

Popular Mechanics

DECEMBER 1995

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SENSE OF TOUCH

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P81
Winey's Bay

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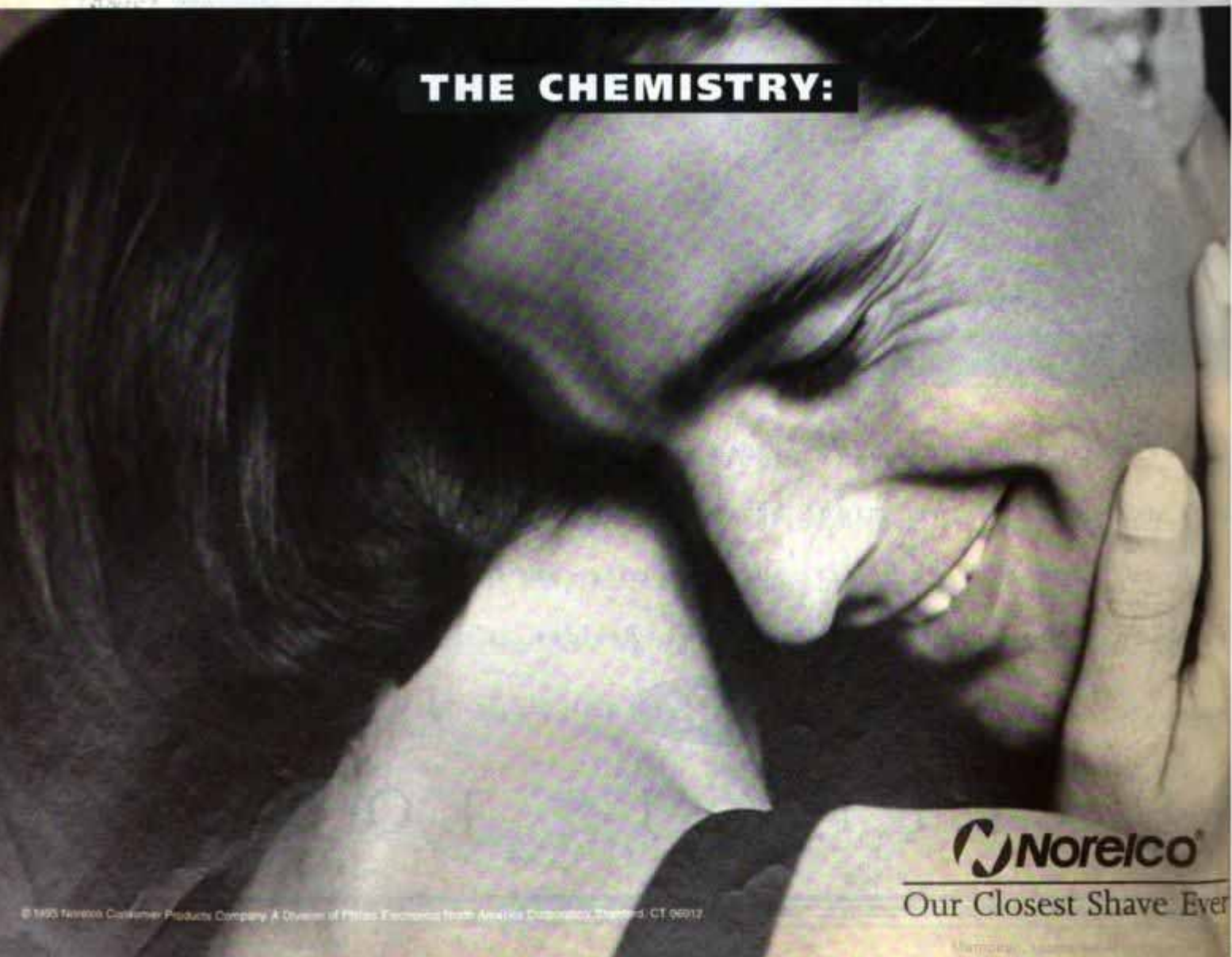


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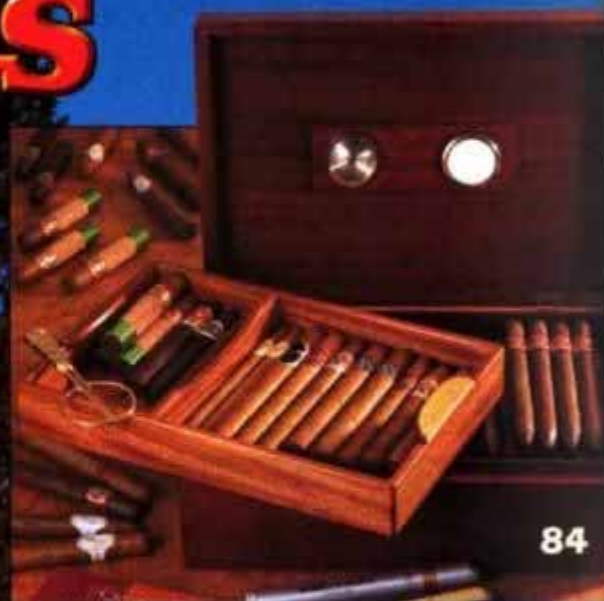
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NO. 12



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EDITOR'S NOTES

● Regular readers have heard me carry on from time to time about something I call "active journalism." I don't believe that editors can sit at a desk and work on articles dealing with topics they know only from a book or, worse, a press release. Not at a magazine like POPULAR MECHANICS. We're a hands-on magazine, and I insist that our editors be hands-on people. So I'm constantly encouraging them to go out and do it themselves. Experience it firsthand. Do it. Live it. Then work on the story from the perspective of someone who *has* done it. That's our credo around here and it holds for all hands. To prove that



Our hands-on managing editor.

we practice what we preach, the photo here is of our managing editor, Deborah Frank, and that is a 32-valve 300-horsepower Cadillac Northstar V8 engine she is bolting together. Frank recently participated in a women's forum sponsored by Cadillac to help Cad execs gain more insight into the women's market for cars. Not only did she tear down and rebuild a Northstar as part of the program, she also spent a week driving a Polo Green Seville STS. "It has a harder edge to it than the Lexus LS 400 in our test fleet," says Frank. "I prefer the Cadillac." And we prefer to have the most knowledgeable, experienced editors—like Deb Frank—working at POPULAR MECHANICS. . . . A chance visit to the Hoover Dam outside Las Vegas, Nevada, led to this month's cover story. A small sign on the dam proclaimed it to be "one of the modern wonders of the world." I wondered what other engineering marvels might be considered modern wonders of the world, so I decided to ask the experts. Science/Technology Editor Greg Pope worked with the American Society of Civil Engineers to poll its members. The result is a fascinating look at some of the great civil-engineering projects of our time. It all begins on page 48. . . . One of my great pleasures in life is opening my humidor, selecting an Arturo Fuente Double Chateau, or perhaps a Hemingway Classic, going out on the deck and enjoying an excellent premium cigar. If you're a cigar smoker, you know what I'm talking about. And if you're a woodworker *and* a cigar smoker—or know one—have we got a deal for you. Contributing Editor Ro Capotosto's plans and instructions for a gorgeous mahogany humidor start on page 84. This is one project that will reward you for years to come. . . . We promised you part two of our "New Cars '96" story this month. Unfortunately, the car companies didn't cooperate. Several new models were introduced so late that we decided to hold the story one more month. It will be in the January issue—and well worth the wait. That's not to say we don't have a most interesting automotive feature this month. In fact, stability systems are the hottest button in the car world this year. These systems can keep you from spinning out and crashing when you drive stupid. And while I'm the first to say that a person should suffer the consequences of driving stupid in the first place, there are so many stupid drivers out there these days that I think stability systems are a necessary technological innovation whose proliferation I support wholeheartedly. Get the complete story on page 74. Till next time.


Joe Oldham

Popular Mechanics

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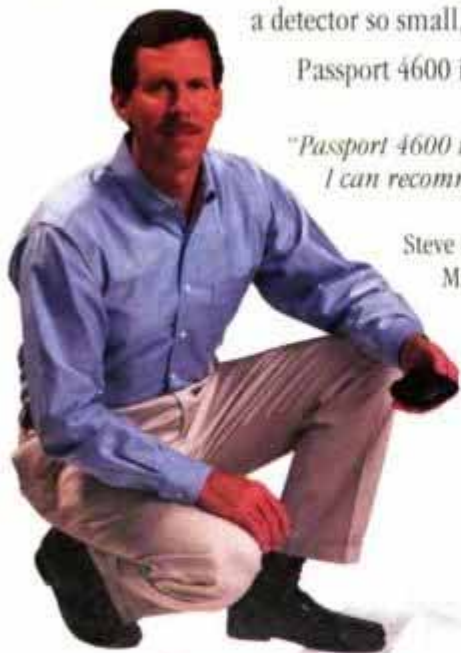
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The engineers of Dodge Ram and Dodge Ram Club Cab spent a great deal of their time in isolation.

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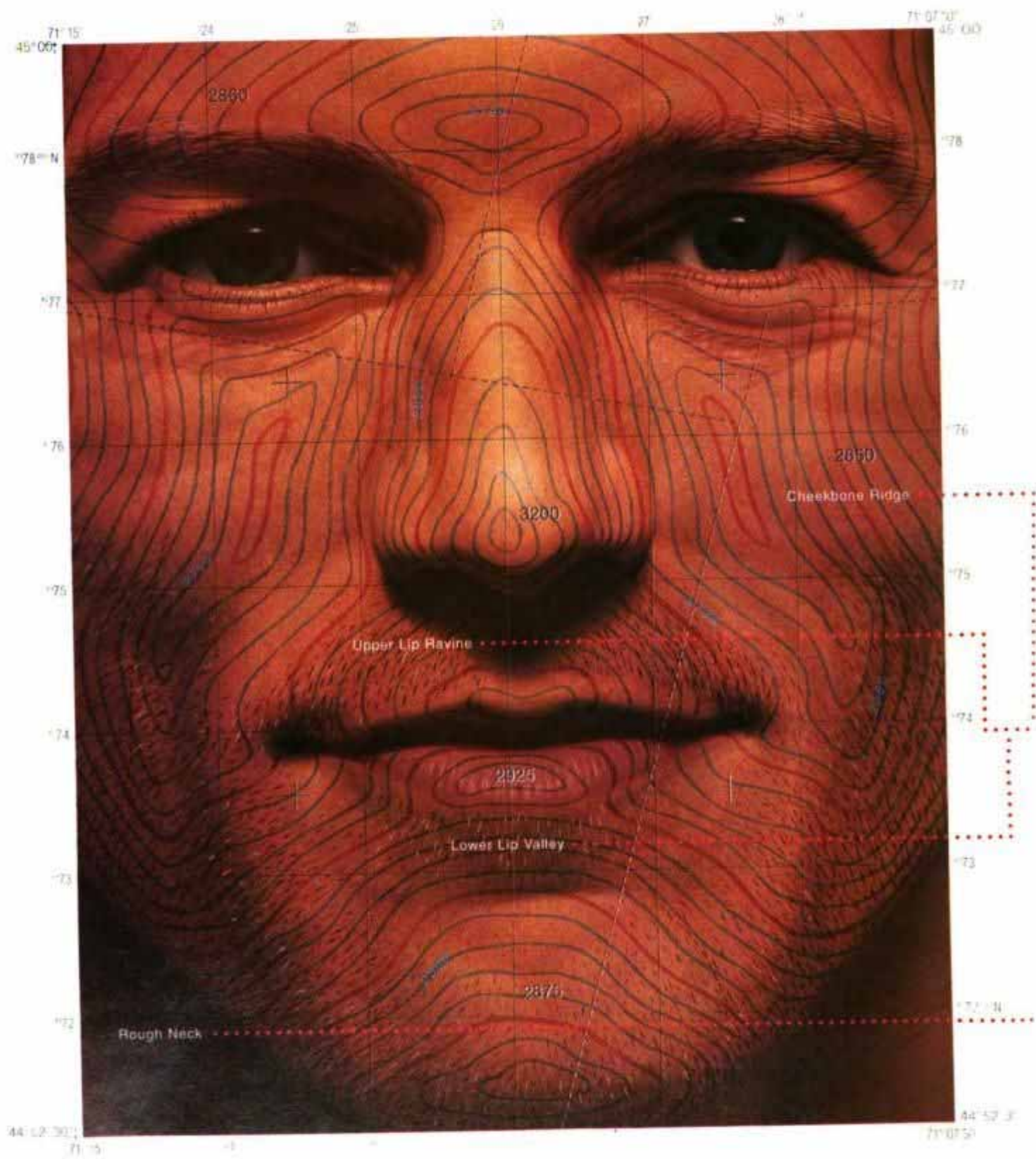
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*We calculated resale using avg. trade-in values for full-size '94 models vs. MSRPs, published in '95 Jan.-July N.A.D.A. Official Used Car Guide® monthly editions. Use of these values does not constitute NADA's endorsement.

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Flying High



Congratulations on the fine article by David North about the B-2 bomber. It was informative and exciting. I'd like to point out, though, one discrepancy. North mentions air refueling by the 19th Air Refueling Wing. However, the photograph showing midair refueling is of a KC-135R from the 155th Air Refueling Wing, Nebraska Air National Guard. The Nebraska marking on the tail is quite clear. Although the 155th is new to the refueling mission, having converted from RF-4C reconnaissance jets to KC-135Rs in January 1994, the unit is fully mission-ready and flying worldwide. Next year, the unit will celebrate its 50th anniversary.

JOSEPH W. JOHNSON JR.
LT. COL., NEANG
LINCOLN, NE

PM TV

I just finished watching "The POPULAR MECHANICS Show" on The Discovery Channel. I definitely enjoyed it. All I can say is that I wish you had thought of it sooner. I have been a regular viewer of such television shows as "Beyond 2000" and "Next Step." I have also been reading PM

Letters are subject to editing for length, style and format.

since I was 10. Keep up the good work and I'll keep reading and watching.

EMFESTUS
VIA INTERNET

You can watch "The POPULAR MECHANICS Show" on The Discovery Channel every weeknight at 5 and on Saturdays at 4 pm.

Helmets Off

Thank you for your article on football helmets. A special tribute should be given to the man who made it his goal in life to see that athletes, especially football players, not be injured while playing. That man is Richard C. Schneider, M.D., former professor of neurosurgery at the University of Michigan in Ann Arbor. During World War II, Dr. Schneider was stationed in Italy and was in charge of a ward of paraplegic soldiers who had been injured in battle. This gave him a challenge in his forthcoming career. While at the University of Michigan, he took special interest in football-related neck injuries and designed a neck piece for helmets that obviated many of these injuries. He was involved with the development of face guards and devised the inflatable liner. Regulation football helmets now incorporate all of these improvements that have done so much to eliminate head injuries. Dick Schneider was my friend and colleague. He died of cancer in 1986.

AUSTIN E. LAMBERTS, M.D.
GRAND RAPIDS, MI

Ford Vs. GM

For the past year or so, I've been noticing something that's starting to bother me. Like most auto fans, I'm very loyal to my favorite make—Ford. Now, I

expect you to run articles on other makes, but Ford seems to be getting the short end of the stick. Issue after issue, Chevy gets the big spotlight. Come on, give us Ford fans a break. Be fair.

KEITH STEVENS
ALBUQUERQUE, NM

Do you guys have stock in Ford or what? That's all I read in your magazine. Give me a break.

CHARLIE PUGLISI
VALLEY STREAM, NY

Could you please let GM know how one of its future customers feels about its big-car lineup? By discon-

tinuing the Buick Roadmaster, Cadillac Fleetwood and Chevrolet Impala and Caprice, GM is killing America's legend and pride. And it will, eventually, kill itself. People will go to Ford for big cars. I'm a GM kid and I don't want to see this happen. I'm 12 years old and have grown up with a Cadillac Sedan DeVille, an Olds Eighty Eight and a Chevy Caprice. My dad was a police officer and he always felt proud and secure driving big GM police cars. Now, in '96, puny Lumina will be used as police cars, and even with the special

(Please turn to page 14)

Advertisement



STANLEY

Reader Project Of The Month

In the December 1966 issue of POPULAR MECHANICS, you published a craft project, "Decorate Your Yard And Home With Walt Disney's Christmas Mobile." At that time, my husband made figures and displayed them on our home. This year he decided it would be a fun project to do with our grandkids, 11-year-old Jason and 8-year-old Jesse. They truly enjoyed working on them with the help of Pop and their mom, Michelle. All were more than pleased with the finished project.

PEGGY AND ROBERT TATRO
OAKDALE, PA

If your project is chosen as Reader Project of the Month, you will receive a Stanley Home Improvement Kit, complete with hand and decorating tools, and an electric stapler/nailer, valued at more than \$200. For your project to be considered, please send a clear, color photo and brief description to: Reader Project of the Month, Popular Mechanics, 224 W. 57th Street, New York, NY 10019.

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JIMMY DOCTOR
NEW ROCHELLE, NY

Best-Kept Secret

In regard to the Oldsmobile Bravada in your New Cars column, you state that "no one knows about it." Well I guess you don't either. The Bravada has been produced since 1991, not 1992. I agree, it's a great truck, but Oldsmobile failed to advertise it enough. As a proud owner of a '91 model, I can vouch for its proven reliability. The 17 harsh winter storms of '94 in the Northeast region let the full-time all-wheel-drive Smart-Trak system prove its strength over conventional 4-wheel drives.

BILL PHILPOT
TOTOWA, NJ

We meant that Oldsmobile did nothing to publicize the car. A '96 Oldsmobile Bravada will soon be joining our long-term test fleet.

—Ed.

Plastic Fantastic

I don't understand why General Motors will be switching to metal bodies on its minivans. The plastic body panels on my new Pontiac Trans Sport were a major selling point for me. Car bumpers hit my minivan twice in my first month of ownership. Both times, I just used rubbing compound and car wax to remove the black streaks that were left behind. Any metal-sided vans would have had to go to the body shop to be fixed. Door marks and dings multiply like rabbits on sheetmetal.

STEVE BRAMMER
MEDFORD, OR

Out Of Line

In reference to the phrase "doesn't scare the bejesus out of you," used in a recent automotive write-up, I'd like to state emphatically that it offended me. Included in the millions of readers of your magazine are probably many thousands of Christians, to whom Jesus Christ is very important. To a born-again Christian, He is not only our Savior, but also our very closest Friend. You'd probably be concerned too if someone were to make a swearword or profanity of the name of your best friend. In this era of "political correctness," everyone seems to be sensitive to the rights of others. It seems that all forms of discrimination are prohibited, except as it relates to the Christian faith. I dare say you would be more careful in your language if it involved any other religious persuasion or subgroup. I know

for a fact that you would not in any way disparage the homosexuals. Why then is it okay to be offensive to the Christian religion?

NORM TOTEY
EVERETT, WA

My apologies.

—Ed.

Going Digital

In reference to your recent article about digital cameras, I believe that someday digital photography will be common. However, I think major improvements in CCD chips and computer displays are required before you find photographers switching to digital. The resolution and lighting may be sufficient for family snapshots, but it has a very long way to go for other purposes.

DAVID MANTHEY
VIA INTERNET

Women's Day

For years, my husband has been reading your magazine. And for years, I have been placing it in his "magazine basket" by the foot of his favorite relaxing chair. Today I happened to pick up an issue and peruse it. I was not only fascinated by what I read, but also educated and re-informed about current events and developments in our society. This is truly a phenomenal magazine. Having both an undergraduate and graduate degree, I venture to say that PM should be required reading for college, as well as high-school, students.

SANDRA G. MATHERS
SPRINGFIELD, OR

Thanks, Mom.

—Ed.

Wow, what a miracle. Being the parent of a 13-year-old Down's syndrome boy, I loved the article "Machines That Listen." This could change his life forever. When IBM can get the price down to an affordable level for the working class, the physically challenged will finally be able to communicate with others. I love the idea.


EILEEN
VIA INTERNET

As a working mother of five, I don't have much time to spend on woodworking. Growing up, I had helped Dad on various projects. When I see the latest projects in each month's issue, I know they're way beyond my skills, even though many are labeled "easy to build." My teenagers take shop in school and love it. A "Junior Workshop Project" would be just what they need to keep up their interest, and mine.


CHARLOTTE SAZAMA
CROFTON, MD

We regularly print articles for novice woodworkers of all ages.


—Ed.



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TIME MACHINE

90 YEARS AGO: DECEMBER 1905

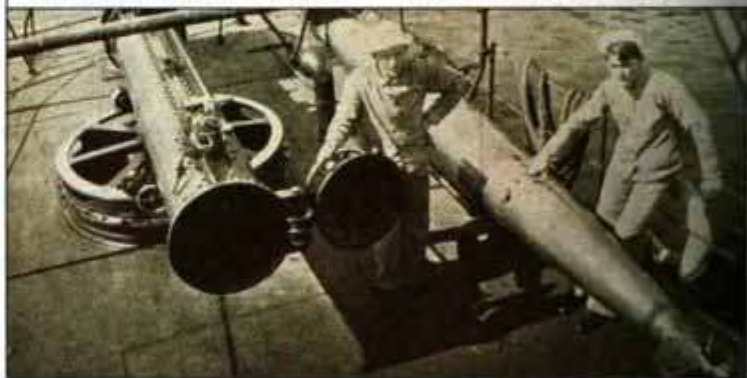
Dropping A Line

Instead of burrowing through riverbed like New York's subway tunnelers, Parisian engineers conceived a novel way to extend the Metro beneath the Seine—without disrupting boat traffic. They built the tunnel's sections on dry land, then launched them like ships. One by one, the metal caissons floated down the river, ducking under bridges by taking in water as ballast. They were then sunk into trenches and joined together.

Sea Power

The debate raged full steam in naval circles: Should nations continue to invest in dreadnought armadas? Or should they recalibrate the balance of power

by unleashing swarms of torpedo boats? Favoring the latter, explosives expert Hudson Maxim pointed out that 50 torpedo boats could be built and manned for the price of one battleship.



60 YEARS AGO: DECEMBER 1935

Sound Tracks

As railroading enjoyed a golden period, locomotive buffs studied train whistles the way ornithologists learned bird calls. Two long blasts and two short blasts, for example, signified an upcoming highway crossing, while three medium toots meant a car had broken loose. The sound could travel as far as 15 miles. And though railways had their own unique whistles and air horns, crafty engineers introduced quavers that their friends could recognize.

Storm Clouds

Italy was hammering Ethiopia in what many considered a preview of the technology of the next great war. The 7-month campaign featured extensive use of air power. Sweeping in from Eritrea, Italy's Bredas and Savoia-

Marchettis pounded desert fortifications with bombs and machine-gun fire. The conflict also revived the specter of chemical warfare. The result: an intensified arms race among the European powers.



30 YEARS AGO: DECEMBER 1965

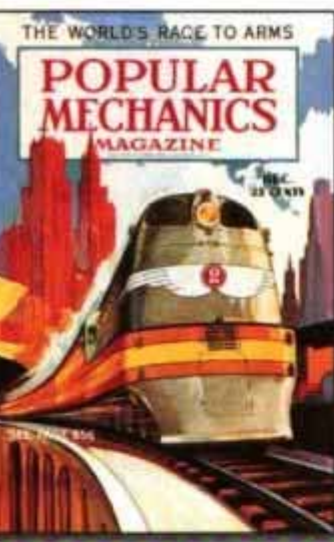
Action Figures

Static Christmas displays might be acceptable to the average homeowner, but not to the avid PM reader. Putting a charge into the holidays, we detailed decorations set in motion with electric motors. To animate the plywood cutouts, you hooked up pulleys, belts and connecting rods. Also, to send colors dancing around the house, we explained how to make a star out of a new space-age material—diffraction-grating film from Edmund Scientific.

News From Olds

The Oldsmobile Toronado drew double takes wherever it went on our cross-country marathon. The big, crouching front-wheel-drive machine handled 6000 miles of freeway, rural

trails and potholed urban moonscape with equal aplomb. At Bonneville, we thought we'd thrill bystanders with some high-speed slaloming—only to be upstaged by Art Arfons and his Green Monster. **PM**



TECH UPDATE

News Of Tomorrow's Technology Today



Robot Weedwackers To Tend Tomorrow's Trees

DORSET, ONTARIO—The way Canadian researchers see it, herds of giant robotic insects will thrash their way through the forests of the future. They'll wield grass trimmers, brush saws and other tools, clearing weeds out leaving young trees unscathed.

Scientists at Canada's National Forestry Institute are quite serious about this vision. The reason? Small trees grow three times faster if weeds are controlled, but new regulations ban the herbicides that control them.

If weeds must be cut by hand, then robotic hands make the most economic sense. Although a robot can work only half as fast as a human, one man can oversee a dozen robots, refueling them and sharpening or replacing their tools as required.

The machines draw their heredity from a remote-controlled walking vehicle designed by Martin Marietta for Mars exploration. Reprogrammed for Earthly forestry, the robots will dis-

tinguish between weeds to be culled and small trees to be protected. Based on machine vision, the software to accomplish this has been tested in the lab, but it could take up to five years to perfect.

Meanwhile, a private company—Autonomous Walking Machines Inc.—is developing the robots and hopes to have them in production in two years. Their legs moved by compressed air, the 6-legged machines will be tall enough to high-step 6-ft. obstacles. A prototype, now undergoing tests, weighs 600 pounds and

Guided by stereo cameras, monster walking machines clear undergrowth to speed development of young forests.

runs on a gasoline-fueled generator.

Foresters figure they can set the machines to work as soon as they're produced, clearing brush from railroad and power-line rights-of-way. This entry-level job will be easier than tending tree plantations because the ground is smoother and the cutting nonselective. Still, it will take hundreds of robots to clear tens of thousands of right-of-way miles in Canada's vast hinterlands.

Highlights This Month

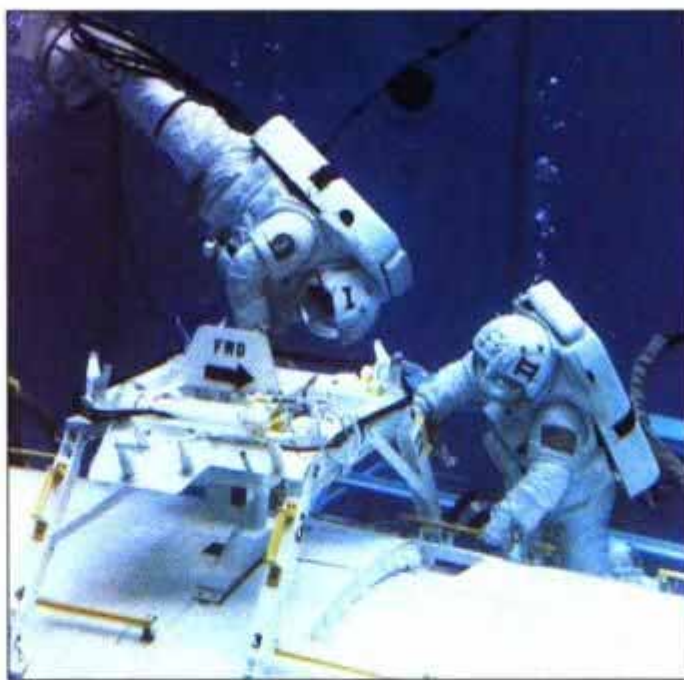
- **Pool Party**—*Skylab* astronauts reunite underwater.
- **Life Bombs**—Rescue rafts to drop from fighter wings.
- **Soaring News**—Tailless sailplane defies convention.
- **Cheap Alcohol**—Germs turn waste into ethanol fuel.
- **Ventilation Plants**—Walls house nature's air purifiers.
- **Crash Program**—Planes wrecked to save general aviation.
- **Trigger Lock**—Smart guns recognize only their owners.

Editor/Writer: Gregory T. Pope
Reporters: John Boatman, Mike Dillon,
Ted Francis, Scott Gourley, Andy Turnbull

Skylabbers' Wet Reunion

HUNTSVILLE, AL—For 21 years, Jerry Carr and Bill Pogue reigned as America's space-endurance champs, having spent 84 days aboard *Skylab* in 1974. But last spring Norman Thagard nudged them out of the record books with his 115-day orbital stint (see "Four Months In *Mir*," page 40, Nov. '95). Unfazed, Carr and Pogue have once again kissed gravity goodbye for the cause of preparing mankind for long sojourns in space.

The *Skylab* partners now work for Boeing, which is



Skylab vets go weightless again, testing space-station procedures in neutral-buoyancy tank.

building key modules of the International Space Station. Last summer Carr and Pogue brought their experience to NASA's 1.3-million-gal. neutral-buoyancy tank.

Along with other Boeing engineers, they rehearsed tasks that astronauts will have to perform both inside and outside the space station. These include hooking up external power cables and replacing carbon-dioxide removal apparatus. The goal: evaluation of mobility aids and restraints, critical hardware that will stabilize crew and equipment.

Fly Composite Airlines

HAMPTON, VA—Sooner or later, the composite structures that lighten and stiffen small aircraft will replace aluminum in the next generation of jumbo jets. Seeking to fast-forward development, NASA is having McDonnell Douglas build a full-scale airliner wing from composite materials.

The key is to keep costs down, so engineers will use a promising process called stitched resin film infusion. Structural components made of graphite will be stitched together first, then soaked in resin and allowed to harden. The last-minute submersion in resin means the parts needn't be refrigerated before curing, thus simplifying manufacture. The stitching also boosts durability. McDonnell Douglas has already delivered a sample wing box to NASA's Langley Research Center for stress tests.



Kevlar-stitched graphite-epoxy wing box undergoes load testing.

Body's Sound Check



An acoustic sweep tests for osteoporosis by checking how much porous bone damps sound.

The amount of sound-deadening indicates the bones' porosities and, hence, their potential to break.

ST. LOUIS, MO—While other researchers have hit upon noninvasive ways to probe bridges and airplanes for hidden deterioration, a mechanical engineer at Washington University is doing the same thing for the human infrastructure. The purpose: to diagnose osteoporosis. This ebbing of bone mass causes more than a million debilitating fractures a year, mostly in older women.

Andrew Dimarogonas's technique is called an acoustic sweep. Pressed against the body, an applicator delivers vibration to the skeleton. An attached sensor picks up the bones' acoustic response.

The Best Of Both Drones

TEL AVIV, ISRAEL—Pioneers of the unmanned aerial vehicle, the Israelis have chalked up another first by bolting together pieces of two different drones.

Called E-Hunter, the new bird is a hybrid of the Hunter short-range reconnaissance vehicle and the much larger Heron, both built by

Israel Aircraft Industries (IAI). According to IAI and partner TRW, E-Hunter can fly twice as long and carry a much bigger payload than Hunter, which is now entering service with the U.S. Army. E-Hunter,

in fact, can stay aloft for 24 hours.

The secret to E-Hunter's success? Its use of the Heron's twin tail and 55-ft. wing, both of which carry fuel. The fuselage carries Hunter's original avionics, so it remains compatible with

Hunter's ground-control system.



Also, soldiers can attach the wing/tail kit to a Hunter fuselage in less than 4 hours.

E-Hunter combines Heron's wingspan with Hunter's intelligence.



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Combat Jet Drops The Bomb Of Life

FORT ERIE, ONTARIO—When a ship or plane goes down in frigid ocean waters, rescuers have minutes, not hours, to save lives. But disasters rarely strike within easy reach of shore-based helicopters or boats. Although high-speed military aircraft could reach the scene quickly, they'd offer little assistance to survivors.

The Lightweight Survival Kit Air Droppable (L.W. SKAD) changes all that. It is derived from the Sea SKAD system used by Canada and Norway to deploy life-rafts from the bomb bay of a slow-moving P-3 maritime patrol plane. L.W. SKAD is specifically designed to be mounted externally on a fast jet, such as an F/A-18.

Each 325-pound canister contains two 6-person rafts plus survival equipment. Looking like a bright yellow and red bomb, it would drop from an altitude of 100 to 500 ft. As L.W. SKAD falls, a fuse triggers a multistage separation sequence. Drogues and chutes deploy and jettison; rafts are expelled and inflated; strobe lights wink on.

An arctic variant replaces one of the rafts with extreme-weather clothing and other items.



L.W. SKAD survival package drops from weapons rack of high-speed fighter.

Solar Drone Eclipses Record

Relying only on the Sun for power, Pathfinder reached a 50,500-ft. altitude during its 12-hour flight.

EDWARDS, CA—NASA's Pathfinder unmanned air vehicle has blazed a trail into the record books, setting an altitude mark for solar-powered aircraft. Last September, the 100-ft. flying wing hit 50,500 ft. near Dryden Flight Research Center. The old record: 14,000 ft., set in 1981 by Solar Challenger.

AeroVironment Inc. originally built Pathfinder for the Ballistic Missile Defense Organization (see Tech Update, page 17, Jan. '94). NASA has refurbished the vehicle slightly by adding a bigger solar array across its wingspan.

Pathfinder was rehearsing for its new mission—to soar as high as possible into the strato-

sphere with sensors to measure atmospheric change. A solar-powered machine is perfect for the job, because—unlike an air-breathing vehicle—it gains power with altitude. And Pathfinder does not squander power. Weighing only 500 pounds, the drone can fly on six one-hp electric motors at a mere 20 mph.

As part of NASA's Environmental Research Aircraft and Sensor Technology program, Pathfinder will resume flights next spring when the Sun climbs back overhead.

Virtual Truck For The Rookie Road Warrior

ZURICH, SWITZERLAND—Remember how hard it was to learn how to drive? Now imagine jumping behind the wheel of a huge military tractor-trailer with an oversize trailer—in mountainous Switzerland.

Instead of throwing raw-recruit truckers right on the road, the Swiss Ministry of Defense will soon use an Oerlikon-Contraves simulator to give novice drivers a head start.

Called the Advanced Driving And Maneuvering Simulator, or ADAMS, the system mounts a wide-angle display around a realistic truck cab. The imagery depicts conditions that range from dawn to dusk, sun to rain, and city to country driving. Meanwhile, a motion base and sound system keep things authentic.



Truck simulator replicates hazardous traffic.

NASA PHOTO

PHOTO COURTESY OF THE U.S. AIR FORCE

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Jet Wiggles Its Nose To Turn

EDWARDS, CA—Question: How do you handle a jet fighter at steep angles of attack, when the plane itself blocks airflow to control surfaces? Answer: ANSER, or Actuated Nose Strakes for Enhanced Rolling. Developed at NASA's Langley Research Center (see *Tech Update*, page 17, Feb. '94), the strakes are now flying on the High Alpha Research Vehicle (HARV).

A modified F/A-18 on loan from the Navy, HARV had already been fitted

with thrust-vectoring vanes. These deflect engine exhaust to boost pitch and yaw control. Engineers installed the strakes—each 4 ft. long and 6 in. wide—last winter. Hydraulic actuators extend them to interact with vortices swirling around the nose.

The strakes work best at turning the jet left and right when it's in high angles of attack. The pilot simply shifts the stick—the strakes' movements are governed entirely by

the plane's flight-control software.

The research program is a broad exploration of high-angle flight, as compared to the X-31's focus on dog-fighting maneuvers.

Look First, Then Dig In



Square metal-detecter coil scans ground ahead of excavator claw.

The detector passes its readings to a laptop inside the control cab, where the operator can see images of the scanned soil—and its hidden contents. The system could one day guide robotic equipment.

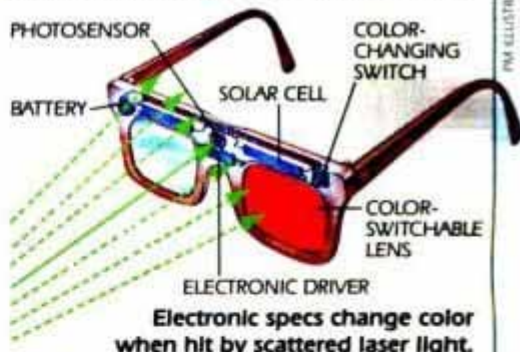
RALEIGH, NC—Clawing into an underground gasoline, an excavator can turn into a detonator. Every year, nearly 200 people die when digging machines blunder into pipelines or electric cables. To skirt these hazards, a North Carolina State University engineer has invented a device that gives the backhoe operator a peek below the surface.

The system mounts a metal-detection coil

Shades Of Any Color

FOSTER CITY, CA—These days, laser surgeons often switch tools in midoperation, cutting with different wavelengths of light. But doctors' protective eyewear had yet to catch up—until now. Reliant Technologies has developed spectacles that change color to match the laser.

The key? A photosensor that measures the intensity of scattered laser light. Filters block all but narrow portions of the spectrum corresponding to various laser wavelengths. If the light exceeds a dangerous value, an electronic driver activates multilayer liquid-crystal lenses. In microseconds, these darken to a hue that momentarily cancels out the laser.



Electronic specs change color when hit by scattered laser light.

Instant Tornado Shelter

CHICAGO, IL—Concerned about workers' vulnerability during sudden tornadoes, Fermilab has devised portable shelters made from modular steel-reinforced concrete.

Each structure is comprised of a series of arch-shaped sections, attached by tongue-and-groove joints and bolted in three places. Needing no foundation, the shelter can rest on a gravel bed or parking lot. A crane disassembles it, and a flatbed truck moves it.

The concrete walls and armored steel doors can withstand 300-mph wind gusts and assaults of 26,000-pound forces from flying debris.



Tornado shelter is assembled from modular reinforced-concrete tube sections.

Trees Taste Tomorrow's Air

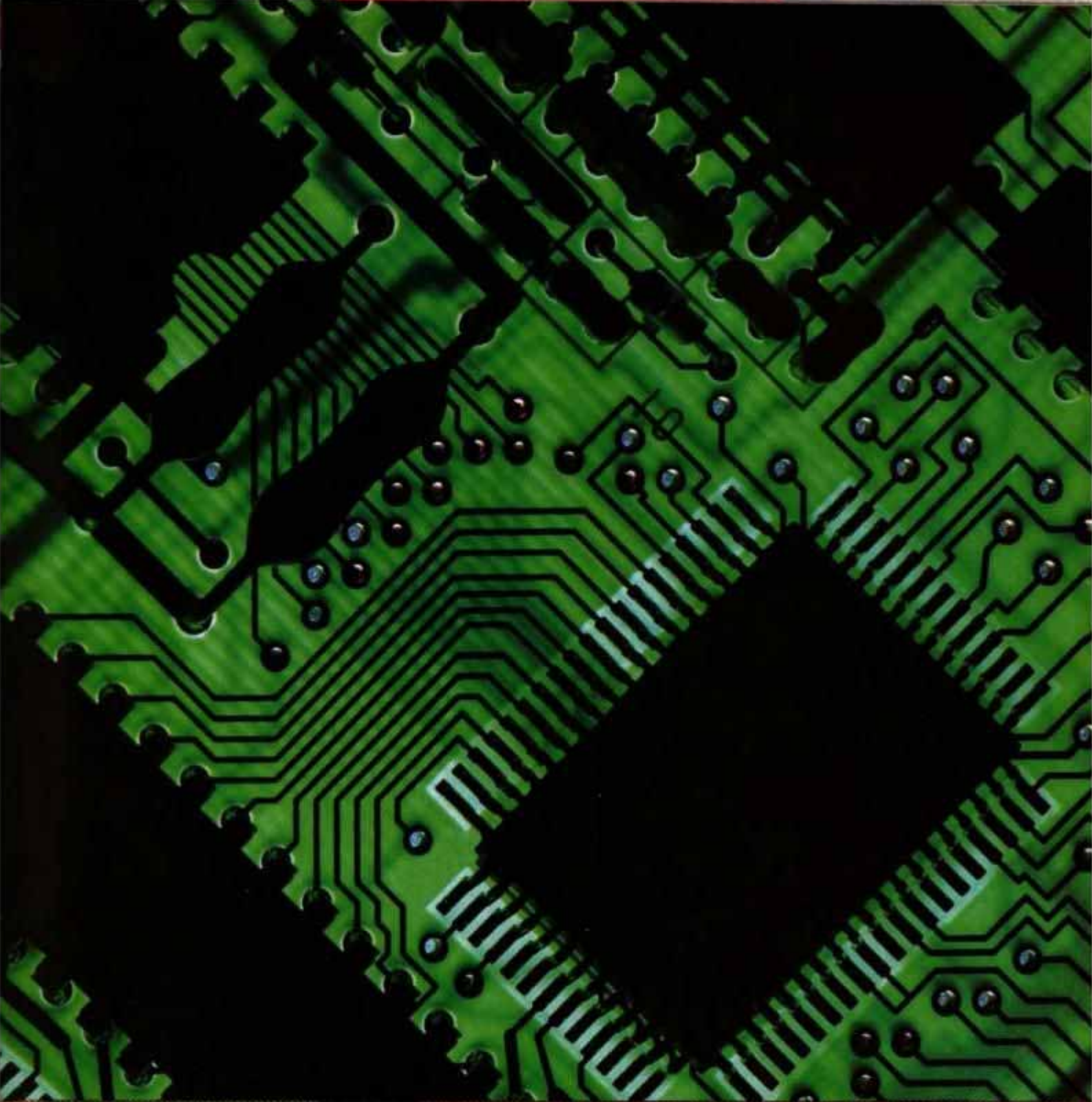


Carbon dioxide floods pine forest in experiment to gauge trees' response.

loom over a grove of loblolly pines. A computer meters out the gas, guided by wind instruments on a second-by-second basis. The ongoing experiment is a first in open air.

DURHAM, NC—If industrial activity increases our atmosphere's carbon dioxide, how will plants respond? To find out, a science team from Brookhaven National Laboratories and Duke University has created a miniature 21st-century forest right in the middle of North Carolina.

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X-33: Eggs May Be In One Basket

HUNTSVILLE, AL—The future of America's space program will begin to take shape next summer, as NASA awards the contract for the X-33 reusable launch-vehicle demonstrator (see *Tech Update*, page 17, Feb. '95). But the three competing teams don't think enough funding will be available to stage a fly-off between the top two designs—or even to build two vehicles of the same design. Having only one X-33 may influence managers to shave high-risk technologies and operations from the program.

Certainly from the outside, the Rockwell-led X-33 design looks to be the most conservative. It's a winged body that launches vertically and lands horizontally, much like a smaller, unpiloted space shuttle. The vehicle would carry its fuel internally, however, sandwiching the cargo bay between hydrogen and oxygen tanks. A single powerplant, probably derived from the shuttle's main-engine



Rockwell hopes its X-33 design will lead to this full-scale reusable launch vehicle.

New Twist On Glider Wings

MARION, OH—A tailless glider with a forward-swept wing? Although it sounds like a proof-of-concept model for a hyperagile fighter jet, it's actually a well-behaved sailplane that will soon be on the market. Group Genesis Inc. is tooling up to produce the aircraft in kit form.

