Editor

● This book and tape combination is the best way I know of to learn basic stairbuilding—short of being taught by a stairbuilder. Together they clearly cover how to lay out and build straight stairs including the handrail, newel post and balusters.

Both concern themselves with stairs that are built in place, not in a shop. Site-built stairs aren't quite as elegant, or expensive, as those built in the shop, but this makes them more accessible to the owner/builder. Neither the book nor the tape covers curved or spiral stairs because they are not built on site and are not "basic" compared to straight-run stairs.

The most complex type of stair covered by the book and tape is an L-shaped version. Also covered are stairs with plywood treads and risers that will be carpeted and stairs with exposed oak treads and risers. Author

and builder Scott Schuttner uses his experience to steer viewers (or readers) around a variety of pitfalls. During layout, Scott advises checking that the floor where the stairs start is level. Again, while trimming out the stairs, he shows how to glue and tape on small mitered moldings to avoid cracking them with a finish nail.

If you're going to tackle stairbuilding, I suggest getting the book and

Basic Stairbuilding

SCOTT SCHUTTNER



the tape. The book provides more information than the tape, and the tape clarifies techniques that appear in the book.

Basic Stairbuilding, the book and tape, costs \$42.45 ppd. from Taunton Press, 63 S. Main St., P.O. Box 5506, Newtown, CT 06470-5506. **FM**

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Attic Load

Three years ago, I acquired an English-style 1½-story all-brick, all-plaster house, 50 years old and in excellent condition. There is a full attic with a catwalk in the center.

I would like to finish the attic, but it only has 2 × 6-in. ceiling joists, 16 in. on center. I am told the joists have to be at least 2 × 8 in., 16 in. on center before rooms can be added.

First, why were houses like this built, and what's the remedy? Can I do most of the work myself?

RAYMOND FRANCESHINI
CHICAGO, IL

When designing a house, the size of the floor joists depends on the distance between the joist supports (span), the on-center distance between the joists (usually 16 in. on center), the species of wood the joists are made of and the loading applied to the floor. In residential structures, the floor loading is usually designed for a live load of 40 pounds per sq. ft., with attic floors designed for loading of 20 pounds per sq. ft. A live load is the load that is imposed solely by occupancy (persons, furnishings and appliances).

The attic's design load is less than the load for habitable rooms because the attic is normally not used for storing heavy appliances or furniture. Hence, ceiling joists are often smaller than the floor joists below.

In determining joist size for a given span, architects use tables that consider bending stress, deflection and

stiffness (in order to minimize the springiness in the floor). For a rough estimate of joist size and span, you can consult the chart shown. Your floor joists are sufficient for a 40-pound-per-sq.-ft. floor, providing their unsupported span does not exceed 9 ft. 6 in. (approximately).

To finish the attic properly, you would need more than such a chart, however. In order to receive a building permit to begin such a project, your local municipal building department will probably require that you have plans drawn by a registered architect or approved by a licensed professional engineer.

Slimy Hot Water

Our hot water storage tank recently leaked and was replaced by another stone-lined tank. My family and I noticed an unsettling change in the feel and texture of the water in the shower and sinks the evening of the installation. My wife described the water as feeling slimy or soft. I thought it felt more silky, such as diluted mineral oil or water that had Portland cement residue mixed in with it. Nevertheless, the water was nice and hot.

What can you tell us about stone-lined hot water storage tanks? Will the residue rinse away with time, and is it a health hazard? JONATHAN ELIE
LEWISTON, ME

The term stone-lined is really a misnomer. The storage tank is actually lined with concrete. Probably, the company that manufactured your

unit uses a fine sand in the concrete mix, which has the texture of flour.

You were on the right track when you said the water had a cement residue feel to it. Any tank residue should flush out shortly. If it doesn't, contact the manufacturer.

There is nothing inherently unsafe with stone-lined hot water tanks, but, if you are concerned, you can have the water tested to see if its mineral content exceeds the EPA standard for potable water.

Water Heater Safety

After reading our safety tip on hot water heaters in a recent clinic, reader Stanley Broadwin, Jericho, New York, sent in the following. I think his comments are worthwhile, so I have included them here.

"I feel you left out a very important aspect of gas-fired water heaters.

"Should the exhaust stack inside the heater collapse, the flame will not vent correctly and the airflow will be interrupted. As a result, the flame will seek air from outside the heater. The flame will then burn an inch or two outside the heater's base. This is called a floating flame. Should this occur, anything combustible stored near the heater's base will ignite.

"I was near my heater when the internal flue collapsed with a loud bang. The next thing I saw was the flame outside the heater. Many people don't realize that an occurrence such as a floating flame is possible and store items near the heater's base.

"This is a definite fire hazard."

Winter Maintenance Tip

According to the Portland Cement Association, the safest de-icers for concrete are also the most common: sodium chloride (rock salt) and calcium chloride. Both of these de-icers rust metal, and sodium chloride damages vegetation while calcium chloride does not.

The association recommends against using on concrete those de-icers that contain ammonium nitrate or ammonium sulfates. **PM**

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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

FLOOR LOAD CHART (FOR SPANS UP TO 21')

For floors supporting 40 lb./sq. ft. (live load)

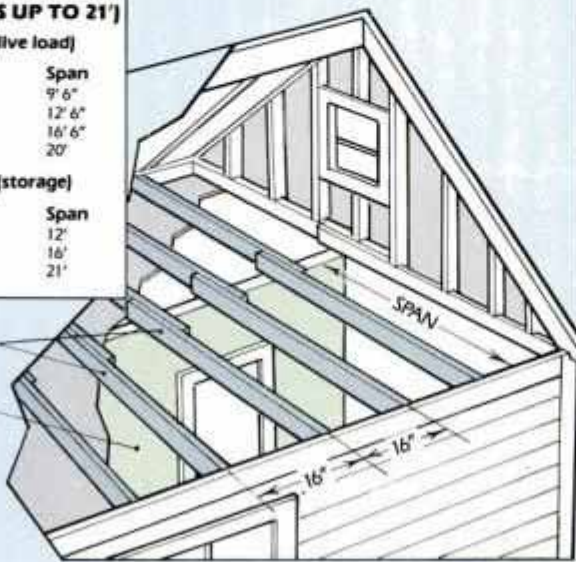
Size	Spacing	Span
2 × 6" joist	16" o.c. (on center)	9' 6"
2 × 8" joist	16" o.c. (on center)	12' 6"
2 × 10" joist	16" o.c. (on center)	16' 6"
2 × 12" joist	16" o.c. (on center)	20'

For floors supporting 20 lb./sq. ft. (storage)

Size	Spacing	Span
2 × 6" joist	16" o.c. (on center)	12'
2 × 8" joist	16" o.c. (on center)	16'
2 × 10" joist	16" o.c. (on center)	21'

CEILING JOISTS
BEARING PARTITION

Several factors influence the size of ceiling joists: anticipated load, span and the joists' on-center distance.



APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Won't Switch Off

We have a Hoover Elite 350 Model U4461-9, serial No. 03800043210 vacuum cleaner. The motor keeps running even when the ON/OFF switch is in the OFF position. We start and stop the vacuum by plugging it into and disconnecting it at a wall switch. The ON/OFF switch on the side of the handle has a long rod with a pointed tip that extends into the vacuum's base. The switch and extension appear to be okay. What would be the next step?

BILL GRIM
SOUTHOLD, NY

The ON/OFF switch for your vacuum cleaner is mounted on the motor. A plastic arm called the switch control rod contacts this switch and turns on and off the motor.

Apparently, the rod is not reaching the switch to shut off the motor. Either that, or the switch is bad.

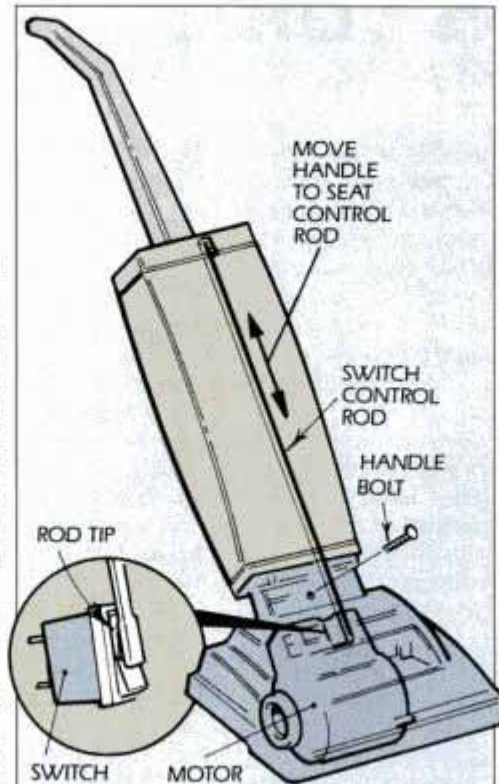
Remove the bolt at the cleaner's base that holds the handle together. Make sure the handle is firmly seated in the cleaner base. Push down on the handle and wiggle it back and forth to be sure it is seated properly. Replace and tighten the bolt. By adjusting the handle, the activator arm will probably contact the switch and correct the problem. If this procedure doesn't help, replace the ON/OFF switch.

Ironed Out

I purchased a Dolce Pizelle iron a few years ago, and it has developed a problem for which I need a replacement part. I need the lower element which has gone bad. The model number is 300-EP. Could you give me the company's address? Thank you.

JOHN HOSTASA
SHADYSIDE, OH

Berar Ducci Brothers Manufacturing Co., the makers of your iron, moved to Smallman St., Pittsburgh, PA 15222. The company tells me if you package your iron along with a check for \$15.60 to cover repair and shipping, they will rebuild your iron. They will replace both the top and bottom elements, the thermostat and will guarantee the repair of your iron for one year.



Remove handle bolt and jiggle handle. Control rod should contact the switch.

Sewed Up

I bought a sewing machine that looks almost new at a garage sale. The only problem is that there is no operating manual with it. The machine is from J.C. Penney. I contacted them, and it seems they are unable to provide me with any information about it. The machine is model No. 6600, serial No. 89500752. Any help you can give me will be greatly appreciated.

T.M. STRIGHT
PHOENIX, AZ

I contacted J.C. Penney National Parts Center in Morrow, Georgia. The people there tell me that the owner's manual for your 1972 sewing machine is no longer in print and is not available as a part. They have a copy of the owner's manual in their publications library, however. If you send them a letter explaining that you would like a copy of the owner's manual, along with the model number of your sewing machine, they will photocopy their manual and send you a copy at no charge. Send your letter to J.C. Penney National Parts Center, 6840 Barton Rd., Morrow, GA 30260; Attn: Manuals.

Yuck!

Every time I use my garbage disposer, water and food waste accumulate in the base of my dishwasher. If I

don't use the dishwasher for some time, a terrible odor is produced from the stagnant water and waste. I can't find a check valve that I can connect between the disposer inlet and the dishwasher. Any ideas?

THOMAS J. MILLEMAN
GLEN ELLYN, IL

Sometimes you can correct this problem by raising the drain hose loop on the side of the dishwasher before it goes down into the disposer. Raise up the drain hose as high as possible under the countertop, then clamp the hose to the underside of the countertop. This will usually eliminate the problem because the disposer will not be able to push up the water or food waste high enough to let it get into the dishwasher.

Another way to correct the problem is to install an air gap on the dishwasher drain line. This requires that you bore a hole in your countertop or the wall behind the countertop to mount the part. The air gap is sold at plumbing supply stores.

As far as using a check valve is concerned, Sears has recently made available a check valve which you may be able to adapt to your dishwasher. The kit contains a rubber check valve that will allow water to flow one way, a drain hose and an instruction sheet. The kit is available from any Sears repair parts center. The kit, part No. 5300809800, costs about \$7, plus tax.

Squeaky Wheel

I have an old GE dryer model No. 1DE516A1W. It runs well except for a loud squeaky noise from a broken plastic insert in the idler wheel. GE only makes a small wheel, and it doesn't work properly in my dryer. Any suggestions?

JOHN NASIF
N. PROVIDENCE, RI

According to GE, the inserts for the idler wheel are no longer available for your 1965 dryer, but a new idler wheel has been developed for it. It's a 1-piece wheel that doesn't require inserts. The GE part number for the idler pulley kit is WE12X81. It costs about \$19, plus tax, and is available from any GE parts distributor in your area.

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

PAINTING WOODWORK

BY GENE & KATIE HAMILTON
PM Illustrations by
George Retseck

● Window sills, door trim, crown moldings and baseboard require a durable protective finish. A good, long-lasting paint job on woodwork and trim involves careful brush work and that takes a little practice. It's worth the effort, though, to learn how to prepare and paint woodwork correctly because it really brightens a room. Done properly, a good paint job lasts for many years and withstands repeated cleanings.

In any painting project, first prepare the surface by cleaning and patching it, then paint it. If you're painting the walls and woodwork, begin by patching the walls and the trim so all surfaces are smooth. Paint the trim first, then paint the walls. It's easier to wipe a little wall paint off woodwork than to get trim paint off a wall.

Wash the woodwork with a solution of water and Spic 'n' Span or trisodium phosphate (TSP). If phosphate cleaners are banned in your area, use a good household cleaner. Rinse the woodwork and let it dry.

Choosing paint

Latex or vinyl (water-based) paints are the predominant choice for the home painter and are best for walls. However, latex semigloss and enamel (glossy) are not as abrasion resistant as oil-based paints (especially important on the window sash, handrails and sills) and can't be cleaned as many times as oil-based paints. Latex trim paints dry quickly, and this makes it difficult to avoid lap marks—even for the most experienced painters. These paints dry to a softer and more flexible film than oil-based paints. Objects placed on latex paint can stick in place if left for a long time, even after the paint has dried.

On the plus side, latex paint is easy to clean up. Spills wipe up with water, and brushes can be quickly washed in the sink. And because it doesn't contain petroleum-distilled solvents, latex paint is less of a threat to the environment.

Oil-based paint provides a tough, durable finish that's ideal for woodwork. It dries slowly to a hard surface. This paint comes in four levels of



gloss: flat, eggshell, semigloss and gloss. You clean up oil-based paint with paint thinner (also known as mineral spirits).

Estimating how much paint you'll need

Most trim paints cover between 350 and 400 sq. ft. of surface per gallon. Painters allow about 8 sq. ft. of paintable area for each window and about 25 sq. ft. of area for each door. Extra paint is needed for the window's trim or casing and its jamb.

To determine the surface area of base and ceiling molding, estimate it at 6 in. wide (regardless of actual width) and multiply this times its length in inches. Divide this number by 144 to arrive at the square-foot surface area. The average room does not require a lot of trim paint. A quart will usually do it. If you need 3 quarts, buy a gallon.

Paint brushes, buckets, rollers and trays

The material your brush is made from should be determined by your choice of paint. A brush with polyester or nylon bristles is suitable for latex or oil paint. If you're going to buy only one brush, make it polyester.

Brushes made from hog bristle (sometimes called China bristle) are best with oil paints and get limp when used with latex paint. Good quality bristle brushes are expensive. Don't buy inexpensive bristle brushes, though. They lose their bristles.

For a quick touchup, use a small, inexpensive foam brush. Avoid the wide foam brushes because they tend to drip when loaded with paint.

Consider brush shape when you're buying your supplies. A sash brush with its bristles cut at an angle is designed for painting thin areas and getting into hard-to-reach corners. It's



1 To allow paint to drain back into the can, punch a few holes in the lid groove with a 4d finish nail. Keep groove clean.

your best choice for cutting in (painting up to a line) and painting windows. A square cut brush is best for painting door panels or wide trim. Brushes with a long pencil-style handle give you a good grip and provide balance.

You should own at least three brushes: a 1-in. and 2½-in. sash brush and a 2½-in. straight brush. Buy the best brushes you can afford. Properly cared for, they will last indefinitely.

You can use a paint roller to work wide sections, such as flat doors. Use a roller with a nap length recommended on the paint can.

Open paint cans by prying around the lid with a wide-tip screwdriver. Pour the paint into a paint pail or a clean paint can and stir it to make sure it's evenly mixed. You can pour some of the paint back into the paint can and work out of that or work out of the pail. If you use the can, don't fill it back up right to the rim. It's a messy and inefficient way to work. Also, puncture the lid of the can in several places using a 4d finish nail to help drain paint back into the can (Fig. 1).



7 Begin painting a window from the inside out. Paint the sides of the muntins, then paint the front surfaces.



2 Degloss shiny surfaces with chemical deglosser (paint adheres best to a dull surface). Solvent also degreases and cleans.

Prepare the woodwork

Paint sticks better to a dull surface. One way to remove its gloss is with a chemical solvent deglosser (Fig. 2). Rub on the deglosser with a clean rag. This is strong stuff, so allow plenty of ventilation.

You can also use 120-grit sandpaper with a sanding block or an electric palm sander to dull a surface or smooth out chipped areas. Feather rough areas smooth.

Remove several layers of deteriorating paint with heat guns or chemical strippers. Your paint store should have a variety of chemical strippers, among them low odor and water-soluble types. Stripping is a messy job, so protect the floor and surroundings by putting down a dropcloth. Wear old clothes and protective glasses.

Let the gun heat up and hold it about a foot from the paint. When the finish bubbles up, scrape it away using a paint scraper. Move the gun slowly forward, and you can keep the paint hot without burning it. Keep a fire extinguisher handy when using a



8 Paint the window jamb after the sashes. Pull the sash cords out of the way to avoid getting paint on them.



3 Fill any cracks or screwholes in the woodwork with spackling compound. Use wood filler for deep holes and cracks.

heat gun, and don't set down the gun on a flammable surface.

Apply chemical strippers with an old paintbrush. When bubbles appear, use a scraper and steel wool to remove it. Clean off the residue on the scraper using the sides of a sturdy cardboard box. A second application is often required. Let the surface dry, then sand it lightly.