Key to the Genesis I's performance is a reflexed airfoil, which twists up slightly at its trailing edge. This geometry

slows down the air sweeping off the upper surface, but speeds up the flow off the lower surface. The result: less turbulence when the airflows meet—and, hence, less drag. The airfoil also resists the pitch-down tendency to which most gliders are prone. So a counterbalancing tail load isn't necessary. That shaves off

weight and drag. The forward-swept wing puts the pilot near the center of gravity and lends excellent cockpit visibility. What's more, it keeps air from spilling off the wingtips, further enhancing lift and fighting aerodynamic stall.

The Genesis I will be equipped with an aircraft-recovery parachute as standard equipment. The kit price will run to \$25,900.

Unusual geometry marks Genesis I sailplane, shown here flying in prototype form.



Microbe Brewery

GOLDEN, CO—Genetic engineers have produced a bacterium that can turn sawdust into booze. But their aim isn't cheaper drinking—it's cheaper driving. The idea is to produce clean-burning ethanol from a much broader range of raw materials, cutting the fuel's cost in half.

In its natural state, the bacterium involved works like yeast, fermenting the sugar glucose



Department of Energy researchers have engineered a bacterium to ferment a waste into ethanol.

to make alcohol. But biotechnologists at the National Renewable Energy Laboratory have spliced in genes that also allow the microbe to ferment xylose, an abundant ingredient in fibrous plant material.

Instead of just corn, the germ can now handle forestry residue, agricultural leavings and other inexpensive stuff—even waste paper. Researchers think the breakthrough could make ethanol as cheap as gasoline.



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The Walls Are Alive

PETERBOROUGH, ONTARIO—A blanket of moving air will soon muffle a leaky building at Trent University. What's more, this blanket will include a complete ecosystem that will act as a biological air filter.

Built in the days of cheap energy, the original 85,000-sq.-ft. building will be enclosed in an airtight shell of glass and steel. Pressurized air will circulate through this space, termed a dynamic buffer zone by architect Johan de Villiers. All heating and a/c systems will feed into this zone, making it, in effect, a giant HVAC duct surrounding the whole building. The air will pass into the building by way of ceiling diffusers and return to the

buffer zone through fan-riddled towers of lava rock called breathing walls.

Although airtight buildings often have air-quality problems, this one won't. A series of balanced, 200-sq.-ft. biomes—featuring plants, insects, shellfish and salamanders—will keep the air

VENTILATION MACHINERY

Cleaned by buffer-zone ecosystem, air diffuses into occupied space.

DYNAMIC BUFFER ZONE

BREATHING WALL

OCCUPIED AREA

clean. Another biome will be located inside the buffer zone itself.

The Russians Are Coming

ABBOTSFORD, BRITISH COLUMBIA—The Federal Aviation Administration is eager to learn about aircraft production in the former Soviet Union because the Russians are eager to sell planes over here. In fact, they're claiming to have an aircraft that already meets Western certification standards. Built at the Smolensk Aviation Plant, the proto-



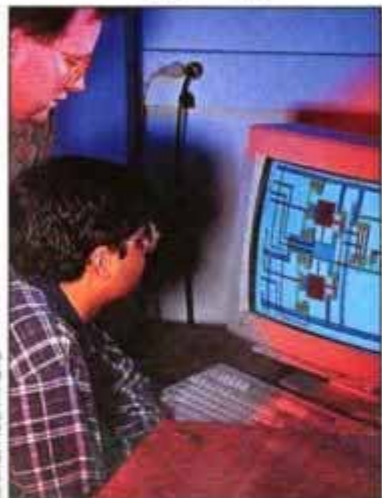
SM-92 looks Russian, but is built for export to the West.

type SM-92 made its North American debut at Airshow Canada '95.

The 6-person plane is roughly the size of a Beechcraft King Air, but its top speed is only 156 mph. It flies on a 360-hp air-cooled reciprocating engine. A 99-gal. fuel tank gives the SM-92 a maximum range of 780 miles.

With spring-loaded landing gear, the plane is suited for 825-ft. takeoff and landing rolls on ill-prepared airfields. The manufacturers are pushing the SM-92 for rugged civilian applications such as forestry patrol, crop-dusting and medical evacuation.

Sizing Up A Sucker



Engineers are studying leech nerve circuitry, seeking novel ways to control man-made equipment.

ATLANTA, GA—Someday, computer chips may be modeled after the human mind, but for now we'll have to be satisfied with leech brains. Some engineers at Georgia Tech have discovered that the blood-sucking parasites contain neurological circuitry that's worth imitating in electronics. Of particular interest is the leech's motor-control neurosystem, which governs the animal's simple swimming movements. The researchers have re-created these biological nerve patterns as analog integrated circuits. The next step: to fabricate chips that contain the circuitry. Ultimately, neuromorphic chips could control pumps, robotics or prosthetic limbs.

Fastest Train In The World

PARIS, FRANCE—Long the wheel-on-rail speed king, the TGV is about to get faster. Next year, manufacturer GEC Alsthom will roll out its third generation of rolling stock: the TGV 2000, which will have a top speed of 217 mph. That's 31 mph faster than the TGV Atlantique (see Tech Update, page 15, Feb. '90).

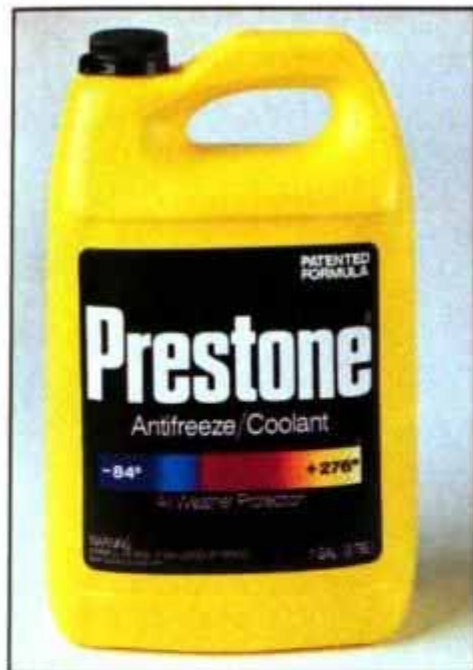
Not only are the new trains swifter, but they will also carry 45% more passengers in double-decker cars. Duplex TGVs are already going into service on the current lines and through the Channel Tunnel, but they won't top 186 mph. The TGV 2000s will feature lighter bogies, stronger brakes and reworked



TGV 2000 will achieve speeds of 217 mph with lighter, stronger locomotive.

aerodynamics. They'll also be quieter inside and out.

GEC Alsthom is designing the trainsets to cruise on any track in Europe. In service by the year 2000, they'll rule until the fourth-generation TGV comes along—in 2010.



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Starships To Crash For NASA

HAMPTON, VA—NASA is finally going to have a pair of Starships! But they won't boldly go where no man has gone before—in fact, they won't even fly.

Raytheon is donating two Beechcraft Starship 2000 airframes—stripped of engines and avionics—to take part in NASA's aggressive new drive to revitalize general aviation. The program, called Advanced General Aviation Transport Experiments (AGATE), teams NASA, the Federal Aviation Administration and more than 50 corporations and organizations.

At NASA's Langley Research Center, engineers will install the first Starship airframe in an immense crash-test rig. The hollow aircraft will be riddled with sensors and filled with a variety



Starship 2000 will take part in experiments designed to improve general-aviation safety.

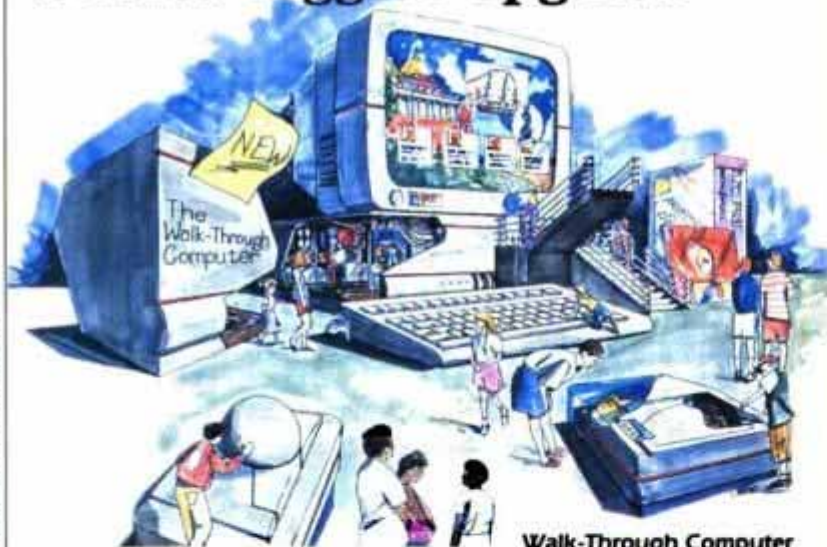
of seats and passenger-restraint devices. Next year, it will undergo a full-scale crash simulation, after which NASA will inspect the composite structure and the seating systems.

Then, an AGATE team will develop improved seats and restraints and

crash test them aboard the second Starship airframe in 1999.

The Starships, by the way, are original prototypes built for FAA certifications. Raytheon delivered the last of 50 production Starships this year and has shut down the assembly line.

World's Biggest Upgrade



BOSTON, MA—Splicing components into your personal computer is hard enough, but imagine upgrading a PC the size of a 2-story house. That was the task facing exhibit managers at the Computer Museum (see "Museums For The Future," page 32, May '90). The original 50:1 scale display simulated a 486-based computer without the multimedia trappings of today's desktop machines.

Last October, the museum was scheduled to unveil its Walk-Through Computer 2000. The upgrade took 18 months. New components abound—and astound by their sheer size. A CD-ROM player holds discs 6 ft. across, with data pits the size of coasters. A 4.2GB hard drive—its read/write heads as big as saucers—spins 8-ft.-dia. platters. Suitcase-size chips stud canyons of all-new printed circuit boards, including video and audio cards. And at the center of the exhibit, a Pentium processor, its circuits flashing with light fibers, stretches 7 ft. on a side.

Walk-Through Computer 2000 now features gigantic CD-ROM, multimedia-board and Ethernet-card simulations.

Smart Guns Will Know Their Owners

ALBUQUERQUE, NM—When a law-enforcement officer is injured or killed, a gun is usually to blame. Too often, it's his or her own gun. So the Department of Justice has asked Sandia National Laboratories to come up with solutions—technologies that would prevent discharge of a firearm by anyone but the authorized user.

Researchers have an arsenal of techniques to investigate. Embedded in the gun's grip, a radio-frequency receiver could disable the gun when activated from a small transmitter, like the device used with a car alarm. Alternatively, biometric sensors could verify the identity of the gun's owner, using fingerprints, for example. A fingerprint reader would arm the gun only when it's in the designated user's hand. Holstered, the gun couldn't fire.

Miniaturization of such devices may mean six years of work before a "smart gun" is ready. **TU**



Sandia researcher demonstrates the miniaturization that's needed before disabler can fit into gun.

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Great gift!

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Berlin Diary: Screen Gems

BY FRANK VIZARD, Electronics Editor

● Every two years, the great Funkausstellung fair in Berlin is awash in new electronic gear, but this time around the biggest news was a simple agreement concerning the planned introduction of a new video CD format next year. Two warring factions began talks that ultimately culminated in a compromise, averting what might have been a marketplace battle between two competing formats.

Whew! It could have been Beta versus VHS all over again—the industry equivalent of a nuclear war. The deal, brokered by IBM, uses most of the video technology proposed by the Time Warner/Toshiba camp. The Sony/Philips group will contribute its signal-modulation process.

Bottom line: Expect a 5-in. disc that is compatible with existing audio CD standards and has a data capacity of 4.7GB, which can accommodate a movie 133 minutes in length. Not only will it be small, but it will also have the best picture quality to date—way beyond the current best of laserdiscs. Look for availability around Labor Day of next year, with the player costing about \$500 and each disc listing for less than \$25.

Other items of interest coming out of Berlin were

digital camcorders (see “Double Your Bits,” page 57), multimedia computers (see “Computing’s Next Step,” page 68) and wall-hanging televisions. We’ll have a full report on this new TV technology next month.

TV sound, meanwhile, got a great deal of emphasis. Perhaps the most



Grundig adds this single-chamber batwing to reproduce stereo sound in its new line of TV and audio equipment.

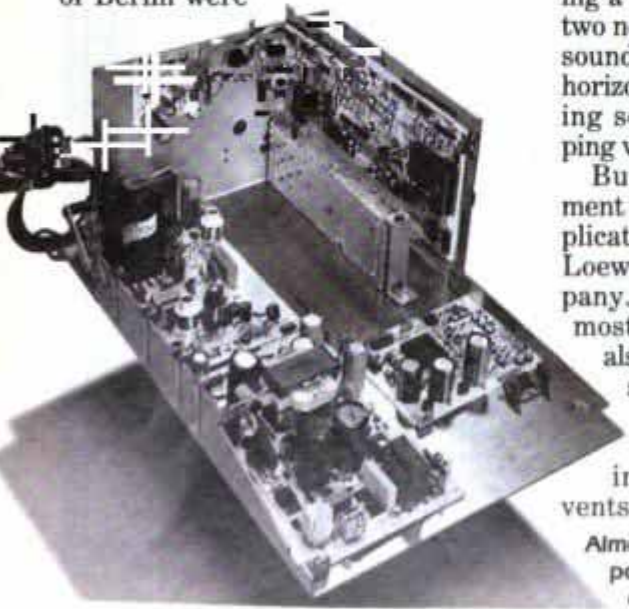
novel notion came from Grundig. This German company’s approach to sound puts a batwing not just on TVs but on conventional audio gear as well. The batwing reproduces stereo sound using a single enclosure rather than the two normally used. The idea is to send sound through the entire room on a horizontal plane instead of reproducing sound along two overlapping vertical planes.

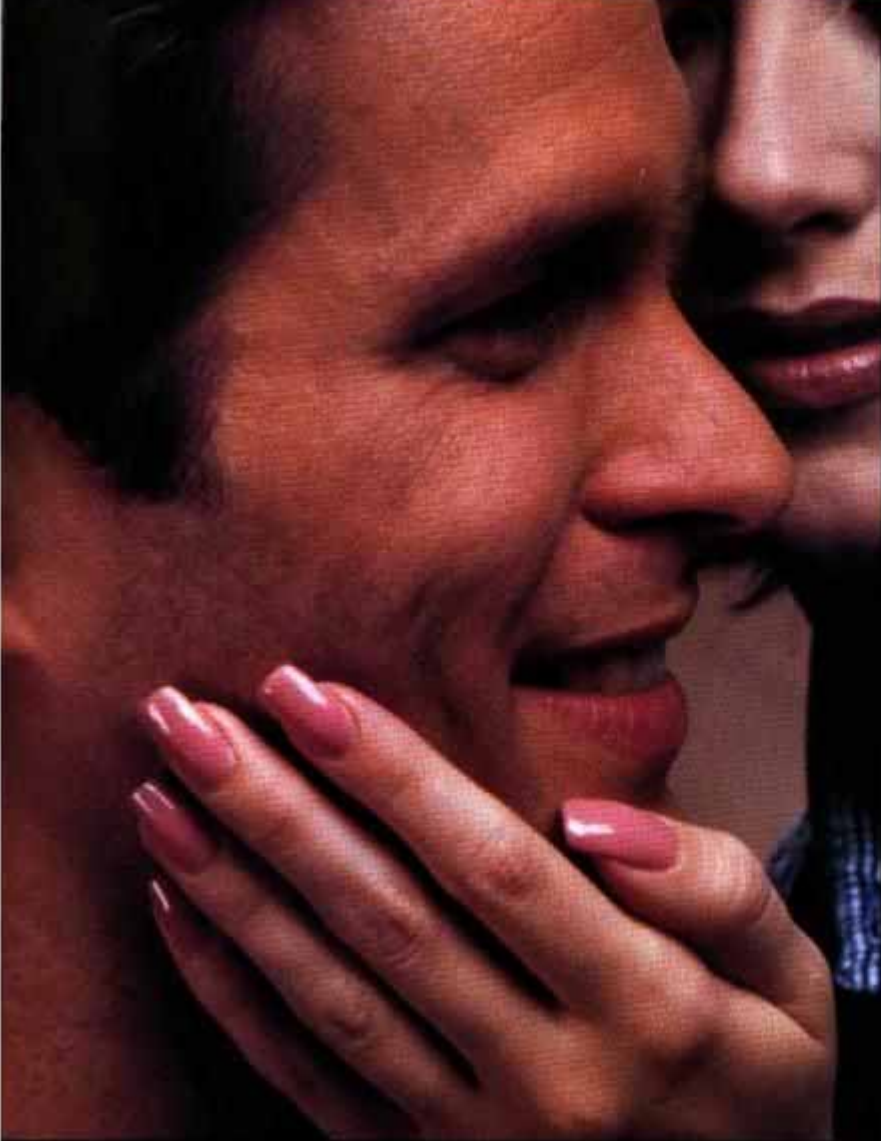
But perhaps the development with the longest-term implications is a television from Loewe, another German company. Its CSI model is made mostly of recyclable materials. The housing is stainless steel, a material that conducts heat and doesn’t burn, thereby eliminating the need for cooling vents and flame retardants.

Almost all of the electronic components used in Loewe’s CSI TV are recyclable, as is the stainless-steel housing.

Inside the CSI, a conventional circuit board is not used. All of the electronic components are made using ceramics, copper, aluminum, silicon and iron—materials that can be easily recycled. In areas where it isn’t possible to replace plastic, Loewe uses small amounts of a type of plastic that can be safely incinerated.

All that remains is the picture tube, a more complicated disposal problem. Energy consumption, incidentally, is only one watt in the stand-by mode. **FM**





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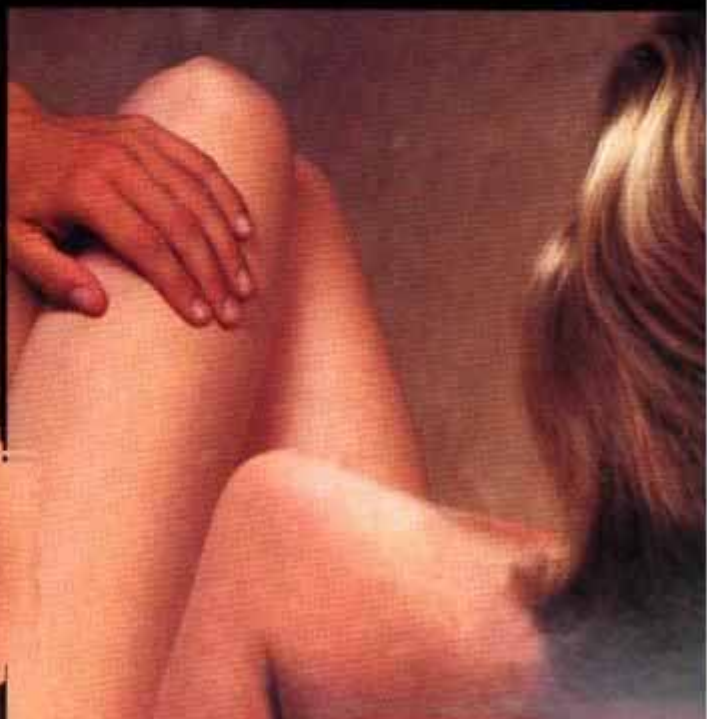
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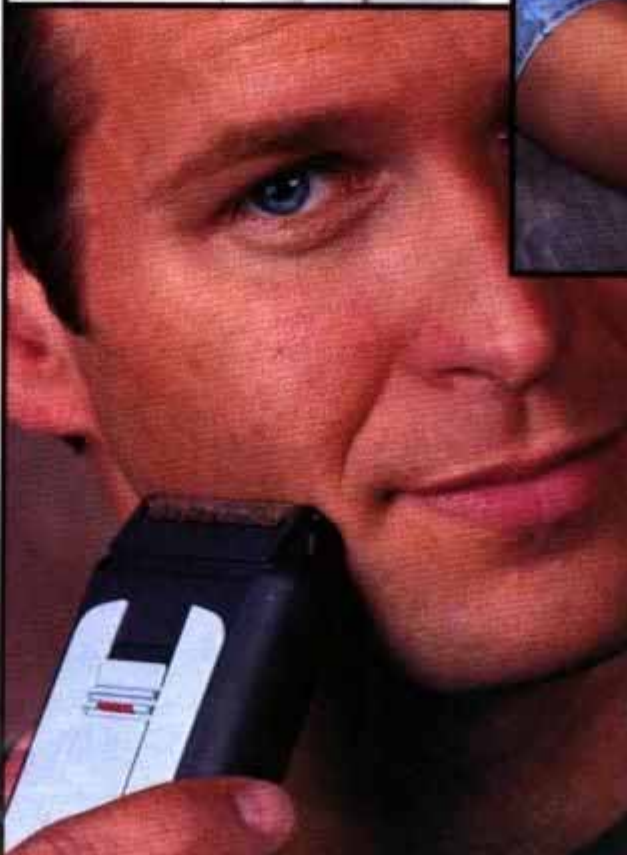
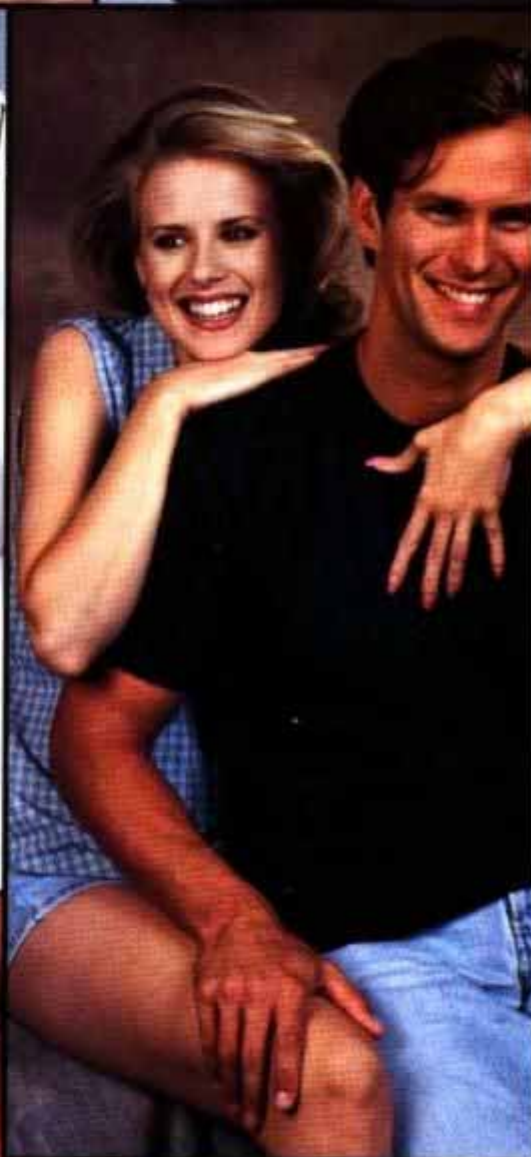
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Europe Spy Report

BY MIKE ALLEN, Associate Automotive Editor

Putting The Cart Before The Prancing Horse

● Ferrari fans, who undoubtedly outnumber Ferrari owners by a ratio of hundreds-to-one, can expect to see production versions of this prototype in about two years. Equipped with a V12, it's probably derived from the current 456 GT 2+2, even though the mule shown here is a pure 2-seater. It's destined to replace the current F 512 M, a midengine 2-seater with a flat-12 engine.



VW Plays Catch-Up

With Volkswagen sales in the United States slowly rebounding after some of the worst years ever, here's a car the company sorely needs to remain in the



This hatchback is Volkswagen's new entry-level compact.

market. This Spanish-built subcompact is one or two notches smaller than the current Golf/Jetta and is intended to compete with domestics in the Neon/Cavalier/Escort class. The photographed prototype is a hatchback, like its big brother, the Golf. We've also seen prototypes of a more conventional notchback sedan to complement the Jetta. Look for this in 1997.

Mercedes Tweaks

Due for launch in Europe in May, here are the estate-wagon versions of two Mercedes-Benz sedans. The E-Class wagon's styling is changed very little from the 4-door, sharing the distinc-

tive oval headlights introduced this fall. The C-Class wagon will retain the rectangular headlights and grille of the C220/C280 sedan. A new coupe based on the C-Class, however, will have a very E-Class-looking nose, complete with those oval headlamps. The introduction date for these vehicles into the U.S. market is still undisclosed.

Elan Rides Again

The Elan model name will be in Lotus dealerships again this winter, with this replacement for the current front-engine version. This tiny midengine roadster will be powered by a 120-hp 4-cylinder engine from Rover coupled to a 5-speed manual transaxle. The chassis is an aluminum spaceframe, and the exterior bodywork is Lotus's customary fiberglass. Expect the price to

be on the high side of \$30,000. Plans for U.S. distribution are sketchy.

Let The Sun Shine

The latest from Stuttgart is that the glass-topped 911 will not be called Panorama, in spite of the fact that Porsche's internal name for the project has been that all along. The Panorama trademark in the U.S. belongs to the Porsche Club of America, as that's the title of their newsletter, so any potential legal conflict seems unlikely. At any rate, the new car, based on the Cabriolet body, will be called by a familiar name: Targa. The structure of the sliding glass roof will be welded directly to the frame, so there's no chance of removing the entire assembly.



Lotus Elan has aluminum-framed, composite body.

But the entire glass roof, from just a few inches from the windshield header to the B-pillar, slides back and inside the glass rear backlite. **PM**



Mercedes E-Class (left) and C-Class (right) estate wagons should be available in the United States in a year or two.

Detroit Spy Report

BY JIM DUNNE, Detroit Editor



Chevy Malibu

● One version of GM's new line of front-drive compacts will be sporting a familiar name when it's introduced in 1997. The Chevrolet will be called the Malibu. The similarly styled



Sleek coupe is a '97 Ford Escort, possibly with 150 or more hp.

Oldsmobile will carry on the Cutlass badge. Early views of the cars show a lot of Saturn influence in the shape of the greenhouse, especially the arched line of the roof where it meets the top of the doors. Initially, these cars replace the Corsica and Ciera in their respective lineups. A third model will end up at Buick dealerships, combining the Century and Regal nameplates into one product line.



Ford's other pickup-truck shoe, the F-250, drops as a '97.

1997 Ford Escort

Sleek seems to be the styling theme for next year. Like the GM compacts, Ford's redesigned Escort subcompact lacks the sharp corners of the current model. The roofline at the rear flows gracefully down into the trunk surface. At the front, the sloping grille and extended bumper form a wedge profile.

Wheels appear to be chrome-plated, perhaps intended to brighten the lower portions of the body.

Late reports on Ford's plans for the Escort indicate that the sleek appearance

of the new model will be merchandised in a higher-priced line of cars. Ford plans to outfit one version of the car with a 150-plus-hp engine, special handling suspension and eye-catching styling. That model will be

offered in addition to the base Escort coupe. Ford is aiming at a \$20,000 price tag for these new models.

Ford F-250

When Ford redesigned its line of F-Series pickup trucks, the company separated the light-duty F-150 from

the heavy-duty F-250/350 models. The F-150 will be at your dealership soon. The "new" big boys will be there next year. But unfinished early prototypes show what the new vehicles will look like. Overall, the cab has a more rounded appearance, with little of the broad-shouldered styling of current models. The sloping hood profile results partly from the change in the front suspension, where A-arms replace the venerable Twin I-Beam layout.

1997 Camaro

A new V8 engine highlights the changes planned for the Camaro series in the 1997 model year. The engine is a completely new design, not a remake of any current GM V8, even though it has a displacement of 5.7 liters, the same as the present Camaro V8. The new engine is all aluminum and has iron cylinder liners. GM insiders say this pushrod engine will be rated at 340 hp. Pontiac's Trans Am and Chevrolet's Corvette also will offer this engine in their 1997 models.

Recent '97 Camaro prototypes, seen testing in the Southwest, reveal a hood bulge to provide clearance for an air intake that's similar to Pontiac's Ram Air system. At the rear, two oversize mufflers take up much of the space below the trunk. Four individual tailpipes replace the large rectangular outlets that are present on today's Z28 models.

To make space for the new



Camaro prototype has a bulging hood for a ram-air induction system.

mufflers, the gas tank looks like it has been moved forward in the chassis, ahead of the rear axle. Evidence of that change is the temporary filler cap that's recessed in the front section of the rear quarter panel. Wheels on the prototypes are new, too. They are cast alloy with what appears to be bolted rim extensions in an extra-wide rating. Note the wheel-opening flares at the rear, necessary because of the wider tires and wheels.

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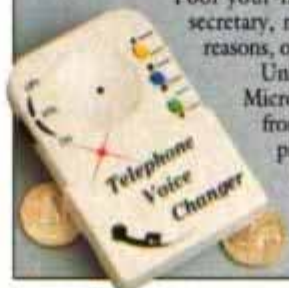
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My First Century

BY JOE SKORUPA, Boating/Outdoors Editor

● I needed a road bike last summer. It was strange. One day I'm happily pounding trails on a fat-tired mountain bike and the next I'm lusting after a sleek, razor-thin, high-speed road machine. Something just seemed to snap.

I can't completely explain it, except to speculate that it probably had something to do with my midweek pavement runs. Although I live a few miles from horse country in northwest New Jersey, unpaved roads are rare. (The horsey set drives jungle-taming Range Rovers, but prefers to drive them on freshly laid macadam.) As a result, my midweek routes are almost entirely paved.

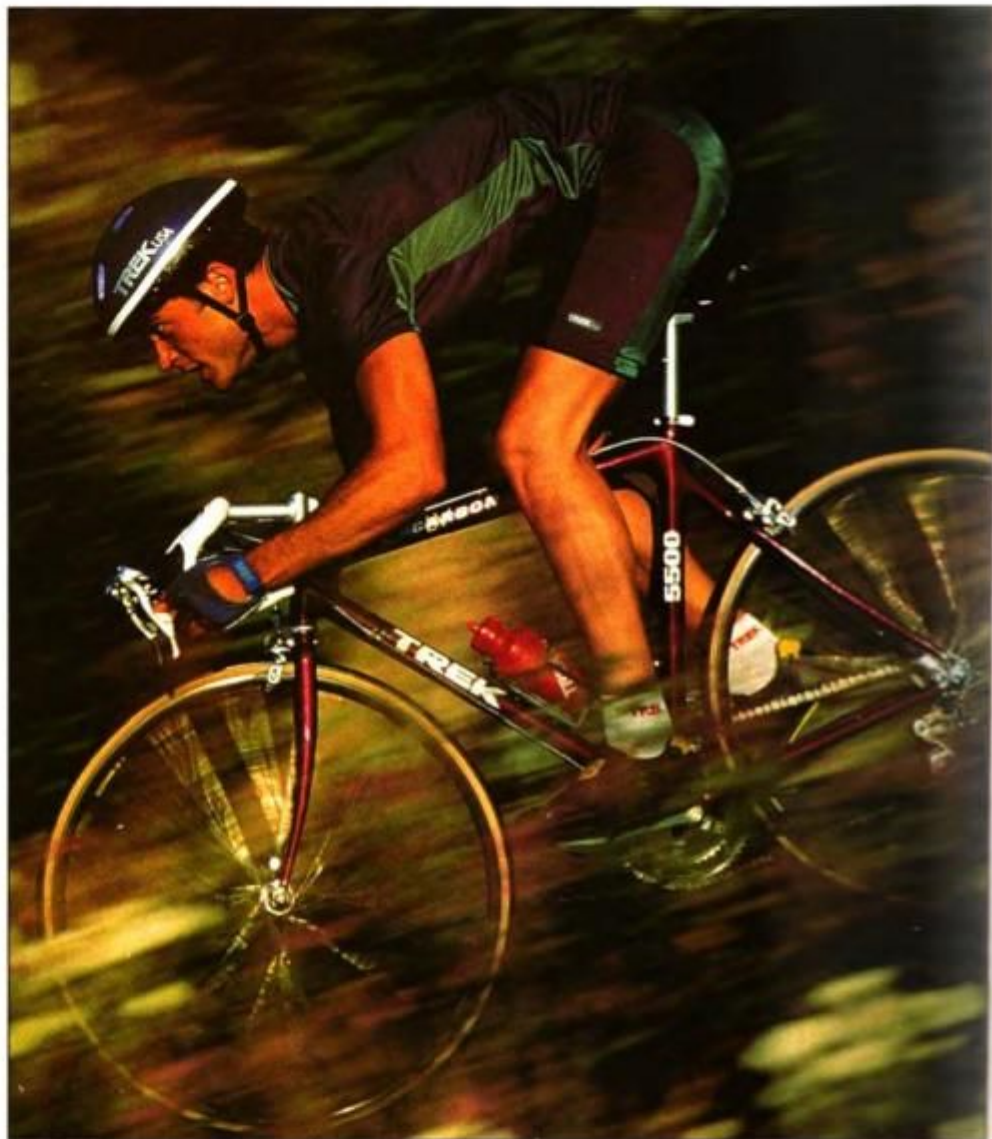
And that's where the trouble occurs. While I'm pushing to maintain a muscle-tiring workout pace, entire *peletons* of shaved-leg, decal-festooned road bikers pass me by as if I were standing still.

Of course, this is understandable, because road bikes are designed with vastly different tires and drivetrains than mountain bikes. Mountain bikes are ruggedly built and designed for high-torque, high-traction, medium-speed operation: think 4x4 sport/utility. Road bikes, on the other hand, are medium-torque, high-speed, low-friction bolts of lightning: think sports car. Comparing components, it's easy to see why I get dusted.

So last summer I traded in my cotton shorts and T-shirt for a Lycra-and-polyester outfit, and hit the macadam with the hottest road bike I could find. To give myself a purpose, other than blowing away slackers, I decided to use the opportunity to train for a century—a one-day, 100-mile marathon. Doing a century is a classic 2-wheel rite of passage, and a goal I'd always wanted to achieve.

Finding a buddy to train with was an important first step, because centuries are notoriously demanding. Friend and neighbor Joe Gillespie took up the 100-mile challenge, and, after mulling over my ambitious 10-week plan, pointed out that it would either make us better friends or cause us to never speak to each other again. He was right. Centuries aren't for whiners.

The final piece of the puzzle was to find the right bike. After looking around at top road bikes, I chose the carbon-fiber Trek 5000 series—the



lightest, stiffest, strongest production bike made.

What makes the 5000 series unique is its frame material, OCLV carbon fiber. The acronym OCLV stands for a concept that only an engineer could love: Optimum Compaction Low Void. After breaking the code, I discovered it means that the material is a carbon-fiber-and-epoxy composite made with a precise multidirectional layering technique (Optimum Compaction), and that in the manufacturing process minute air pockets that normally occur are reduced to less than 1% of the volume (Low Void).

Using OCLV material, Trek 5000-series frames weigh in at just 2.44 pounds, including paint. This point was made clear after Gillespie and I picked up our 5000s at Marty's Reliable Cycle (173 Speedwell Ave., Morristown,

NJ 07960). When we hopped on for our first ride, we were startled by what can only be described as the absence of weight. The ride is like being on wheels, seat and handlebars with nothing in between. Out-of-the-box 5000s weigh just 20.4 pounds.

Like the frame, the 5000's state-of-the-art components contribute to its phenomenal ride. The 5000-series road bike comes in three models: the 5000 with Shimano 105SC drivetrain, the 5200 with Shimano Ultegra drivetrain and the 5500, which is a kit-option bike. Prices range from \$1900 to \$3300. Contact Trek USA, 801 W. Madison St., Waterloo, WI 53594; (800) 369-8735.

The century training schedule began by adding long-distance weekend runs to regular workouts. While Gillespie and I were in fairly good bike-riding shape, we had rarely made

runs longer than 20 miles. So that was our first goal. The plan was to increase the distance by 5 miles each week.

Despite several setbacks due to weather and work-related conflicts, we stuck closely to the schedule. We zoomed up to the 40-mile mark with minimal fatigue, but things began to change after the 45-miler. Serious effort and a post-ride recovery were required from that point on. Our final long-distance run was 65 miles.

At 7:30 one August weekend morning, Gillespie and I met at the agreed-upon starting point and began pedaling. At the 65-mile mark, we stopped for lunch, and felt pretty good about our 14-mph pace. We were shooting for 15 mph, but got ambushed on a mostly uphill 8-mile dirt road that was marked as paved on a county map.

The final third was the hilliest portion of the route, and the pace dropped another notch. The crunch came at the 85-mile mark. After nearly 7 hours in the saddle and just 15 miles to go, mind and body fatigue became a major factor. At that point, every activity—pedaling, shifting, popping out of the clipless pedals, even reading the map—required significant willpower.

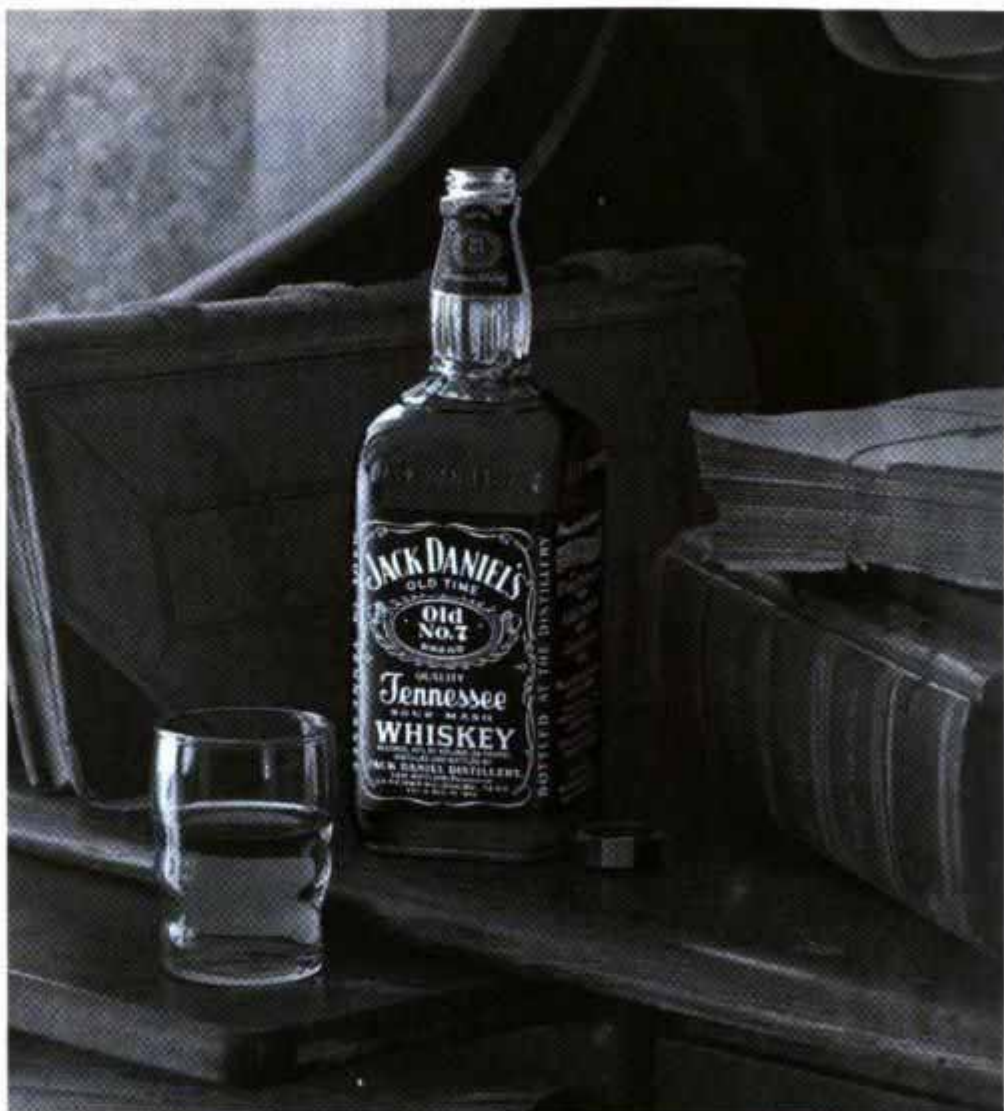
We broke the 100-mile mark on a steep downhill run while traveling at about 35 mph, and risked crashing by throwing our arms up like Greg LeMond winning the Tour de France. In the end, we rode a total of 102 miles in 8 hours, for an average of just under 13 mph. Counting all the breaks, it was a draining 10-hour day.

Clearly, riding a century is a singular achievement, even at our pace. And while Gillespie and I needed a day for our muscles to recover, we bounced back quickly and suffered no lasting ill effects. Surprisingly, we're even still friends.

I attribute the successful completion of the century to three factors: strong commitment, solid training and the cutting-edge Trek 5000 bike. Riding the 5000 throughout the summer, I came to truly appreciate its strength, power and speed. I loved many things about the bike, such as the Shimano STI Dual Control Shifters (brakes and gear shifters integrated into one unit) and the Shimano SPD clipless pedals. But I came away most impressed by the OCLV frame. If there's a better frame available, even disregarding weight, I haven't seen it.

While I have no plans to give up my mountain bike, I'm now a devoted fan of long-distance riding. One day I'm happily pounding trails on my fat-tire 2-wheeler. And the next I'm blowing away slackers on my razor-thin lightning bolt. Ah, the best of both worlds.

PM



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The Big Bopper

BY GREGORY T. POPE, Science/Technology Editor

● Who are Alan Hale and Tom Bopp? Just two guys who like to cruise out to the desert in the middle of the night and look at the stars. Hale ranks as an amateur astronomer turned pro—he founded the Southwest Institute for Space Research. Bopp works for a construction-materials company outside Phoenix. The two of them have been watching the skies for more than 25 years, but they have never met.

Yet, as chance would have it, both had telescopes trained on the constellation Sagittarius last July 23. Both noticed a fuzz of light that didn't belong there. Both notified the authorities. And 12 hours later, the International Astronomical Union stamped their names on a newly discovered comet—the most distant comet ever found by amateurs—that might just turn out to be the comet of a lifetime.

Yes, here we go again. A huge cosmic snowball appears seemingly out of nowhere and throws astronomers into a tizzy. The Internet is smoking with amateur observation reports, professional circulars, e-mailed commentary, even animations outlining Comet Hale-Bopp's passage through the heavens. Every day seems to bring a fresh portrait of astronomy's new dar-

ling, such as the false-color infrared astrophotograph above, courtesy of the European Southern Observatory in La Silla, Chile.

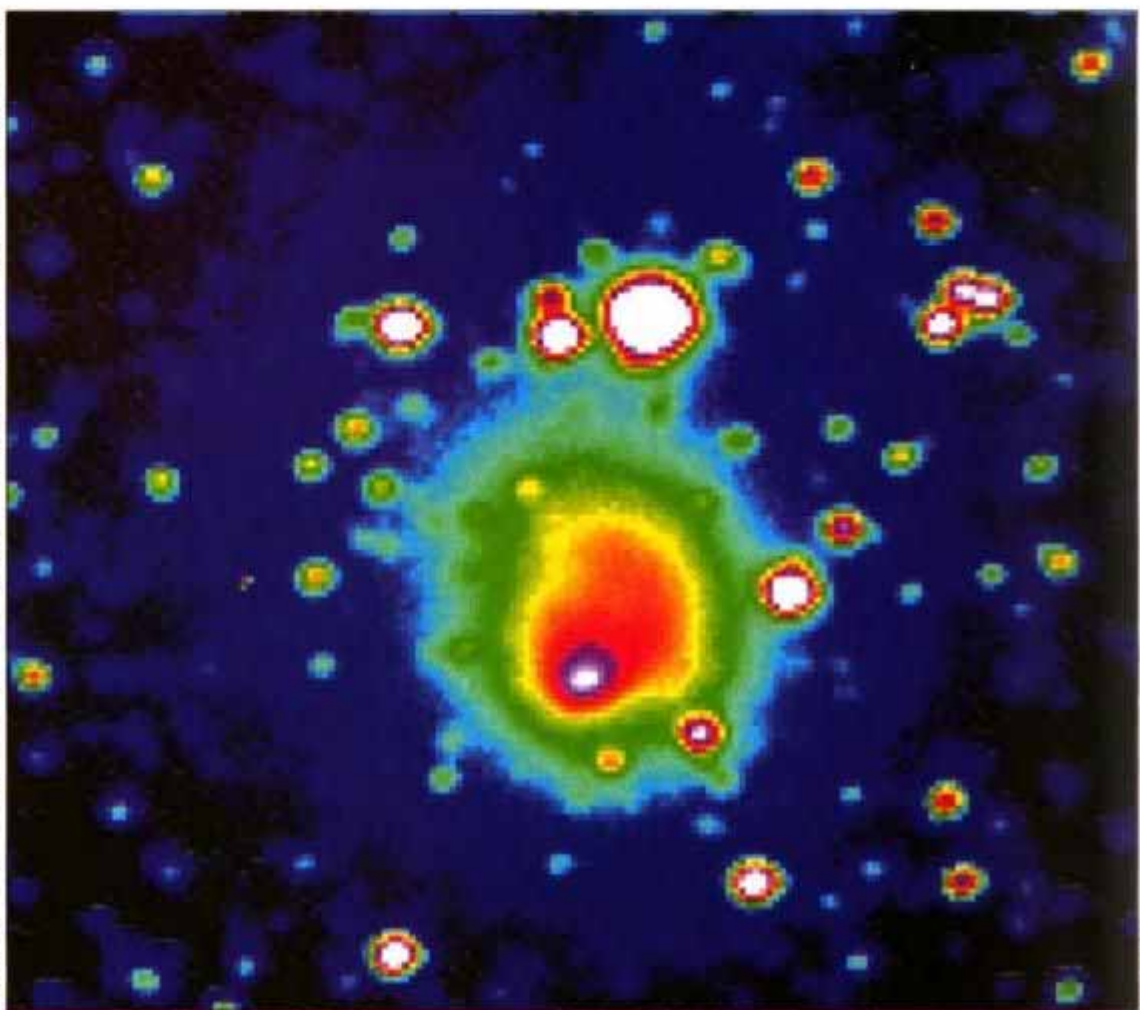
Comet nuts have barely caught their breath since Shoemaker-Levy 9's rendezvous with Jupiter (see "The Year Of The Comet," page 40, Dec. '94). Now they are slaving in anticipation of the greatest sky show since 1811.

1811? That was the year a dramatic comet—its tail as long as the distance from the Earth to the Sun—heralded Napoleon's downfall. So Hale-Bopp is getting some kind of advance work. Showtime: March and April 1997.

Shades of Comet Kohoutek, the much-hyped 1973 dud? Well, astronomers aren't back-pedaling quite yet. Kohoutek was a flash in the pan, the flash taking place when the comet was still back in Jupiter's neighborhood. Kohoutek blew its top early, probably when a chunk of its nucleus vaporized, temporarily boosting its brightness. Hale-Bopp, on the other hand, looks as though it has some staying power.

For one thing, an Australian astronomer was rifling through some 2-year-old photographic plates when he noticed a fuzzy blur right where Hale-Bopp should have been in 1993. If Hale-Bopp was that bright that long ago, it's not likely to be bamboozling

(Please turn to page 47)



Hale-Bopp's Approach



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us with temporary outbursts, reasons Brian Marsden of the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

Tracking from its 1993 location, astronomers have confirmed Hale-Bopp's trajectory—and concluded that the comet isn't a newcomer to the solar system. It's got a definite orbit, with a period of 3000 years, swinging it 10 times farther out than Pluto.

The fact that Hale-Bopp has been around the block a few times also raises hope that it will put on a show for us. Why? Because it's already burned off the flashy clothing that teases observers from afar. Objects (like Kohoutek) that have just recently blundered out of the Oort Cloud—the ring of comets that lies beyond Pluto's orbit—come laden with volatile compounds. These chemical trappings don't need much energy from the Sun to vaporize, so they tend to flare up while the comet is still distant. A comet that's a return visitor typically lacks these compounds.

To stay bright as it nears the Sun—and Earthbound viewers—a comet has to bring a good head of steam. In other words, it must pack plenty of water ice, which turns to vapor as sunlight bombards it. Escaping steam carries cometary dust with it, and it's the dust that twinkles in sun-

light and is blown into a brilliant tail. How steamy Hale-Bopp actually is remains to be seen. Astronomers admit that they still don't know that much about Hale-Bopp. Based on its brightness, it could be 100 miles across—10 times the size of Halley's comet. But dust and gas cloak the comet's nucleus, so no one's sure. Hale-Bopp's composition? Data, at least at press time, remain inconclusive, although observatories have taken several spectrographic observations. Whatever is causing the comet to shine so far from the Sun, it's not the ventilation of cyanic acid or carbon monoxide, the gases usually involved.

All these unknowns translate into a wide range of predictions for Hale-Bopp's glitz. At worst—that is, if it doesn't pull a Kohoutek and fizzle—the comet will resemble the North Star (a sky object that never seems as bright as it should be, given its fame). Several forecasts put Hale-Bopp in the same ballpark as Vega, summer's showiest star. The rosier scenario has Hale-Bopp waxing more brightly than Jupiter. In that case, we're talking about a comet easily visible with the naked eye from light-polluted midtown Manhattan.

What is known about Hale-Bopp is the route it will trace through the solar system. Like the great comet of 1811,

Hale-Bopp is coming at us from below. As you read this, the comet is crossing the ecliptic—the plane in which the planets lie. Over the next year and a half, Hale-Bopp will vault over this plane, diving back through it in May 1997. The closest it will get to the Sun: 85 million miles. The closest it will get to Earth: 120 million miles—and its trajectory won't intersect Earth's orbit. Lucifer's Hammer it's not.

The comet's path spells great news for observers in the Northern Hemisphere. Right now, you'd have to stand in the lower latitudes to see Hale-Bopp, but because the comet is still loitering in Sagittarius, the Sun is washing it out. By this spring, it will return to the northern morning sky, visible with a pair of binoculars. By summer, the naked eye will discern Hale-Bopp. As winter approaches, the Sun again will obscure it. But next spring—as the comet's brightness peaks—it will blaze in the evening sky, the Moon conveniently out of the picture. If you're at latitude 45° or above, Hale-Bopp will stay up all night long. The constellation Andromeda will be its home.

So for once this isn't one of those astronomical events that requires a trip to Siberia or Hawaii to observe. This is going to be *our* comet. Let's hope it lives up to our expectations. **FM**

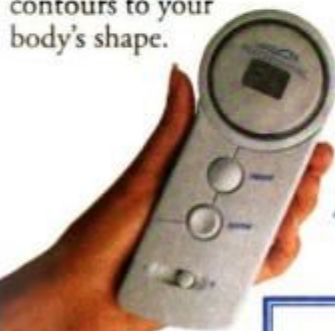
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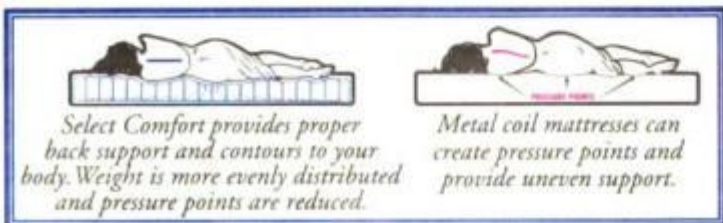
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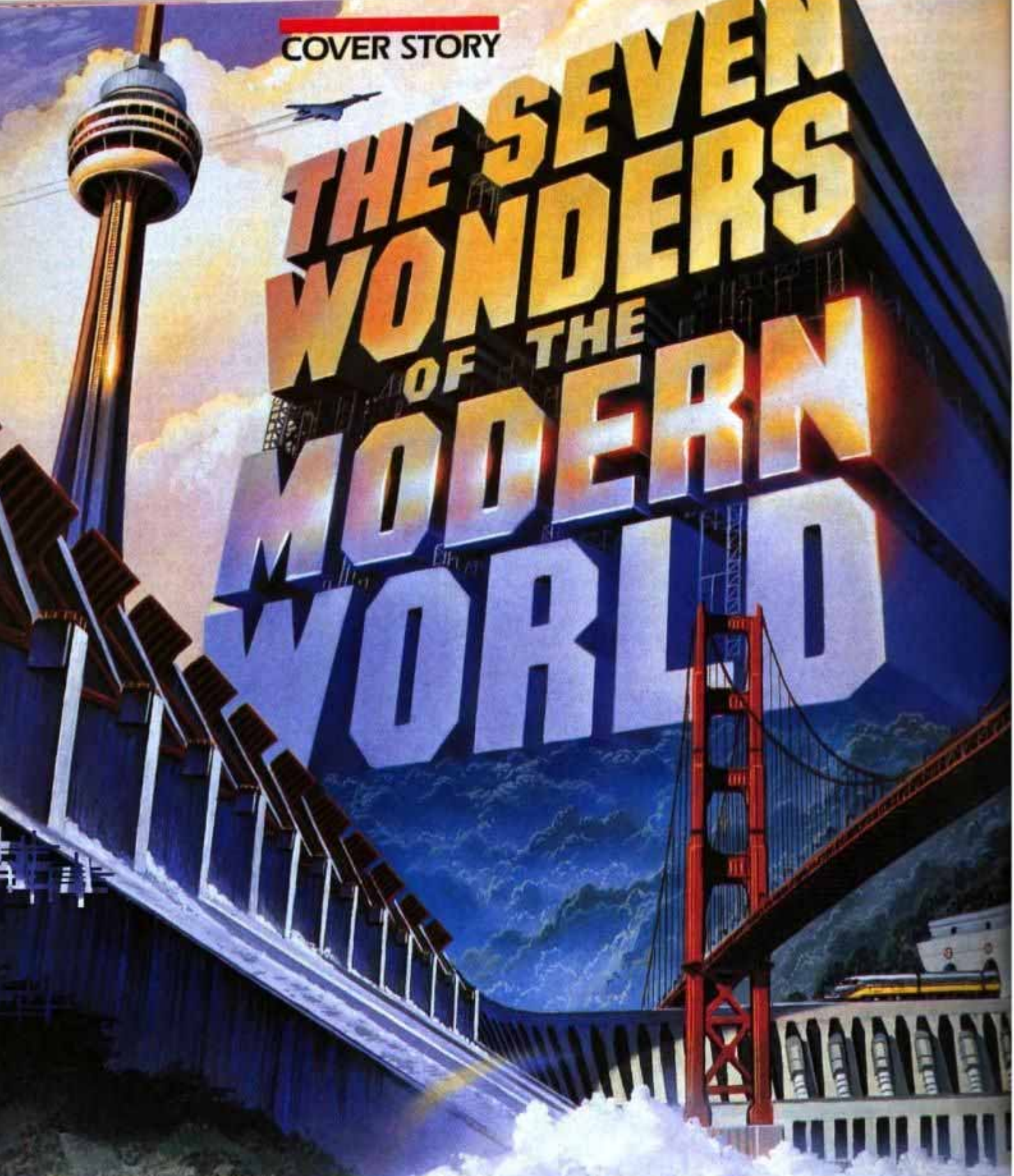
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THE SEVEN WONDERS OF THE MODERN WORLD

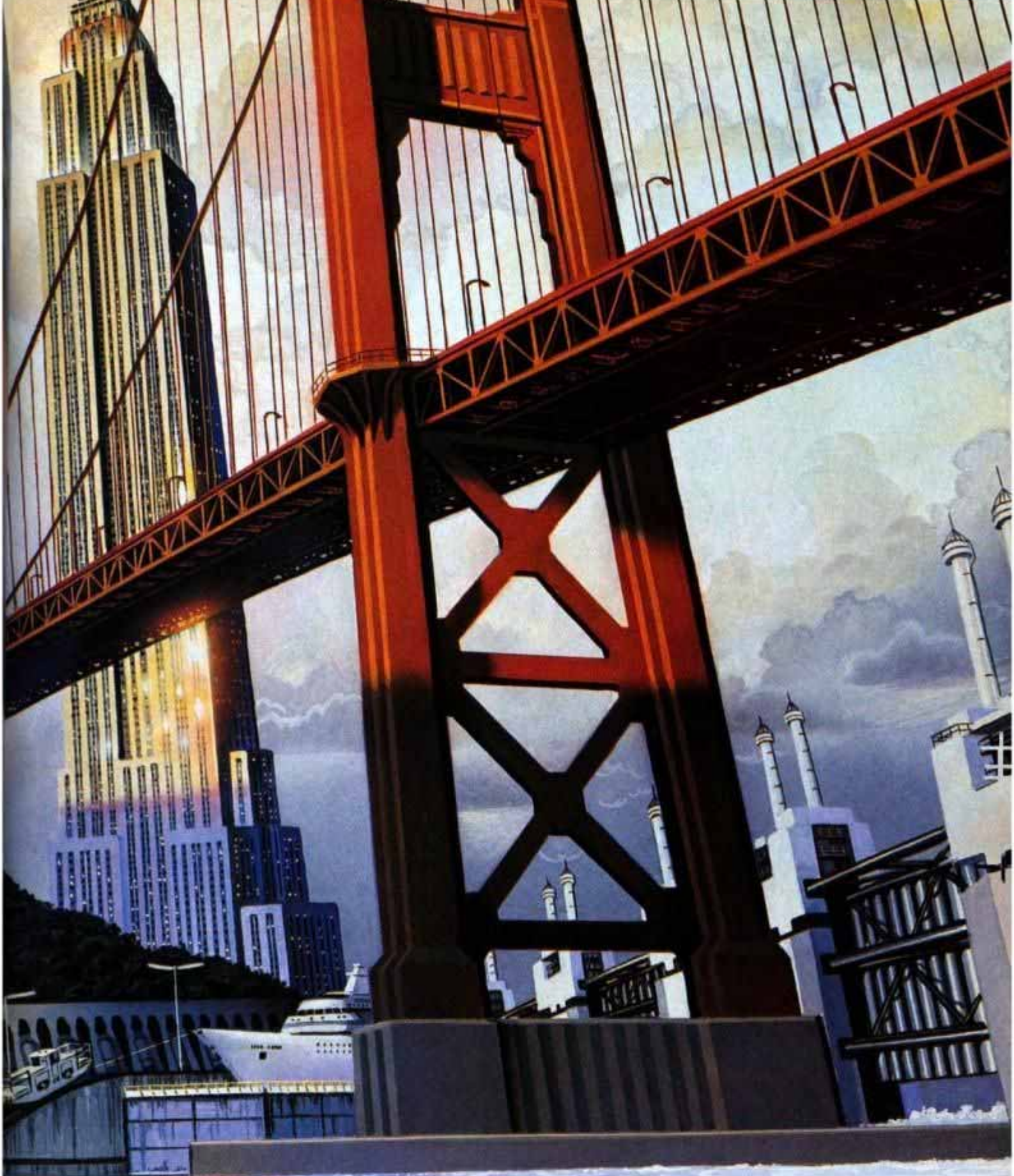
Celebrating the 20th century's greatest civil-engineering achievements.

BY GREGORY T. POPE, Science/Technology Editor
PM Illustrations by Alan Gutierrez and John Berkey

● Only five years separate this day from the dawn of a new millennium. Our prize for making it through the 20th century? The richest engineering legacy that mankind has ever received. With few exceptions, the monumental structures that mark the modern world

are products of the past hundred years.

When the Greek historian Antipater listed the Seven Wonders of the Ancient World in 240 B.C., he had but a handful of wonders to choose from (and he still drew arguments from his contemporaries). His picks: the Pyramids of Egypt, the Hanging Gardens of Babylon, the Temple of Artemis at Ephesus, Phidias's statue of Zeus, the Mausoleum, the Colossus



of Rhodes and the Pharos at Alexandria.

But today we have hundreds of engineering masterpieces on seven continents. Fortunately, we also have the American Society of Civil Engineers, which regularly honors landmark structures. The ASCE was delighted to lend its judgment, and this month joins with **POPULAR MECHANICS** in presenting these works.

How did we select the seven? The ASCE began by canvassing engineering societies across the globe. Nominations flew in from scores of nations. We then assem-

bled an international panel of distinguished advisors to winnow the proposals. What advances, engineering challenges and long-term significance did each project represent? Debates ran long and lively among our experts.

What emerged, finally, were the great works that appear on the following pages—the Seven Wonders of the Modern World. They stand as testament to the brains and brawn of the 20th century, and the spirit that lifts the human race to its highest destiny: conquest of the impossible.

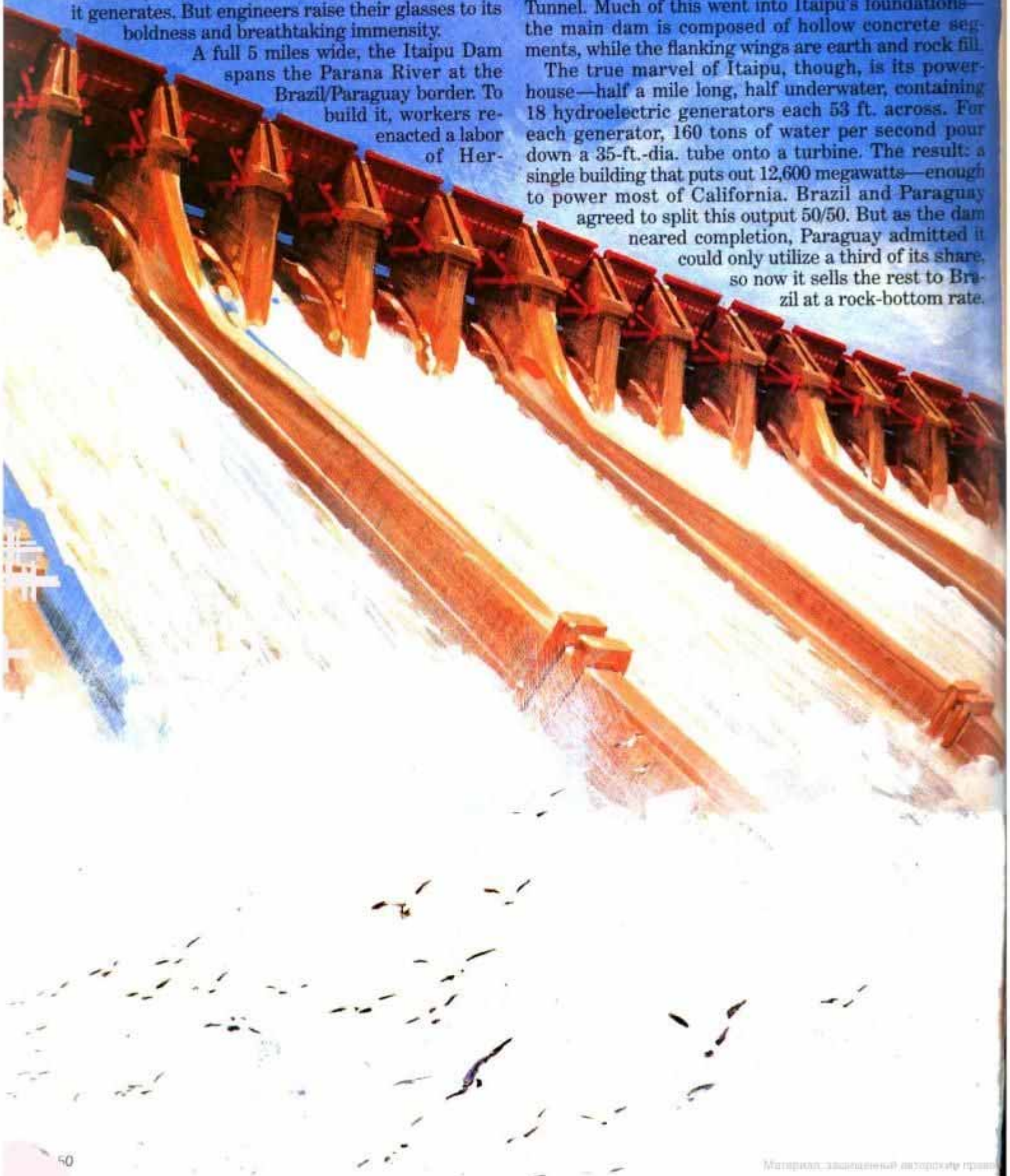
Itaipu Dam

Boon or boondoggle? The jury's still out on the Itaipu Dam, the world's biggest hydroelectric plant. Economists raise their eyebrows at its staggering cost—more than \$18 billion—and the surfeit of power that it generates. But engineers raise their glasses to its boldness and breathtaking immensity.

A full 5 miles wide, the Itaipu Dam spans the Parana River at the Brazil/Paraguay border. To build it, workers re-enacted a labor of Her-

cules: They shifted the course of the seventh biggest river in the world, removing 50 million tons of earth and rock to dig a 1.3-mile bypass. Then came the concrete—15 times as much as was used to build the Channel Tunnel. Much of this went into Itaipu's foundations—the main dam is composed of hollow concrete segments, while the flanking wings are earth and rock fill.

The true marvel of Itaipu, though, is its powerhouse—half a mile long, half underwater, containing 18 hydroelectric generators each 53 ft. across. For each generator, 160 tons of water per second pour down a 35-ft.-dia. tube onto a turbine. The result: a single building that puts out 12,600 megawatts—enough to power most of California. Brazil and Paraguay agreed to split this output 50/50. But as the dam neared completion, Paraguay admitted it could only utilize a third of its share, so now it sells the rest to Brazil at a rock-bottom rate.





The Panama Canal

"Gamboa's busted!" cried a gleeful President Woodrow Wilson as he pressed a telegraph key, detonating 40 tons of dynamite to shatter the Gamboa Dike—the fill barrier between two oceans. Water thundered into the "Ditch"—the celebrated Gaillard Cut, an 8-mile channel carved through the Continental Divide.

The severing of North and South America still ranks as one of man's great victories over geography. The French tried it in the 1880s, but sank the project into morass by 1898. With the signing of the Spooner Act in 1902, American engineers took over.

Under the direction of Col. George Washington Goethals, 42,000 men dredged, blasted and excavated from Colón to Balboa. They moved enough earth and rubble to bury the island of Manhattan to a depth of 100 ft.—or to open a 16-ft.-wide tunnel to the center of the Earth. They finished on time and within budget.

Challenges abounded. How to tame the flood waters

of Chagres River, known to jump 25 ft. in a day during monsoon season? Solution: a dam that formed the world's then-biggest man-made lake. How to check the scourges of yellow fever and malaria? Solution: an unprecedented public-health war against the mosquito, in which workers drained swamps, screened living quarters and raised sanitation standards above those of most American cities. To say the Panama Canal was built by doctors is little exaggeration.

Today the Canal operates much as it did in 1914. From the Caribbean Sea, a ship steams through a 7-mile dredged channel, then is towed into the 1000-ft.-long Gatun Locks. Raised 85 ft., it then crosses Gatun Lake and the Gaillard Cut. The Pedro Miquel Locks drop the ship 31 ft.; the Miraflores Locks let it down another 54 ft. Gravity, not machinery, feeds water into the locks. In each transit, 52 million gallons of fresh water is lost, though it is quickly replaced by Panama's heavy rainfall.

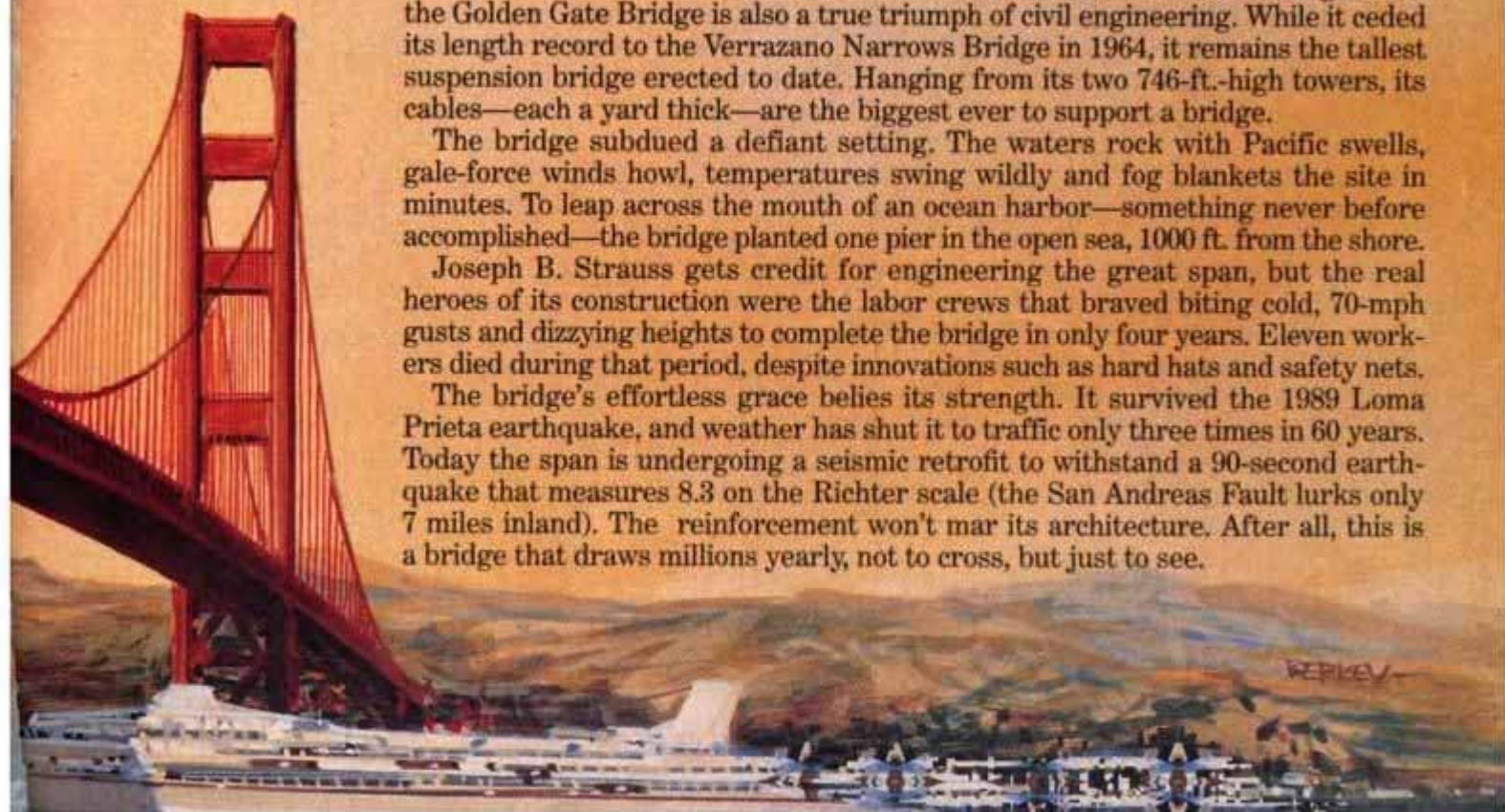
The Golden Gate Bridge

Call it the most beautiful structure man has ever made, and who could argue? Yet the Golden Gate Bridge is also a true triumph of civil engineering. While it ceded its length record to the Verrazano Narrows Bridge in 1964, it remains the tallest suspension bridge erected to date. Hanging from its two 746-ft.-high towers, its cables—each a yard thick—are the biggest ever to support a bridge.

The bridge subdued a defiant setting. The waters rock with Pacific swells, gale-force winds howl, temperatures swing wildly and fog blankets the site in minutes. To leap across the mouth of an ocean harbor—something never before accomplished—the bridge planted one pier in the open sea, 1000 ft. from the shore.

Joseph B. Strauss gets credit for engineering the great span, but the real heroes of its construction were the labor crews that braved biting cold, 70-mph gusts and dizzying heights to complete the bridge in only four years. Eleven workers died during that period, despite innovations such as hard hats and safety nets.

The bridge's effortless grace belies its strength. It survived the 1989 Loma Prieta earthquake, and weather has shut it to traffic only three times in 60 years. Today the span is undergoing a seismic retrofit to withstand a 90-second earthquake that measures 8.3 on the Richter scale (the San Andreas Fault lurks only 7 miles inland). The reinforcement won't mar its architecture. After all, this is a bridge that draws millions yearly, not to cross, but just to see.



Channel Tunnel

It cost nearly twice as much as anticipated and ran more than a year behind schedule. But you won't hear a civil engineer speak an uncivil word about the Channel Tunnel. Like the Panama Canal, the 31-mile link between France and England fulfilled a centuries-old dream. It's more than just a tunnel—it rolls infrastructure and immense machinery into a transportation system of unprecedented ambition.

Three concrete tubes, their walls 5 ft. thick, plunge into the earth at Coquelles, France. Burrowing through the chalky basement of the English Channel, they reemerge at Folkestone, behind the white cliffs of Dover. Through two of them rush the broadest trains ever built—double-decker behemoths 14 ft. across—traveling close to 100 mph. The passengers board not on foot but in automobiles and buses. Trucks laden with freight also ride. Maintenance and emergency

vehicles ply the third tunnel, between the rail tubes.

Meanwhile, machines are always at work, turning the Channel Tunnel into a living, intelligent structure. Huge pistons open and close ducts, relieving the pressure that builds ahead of the trains' noses. Cold-water piping, 300 miles of it in total, snakes alongside the tracks to drain off the heat raised by air friction. Fresh air is breathed into the service tunnel. Pumps siphon away water from rain or condensation. Twice, 100-ton tracks race through great man-made caverns where emergency crossover switches are located. And fiber-optic cables make up the Tunnel's nervous system, relaying signals from controllers to engineers.

The newest of our Seven Wonders, the Channel Tunnel caused no dissent among nominators. Not only does it join two nations, but it links civil, mechanical and electrical engineering in one masterwork.





Netherlands North Sea Protection Works

The war has raged for centuries. The proud waters of the North Sea consider the Netherlands their own and from time to time mount assaults on this subsea-level territory. Just as proud, the people of the Netherlands have repeatedly pushed back the sea—only to watch merciless storm surges flood their efforts.

By the 20th century, the Dutch decided that to win this unequal struggle they must reshape the battlefield. In two monumental steps, they have smoothed hundreds of miles off their ragged coastline.

Step one: a 19-mile-long enclosure dam. Built between 1927 and 1932, this immense dike—100 yd. thick at the waterline—now collars the neck of the estuary once known as the Zuiderzee. Engineers fielded 500 hopper barges, floating cranes and dredges to deposit two parallel clay dams. Pumps then filled the gap with sand. Once finished, the wall turned a wild inland sea

into a tame freshwater lake, its level controlled by 25 discharge sluices. An unprecedented land reclamation project ensued, baring half a million fertile acres.

Step two: The Delta Project. After a 1953 flood claimed more than 1800 lives, engineers turned their attention to southwest Holland, where the mouths of the Meuse and Rhine rivers break into a complex, treacherous delta. Dams, dikes, canals and sluices have now put man in control of the landscape.

The crowning touch was the Eastern Schelde Barrier. Here, tidal waters flow unimpeded below a series of steel gates slung between massive concrete piers. The gates fall only when storm-level waters threaten. The 2-mile barrier was constructed on land. Then, an armada of purpose-built vessels re-engineered the seabed, floated the 10,000-ton piers into place and installed the gates and their hydraulic machinery.





Empire State Building

True, the World Trade Center and the Sears Tower snatched its crown away. But what building could ever steal its majesty? Think "skyscraper"—the defining architecture of our century—and the Empire State Building still rules the definition.

Its construction culminated a dizzying race into the sky. In the 1920s, skyscrapers already pierced urban airspace across the nation—to drape masonry on a load-bearing skeleton was no longer an engineering novelty. But the limits of construction—and of developers' egos—had yet to be reached. Only the Great Depression halted the race, leaving the 1248-ft.-high Empire State Building to tower unchallenged for 40 years.

More astounding than the building's height was the breakneck speed at which it shot into the skyline. Work began a day after the stock market crash of 1929. It ended a year and 45 days later, without a dime of overtime paid out. Deliveries of steel and stone at the Fifth Avenue site took place with the efficiency of a military exercise. Ironworkers set a torrid pace, riveting the 58,000-ton frame together in 23 weeks. Working just below them, a small army of masons finished the exterior in eight months, while plumbers laid 51 miles of pipe and electricians installed 17 million ft. of telephone wire. The precise choreography of the operation revolutionized construction. **PM**

7 Wonders Of The Future

● Pick them a quarter of a century from now, and the slate of candidates will look very different. And while the funds that fueled this century's great works flowed mainly from the United States and Europe, Asia is leading the charge into the new millennium. Here are seven projects that qualify if we do this again in 2020.

The **Airport Core Programme** represents a vast facelift for Hong Kong's geography. Two years from completion, the enterprise has turned the hilly, 745-acre island of Chek Lap Kok into a 3000-acre flattop. Enough earth has been moved to fill 500 Astrodomes.

In 1998, Japan will boast the world's longest suspension span—the **Akashi-Kaikyo Bridge**, linking the city of Kobe with Awaji Island in Osaka Bay. At 6528 ft., its main span will leapfrog the current record holder, England's 4626-ft. Humber Estuary Bridge.

Nearby, **Kansai International Airport**—partly operational already—lies on a vast artificial island planted a full 3 miles from the shore. More than 200 million cu. yd. of earth went into its construction.

Meanwhile, the world's tallest building will soon grace Kuala Lumpur. The **Petronas Twin Towers**, 1476 ft. high, will top out next month. (Melbourne, Australia, may one-up the Malaysian capital, however, with its proposed 1640-ft. Grollo Tower.)

China has begun work on a project worthy of the Great Wall—the **Three Gorges Dam** on the Yangtze River. This behemoth—already termed the last giant dam ever to be built—will crank out 18,000 megawatts of power, outmuscling Itaipu by 50%.

The kings of Spain and Morocco have given up their grand plan to bridge two continents. Instead, a 26-mile **Afro Tunnel** will cross the Mediterranean Sea a quarter of a mile below the Straits of Gibraltar.

And in the North Sea, a 1541-ft.-high concrete rig now stands in 1000 ft. of water. Soon to be the **Troll Gas Field** platform, it was towed 174 miles to its site. Inside: enough reinforcing steel to build 15 Eiffel Towers.



DOUBLE YOUR BITS

Picture quality is twice as good with the new digital camcorders.

BY GEORGE MANNES

• Home video-making is finally leaping into the digital age—a jump that means picture quality is now twice that of the VHS videotapes that currently dominate the market. Leading the way are new digital camcorders from Panasonic and Sony. Because these new camcorders record images using a precise stream of digital bits—the computer language of zeros and ones—the implications go well beyond better baby videos.

What's unequivocally impressive about DV (for digital video) is the sharpness of its picture. On a standard

scale used to measure video clarity, a VHS recording is rated as having 240 lines of horizontal resolution. Television that arrives in homes via broadcast or cable has a maximum of 330 lines. And high-resolution home camcorders in the Super VHS and Hi-8 formats boast between 400 and 425 lines of resolution, provided they are connected to a good-quality television using separate audio and video inputs, not a single-line radio frequency (RF) connection that combines the audio and video into one signal.

DOUBLE YOUR BITS

The new DV camcorders, however, record a picture with 500 lines of resolution. At a press conference to introduce Sony's two new camcorders, company executives displayed a split-screen television picture showing a closeup of a bouquet of flowers—a live shot on one side and a recording on the other. To paraphrase a classic audiotape commercial, reporters couldn't guess which was live and which was taped.

And the high-quality pictures that DV camcorders record aren't diminished when you make a copy of the tape—or a copy of a copy of a copy. In contrast with analog home video recordings, which get smeary, bleached-out and noisy when transferred from one tape to another, digitally produced copies are next to perfect—no matter how many generations away from the original.

The DV format has excellent audio quality, as well. Giving it an edge over VHS Hi-Fi sound, DV allows for 16-bit digital stereo recording, just like a compact disc. And the DV format is flexible, too. Making a slight sacrifice in sound quality, DV users can record two pairs of stereo soundtracks for the same footage: an audio track recorded at the time of taping, for example, and a music or narrative track added subsequently. No mixing is necessary—the two sets of stereo tracks exist side by side. Even better, these soundtracks can be added or erased without disturbing the video track, and video can be dubbed without erasing the audio.

Unfortunately, it may be difficult for early adopters to take advantage of these aspects of the format. On the bright side, the Panasonic camcorder has a microphone input that lets users dub a second audio track onto a tape that's been previously recorded in the dual 12-bit stereo mode. But Panasonic's camcorder has no other video or audio inputs. And it doesn't have any digital outputs, either, for keeping the signal in the digital domain during the editing process.

Sony's two new camcorders have no analog audio input other than the microphone jack, which can't be used for subsequent audio dubbing. The camcorders have no analog video input. And they don't offer 16-bit stereo recording. They do have a special digital port for input and output of audio, video and other data. But there's nothing yet to connect them to—other than another Sony camcorder. Eventually, this digital port could be used to connect to a digital-editing VCR. Or it could be connected to a computer to supply high-quality stills or moving video for multimedia creations. But for now, the DV format seems



SONY DCR-VX700

best suited for shooting video, not editing it. Users can play back their high-quality tapes in a DV camcorder and watch them directly on a television or copy them to another tape format, such as VHS or 8mm. But home users shouldn't expect to have a digital-editing studio anytime soon.

Even without this new digital recording, these camcorders would qualify as high-end models. For example, just like pro video cameras, Sony's DCR-VX1000 uses three silicon chips to convert an image entering the lens into electrical signals. One chip handles the luminance signal, while the other two divide the data-intensive chrominance signal between them. It has a high-resolution color viewfinder, an image stabilizer that takes the shakes out of handheld shots and a 10:1 zoom lens (20:1 with digital zoom). It permits dissolves from a still picture at the end of one shot to a moving picture starting the next.

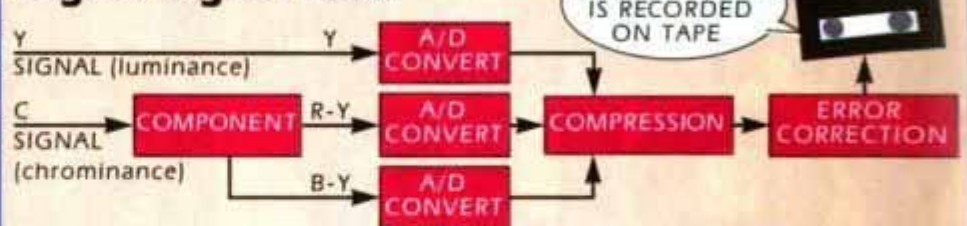
Priced at \$4199, the DCR-VX1000 is expensive. Sony's other new digital camcorder, the DCR-VX700 (\$2999),

shares the higher-priced model's viewfinder, zoom-lens ratio and image stabilization, but uses only one chip behind the lens to pick up recorded images. It also has neat effects for making the transition from one shot to the next, such as one that slides the whole first picture off the side of the screen to reveal a second picture below it.

Panasonic's PV-DV1000, expected to be priced between \$3500 and \$4000, is a camcorder that doesn't look much like Sony's DCR-VX1000 but shares many of its features. It has three chips, a high-resolution color viewfinder, a 10:1 zoom that extends to 20:1 digitally and an image stabilizer. And, as with the other models, it can record digital stills: images that freeze for 6 or 7 seconds on-screen while audio continues to be recorded underneath.

These three camcorders are only the first wave of DV-based devices to hit the market. In April 1994, Sony, Panasonic and more than 50 other companies agreed on this standard-definition DV tape format, along with a separate high-definition version for

Digital Signal Path



C signal is divided into R-Y signal and B-Y signal for easier processing.

Features Of Component Signal

- More color signal data can be handled, so color blur is minimized.
- Adaptable for future systems such as HD (high definition).

Signal Flow Of Analog Video



C signal is recorded after the frequency conversion.

even sharper recorded pictures.

The standard-definition version employed by the new camcorders starts with the 162 megabits of information per second (about 20MB) that it takes to digitally duplicate a regular television signal without compression. Thirty-five megabits of information that correspond to nonvisible picture information are discarded, leaving 127 megabits. The remaining information is compressed at a 5:1 ratio, so that a stream of 25 megabits (about 3MB) per second is recorded to capture moving video.

The tape cassette on which the new camcorders record is about $2\frac{5}{8} \times 1\frac{7}{8} \times \frac{1}{2}$ in.—not much bigger than a Zippo lighter—but it holds a staggering amount of information. A one-hour tape—the longest recording time now available—holds 11GB of data. As with other video formats, DV signals are recorded on a tape in diagonal tracks with a moving head, not in linear tracks with a stationary head, as in audio-cassette recording. The width of each recorded track is extremely narrow in the DV format: 10 microns, or ten-one-thousandths of a millimeter. Ten tracks could fit in the width of a human hair.

Fitting onto the tape along with audio and video data is other information about the picture. The DV format automatically records a time code, an absolute numeric address for each frame of video that's useful in searching for footage and editing it. In contrast, real-time counters on home VCRs are relative address systems that are helpful only when one has re-wound the tape and reset the time counter to zero. An extended data section can be used to record any information a manufacturer chooses to specify. Sony's camcorders, for example, automatically record exposure information, such as shutter speed and iris setting, along with the date and time of the recording. That way, users will always be able to find a record of when they shot some particular footage—without having to record an on-screen date/time label.