Fill holes and cracks

Most trim has some cracks and holes in it that should be filled with spackle or wood filler before applying paint. Spackle, premixed or 2-part fillers are applied with a small putty knife (Fig. 3). Just overfill the hole or crack, smooth the filler and let it dry. Sand the filler flush, and it's ready for paint (Fig. 4). You might have to use two coats on large repairs since some fillers shrink.

Window painting—protecting the glass

When you're painting windows you can use masking tape or a wipe-on



9 After the sash and jamb are painted, paint over the window trim. Begin next to the jamb, then do the outside edge.



4 Wrap sandpaper around a sponge to sand curved areas, like window or door trim. Sponge takes on molding profile.



5 Rub sealant on glass before painting. Afterward, scrape the window clean with a retractable razor scraper.



6 You can also keep glass free of paint with a trim guard. On bare wood windows, allow some paint to seal against glass.

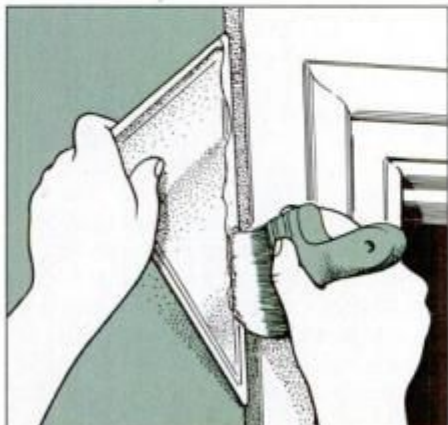
protective film that's dispensed much like deodorant (Fig. 5). Another option is to skip this step and scrape off any paint from the glass with a razor. It's a case of spending your time masking or scraping, but if you paint carefully, you will spend less time scraping.

Apply the tape or film only after thoroughly dusting the corners of each window pane. The crevice tool of a vacuum works well to do this.

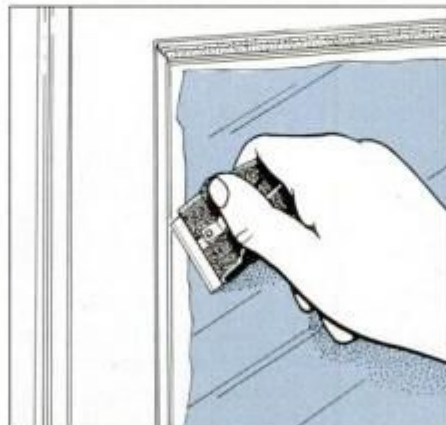
If you paint the windows without tape or film, you can use a trim guard to protect the glass area. These come either as a small triangular-shaped piece of metal or a metal strip with a plastic handle. Hold the guard tightly against the muntins while you paint them (Fig. 6). After each use, check for paint on the backside of the guard and wipe it away.

Hardware and what to do about it

Should you remove hardware or should you paint over it? A purist will tell you to remove it before painting.



10 Use a trim guard to protect the walls when painting woodwork. Hold the guard tight in the corner between trim and wall.



11 Run razor scraper down the joint between the glass and frame, then scrape away the paint working toward the sash.



12 Start painting a paneled door by outlining the molding around each panel. Use a 2½-in.-wide, square-tip brush.

And of course, that's the right answer. But for practical purposes, it's not always the realistic one.

If a window lock is covered by several layers of paint but works properly, decide how much time you want to spend on the window. You will crack the existing paint if you remove the lock, and this also leaves a dent in the paint the shape of the lock. Unless you replace it with the same type, you will have to sand away the paint buildup in this area. If the hardware is not painted, it may be easier to remove it rather than paint around it.

Painting windows

Paint windows from the inside out. Begin painting the thin vertical and horizontal dividers between the panes in double-hung windows (Fig. 7). The same holds for painting casement windows.

If your window has a removable window grille, take it out for a much easier job. Use a 1½-in.-wide sash brush, and don't drag your brush back across the edge because this will

cause a run in the paint.

If you are painting a double-hung window and the upper sash is movable, reverse the position of the inner or lower sash and the outer or upper sash. Paint the lower half of the outer sash first, then paint the inside sash, but don't do the top edge where the lock is. Save that until last.

Return the sashes to their normal positions, but don't close the window completely. Then paint the top of the outer sash and the top edge of the inner sash.

Switch to a 2½-in.-wide brush and paint the window frame from the inside out moving the sash cord, if there is one, out of the way (Fig. 8). Next, paint the window casing (Figs. 9 and 10). Cut in a nice, clean line where the casing meets the wall. Then paint the sill and the apron, which is the trim beneath the sill. When the paint is dry, scrape it off the glass with a razor scraper (Fig. 11).

Of course, if the upper sash is painted shut, you can't move it, so paint the upper sash from the inside out then



13 Next, work from the top down and paint the panel's face. Work the paint into outlined area to prevent lap marks.

open the lower sash and paint it. Leave it slightly open so the paint will not get dirty at the bottom of the sash.

Painting a panel door

Like a window, paint a panel door from the inside out. Paint a small section at a time to avoid creating lap marks. A 2½-in.-wide brush should be used for this job.

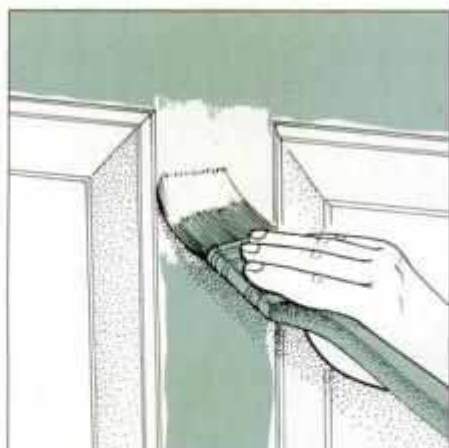
Start with the decorative edge molding surrounding the door panel followed by the panel itself (Figs. 12 and 13). Then paint the stiles between the panels (Fig. 14). Next, paint the top and bottom rails (Fig. 15) and work down the remaining stiles. Finish by painting the edges, cutting in cleanly around the hinges and avoiding drips (Fig. 16).

After the door is painted, do the door jamb. Start on the inside (door stop) and work out. Finish by making the cut along the outside edge and the wall.

When painting moldings, don't get too far ahead on one part of the molding. You don't want the paint to begin to dry or set up before you can finish. If you find your brush drags or sticks to an area where you have painted, don't try to smooth over it by brushing into the area. You'll just make it worse. In this case, let the lap mark dry, then sand it and repaint.

Painting ceiling molding and baseboard trim

To make a clean cut along a ceiling molding and the wall, hold your brush at an angle to the work surface and work away from the area you're painting. Don't set the ladder too close to the work. Move it often so you can easily reach the area you're painting. You can't paint a straight line if you have to stretch.



14 Paint the stiles between the panels. For a smooth finish, feather out the paint at the intersection of stiles and rails.



16 Paint door's side, top and bottom edges. Cut in cleanly around hinges, avoiding drips. Next, paint the door jamb.

Cleanup

Latex paint is water soluble, so wash out the brush (or roller) under a steady flow of warm water until all the paint is removed. Then soak the brush in warm water and mild liquid soap. Towel dry the brush, and use a spinner to remove excess water. This device grips the paint brush and spins it as you pump the spinner's handle. Spin the brush holding it in a paint can or in a paint pail.

Oil paints require paint thinner for cleanup. Hang the brush in thinner using brush hooks or bent wire coat hangers. You can use handle clips for long-handled brushes (Fig. 17). Clean the brush completely at the end of the job.

Fill the container the brushes are hanging in about half full with mineral spirits. To store the brush for a couple of days, dip it in the spirits and work out most of the paint by spreading the bristles with your fingers. If you're concerned about getting the mineral spirits on your hands, wear a pair of



15 Paint the top and bottom rails and then the outside stiles. Paint the long surfaces with a continuous stroke.



17 Suspend brushes in thinner at the end of the day. Keep the paint brushes off the bottom by using brush hooks or clips.

rubber gloves. Use a brush comb to work out any stubborn paint deposits, especially those that accumulate near the ferrule (the metal band where handle and bristles meet). It's important to keep the tip of the bristles off the bottom of the container, where pigment residue settles.

When you're ready to paint again, squeeze out the excess thinner from the brush. Then use a paint spinner to spin dry the brush.

Wrap a paint roller in plastic or aluminum foil overnight to keep it from hardening. You can clean or discard the roller at the end of the job. To clean it (or store it overnight), force out excess paint from its nap using a stirring stick. To clean it, pour some paint thinner in the pan and work the roller around in it. Force out the remaining residue, then wash the roller in soap and water. Blot it dry, then let it air dry.

After paint buckets and pans have been cleaned with thinner, wash them out with warm soap and water. **PM**

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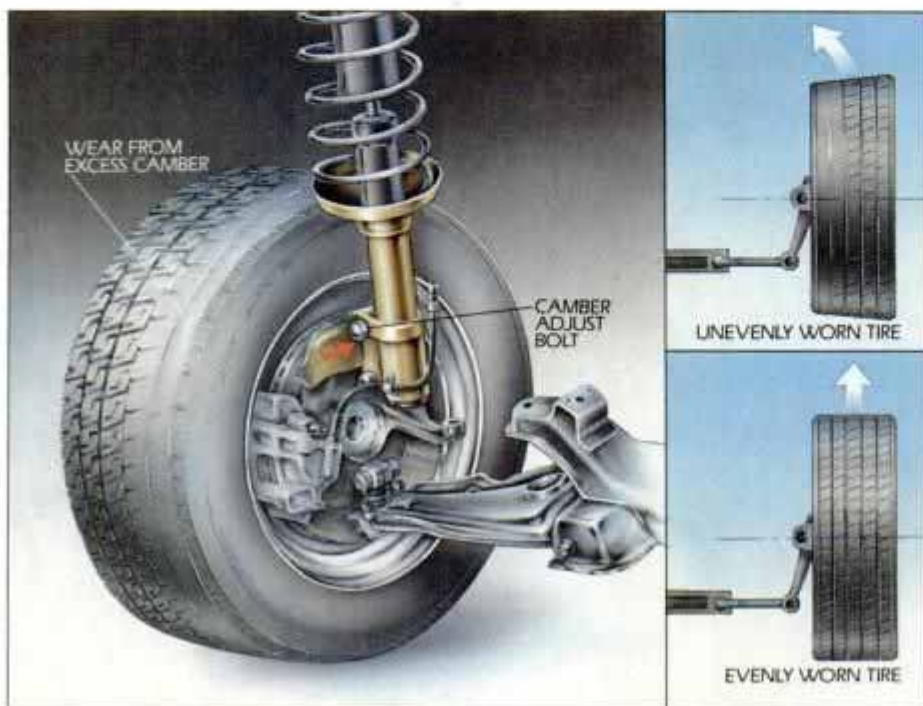
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CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PH ILLUSTRATION BY DON MANNES

Turn, Turn, Turn

The mechanic at the alignment shop told me that he can't align my car unless he replaces the worn tires. The left front is worn just on the inside edge, undoubtedly from being improperly aligned. But the rest of the tread is fine, and I don't really want to buy new tires just yet. Is he right? Can't I just align it anyway to stop the asymmetrical wear and buy new tires at a later date?

ROBERTA HOULIHAN
MANASSAS, VA

Well, he's partly correct.

First off, because the worn tire now has a slightly different diameter than the other side, it'll be difficult to properly set camber and toe-in. These are influenced by the ride height, although I dare say the difference would be minor. This is because as the suspension moves vertically, the lower control arm moves the hub in an arc, and the horizontal distance between the frame and hub changes, which changes the camber. When the alignment technician sets the camber, he does so by turning the eccentric bolt at the bottom of the strut, which moves the bottom of the strut in and out.

You could rotate the tires front-to-

rear to do the alignment, regardless of whether you wanted to rotate them permanently.

The big problem is that the worn tire is going to want to turn in a circle forever. Think about it—a cylinder rolls in a straight line, and a cone always rolls in a circle. So your car will always pull to the opposite side.

You can indeed get an alignment without getting new tires, which will prevent further wear. But the pull to one side will remain until you replace the tire.

A Slivering Situation

I think I have a problem with my 1988 Toyota. I always change the oil every 2000 or 3000 miles myself, and I'm in the habit of probing the contents of the oil drain pan with a magnet. Recently, I've noticed that the Toyota's oil has had slivers of ferrous metal stuck to the magnet. I can't say there's a lot of these slivers—but there never were any before. Please advise on this matter.

GEORGE GARCIA
CUPERTINO, CA

You need to send a sample of your next oil change to an oil analysis lab. They'll be able to tell you pretty specifically what the slivers are from.

I'd be concerned. While it's not uncommon to find an occasional chip or two in the oil pan, an upward trend is a bad sign. It also depends a lot on the exact size and consistency of the slivers—bigger is bad, while a certain amount of very fine powder is perfectly normal.

My guess? You're losing a camshaft lobe.

Intermittent Fuel Crisis

My 1984 VW Rabbit has a habit of cutting out when the fuel level is below 3/4 of a tank and when I go around right turns. I've taken the car to mechanics who work almost exclusively on VWs, and they feel that it's not any sort of electrical problem. They've jacked up the car to simulate a turn, and this doesn't seem to make any change electrically.

I've replaced the fuel filter, but so far we haven't dug into the pump or the accumulator. One mechanic suggested it was caused by the rotor grounding in turns. I replaced the rotor, but there was no change.

TERRY VAN DEN
ST. PAUL, MN

It's not the rotor or anything else electrical. This is a phenomenon well-known on older VW Rabbits—the pump won't pick up the last few gallons unless the car is going straight. I raced a Rabbit for a while and found there is a tremendous variation in fuel tanks. Some tanks will suck up fuel consistently down to the last gallon or so, while others need to be carefully spoon-fed the last 3 gallons. Also check for a gas-filled accumulator, although those are supposed to be bulletproof.

Later model tanks had some baffles. You might drop out the tank and see if the pickup and baffles can be repositioned to keep the fuel flowing.

At any rate, you should try to keep at least a quarter-tank of fuel on board. Momentary loss of fuel feed will cause the bearings to run dry and prematurely wear out the pump.

Grandma's Preserves

Many senior citizens spend several months away from their permanent

(Please turn to page 74)

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residences and need to store a car while they are absent. Some disconnect the battery, while others arrange for a friend to periodically start and run the car. What do you recommend?

F. F. DIETSCH
FRANKLIN, TN

Modern cars with onboard computers draw electrical current constantly, whether the key is shut off or not. This is necessary to retain the computer's memory, as well as the presets on the radio and the clock. This does, however, run down the battery in as little as a month.

But there's a larger issue than keeping the battery charged. It's necessary to run the engine long enough to lubricate internal surfaces. Brake discs will rust, and rubber seals will dry out and shrink. The fuel injection can become gummed up, and water will collect in the tank.

For storage of 30 to 60 days, remove the battery and store it someplace dry and above freezing. Wash and dry the exterior surface because the dirt represents a place for current to leak directly from the terminals. Fill the gas tank to the brim to prevent atmospheric moisture from col-

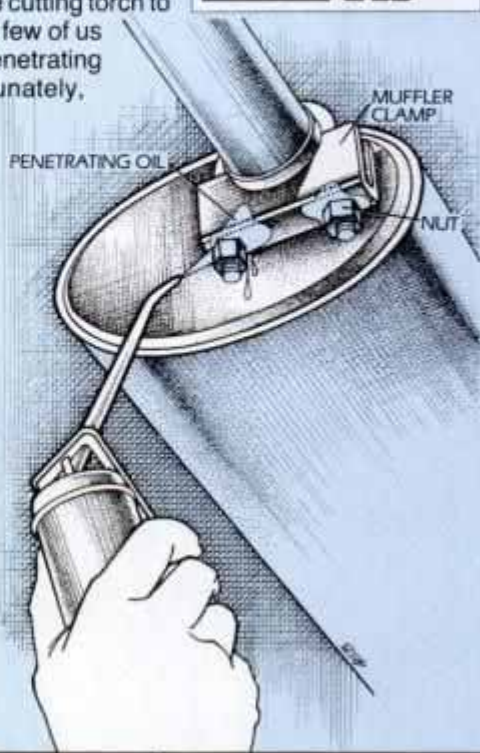
One Good Turn

● We hate muffler work—it's dirty, hard work, with rust and dirt falling into your eyes, giving you a handful of barked knuckles before you even get things apart.

Guys at muffler shops simply use the cutting torch to remove all the junk, but that's a luxury few of us have. So we rely on the trusty can of penetrating oil to smooth the way, which, unfortunately, doesn't make much of an impression on the hardware that's held on a muffler through a couple of seasons of 800° F heat and wintertime salt slush.

Go ahead. Sprinkle some oil around, but don't count on it helping much. But at least on the disposable hardware, like muffler clamps or anything else you're replacing, forget about *unscrewing* the nut.

Huh? Simple. Tighten the nut before you try to loosen it. Usually, the threaded part of the clamp will give up under the strain and snap off clean. This saves you the trouble of turning the nut back over an inch of rusty, corroded threads. It's generally a good idea to replace these clamps anyway, as the metal has little strength left after being in service.



PM ILLUSTRATION BY ADOLPHE BROTMAN

"COACH SAID THE KICKOFF WAS AT 2:00."



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lecting inside the tank.

For longer storage, you should do this, as well as adding some fuel stabilizer to prevent gumming. You can find this stuff at hardware stores and auto parts stores. Follow the directions on the can. Change the oil just before storing the car. Remove the spark plugs, add a tablespoonful or so of oil to each cylinder, and turn the engine over briefly with the starter motor before replacing the plugs. This will reduce corrosion of the cylinder walls.

For longer-term storage (years), there are a number of other things you might do, but there's not enough room here to cover all of them.

The best solution would be to get some trustworthy person to drive your car every 10 to 14 days. A trip of at least 30-minutes duration will charge the battery, warm up and circulate the oil long enough to expel moisture and generally keep things from corroding and seizing up. Have them run the air conditioner for a few minutes to protect the compressor, too.