An optional feature of DV cassettes is a 4K memory chip. On Sony's camcorders, this generates a rudimentary table of contents displaying a list of dates on which footage in that particular cassette was shot, or a numbered list of the still photos on the tape. Between the expense of the memory chip and the evaporated-metal tape employed in the DV format, Sony's cassettes will be relatively costly:



SONY DCR-VX1000

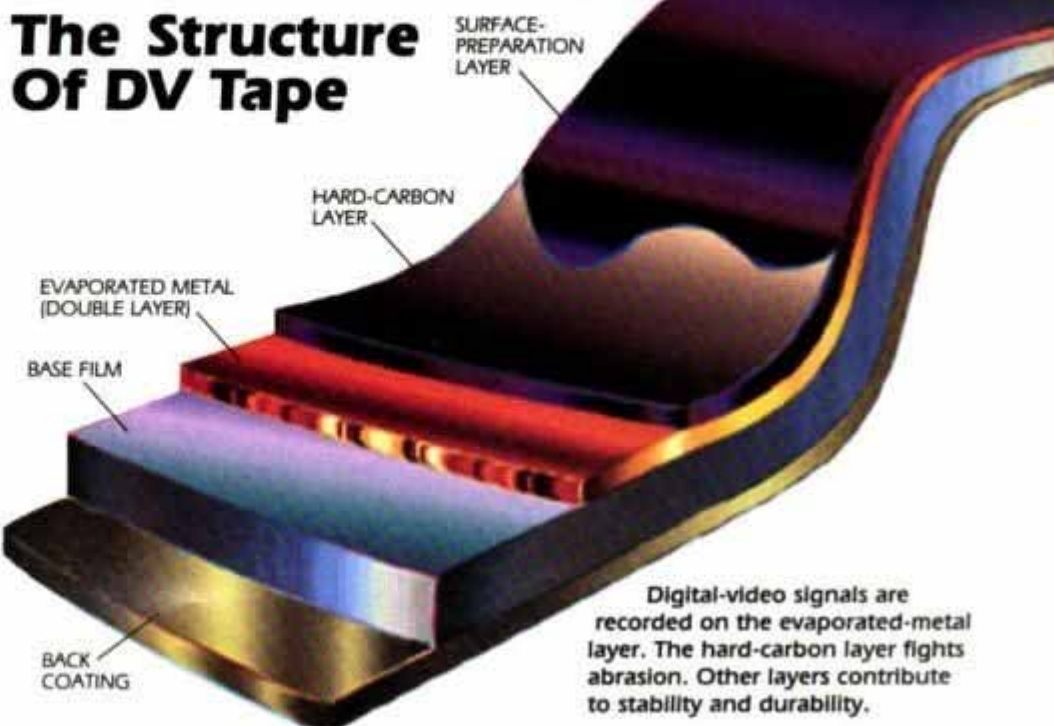
\$24.95 list for a 60-minute tape and \$19.95 for a 30-minute tape. Panasonic's tapes won't have the memory chip, and its camcorder won't read or write from them, so the prices on those tapes are expected to be lower.

The tapes on which the Sony and Panasonic camcorders record are actually "Mini DV" tapes—a subset of the DV standard. Officially defined, but not yet on the market, are larger-

cassette DV tapes that have a higher capacity of $4\frac{1}{2}$ hours. These tapes are designed for home DV-standard VCRs. The problem, though, is that neither Sony nor Panasonic has firm plans to start selling such a VCR. According to Sony, the holdup is that a copy-protection system for the DV format has yet to be developed. Companies like Sony (which owns the Hollywood major Columbia) and Panasonic parent Matsushita (which retains a stake in MCA) are obviously nervous about giving consumers quality that's too good. If a person could use a DV VCR to make a near-perfect digital copy of a movie out on video, what would prevent that person from making and selling a lot of perfect, illegal copies? Time will tell. **FM**



The Structure Of DV Tape



Digital-video signals are recorded on the evaporated-metal layer. The hard-carbon layer fights abrasion. Other layers contribute to stability and durability.

RECOVERY ROOM

The latest piece of sports gear is a rocket-shaped hyperbaric chamber that promises to heal athletic injuries faster.

BY REBECCA DAY



● No one appreciates a quick fix more than an athlete who's been injured. And that's exactly what this wild-looking chamber is promising—faster healing times to help put an athlete back on the playing field twice as soon as expected.

Developed by OxyMed Systems, in Vancouver, British Columbia, adjunct therapy with hyperbaric therapy units in the treatment of athletic injuries has received a lot of attention from sports clubs over the past year or so since the 1994 Stanley Cup hockey playoffs, when the Vancouver Canucks attributed speedy recovery times for typically slow-healing sports injuries—and even jet lag—to hyperbaric oxygen therapy.

An oxygen-boosting treatment, hyperbaric therapy is grounded in the medical principle that oxygen is critical to the healing of wounds and fractures. Since traumatic injuries cause tissue damage and swelling that can impair blood flow and oxygen delivery to an

injured area, and since inflammation produces cells with high oxygen requirements, the oxygen demand of injured tissue is at its highest when it is least available.

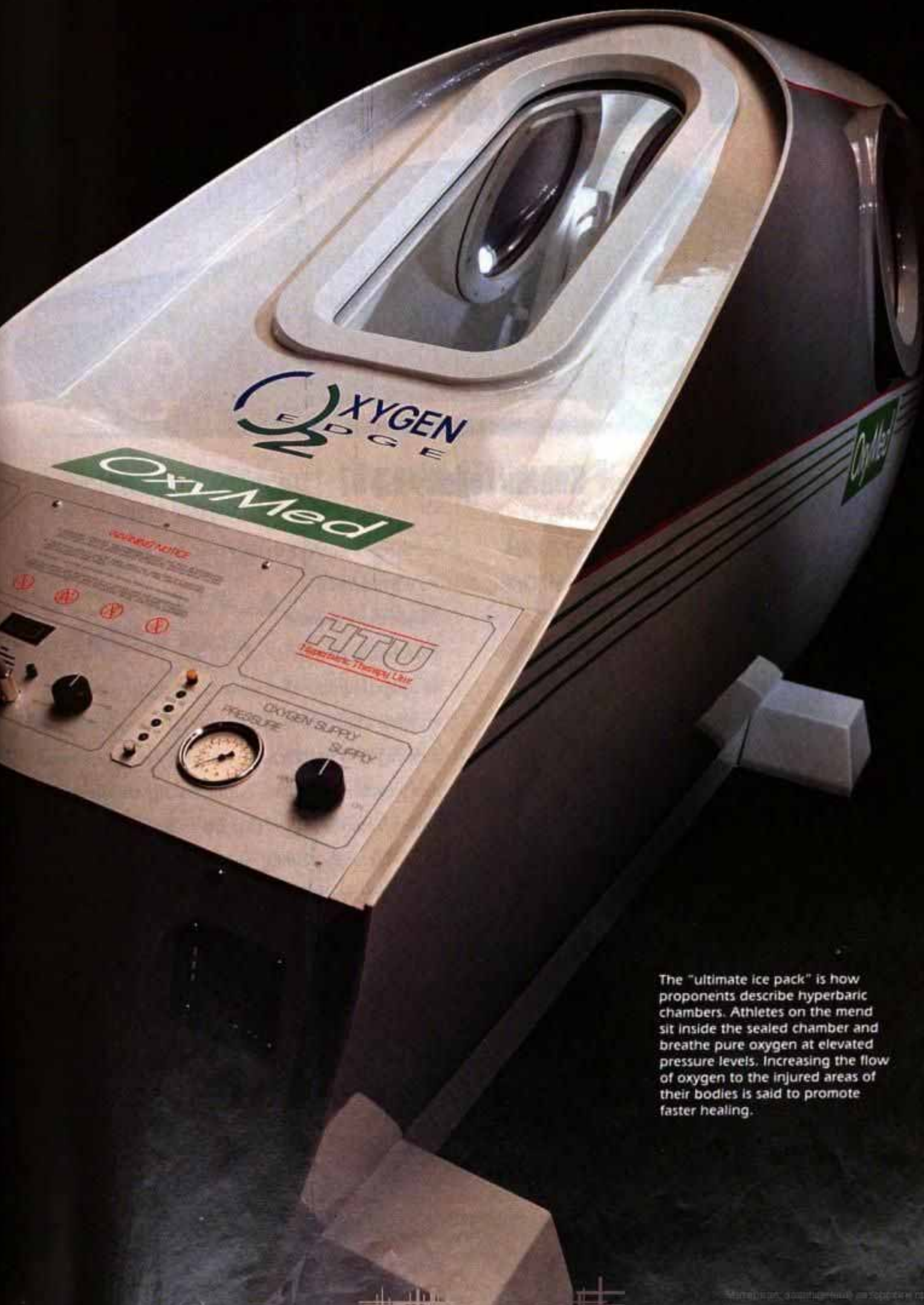
According to OxyMed, the only effective way to significantly increase the oxygen content of blood is to dissolve greater amounts in the plasma. That's where the hyperbaric chamber comes in. With the body at twice-normal atmospheric pressure during the therapy, the amount of oxygen dissolved in the plasma is boosted to 15 times its usual level so that more oxygen can be pumped into injured tissue for faster healing.

In addition, the elevated pressure of the oxygen reduces blood flow by as much as 20%, which decreases capillary blood pressure. There are still megalevels of oxygen in the blood because of the large amount dissolved in the plasma, but the reduced blood pressure reverses the tendency for fluid to accumulate in injured tissue. This helps circulation and impedes swelling. OxyMed calls the chamber the "ultimate ice pack" for its ability to reduce swelling while improving oxygenation, thereby accelerating the healing process.

Athletes receiving hyperbaric oxygen therapy sit in a sealed 54 × 32 × 89-in. enclosure that resembles the nose of a space capsule—portholes and all. They breathe pure oxygen through an F-16 pilot's mask while they're inside the pressurized chamber.

OxyMed says the effect is similar to what you feel during ascent and descent in an airplane. There's one difference: You don't have to discontinue operation of electronic devices at any point during the 60- to 90-minute ride. The capsule is outfitted with speakers that connect to an entertainment system, so athletes can kill time by watching television, studying game films, playing videogames or listening to music.

So far, teams like the NFL's New York Jets, and baseball's White Sox, Rangers and Expos are reporting mixed results. Apparently, the biggest problem is many athletes' claustrophobia. **FM**



OXYGEN
EDGE

OxyMed

WARNING NOTICE

HTU
Hyperbaric Therapy Unit

OXYGEN SUPPLY
PRESSURE

SUPPLY

The "ultimate ice pack" is how proponents describe hyperbaric chambers. Athletes on the mend sit inside the sealed chamber and breathe pure oxygen at elevated pressure levels. Increasing the flow of oxygen to the injured areas of their bodies is said to promote faster healing.

APPLES TO APPLES,



*The nerve of us. Pit the engineering ingenuity of the legendary Porsche 911 Carrera 4**

Subaru Legacy 2.5 GT

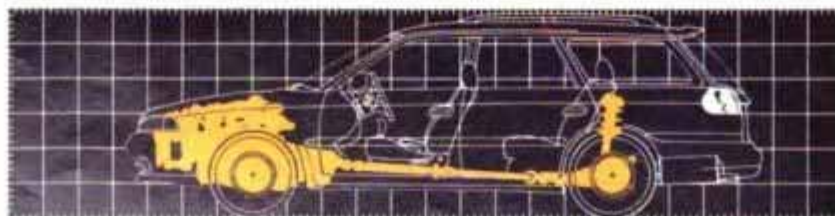
THE TRACTION CONNECTION:
ALL-WHEEL DRIVE.



against that of the new Subaru All-Wheel Drive Legacy® 2.5 GT? Preposterous! And yet — call us crazy — we see distinct similarities.

TWO BOXER ENGINES: HORIZONTALLY OPPOSED, YET SO MUCH ALIKE.

Ah, the boxer engine. A unique horizontally opposed configuration with a lower center of gravity that increases stability and reduces vibration for a smoother, more enjoyable ride. Naturally, Porsche's got one. Well — talk about similarities — so do we! (Eerie, huh?) Ours is a 2.5-liter, 16-valve, DOHC beauty. And though our 155 horses may not be quite as numerous as theirs (270 hp), the 2.5 GT's low-end 155 lb-ft torque delivers a highly responsive, high-performance engine. So responsive, we use a modified version to propel Subaru to victory in road rallies worldwide.



Sure, the Carrera 4 sticks to curves like bug splats on a windshield. Maybe that's because Porsche has seen fit to equip their top-of-the-line car with the superior traction and control of All-Wheel Drive — just like us! Subaru All-Wheel Drive continuously monitors road and weather conditions, automatically transferring power from the wheels that slip to the wheels that grip — actually helping you avoid accidents. Combine this with a horizontally opposed engine and optimally tuned suspension, and you have all the makings of the Subaru All-Wheel Driving System, a unique system that makes the Legacy 2.5 GT daringly fun to drive.

THE TWO FACES OF BEAUTY.

We're the first to point out: When it comes to style, the Porsche 911 is one of the hottest cars going. But with aerodynamic ground effects bodywork, contoured halogen headlights, rear

OR TOTALLY NUTS?

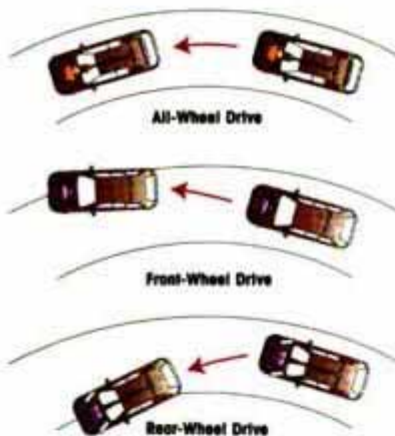


decklid spoiler and polished 5-spoke alloy wheels, the Legacy 2.5 GT is sure to spice up the

Porsche 911 Carrera 4

911 Carrera 4 included. What's

more, with an EPA fuel economy of 20/26 mpg, the Legacy 2.5 GT has a much less voracious appetite. And with typical Subaru low maintenance, it won't cost you much down the road, either.



daily commute, as well. Inside, too, it's engineered with both style and ergonomics in mind. With easy-to-read analog gauges, easy-to-reach controls, a deeply bolstered,

10-way adjustable driver's seat, with matching velour door trim inserts — even a retractable dual cupholder — the 2.5 GT driving environment is actually built around a driver, not a formula. What's more, its superlative design is available in two sleek body styles: the sporty Legacy 2.5 GT Sedan and the roomy Legacy 2.5 GT Wagon. Body styles, we might add, that Porsche doesn't even make. (Oh well, so much for comparison.)

OUR PRICE IS GREAT. THEIRS IS MUCH GREATER.

We admit it. Starting at just \$22,295,[†] the Legacy 2.5 GT is no match for, well, any Porsche — the



So there you have it. But don't take our word — compare for yourself. See your local Subaru dealer for a test-drive, or call us at 1-800-WANT-AWD.

Now, how do you like them apples?

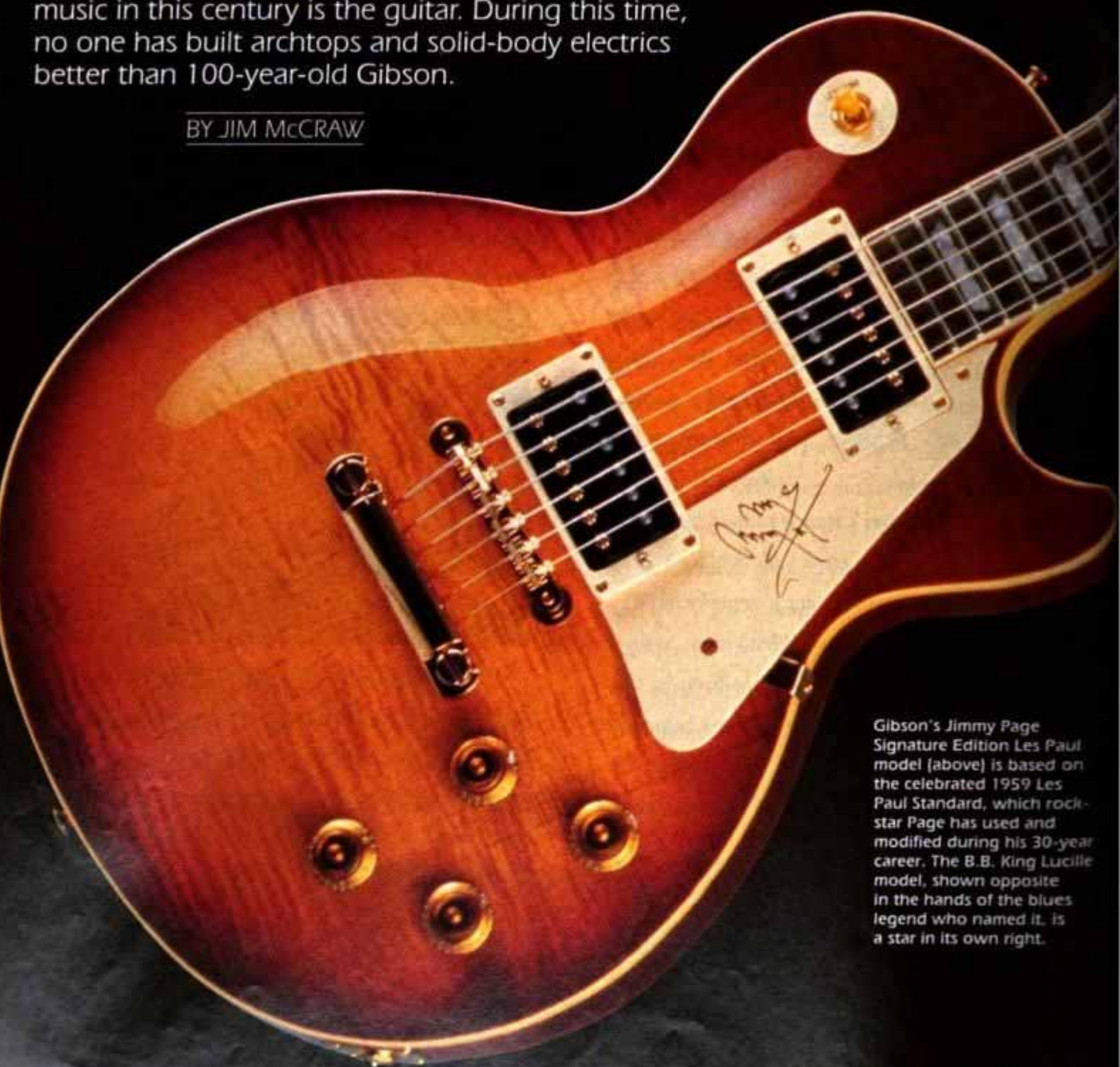
SUBARU 
The Beauty of All-Wheel Drive.™

*Pictured is the Porsche 911 Carrera 4. †MSRP of Legacy 2.5 GT Sedan 4EAT with a 2.5-liter engine. Price does not include inland transportation, taxes, license and title fees. Dealer's actual price may vary. 1996 EPA estimate. City 20/Hwy 26. Use for comparison only. Your actual mileage may vary.

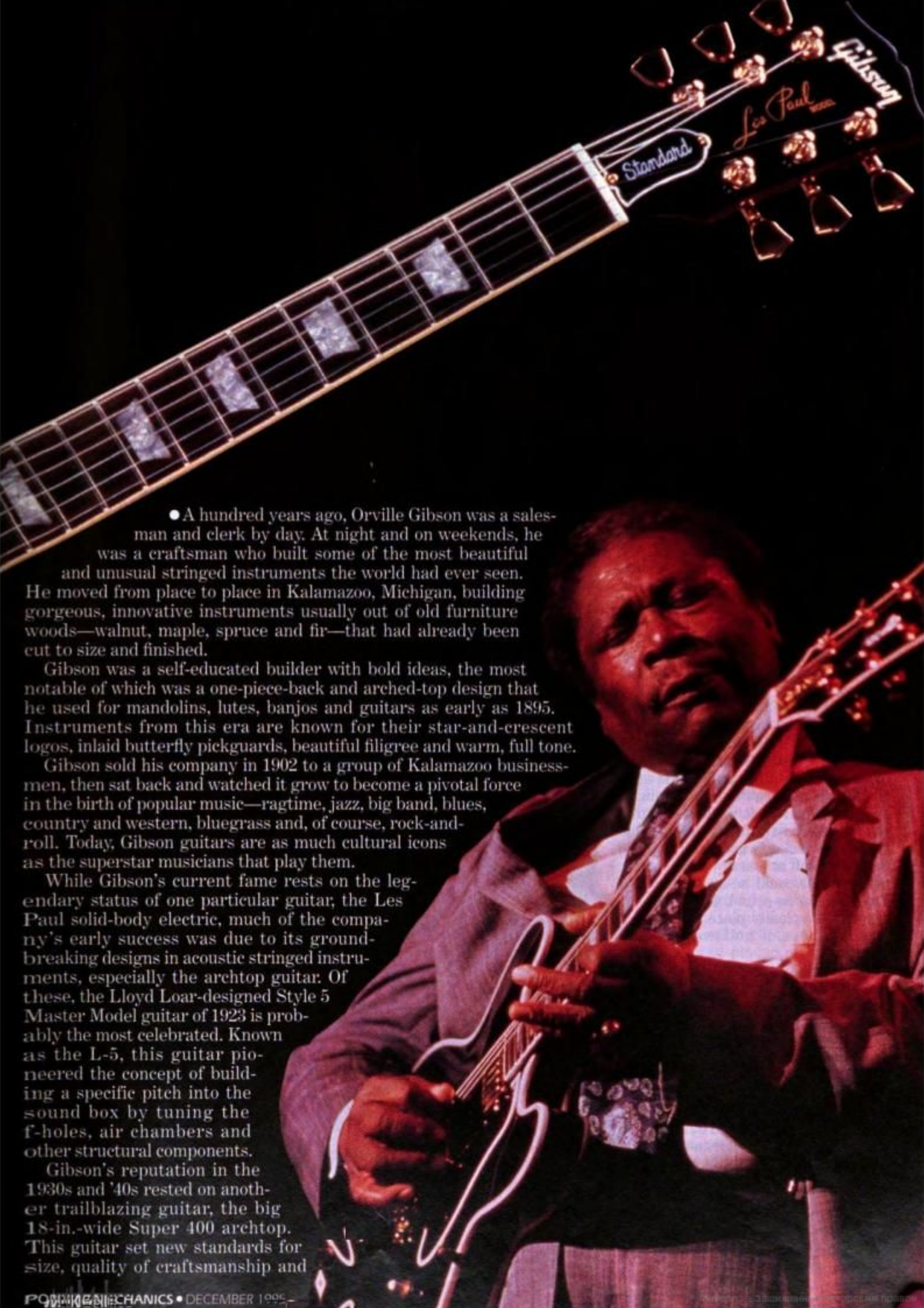
THE GIBSON GUITAR

The most influential instrument to emerge in popular music in this century is the guitar. During this time, no one has built archtops and solid-body electrics better than 100-year-old Gibson.

BY JIM McCRAW



Gibson's Jimmy Page Signature Edition Les Paul model (above) is based on the celebrated 1959 Les Paul Standard, which rock-star Page has used and modified during his 30-year career. The B.B. King Lucille model, shown opposite in the hands of the blues legend who named it, is a star in its own right.



● A hundred years ago, Orville Gibson was a salesman and clerk by day. At night and on weekends, he was a craftsman who built some of the most beautiful and unusual stringed instruments the world had ever seen. He moved from place to place in Kalamazoo, Michigan, building gorgeous, innovative instruments usually out of old furniture woods—walnut, maple, spruce and fir—that had already been cut to size and finished.

Gibson was a self-educated builder with bold ideas, the most notable of which was a one-piece-back and arched-top design that he used for mandolins, lutes, banjos and guitars as early as 1895. Instruments from this era are known for their star-and-crescent logos, inlaid butterfly pickguards, beautiful filigree and warm, full tone.

Gibson sold his company in 1902 to a group of Kalamazoo businessmen, then sat back and watched it grow to become a pivotal force in the birth of popular music—ragtime, jazz, big band, blues, country and western, bluegrass and, of course, rock-and-roll. Today, Gibson guitars are as much cultural icons as the superstar musicians that play them.

While Gibson's current fame rests on the legendary status of one particular guitar, the Les Paul solid-body electric, much of the company's early success was due to its groundbreaking designs in acoustic stringed instruments, especially the archtop guitar. Of these, the Lloyd Loar-designed Style 5 Master Model guitar of 1923 is probably the most celebrated. Known as the L-5, this guitar pioneered the concept of building a specific pitch into the sound box by tuning the f-holes, air chambers and other structural components.

Gibson's reputation in the 1930s and '40s rested on another trailblazing guitar, the big 18-in.-wide Super 400 archtop. This guitar set new standards for size, quality of craftsmanship and

THE GIBSON GUITAR

THE FIRST GUITAR

The oldest surviving instrument made by craftsman and innovator Orville Gibson, of Kalamazoo, Michigan, is this unusual 10-string guitar from the late 1800s.



decoration. Fitted with optional pickups, it marked the transition into the age of electric guitars. A modified version of the Super 400 became Gibson's first successful electric model in 1951, and Bill Haley used a variation of it to *Rock Around The Clock*.

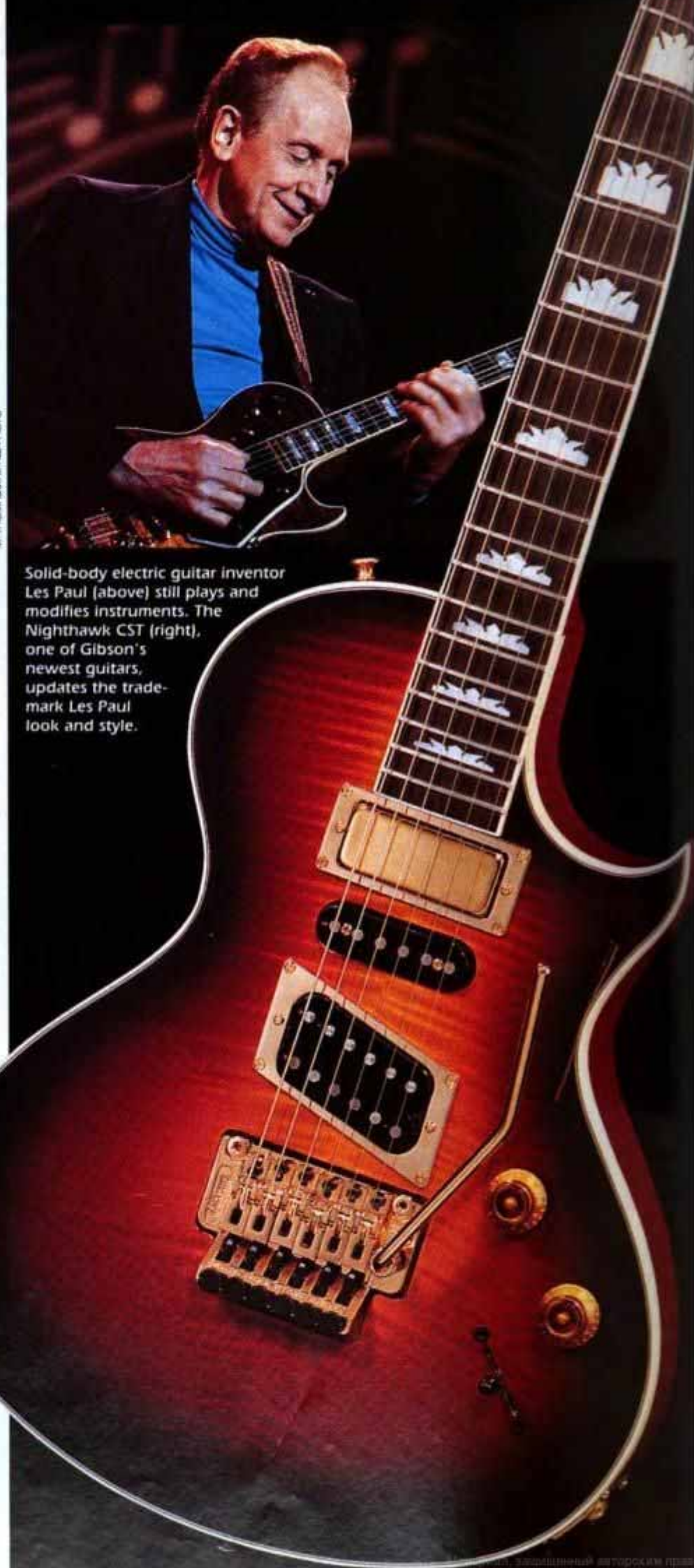
But of all the dozens of guitar models bearing the Gibson name over the past century, one stands out above the rest: the Les Paul solid-body electric.

Gibson's dabbling with electric guitars goes back to 1935 and the aluminum-bodied Electric Hawaiian Guitar. This model used crude magnetic pickups made with thousands of wire windings to literally "pick up" vibrations off the guitar strings and send them through a cable to an amplifier/speaker. The way it worked was that the vibrations from the strings disturbed the pickup's magnetic field and created small amounts of alternating current that could be reproduced by the amplifier as sound. Early pickups were typically placed in the air chambers of hollow-body guitars.

One musician, however, reasoned that by using improved pickups, he could dispense with the air chamber to create a thin-bodied guitar that would be far more comfortable to play than the big-bodied designs of the day. He figured he could just take the sound waves directly from the strings for a purer, cleaner and brighter sound, without the overtones that hollow-body electric guitars typically produced. These factors were important to him because he was interested in using the guitar as a lead solo instrument, not simply as part of the rhythm section.

M. THOMAS/STANI FILE PHOTO

Solid-body electric guitar inventor Les Paul (above) still plays and modifies instruments. The Nighthawk CST (right), one of Gibson's newest guitars, updates the trademark Les Paul look and style.



LES PAUL CLASSIC GOLD TOP

Bullion-gold-finished models appeared during the first year of production in '52. This reissue is based on a '57 model.



LES PAUL CUSTOM PREMIUM PLUS

This investment-grade model is built with high-quality maple, and a heritage cherry sunburst finish. It's based on the Standard of '59.



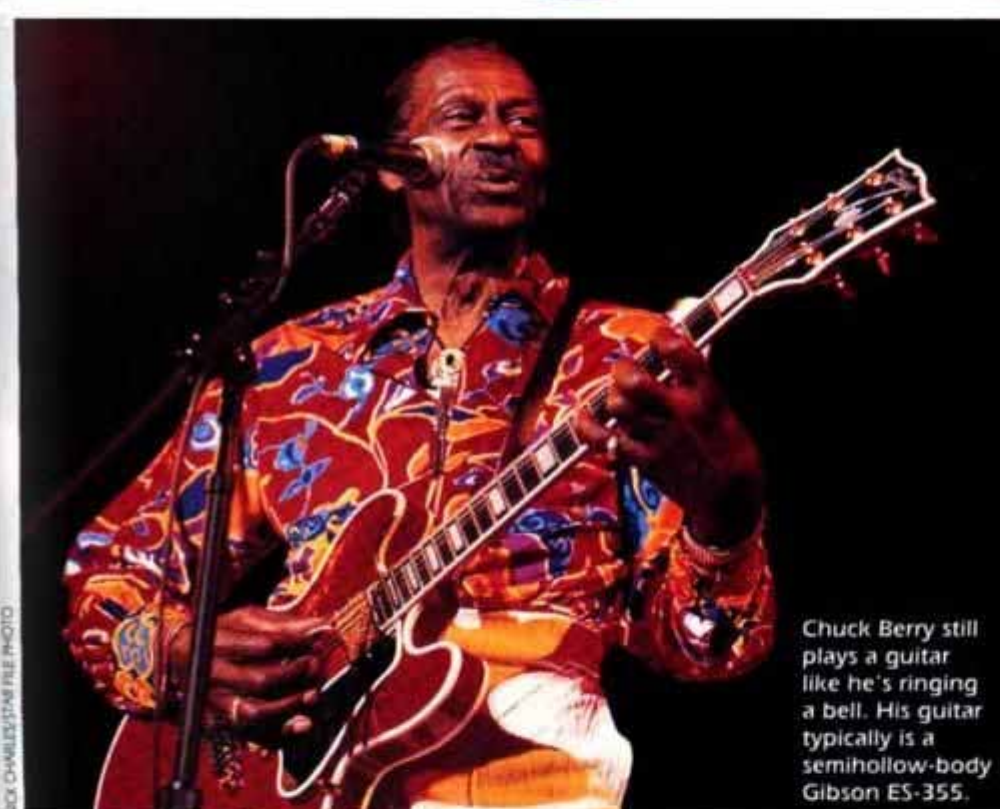
SG SPECIAL

Guitar-driven rock exploded in the '60s and took the slim SG along for the ride. This SG Special is based on the body of a '67 SG Standard and the neck of a '62.



FLYING V

Gibson's rocket-shaped Flying V didn't catch on in 1958. Today, those first-run guitars are worth \$50,000. Current Flying Vs are based on a '67 reissue.



Chuck Berry still plays a guitar like he's ringing a bell. His guitar typically is a semihollow-body Gibson ES-355.

he had been endorsing since 1928, and they flatly rejected the idea. However, in the postwar era, Leo Fender, a radio repairman from Anaheim, California, introduced an all-maple solid-body electric guitar that came to be known as the Fender Telecaster. By the late 1940s, Fender solid-body electrics were becoming so successful that Gibson decided to revisit the idea, and ultimately issued the first Gibson Les Paul in 1952.

The original Les Paul had a maple cap on top of a mahogany back and neck, a striking gold paint job, a cut-away in the lower half of the body so that players could easily reach the highest notes, and a sculptured, arched center section on the body. In contrast, the Fender Telecaster of the era was a flat slab of ash with a natural finish.

The Gibson Les Paul used two adjustable pickups with separate volume and tone controls for each. It also had a 3-way tone toggle for switching between and combining the two pickups, cream-colored plastic pickguard and pickup covers, and a long trapeze bridge piece at the bottom. A patent was filed on January 21, 1953.

Since the introduction of the first Les Paul model, Gibson has never stopped refining the design, and Les Paul has provided input on most of the changes. A "stop" tailpiece replaced the trapeze tailpiece in 1953. In 1954, the Les Paul Custom was introduced, which was painted in black and trimmed in white to resemble a tuxedo. It became an instant hit, and was later known as "Black Beauty" or "The Fretless Wonder" because of the ease with which it could be played.

A new type of tailpiece that included
(Please turn to page 122)

To make his dream a reality, this musician made his first pickup from the tone arm of a phonograph, and his first amplifier from components cannibalized from a Bell & Howell movie projector. His name was Lester William Polfuss, and he had been playing professionally since the age of 15 under the stage name Rhubarb Red. In later years, he became known as Les Paul.

Les Paul the Grammy-award-winning guitarist and entertainer is also Les Paul the inventor and electronics wizard, who is credited with the invention of sound-on-sound multiple recording, echo effects, layering, phasing and 8-track recording. With his wife and partner, singer and gui-

tarist Mary Ford, he had a long string of hits in the postwar years and on into the '50s.

Paul first presented his idea of the solid-body electric guitar to Gibson in 1941, two years after he had built a prototype fondly known as "The Log." This prototype was made up of a Gibson guitar neck attached to a 4 x 4-in. block of pine and fitted with two pickups, one for treble and one for rhythm. It could have been played as it was, but Paul bisected the body of an Epiphone f-hole acoustic guitar and glued the two pieces around the central log to make it look more like a real guitar.

Paul took this 20-pound prototype to the people at Gibson, whose guitars

COMPUTING'S NEXT STEP

New computers are ready to reap the benefits of Windows 95.

BY STEPHEN A. BOOTH, Contributing Editor

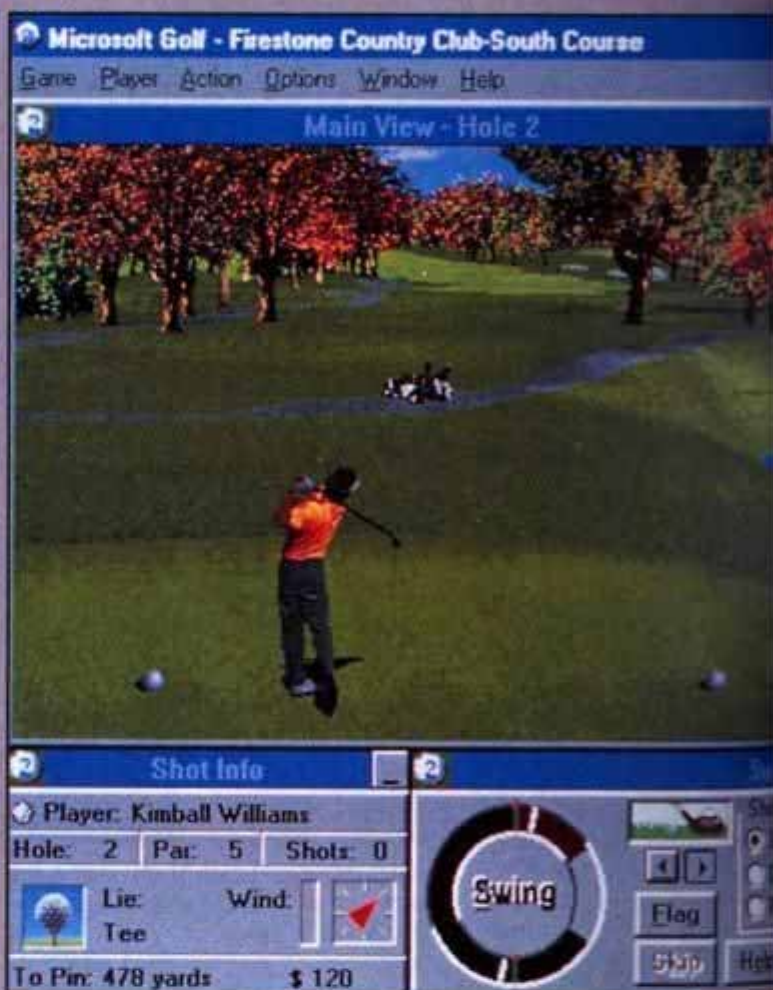
● If you listened to just the hype surrounding the launch of Microsoft's Windows 95, you might understandably think there's nothing more to it than a fancy start button, some new graphic interfaces and a new on-line service. And you might also have concluded that geeks rule, as Microsoft chairman Bill Gates buddied up to the Rolling Stones after licensing *Start Me Up* as the theme for this new computer software.

You may be even more puzzled if you've ever used an Apple Macintosh computer. All this hoopla for a new PC operating system that's finally comparable to the Mac's? What's the fuss?

Some of it has to do with sheer numbers. Microsoft's Windows operating systems run 80% of the world's computers, a fact that may be due more to clever marketing than technical genius. Nevertheless, the number of people affected by Windows 95 will be enormous. The promise of the software is that it will make computing easier and put to rest those mind-bending operations required by previous Windows systems.

What you might have missed, though, is the deeper implications posed by the arrival of Windows 95, those affecting how computers will work. The true impact of Windows 95 is only now becoming apparent with the new generation of computers now becoming available.

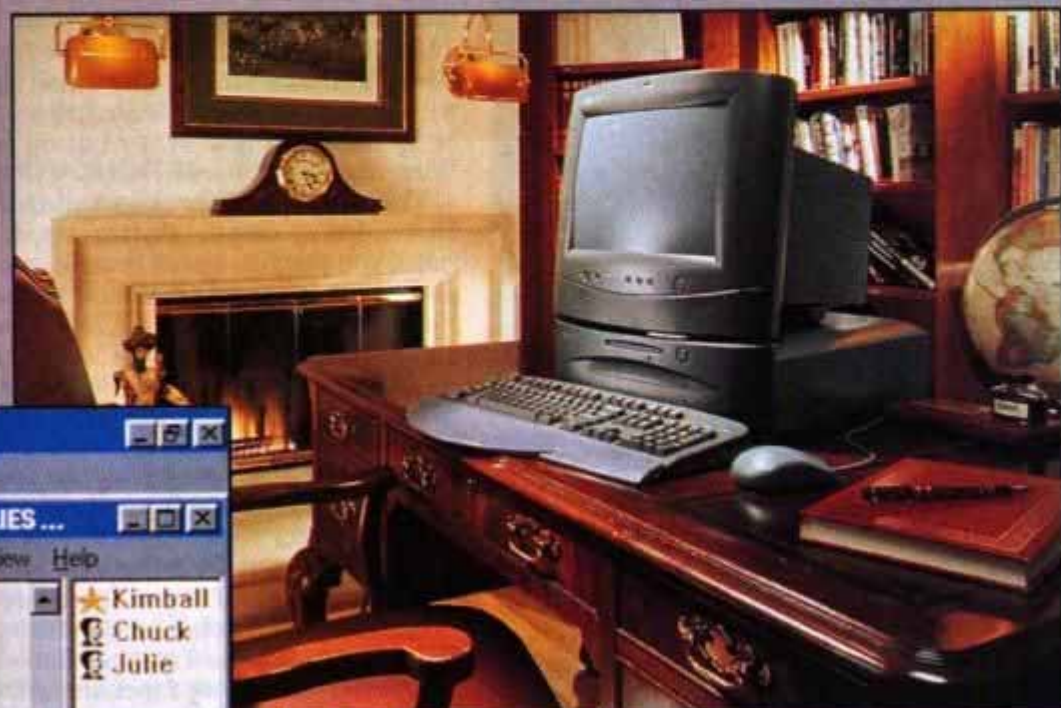
Peel back the top and most visible layers of Windows 95, and underneath you'll find a technology that brings computing to a new level of performance and interconnectivity. The effect will be felt across the board. For instance, Windows 95 puts computer games on a par with dedicated videogame players like those offered



by Sega and Nintendo. CD-ROMs are easier to load and play—something that can only lead to an increase in the number of titles available. Connecting and operating peripheral devices like printers and scanners will be easier. Speech operation becomes a real option, rather than just a novelty. In general, Windows 95 will spur the development of innovative hardware and software.



ACER ASPIRE



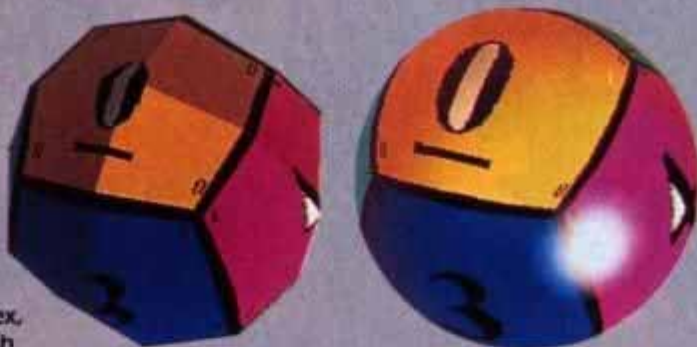
Many computer manufacturers are tossing out the old industrial look and restyling their PCs to complement home decor. For example, the desktop PCs in Acer's Aspire line have sweeping contours and come in either emerald (shown here) or charcoal hues. Under the hood? Full-motion video playback, voice-activation for hands-free operation, fast modems for connection to online services, voicemail and fax. The line costs \$1299 to \$2999, plus \$299 to \$799 for 14- through 17-in. monitors.



DIAMOND MULTIMEDIA



Nobody ever mistook a computer for an arcade-quality game machine—until now. PCs could process words and crunch numbers, but lacked the kind of graphics muscle that lets dedicated videogame consoles punch out complex, changing shapes at high speed. Now, the combination of 32-bit Win95 processing, Pentium chips and ample memory gives the PC a fighting chance. All that's needed to smooth straight lines into gentle curves is the Gambit graphics-accelerator board from Diamond Multimedia. This \$249 add-on brings engineering-workstation



power to the home PC for real-time rendering of highly textured 3D surfaces. It can project motion-video onto a rapidly changing shape—all the while maintaining correct perspective. Gambit greatly improves the quality of movies from MPEG-video CDs.

Much of the credit for this belongs to the new 32-bit operating system that Windows 95 (Win95) employs. Compared to Windows Version 3.1 (its 16-bit predecessor), the new operating system enables PCs to do things better, faster and easier than before.

Much of the early publicity about Win95 focused on the look and feel of its graphic interface—the on-screen display that lets you point an arrow at pictures of files or programs, then launch a function by clicking buttons on a computer mouse.

Thanks to a 32-bit processor, Windows 95 allows you to keep multiple applications or screens open at the same time. Called multitasking, this capability allows you to keep track of several things at once, even if one of those happens to be the online golf game you're playing with some old 19th-hole buddies.



Compaq's top minitower models sport 1GB to 1.6GB hard drives.



The hands-free InterVision System Six PC latches onto your belt. Monitor and microphone are mounted onto headgear.



The part of Win95 you see is a GUI (graphical user interface), or "shell," that keeps the operating system out of sight, so you'll never need to know the cryptic codes that make a PC fetch a file, print a document or even install a new piece of hardware to the system. The GUI uses picture icons and command bars to represent programs and functions. Using an input device such as a mouse or trackball, you just point and click.

In this regard, Win95 is pretty slick. You can launch any function with a single click on its Start icon—or by using the new START button on Windows 95 keyboards.

The filing system is clean and neat. Instead of a screen cluttered with icons, you point to one of several category icons to reveal what's on board. For example, if you click the My Computer icon, it will display a menu including an icon for games. Point here to open a submenu window showing icons for your toy chest. Had you clicked on the category icon for programs, it would display only those relevant icons.

Similarly, icons for Microsoft Network (the company's new online service), Microsoft Exchange (for faxing and e-mail) and the Internet launch you directly into those functions when you hit the starter. Even turning off the computer is easier than before, when you had to first exit from Windows and return to a DOS prompt before hitting the power button (lest you really stress the PC). With Windows 95, just point to the Shut Down icon and hit—oddly—START. Microsoft does the housekeeping, then tells you when it's safe to cut power.

Convenience is the strong suit of Windows 95. For example, loading a multimedia CD-ROM used to be an elaborate chore involving a series of setup instructions. With Windows 95, you simply insert the CD, point to the icon for the CD drive (usually drive D) and click on INSTALL. In a few seconds, it's done.

Another annoyance was adding new hardware to the PC: a printer, modem, soundboard, disk drive, et al. The installation could kill a day—most of it in trying to decode the owner's manual and the computer's hiccups and error messages while you loaded the new software drivers. No more. The Plug And Play feature of Windows 95 means just that. You'll still have to pick up a screwdriver occasionally, but virtually every piece of equipment now coming down the pike will operate automatically.

That isn't all. The 32-bit system lets you write file names that are as

long as you like—no more 8-character limit as in the old DOS/Windows format. And 32-bit processing means you can run more than one application at the same time, a process called multitasking. But the applications do have to be designed specifically for 32-bit operation with Win95, otherwise multiple operations will slow everything down. To keep track of all the programs you've got running simultaneously, Windows 95 displays their names in a taskbar at the bottom of the screen. By pointing and clicking, you can jump from one to another.

Prerequisites

Installing Windows 95 itself is a breeze. It takes about an hour with the CD version, a bit longer with the floppy diskettes that owners of most portable PCs will have to shuffle.

This is academic if you buy a new computer, as most will come with Windows 95 preloaded. New PCs will also be up to speed regarding microprocessor and memory requirements for the new system. If you're adding Win95 to an older PC, you might have to do some upgrading. All this user-friendliness requires greater hardware performance, and it comes at a price.

According to Microsoft, Win95 will work on any personal computer whose microprocessor is the equivalent of an Intel 486, and with 4MB/RAM (4 megabytes of random-access memory). As a practical matter though, you will need a minimum of 8MB/RAM to run any interesting software, and that 486 chip ought to be at least a DX2 model running at a speed of 66 MHz.

To really see results from Win95, you'll want an Intel Pentium processor (or an other-brand equivalent) and 16MB/RAM. This is needed to exploit the new 32-bit programs being written, and for multitasking.

You can upgrade some 486 chips to Pentium power—Intel sells OverDrive processors to do this (about \$300). RAM upgrades usually come in 4MB portions at \$35 to \$50 a megabyte. You'll probably also want additional hard-disk memory, which means replacing your current storage drive. Here's why.

Most new programs, applications and multimedia CDs are pigs for memory. It starts

In Europe, Siemens is putting A/V jacks on the front of the computer.



The S3500 Modula-Executive is an electronic desk blotter linked via infrared beams to your PC. The monitor is touch-sensitive so your finger works like a mouse.

with the Win95 operating system, which hogs 30 to 60MB of storage (depending on features). Ditto for the new 32-bit programs. For example, Microsoft Office wants 55 to 89MB. Back when Windows 3.1 took 10MB and Office maxed out at 69MB, a

“puny” 420MB hard drive was fine. Now, start thinking 1GB (a gigabyte, meaning 1 billion bytes).

It's not farfetched—once you get into multimedia and the Internet, the closet space runs out fast. It's not astronomically priced, either. Gigabyte drives go for as little as \$300. Often, they're bundled with a 4MB/RAM chip set for about \$450, while \$700 buys bigger 1.6GB hard drives with 8MB/RAM. Why 8 instead of 4MB? The thinking is that if you've already got 4MB or 8MB, you should have 12MB or 16MB to run Win95. By the way, the quad-speed CD-ROM drive built into most recent PCs should do fine—for now. If your computer has an older CD-ROM drive, you probably ought to weigh all the upgrade costs against the price of a new PC.

Ultimately, the cost of adopting Win95 will entail software up-



COMPUTING'S NEXT STEP

grades to 32-bit applications. For the record, Win95 runs almost all existing DOS and Windows 3.1 programs, but with no performance enhancements. Microsoft concedes it won't run every piece of older software, particularly some DOS games.

More important, perhaps, current 16-bit utilities and antivirus programs do not work with Win95. The utilities, such as those that automatically create backup files, could not, in any event, handle the longer file names that Win95 lets you write. As for the antivirus programs, they no longer can protect even 16-bit programs against viruses—let alone any 32-bit-strength strains that might come along. This is because existing antivirus titles were so-called DOS TSRs (terminate and stay-resident programs).

Although Win95 still has DOS underpinnings, some aspects, such as the TSRs, have been junked. This prevents an older antivirus program from being launched. The TSR has been replaced by the ominous-sounding VxD (virtual-device driver)—and antivirus software for Win95 needs this booster shot. If you are concerned about computer viruses, you will have to acquire an antivirus program. Unlike Windows 3.1, there isn't one built into Win95.

Multimedia shines

Windows 95 gives multimedia a swift kick to a higher level. Generally speaking, the new generation of PCs running Win95 has a combination of features beneficial to games and software containing motion video and animated graphics—including the all-important 3D rendering. Besides the 32-bit operating system, the right stuff includes Pentium processing power, ample RAM and hard-disk memory, fast CD drives and Plug And Play compatibility for devices like joysticks and control pads.

At the same time, individual computer makers are adding improvements of their own to exploit the potential. IBM, for example, equips its



GRIP's multiplayer game controller.



Hewlett-Packard Pavilion model has the space for extra drives.

new Aptiva PCs with its own Mwave microprocessor. This digital signal-processing chip has many uses, but in the Aptiva line it lets multimedia shine. The computers can display full-



IBM's Aptiva features the Mwave processor.

screen, full-motion video from so-called Video CDs, but without the usual requisite MPEG decoder board.

MPEG, for Motion Picture Experts Group, is a standard for compressing video digitally to fit the storage capacity of CDs or other carriers. It can be decoded by hardware—a separate and additional circuit board or chip set. For example, Compaq delivers full-motion video in its new Presario PCs using new proprietary TrueQ circuitry.

It's also possible to decompress MPEG data through software programs, as Packard Bell does in its new computers, but there's a hitch. These send all the work to the PC's main microprocessor, with varying re-

sults. Either the video runs slower than the TV-standard 30 frames per second, or the video can be displayed only in a small area of the PC's screen. "Software" MPEG really taxes the microprocessor, so a powerful one is needed. Some proponents of MPEG claim a 90-MHz Pentium will do, but Intel says it takes a 120-MHz Pentium to do it well.

Aptiva performs what IBM calls "software MPEG with a hardware assist." This means the Mwave chip handles the MPEG digital audio chores, thus leaving the Pentium processor headroom to decode just the video. Acer Computer's radically styled Aspire PCs employ a similar split-the-load scheme to handle MPEG.

When IBM's Mwave isn't decoding motion-picture soundtracks, it provides speech-activation of Windows 95 functions—"word-mouse" in PC jargon. In the high-end models with 120- and 133-MHz Pentium chips, Mwave performs speech recognition for speech-to-text dictation.

Another hardware assist for Win95-equipped Pentium PCs comes from Diamond Multimedia, which recently introduced its Gambit graphics accelerator (\$249). This add-on board brings engineering-workstation power to the home PC for rendering highly textured 3-dimensional shapes in real-time motion. The way it projects motion-video onto the surface of a rapidly changing shape—all the while matching the changing perspective—is truly amazing. It's the kind of thing that only the best dedicated video-

(Please turn to page 120)



With any luck, there'll
be leftover turkey.

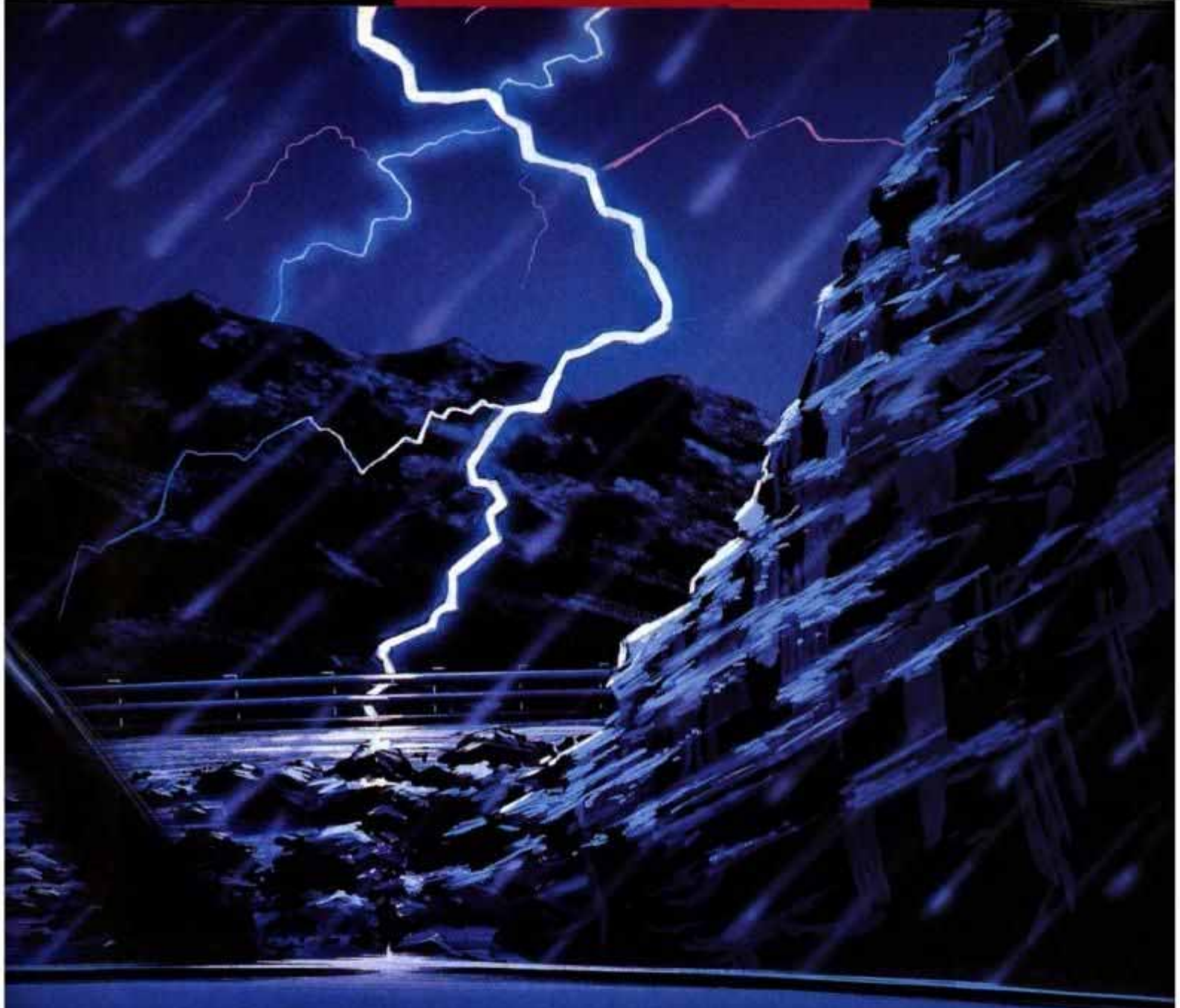


WILD TURKEY
101 proof, real Kentucky.

MAY THE CORNERING FORCE BE WITH YOU

The newest stability-control technology keeps your car between the lines—even when you can't.





● The light-colored surface beneath me was as slick as a Teflon frying pan, and covered with light rain to boot. The Geo Prizm's windshield wipers periodically cleared the raindrops from view—but to little avail, as the landscape was blurred anyway. Blurred because I was spinning, spinning totally out of control.

The special low-traction surface changed to more mundane black asphalt, and the 50-mph joyride ended rapidly as the tires regained adhesion. By another 360° or so, I had lurched to a halt.

The low-traction surface was part of a handling and braking test area at Ohio's Transportation Research Center, an ideal place to investigate the outer reaches of vehicle control. Acres of flat black asphalt surrounded me in every direction, so there was no real danger, except perhaps to the box lunch I'd consumed less than an hour earlier. (Mental note: Next time, lunch after the handling demo.)

The Geo I had just spun was a research vehicle built by engineers at Delphi Chassis

BY MIKE ALLEN, Associate Automotive Editor
PM Illustration by Thierry Thompson

Systems, which you may remember as Delco-Moraine, a subsidiary of General Motors.

The Delphi engineer sitting shotgun grinned fiendishly as I drove, carefully, back to the far side of the test area. He flipped a switch on a high-tech-looking box bolted crudely to the dash, initializing Delphi's Traxxar stability-control system, and the reason for my trip deep into the wilds of the Midwest.

At 50 mph, I paralleled the low-traction area briefly, and then made a sharp lane-change maneuver onto it. The vehicle's dynamics were completely different this time. Instead of a lurid spin, it was as if a giant hand had grabbed the rear bumper. The rear of the car stayed behind me. Where before I had to resort—futilely—to violent countersteering moves to try to regain control, the Geo's nose stayed pointed more or less in the direction I turned the steering wheel. After regaining steady-state control of the vehicle, I tried a second maneuver—making a second lane change back onto the wet asphalt. Earlier attempts had led to frustration, as the car would continue in a nearly straight line after I moved the wheel, refusing to turn. This

CORNERING FORCE



Mercedes-Benz on left has stability control switched off. Note tail-out attitude on frozen lake.

time, however, the front wheels were heading toward the left, although steering response was sluggish until we reached the black part.

This is the dawn of a new era in vehicle dynamics, folks, and it's called stability enhancement.

Big Brother is watching

In the beginning, there was ABS (antilock-braking system), which rapidly is becoming standard equipment throughout the industry. ABS prevents your brakes from locking up, and provides not only near-optimum braking levels but allows steering control throughout a maximum-effort stop. Sensors on the wheels relay information about wheel speed to the ABS controller, where a computer determines if any wheel is about to stop rotating. The controller then pulses the brakes to that wheel, preventing lockup and a skid.

Soon after ABS technology ma-

tured, traction control became available on many vehicles. Based on essentially the same technology as ABS, traction control, depending on the specific system, lowers engine output or actually applies the brakes on one or more wheels to prevent wheel-spin on acceleration. This guarantees optimum traction on slippery roads.

Staying on the road

Stability control is the next logical extension of these technologies. The basic system starts with ABS, because it requires virtually all of the same hardware to start—wheel-speed sensors, on-board computer and a mechanism to actuate the brakes. Two additional sensors are needed: a steering-wheel angle sensor and a yaw sensor.

The steering wheel sensor's purpose is obvious—it tells the computer in which direction you intend the vehicle to be headed. The yaw sensor provides in-

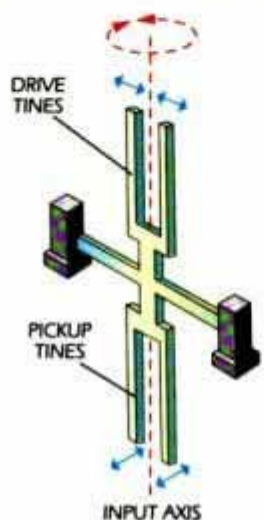
formation about the rate the vehicle is actually turning.

During a normal dry-pavement turn, a vehicle's yaw rate—the rate at which it is rotating around its center of gravity—and the rate it goes around a turn are identical. Add a slippery surface or a violent evasive maneuver, and the two rates can differ. In an oversteer condition, the vehicle will rotate faster than the turn, so the rear wheels seem to be trying to pass the front. In an understeer condition, the vehicle doesn't rotate, so the front end goes straight even if the front wheels are turned.

The computer takes data from a variety of sources: the yaw sensor, the steering-wheel angle sensor, the ABS sensors and, in some cases, a lateral-acceleration sensor, as well as engine information. The computer then decides if the car is traveling in the direction the driver intends.

Here's the trick part: The computer will then actuate the brakes on one wheel to make the car yaw more or less, and change its path around the turn. If the car is oversteering, and the rear wheels are headed for the weeds, the stability-control computer will apply the brakes on the outside front wheel, just hard enough and just long enough to make the car point in the direction the driver has the wheel pointed. Or, if the car is headed hood-ornament-first for the outside of the turn—and the guardrail—it will apply the brakes to the outside rear wheel to swing the rear end out.

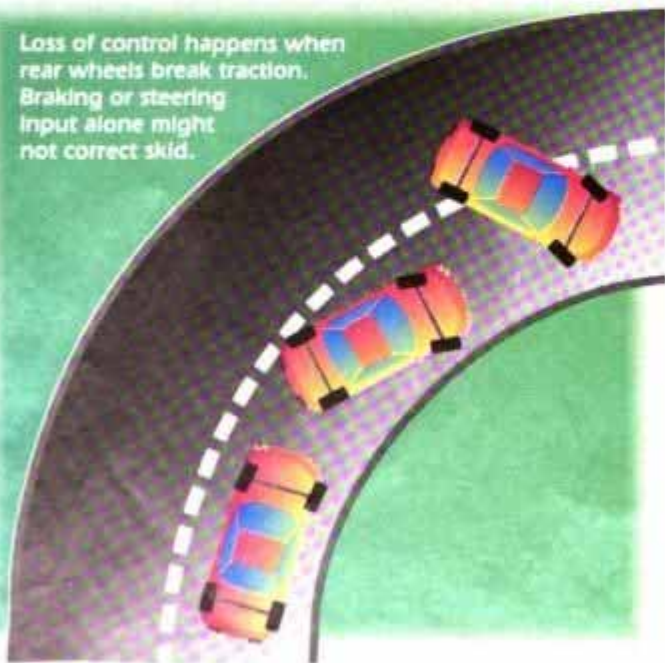
The effect is eerie, I must say. And not completely idiot-proof. Intelligence built into the vehicle still can't change the laws of physics. A vehicle entering a corner too fast will still run off the road. But a stability-



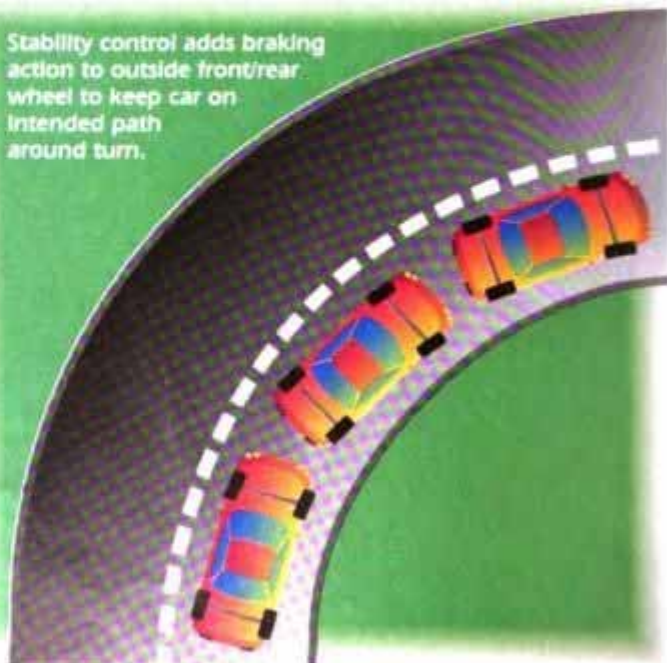
Delphi system uses solid-state piezoelectric yaw sensor. Vibrating ceramic tuning fork generates electrical output when rotated around its axis.

How Dynamic Stability Control Works

Loss of control happens when rear wheels break traction. Braking or steering input alone might not correct skid.



Stability control adds braking action to outside front/rear wheel to keep car on intended path around turn.



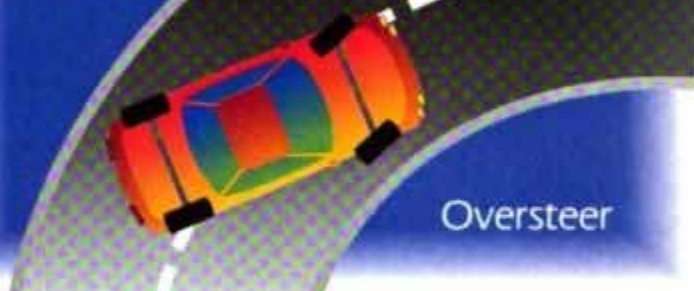
Staying On The Road

Understeer happens when the front wheels lose traction and the car heads nose first for the outside of the turn.



Understeer

Oversteer is defined by the vehicle's tail going around the corner faster than the nose. Countersteering by an expert driver is needed to regain control.



Oversteer

control system will give you a fighting chance of slowing down and safely negotiating the corner.

The state of the art

If all this sounds like it'll be here right after the government balances the budget, surprise! You can buy a car with stability enhancement today. It's the Mercedes-Benz S600. M-B's version is called ESP, for Electronic Stability Program. Mercedes' Bosch-based system uses an electromechanical yaw sensor, and adds extra information from a lateral-acceleration sensor (both buried under the rear seat, near the center of gravity) for additional refinement. But, in principle, it uses the same concept as the GM test mule I drove. The S600 is available in very limited production,

however, and costs a hefty six figures. But look for ESP to be available in other big-ticket Benzes by spring.

Similarly, BMW is developing stability-enhancement systems for its larger, more expensive cars, also in concert with Bosch. The company is calling it Dynamic Stability Control (DSC). Unlike Delphi's Traxxar system, BMW's Bosch system will also reduce engine output if the software decides it's necessary to slow down the vehicle. It does this by actually closing the throttle blades as well as retarding the ignition timing.

ITT, a major aftermarket supplier of braking systems to domestic manufacturers, is also well along in developing a system, although it seems, like Delphi, to be several years behind the Germans. But the systems ITT

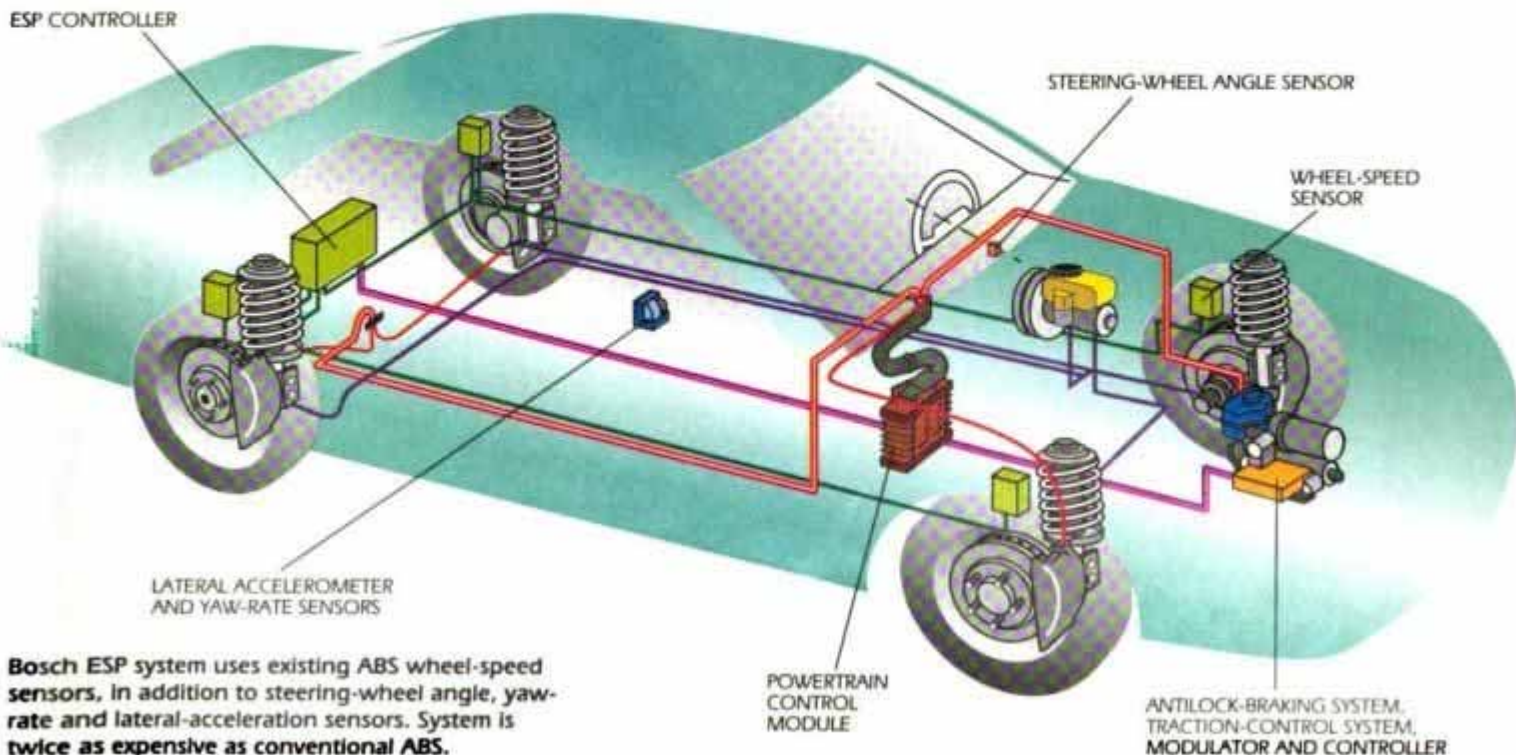
and Delphi bring to market will no doubt be less expensive. Bosch estimates the price to the carmaker for a complete system to be double the cost of conventional ABS, which means several thousand dollars at the consumer level.

Delphi's system uses electrically rather than hydraulically actuated rear brakes, which means it's simpler and more economical. But it's still a model-year or two from readiness. Toyota has announced a system of its own, based on a similar concept and utilizing technology comparable to that of the Bosch system, although we've seen no indication of when it'll be ready or what it'll be available in. Our guess is a Lexus sedan. **FM**

Detroit Editor Jim Dunne contributed to this article.

The Bosch Electronic Stability Program

ESP CONTROLLER



Bosch ESP system uses existing ABS wheel-speed sensors, in addition to steering-wheel angle, yaw-rate and lateral-acceleration sensors. System is twice as expensive as conventional ABS.

FEELINGS

With a new sense of touch, bionic limbs feel more real than ever.

BY MIKE FILLON; PM Photo by Ray Hand, Illustration by Don Mannes



● Imagine losing one of your limbs. Sure, you could get by with a prosthesis—an artificial arm or leg. And after months of therapy, you could walk again or hold a cup of coffee. But something would have been taken from you, something that couldn't be replaced. No longer could you tell hot from cold water, or cradle a delicate wine-glass, or sense the warmth of a loved one's embrace.

That is, until now.

In Oklahoma City, NovaCare Inc.'s Sabolich Prosthetic Research Center has breathed life into the artificial limb. A 5-year effort has culminated in prostheses that provide a sense of touch and the ability to distinguish hot from cold. The National Institutes of Health is sponsoring a nationwide trial in which 120 amputees are wearing the sensory prostheses. The enhanced artificial limbs could appear on the market a year from now.

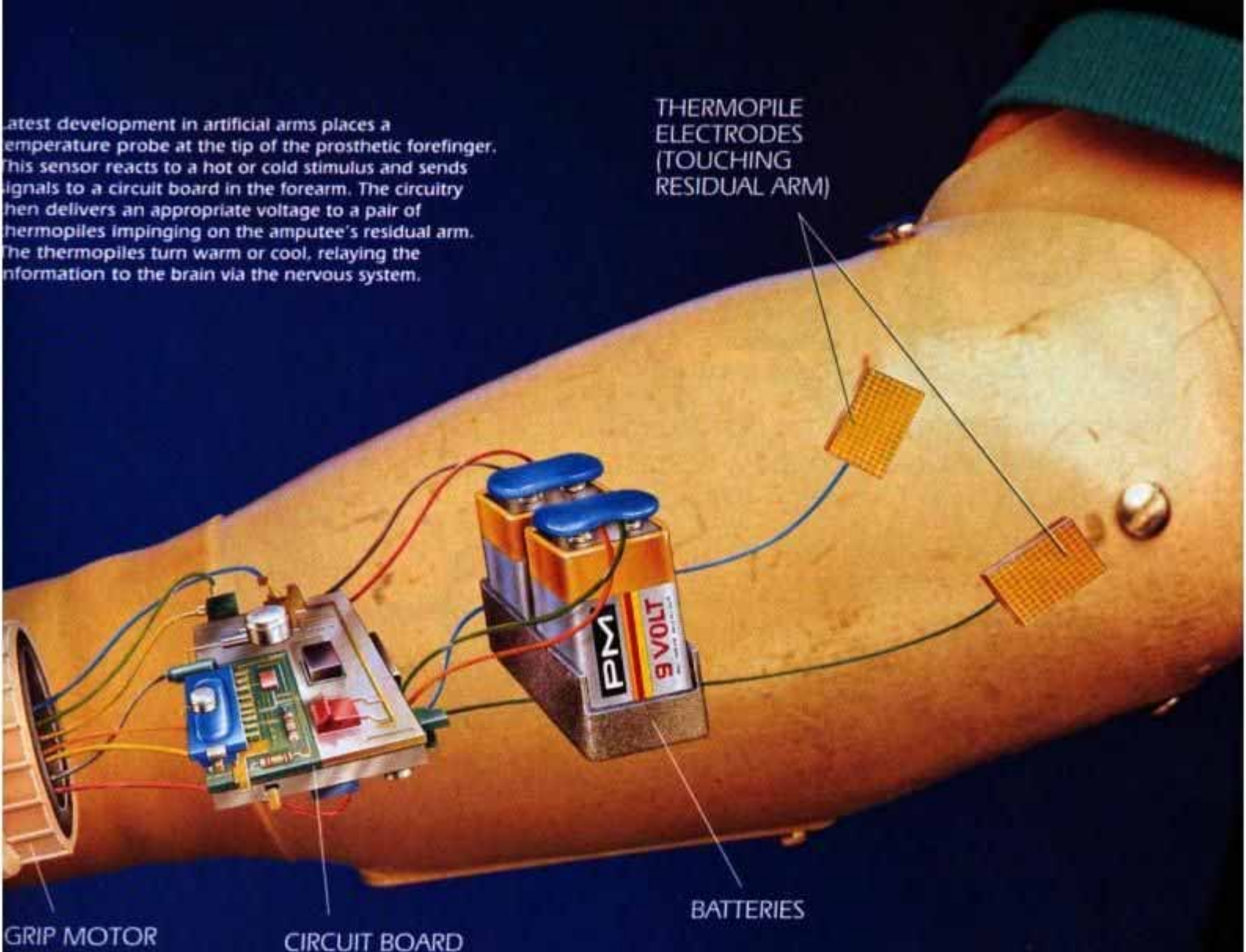
Furthest along are the Sabolich Sense Of Feel System artificial legs and feet. The goal is to give patients better control over their centers of gravity as they

walk. The key technology: pressure transducers embedded in the sole of the artificial foot. It's been tried before, but earlier sensor technology wasn't up to snuff. "The sensors we have available today are much thinner, less costly and more accurate," notes project manager Giovanni Ortega.

These sensors, three near the heel and three near the toes, respond to floor pressure on different parts of the foot. They send proportional signals to a controller inside the leg. This electronic interface then relays commands to corresponding electrodes that touch the front and back of the patient's residual limb—the stump inside the socket of the prosthesis. Each electrode delivers a tingle to the limb, and the tingle waxes and wanes as pressure on the foot increases and decreases.

Then the brain takes over. After only minutes with the device, amputees interpret sense electrode signals as coming directly from the foot, approximating the brain's analysis of sensations it once received from the

Latest development in artificial arms places a temperature probe at the tip of the prosthetic forefinger. This sensor reacts to a hot or cold stimulus and sends signals to a circuit board in the forearm. The circuitry then delivers an appropriate voltage to a pair of thermopiles impinging on the amputee's residual arm. The thermopiles turn warm or cool, relaying the information to the brain via the nervous system.



THERMOPILE ELECTRODES (TOUCHING RESIDUAL ARM)

GRIP MOTOR

CIRCUIT BOARD

BATTERIES

natural extremity. But that's not all. Some patients actually "feel" the entire foot and lower leg again, in a phenomenon known as cerebral projection. Others report that the system greatly reduces phantom pain, a cruel trick the brain plays on an amputee in which missing limbs "hurt."

Encouraged, the Sabolich group has high hopes for this hardware. They believe the Sense Of Feel System will allow amputees to feel their feet not only while walking or running but while undertaking subtler motions, such as pushing automobile-brake or bicycle pedals.

What's more, they are modifying the system for artificial arms, with similar transducers on the thumb and forefinger of a prosthetic hand. These control a small servomotor that squeezes a cuff around the patient's residual arm.

With a conventional prosthetic arm, the patient must flex a residual muscle to open and close the hand. Because the hand can't feel, the eye alone provides

judgment as to how much pressure to apply. But with the Sabolich device, the amputee can tell how much pressure the fingertips are applying because that much pressure is being exerted on the residual arm.

Most recently, Sabolich has developed a Hot & Cold Sensory System for artificial arms. A temperature probe at the prosthetic fingertip sends readings to circuitry inside the arm. Signals then go to a pair of thermopile-based electrodes that touch the patient's residual limb. These devices become warm or cool depending on the voltages they receive from the circuitry.

How well do these devices work? Just ask Chuck Tiemann. A former utility lineman, Tiemann lost his left leg and right arm in a work-related accident 15 years ago. Today, he's participating in the clinical trials, and he's pleased with the results. "For the first time in a decade, I could reach out and touch my wife's hand and feel the warmth," he says. "That was a very emotional moment."

PM

WHITE HEAT

Roaring through the Rockies on the longest snowmobile trail in the country, we torture test Arctic Cat's new EFI and high-altitude technology.

BY JOE SKORUPA, Boating/Outdoors Editor
PM Photos by Charles Plueddeman

● Nothing commands a long-distance snowmobiler's attention quite like a flickering oil light. One second I'm happily cruising along at 50 mph, enjoying a spectacular sunset over the Grand Tetons, and the next I'm desperately trying to coax a few extra miles out of an increasingly reluctant machine. My goal is to get as close to the nearest outpost of civilization before the idiot light begins to burn like a supernova. Idiot comes from a fine Greek word that means ignoramus, and while I take exception to its harshness of tone, I have to admit it justly applies to my situation.

Ten miles from Togwotee Pass, in Wyoming, I'm forced to shut down my Wildecat. Evening is rapidly advancing and the temperature is well on its way to its nighttime average of -10° F. I'd taken a calculated risk (one I don't recommend others taking) that Arctic Cat had built an idiot-light grace period into the Wildecat's 700-cc EFI engine, but now, even this is gone.

Leaning back on the seat, I watch as the stars pop out of a darkening sky. The only sound comes from a light breeze. Earlier in the day, I crossed paths with a herd of elk near Pinedale and a moose near Dubois. Aside from freezing, what worries me is that wildlife-rich Yellowstone National Park is relatively close by as the crow flies. Yellowstone, of course, means grizzlies, which probably are sleeping, and wolves, which probably are not. Is that rustling in the trees caused by the breeze or something else?

One of the good decisions I made before the trip was to bring along a riding partner, Charles



Plueddeman, who right now is off trying to locate oil. Charlie and I snowmobiled here in the Wind River Range a couple of years ago. We learned that one of the unique things about the area is that each of the major trailheads that leads into the Winds connects near the Continental Divide, which runs through the heart of the range. As a result, touring snowmobilers can actually ride a long end-to-end trail—dubbed the Continental Divide Snowmobile Trail—that starts in the east just outside the town of Lander, and runs all the way to a point 15 miles beyond Togwotee Pass in the west. If you map it out properly, this twisty 200-mile route has gas stations, restaurants and lodges located at convenient intervals.

Charlie and I always wanted to make this run, and then go one better—to continue riding beyond Togwotee Pass, through Grand Teton and Yellowstone National parks and all the way to the town



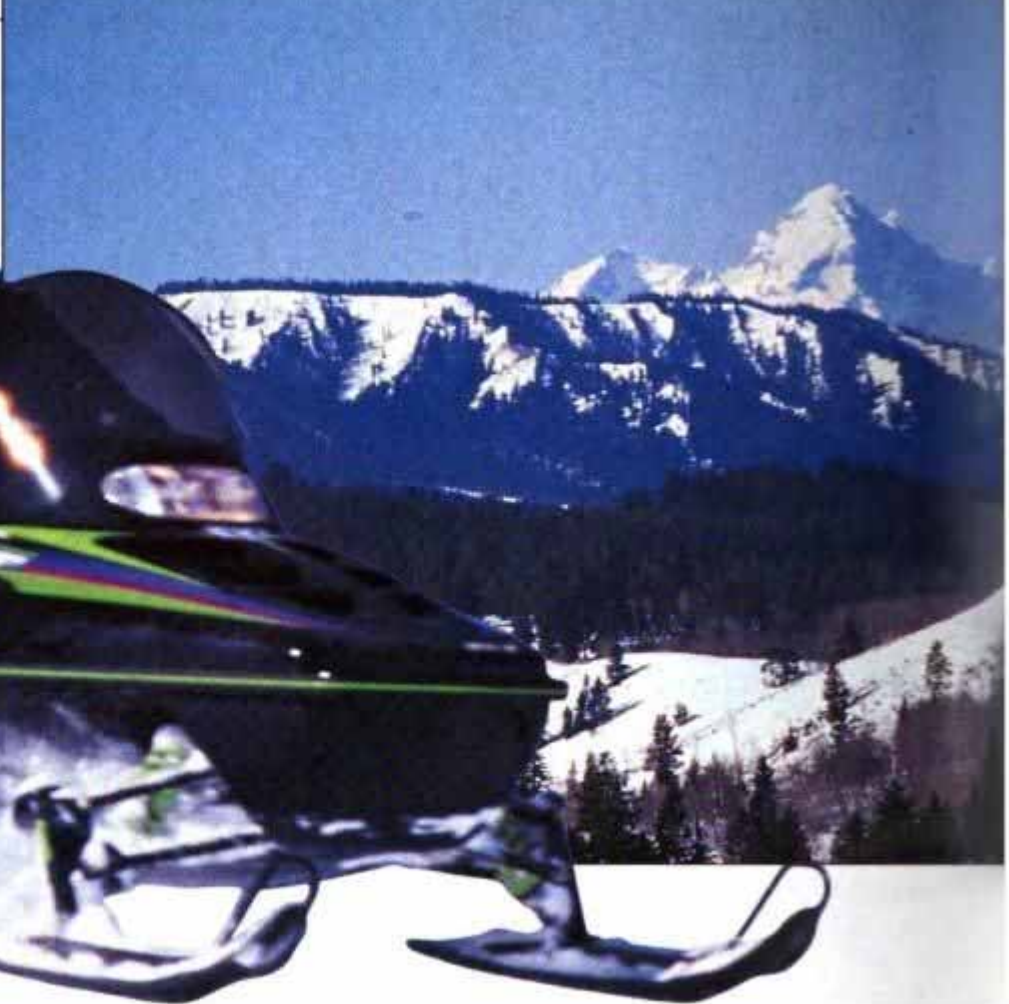


of West Yellowstone, Montana. This would add another 150 miles to the trip, and make it the longest point-to-point snowmobile route in the country.

The only problem with this dream was that Grand Teton, unlike Yellowstone, didn't permit the use of snowmobiles. That is until this year. In the fall of 1994, an environmentally friendly snowmobile trail was built in Grand Teton. After years of anticipation, the route

from Lander to West Yellowstone was finally a reality.

Naturally, Charlie and I wanted to make this run as soon as possible. After scouting around for the right equipment, we selected two Arctic Cat snowmobiles, the 700-cc Wildcat and the 580-cc EXT. We chose these models because both have cutting-edge electronic fuel-injected engines, a technology in which Arctic Cat is a leader.



The importance of EFI is that it automatically adjusts to sharp changes in altitude. Snowmobiles—indeed all carburetor-equipped vehicles—lose an estimated 10% of performance efficiency for each 1000-ft. rise in elevation. During our 350-mile journey, Charlie and I went from less than 7000 ft. in elevation to more than 10,000 ft., a range that would have sorely tested a carburetor-equipped snowmobile.

Both Arctic Cat models also come in Mountain Cat versions, which means they are equipped with extra-long 136-in. tracks and

wide 1.4-in. lugs. Extra-long tracks give snowmobiles large footprints, so they can float over deep powder without sinking. Wide lugs, sometimes called paddles, improve traction in deep snow. These features are essential for high-mountain touring, especially in the arid, deep-powder conditions found in the West.

At the moment, however, the only technology I'm interested in is lubrication. Apparently, my brand-new Wildcat was set to run oil-rich for a short break-in period. Clearly, I

should have monitored it more closely. If I get out of here, I vow never to run out of oil again.

Suspicious sounds seem to be get-

ting louder and nearer. Fortunately, it's only Charlie returning with oil. He brings enough to completely fill my empty reservoir, plus extra to stow as

Mountain Cat Tech

- To compensate for the radical elevation changes along Wyoming's Continental Divide Snowmobile Trail, which range from 6000 ft. in the Lander area to about 10,000 ft. at Union Pass, Arctic Cat's Mountain Cat EXT (\$6299 with a 580-cc 98-hp engine) and Mountain Cat Wildcat (\$7499 with a 700-cc 117-hp engine) are equipped with electronic fuel injection instead of standard carburetors. The throttle-body EFI system on these snowmobiles utilizes a microcomputer to monitor barometric pressure, air temperature, throttle position and engine rpm to deliver a precise fuel/air mixture regardless of elevation and oxygen density.