Grab Bag

I have a problem with a chattering clutch on my '83 Cavalier. It seems to

be a problem at a start from a full stop, and a bigger problem going uphill from a stop. Is this the clutch, or is it the rubber motor mounts? It did this even before I had the clutch changed last year.

VICTOR WOOD
CHESHIRE, CT

I would look carefully at the engine mounts—all of them. Check for any separation of the rubber pad from the metal, and replace them if necessary. It may just make your chatter go away. It's worth a try.

I'd be more suspicious of your clutch, however. Exactly what did they replace—just the disc, or did they replace the pressure plate as well? Did they machine the flywheel? Did the chatter go away for a while and then return?

*Pull the transaxle and look for an oiled or burned clutch disc, a bent or unevenly worn pressure plate or flywheel, a bent transmission input shaft, or one with worn splines. **PM***

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIPS

- Ford TSB 87-18-14 has a chart detailing FoMoCo transmissions and the appropriate automatic transmission fluid to use—either the traditional Type "F" or MERCON. This list also includes a number of manual transmissions for which ATF is the specified lubricant.
- 1989 or '90 Chevy Lumina owners who have a persistent transmission fluid leak should look for the casting number "567" and consult their dealer. Some transmissions were built with porous cases, and according to TSB 90-38-7A, the fix is to replace the case rather than to plug the leak.
- Anybody who has a serious problem with vapor-locking might look at a Ford dealer for Rotunda tool No. 113-00002. It's a kit for checking the actual vapor pressure of a sample of gas.
- Peugeot 405s that have a problem with ice and moisture buildup on the steel mesh of the oil filler cap can benefit from following the instructions of TSB 330. Simply remove and discard the steel mesh.
- According to gasket manufacturer Fel-Pro, a faulty EGR valve can be the culprit causing major engine damage, and needs to be checked for proper operation during engine rebuilds.

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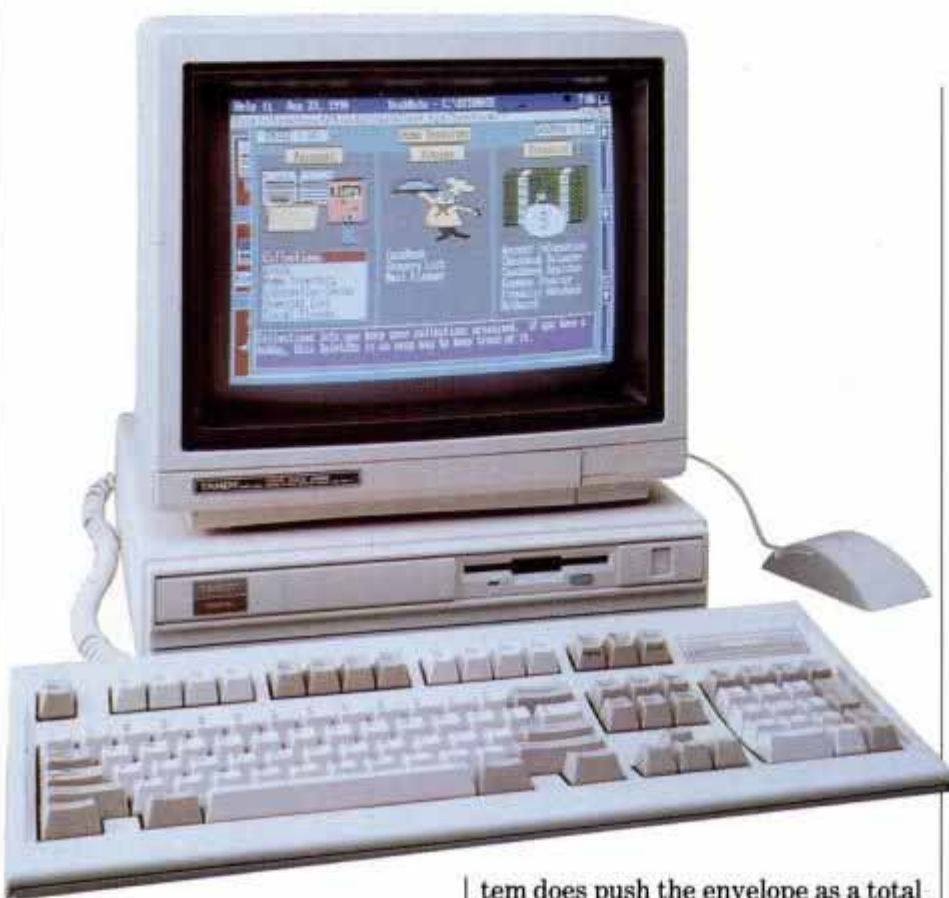
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WHEN YOU JUST CAN'T WAIT TO GET STARTED!

HOME MANAGERS

BY RON SCIBILIA



● The '80s, pundits predicted, would be the Decade of the Home Computer, and for a while, back in the heyday of the Commodore C64 and Apple II, it looked as though they might be right. Then the computer-in-every-pot craze fizzled as consumers found home computers were really a solution searching for a problem.

Home computers never really went away, of course. They just changed complexion. The fun-and-games home computer of the early '80s became the money-making home office computer of the late '80s, and suppliers like Packard Bell, Epson, Headstart and others flourished as providers of low-cost computing tools for extending productivity from the traditional workplace to the home.

IBM's new PS/1 line, mass-market successor to the company's ill-starred PC jr of six years ago, recognizes the importance of the home office phenomenon with four models specifically targeting the work-at-home computer user. Though the PS/1 doesn't qualify as cutting-edge in terms of spec-sheet performance, the new sys-

tem does push the envelope as a total computing package capable of doing serious work with a minimum of muss and fuss. This is a computer that's truly a snap to set up, simple to use and painless to service.

Whether IBM read the home market right this time around only time will tell, but the computer giant definitely did its homework, designing the PS/1 based on lengthy input from consumer focus groups. The result is a well-conceived computer that is easy on the eyes (built-in high-resolution VGA color graphics) and the hands (a "Selectric Touch" keyboard that lays to rest memories of the PC jr's membrane keyboard), while also being easy on the workspace (small footprint) and, by IBM standards, relatively easy on the wallet.

Prices start at

\$999 for the most basic model. A system with a color monitor and 30MB hard disk drive, lists for \$1999. An IBM mouse and a 2400-bps Hayes-compatible modem are also included in the PS/1 package, along with Microsoft's versatile integrated software suite, *Microsoft Works*. This software comes pre-installed on hard-disk versions.

You communicate with the PS/1 via a custom, mouse-controlled menu that effectively hides forbidding DOS prompts behind colorful graphics. Newcomers to computing should have no trouble getting started on this machine. Both the operating system and the menu are burned into the machine for faster startup.

Other PS/1 pluses include the built-in modem. This lets users use a free introductory subscription to tap into the Prodigy on-line information service as well as to an on-line bulletin board specifically created for PS/1.

IBM provides a toll-free service number that lets owners either solve problems on-line or get a new part expressed to them within 48 hours. The computer comes with a 1-year warranty.

The downside? The PS/1 clearly knows who it's for, but it's not for everyone. This 10MHz 286-based system is no more than a middleweight performer by today's standards, and though certainly adequate for most core home/office-type tasks, users who need to do heavy number- or graphics-crunching are better off opt-



IBM and Tandy (top) see computers as home appliances.

ing for a more powerful computer with at least a 386SX and preferably a full-blown 386 processor. The PS/1 is also not an ideal choice for buyers attracted to programs that run under Microsoft's touted *Windows 3.0* graphical environment, which benefits from more processing horsepower. And users who need more than what's already on-board will also find that, except for upping system memory, the PS/1 requires an extra-cost (\$169) expansion chassis for accommodating add-in circuit boards.

Tandy's new 1000 RL home computer, meanwhile, harks back to less sober visions of the home computer as a kind of family-bonding device, an all-purpose, in-home information appliance that plays as hard as it works. Tandy shows the 1000 RL tucked away in the kitchen, comfortably at home with the blender, the toaster and the microwave.

Tandy designed this PC to be left running like a home appliance. A built-in "sleep" mode automatically shuts off the screen, then the hard disk drive after a period of inactivity. At a touch of a key, the computer's ready to use again, powering up at exactly the same place where it dozed off. Because there's no fan, the unit is noiseless, and Tandy claims it draws no more power than a clock radio.

Tandy's 1000 RL systems start at \$750, with hard disk models (20MB) listing for \$1149 and \$1299, depending on whether you opt for monochrome or color versions.

Key to the 1000 RL's appeal is the included software. As opposed to the PS/1's business-oriented package, the 1000 RL instead offers 24 programs specifically written for a wide range of home and family tasks. There are programs for checkbook balancing, expense itemizing, home possession and hobby inventories, travel planning, individual diaries, meal planning and grocery shopping. There's also basic DeskMate productivity programs for writing, drawing and telecommunicating. The unit also offers a built-in sound/speech capability that is an option on the PS/1.

Tandy has chosen to emphasize the down-home virtues of low cost and simplicity over up-to-date computing capability with this system, arguably limiting its appeal for many home office users. The 1000 RL, with its venerable 8086 processor, low-density 720KB disk drives, slow 20MB hard drive and low-resolution CGA or monochrome Hercules-compatible video, doesn't match up well to the PS/1 or most modern workhorse PCs on the hardware side, despite its affordable price tag. Whether its soft-

ware will win it purchasers depends on whether there's really a market for all-purpose family PCs, a questionable proposition in light of previous history. Many analysts believe that dedicated appliances, perhaps built around the telephone or the TV, are more likely to answer the kinds of needs the 1000 RL addresses.

Alternatives

You can replicate the kind of functions Tandy provides with its software collection through an enormous variety of current DOS programs.

Among the most popular financial titles are MECA's *Managing Your Money* (\$220) and *Money* magazine's *WealthBuilder* (\$246), both money-management analysis programs; Intuit's *Quicken* (\$50), which does check writing and lots more; and Dac Software's *Dac Easy Lite* (\$50), a no-frills home and home/office accounting package. ChipSoft's *TurboTax* (\$75) is a highly regarded tax preparation package, one of many now on the market. *CheckFree*, from CheckFree Corp. (\$50, plus \$9 per month), lets you pay your bills electronically, while NoloPress's *WillWriter* (\$50) prepares you for the inevitable and final power-down.

Other potentially useful programs

include Rubicon Publishing's *Dinner At Eight* (\$50), a recipe database and meal planner that features more than 140 recipes collected from restaurants around the country. ESHA's *The Food Processor II* (\$250), Camde Corp.'s *Nutri-Calc PC* (\$145), Nutridata Software's *The Diet Balancer* (\$75), Natural Software's *Diet Analyzer* (\$50), and the Center for Science in the Public Interest's *Nutrition Wizard* (\$100) are five databases that analyze nutritional and caloric content. Datachem's *Sexu-Caution* (\$60) teaches sex education, while *Family Care* (\$99) from Lundin Laboratories helps diagnose illnesses and accidents.

Apple Computer, meanwhile, is offering a new line of Macintosh computers whose most attractive feature is price. With this new line, the entry price to the world of Macintosh computing is 50 percent less.

The least expensive model—at a list price of \$999—is the Macintosh Classic. This computer comes with a 9-in. monochrome monitor. A version with a hard disk drive is available for a list price of \$1499. Two other models, the Macintosh LC and the IIsi, offer more powerful computing capabilities at list prices of \$2499 and \$3769, respectively.

FM

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HOME VIDEO

8MM HEADS HOME

BY STEPHEN A. BOOTH, Contributing Editor



● Since its introduction in the mid-1980s, 8mm videotape has been considered a format to be used for mobile moviemaking in camcorders, rather than an alternative for home recording and video playback. In that time, 8mm home VCRs—especially those with built-in TV tuners—have been few and far between.

Now, with the increasing popularity of 8mm camcorders, you're likely to see more 8mm home decks on the market. If for no other reason, the availability of 8mm home decks will make it easier for 8mm camcorder owners to edit their home movies. Without an 8mm deck, it's necessary to connect the camcorder to a VCR of another format, such as VHS or Beta, and dub the raw footage over to that format for editing.

Of course, an 8mm VCR with TV tuner also can be used to record programs off the air, just as VHS or Beta VCRs do. The only difference among the formats is recording time. The longest 8mm videotape has the capacity for 2 hours of recording in the standard play mode and 4 hours in the extended play mode, whereas the VHS format, for example, offers recordings as long as 8 hours in the EP mode. An 8mm home deck could also play back prerecorded cassettes. Currently, about 1500 movies, music videos and instructional tapes are available for sale or rental.

Leading the 8mm home movement is Sony, with four decks. The latest, model EV-S550 (\$800), has a cable-compatible 181-channel tuner for TV recording and a host of advanced editing functions for home movie lovers.

For example, the EV-S550 has an Edit Shuttle dial to control the opera-

tion of the VCR and an 8mm camcorder that is hooked up through the deck's Control-L connection. The dial permits slow-motion and frame-by-frame tape movement for precise editing. A flying erase-head in the deck provides glitch-free scene transitions, and other features synchronize deck and camcorder tape movement.

Another feature of the EV-S550 is PCM digital stereo sound, in addition to AFM hi-fi stereo. You can use the digital soundtracks to add voiceovers, sound effects or music to your home movie, while retaining the tape's original audio on the AFM stereo soundtracks. As a further benefit for home movie editing, all of the EV-S550's control functions are duplicated on its wireless remote control.

A VCR You Won't Own

Let's face it. Few TV commercials attain the classic stature of those old Miller Lite ads featuring John Madden, Rodney Dangerfield, Mickey Spillane and their sports-bar buddies. That's why, for most people, the ultimate video dream-machine would be a VCR that automatically deletes commercials as it records broadcasts.

Keep dreaming. Although Mitsubishi introduced such a VCR in Japan, the company won't offer it here. The fact is, it wouldn't work here—and it's backfiring in Japan.

The "auto-cut" feature in the Mitsubishi VCRs worked on some programs in Japan because of a quirk in Japanese broadcasting practices.

In that country, TV sound is broadcast as 2-channel stereo. But for some foreign programs, such as American movies, the stereo signal is split to

provide the original English soundtrack on one channel and the overdubbed Japanese translation on the other channel.

Japanese commercials, though, have only a Japanese soundtrack and come through in stereo. When the tuner circuitry in the Mitsubishi VCRs sensed this return to a stereo signal, it would trigger the auto-cut to pause recording until the signal split to bilingual monaural again.

The feature wouldn't work in the U.S. because there is no such change in the soundtrack to trigger it. Nor did it work in Japan on domestically produced programs, which have only a Japanese soundtrack broadcast in stereo. Now the auto-cut doesn't work at all because of a backlash reaction by Japanese TV broadcasters.

Fearing that the spread of the auto-cut feature would cut into their advertising revenues, the broadcasters began transmitting a signal that would confuse the auto-cut feature by masking the transition to commercials. Although Mitsubishi could refine the feature to overcome such trickery, the company says it won't. The large, diversified company has many products and services that might be subject to boycott by corporate customers, so Mitsubishi won't rock the boat any further.

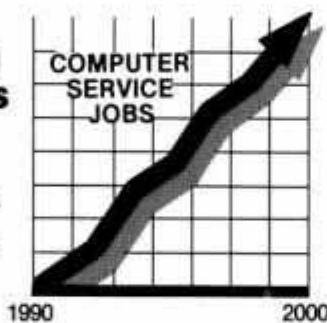
Ironically, the company never used TV commercials to advertise its auto-cut VCRs.

FM

5 sure steps to a fast start as a high-paid computer service technician

1. Choose training that's right for today's good jobs

Jobs for computer service technicians will almost double in the next 10 years, according to the latest Department of Labor projections. For you, that means unlimited opportunities for advancement, a new career, or even a computer service business of your own.



But to succeed in computer service today, you need training—complete, practical training that gives you the confidence to service any brand of computer. You need NRI training.

Only NRI—the leader in career-building, at-home electronics training for more than 75 years—gives you practical knowledge, hands-on skill, and real-world experience with a powerful AT-compatible computer you keep. Only NRI starts you with the basics, then builds your knowledge step by step until you have everything you need for a fast start as a high-paid computer service technician.



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NRI knows you learn better by doing. So NRI training works overtime to give you that invaluable practical experience. You first read about the subject,

studying diagrams, schematics, and photos that make the subject even clearer. Then you do. You build, examine, remove, test, repair, replace. You discover for yourself the feel of the real thing, the confidence gained only with experience.

3. Get inside a powerful computer system

If you really want to get ahead in computer service, you have to get inside a state-of-the-art computer system. That's why NRI includes the powerful new West Coast 1010 ES computer as the centerpiece of your hands-on training.

As you build this fully IBM AT-compatible micro from the keyboard up, performing key tests and demonstrations at each stage of assembly, you actually see for yourself how every section of your computer works.

You assemble and test your computer's 101-key "intelligent" keyboard, install the power supply and 1.2 meg 5¼" floppy disk drive, then interface the high-resolution monitor. But that's not all.

You go on to install a powerful 20 megabyte hard disk drive—today's most-wanted computer peripheral—included in your training to dramatically increase the data storage capacity of your



Now—**AT Compatible!**

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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Shaping Up The Mark VIII

● Judging by this prototype, there'll be a lot of Thunderbird in the Mark VIII, Lincoln's personal luxury car series. Due for the '93 model year, the new Mark will substitute a laid-back waterfall grille for the more upright

be completely computer-controlled and entirely independent of the car's front wheels. Rear steering will come into play when the system's electronic brain perceives a need.

Up Tempo

The rounded aero look that characterized Ford cars in the late '80s seems to be giving way to harder lines and fewer soft curves in the early '90s. Snapped in Dearborn, this 1993 Tempo prototype is more wedge-shaped than the current model, with a steeper hoodline that should help to improve its coefficient of drag.