These benefits more than make up for EFI's disadvantages, especially in the high mountains out West. The EFI system and the small battery required to power it add about 15 pounds to the sled's weight, and about \$300 to its cost.

For extra flotation in deep, untracked snow, Arctic Cat's Mountain Cats are equipped with a longer track than standard sport models (136 in. versus 121 in.) and with staggered, 1.4-in. deep-paddle lugs, which provide more traction in deep snow than standard .75-in. lugs. A large 11-gal. fuel tank offers a range of about 110 miles at normal trail

speeds. We averaged 10 mpg over the three days for both sleds.

A cargo rack (\$60) supported the saddlebags (\$100), both of which are optional. The saddle-

bags stored all of our gear and worked well on trails, but dragged in deep snow. There was plenty of room above the saddlebags to bungee down the additional gear that we recommend you carry: food, water, survival gear, trail maps, compass and handheld GPS. For information about the Continental Divide Snowmobile Trail, call (307) 777-6560. —Charles Plueddeman





Photographer (above left) fuels up along the trail. Author (above right) checks GPS position at Union Pass, on the old Oregon Trail.

an emergency supply for the remainder of the trip.

I stuff the spare oil into my saddlebags, which are mounted onto a handy rear cargo rack. This is the location it should have occupied before I left this morning. The optional Arctic Cat cargo rack and integrated removable saddlebags prove to be a lifesaver on this trip. They easily accommodate three days' worth of clothing, a first-aid kit, tools, spare parts and photo equipment. Another lifesaver is the set of Arctic Cat leathers—insulated bib pants, jacket and gloves—which has kept me warm at -10° F while riding at 50 mph.

"Joe, I have good news and bad news," Charlie says with too much good cheer, as I finish packing gear.

"Really?"

"Yep. The good news is that I reserved the last two rooms at the Togwotee Lodge. So we're guaranteed to have a place to stay for the night. The bad news is that Grand Teton National Park announced it will shut down the snowmobile trail from the Blackrock Ranger Station to Flagg Ranch at midnight."

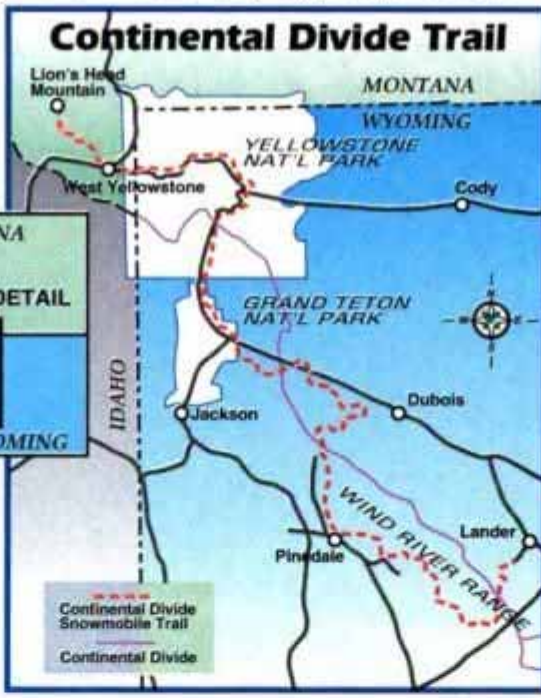
Uh-oh. Another trail closure. The portion of trail Charlie is talking about is 40 miles long and located at the relatively low altitude of 6900 ft. It runs exposed to the sun along a state highway and then through the Grand Teton National Park entrance to

Flagg Ranch, a wintertime snowmobile mecca near the gateway to Yellowstone. Apparently, thin snow cover and unseasonably high daytime tem-

peratures have prompted park officials to close this trail in order to protect the ground underneath.

peratures and a determination to not give up without a fight. During the 10-mile ride to the lodge, I switch sleds with Charlie. While both the Wildcat and EXT are ideally suited to conditions typically found along the Continental Divide, they are very different machines. The bigger, heavier Wildcat seems to soak up bumps like an ultrastable, long-distance cruiser. In tight turns, however, it requires a good deal of rider muscle. The EXT, on the other hand, has a taut, performance feel that allows it to easily pin tight corners and use the contours of the trail to launch into bursts of instant acceleration. While the sleds are about even in hole-shot speed, the Wild-

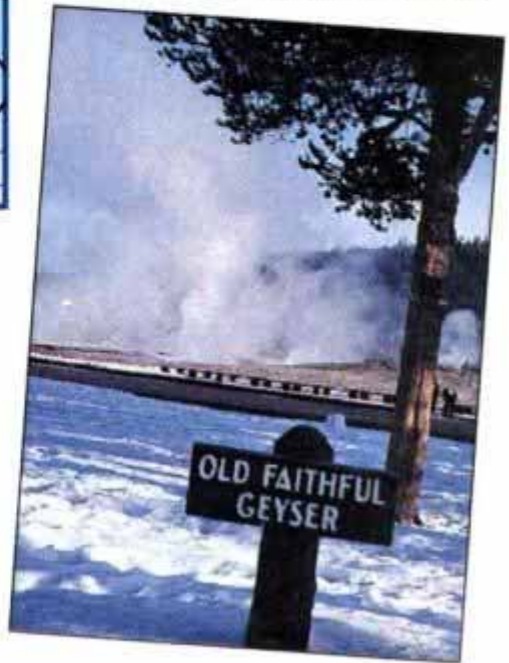
(Please turn to page 119)



peratures have prompted park officials to close this trail in order to protect the ground underneath.

Charlie and I came across a similar situation earlier in the run in the Lander area, where the trail runs through long sections at elevations near the 6000-ft. mark. We ended up skipping that section of trail to ensure the mechanical health of our sleds. Instead, we started in Pinedale.

Thinking that we may be facing the end of the line at Togwotee Lodge, Charlie and I roar off with headlights



HOME&SHOP

JOURNAL



SHOP PROJECT

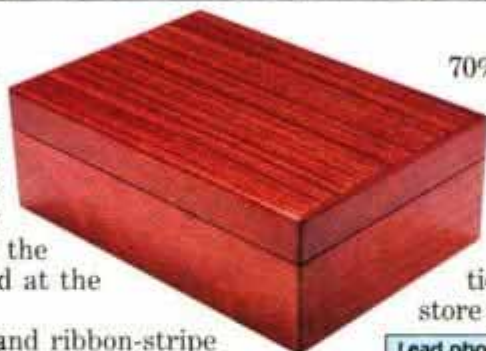
Fresh And Tasty

A finely crafted mahogany cigar humidor.

BY ROSARIO CAPOTOSTO, Contributing Editor

● If you enjoy a fine cigar, and the fragrant smoke that comes only from a fresh one, you should make this attractive humidor—it keeps your cigars in peak condition. Not only is it a pleasure to build, it's a pleasure to use. Every time you open it, you'll be greeted by the inviting aroma of fresh tobacco stored at the correct humidity.

It's constructed of solid mahogany and ribbon-stripe mahogany veneer. Dimensioned to hold 50 cigars, it's fitted with a humidifier to provide relative humidity of about



70%. It's also fitted with a dial hygrometer that indicates the percentage of humidity present in the humidor.

If you're not a cigar smoker, you might want to consider this project anyway. Its high-luster finish, fine brass hardware and elegant construction make it an attractive case in which to store coins, stamps, jewelry or cutlery.

Lead photo: Spencer Jones
Step-by-step photos: Rosario Capotosto
Technical art: Eugene Thompson

Construction

Begin by thickness planing stock to $\frac{1}{2}$ in. for the box and $\frac{1}{4}$ in. for the tray. You can also order material of this thickness from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461. The company also carries veneer.

Rip and crosscut the stock for the sides and ends slightly overlength. Next, miter one end of each piece. Make a stopblock with a 45° end and clamp the block to the miter gauge fence with the miter face down. Then, gently butt each mitered workpiece

against the mitered stopblock and make the cut (Photo 1). Tape the pieces together and check their fit. Dull the fragile outside corners by hand sanding (Photo 2).

The sides and ends are held in a 45° jig as they are moved over the slot-cutting bit in the router table (Photo 3). Next, cut the panel rabbets slightly overdepth to allow the rabbet to be trimmed flush to the panel.

The splines are cut from $\frac{1}{8}$ -in.-thick plywood shaved to $\frac{3}{64}$ in. thick. To do this, cut a strip of plywood $\frac{5}{16}$ in. wide

and 24 in. long. Its face grain should run across its width. Attach this strip to the edge of a $\frac{3}{4}$ -in.-thick board using artist's rubber cement, not contact cement. Apply the cement to one surface only. Adjust the table saw fence to shave $\frac{3}{64}$ in. off the strip. Carefully peel off the spline stock and rub off any residual cement.

The humidor is assembled with waterproof glue. We used Franklin's Titebond II, a rapid-setting type. Spread it sparingly in each slot and on the miters, using a hair-colorant squeeze



1 Cut the miters on the sides and ends, using an auxiliary fence and a 45° miter stopblock clamped in place.



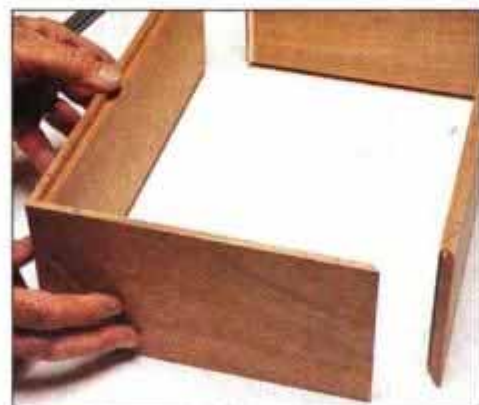
2 Test fit the sides and ends. Tape the pieces together and remove the sharp corners by hand sanding.



3 Use a sliding jig and slotting cutter in the router table to cut the spline slot. Make a test cut first.



4 Apply glue sparingly and evenly in the spline slots. Use a hair-colorant squeeze bottle with a fine nozzle.



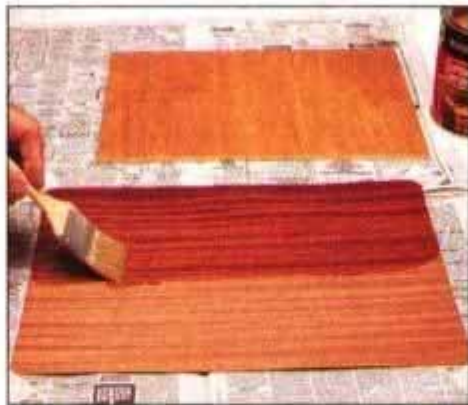
5 Make two L-shaped subassemblies, each comprised of a side and an end. Press the subassemblies together.



6 The waterproof glue sets quickly, so six clamps and cauls must be ready. Position the clamps and cauls as shown.



7 Make a cardboard template of the top panel. Test it in the rabbet—it should fit in the space snugly.



8 Evenly apply contact cement to the veneer and the plywood panels, using a small bristle brush.



9 Use a sharp knife to trim off the excess veneer. Cut from both ends toward the panel's center to prevent tearout.

bottle (Photo 4). Make two L-shaped subassemblies and apply pressure with six bar clamps (Photos 5 and 6).

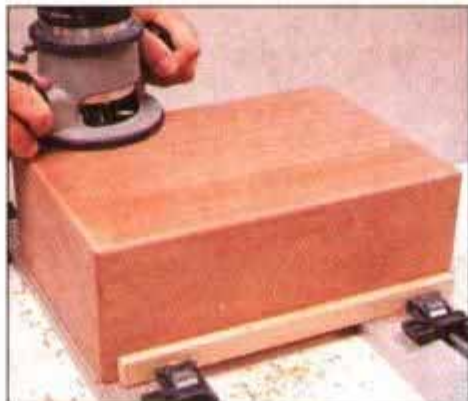
The top panel must fit precisely, so cut a template out of cardboard, test fit it (Photo 7) and use it to adjust the table saw fence. Cut the pieces of panel veneer oversize by 1 in. in width and length, and apply contact cement (Photo 8). When one coat dries, apply a second. Bond each veneer sheet to the panel with a roller.

Use a utility knife to trim the overhanging veneer (Photo 9). Make the end cuts first, and work from the corners to the panel's center to prevent splitting out the veneer. Veneer the panel's second side in the same way, and finish sand the inside face with 220-grit paper.

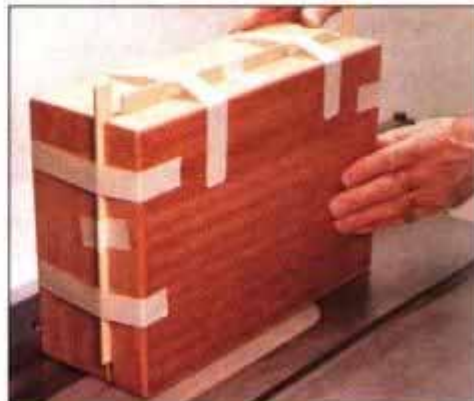
Glue and clamp the panels to the box body. Use a router with a flush-cutting bit to trim the rabbets flush to the panel, and cut the curve on the edges using a $\frac{3}{16}$ -in.-rad. corner-rounding bit (Photo 10).

Now cut the lid off on the table saw. Raise the blade so it projects about $\frac{5}{8}$ in. above the table. Tape a spacer strip into each kerf after it is cut. Keep in mind that the thickness of the spacer strips should equal the width of the saw kerf. Cut the ends first, then the sides (Photo 11).

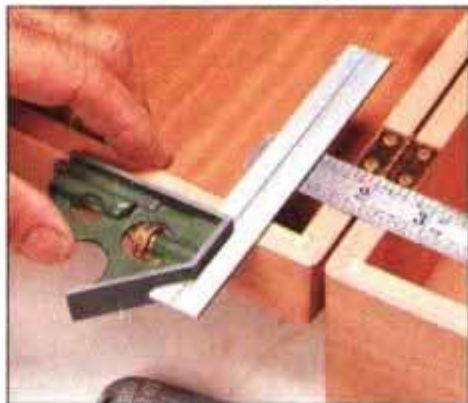
Before moving on to cut the hardware mortises, note that the mortise dimensions and placements are based on the hardware we used: The lid hinge is Stanley No. 73A70B, and it's available from Constantine's. The Brusso lid support is No. 62166, and is available from The Woodworker's Store, 21801 Industrial Blvd., Rogers, MN



10 Using a $\frac{3}{16}$ -in.-rad. corner-rounding bit in the router, make the crossgrain end cuts before cutting with the grain.



11 Cut the lid off the box on the table saw. Tape in a spacer strip to support the lid after making each cut.



12 Use a ruler, square and knife to lay out and mark location of lid-support hole. Measure from the hinge pin's center.



13 Cut the mortise for the lid support using a router and jig. Try the cut on a scrap piece first.

55374. The jig dimensions are based on routers with $5\frac{3}{4}$ -in.-dia. bases.

Clamp the hinge mortising jig to the box body, and cut the mortises. Next, temporarily attach the hinges to the lid and the humidor box. Note that the hole in the lid and the mortise for the lid support are positioned from the hinge pin's center. Use a ruler,

square and knife to mark the hole 1 in. from the pin's center (Photo 12).

To cut the lid-support mortises, clamp the jig to the humidor body and then make the cut (Photo 13).

Temporarily install the lid-support hinges, and check them for operation. If everything works okay, bore pilot holes for the support's screws.

Making The Liner And Tray

Rip and crosscut the liner pieces, and cut miters on their ends. Cut their curved edges using a $\frac{3}{8}$ -in.-rad. corner-rounding bit. Adjust it so it leaves

a small flat area on the top edges.

Temporarily install the liner pieces in the box and check the lid's fit on them. Hand sand high areas.

Apply a 1-in.-wide strip of glue along the sides and ends of the box

about 1 in. from the top edge. Press the end liner pieces in place and slide in the front and back pieces. After the glue has set, attach the tray supports with glue and brads.

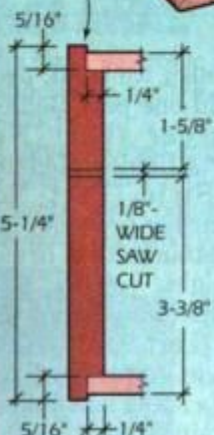
Rip and crosscut the tray pieces.

CIGAR HUMIDOR

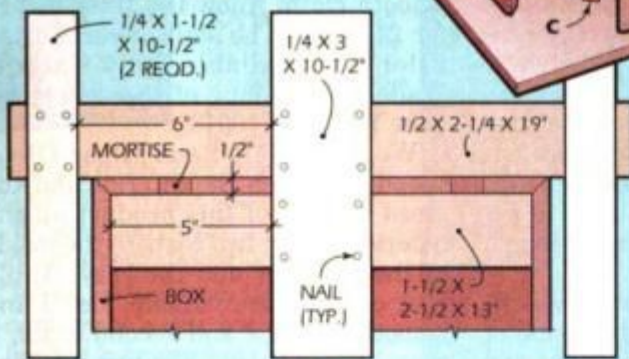
5" HIGH X 9-7/8" DEEP X 14" WIDE

D1— VENEER BOTH SIDES

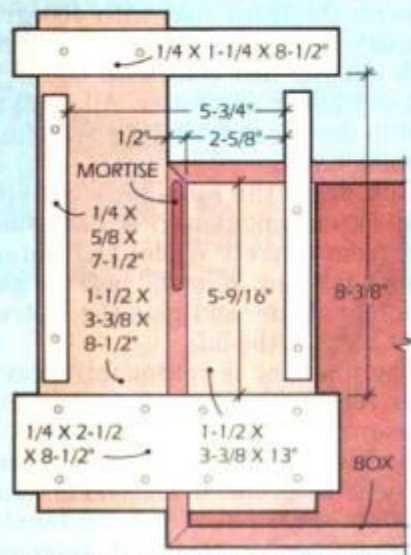
B1 ROUT TOP AND BOTTOM FLUSH BEFORE CUTTING BOX APART



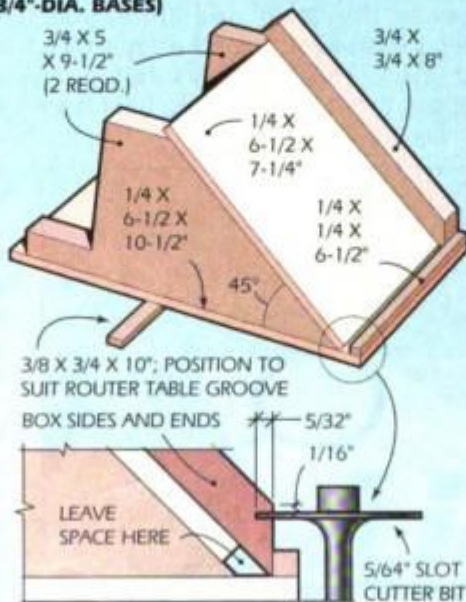
D2— VENEER TOP ONLY



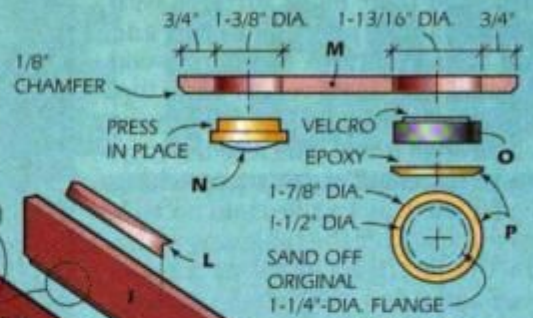
HINGE MORTISE ROUTING JIG (FOR 5-3/4"-DIA. BASES)



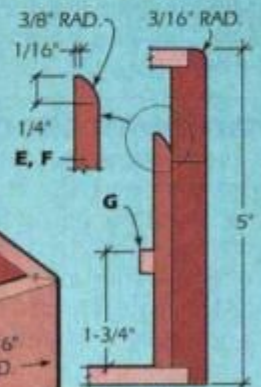
LID SUPPORT MORTISE ROUTING JIG (FOR 5-3/4"-DIA. BASES)



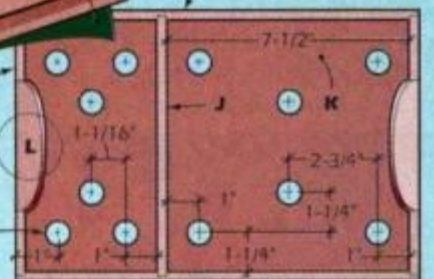
MITER SPLINE SLOTTING JIG



DETAIL 1— DEVICE BOARD



SECTION VIEW AT SIDE



TRAY ASSEMBLY

MATERIALS LIST—HUMIDOR

Key	No.	Size and description (use)
A1	2	1/2 x 1 3/8 x 14" mahogany (lid side)
A2	2	1/2 x 3 3/8 x 14" mahogany (box side)
B1	2	1/2 x 1 3/8 x 9 5/8" mahogany (lid end)
B2	2	1/2 x 3 3/8 x 9 5/8" mahogany (box end)
C	4	5/8 x 5/8 x 4 5/8" plywood (spline)
D1	1	3/4 x 9 3/8 x 13 1/2" plywood (top panel)
D2	1	3/4 x 9 3/8 x 13 1/2" plywood (bottom panel)
E	2	3/4 x 3 1/2 x 13" mahogany (insert side)
F	2	3/4 x 3 1/2 x 8 5/8" mahogany (insert end)
G	2	3/4 x 3/8 x 8 5/8" mahogany (support)
H	2	3/4 x 1 3/8 x 12 3/8" mahogany (tray side)
I	2	3/4 x 1 3/8 x 8" mahogany (tray end)
J	1	3/4 x 1 1/2 x 8" mahogany (divider)
K	1	3/4 x 8 x 12 3/8" plywood (tray bottom)
L	2	1/2 x 3/8 x 3 1/2" mahogany (handle)
M	1	5/8 x 2 3/8 x 7" mahogany (device block)
N	1	hygrometer
O	1	humidifier
P	1	humidifier ring
Q	2	lid support
R	2	hinge

Misc: Ribbon-stripe veneer, contact cement, rubber cement, waterproof glue, epoxy.

Finish sand their inner surfaces with 220-grit sandpaper, then glue and clamp the assembly. Cut the plywood tray panel, and apply veneer to its top. Finish sand the panel, bore the vent holes through it and glue it to the tray.

Next, rip and crosscut one long piece for the tray handles and notch it by running it over the table saw with a dado blade tilted at 30°. Saw the curved outline on each handle.

Sand a bevel on each of the handles by taping it to a scrap block and pressing it against a disc sander (Photo 14). Glue and tape the handles to the tray (Photo 15).



14 Cut the curve and notch in the handle pieces, then sand the taper on them, using a disc sander.



15 After the tray is sanded, apply glue on the handles and hold them in place with masking tape until the glue sets.

Instrument Block

Rip and crosscut the instrument block to size, then bore the holes through it with a Forstner bit on the drill press (Photo 16). Note that the holes have different diameters. We had to enlarge the hole for the humidifier to 1³/₁₆ in., using a sanding drum on the drill press.

The humidifier is a clay disc set in an aluminum cup, which attaches to the lid with a Velcro strip. It's available from Atmos Products, 39 Central Ave., Harrison, NJ 07029. The humidifier costs about \$3, shipping included. The hygrometer is available through



16 Bore the holes in the instrument block using a Forstner bit. Enlarge the hole for the humidifier with a drum sander.



17 To sand off the center flange, the lock collar is secured to a scrap block with adhesive mounting squares.

Forecaster Wind and Weather Shop, 8 Front St., Greenport, NY 11944. It costs about \$12.50, shipping included. Be sure to specify gold or silver finish when you order.

To improve the appearance of the humidifier and to provide a grip to lift it out, we made a brass ring adapted from a cylinder lock collar. The lock collar has a 1⁷/₈ in. outside diameter and a 1¹/₄ in. inside diameter. It costs about \$1, and you can find them at locksmith shops and at hardware stores that do lock work.

To make the ring, bore a 1⁵/₈-in.-dia. hole in a 3/4-in.-thick scrap block that's about 2¹/₂ in. long on each face. Secure the ring to the block with 3M Heavy-Duty Mounting Squares. Press the collar against the center of a disc sander (Photo 17). Hold it in place until the center flange of the collar drops off. Then, use a drum sander to remove the sharp edge left on the flange by the disc sander.

Next, apply a thin coat of quick-setting epoxy cement to the inside of the ring to thwart galvanic corrosion between the brass and aluminum. When this has set, tape the cup to the ring (Photo 18) and apply a thin bead of epoxy around the ring to hold it to the clay cup.



18 Seal the flange with epoxy and let it set. Then, tape the flange to the humidifier and fasten it with epoxy.

Finishing

To duplicate the finish we used, proceed as follows: Add one part Behlen Solar Lux Retarder (Part No. 99P12.01) to 10 parts Behlen Medium Red Mahogany Stain (Part No. 99P03.04). The retarder prevents lap marks. Apply the stain with a brush and let it dry overnight.

Next, apply Medium Red Mahogany Paste Wood Filler (Part 99P10.03) to the humidifier's outside. Apply the filler with a rag. When its shine has dulled, wipe across the grain using a coarse cloth then wipe with the grain using a smooth cloth. Allow the filler to dry for 24 hours. The stain, retarder and filler are available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

We used Deft Semi Gloss Clear Wood Finish on the interior and the gloss version of this product on the exterior. Apply two coats to the inside of the humidifier and the tray. Apply four coats to the outside. Level and smooth the first and second coats, if they need it, using 320-grit wet/dry sandpaper on a rubber sanding block. Smooth the third coat with 400-grit wet/dry paper lubricated with water. Rub out the last coat with 600-grit wet/dry paper and water. Allow each coat to dry for at least 4 hours before rubbing it out.

Rub down the humidifier's outside with rottenstone (which is also available from Garrett Wade) and water, using a felt pad. Wax and buff the humidifier's outside, and glue the instrument block to the lid.

The humidifier is reasonably heavy when filled with cigars, so we suggest you apply felt to its base. We used self-stick green felt from JBA International. Its products are sold in catalogs and home centers. To locate a distributor, contact JBA International, 114 Old Country Rd., Mineola, NY 11501; (800) 741-0005. **FM**

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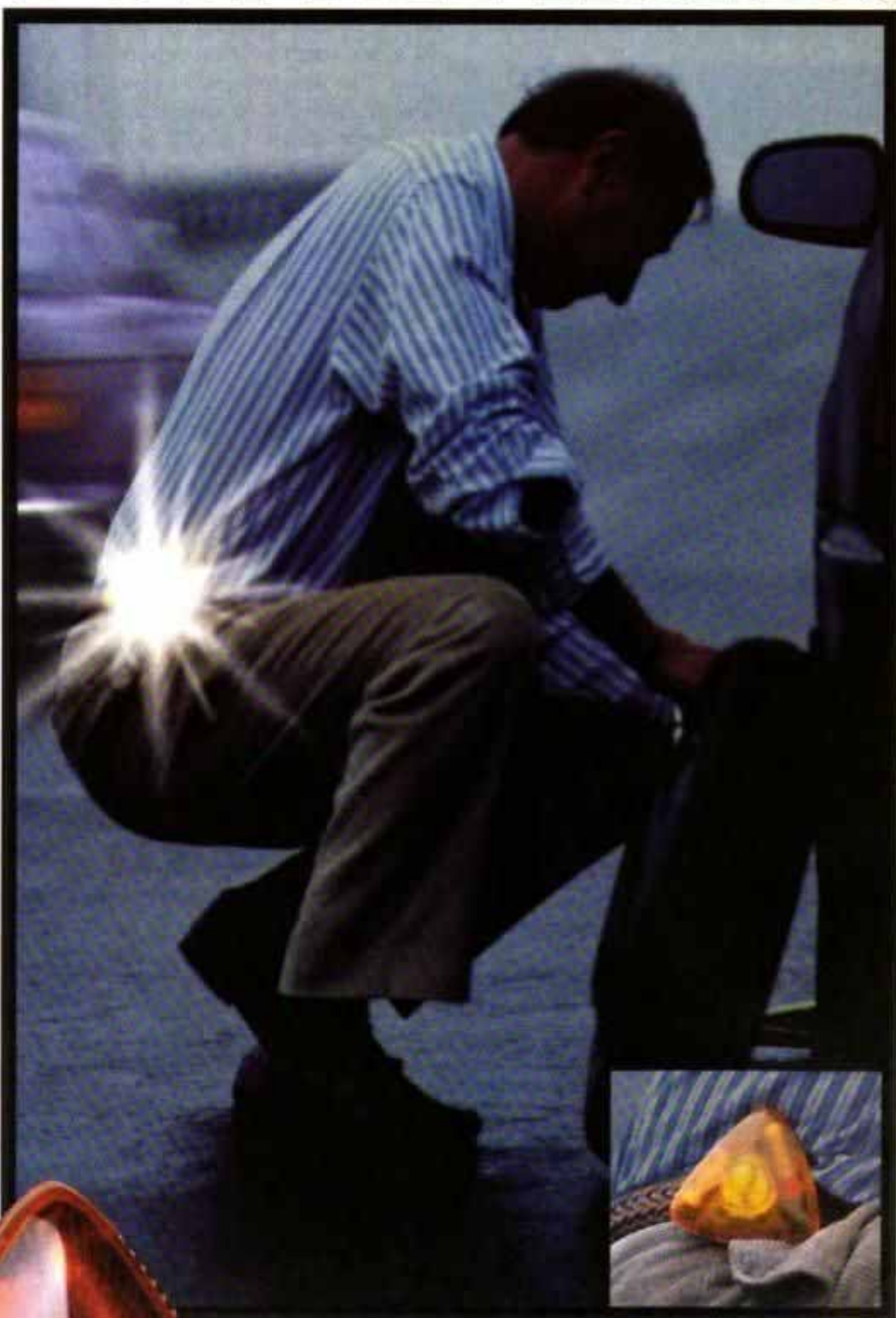
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"I DEPEND ON MY GRIZZLY EQUIPMENT."

Al Rosen

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Homeowners Clinic

BY NORMAN BECKER, P.E.,
Contributing Editor
PM Illustrations by
George Retseck

Indirect-Fired Water Heater

I am considering installing an indirect-fired water heater but cannot find sufficient information. Any help would be appreciated. Thank you.

JOHN DEVEREAUX
HUNTINGTON, NY

The indirect-fired water heater was developed about 20 years ago. It's called indirect-fired because water from the boiler is the heat source.

There are basically two types of heat exchangers used in indirect-fired water heaters. One is a coil inside the tank (shown), and the other is a shell filled with hot water that surrounds the heater tank.

In both cases, the water heater is isolated from the space-heating system by zone valves.

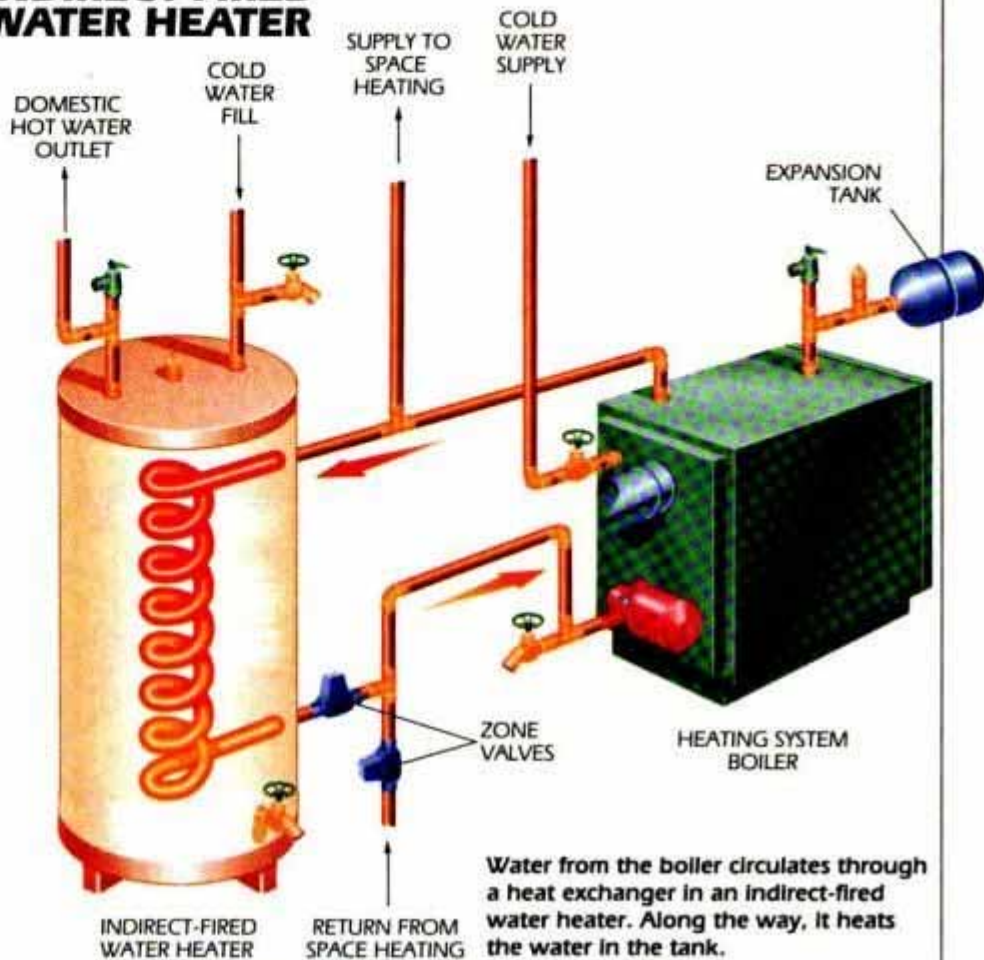
Indirect-fired water heaters generally have higher recovery rates than typical gas-fired or electric water heaters because they use the BTU output from the boiler as their heat source.

Also, they tend to be durable appliances, because they are not subject to thermal stresses produced by heating with a direct flame or heating element. Some manufacturers give a lifetime warranty for indirect-fired water heaters.

Dome Septic System

I have a home in the Poconos that uses an old-style septic system consisting of a tank and disposal field. The building code now requires a

INDIRECT-FIRED WATER HEATER



Water from the boiler circulates through a heat exchanger in an indirect-fired water heater. Along the way, it heats the water in the tank.

dome system. Where can I get information on building this system, and how it works and differs from the ground type?

DONALD ANDREWS
LITTLE FALLS, NJ

Rather than use the phrase "old-style septic system," I prefer to use the term "basic," or "conventional." The basic system is alive and well, and is still being used in many parts of the country. The dome, or mound, system that you refer to is a modified basic system, and is generally used in areas where the soil percolation rates are poor or in regions where the seasonal water table

is close to the ground surface.

Mound systems consist of a septic tank, pumping station and an absorption field that's built into an elevated sand mound. The mound usually consists of at least 12 in. of sand that meets specific guidelines as to clay content and the amount of coarse fragments. The sand is covered with gravel, and a 12-in.-deep layer of topsoil is spread over that. The mound must be built correctly or the system will not work properly.

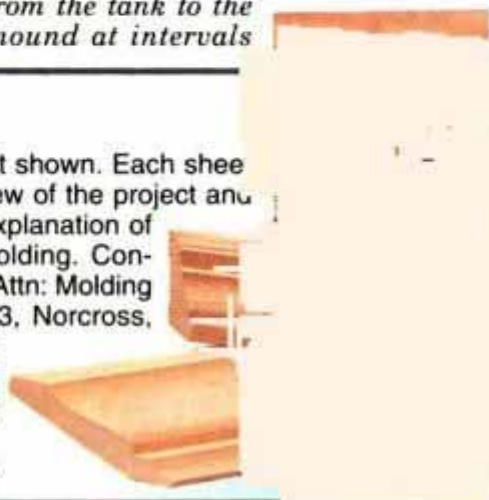
An underground pump chamber is located between the septic tank and the mound. It pumps effluent from the tank to the mound at intervals

Help With Moldings

• Winter is the perfect time to spruce up a room with wood moldings, and this brochure from Georgia Pacific is a good introduction to basic trim installation. It unfolds into 20 panels that take you through a variety of trim projects with crown, cove, bed and base moldings as they are used around doors, windows and walls. Each project is shown in a photo and the parts are clearly illustrated in a line drawing. Furthermore, the industry-standard profile number is given for each component. As an example: WM 49 is listed next to the crown molding it stands for. If you want more information, you can also order a separate

sheet for each project shown. Each sheet gives you a larger view of the project and provides a concise explanation of how to install the molding. Contact Georgia Pacific, Attn: Molding Dept., P.O. Box 1763, Norcross, GA 30091, or call (800) 284-5437. Ask for the *Combination Moulding* brochure.

—Roy Berendsohn



to prevent the absorption field in the mound from being clogged. The chamber has a capacity large enough to contain a full day's sewage flow.

For more information about mound systems, write to Agricultural and Biological Engineering Extension, The Pennsylvania State University, 246 Agricultural Engineering Building, University Park, PA 16802. Ask for Fact Sheet F-164.

Asbestos Shingle Disposal

In an article in your August '94 issue, you answered a question about asbestos shingles that were installed on a house in Yorktown Heights, New York.

Possibly it is different in New York State, but in Minnesota, a homeowner is allowed to remove asbestos in his own home and can dispose of it without any restrictions. Although people should not take shortcuts when removing asbestos, it can be removed. Your comments, please.

PAT O'BRIEN
 MORA, MN

According to the federal Environmental Protection Agency, the regulations that govern asbestos removal and disposal are the National Emission Standards for Hazardous Air Pollutants. These rules, however, do not apply to houses of four families or less. You are correct in that someone who owns a single-family residence can remove and dispose of asbestos cement shingles without being subject to federal restrictions that apply to contractors. Nevertheless, there may be state and local ordinances governing asbestos shingles and their removal. These may prohibit removal and disposal by anyone other than a licensed and certified asbestos contractor.

Before removing any asbestos-containing material from your

Electric Heater Safety

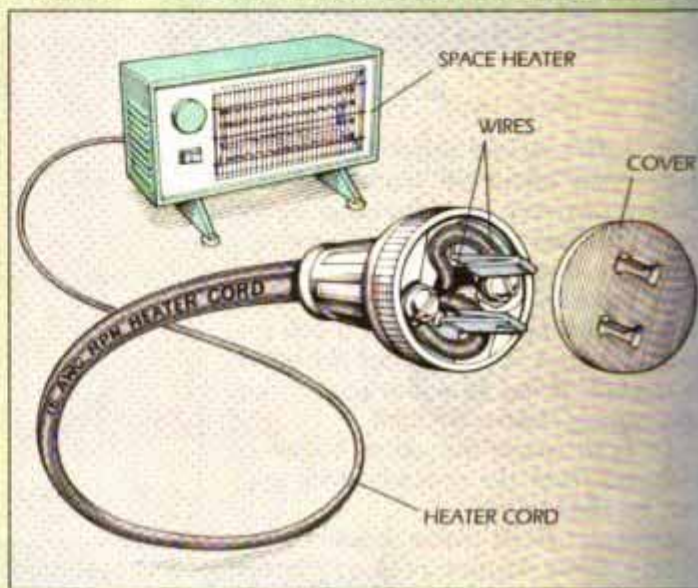
● Before using your electric heater this season, give some thought to the condition of its cord. Heaters often suffer rough use, especially in work areas, and their cords may get damaged as a result. A homeowner can repair a light-wattage cord, but repairing a high-wattage cord is best left to a technician. An inexperienced person may use the wrong cord type, the right cord type but the wrong amperage, or he might use the right cord type but make the electrical connections improperly.

First, check that the cord does not have a loose plug or damaged insulation. Next, plug in the heater and wait 15 minutes—the cord should not be hot. If these problems exist, bring the appliance in for service. Even though the appliance came with a molded plug and cord, the servicer may use a separate plug and cord. There's nothing improper about this. With a separate plug, the cord wires wrap clockwise around the prongs and terminal screws, as shown. This makes for a very firm connection. However, you should check that HPN heater cord is used. This is the only acceptable cord for electric heaters, and it's easy to verify: The HPN designation is printed on the cord. One last safety tip: Vacuum the dust out of the appliance before using it.

—Sterling Frey



APPLIANCE CARE TIP



house, you should check with your local government authority.

Self-Flushing Toilet

I don't know why, but every so often my toilet flushes by itself. It's quite disturbing. About 10 years ago, I had a water-pressure reducer put on my waterline. I wonder if this causes it.

BLANCHE A. DIAMOND
 BALTIMORE, MD

When a toilet flushes by itself in the middle of the night, it's enough to

make you think you have a ghost living with you.

The flushing is actually caused by a deteriorated flapper or tank ball that covers the flush-valve opening in the toilet tank. If either the flapper or ball has deteriorated, water will leak out of the tank. The water level in the tank will drop and trip the fill valve, and the toilet tank will refill with water. When this happens, it sounds like the toilet has flushed when actually it is only the tank refilling with water.

When the ball and flapper are badly deteriorated, the leaking water will be quite noisy and noticeable. When they are not badly deteriorated, the water loss is hardly noticeable.

To correct it, drain the tank and scrub the valve seat with steel wool to ensure a watertight seal. Then, install a new ball or flapper. **FM**

BUZZWORD

● If you've shopped for a household air cleaner or a filter for one lately, you've probably noticed the acronym HEPA. Pronounced like the first two syllables in hepatitis, it stands for high-efficiency particulate air. It describes the ability of the filter or air cleaner to capture particles. The acronym originated in World War II to describe filters used in gas masks, and a military specification was written to describe these filters. The

HEPA

specification requires that a HEPA filter remove at least 99.97% of the particles in the air down to three-tenths of a micron in size (a micron is one-millionth of a meter). Particles this small are troublesome. They are small enough to escape most types of filtration and are easily inhaled. It's no surprise, then, that particles that trigger asthma and allergies fall within this size range.