The new headlight arrangement

shown here may or may not find its way to the production line, but it seems certain that there'll be more power available for the next-generation Tempo. Ford plans to make its 3.0-liter Vulcan V6 engine available when the new car is introduced in the later part of '92, giving Tempo an edge versus competi-

tors like the popular Honda Accord.

New Big Blazer

Chevrolet will round out updates to its light-truck family with this reskin of the full-size Blazer, due out next fall.

Although the new Blazer's front end borrows most of its look from the current Chevy pickup line, it retains the established Blazer appearance, particularly in the shape of the rear side glass.

This model, a finished prototype, was snapped while it was undergoing testing at a GM proving ground in Michigan.

Look for a 6.9-liter diesel V8 to be among the engines offered with the new Blazer. The big diesel will be part of an extra-cost package aimed at the construction trade.

Leather Boom

Although automotive upholstery fabrics continue to be more and more durable, as well as more attractive, sales

(Please turn to page 86)



Sextet of tiny headlamps may or may not be part of '93 Tempo's styling.

treatment used on the current Mark VII lineup. Insiders suggest the new car will also include 4-wheel steering among its technical features.

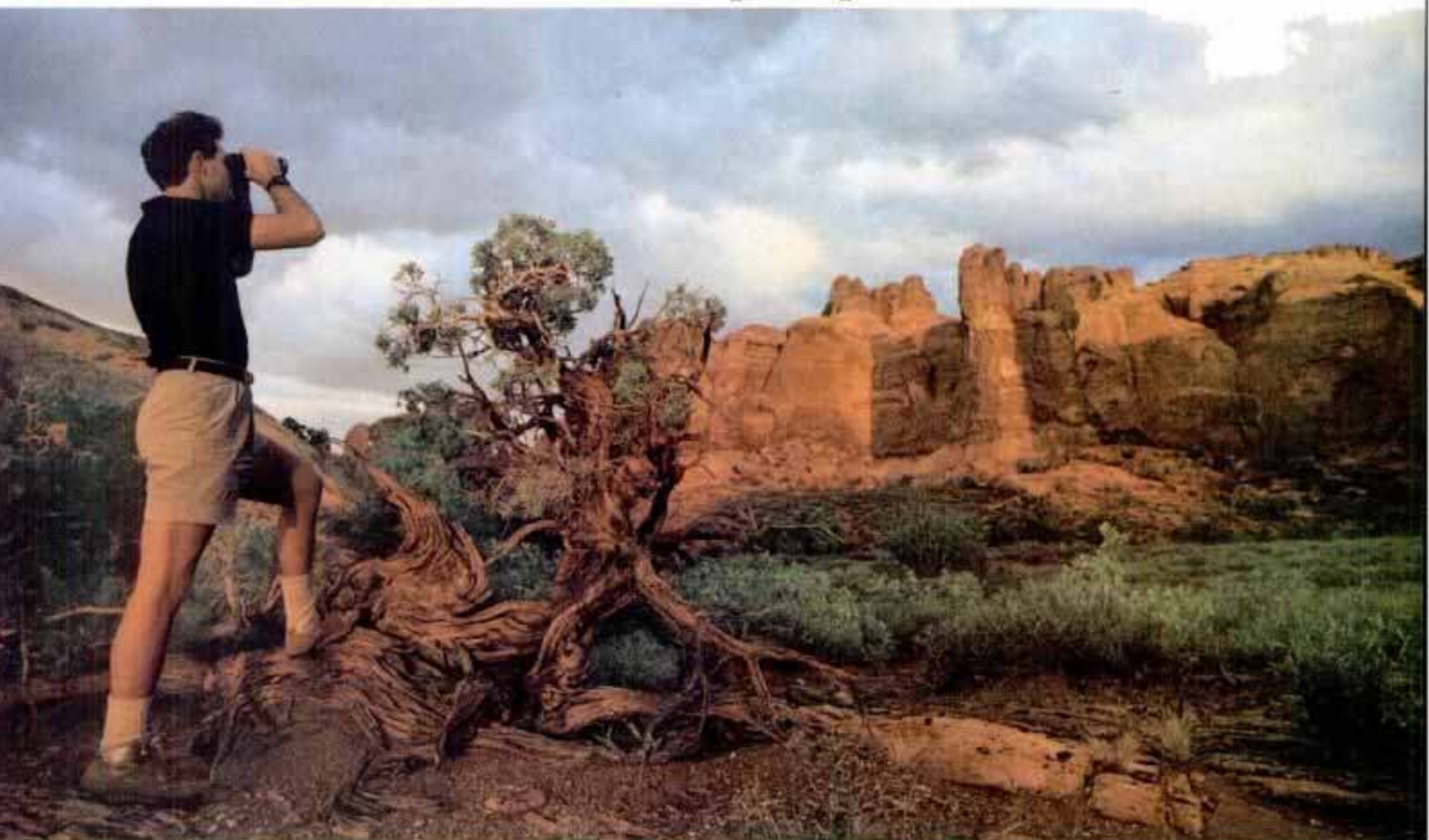
Although 4ws has largely been a sales disappointment to the various manufacturers—Honda, Mazda and Nissan—who have already brought this innovation to market, Lincoln product planners apparently feel the feature is needed to boost the division's technology image.

These same sources also suggest that the Mark VIII's 4ws system will



1992 Blazer will adopt current Chevy pickup truck styling.

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



You like people. You also like your privacy. You believe there should be room in life for both. And, you're right.

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

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*Sound perfect for you?
You're in good company;
Explorer is today's best-selling compact utility.**

*Based on Manufacturers' Reported Retail Deliveries, May 1, 1990 to date.



Buckle up — together we can save lives.



Have you driven a Ford... lately?

Your Explorer is ready.



Due as a 1991 midyear, Mercury Grand Marquis mates new body to current chassis.

of leather interior trim packages are booming.

Examples: Almost half of Ford's Eddie Bauer edition Explorer sport/utility vehicles are leather-clad, while Honda reports that 20,000 of its cars were ordered with leather interiors last year.

Vinyl, meanwhile, is disappearing from all but the cheapest models.

Marquis Update

Like its full-size sedan competitors from Chevrolet, Buick and Oldsmobile, the Ford Motor Co. update on its traditional family sedans—Ford Crown Victoria and Mercury Grand Marquis—will entail a new shape on the same rear-drive platform employed for the current cars.

Unlike the GM entries, however, the Crown Vic and Grand Marquis will also offer a brand-new engine, Ford's 4.6-liter sohc V8.

Crown Vic and Grand Marquis styling will be more rounded and contemporary than the current cars, as this Grand Marquis production-ready prototype indicates. Construction will be the same rugged body-on-frame technique as the current cars, and dimensions will be virtually identical.

Lens Losses

The new generation of aero headlights may look sleek, but they're costly to replace.

For example, if the headlight lens for a new Chevy Caprice is damaged, the replacement cost is \$90, plus another \$5 for the bulb, plus labor.

By comparison, a replacement for a burned out sealed beam is under \$10, and installation takes 15 minutes.

Automakers say the new plastic lenses are stronger and resist damage better than the old sealed beams, thus reducing replacement costs overall.

Mustang Muddle

Ford is still trying to decide which way to go with the 1994 Mustang.

The options are to use the current Thunderbird platform, update the current Mustang platform or use a variation of the new Tempo platform.

The Thunderbird platform seems

to be the least likely option, owing to weight. The new Tempo platform addresses the weight problem effectively. But with the Probe solidly established, Ford is committed to rear-wheel drive for the Mustang, which would mean an extensive adaptation to the new Tempo chassis for use in a new Mustang.

Mustang's current Fox platform, which began life as the Ford Fairmont, is definitely long in the tooth. Although more development is possible, most chassis engineers would rather start with something more modern.

Consequently, smart money is on a rear-drive version of the new Tempo platform, powered by a high-output edition of the new 4.6-liter V8.

Super Cars

The supercharged Park Avenue Ultra's 3800 V6 is slated to appear in very few cars during the 1991 model year. Probably around 500 cars total, and those toward the close of the model year. Supercharging the 3800 ups the power from 170 to 200, more in line with the upscale buyer's expectations for a high-line car. Buick's engineers claim to lose only 1 mpg, with consumption at about 18/27.

Unconfirmed reports also say that the super motor will be available, if not standard, in the Olds 98 Touring Sedan and the Pontiac Bonneville SSE.

Bagging It

Look for air bags to be standard equipment on more than 90 percent of the cars sold by the 1995 model year.

But not everybody is comfortable with them yet. Emergency crews, coming upon accident sites where air bags have deployed, have mistakenly assumed the talcum powder/baking soda smoke from the air bags to be toxic, and in some cases have delayed treatment to injured drivers until the powder could be washed off. There are no toxic compounds produced by an air bag deployment, except for a very small amount of sodium hydroxide, which quickly decomposes in atmospheric moisture. **PM**

VIDEO TO GO

(Continued from page 41)

speed zoom lens and $1/60$ -, $1/500$ - and $1/1000$ -second shutter speeds.

The E08 also features Auto-Tracking Focus, which follows subjects as they move sideways in relation to the lens. And, the E08 comes with a wireless remote control. This accessory not only enables the camcorder operator to join the fun and operate the E08 from a distance, it also lets you operate the E08 like a VCR when you connect it to your TV.

What's available: VHS-C

Unconventional styling also can be found in one of the 10 subcompact camcorders in the VHS-C format. This time, it's in a twist-and-shoot configuration from Hitachi.

The company dubs its Model VM-C1A camcorder (\$999) "The Thin Man"—with reason. The 2-pound 3-ounce camcorder measures just $2\frac{11}{16}$ in. wide—thin enough to fit in a briefcase. Height is $4\frac{1}{4}$ in., and length is 11 in. The hand grip with its finger controls is located at the front of the camcorder. When it's twisted clockwise into operating position, the power, 6x zoom lens and recording function are activated automatically.

VHS-C models more similar in styling and size to the Sony and Hitachi/RCA/Minolta handhelds hail from Panasonic, Quasar, JVC, Minolta and Zenith.

Both the Panasonic PV-40 (\$1600) and Quasar VM508 (\$1700) boast Digital Image Stabilization—a neat bit of digital technology that keeps your picture rock-steady, as though you've used a tripod or dolly, no matter how much rocking and jittering accrue from handholding the camcorder.

With so much going for them, the only question about subcompact camcorders is: Are they for you?

Concern yourself with how well your fingers match up to the controls and how comfortable you feel holding the camcorder to your eye in the "ready" position for arm wrestling. Are the control buttons large enough for your fingers to operate accurately? Is the camcorder light enough and well-balanced enough for you to hold it steadily in one hand—or would you rather have something you could rest on your shoulder?

If you travel frequently, if you lead an active outdoors lifestyle or if you have family get-togethers regularly, then bet the rent on the subcompact. Human nature being what it is, the smaller and lighter the camcorder, the more likely it is to find a space in your carry-on luggage, backpack—or even the console or glove compartment of your subcompact car. **PM**

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WILL LAST... AND
LAST...AND LAST!

You've seen the price of new cars...they go up every year! Cars get flimsier...prices get higher...it never seems to end. There are lots of reasons to keep that nice car of yours on the road as long as possible.

Car sales are down and Tufoil sales are up. People are smart...they're taking the economical way out and what could be easier than Tufoil. Just add Tufoil to the crankcase. You don't have to shake the container or add an engine flush. Just pour it in and drive away.

Your throttle will get silky smooth...acceleration will improve. One customer said his car "takes off like a scared rabbit!"

Tufoil works wonders for all known engine oils. It's actually slipperier than Teflon (according to a famous U.S. Government laboratory).

You'll get astonishingly fast starts on cold mornings with both diesels and gas engines. The Canadian government tested Tufoil at it's cold regions lab. They showed faster cranking and significant fuel savings with Tufoil.

What about additives that claim to be a one-time treatment that will last the life of an engine? Well, I've been following the scientific literature on lubrication for a very long time. As far as I know, there isn't a shred of scientific evidence for such a claim. So don't believe it!



TREAT YOUR CAR
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IMPORTS

VOLVO'S NEW 9-SERIES

BY TONY SWAN, Automotive Editor



● If Charles Darwin were to pick the car company that best reflected his theory of evolution, we'd be willing to bet that Volvo would be the company so designated.

Without putting too fine a point on it, change comes slowly in Gothenburg. Lacking the vast capital resources required to make frequent model redesigns, Volvo pursues a course similar to the one that guided the long evolution of the VW Beetle: deliberate development of an established model.

While this approach to carmaking doesn't generate much flash, it does have a way of producing cars of substance and quality—two words that definitely apply to Volvo's new 9-series sedans and wagons. And so does the word evolutionary. It's not hard to perceive the origin of this Swedish subspecies.

There's new, and then there's new

In fact, from the front it's hard to tell a 9-series from its predecessor, the 7-series. Sheetmetal changes are confined to the rear of the car. The hard-edged formal roofline has been rounded, the rear window has more slope, and the deck height has been raised. While this has given Volvo's flagship sedan a look that's less distinctive than the 7s, the benefits are substantial: a 12-percent improvement in aerodynamic efficiency and enlarged cargo capacity. The trunk lid has been extended down to the bumper, improving access considerably. And improved aero adds up to a quieter interior, aside from any fuel consumption considerations.

The new car's mechanical inventory is essentially 7-series, and basic chassis dimensions are virtually identical. Antilock braking, a feature Volvo was strangely slow to adopt, is standard 9-series equipment and optional elsewhere in Volvodom. A driver's air bag is also standard, as are a trio of 3-point rear seatbelts.

One other interesting tweak is an automatic limited-slip differential that locks out at speeds over 25 mph, which is standard in two of the three 9-series trim levels. A 740 live axle with Volvo's constant track rear suspension is offered on the sporty Turbo model.

Aside from reduced wind noise, there's little difference between 9s and 7s on the road. The new cars feel very much like Volvos—predictable, with a fair amount of body roll in cornering and excellent straight-line stability at high speed. We ran several 125-mph laps in an absolute downpour on a Volvo test track in Sweden with total confidence.



New aluminum alloy 24-valve dohc inline-Six is still one year away from U.S. debut.

The bottom line

The 9-series comes to us in three trim levels, all of them 940s—the 940 GLE (\$27,885), the 940 Turbo (\$29,295) and the luxu 940 SE (\$32,950)—with station wagon versions of each. All are powered by 2.3-liter 4-cylinder engines—the old PRV V6 is history—in either normally aspirated (153 hp) or turbo (162 hp) tune. And all are bolted to automatic transmissions.

However, the biggest news with this new model—an all-new under-square (83mm bore, 90mm stroke) 3.0-liter dohc 24-valve all-aluminum inline-Six—is a year away from its U.S. debut, due to unspecified difficulties with California certification.

The new engine is rated at 204 hp and produces gratifying low-end torque, but perhaps its most impressive operating quality is smoothness. We base this impression on a day of touring and test track driving in Sweden and look forward to a more comprehensive evaluation when the 6-cylinder cars—the 960s—hit U.S. showrooms.

In the meantime, we continue to be impressed with what automotive Darwinism, as interpreted by Volvo, can produce.

Although 9-series pricing puts these cars into direct competition with some formidable Japanese entries, we think they'll hold their own in the marketplace based on the virtues that Volvo has emphasized for decades: quality, comfort, durability and, of course, safety.

Volvo's interpretation of luxury may not exactly be high profile, but attention to detail has a way of paying off in this business. **PM**



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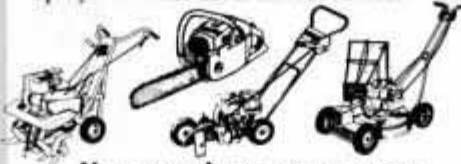
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ALTERNATIVES

BY ABE DANE, Science/Technology Editor



A solar thermal trough (right), built by Luz International, represents one alternative to the specter of gas warfare in the Middle East.



● For the second time in 20 years, events beyond our control in the Middle East have caught us flat-footed and held our economy hostage. Spurred by high oil prices, along with government funding and tax incentives, the 1980s saw brisk progress in efforts to develop alternative energy sources that would reduce our dependence on Mideast oil. But then, reduced oil prices over the past few years brought nearly total amnesia, expiration of tax incentives, the return of big cars and hard times for the fledgling alternative energy industry. The U.S. Department of Energy went with the flow, cutting funding for research into renewable energy sources by 82 percent between 1980 and 1989.

It's easy to second guess. So let's not get bogged down in asking who's to blame for our past complacency. Let's look at what's being done right now to get to the root of the problem and prevent us from getting dragged into any more of these entanglements with unruly Arabs.

What are the alternatives?

During the brief boom of the early 1980s, a whole slew of practical, renewable alternatives to fossil fuels emerged. Hundreds of little companies sprang up, offering myriad ways

to harness the natural forces around us. Wind turbines, geothermal wells and biomass burning plants became significant suppliers of electricity in some areas of the country, and technology was developed that promises to make solar thermal and solar photovoltaic power practical in the near future. Along with hydroelectric plants, these renewables came to account for 8 percent of our energy supply. For a few years, America was



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For a while, it looked like oil shale and coal were the two most viable alternatives. The U.S. has hundreds of years of coal reserves and possibly that many in oil shale. The problems with these two resources quickly became obvious however. Right now, burning coal is a dirty business, and this country is more environmentally aware than it has been in years. Besides the noxious problems associated with coal burning, you run into the social problems that coal mining brings with it. Coal mining is a tough, unpleasant task in an industry where unions and management have been at odds for years. Add to all this the problem of underground fires in coal mines and you wind up with a big zero—or at least a resource whose time has either come or passed.

What about oil shale? In the Western U.S. there are literally millions of barrels of oil reserves. The problem is that it's all locked up in oil shale—roughly an oily sand. Extracting the oil from the shale becomes economically feasible as the price of oil goes up. At \$40 a barrel, it's feasible. At \$20, it's foolhardy.

Alternative energy is a young and fragile industry and needs just the

right combination of market and regulatory conditions to grow. With oil prices dropping as low as \$8 a barrel in recent years, those conditions have taken a grim turn. Companies are dropping like flies, victims of bankruptcy and foreign buyouts. According to a 1988 study by the highly regarded Investor Responsibility Research Center, new powerplants scheduled to come on line in 1993 will add only 200 megawatts to our total renewable energy supply, down from 1200 megawatts added in 1989.

The free market can be a wonderful thing, but it is also merciless and without foresight. Worse, there is an important sense in which the playing field is tilted against alternative energy. That tilt comes from what energy analysts call "external costs."

Oil's hidden price

What's happening now in the Middle East is a good example of just one of these external costs. In addition to the billions of dollars now being spent to maintain some semblance of order in that troubled region, there is the inestimable environmental impact caused by the use of oil, ranging from the fouling of Prince William Sound to global warming.

What does all this have to do with the price of gas at the filling station? Nothing. That's just the problem. All these things unquestionably cost us as a country, but the cost is spread around, rather than resting squarely on the shoulders of each individual as he makes the decision whether or not to buy oil. Thus, it can be argued that fossil fuels enjoy an unfair subsidy of sorts, since people who have nothing directly to do with the purchaser are paying for his decision. They pay, for example, by suffering damage to their environment, and if war breaks out in the Middle East, some will pay with their lives.

Technology's promise

So the deck is stacked in favor of fossil fuels. The question is: Do the alternatives have what it takes to stand on their own if they're given a chance? The gains made during the early '80s say unequivocally that the answer is yes. During that period, advances

in technology brought costs down sharply. Geothermal energy, made by running turbines on underground steam, dropped to as low as 4 cents per kilowatt-hour, actually beating out the 4.5- to 25-cent cost of power from current coal, gas or nuclear plants. Biomass, which involves the combustion or decay of organic

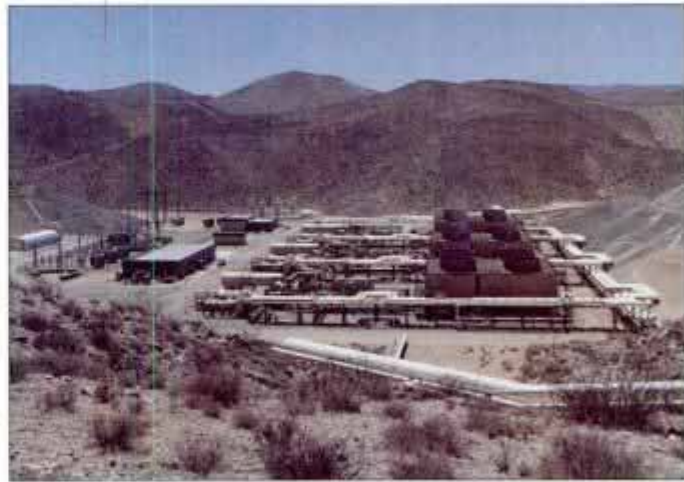
wastes, reached 6 cents per kwh, and wind power came down to 7 cents. Solar power, which many believe offers the greatest long-term potential, made remarkable strides, with solar thermal steam generation now as little as 8 cents per kwh, and photovoltaic solar cells able to produce electricity at \$5 per watt, less than half the level of six years ago.

"The '80s were almost an experimental lab," says Susan Williams, an analyst at IRRRC. "There were a lot of designs that failed. But those that succeeded have done very well in bringing down costs."

A national strategy

Thus, the renewables industry stands poised to expand dramatically, if it can weather its current problems. As of press time, the key to determining this is to be placed on President Bush's desk in December of 1990. Called the National Energy Strategy, this massive document is the product of more than a year's research at the many labs and offices of the U.S. Department of Energy. Now in its preliminary form, it does not recommend any specific course of action. Rather, it lays out the options, along with their predicted consequences for our economy, the environment and national security. President Bush will have to weigh these factors and decide if programs should receive emphasis or be cut back.

Although the final strategy is up to the president, the research contained



U.S. Navy geothermal plant already beats coal for cost.

in the preliminary version does lend strong support to certain measures. According to DOE spokesman Phil Keif, conservation will receive renewed emphasis, as will development of domestic oil supplies, including opening up the Arctic National Wildlife Refuge for oil exploration.

These, however, are only stopgaps. For the longer term, money to support renewables is critical. A preliminary DOE white paper, which I secured shortly before press time, has this to say on the subject: "The extent of federal R,D&D support can have a great influence on the rate of increase of renewables' market share, and on the success of the domestic RET [renewable energy technologies] industry in the U.S. and world markets in the coming decades."

It goes on to say that if funding levels remain the same, also known as the business-as-usual scenario, renewable energy will grow to only 15 percent of our supply by 2030, whereas if those expenditures double or triple, it would increase to 28 percent. And the report cautions that this in no way represents an upper limit.

It might sound like a lot of money, but out of a \$16- to \$17-billion budget, the DOE now spends only \$133 million on all renewable energy R&D. That represents only 5 percent of an energy research budget that goes primarily to support coal, fossil fuel and nuclear technologies, most of which carry environmental costs that will eventually be unacceptable. **PM**

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OLD HOUSE RESTORATION

SHINGLES AND SHAKES

BY BOB VILA, Contributing Editor



CEDAR SHAKE & SHINGLE BUREAU PHOTO

● From the saltboxes that dot the Northeastern shoreline—especially in Cape Cod—to California's ornate Victorians, wood shakes and shingles are part of America's past. Whether the traditional square butt or the multipatterned fancy-cut variety, it's hard to beat the beauty of this natural, textured siding.

Historically, shakes and shingles were made from many types of wood, including cedar, redwood, oak, cypress, pine, spruce and fir. Although they are still made from a variety of species—particularly on some of the more sophisticated architectural restoration jobs—cedar is the most common wood used for today's shakes and shingles.

Let's take a look at the advantages this type of siding offers both the restorer and new homeowner alike. And, you'll see that it's relatively easy to repair and maintain the cedar siding you've already got. You can even find replacements for the fancy-cut Victorian shingles. And when the sit-

uation calls for re-siding an entire wall or structure, we have some tips on the best way to do this job that will guide you on your way.

Single coursing

Most of you probably know the difference between a shingle and a shake. Shingles are machine-sawn into smooth, tapered boards that range in size from about 3 or 4 in. wide to over 16 in. wide. Shakes, on the other hand, are hand-split with a steel-bladed froe, then sawn in half. This gives them their rough surface and flat, smooth back.

The traditional way to install shakes and shingles is called single coursing. Each piece of siding is attached so that it covers about half of the one below it. Only two nails are used to secure each shake or shingle and are spaced so that the following course covers them. This is the common way homes were shingled on the East Coast.

Double coursing

Siding with double courses is the way to achieve deeper shadow lines and

Using cedar shakes or shingles, like those shown at left, for re-siding purposes is a great way to create a whole new look on any restoration job.

wide weather exposures, from 12 in. to 16 in., depending on the shingle size you use. It can also be more economical, since a lesser-grade product is used for the undercoursing that is fastened with one nail at the top of each shake or shingle.

There are two ways to do this. The more common way is to apply the exposed course $\frac{1}{2}$ in. lower than the undercourse using two nails placed about 2 in. above the bottom edge and $\frac{3}{4}$ in. from each edge. In this type of installation, the nails will be visible, which most people will consider to be unacceptable.

If you are trying to match coursing that's been applied this way, then by all means, use the surface nailing. But, generally speaking, it's a better idea to always plan your work so the subsequent course will cover up the nails.

The other way to apply double coursing was common on the West Coast in the early 1900s, and is a way to achieve even deeper shadow lines. You start out with the basic double course at the bottom of the wall (as you would with any job), then lay a single row of shingles 4 in. above this. Lay another row only 1 in. above the butt line. Skip 4 in. and repeat. Nails are placed about $\frac{3}{4}$ in. from the outside edges and are covered by each ensuing row.

Nails that are aluminum, double-dipped galvanized or stainless steel (the most expensive choice) work well on cedar. Don't be tempted to use plain steel nails. The natural reaction of iron oxide with the cedar and water will create ugly dark stains on the siding. When nailing shakes or shingles, don't push the head too far into the wood. It may crack. Rather, the heads should be just flush with the siding surface.

Repair and replacement

If you're restoring a house with shake or shingle siding, simply nailing down any warped or cracked pieces with an aluminum or galvanized nail may be all that's needed to keep the siding

"Home Again With Bob Vila" is the title of our contributing editor's new TV show.

functioning properly and looking good. Depending on the severity of the damage, you may want to slip a patch (made of roofing paper) underneath the siding for protection from the weather.

When a shake or shingle is damaged too much for this to work, replacement is necessary. This, too, is a relatively easy job, and, if you have the tools and materials lined up and ready to go, this shouldn't take more than 5 minutes to accomplish.

First, of course, you've got to remove the old shingle. The best way to do this is with a tool called a shingle puller or shingle thief. Shaped like a long T (with a handle), this tool has two hooks at one end designed to snag nails when the long, thin blade is pushed up under a shingle. Once a nail is caught, a few hammer raps to the puller's handle are usually all that's needed to remove the nail. You can also cut the nails holding the damaged shingle with a plain hacksaw blade, then splinter the shingle and remove it in pieces.

That was the hard part. Installing the new shingle is even easier. As long as the underlying paper is in good shape (use your judgment here—you may need to add some new material), all you have to do is slip the new piece (which is the same size and thickness as the original one) up into the space and nail. Keep in mind that cedar is a very workable wood. Not only is it soft, it's also very straight-grained. So, if you have some precise fitting to do, all that's required is a sharp coping saw or utility knife. A sharp block plane is handy if you have several shingles to fit.

Often, the replaced shingles are bleached with baking soda and water, which grays the patch job so it blends with the rest of the aged cedar. When this mixture is exposed to the sun, a chemical reaction occurs which ages the new cedar in a few hours.

If you have to replace fancy-cut Victorian shingles and can't find the pattern you need in the right size, the folks at the Cedar Guild (51579 Gates Bridge E., Lyons, OR 97358; (503) 897-2541) can probably help. Experts at recreating the work of the Victorians, they custom produce shingles in a myriad of handcut patterns, including fish scales, rounds, diamonds, hearts, bells and acorns.

Once the repair work is done or the new siding is installed, learning how to maintain it to make the most of its natural beauty and longevity is next.

Keep it clean

Maintaining cedar siding is a matter of keeping it hosed down, clean and

free from moss and mildew that invade the tissues of the wood. Shakes or shingles should not be continually exposed to moisture, so they should not touch the ground or be in contact with any vegetation.

Although you can leave the cedar to weather naturally, applying a preservative or sealer helps protect it and increase its longevity. Painting shingles or shakes, a common practice on saltbox-styled homes, is an excellent way to protect them. Just make sure the paint you choose is formulated for use on cedar. Staining is a great way to provide protection yet retain the grain and texture of the natural wood. A translucent stain should have an ultraviolet barrier that protects the wood from the sun and its destruction of connecting tissue between the individual cells.

If you choose to leave them to their natural weathered gray, a clear sealer or preservative with either copper or zinc as its active ingredient will help inhibit moss. It should also offer ultraviolet protection. Petroleum-based oils are usually a pretty good choice. Let the wood age to the stage of gray you desire before treatment. Properly installed and maintained cedar siding should last at least 30 years. It's

not uncommon to find it still functioning on structures that are much older. In fact, I've seen it on houses that are more than 70 years old.

If you live in a very humid climate or in an area that suffers from high humidity and heat for at least four or five months of the year, choosing a copper chromium arsenate (CCA) pressure-treated product can increase its longevity. It won't be receptive to sealers or paint until it's left to weather at least six months, sometimes longer. But, the manufacturer's warranty on most of these products is 30 to 40 years.

Old house or new, the aesthetics of shake or shingle siding can complement most architectural styles. For those of you lucky enough to own an old house with this siding, you've seen that it's usually not difficult to restore it. And for new-house owners, choosing wood shakes or shingles is a way to bring a bit of America's past to the present.

Note: If you'd like to receive the 12-page "Design And Application Manual For Exterior And Interior Walls," just send \$1 to the Cedar Shake & Shingle Bureau, 515 116th Ave. N.W., Suite 275, Bellevue, WA 98004. **PM**

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PAN AM EXPRESS REDUX

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY RICH COX

● Tim Cahill and I are walking on the Arctic Ocean. It's frozen solid, and we're heading for a patch of green ice. Neither of us has walked on an ocean before, but we know that saltwater freezes unevenly. It often forms pockets of transitional ice similar in consistency to a blender drink. In fact, we're headed for one of the slushy cocktails now.

Cahill is an adventure writer and has just completed an expedition that will become the basis for his next book. Tim and endurance driver, Garry Sowerby, just set a world record by driving from the tip of South America to the tip of North America in 23 days. Garry is busy right now with a video crew, so Tim and I take an Arctic hike.

I reach the green ice first and step forward cautiously. "It feels pretty solid," I say to Tim, who's about 5 yards behind me. Unexpectedly, he starts to sprint. When he reaches the green ice, he leaps into the air and slams down flatfooted with all his

weight. A shockwave ripples through the slush, but it holds.

"You could have punched right through, Tim," I say in stunned disbelief, edging off the rolling ice.

"I know," he says, smiling. "It would have made a great ending for the book."

On the road

POPULAR MECHANICS is nothing if not a magazine that explores the interface between man and machine. When I wrote about Garry and Tim's 15,000-mile trip ("Pan American Express," page 77, Feb. '88), I concentrated on the achievement itself, a new world record and the tremendous effort that went into it. I focused on the way Garry and Tim persevered through 23 difficult days and how the third member of the team—a GMC Sierra pickup—handled extreme abuse.

But to a man who uses his body to test the firmness of green ice, this isn't the whole story. In fact, the actual record run comprises little more

than half of Tim's just-released book, *Road Fever: A Very Fast Travelogue*, published by Random House. The first portion, which is interspersed with humorous anecdotes that reveal a finely honed sense of the offbeat, is basically about the 10 months that preceded the trip.

It tells of gaudy GMC dealer meetings in Las Vegas, bizarre interviews in London with the trivia-obsessed editor of the *Guinness Book Of World Records*, strange tactical sessions with a gung-ho antiterrorist expert and numerous other hilarious events that form the long preparatory phase of the intercontinental adventure.

I'm not a book reviewer, but I know what I like, and I recommend *Road Fever* to anyone who's ever dreamed about doing an exotic road trip. What equipment do you bring? How do you raise money and obtain sponsorship? What documentation and interpersonal skills are required to pass through lawless cocaine country and a civil war? How do you get into the

Guinness Book Of World Records? The answers to these and many other questions are provided with insight, irreverence and, when the occasion calls for it, wild humor.

Despite the swashbuckling nature of his subject, Tim's no Indiana Jones. His purpose isn't machismo, although he often needs it—sneaking into Brazil without a passport, for example, or outwitting machine-gun-toting policemen. His purpose is to have a good time. And his story isn't one of high-wire suspense or epic struggle, but of wisecracking adventure, which he conveys through witty dialogue and dazzling comic riffs.

Although Tim didn't include the green-ice episode in *Road Fever*, he did cover POPULAR MECHANICS' involvement in the project, which somehow seems a lot funnier now than it seemed at the time. But then, everything is funnier from the Cahill point of view.

Gadgets Redux

One of the great pleasures of my job is to be able to test some of the latest outdoors gear to come on the market. Here's a look at a few of the best items that have recently passed my way.



Sunglasses, by Killy Technical Eyewear, have frames that act like tuned suspensions.

Killy Technical Eyewear (KTE), a new concept in sunglasses, is designed specifically for the high-action sportsman. The interesting element about these shades, designed by champion skier Jean-Claude Killy, is the high-tech frame, which acts like a tuned suspension for your face. The spring-action nosepiece is a reactive, movable component that permits a tight fit without discomfort, and becomes a shock absorber when put under stress.

Rotating earpiece tips give the frames a dual-function personality. For normal activities, keep the tips in the standard loose-fitting position. But for skiing, biking or other high-action sports, rotate the tips 180° and the frame locks tightly on your face.

To ease the sunglasses on and off, and also to increase durability, the frame comes with dual-action spring temple hinges. Another key element

is the padded brow bar that serves a protective function in extreme cases of frontal shock.

The frames are made of a polyimide, carbon fiber, and all surfaces that touch the skin are covered with soft silicone. The lenses are high-quality glass and offer full UV and UVB protection. This kind of specialized componentry doesn't come cheap. The KTE sunglasses cost from \$290 to \$345, but there's little doubt they're among the most comfortable shades I've worn. And they look great, too.

Feeling good and looking good are the ideas behind a new line of outdoors jeans by Wrangler that eliminates the need to wear thermal underwear. Called Wrangler Rugged Wear Thinsulate Jeans, the new jeans provide all the insulation you'll need for temperatures as low as 0° F.

The heavyweight, all-cotton jeans are lined with Thinsulate, a micro-fiber made by 3M that traps air for improved insulation. Despite the additional layer, the Wrangler Thinsulate Jeans are only 6 ounces heavier than traditional jeans. Price runs from \$30 to \$50.

AF Binoculars

The mind of Minolta is at work again and now has come up with the world's

first continuous autofocus (AF) binoculars. Available in two models, the Minolta Autofocusing Binoculars feature the same technology used in the Maxxum SLR camera system. In other words, just press the AF button and your subject will automatically stay in focus regardless of where it moves—from 6.6 ft. away to infinity.

The roof-prism-type binocular, which is powered by one 6-volt lithium battery, requires a specific setup for each individual user. These adjustments include setting the distance between the pupils of each eye and allowing for individual diopter correction, which is basically standard procedure for all adjustable non-permanent-focus binoculars.

Once set, focusing becomes automatic, unless you choose the manual override mode. To lock focus, you simply lift your finger off the AF button. Control buttons are also provided for powered manual focus.