—Roy Berendsohn

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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



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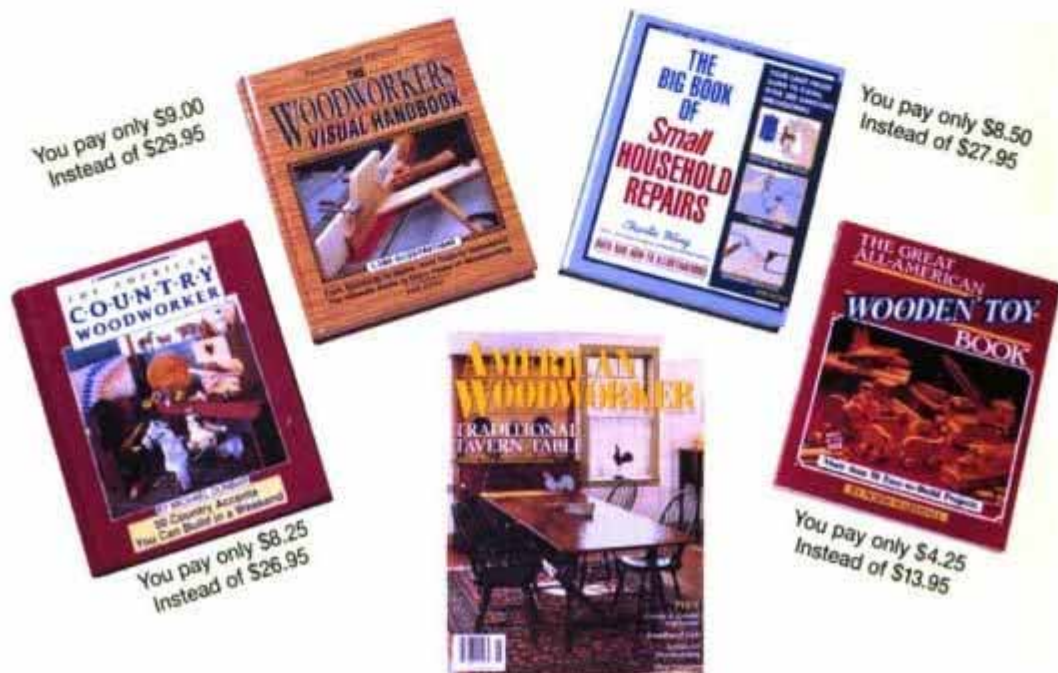
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P

HOME
IMPROVEMENTHow To
Finish
Drywall

BY STEVEN WILLSON,
Home Improvement Editor
PM Illustrations by
George Retseck

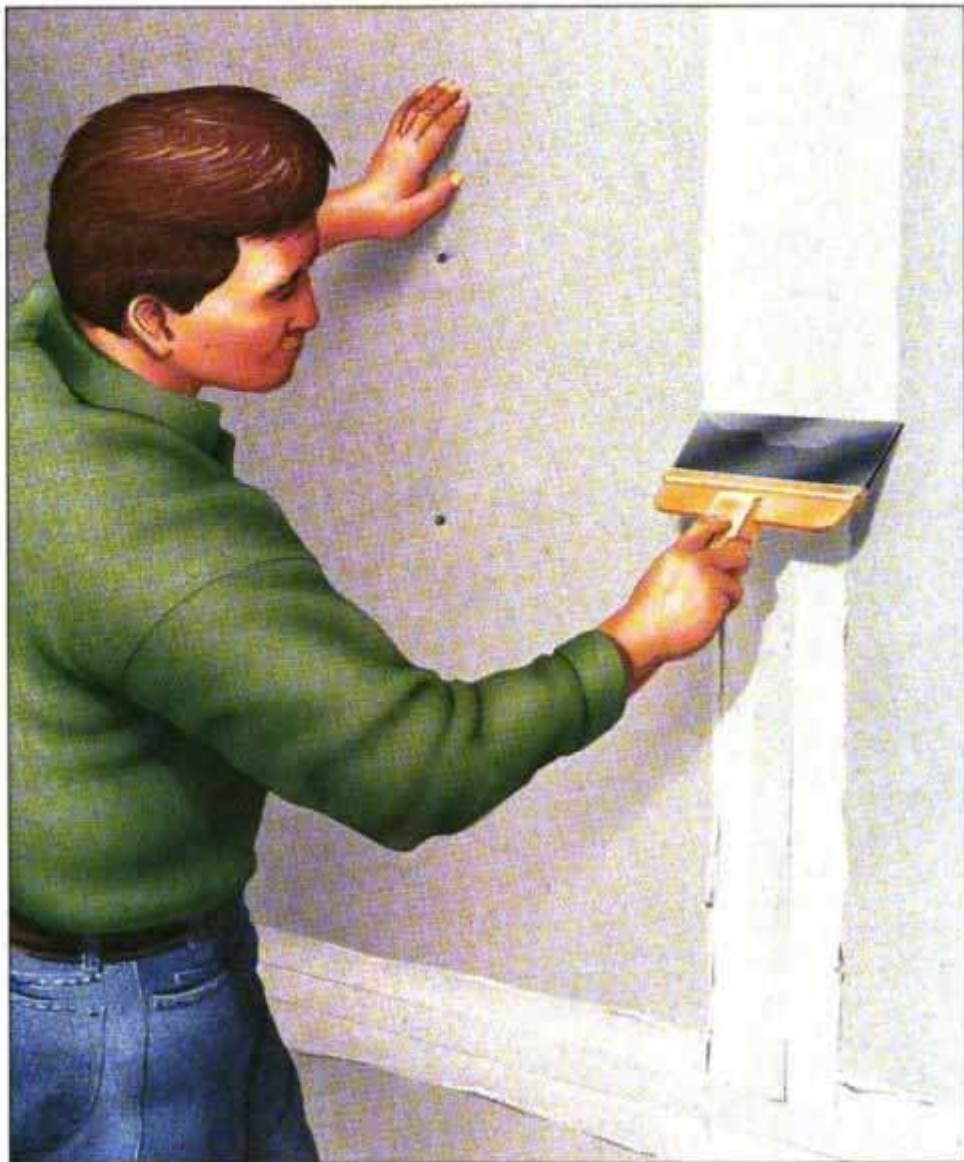
● There are few home improvement tasks greeted with more dread than finishing drywall. You may call it taping, or even Spackling, and you may be able to avoid expletives altogether when talking about it. But if you're like most people, you hope that you've already done your last finishing job. Unfortunately, if you enjoy working on your home and have even modest plans for remodeling in the future, you are bound to be confronted by this old nemesis again. So it could be worth your while to check out the tips and techniques we discuss here.

Before you begin

The selection of tools we show here (Fig. 1) is not the only one that will work. Some people prefer a 6-in. knife for applying the first coat of compound. And then they follow with a 10-in. knife for the second coat and a 12-in. blade for the final skim coat. Generally speaking, these wider knives are harder to control, so that's why we recommend a narrower knife for each step. Regardless of your preference, just make sure that the knife blades are all very flexible. You should be able to easily bend the blades as shown.

Your selection of compound is just as important as your selection of tools. Compound is available in two types. One is called a setting compound that hardens by a chemical reaction. The other is a drying compound that cures by evaporation. The latter is available in powder or a ready-mix version, but for most people the ready-mix version is much more convenient.

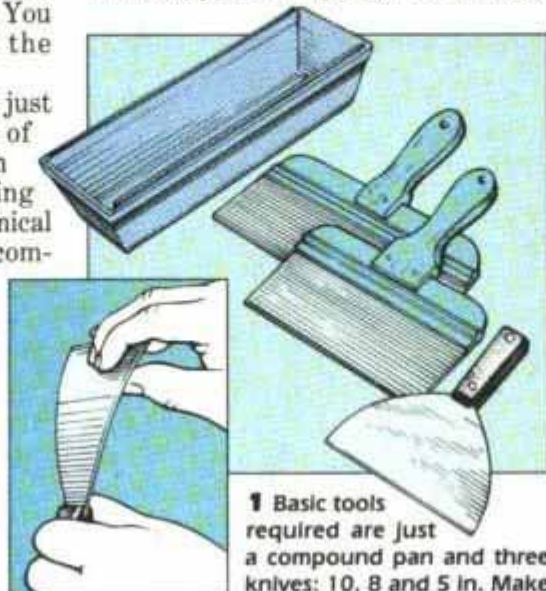
For this job we used USG's relatively new ready-mix drying compound called Lightweight Plus 3. It's supposed to shrink less, weigh less and be easier to sand than the company's standard drying compound, without



sacrificing any strength. After using the product to finish an entire house, we have to agree.

You also have a choice when it comes to joint tape—between paper tape and self-sticking fiberglass mesh tape. The great advantage

of the fiberglass tape is that it eliminates the need for the first coat of compound—and that's a big deal. But tape manufacturers say the fiberglass product should be used only with setting compounds, not drying ones. In our opinion, the difficulties of working with a setting compound outweigh the advantage of using the fiberglass tape.



1 Basic tools required are just a compound pan and three knives: 10, 8 and 5 in. Make sure knife blades are flexible.



2 Premixed joint compound is the best choice for most work. Buy an inexpensive cover tool to open the 5-gal. buckets.

One last tip: If you buy your compound in 5-gal. pails like we did, be sure to buy an opening tool like the one shown (Fig. 2). It costs about \$1, and opening these pails without one is very frustrating.

Getting started

There are probably as many approaches to the finishing process as there are finishers. But a few rules of thumb are appropriate for beginners.



3 Though not required, your results will improve if you stir the compound with a mixing paddle chucked into an electric drill.

First, always keep your knives as clean as possible. This means wiping off the excess compound on the edge of the pan after each pass with the knife. Second, never mix dried compound into fresh compound. Even the smallest piece of dried debris will leave a messy gouge in the finished surface. If dried compound does find its way into your pan or pail, remove it immediately. Finally, remember that the surface of the compound will



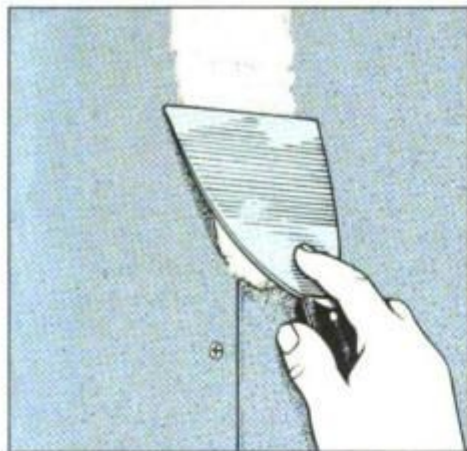
4 Begin work on the butt joints by loading a 5-in. knife with compound. Scrape the excess compound off both corners of the knife.

be only as smooth as the stroke you use to apply it. In the beginning, make a concerted effort to lengthen your strokes and keep the knife aligned with the direction of the joint. Until you get the knack, compound will certainly squeeze off the knife and fall to the floor. But by loading the knife with less compound, you can minimize the mess.

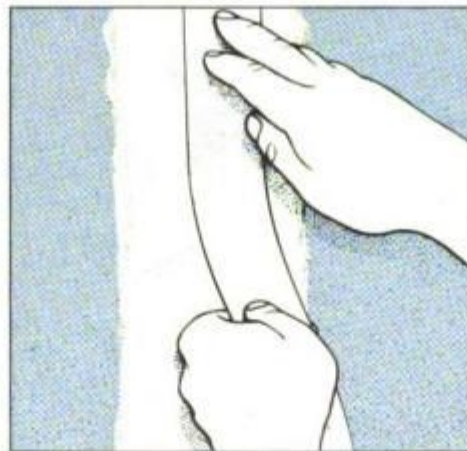
Joint sequence usually begins with the butt joints—those on the ends of the boards—followed by tapered joints—those along the edges—followed by inside corners and then outside corners. Keep in mind that the inside corners have to be done in two steps because you can only work on one side of the joint at a time. If you try to finish both sides at once, your knife will foul the first side while you work on the second side.

Butt and tapered joints

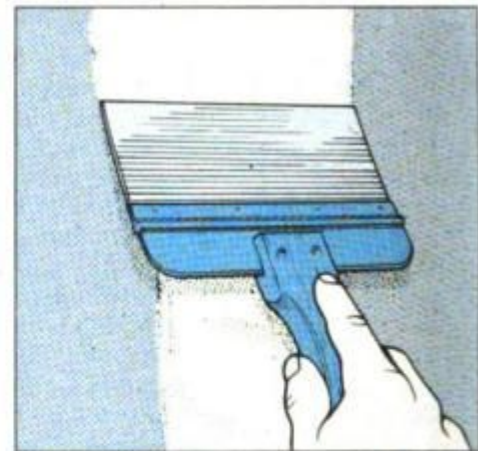
Begin work by mixing the joint compound (Fig. 3). Although this isn't absolutely necessary with ready-mix compounds, it does smooth out the compound and make it easier to apply. Starting at a butt joint, load up a 5-in. knife, making sure its corners



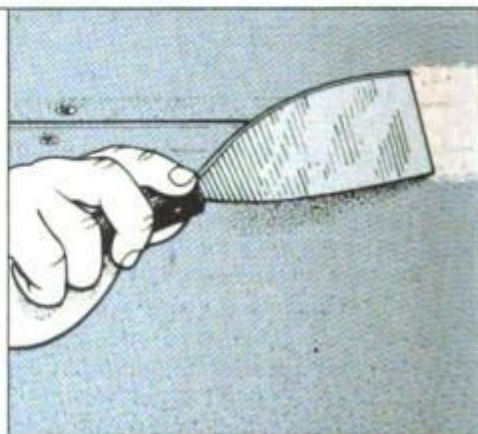
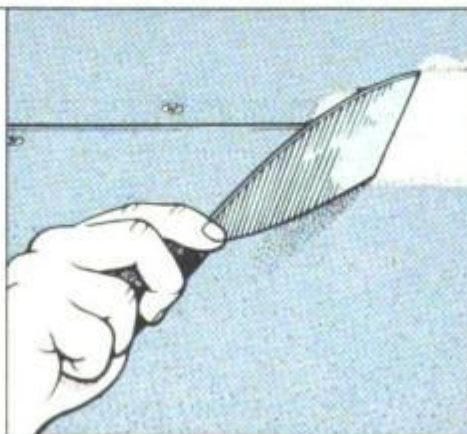
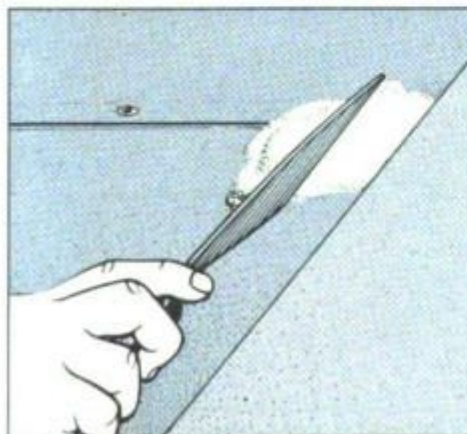
5 Starting at one end of the butt joint, apply the compound to the wall. Use one continuous stroke until the knife is empty.



6 Once the entire joint is covered smoothly with compound, cut a piece of tape and embed it in the compound over the joint line.



7 Having embedded the tape in the compound, cover the tape with another coat of compound using an 8-in. knife.



8 Finishing ceiling joints is difficult because the compound tends to fall. Proper knife control (as shown from left to right) can prevent this mess. Press the knife firmly against the ceiling. Then, as you draw it across the ceiling, flatten out the blade.

are clean (Fig. 4), and apply the compound starting at one end of the joint (Fig. 5). Work as smoothly as you can, reloading the knife when you run out.

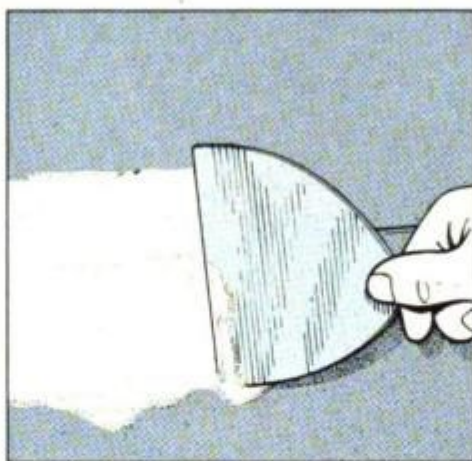
Then, clean off the knife on the side of the pan and smooth the entire joint in one stroke. Don't press so hard that you remove all of the compound. If you scrape the surface clean in an area, reapply compound because the paper tape won't stick to the paper covering on the drywall without compound underneath. Once the compound is smooth, cut a piece of joint tape to length and embed it in the compound using your fingers (Fig. 6). Align the middle of the paper directly over the middle of the butt joint.

With a 5-in. knife, smooth the tape into the compound and wipe off any excess that squeezes out. Your goal is to get enough compound on the wall to hold the tape, but not so much that you leave a noticeable bump. After a little practice, you should be able to get a relatively smooth surface with the tape straight and flat.

Once the tape is in place, cover the entire joint with more compound, this time using an 8-in. knife (Fig. 7). Use the same techniques as described with the 5-in. knife.

Certainly one of the most difficult joints is a ceiling butt joint. In the first place, you are working over your head, which is always awkward. And in the second, a butt joint has no tapered edges that tend to hold compound better. To start such a joint, load your knife as before and press it against the ceiling. Then slowly move across the joint in a smooth stroke, progressively flattening the knife as you move (Fig. 8). This will help reduce falling compound while at the same time yield a smoother surface. It does take time to get the feel of it, but with practice, you can keep the mess to a minimum.

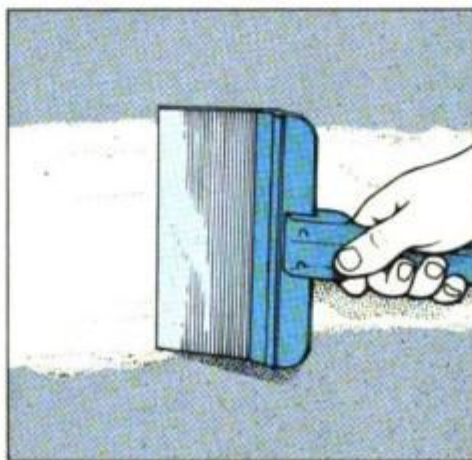
The tapered joints are easier to finish because of the depression built into the long edges of all drywall panels, but they are approached just like the butt joints. First, you fill the joint with compound using a 5-in. knife (Fig. 9). Then, you embed the tape with your fingers (Fig. 10) and smooth it into place with the 5-in. knife. Last, finish up the first coat by applying compound with an 8-in. knife (Fig. 11). When you are doing your flatwork, as the butt and tapered joints are sometimes called, it makes sense to cover the screw- or nail-heads, too. Just apply joint compound over each of them (Fig. 12), and scrape off the excess.



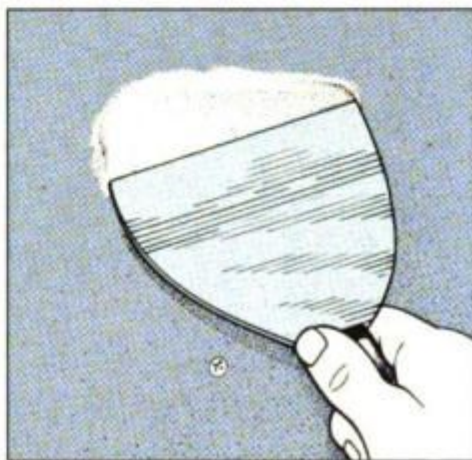
9 When all the butt joints are taped, turn to the tapered joints. Using a 5-in. knife, fill the tapered area with compound.



10 Once the base coat is smooth, embed the tape in the compound. Keep the middle of the tape directly over the joint line.



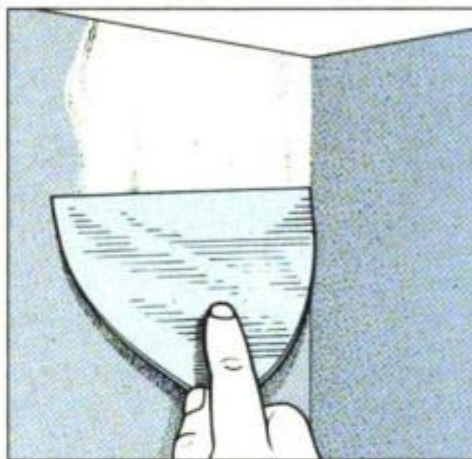
11 Smooth the tape into place using the 5-in. knife, and then cover the entire joint with compound using an 8-in. knife.



12 Fill the nail or screw depressions with compound using the 5-in. knife. Scrape off excess compound before proceeding.



13 To reduce compound squeeze-out when working on inside corners, load only one knife corner with compound.



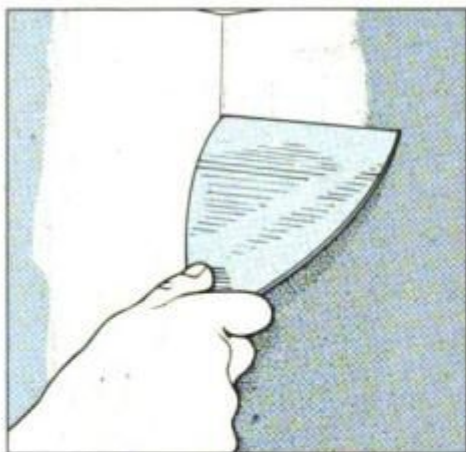
14 Press loaded knife against inside corner and move it smoothly along joint. Very little compound should squeeze out.

Corner Joints

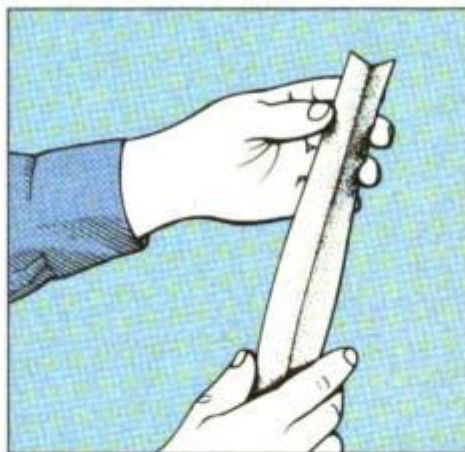
As mentioned earlier, inside corner joints are more difficult, because each stage—except the first—of the finishing process has to be done in two steps, to allow drying time in between. Although this seems inconvenient, sensible planning will allow you to organize your work in a way that incorporates the needed drying time.

To start an inside joint, first load a

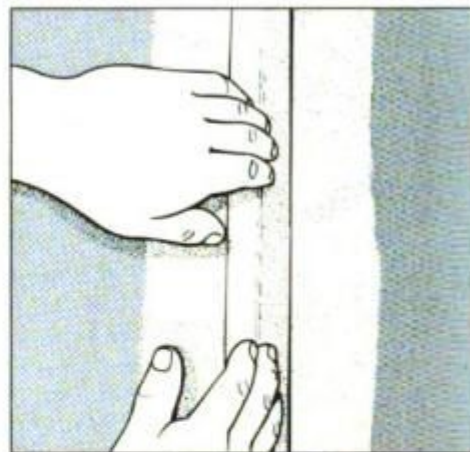
5-in. knife on one corner only (Fig. 13) and then apply the compound to one wall with a smooth, steady stroke (Fig. 14). By working in this fashion, you will limit the compound that squeezes out. Then load the other corner of the knife and coat the other side of the joint (Fig. 15). You are bound to foul the first side when you coat the second, but just try to avoid it as much as possible.



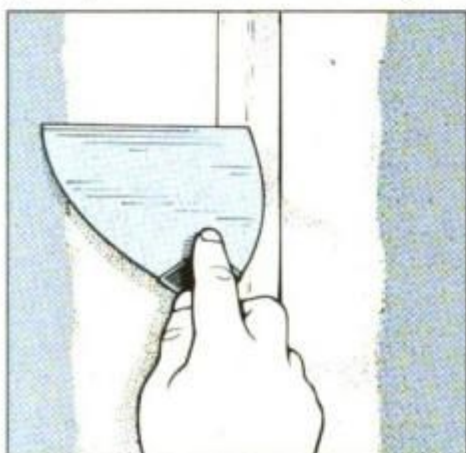
15 Once one side of the joint is coated, load the other corner of the knife and apply compound to the other side of the joint.



16 Cut the paper tape to length and fold it from end to end along the center depression line. Take care to avoid paper cuts.



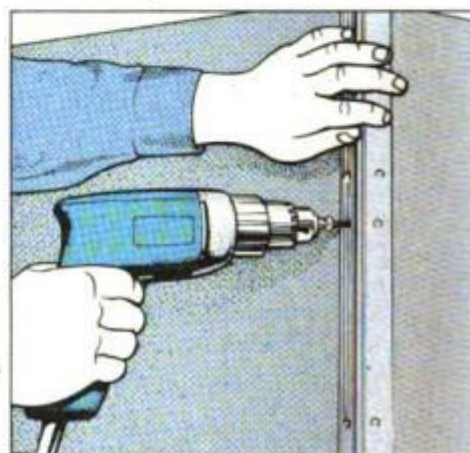
17 Carefully press the tape into the compound. Make sure the folded edge is aligned with the midpoint of the inside corner.



18 Lightly embed the tape in the compound using a 5-in. knife. Finish one side completely before moving to the other side.



19 Once both sides of the tape are embedded in the joint, add another coat of compound to one side using an 8-in. knife.

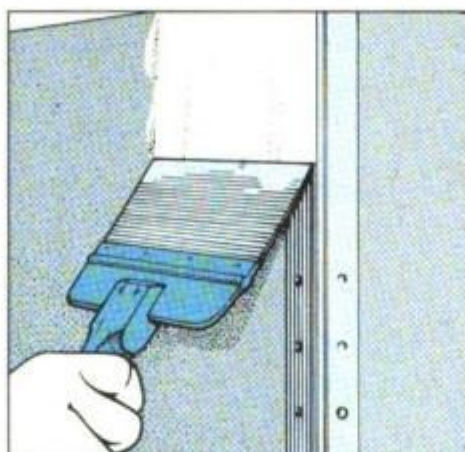


20 Outside corners require angled corner beads. Cut the bead to length and attach it with screws driven from both sides.

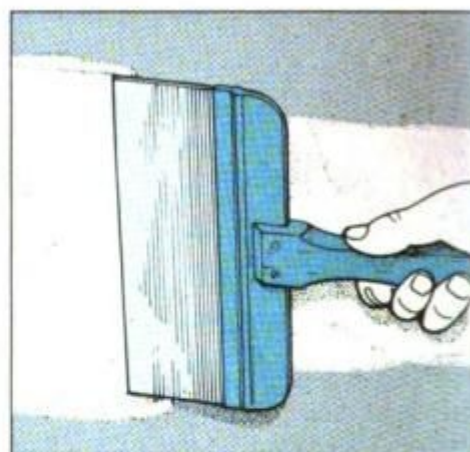
Next, cut a piece of tape to length and fold it down the middle (Fig. 16). Carefully push the tape into the joint with your fingers (Fig. 17). Make sure that the fold in the paper lines up with the corner of the joint. Embed the tape on one side of the joint at a time using a 5-in. knife (Fig. 18). Do not bear down hard. Just keep steady, even pressure on the knife and do your best to keep the surface smooth. Once the excess compound has been removed from both sides, apply a top coat to one side of the joint using an 8-in. knife (Fig. 19).

The inside corners along the ceiling are finished in the same way. When those are complete, move on to any outside corners. The first step in finishing these is to attach metal corner bead to the joint with drywall screws or nails (Fig. 20). Then, using an 8-in. knife, fill the area over the corner bead with compound (Fig. 21). Work on one side first and then finish off with the other.

At this point, you should return to coat the other side of all the inside corners, and then you'll be done with your first coat of compound. Once



21 Fill the depression created by the corner bead with compound using an 8-in. knife. Employ the corner of the bead as a guide.



22 When first coat of compound on all joints is dry, apply another coat using a 10-in. knife. Be sure to feather out both edges.

everything is dry, scrape off any ridges or chunks of dried compound with your 5-in. knife. If you've done a reasonable job of applying the compound, sanding isn't necessary. Remember, a depression is easy to fill on the next coat, but a ridge will prevent the knife from laying flat and will ruin any hopes of a smooth second coat. When everything is smooth again, use a 10-in. knife to apply a

second coat of compound, following the same joint sequence as you did for the first coat (Fig. 22).

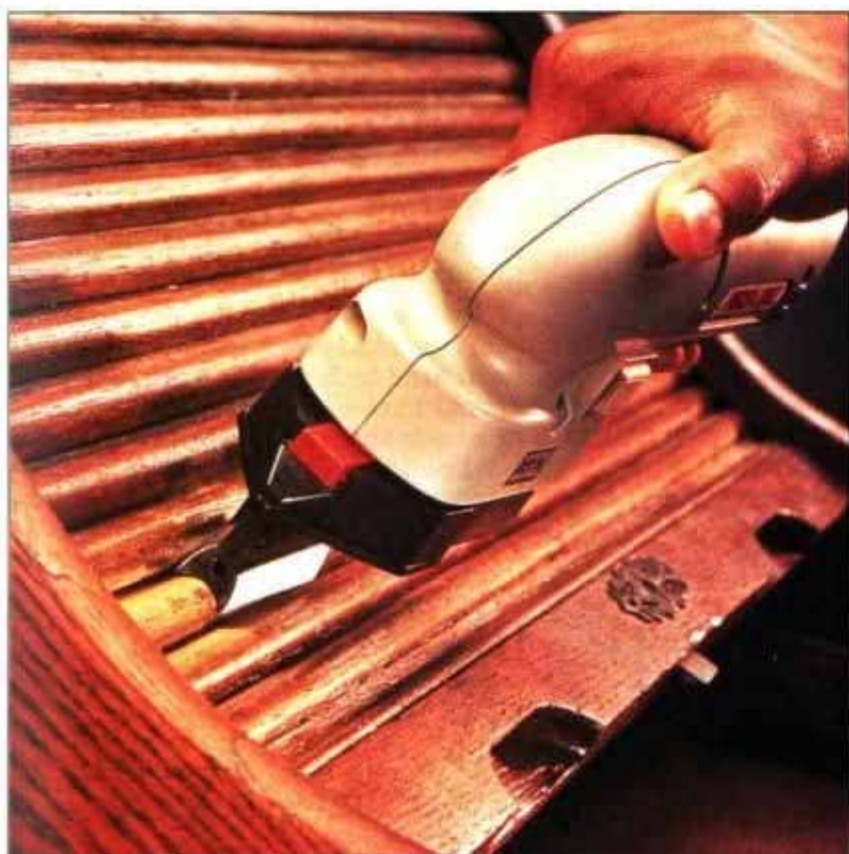
Repeat the whole process for a third coat, and when it's dry, sand the surface with 180- or 220-grit paper, making sure to wear a respirator and safety goggles. Then vacuum up the mess, apply a coat of primer to the walls and you'll be ready for paint or wallpaper. **PM**

NEW PRODUCTS

Top Tools

The cream of the crop from this year's National Hardware Show.

BY ROY BERENDSOHN,
Associate Home Improvement Editor

**A Perfect World**

In a perfect world, you'd never have to sand moldings, because routers and shapers would cut them flawlessly and chemical strippers would remove paint perfectly. But, as they say, the world is not perfect. To make contoured surfaces and inside corners easier to deal with, Porter-Cable has introduced its Model 9444 Profile Sander Kit. The tool moves at 6000 linear strokes per minute and comes with the following pads: six convex and six concave in radii starting at 1/8 in. and going up to 5/8 in., four that are triangular in section and two flat for sanding into corners. The curved sanding pads are semirigid foam, which you cut and apply adhesive-backed sandpaper to. The pads can also be cut to conform to any molding. A roll of sandpaper is included, and additional pads and sandpaper are available wherever the tool is sold. The profile sander kit costs about \$125 at hardware stores and home centers. Write Porter-Cable Corp., 4825 Hwy. 45 N., P.O. Box 2468, Jackson, TN 38302.

**Woodworker**

Ryobi's WDP1850 has several features designed specifically for woodworking, including a tilting bed with a wood insert, a sliding lever-lock fence and a built-in workpiece clamp. The drill head rotates 180°. And to top it off, literally, note the speed-control crank at the top of the drill head. It eliminates the need to switch the belt between pulleys. Turn the crank to adjust the speed from 500 to 3000 rpm. The machine has a cast-iron base and motor housing. It comes with a work-light and costs about \$450. To find the nearest distributor, contact Ryobi, 5201 Pearman Dairy Rd., Anderson, SC 29625; (800) 525-2579.

Just Add Water

This set of four water-lubricated sharpening stones (about \$160) is worth considering when it's time to replace your hollowed and glazed oilstones. We tried them and found they can quickly put a razor-sharp edge on a variety of woodworking hand tools. They come in the following types: a 220-grit green silicon-carbide stone for quick metal removal, and 1000-, 4000- and 8000-grit aluminum-oxide stones to take the tool to finish sharpness. Because you use water as the lubricant, there's no odor from sharpening fluids or oily rags. The stones are sold through woodworking catalogs and at tool stores. Contact Norton, One New Bond St., P.O. Box 15008, Worcester, MA 01615.





Cool Caliper

Model makers and anyone who loves gadgets will no doubt find this tool delightful: a digital caliper priced closer to a dial readout type, which is usually much cheaper. The Swiss-made instrument is constructed out of fiberglass-reinforced plastic, and sells for about \$75 at hardware stores, home centers and through tool catalogs. It gauges inside and outside diameters and hole depths up to 6 in. (152mm). For more information, contact General Tools Mfg. Co. Inc., 80 White St., New York, NY 10013.

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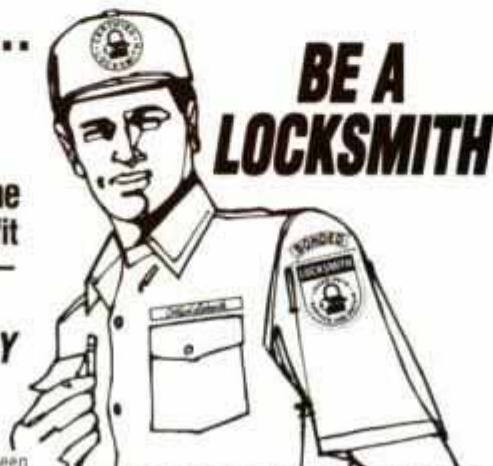
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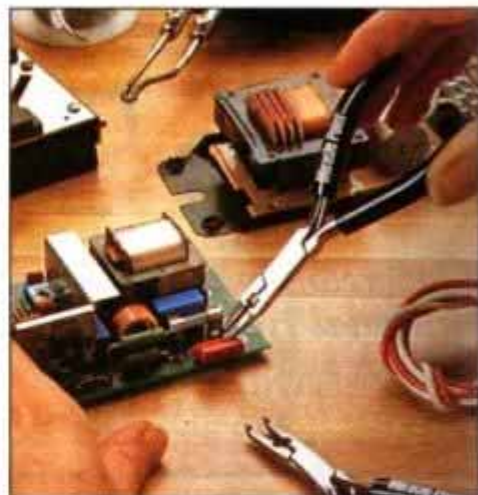
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All in One

Toolfree blade changing, toolfree shoe adjusting and a linear counterbalance drive system are the features that make the 10.5-amp Bosch B4610K unique among reciprocating saws. No other saw has all of these features. It also boasts two speeds: 0-2700 rpm for soft materials, such as wood, and 0-1900 rpm for hard materials, such as steel. And it has a variable-speed trigger, orbital and straight cutting action and a pivoting shoe to facilitate plunge cuts. It will be available in January for about \$190 to \$220 at hardware stores and home centers. For more information, write Bosch Power Tools, 4300 W. Peterson Ave., Chicago, IL 60646.



Stand Out

Just when you thought you had heard the last word about tape measures, along comes the 25-ft. Stanley Maximum Steel Contractor Grade tape. This tape has three rivets on the end hook, while the company's previous Powerlock models had only two. The slide lock is positioned high on the body for better access, and the tape itself is 25% thicker than the Powerlock's, a tool famous for its toughness. The extra thickness increases the rigidity and durability of the blade, enabling it to extend out 9 ft. without support. Also, the tape's back received a molded rubberlike grip, and the bright yellow casing makes it easy to spot once you've laid it down. It costs about \$14 at hardware stores and home centers. Write Stanley Tools, 600 Myrtle St., New Britain, CT 06053.



Make It Easy

The Delta Q-3 scroll saw has its ON/OFF switch and speed-control dial in the most convenient place: at the front of its graphite arm. Another ease-of-use feature is the convenience of being able to change its blade without using a wrench. The saw has an 18-in. throat capacity, and it cuts stock up to 2 in. thick. Its 16-in.-dia. cast-iron table tilts 45° right and 9° left. The machine's base also is cast iron. Here are two other benefits: It comes with a worklight and the adjustable steel stand shown here. The Q-3 costs about \$600 at Delta dealers. Contact Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15238; (800) 438-2486.

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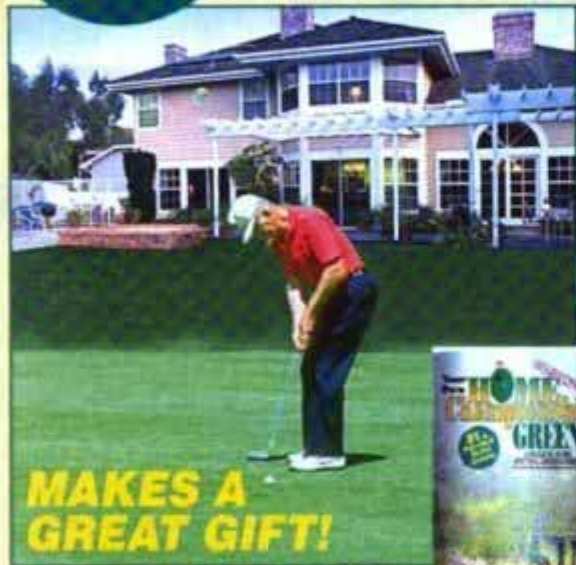
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HOME&SHOP JOURNAL



Weld It Yourself

Welding doesn't get more homeowner-oriented than it is with the Weld-Pak 100, a 110-volt, 15-amp wire-feed machine that costs about \$350 at home centers and hardware stores. To use it, find the thickness of the stock you are welding on the chart provided on the machine. Then, set the welder's controls where the chart tells you to. Put the welding gun in position, and when you pull the trigger, out feeds the flux-core (self-shielding) wire. The company says the machine welds up to 3/16-in.-thick low-carbon steel. A \$100 accessory converts it to a MIG welder (one that shields the arc with inert gas). And a 230-volt version, the Weld-Pak 155, is available for heavier applications (about \$520). Contact The Lincoln Electric Co., 22801 St. Clair Ave., Cleveland, OH 44117.

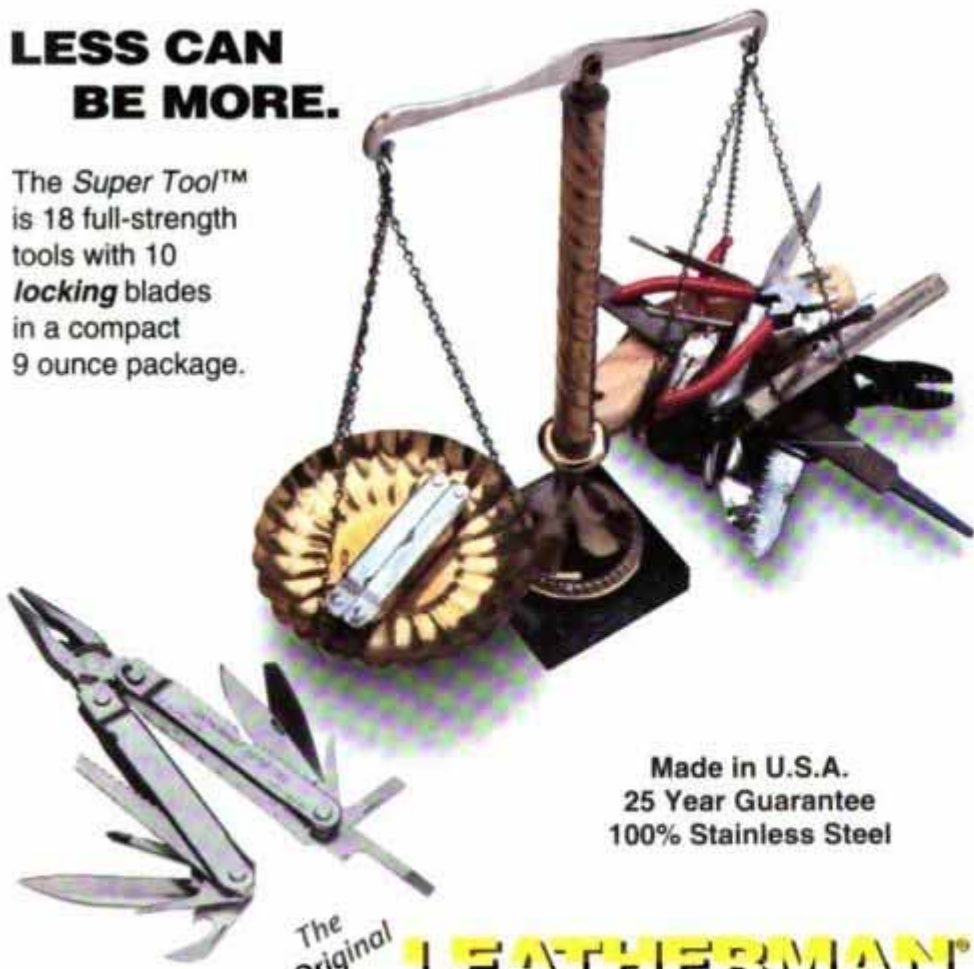


Steady There

You can put an end to unstable edge routing with this clear plastic retrofit router base (about \$17). Its screw-down knob provides a handle that allows you to apply counterbalancing pressure to keep the router on an even keel. Furthermore, when you use it, you can stand so that you get a better view of the router bit. It's sold at hardware stores and home centers. Write Vermont American, P.O. Box 340, Lincolnton, NC 28093.

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(More New Products on page 106)

We originated the little 2516-H COMPACT BENDER which has been extremely popular with both large and small companies, from the automakers right down to many home users. We even sold one to the prime minister of Malaysia.

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2516-H Compact Bender (Shown with optional tubing dies)

Specifications:

Capacity: Bends up to 3/16" x 2" flat, 3/4" solid round or solid square hot rolled mild steel. Sharp Right Angle Bend Attachment bends up to 3/16" x 2" or 1/4" x 1 1/4"

Tooling: Each machine includes (7) 1"-3" heat treated steel dies, die rack, square stock block, heat treated pins, stand, sharp right angle bend attachment, and instruction manual.

Weight: Approx. 60 pounds
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It costs us more to manufacture you a good industrial quality bender that will do more and uses special hardened and heat treated dies and pins, but it's worth it. The CNC carefully machined parts will actually fit our new patented attachments. Buy the best and next year when our new project book comes out you'll be glad you did. *If you feel you have been deceived into purchasing what you thought was one of our benders, you may want to consider returning it to it's source. Thanks to all our faithful customers.*



MADE IN USA



Se Habla Español



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#SB Ornamental Iron Scroll Attachment with Bench Mount Stand
Bends up to 3/16" x 1" hot rolled flat stock. Includes 112 page (full 8 1/2" x 11" pages) *Ornamental Iron Idea and Design Book*. Scroll attachment can be purchased without stand for \$98.00 (including book). Fits into the 2516 series compact benders.

SHOP OUTFITTERS

805 South Adams St., Dept. PM • Laramie, WY 82070



MADE IN USA

Potent Pair

If you want one cordless tool to do everything, consider this one: a 14.4-volt combination drill, hammer drill and driver (about \$395). As a drill, it operates as a reversible tool with settings of 0-600 rpm and 0-1750 rpm. Switch it to a hammer drill and it delivers 0-600 bpm (blows per minute) at low speed and 0-19,500 bpm at high speed. It has a 1/2-in.-dia. keyless chuck. A good bit to use is Black & Decker's Bullet Speed Tip Masonry Drill Bit. The bit is a rotary type, and is used without the hammer mode.