A 4-step battery indicator alerts the user to battery condition whenever the binoculars are turned on for use, and power automatically shuts off after 50 seconds to save energy.

The 8x22 retails for about \$376, and the 10x25 for about \$421. No doubt they're the ultimate permanent-focus binoculars. **PM**



IMPORTANT SAFETY WARNING TO OWNERS OF RUGER P-85 9MM PISTOLS



We have recently learned of a broken firing pin in a P85 automatic pistol which caused the pistol to fire as a result of decocking. This is the first report of this nature in over 200,000 pistols delivered to customers since 1987. No injury occurred because the shooter kept the pistol pointed in a safe direction during decocking.

Nevertheless, we regard this incident as important because it reveals a potential danger which we are prepared to eliminate in all P85 pistols now in use. This modification is very simple and does not alter the handling or appearance of this pistol, but it must be installed at the factory.

Accordingly, we urgently request that all owners of P85 pistols contact us immediately to obtain any further information they may desire, and to arrange for return of their P85 pistols to the factory for modification. Please contact us at:

STURM, RUGER & CO., INC.
Dept. S, Ruger Road
Prescott, AZ 86301

Or call us for P85 inquiries *only* at: 1-800-424-1886. Please have your pistol serial number available when contacting us.

We will schedule your gun for factory installation of a new safety/decock system free of charge. It will prevent this type of accidental firing even in the rare event of firing pin breakage.

This free safety modification applies *only* to pistols rollmarked "P85" on the slide. Pistols which are rollmarked "MKII" will have these modifications as part of their original manufacture, and are not subject to this modification.

We are also taking this opportunity to remind shooters of the most common and basic firearms safety rule:

ALWAYS KEEP THE PISTOL POINTED IN A SAFE DIRECTION!

This is particularly important when loading, unloading, or decocking any pistol.

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More muscle, less fat.

The new mid-size Dodge Dakota. Now with V-8 power.

More payload than standard Ford and Chevy half-tons.

Its agility approaches compacts. Its payload capacity holds its own against that of meatier half-tons. And with available V-8

power, it's the best all-around pickup on the road. It's the new mid-size Dodge Dakota.*



We revved up our Dakota with a 170 hp V-8.

Dodge Dakota
4x4 Sport

Flexes new V-8 muscle.

To any skeptic who thinks Dakota's a dressed-up compact, take a look under the hood. There you'll find a choice of hard-working engines that no compact pickup can offer. Including a 3.9L V-6. And our 5.2L 170 hp V-8, turning out 262 lbs-ft of torque at 2,400 rpm.

Equipped for heavy loads.

If you want to see what a Dakota can

carry, fill it up with a load of topsoil. We've got up to 2,550 pounds of available payload, depending on engine and model. Standard Chevy and Ford half-

tons can't haul as much. And though it's lighter than Chevy C1500, Dakota can carry 300 pounds *more*.** Not bad for a truck that's a lot leaner than its full-size competition.



Bodies of all sizes and shapes: 4x4, 4x2 and Club Cab.

The body you always wanted.

Take your pick of Dakotas. From 4x2, 4x4, longbed, shortbed, Club Cab

and Sport models. Every one has been restyled for 1991.

Welcome home to Dodge.

America is coming home to Dodge. And with trucks like Dakota V-8 and our full-size Cummins Diesel, the only turbo diesel pickup you can buy, we think they're home to stay. Come see what we're made of.

*Competitive claims based on '90 data ('91 competitive data incomplete at time of printing).
**Available regular cab 4x2 payload comparisons.

Buckle up for safety.



Advantage: Dodge.



CHANGING LIGHT BULBS

BY DON CHAIKIN

● As you near your exit, you move the directional signal stalk up and steer to the right. You move to the right lane and onto the off ramp, slicing between traffic that seems oblivious to your signaling. And as you instinctively glance down at the dashboard, you notice that the little arrow isn't blinking. It's glowing steadily. You're also aware of the flashing lights of the police car behind you. "What's the matter pal?" asks the officer. "Doesn't this car have directional signals?"

Light bulbs, whether they're \$20

halogen headlights or \$1.59 directional signals, periodically burn out—no matter how well you care for your car. But this problem should never become more than a temporary irritation, because it's usually a simple matter to replace a burned-out lamp.

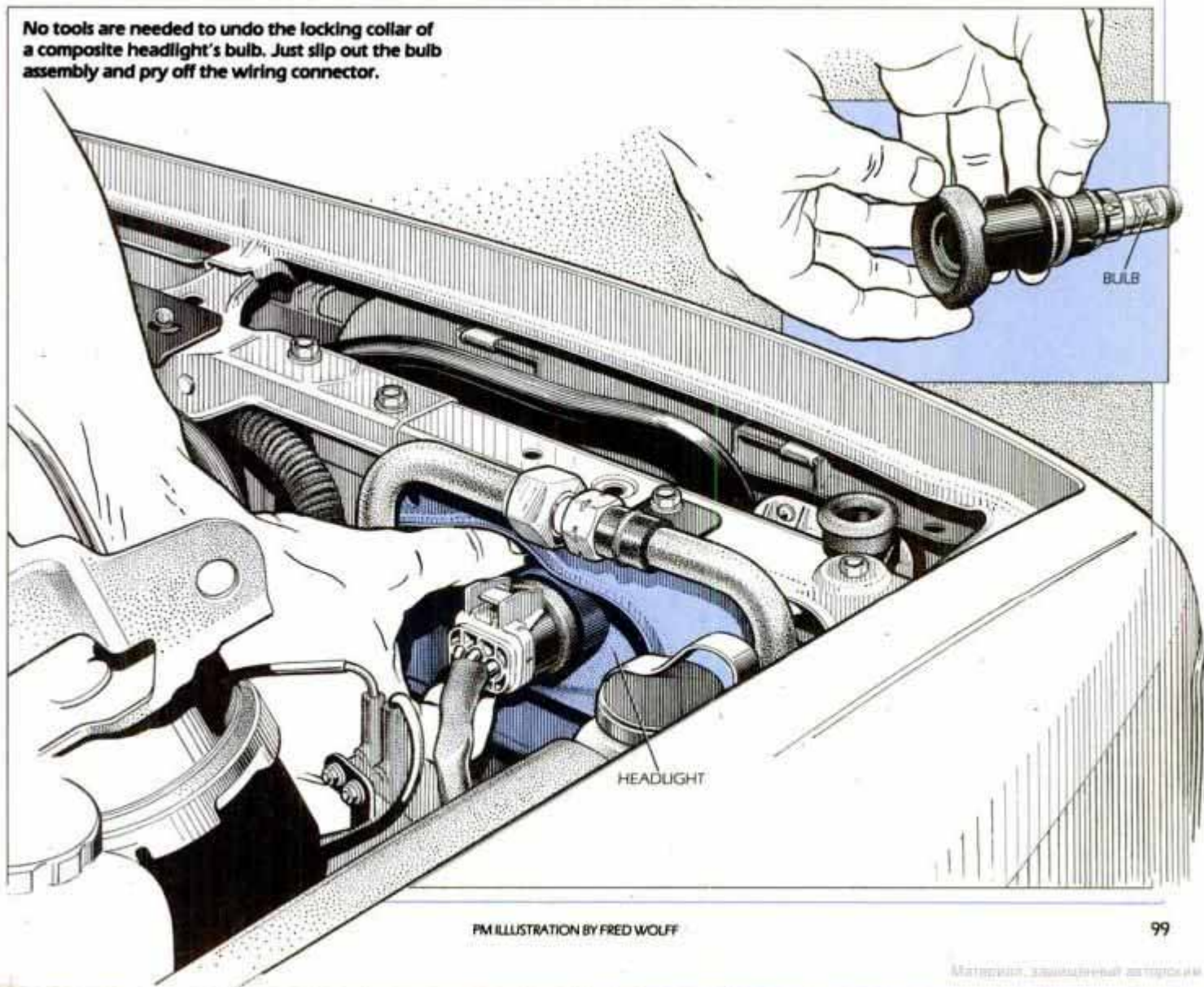
Sealed fate for sealed beams

In fact, thanks to the sleek, aerodynamic noses of today's cars, replacing a headlight is easier than ever on many new cars. The designers' efforts to lower hoodlines with narrow head-

lights coincided with engineers' quests for reduced weight. The result was a change in the federal regulations concerning headlights that allowed the carmakers to develop stylish headlight housings, made of lightweight durable plastics, with separate, replaceable halogen bulbs. These composite headlights grace the noses of most new cars.

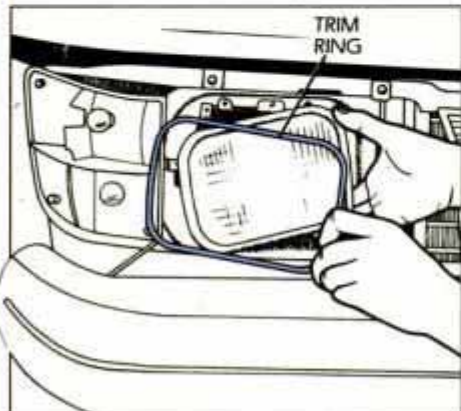
When a composite headlight stops shining, you need only change the bulb—not the complete unit. If you're not sure whether your new car has composite headlights, first check the

No tools are needed to undo the locking collar of a composite headlight's bulb. Just slip out the bulb assembly and pry off the wiring connector.



headlight's shape. If it's not a rectangle or circle, the same size and shape as the standard sealed beam from a 2-headlight setup, you've got a composite. You'll know for sure if you try to replace the headlight as though it were a sealed beam and discover that you can't find any mounting screws or retaining ring holding the light.

Changing the bulb in a composite headlight doesn't require the removal



Unscrew the trim ring's mounting screws, and slip in a new sealed-beam headlamp.

of screws. In most cases, you don't even need any tools. Open the hood and reach into the engine compartment behind the headlight. You'll find either a plastic collar or a spring clip around the base of the bulb, protruding from the rear of the light's housing. Simply twist the collar counterclockwise or flip the spring clip to unlock it. Then pull the bulb out of the back of the light. Next disconnect the wiring connector from the bulb by lifting up on the connector's locking tab and gently rocking while pulling the connector off the bulb. If the bulb is the type that uses a locking collar, slip the collar off the bulb. Reverse the procedure to put in the new bulb.

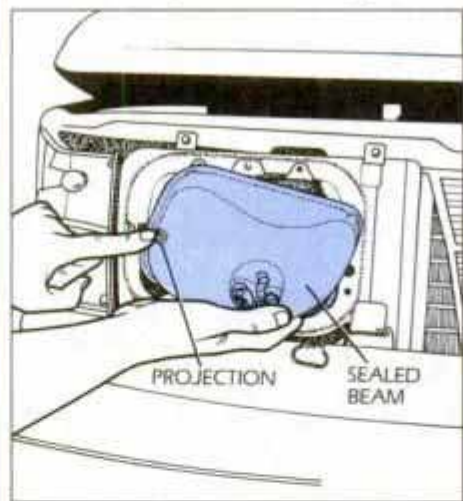
Be careful, however, not to touch the glass of the bulb with bare fingers. Like all halogens, these bulbs burn brighter and hotter than standard headlights. The glass of the bulb is special to withstand the heat. But the oily deposit left on the glass by your skin creates a hot spot. That hot spot is all that's needed to cause the bulb to burn out again sooner than normal. Play it safe and, besides taking care to avoid touching the glass bulb, wear clean work gloves when handling the halogen bulb. The relatively large plastic base end of the bulb offers plenty of grab area. Also, take care not to pinch or cut the rubber O-ring on the new bulb's base—this keeps moisture from getting inside the housing.

Unfortunately, these slimmer headlights are only part of the trimming done on new cars. Chances are you'll discover your new car has a crowded engine compartment and that greatly limits your access to the rear of the headlight. It can be so cramped that you may not be able to contort your hand into a position to undo the bulb's locking collar or clip. So, even though the headlight bulb replacement itself requires no tools, you may need an assortment of wrenches to temporarily remove underhood components—the cruise control module or air-cleaner housing—mounted behind the headlight.

Sealed beam strategies

If you own a pickup truck or a car that's a few years old, you still have traditional sealed beams to contend with. Replacing a burned-out sealed beam begins with buying the right replacement headlight. Your rig has either dual round or rectangular lights, or quad round or rectangular lights. If it's a quad setup, the low beams are the outer or upper headlights, and the high beams are the inner lights or lower ones. The sealed beams for a quad system are smaller than the ones for a 2-light system. The headlights are not interchangeable from one system to another.

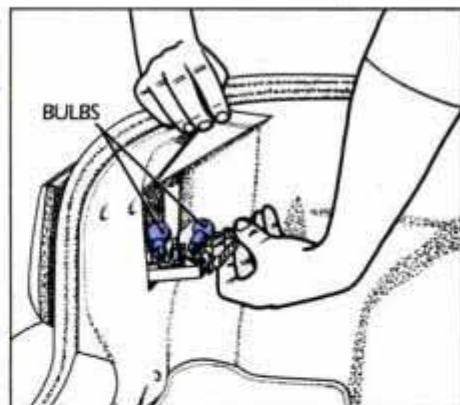
To remove your old headlight, first



Small projections on the back of the bulb will mate with slots in the mounting bezel.

remove any trim ring or cover. On some cars, you may even have to remove the grille or part of it, since the headlight trim is integral with the grille. The trim ring on some cars (GM models in particular) is held by a Torx fastener. You'll need a Torx driver to undo the screws. They're available at auto parts stores.

With the trim off, you have access



Some marker light assemblies are easily accessible from inside the trunk.

to screws for the ring that holds the light. Round headlight retaining rings are held by three screws, and rectangular ones by four screws. Before you start loosening screws, however, make sure you know which are the mounting screws and which are the aiming screws. Rectangular-sealed beams have an aiming screw either at the top or bottom and on one side or the other. Round ones typically have one screw at the 12 or 6 o'clock position and one at either 3 or 9 o'clock. When replacing a sealed beam, there is no need to disturb the aiming screws.

And before you can loosen and remove the retaining screws, chances are you'll have to free them up since they've probably rusted in place. Treat the screws to a healthy dose of penetrating oil and allow the oil to sit for 10 or 15 minutes. Then attempt to loosen the screws. If they don't move, give them more penetrating oil and wait some more. If you maul the soft head of the screw and your screwdriver can't grip it, you'll have to drill out the screws, working in very cramped quarters. So be patient, and start off with a new, high-quality Phillips or Torx driver—one that hasn't been rounded off yet. While you've got the penetrating oil out, give the aiming screws a squirt as well.

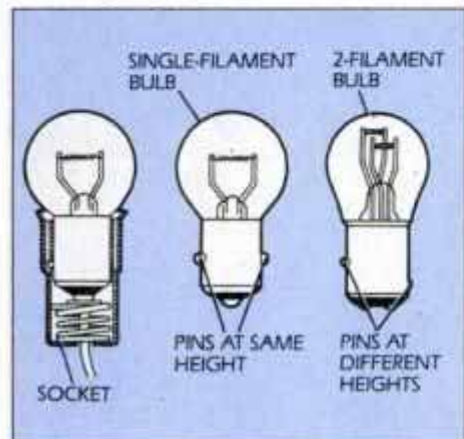
If you're having a really bad day, the screw-mounting tabs of the retaining ring will break off as you loosen the screws. Fortunately, replacement retaining rings are available at auto parts stores.

With all the screws out, you can lift off the retaining ring. As you do, the headlight will probably slide out of its housing. The light's wiring keeps it from falling. Grasp the headlight in one hand and the wiring connector in the other. Work back and forth while pulling to remove the connector.

Before installing the new light,

check the condition of the connector and the wire. If there's corrosion inside the connector's terminals, clean the terminals with aerosol electrical contact cleaner, available at electronics supply stores. If the insulation of any of the wires is chafed or torn, wrap it with electrical tape, or splice in a replacement section of wire if the damage is bad enough.

To install the new sealed beam, push the connector fully onto the tabs on the back of the new light. Slip the headlight into its mounting housing, making certain that the light is right-side up. Small projections on the rear of the light go into notches in the re-



Be sure you're using the correct type of bulb when replacing tail/marker lights.

ceptacle to ensure proper mounting. Some sealed beams are marked to indicate which side is up. As a rule, the writing on the face of the light's lens should be right-side up. If you mount a sealed beam upside down, the light pattern will not be thrown properly. Put a small dab of antiseize compound on the screw threads of the mounting screws so they'll come out easily next time, and then slip the retaining ring over the light and replace the screws. Tighten the screws halfway at first until all are caught. Be sure the light is seated properly in the housing before snugging up the screws.

Before replacing the trim ring, check the new light's aim. Though there's usually access to the aiming screws through the trim ring, it's an easier task with the ring still off. You should also check the aim of a newly replaced composite headlight bulb.

Ready, aim

Though sealed beams and composite headlights are designed not to have their aim altered when the bulb is replaced, it's good practice to verify proper headlight aim.

If you've planned in advance know-

ing that someday you would have to check the headlight aim, you have already marked the wall of your garage with crosses where the bright spot of focused light hits when the car is 25 ft. away. The marks should be made with the car on a level surface, no load in the trunk or seats and the tires properly inflated. Then all you need to do is check that the focus of the new light corresponds with the old.

If you haven't marked your wall, pull up the car to the garage wall or any vertical smooth surface and put a dot on the wall directly opposite the middle of each headlight lens. Drive the car straight back 25 ft. Use masking tape or chalk to make crosses over each of the dots you made on the wall. Again, be sure that the car is on a flat, level surface, that the trunk isn't loaded and that all the tires are properly inflated. Turn on the headlights. The bright spot of light should be just below the horizontal part of each cross and just to the right of vertical.

To adjust the aim of light, turn the adjusting screws in slight increments. The adjusting screws for composite lights may be accessible only with the hood open, either on the front or rear side of the headlight. After you've aimed the lights, reinstall the trim rings.