Its unusual flute design helps it quickly eject debris. In a cordless drill, this efficiency produces more holes per charge. We tried the bit and found it fast and easy to use. Depending on size, it costs between \$1.50 and \$3.50. Both tools are sold at hardware stores and



home centers. Contact DeWalt Industrial Tool Co., P.O. Box 158, 626 Hanover Pike, Hampstead, MD 21074; (800) 433-9258. Contact Black & Decker, P.O. Box 618, Hampstead, MD 21074; (800) 762-6672.

Go Further

Your tool purchase goes that extra mile with these pipe clamps, because they function as spreaders, too. Called the PowerPress, each has jaws that slide into position at both ends of the pipe. The head has a quick-release button, and the jaw has spring-loaded levers. The beauty of this design is that it doesn't require threaded pipe, and it's easier to use than conventional pipe clamps. A finely threaded screw allows for precise application of pressure. The flip

handle on the screw allows you to apply pressure when the head is located anywhere along the length of the pipe. Turn the jaws around and you have a clamp that acts as a spreader. The clamp costs \$20 to \$25 at hardware stores and home centers and through tool catalogs. Write American Tool Co., 8400 LakeView Pkwy., Suite 400, Kenosha, WI 53142.



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The Toolz They Are A-Changin'



*Bathing Suit Not Included

P212

Put It On The List

Thinking of adding a plate joiner to your power-tool arsenal? Add Makita to your list when you go out shopping. Its Model 3901 is powered by a 5.6-amp horizontally positioned motor, and has a 4-in.-dia. carbide-tipped blade adjustable to six cutting depths to accommodate No. 0, No. 10 and No. 20 biscuits. To change blades, just loosen a knob on the blade cover. The cover lifts off, giving you full access to the blade.

Its fence

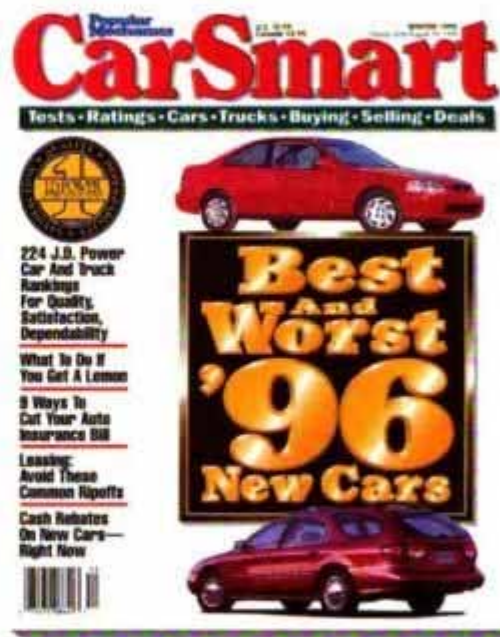


adjusts with a rack-and-pinion gear, and pivots to any angle from 45° to 90°. The 3901 is equipped with a dust nozzle that rotates through 360°, and a dust bag is standard. The tool comes complete with a plastic carrying case, and it costs about \$375 at hardware stores and home centers and through tool catalogs. For more information, write Makita, 14930 Northam St., La Mirada, CA 90638.

PM



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CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Thar She Blows!

I recently changed over to snow tires. The tire technician said that there was almost a gallon of water inside one of my regular tires—which probably explains the intermittent out-of-balance condition I was experiencing for the past few months. I think the guys at the corner gas station sabotaged my car in order to sell me new tires, because they were the only ones to keep my car overnight.

How can I prove this?

PAUL WESTCOTT
CHEBOYGAN, MI

You can't. It's not provable because it's probably not true.

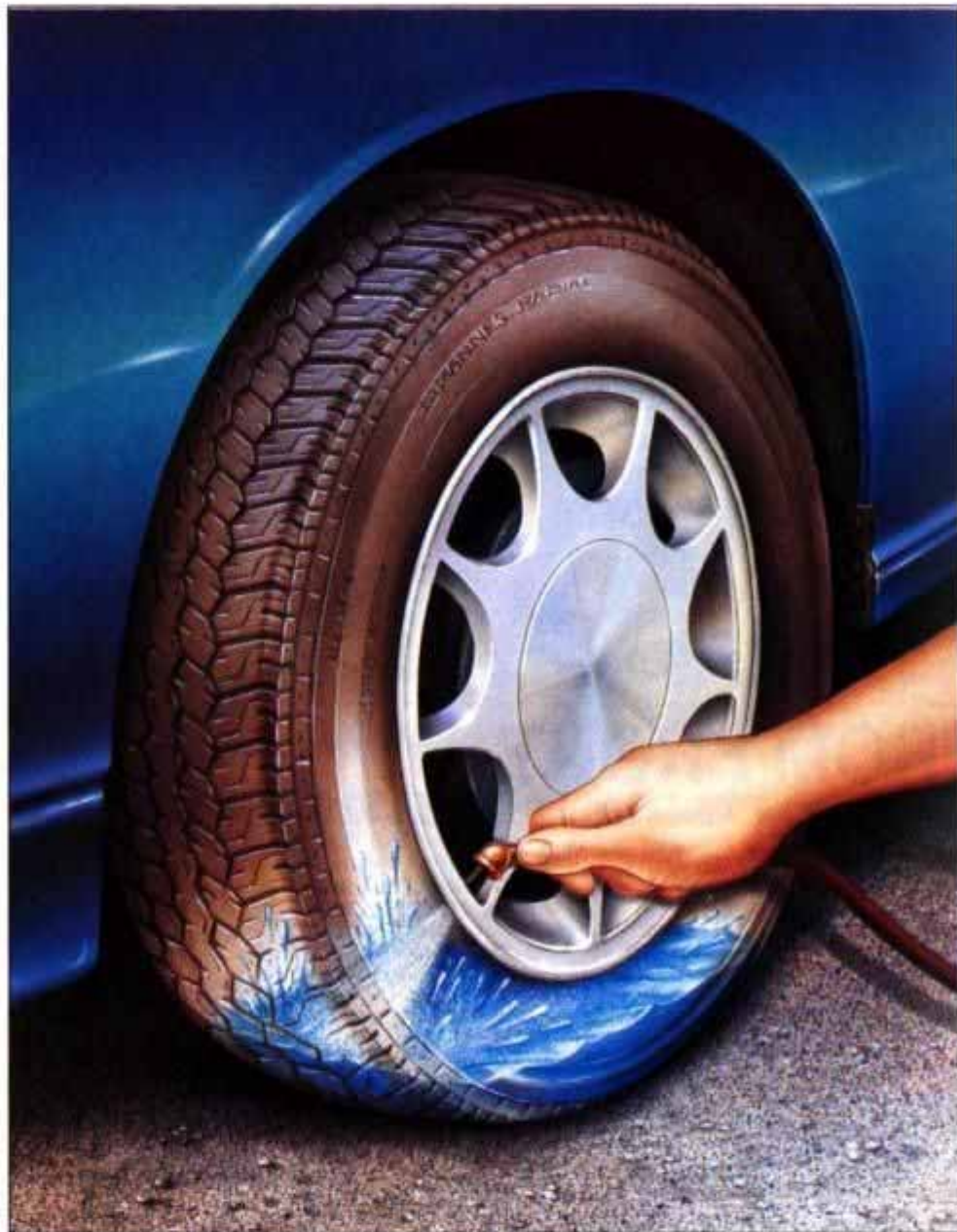
Air contains a significant amount of moisture—that's what's called humidity. Humidity can be very high during the summer, especially near the Great Lakes where you live. This water is sucked into the air compressor at every gas station and tire dealership, where it collects in the bottom of the compressor tank. Periodic draining of this water from the tank is necessary. In addition, there should be a water trap in the compressed-air line near the tank to catch any moisture that makes it into the tank's outlet. This water trap needs to be drained periodically, as well, maybe as often as once a day during the humid summer months.

Needless to say, any water that makes it into the hose is pumped into your tire when you add air.

Before inflating a tire, I recommend you do what I do—take your thumbnail or a pencil and depress the valve in the end of the air chuck for a few seconds. If your finger gets wet, there's water in the line.

How High The Moon?

I have a 1987 Ranger pickup that idles roughly and seems to lack power, even for a 4-cylinder engine. Could it be the elevation here in Colorado? Most of my driving is above 4000 ft. The truck was purchased in Ken-



tucky. Several mechanics have suggested that it might be the feedback carburetor.

ANDREW SELL
PUEBLO, CO

The thin air at high altitudes makes vehicles, like people, run poorly. Every time I go to Pikes Peak I'm amazed at how poorly whatever vehicle I'm driving runs.

There may be a high-altitude kit for your Ranger's carb. A good mechanic will know how to change the jetting to lean out the mixture, although this may make your engine run too lean at lower altitudes. Elevation was more of a problem before

feedback carburetors and fuel injection, which tend to compensate for thinner air. Adjustments should reduce the rough idling, but probably won't help the lack of power—you may see better fuel mileage, but not a great change in acceleration.

The Check's In The Mail

When accelerating uphill, the CHECK ENGINE light comes on in our 1985 Oldsmobile Cutlass. It goes out when on level ground. Our local mechanic can't find the problem. Is there any chance we're damaging the engine?

MAYNARD HOLLBERG
SPRING VALLEY, CA

Get a different mechanic, one who is willing and able to test drive the car while he's got his diagnostic scan tool hooked up to the car's computer. This will tell him pretty rapidly where to start looking for the problem. I assume he can't figure it out because the computer isn't setting any fault codes, so by the time the car is brought to him, there's no evidence of the problem. But if he uses his scan tool in its flight-recorder mode, he'll be able to capture the data stream from the computer when things are actually awry. In fact, he can just send you home from the shop with the tool connected, and you can return in the morning with the data in memory.

My best guess is that the O₂ sensor is getting lazy, which often happens with high-mileage cars. But don't install a new sensor on my guess. A test-drive up a hill with a scan tool recording should confirm this.

Gasket Aghast

There's a small leak at the corner of the oil pan on my 1991 Mercury Grand Marquis. A piece of the gasket just pushed out. The gasket is only about \$15—but the mechanic says the

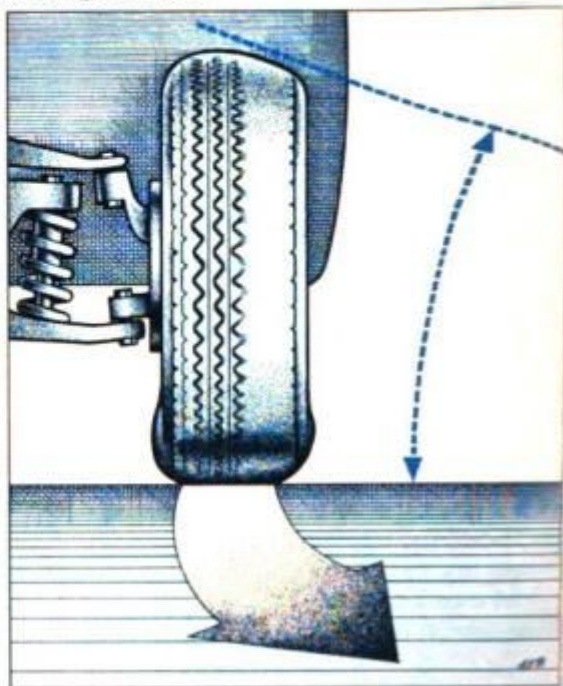
Return Of The Coneheads

● I got a phone call from a friend last week, right after she'd picked up her car from the alignment shop. She had taken it in because her front tires were wearing unevenly. But now her car pulled heavily to the right. She wanted me to go back to the shop with her, because she was sure that she—as a single woman—got ripped off.

I looked at her car. The tires were unevenly worn. I asked her why she hadn't replaced them before getting an alignment. She told me she didn't want to drive on her new tires from the tire store to the alignment shop.

The uneven wear, not poor alignment, was causing the pull (a large cone will tend to roll in a circle, not straight ahead like a cylinder). The shop should have told her to get the new tires first, to ensure pull-free steering and a correct alignment with the new tires.

My friend bought new tires that afternoon, and the alignment shop was happy to align her car again.



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CAR CARE

labor involved will be more than \$200. This seems absolutely absurd.

RON KELLEY
DUBLIN, PA

It is absurd. But true. And who said that modern fwd cars are harder to maintain? Your Merc is one of the last rear-drive V8 dinosaurs around, and you'd think it would be easy to fix a simple matter like this. Not so.

The service manual calls for removing the windshield-wiper assembly, the dipstick, a lot of plumbing, the fuel lines and the rear engine-mount bolts. Then, jacking up the engine several inches and propping pieces of wood into place to keep it raised. With that done, you can loosen the oil pan, but you still have to remove the oil-pump pickup tube to slide out the pan.

This all works out to more than 4 hours to replace the gasket. I'd suggest you use the best gasket you can find, as you won't want to go through this again.

Dazed And Confused

I'm confused about synthetic oil. My dealership mechanic says to use only conventional oil or my warranty will be void. Why do they make synthetic oil if it voids warranties?

GARY BENKELMAN
HAMBURG, NJ

SERVICE TIPS

● If your 1994 Toyota Camry's passenger footwell gets soaked after a heavy rain, a dealer can easily seal up the two known water entry points.

● Ford has recalled some 1994 F-Series trucks and Broncos because the front bumper may fall off while the vehicle is being driven.

● A new aluminum lace wheel center-cap retainer (PN 4472535) is available for 1990-93 Chrysler vehicles whose center caps keep falling off.

● Does your 1993-94 Honda Prelude drift to the right on flat roads? If so, it's probably caused by a defective power-steering 4-way spool valve (PN 53647-SM4-010).

● Oldsmobile has recalled certain 1994-95 Eighty Eights and Ninety Eights to inspect and replace the headlight switch, which can shut off unexpectedly.

● Nissan has come up with revised automatic transmission parts for 1993-94 Altimas, Maximas and Quests that sometimes cannot be shifted into Reverse gear.

If that's really what your mechanic said, he's wrong. Any SH-rated synthetic oil, like any SH-rated mineral oil, will meet the manufacturer's warranty specs, provided it's within the approved viscosity range listed in the owner's manual.

However, don't think you can change your oil less often because of the synthetic oil's superior lubricating qualities. First, the warranty requires that you adhere to the owner's manual mileage/oil change

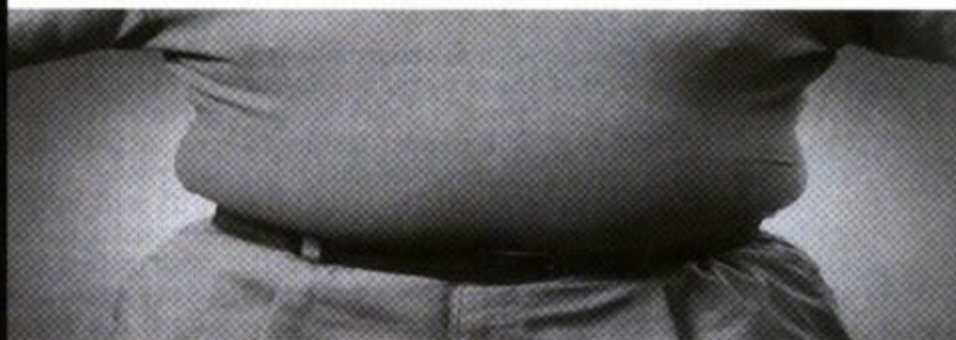
recommendations at a minimum. Second, no matter how good the oil is, it still becomes contaminated by road dirt, metallic wear particles, carbon, water, acids and unburned fuel—and needs to be changed on a regular basis.

PM

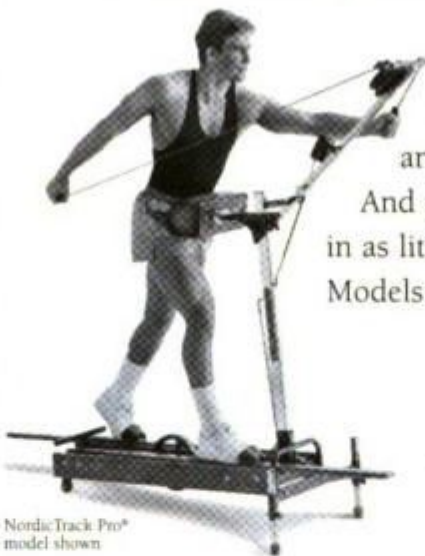
DO YOU HAVE A CAR PROBLEM?

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

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them from the damaging effects of heat. The gift pack sells for \$14.99 at mass merchandisers and auto parts outlets. Contact Auto-Shade Inc., 609 Science Dr., Moorpark, CA 93021; (800) 346-9453.

Power Sockets

With all of the electronic gizmos, such as radar detectors and cellular phones, prevalent these days, one in-car power socket isn't enough. Buttonwood's 2-socket Cigarette Lighter Extender features a green night-glow, HIGH-MID-LOW battery-strength indicators, 3-ft. heavy-gauge cord and a dual-contact mating plug with fuse protection. The unit costs \$19.95 (a plain, 3-socket version is also available for \$16.95). You can order both versions directly from Buttonwood Enterprises, 135 Fort Lee Rd., Leonia, NJ 07605; (800) 592-5513.



Emergency Road Kit

When travel tribulations occur without warning, this gift will help motorists deal with them. The Emergency Road Kit from Neiman Marcus contains many items no traveler should be without, including jumper cables, flares, flashlight, help sign/emergency flag, tire inflator and first-aid kit. All this fits into a durable, tire-shaped plastic case and sells for \$42. The kit is available through the 1995 Neiman Marcus Christmas Book and can be ordered by calling (800) 825-8000.



Creeper

Tired of creepers that tip and flip you and are stopped in their tracks by a dropped bolt? The Bone is a new creeper that cradles you between its large, 5-in. industrial wheels that roll over just about anything. Low, 1-in. ground clearance gives you more under-car room. The Bone provides a comfortable support for your body and a headrest to reduce fatigue. It costs \$119.95 and is available through tool and auto parts outlets. For more information, contact Pegasus Products Co., 315 Gougler Ave., Kent, OH 44240; (800) 266-3321.

It costs \$119.95 and is available through tool and auto parts outlets. For more information, contact Pegasus Products Co., 315 Gougler Ave., Kent, OH 44240; (800) 266-3321.



Performance Meter

Here's a great gift for performance buffs. The G-Tech Performance Meter automatically measures 0-60-mph times, horsepower, and cornering and braking (g-forces). About the size of a small radar detector, the meter mounts to the windshield and plugs into the cigarette lighter. Easy to use, all you do is plug it in and get moving. Accuracy is said to be within $\pm .01$ sec. for acceleration, within ± 1 hp for horsepower and within $\pm .01$ g for g-force. It costs \$99 and is available through auto parts outlets. Contact TESLA Electronics, 1653 Amberwood Dr., Suite 20, South Pasadena, CA 91030; (818) 403-0554. **FM**

Natural Prostate Relief

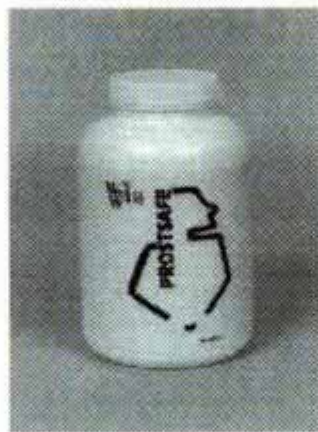
It's a natural fact. If you are a male over 40 and don't already suffer from a prostate gland disorder, the odds are 2 to 1 that you will before you are 59. By the age of 65, most American men have enlarged prostates.

As the years pass, mild discomforts can become disabling. Today, prostate surgery is the second most commonly performed surgery in men over age 65! Surgical complications can include total loss of bladder control and sexual dysfunction.

Prescription drugs may halt the swelling, but rarely ends the suffering. Like many prescription drugs, they have side-effects, like weak erections and low sex drive.

Many doctors feel that prostate disorders can be treated or prevented by giving the prostate gland the nutrition it lacks.

Recent scientific research has shown how to remedy the underlying problems associated with prostate disorders--safely and effectively. These results have been published in the *British Journal of Clinical Pharmacology*, the *American Journal of Gerontology* and papers from the *National Cancer Institute*. They reveal that several vitamins, minerals and natural herbs can dramatically shrink the prostate and improve urinary performance in older men.



The most modern application of these healthy ingredients is found in **Prostsafeproduct** from Whitewing Labs. **Prostsafeproduct** is the nutritional "tool kit" for men with prostate problems, and those who wish to prevent them. It is a mixture of zinc, serenoa serrulata, ginseng, certain amino acids, bee pollen and vitamins A, B-6 and E. Working as a team, these ingredients have been scientifically proven to shrink a swollen prostate.



Dr. Michael Rosenbaum, M.D. says "Prostsafeproduct supplies essential vitamins, minerals and herbs needed to nourish and maintain a healthy prostate."

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- Improve bladder control!**
- Empty bladder completely!**
- Sustain erections and enhance virility!**
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THE DOG DAYS

It's a long summer drought for Team PM.

BY AL PEARCE

● Darrell Waltrip and his Western Auto/POPULAR MECHANICS race team continued its more-bad-news-than-good season.

GM Goodwrench Dealer 400

The team started 32nd at the 400-miler at the Michigan International Speedway and finished 15th.

Waltrip held his own through the first 100 miles, but lost a lap when he pitted one lap before a yellow caution. Darrell summed it up, "The chassis was off and we had our hands full."

Goody's 500

For the second time this season, the team was a threat at Tennessee's Bristol Raceway. Waltrip qualified 20th, but quickly came to the front of the pack.

He ran a solid race, leading laps 306 and 307 before reaching the checkered flag fourth. "We had an awfully good car, and I thought it was going to be our night," Waltrip said.

Mountain Dew Southern 500

The 367-lap, 500-mile race at Darlington Raceway marked the third anniversary of Waltrip's last NASCAR victory. But there would be no repeat. His new Chevy Monte Carlo had teething problems and just didn't embrace the slick and treacherous track.

Waltrip was lapped early and was simply riding out the race when several backmarkers crashed right in front of him. There was nowhere to go except the outside wall. Waltrip hit it hard.

"There were three cars side by side going into Turn 1, and you just can't do that here," Waltrip said. "They were in the middle of the track, and



the next thing I knew, I was in the middle of them. The car is killed."

Waltrip finished 40th, 104 laps behind race winner Jeff Gordon.

pitstop. By then, he was already a lap down to eventual winner Rusty Wallace. In the end, Waltrip finished 22nd, four laps behind.

MBNA Bank 500

This race was perhaps the team's most frustrating of the season. Waltrip started 19th in the 500-lap event in Dover, Delaware, and began experiencing chassis and handling problems with the car almost immediately.

"The car never did drive right," he said. After the crew changed suspension and chassis parts in the garage, Waltrip eventually finished 36th. **PM**



Miller Genuine Draft 400

Waltrip qualified 17th at the Richmond International Raceway. Unfortunately, a spark-plug wire somehow got jostled off, reducing the Western Auto/POPULAR MECHANICS Chevrolet Monte Carlo from a V8 to an underpowered V7 until Waltrip had the wire reattached during a



Waltrip wasn't even in contention at Darlington (top) or MIS (above left). At Bristol, he led brother Michael on his way to fourth (above). Waltrip with Ricky Hendrick (right).



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TALE OF THE TAPE

Tape drives move from a backup role for hard drives to a starting position as portable data carriers.

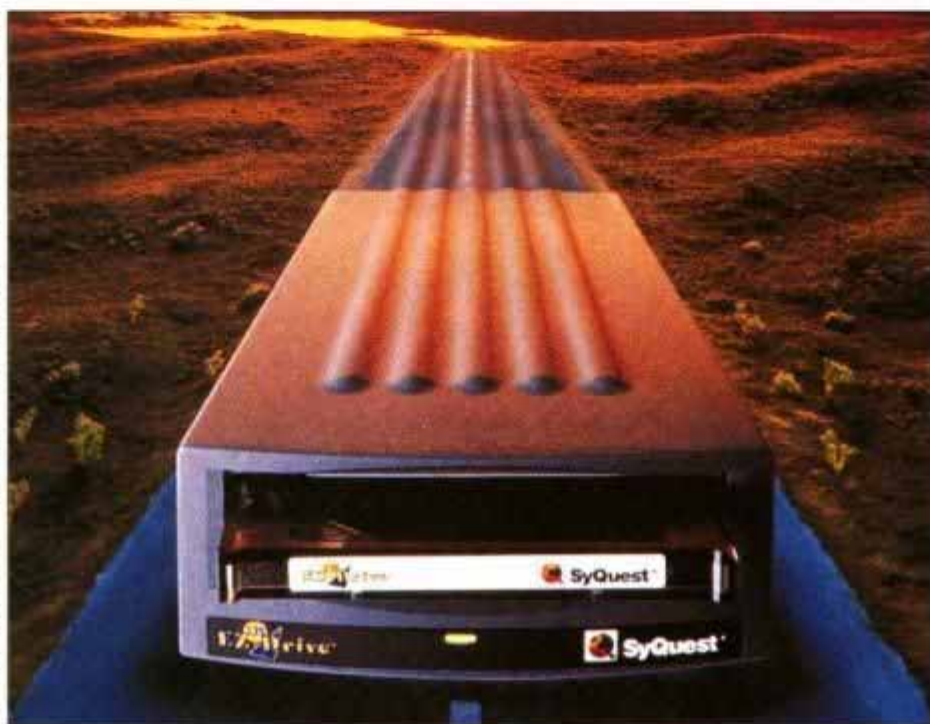
BY GEORGE MANNES

● How much is it worth to you to have an extra copy of all the programs and data on your hard drive? \$200? \$400? No more than \$25? Your answer probably depends on how bad your luck has already been with a computer—whether you've ever suffered the queasy realization that you've lost all the data on a hard drive that had not been backed up.

Each day, the universe of data that's worth backing up expands. Hard drives are ballooning, and inevitably filling to capacity. Connected to online

services and the Internet, people are downloading more and bigger files for personal productivity and amusement. In these data-inflationary times, using 1.44MB floppy disks to back up a 540MB hard drive doesn't quite cut it.

That's why manufacturers of removable media—tapes and disks that hold more than your usual floppy—are making a big push into the home-computer market. Used commonly by



SyQuest's EZ135 tape drive stores and retrieves mountains of information quickly.

businesses to back up hard drives, or to carry large graphic files from one location to another, multimegabyte removable cartridges are tempting home users with appealingly large memories and prices that are lower than ever.

Only 7% of computers sold come with drives for backing up

uncompressed megabytes of information on a tape ¼ in. wide and 400 ft. long. But the new, chubby 3M cartridges at the heart of the Ditto Easy 800 hold 400MB of uncompressed data, using a tape that's 0.0065 in. wider than the original QIC tapes and 350 ft. longer, for a total of 750 ft. (To put their products in the best light, Iomega and other manufacturers assume maximum 2:1 data compression when referring to the memory capacity of a tape. That's why Iomega sells the Ditto Easy "800" even though 3M says the new tape holds 400MB.)

10% solution

However you measure storage capacity, one of the most appealing attributes of the Ditto Easy 800 is its price. Since people typically won't spend more than 10% of the cost of their computer on hardware for backing up files, the Ditto Easy 800 has been priced to sell for around \$150 in stores, the company says. An 800MB (compressed) cartridge,

(Please turn to page 119)



Iomega's Zip drive paved the way for lower prices.

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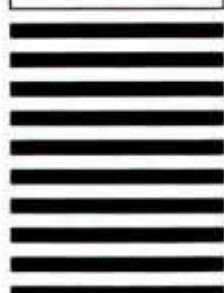
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CARD 103

Материал подготовлен авторским отделом...

cat's more powerful engine enables it to run away from the EXT on long, flat straightaways. By switching between sleds, Charlie and I enjoyed the best of both worlds.

After arriving at the Togwotee Lodge, Charlie uses the only pay phone at the hotel to call friends, colleagues, friends of friends and friends of colleagues. Eventually, he locates a driver who agrees to haul our Mountain Cats from Blackrock Ranger Station to Flagg Ranch, at which point the trail resumes. The driver is booked all day but has a one-hour window of opportunity. We need to be at the Blackrock Ranger Station at the appointed time or lose the ride. We arrive a few minutes late, but fortunately the driver is waiting.

From Flagg Ranch, it's an easy cruise to the border of Yellowstone, where we enter the most spectacular network of snowmobile trails in the world. The scenery is awesome, bison and elk are everywhere and the trails are long, wide and groomed to perfection. Charlie and I spend the night at the Old Faithful Snow Lodge, and in the morning catch a clockwork eruption of the lodge's namesake.

The next day, we run every possible route in the crown jewel of national parks, then cross the border into Montana. We reach West Yellowstone with a few hours left before sunset, and use the time to explore 30 additional miles of trails. As the sun goes down, we stand on the summit of Lion's Head Mountain at more than 10,000 ft. and survey a panorama that includes three states, two national parks and several gold-tipped mountain ranges.

After putting about 350 miles on my sled in three days (despite the trail closures), I can offer a few tips for anyone who wants to explore the longest snowmobile trail in the country. First, do it in January or February, when snow cover is normally at its peak. Charlie and I did it in early March because we wanted to ride '96-model snowmobiles. Second, plan the route and reserve all hotel rooms a month in advance. There are few lodges along the way, and most sell out during the short snowmobile season. Third, make the trip on the ultimate Continental Divide trail snowmobile—an Arctic Cat Mountain Cat, either a 700-cc Wildcat or a 580-cc EXT. Equip both with optional deep-snow Mountain Cat features, plus a touring rack, saddlebags and an EFI engine.

Oh, and do one more thing. Bring spare oil. The only light you want to see when the sky gets dark and you're in the mountains far from home is a headlight. They don't call dash-panel warnings idiot lights for nothing. **PM**

not included with the drive, costs an additional \$25. The drive is available in two versions: an internal model operated through a Windows-compatible PC's floppy disk controller and an external model that plugs into an enhanced parallel port.

A second selling point of the Ditto Easy 800 is the simplified software, which Iomega hopes will make it attractive to consumers turned off by the complexities of backup setups—the main hassles being how to specify which directories one wants to include or exclude, and whether the backup should be full, differential or incremental. In addition to these options, the Ditto Easy also features one-button operation as an alternative. Just clicking on an icon labeled "Backup" backs up a hard drive.

Though it's slick, the Ditto isn't quick. At its 10MB per minute transfer rate, it would take one hour and 20 minutes to back up an 800MB hard drive. According to Joseph, the backup runs in the background, though, so it won't interfere with programs.

Second hard drive

Removable disks are more than alternatives to tape for backing up hard drives: They're also useful as substitute hard drives, allowing people to add unlimited memory in increments of 100MB or so without being boxed in by the finite capacity of a hard drive.

Iomega debuted its Zip drive earlier this year. It uses flexible disks that can hold 100MB of uncompressed data on each. Priced at \$200 for a drive with one 3.5-in. disk, with additional disks costing \$20 apiece, the Zip is available in two external versions—one plugs into a parallel port and the other into a SCSI port. It has software for running in DOS, Windows, the Macintosh operating system and OS/2. The sustained transfer rate is a maximum of 1.4MB per second, and the seek time averages 29 milliseconds using the 100MB disks (25MB disks are faster). That makes the disk slower than a hard drive, but still fast enough, says Iomega, for a person to run a nonmultimedia program like a word processor directly from the Zip drive. Macintosh clonemaker Power Computing plans to be the first computer manufacturer to include internal Zip drives in its machines.

Fast rival

Playing the computer industry version of one-upmanship, Iomega rival SyQuest Technology has just released the EZ135 drive, a model that competes with the Zip and boasts some performance advantages. Based on nonflexible Winchester hard-disk technology, the EZ135 uses 135MB

disks. It claims an average seek time of 13.5 milliseconds and a sustained transfer rate ranging from 1.4MB to 2.4MB per second.

Like the Zip, the EZ135 is priced to sell: An internal model that plugs into a computer's IDE port is \$200, and an external SCSI version sells for around \$240. The 135MB disks sell for \$20 apiece.

Office to home

The flexibility of the EZ135 can make for some interesting applications, says Ron Brown, SyQuest's vice president of corporate marketing. Businesspeople who have a program they use both at home and at the office don't have to worry about copying data files back and forth from one computer to the other. Instead, they can buy an EZ135 drive for both machines, put the program and its related files on the same disk and just carry the disk back and forth between the two machines.

Though 135MB on a disk the size of today's floppy seems like a lot, consider Iomega's next step. The company says its forthcoming Jaz drive will fit 1070MB of data on the same real estate. Using a nonflexible hard disk, the Jaz drive will be priced at \$500 for an internal version and \$600 for an external one, with a disk included with each. Additional hard disks will cost \$120 apiece.

More capacity

Meanwhile, tape capacity isn't standing still either as 3M builds on the technology (dubbed "Travan") that's at the heart of its new 400MB QIC tapes. By the end of this year, 3M is planning to bring out tapes storing up to 1.6GB of uncompressed data. Next year, the goal is 4GB of data.

And if 3M has its way, tape drives won't be limited to file backups, either. Earlier this year, the company said it was working with PGSoft, a California-based company, to develop software to make its QIC and Travan tapes speedier. Such software, 3M hopes, will make it possible for tapes to record, retrieve and play back audio, video and other multimedia files, as if the tape were a diskette.

If you believe you couldn't possibly need a tape that holds 4GB of data, or even a disk that holds 1GB, think again. When this reporter bought a computer in 1992, I chose one with an 80MB hard drive, thinking that even 130MB was a waste of money. Knowing that, one might think that my current 1GB hard drive would last a lifetime. But after six months of use, it's half full. My new maxim is that if the data is worth holding onto, it's worth backing up. **PM**

game consoles could do in the past.

Much of what Mwave and Gambit do now in conjunction with Pentium chips will be done singlehandedly in the future by Intel's next-generation microprocessor, code-named the P6. According to Intel, this new chip has the kind of speed needed to perform speech-recognition and render complex 3D graphics.

The P6 gets its legs from a process called Dynamic Execution—the chip actually predicts what a program is going to ask it to do, and does so before it's asked. For now, the P6 is found only in high-level industrial computers—but by this time next year there will be enough 32-bit software available to make it worthwhile for home PCs. In fact, it doesn't work with 16-bit software at all.

More control

Windows 95 is already leading to advances in other products. You can thank Win95 for the GrIP (Gravis Interface Protocol), as in GrIP Multi-Port from peripherals-maker Advanced Gravis. It's a breakout box that accommodates four digital joysticks, or controllers, all with multiple-function buttons and operating in multiple axes.

Until now, the PC game-port standard has limited play to two controls

with two buttons and motion only in the X and Y axes. The analog system was slow, too, resulting in a 12% to 15% performance loss on most games. Also, joysticks and controller pads had to be recalibrated manually for different games. With the GrIP digital system and Windows 95, there's no sacrifice in game speed, and calibration is Plug And Play automatic. With six degrees of freedom in movement and 2-way, digital communication for tactile feedback, virtual reality is virtually a cinch on the PC.

Video editing by computer is virtually a done deal, too—another thing that used to be handled only by dedicated black boxes. There's lots of add-on hardware and software that will let camcorder owners edit their home movies on a PC, but the new Multimedia Star line introduced in Germany by Siemens has everything built in and hints at a new direction for PCs.

Besides an extensive array of audio/video jacks on the PC's front panel, Siemens' FD206 comes loaded with video-editing hardware and software. This includes a second hard-disk drive, for copying memory-hungry raw video.

Once recorded digitally, the signal-processing software lets the operator edit, rearrange the order of scenes, add special effects and otherwise em-

bellish the movie—all in the digital domain to preserve image quality. When the job is done, you simply copy the finished product to a VCR. No one offers such a VCR in the United States yet, but you could assemble your own. There are plenty of editing boards, which provide the needed audio/video jacks. And there's plenty of space for a second hard drive in minitower PCs such as Hewlett-Packard's Pavilion series. And where space is a concern, consider Packard Bell's new oddly styled desktop PC, which has bays to spare and is shaped to tuck away in a corner.

Window to tomorrow

What's next? Well, if PC-controlled desktop video sounds good, how about a video desktop that controls PCs? It's called the Modula-Executive (\$3500), the brainchild of a French company named Source Development, and sold in the United States by Source Innovation (310-988-6574).

This particular innovation combines PC input and output devices on what's basically a 27 × 19-in. electronic desk blotter. The keyboard and a flat LCD color monitor are embedded, and since the monitor is touch-sensitive, your finger does the work of a mouse. A loudspeaker and a microphone handle speakerphone, dictation-recording and general audio chores. No, the computer, memory and disk drives aren't built in—not yet, anyway. But a 2-way infrared link communicates with a PC up to 5 ft. away.

If this sounds like a shortcoming, don't sweat it. You could be wearing your next computer.

You'll be wearing it very soon if you're in the Army, Navy or any of several service industries now using InterVision's System Six. A 3.3-pound PC hitches to your belt like a canteen. You'll have to get used to a hard hat, though, because that's where the LCD monitor, headphones and microphone mount.

The microphone facilitates speech-activation or 2-way communications. Though the monitor is smaller than an inch diagonally, it simulates the image of a 17-in. TV to the nearby eye. When the eye is not focusing on the image, it can see right through the monitor.

System Six starts at \$8000, but prices tend to go down in the PC business. With the addition of a microphone, such a video visor could be the front end of a wallet-pocket PC with folding keyboard and credit-card-size flash memory devices. You can open Windows by voice today, but tomorrow? Don't blink. There's so much going on in eye-control technology that you'll probably just look at an icon to hop on the Internet.

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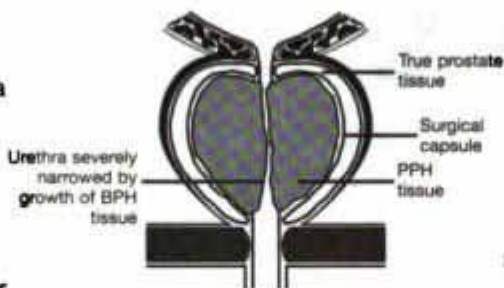
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The male prostate gland

Sidney L. Snow, M.D., a Urologist says, "An astonishing 80% of men will eventually get a prostate disorder. Prevention is the key. For many patients I see in my practice, the Serenoa contained in Pymoxin has



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The major cause of prostate problems is a malfunction in the hormonal system which introduces an unnatural hormone into the body. This hormone cause the cells of the prostate to multiply, thereby squeezing the urinary tract.

Dr. G. Champault reported in the *British Journal of Clinical Pharmacology* that *Serenoa* inhibits the production of the offending hormone. Other tests indicate the *Pygeum* does the same.

Dr. Alan Gaby reported in the *Townsend Letter For Doctors* that double-blind tests show these substances caused the urine flow and ability to empty the bladder to double. All the pain, difficulty urinating, uncontrollable wetting and sexual problems are a result of the restricted urine flow.

A company in the United States, S & G Laboratories has made the combination of *Pygeum* and *Serenoa* available in a pill called Pymoxin. It's not in the stores yet, but you can order it by phone or mail.

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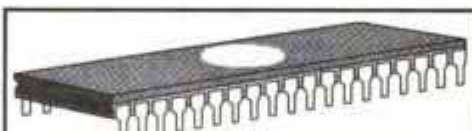
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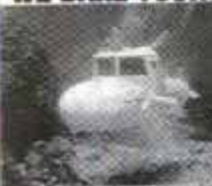
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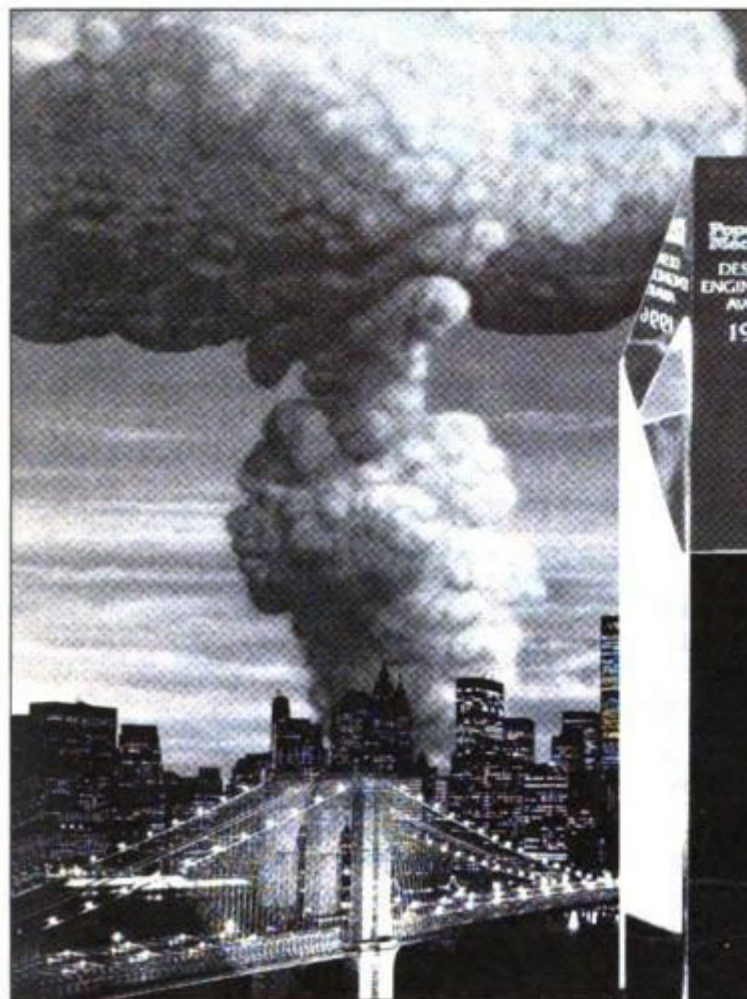
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Coming Up In

Popular Mechanics



When Terrorism Goes Nuclear

The U.S. faces its ultimate threat—terrorists with nuclear capability. Special response teams, which include robots that can defuse nuclear bombs, are our main defense. Our cover story gives you an inside look at the weapons and tactics of these elite units.

More New Cars '96

Here's our second report on the new '96 cars. We drive these models and show you what's new under the skin.

Picture This

Since the early days of TV, the dream was a thin screen that could be hung on a wall like a painting. After several false starts, reality has now overtaken fantasy with a 40-in. gas-plasma picture screen that's only 4 in. deep.

Design & Engineering Awards

PM editors pick the innovations of the year for our annual Design & Engineering Awards. See the winners in our January '96 issue.

Blanket Chest

Challenge your woodworking skills by building our beautiful, traditional solid-cherry blanket chest with a single-dovetail drawer. Our step-by-step instructions make it easy.

Deep Diving

Previously, scuba dives were limited to about 20 minutes at a maximum depth of 150 ft. Now, new apparatus allow free swimming to depths of 300 ft. and dive times more than three times as long. Here's the hardware that opens up this deep new world.

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