Lighting the corners

Replacing a directional signal, tail-light, brake light or marker light is equally simple. But there are a number of variations by the carmakers as to exactly how you have to go about it.

On some cars, you must remove the lens to gain access to the bulb. With others, the light's entire housing must be removed to gain access to the bulbs, and still others offer easy access via a removable trim panel inside the trunk or under a bumper.

The quickest way to tell how to get to a specific bulb is to check the light's lens and housing for screws. Screwheads in the lens itself indicate that you have to remove the lens. A lens housing with no retaining screws means that access is from inside the trunk or behind a fender or bumper. You may have to remove a trim panel—often there's an access flap, but sometimes you must remove some retaining screws for the trim panel—or if the bulbs' receptacles are exposed through the trim panel, there's nothing else to remove.

Screwheads, possibly Torx-head ones, around the perimeter of the housing and the lack of any access from the inside of the car indicate that

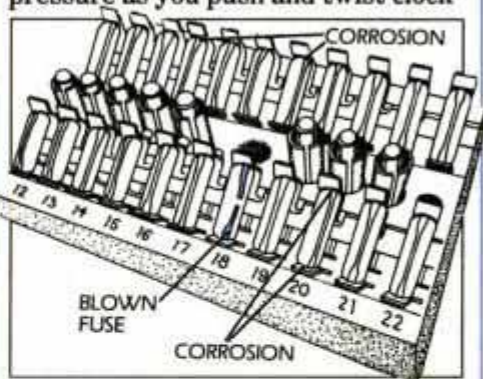
you must remove the entire light unit.

When removing a lens, take care to note which way it mounts. Also, be careful lifting it off the housing. In all likelihood, there's a gasket between the lens and housing. If you tear the gasket, moisture will enter the light and quickly corrode the socket. With the lens off, remove the bulb by gently pressing the bulb into its socket while turning it counterclockwise to release it. Then pull out the bulb.

To remove a bulb from the back side of a housing, either through a trim panel or after removing the entire lamp housing from the car, twist the bulb's socket counterclockwise to release it, then pull out the socket. Remove the bulb by pressing it and twisting counterclockwise.

Before replacing the bulb, check that the socket isn't corroded. If it is, spray it with electrical contact cleaner and, if necessary, clean it with a small parts-cleaning brush. If the corrosion is serious, replace the socket with one from an auto parts store. Then note the grooves and retaining slots on the inside walls of the socket. If the bulb is a dual-filament one—a bulb that does double duty, typically as taillight and brake light—the retaining slots are at different heights inside the socket.

If the bulb has a single filament and performs only one task, the retaining slots are at equal heights. Be sure to install a dual-filament bulb correctly, with the lower locating pin aligned with the lower retaining slot. If the bulb doesn't lock into place with slight pressure as you push and twist clock-



Check for blown or corroded fuses. You may need to probe with a test light.

wise, remove it and check that you're installing the correct type of bulb—single- or dual-filament—and that it's properly aligned.

When reinstalling the socket in the back of the housing, be sure that it locks properly in place and that any metal tabs on the socket make contact with the metal inside the housing. These contacts serve as the ground

connection. Replace the housing or the trim panel.

When reinstalling a lens, be sure that the gasket is in place and not pinched. And don't overtighten the retaining screws or you might crack the lens.

Problems connecting

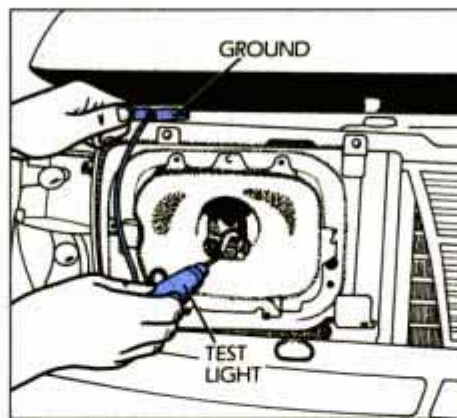
If you've installed new bulbs or sealed beams and the light still doesn't work, first check that the replacement itself isn't defective. Either install the new light on the other side of the car, if the light on that side has been working, or briefly connect the new light directly to the battery using jumper wires. If the light works, your problem is in the circuit or connection.

If none of the lights in the circuit—both headlights, taillights, and so on—is working, check the fuse. Most cars have their fuse panel under the dash on the driver's side, often on the kick panel. If the fuse panel isn't under the dash, it may be under the hood on the firewall.

Most recent-model cars use color-coded, spade-type plastic fuses. You'll still find glass-tube fuses on older cars and possibly even ceramic ones on European imports.

You can check the fuse without struggling to get it out of a hard-to-reach fuse panel. Turn on the switch for the offending circuit. Ground the lead from the test light and probe both ends of the fuse. If the light goes on only at one end or the other of the fuse, the fuse has blown. Replace it with one of the correct amperage.

Fuses can blow due to circumstances that may not recur, and changing the fuse may be all that's necessary. If the new fuse blows,



Ground test light lead, and the light should light up when you touch a "hot" circuit.

however, there's a short somewhere in the circuit, and until it's found and repaired, fuses will keep blowing. The most likely cause of a short in a lighting circuit is a chafed wire, typically somewhere near one of the lights. Check the wires where they go through the car's chassis and body for nicks or rubbed-off insulation. If the wire is otherwise good, but the insulation is missing, wrap it with electrical tape. If the wire itself is damaged, cut out the bad section and splice in a replacement. Be sure to match the gauge of the wire.

If the fuse is good but the lights still don't work, there's an open circuit, possibly caused by a defective switch. Check the switch by connecting a jumper wire directly from the light socket to the battery. If the light works, suspect the switch. Simple push/pull dashboard switches are easily replaced. However, the steering-column stalk-mounted switches popular in new cars require a fair bit of disassembly to replace.

If only one beam—high or low—of a

headlight works, check the connector's terminals with a test light. Ground the test light.

With the light switch on and the dimmer switch set to low beam, probe all three of the connector's terminals. Repeat the test with the dimmer switch on high beam. The test light should not go on when you probe the ground terminal.

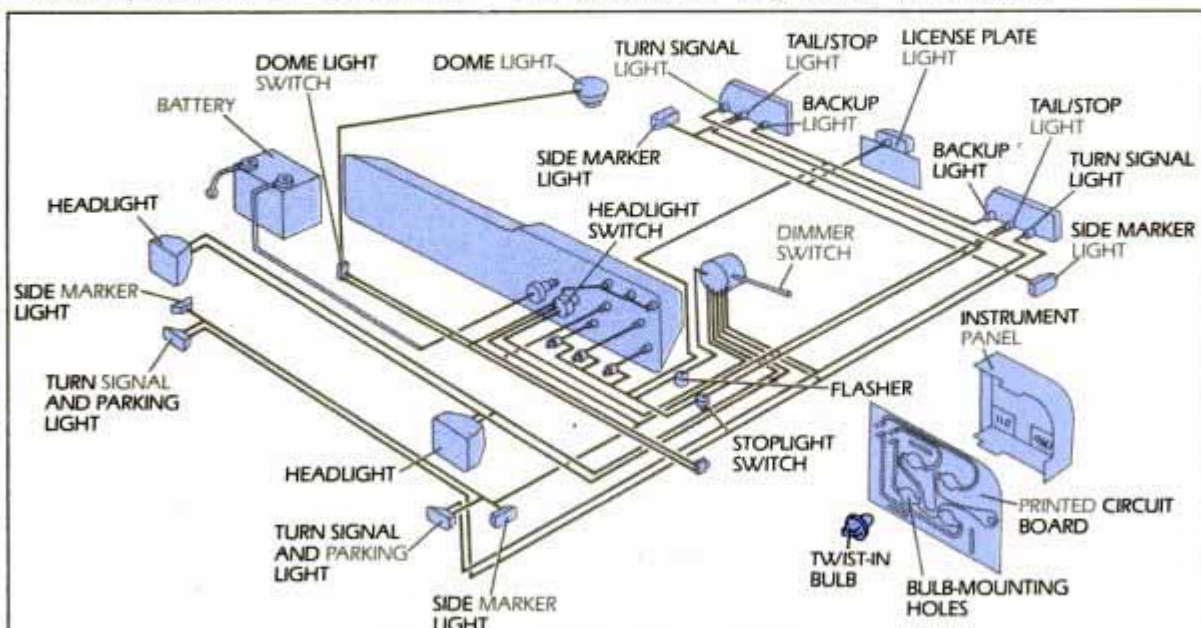
If the test light fails to light at all in either of the other terminals, either the connector is defective or there's a break in the wire to it. You can replace the 3-pronged connector with individual female spade-type crimp connectors and splice in a longer section of wire to replace the wire to the connector in case there's a break.

An ounce of prevention

You can reduce your chances of suffering the tension of a dimly lit night drive or unnecessary hassle of a ticket by giving your car a weekly inspection. You can do the inspection from the driver's seat while still in your garage. Turn on all the lights and check the reflections off the walls. Step on the brake pedal and watch that both brake lights, and the high-mounted stoplight on newer cars, go on. Check directional signal bulbs by turning on the 4-way hazard flasher, which uses the same bulbs.

And be aware of changes while you're driving. A dashboard directional signal arrow that glows instead of flashes is a tip that one of the bulbs has blown. Dashboard lights that no longer light can indicate that the tail-light fuse has blown. Spotting problems early can save you headaches later.

PM



There are plenty of bulbs to burn out on a modern automobile. Fortunately, almost all of them can be replaced with simple hand tools like a screwdriver—or without any tools at all.

ELECTRONICS

LOOKING AHEAD

BY FRANK VIZARD, Electronics Editor



● That's me, staring into the lens of a camcorder at the Japan Electronics Show in Tokyo. Neither I nor my anguished and anonymous companion are central to the picture. What's important is the picture itself.

The picture is a still-frame image taken with a Panasonic Palmcorder that's been transferred to paper with a new device called a movie printer. The picture is made using a thermal printing process that takes about 80 seconds to yield a print. Up to nine prints of the same image can be made at once. About 100 prints can be made before the ink cartridge is replaced.

The component-sized movie printer obviously allows you to make a video snapshot of anything that appears on the television screen. As you can see, the picture quality is impressive. Whether it be used for sending a picture of the children to grandma or for getting a hard copy of some on-screen text, the potential uses for a movie printer are many and varied.

The movie printer was just one of the prototypical devices exhibited at the show. As the first major Japanese electronics show of the decade, this exhibition indicated where we are headed electronically for the near

term. The emphasis, at least from the standpoint of the Japanese manufacturers who dominate the business, seems to be on video.

Among the more interesting devices at the show was the device pictured at upper right. This is not a telephone but a VCR remote control. What's different about this remote control is that it allows you to program your VCR using voice commands. Following visual prompts on



New VCRs feature center-loading for better picture stability.



the LCD screen, you speak into the remote, communicating the necessary date, day, time and channel information needed for time-shifting. This data appears on the LCD screen. If correct, you press the OK button for transmission to the VCR.

Wide-screen televisions offering an aspect ratio of 16-to-9 instead of the current 4-3 ratio were also on display from Sony (see photo) and others. Judging from some of the prototypes on display, you'll have the ability to switch between 16-to-9 and 4-to-3 versions of the program you're watching. The side panels of the wide-screen picture are dropped in the 4-to-3 version but the central panel is magnified to fill the screen.

Other prototypes demonstrated an ability to produce a better picture. JVC, for example, showed a digital time-base correction circuit that helps eliminate jitter. JVC also demonstrated a "full-area fine circuit" that reduces the jagged edges sometimes found at the bottom of the screen.

Another JVC exhibit extolled the

(Please turn to page 104)

virtues of a "Hadamard" circuit that brightens up unintentionally dark areas of the screen. Hadamard, says JVC, is a French mathematician who invented the circuit. JVC also demonstrated the virtues of DNR, circuitry that reduces on-screen video noise, and a digital comb filter that offers improved color definition.

Ghost cancellation is another area being researched by JVC. The company demonstrated a circuit that was able to eliminate unwanted secondary and tertiary images from a still picture. A full-motion capability was not demonstrated.

Development of liquid crystal displays (LCDs) for televisions continues. Casio showed some small models with better contrast. Toshiba and Sony exhibited projection TV models using LCD technology. Toshiba also showed a 4-in. LCD TV for the car that retracts into a DIN-sized opening in the dashboard.

Videocassette recorders were in evidence from every major manufacturer, most of which had Super-VHS capability. Most VCRs utilized a mid-mount chassis that has the tape-loading port in the center of the front panel. This configuration is supposed to reduce the amount of vertical shaking and jitter in the picture.

Other new VCR features included a "rental" position which, when activated, restores some of the luster to well-used tapes. Pioneer demonstrated a "compound" feature that basically squeezes the picture horizontally while stretching the picture vertically. The result is an elongated image

that, in certain instances, puts more visual information on the screen.

Universal VCRs, which play any of the world's video standards, were also in evidence. Hitachi showed a portable model which switched between NTSC, SECAM and PAL at the touch of a button. A previously exhibited Panasonic model which does the switching automatically carried a price tag for the first time: \$1800.

Many VCRs also came equipped with direct broadcast satellite (DBS) tuners for receiving video signals from orbiting satellites. Signals are received by pizza-pan-sized antennas. While DBS is the direction Japanese TV viewers are moving toward, DBS does bring its own set of minor problems with it. Toshiba, for example, has a "rain" feature on one satellite tuner to reduce the on-screen sparkles resulting from the interference caused by inclement weather.

Camcorders, meanwhile, are becoming more like cameras in that there is now a technical standard that allows for interchangeable lenses. Both Mitsubishi and Hitachi showed ones packaged with two different lenses. Panasonic debuted a VHS-C camcorder with a color viewfinder.

Sanyo, though, is asking people to join the "horizontal revolution," a nonpolitical movement centered around its binocular-shaped camcorder. Sanyo has developed a housing for this 8mm camcorder that remains permanently moored to your audio/video system. If you want to watch a tape, just drop the camcorder into the housing and connect a single wire.

Also part of the future is fax broadcasting.

Let's say you want a recipe used on a television cooking program. Instead of using the mail, the recipe is sent to you over the air. The fax is received by circuitry built into the TV or into a telephone/fax machine. Adapters will also be available for retrofitting existing fax machines. We'll have more on fax broadcasting in a future issue.

In a related technology, interactive com-



New camcorders, like this Mitsubishi model, will have interchangeable lenses.

compact disc (CD-I) machines—in which video images stored on a CD are displayed on a television screen—were shown by a number of companies. These included Panasonic, Yamaha, Philips, Sony, Sharp, Fujitsu, Pioneer and Sanyo. The Sony model was a portable in which the CD is inserted beneath a control panel. Data is viewed on a pop-up screen.

Sony also demonstrated its portable prowess by exhibiting a portable, recordable CD player at the Japan Audio Fair a few days later. Slightly larger than a current Discman, Sony said the machine can be recorded over or "rewritten" up to 1 million times.

Photos On CD

Not all technological innovations are taking place in Japan. Kodak and Philips have developed a method that allows you to put 35mm photographs on a CD for viewing on a TV screen.

The transfer of film onto CD would be done at the photofinishers for a cost less than \$20, says Kodak, assuming that each CD contains 24 pictures. Each CD can hold up to 100 images which means that consumers could take a photo CD back to the photofinisher to fill the unused capacity. Playback is done using newly developed CD players made by Philips.

The first of these new CD players will be priced at around \$500. These CD players will have a number of special features designed to enhance the playback of photo CDs. You will, for example, be able to rotate images from horizontal to vertical, expand a portion of the image to full screen with no loss of image quality, view images in any sequence, and skip over images you don't want to see.

Kodak does not expect to market this product before 1992, however. In the meantime, it plans to license the technology to other manufacturers.

Meanwhile, a compact disc video system developed by Commodore and reported on by PM in October (page 116) has had its launch date postponed. Originally scheduled for a Christmas debut, interactive CDTV from Commodore is now scheduled for launch this spring. **PM**



Kodak's new Photo CD system puts photographs on TV.

FREEWHEELING

ZENDERTECH

BY TONY SWAN, Automotive Editor



● Machbusting shapes are becoming the norm rather than the exception in autodom today, but this one actually houses a pretty unusual inventory of goodies. It's called the Zender Fact 4, and it made its North American debut at the recent Specialty Equipment Manufacturers Association (SEMA) show in Las Vegas.

Zender, a German specialty house with an increasing presence in the U.S. aftermarket (alloy wheels, aero add-ons), developed this swoopy concept car to demonstrate its range of capabilities and general knowhow. And judging by the result, we've raised our estimation of Zender's knowhow index by several points.

Show and go

For one thing, this is one of those rare concept cars that can actually deliver on the promises of its exterior.

The Fact 4 is capable of speeds in the rarefied region of 190 mph.

Zender used Audi's 3.6-liter 4-cam 32-valve V8 for propulsion, but it was obvious that a mere 240 hp wouldn't be enough to create the right sensations. Accordingly, the engine was farmed out to the Lehman racing shops, in Liechtenstein, for a thorough massage.

The Lehman people, who are also the sole preparers of all Audi racing engines, bolted up a pair of KKK K16 turbochargers, each with its own intercooler, and their own 4-pipe exhaust system. Boost is relatively mild, for a supercar, at 11.8 psi, but output is definitely eye-opening—448

hp at 6500 rpm, with a whopping 490 ft.-lb. of torque at 4000.

Mounted longitudinally ahead of the rear axle, the V8 is mated to a ZF 5-speed gearbox, sending power to the rear wheels through a big double-plate clutch, 40-percent locking differential and dual CV joints. Stir low curb weight into the mix, and you've got a combination that produces 0-60 mph times of 4.3 seconds.

Designer bodywork

The Fact 4's most interesting feature, though, lies in the area of materials, rather than muscle. To make the strongest possible statement, Zender decided to apply a liberal dollop of Formula One technology, employing



Zender Fact 4 carbon-fiber/aramid body shell weighs just 122 pounds.

a carbon-fiber monocoque chassis.

This monocoque design differs slightly from standard racing practice in that the engine and gearbox ride in a detachable tube steel subframe, rather than serving as stressed members of the chassis. But the net effect is the same—exceptional torsional rigidity, thanks to the tensile strength of carbon fiber, which makes titanium look like linguine by comparison.

The sexy skin is similarly space-age, fabricated from carbon-fiber layers sandwiched around an aramid core. While the Cd isn't exceptionally impressive at 0.34, weight savings are. The forward-hinged gullwing doors weigh 6.6 pounds each. The rear cowl is 26.4 pounds, and the main body shell weighs only 121 pounds.

What all this adds up to is a curb weight of just 2442 pounds—a little less than a Toyota Corolla.

So what's the bottom line? Yes, the Zender Fact 4 is strictly a 1-off concept car, and in that sense could be more gee-whiz show car stuff.

But, we think this car—as well as the limited-production Consulier sports car—shows where the industry will be going in the years ahead, at least in terms of materials. To meet the conflicting demands of economy and safety, cars will have to become simultaneously lighter and stronger.

(Please turn to page 106)

Judging by cars like this one, it looks like they can still be fun, too.

Jeep Thrills

While it's rare for any of us to feel much jubilation about our 50th birthday, we do tend to take grateful notice when our favorite institutions hit their golden anniversaries. So it is with the ongoing survival of the Jeep, which just hit the half-century mark.

With the possible exception of Henry Ford's Model T, no American vehicle is better known than this one, and it's probably the most revolutionary thing to come along in military transportation since the horse.

Gen. George C. Marshall, in a burst of patriotic pride, called the Jeep "America's greatest contribution to modern warfare." While that assertion merits some argument from certain sectors of the aircraft industry, there's no doubt that the Jeep was the outstanding all-purpose utility vehicle of the second World War, and the most imitated afterward.

Origin of species

Willys-Overland is generally credited with the Jeep's development and eventually wound up with the trademark. But the gestation of this new



Willys-Overland Quad prototype was the forerunner of WWII production Jeeps.



CJ-5 enjoyed a 3-decade production run, from 1954 to 1983.

breed was murky and full of intrigue.

The Pennsylvania-based American Bantam Car Co. was actually first on the scene, responding to the Army's desire for a new dispatch vehicle with

three lightweight (1275 pounds) prototypes in September of 1939. The vision at that point was limited, at least in terms of the range of capabilities the Jeep would eventually embody. Army brass simply wanted to replace the old motorcycle-with-sidecar.

Willys-Overland got into the act later that same year with a different spin on the concept—a bigger vehicle capable of carrying weapons, in addition to its other duties.

As 1940 rolled along, and the German *Wehrmacht* rolled over Europe, the Army's interest in the new vehicle grew to urgency. Bantam eventually won the bid for prototype production and delivered its first number—the "Blitz Buggy"—in September.

Representatives from Willys-Overland and Ford were invited to the Blitz Buggy's trials, which was strange, but even stranger was the Army's decision to share Bantam's blueprints with the other contenders for the Army contracts.

The Willys-Overland contract contender, known as the Quad, eventually became the prototype. Bantam executives claimed—not without some justification—that the Willys design stole shamelessly from their own creation. The Quad was also 240

 Left and right together. Jacking up. C/W/O/G/M/Co. At right to mount.



Introducing a station wagon so remarkable, we were able

pounds over the new weight limit of 2160. But it was tough, agile and, with 4-wheel drive, capable of handling just about any kind of terrain.

It also offered the advantage of a proven powerplant—the Willys "Go-Devil" Four—with substantially more torque than the new engines proposed by Bantam and Ford.

After evaluating prototypes from all three manufacturers, the Army proposed a hybrid version, based largely on the Quad. Willys then outbid the others for the first large run—16,000—in July of 1941, and the Jeep was on its way to glory.

GP Jeep

The origin of the Jeep name is also wreathed in fog. The majority of those who concern themselves with such things seem to favor E. C. Segar's old "Popeye" comic strip as the source for the name, borrowed from the sailor's mysterious doglike companion "Eugene the Jeep."

Another contention is that the name was coined by one Sgt. James T. O'Brien in Fort Ripley, Kansas. O'Brien was test driving a utility vehicle designed by Minneapolis Moline Power Implement Co., another large WWII defense contractor, and re-



Willys-Overland anticipated sport/utility market with 1946 all-steel station wagon.



A rugged 1-ton 4x4 pickup truck was introduced in 1947.

ferred to the vehicle as a Jeep.

My favorite explanation for the name has to do with official Army nomenclature, a peculiar language that invests even the simplest items

with a sort of olive-drab other-worldliness. In this jargon, the Jeep was rendered as something like a "Vehicle, General Purpose, one-quarter ton."

General Purpose. GP. Jeep. Sounds like the Army to me.

MA to CJ

One last note on nomenclatures: As World War II wound down, Willys-Overland began working on plans to issue a civilian version of the Jeep. Given the success of the GI version—some 600,000 were built during the war, 368,714 of them by Willys—there didn't seem to be much doubt about the civilian market potential.

Willys-Overland worked up 22 civilian prototypes in 1944. The guiding concept was that Jeeps would make great utility vehicles in agricultural applications. And since they'd be sold to civilians, the M prefix used up to that time—for Military—was no longer appropriate. Accordingly, the prototypes bore the designation CJ-(Civilian Jeep) 1A (first civilian model of the Army edition).

CJ-1A led to CJ-2A, which went on sale in August 1945, for \$1090. And the rest is, as they say, history.

Happy Birthday to a great American tradition. **PM**



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PHOTOGRAPHY

CHOICE FILMS

TEXT AND PHOTOS BY GEORGE SCHAUB



● Despite those TV commercials, where a pair of fast-talking store clerks do their best to confuse a prospective film buyer, there are very good reasons to choose from a variety of films for your camera. The film the commercial is touting—OneFilm from Polaroid—is a good, medium-speed color negative film that delivers acceptable pictures in a fairly wide range of shooting conditions. But with nearly 100 types of color print, color slide and black-and-white film available for your 35mm camera, there's no reason to stick to just one. We'll cover some of the more interesting color print films here.

If you always shoot in daylight, keep the distance between you and the subject in flash shots at about 8 ft., and don't enlarge prints bigger than 5 × 7 in., one type of color print film might be enough. But in all likelihood, your photography isn't limited to those conditions. There are times when you'll be shooting indoors without flash, such as in a sports arena, or when you'll want to blow your pictures up to a large size. That's when it's time to pick and choose your film carefully for optimum results.

Photography has a few golden rules. One is that when you want the best quality—the finest grain (the salt and pepper pattern in photographic images), the best sharpness and the most vivid colors—choose the lowest

speed the shooting conditions and your camera allow.

As you might already know, film speeds indicate just how sensitive a film is to light. The higher the ISO number, the faster, or the more sensitive the film is to light. For example, a film with an ISO number of 200—the speed of Polaroid's OneFilm—is twice as sensitive to light as an ISO 100 film and is half as sensitive to light, or "slower," than an ISO 400 film. The 35mm film for general use is available in a range of ISO 25 to 3200. A film with a speed of ISO 100 is perfect for a sunny day, while a super-fast film, such as one with an ISO 3200 rating, is made for shooting in low light without flash. There's a time and a place for every film on the shelf.

One obvious question is: If a fast

film allows you to shoot in nearly every lighting condition, why not make the fastest film the one film for your camera? You could use it for sunny days, as well as getting pictures in the interior of a coal mine. That's when our golden rule comes in. As film speed goes up, overall picture quality tends to diminish—grain increases, sharpness decreases and colors may not be as bright. There may not be a dramatic change when switching from ISO 100 to 200, but you can really see the difference between, say, an ISO 25 and ISO 1000 film, and it really becomes apparent when prints are enlarged. Films at all speeds can deliver good pictures when used right, but for those with a critical eye, a slow film beats out a fast one every time.

You may be limited in your film speed choice by the type of camera you own. If you use a current SLR, there are no speed limits, as the camera's exposure system can handle any film speed on the market today. However, some point-and-shoot cameras can only read light correctly when loaded with films in the ISO 100 to 400 range. Put an ISO 25 film in such a camera and you'll have underexposed pictures. Go for the ISO 3200 film and you'll have overexposure problems. Either way, quality will suffer greatly. But don't fret if you have a basic camera. There are plenty of excellent films in the ISO 100 to 400 speed class.

Aside from quality differences, different films have distinct personalities and vary in the way they record color and contrast. Though some of these differences can be minor, using the same film over and over again can

FILM COMPARISON CHART

MANUFACTURER	FILM	COMMENTS
Agfa	XRC 100	Medium speed with super-rich colors
Fuji	Reala (ISO 100)	A "smart" film for true colors under odd lighting conditions; also great for daylight/flash
Fuji	Super HG 400	Quality of slower films of the past in a medium-fast film package
Kodak	Ektar 25	Though slow, great for blowups and ultrasharp pictures
Kodak	Ektar 1000	Same technology as Ektar 25 for low-light photography with great quality
Konica	SR-G3200	World's fastest color print film, for shooting in dim light without flash
Konica	SR-G 200	Lower film contrast great for portraits, landscapes in daylight or with flash



These pictures show the effect of Fuji Reala's "smart" chemistry. Shot under artificial light, most films yield a yellow-green print (top). Reala reacts to light and alters the way the film "sees" color. The result is a more lifelike picture (bottom).

be like ordering vanilla each time you belly up to the ice cream counter. The vanilla might be great, but it's hardly adventurous to get the same flavor each time, and you may be missing out on some real treats. All films on the market today are good—trying different ones will give you a better sense of how each can serve a particular type of picture.

Fast or slow?

With all that in mind, let's take a look at some of the films on the market you may not have tried and see how they can expand your photographic horizon. We'll start with the fastest and slowest color print films available—Kodak's Ektar 25 and Konica's SR-G3200. The world's fastest color print film is Konica's ISO 3200 film. In camera-speak, it's five stops faster than an ISO 100 film. Practically, you can

use the film to photograph a child blowing out birthday candles in a darkened room, a basketball game in a dimly lit gym or a carnival ride at night, all without flash or worrying that your shutter speed will be too slow for handheld shooting. In other words, this film allows you to shoot in very dim light in a way that no film has allowed before.

The slowest color print film today is Kodak's Ektar 25. One drawback of this film is that it is so slow it may hinder you when shooting with a telephoto lens in all but the brightest light. This brings up another golden rule—for shake-free pictures, set the camera shutter speed at the inverse of the focal length of the lens on your camera. For example, when using a 200mm lens, set the shutter speed at a minimum of $1/250$ second. Some automatic SLRs do this without having

you set the speed yourself. If you shoot in shutter-priority mode, set the speed accordingly. If you use a zoom lens, apply the rule to the longest focal length in the zoom range. For example, if using a 70-210 lens, set the speed at the higher number, $1/250$ second. All bets are off if you use a tripod, but who wants to lug a tripod around all the time?

Though the film has its limitations, Ektar 25 is the sharpest, finest grain color print film ever made. (See the Times Square photo.) You might not notice this in snapshot-size prints, but when big enlargements are made—wow! Poster-size prints from Ektar rival 8×10 prints from faster films. The Ektar 8×10 prints are terrific, with grain nearly undetectable.

Oh, one more thing about Ektar. If your lens is not topnotch, or you didn't take the time to pinpoint your focus,

the film will reveal every flaw. It's that sharp.

Smart film

There are some fantastic films in the medium-speed range as well. Fuji's Reala, an ISO 100 film, has the equivalent of an extra layer in the color filter sandwich that makes up color film. This, along with some magic involving chemical switches that react to different types of light, gives Reala the uncanny ability to adjust to lighting conditions unlike any film today.

For example, if you shoot inside your fluorescent-lit garage without flash, most films will yield a sickly green-yellow color. That's because they're daylight-balanced—that is, they're made to record colors faithfully in daylight or when an electronic flash is used. Shoot these films under artificial light and their colors will be off. Reala is daylight-balanced as well, but it has a kicker. Reala is smart and changes its recording information in response to the light. The result is better color under a wider variety of lighting conditions, even fluorescents. Benefits spill over into color recording under more normal lighting conditions, and this film delivers some of the truest colors of any film. True, a custom color lab can rebalance color print film to a certain extent, but Reala is more on the mark.

Another Fuji product worthy of mention is the ISO 400 Super HG film. Remember golden rule No. 1, about the speed/quality equation? Fuji's 400 Super HG bends that rule a bit, and gives the quality of an ISO 100 film of a few years past in a faster speed model. That means grain and sharpness are very good for such a fast film.

Finally, how do you choose among the many color print films offered by manufacturers—Agfa, Fuji, Kodak, Konica and 3M—that have the same speed? Each filmmaker has at least one, and some have more, in the ISO 100, 200 and 400 ranges. To tell the truth, it can come down to a matter of taste. All the competition has kept manufacturers on their toes, and none can afford to fall behind in its product quality. But the films do vary slightly in the way they record color and in the way they render grain. **FM**

MELT METAL!

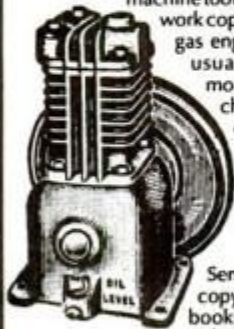
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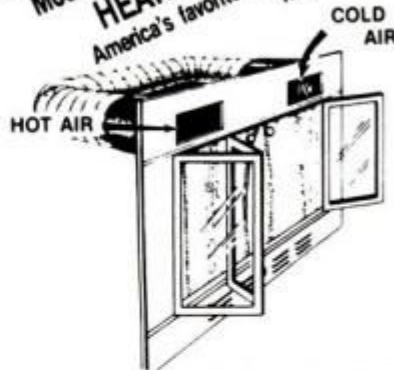
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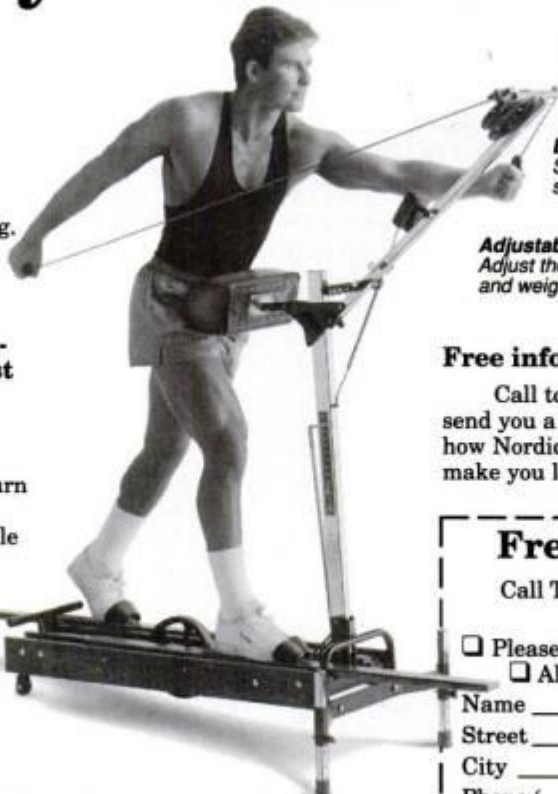
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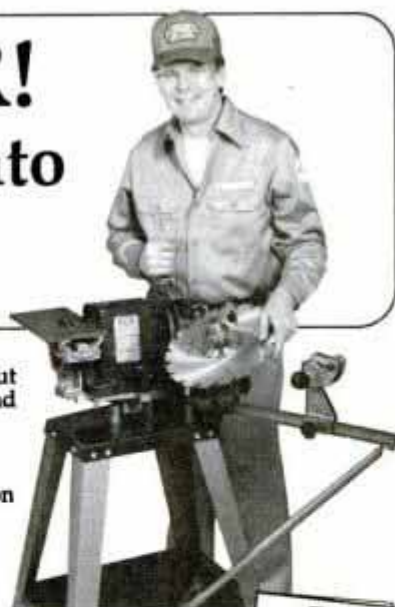
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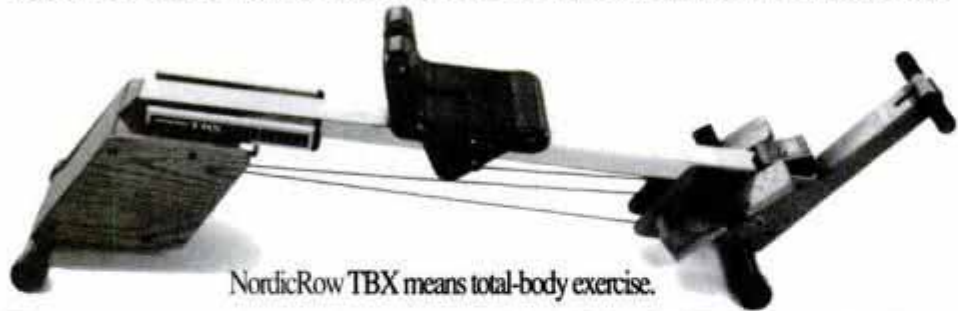
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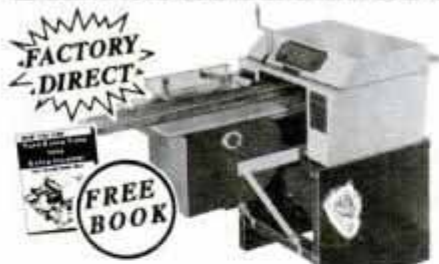
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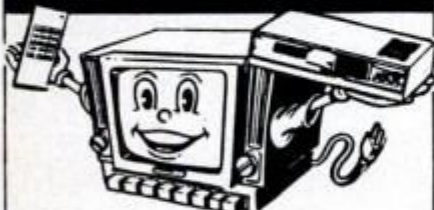
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