

month.
LION*
IZES!

RE



CAMEL FILTERS: 16 mg. "tar", 1.0 mg. nicotine,
WINSTON KING: 16 mg. "tar", 1.2 mg. nicotine,
SALEM KING: 17 mg. "tar", 1.3 mg. nicotine,
av. per cigarette by FTC method.

Here's how to play

- Get game tickets in special packs of WINSTON, SALEM and CAMEL cigarettes, or see Official Rules below for alternate bonus game ticket offer.
- Each game ticket has four multiple choice trivia questions about TV, music, sports, movies and other fun subjects.
- Answer questions by circling the letter in front of your answer.
- Use the four circled letters to spell the "Payoff Word" answer. A "payoff clue" is provided to help you (see Sample Game Ticket).
- Every correctly answered game ticket is worth one "point."
- The goal is to submit an entry with as many points as possible to win prizes (minimum 10 points needed to enter).
- There are six monthly contests beginning April 1988. You can enter every month. Or, you can save game tickets for several months to submit a higher point score entry. It's up to you.

SAMPLE GAME TICKET

* Circle letter to answer question.

1. WHICH FILM WON THE 1961 ACADEMY AWARD FOR BEST PICTURE?

- B. On Golden Pond
- T. Ordinary People
- G. Gandhi
- J. Charo's Off Fire

2. WHICH IS THE ONLY CONTINENT THAT DOES NOT HAVE DESERTS?

- N. North America
- O. Europe
- A. Australia
- E. Asia

3. IN WHICH YEAR WERE THE FIRST WINTER OLYMPICS HELD?

- O. 1924
- C. 1828
- N. 1928
- R. 1920

4. "LICORICE STICK" IS THE MUSIC SLANG NAME FOR WHICH INSTRUMENT?

- H. Harmonica
- N. Clarinet
- F. Flute
- S. Saxophone

* Use circled letters to spell Payoff Word under Payoff Clue.

PAYOFF CLUE: AFFIX
PAYOFF WORD: JOIN

* 10 or more tickets needed to enter.

Signature: John Smith
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OFFICIAL RULES

You may obtain official rules and two bonus game tickets by sending handprinted requests with a stamped, self-addressed envelope to Bonus Tickets, P.O. Box 5699, New Milford, CT 06774. Limit: one request per envelope, person or household per day (VA state residents need not include return postage). All requests must be received by September 15, 1988.

Millionaire Cash Quiz is void in VT, MD, KY, AZ and where prohibited by law. Contest ends September 30, 1988. All promotional costs paid by manufacturer. Contest open to U.S. residents age 21 and over.

* Projected total cash payout, based on consumer response to minimum entry requirement as of May 20, 1988 as a percentage of total game tickets in distribution, extended for duration of contest.

Statistics say this year one
in every four homes will be burglarized.
Tonight, go out your front door and
look to your left.
Count down three houses.



It should take you only a little over an hour on a Saturday morning to install the Schlage Keepsafer.™ After all, it's wireless. So you'll find a screwdriver's all that's needed to securely alarm doors and windows. Yet Keepsafer is so effective, experts claim it's every bit as good as

professionally installed systems. At a starting price that's much more reasonable, \$199. You can even add on an emergency dialer.

A do-it-yourself security system has never been this good. Or this easy. One hour. Think about it.

Look for the Schlage Keep-

safer at home centers, hardware stores and locksmiths. Or if you'd like more information, we're at 1-800-84-ALERT.

Schlage
KEEPSAFER
SECURITY SYSTEM



58 COVER STORY

The phenomenon that we call rust or corrosion is causing tragic failures of metals in America's buildings, bridges and airplanes. Renowned author William Hoffer explains why —PM illustration by Ed Valigursky



53 American posh



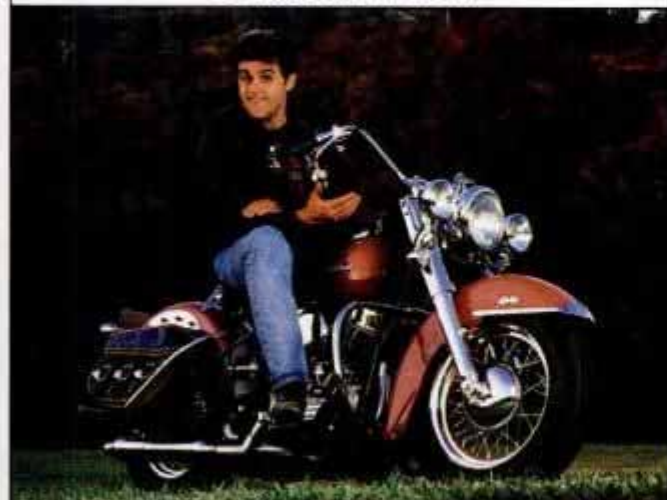
80 Fast fun!



88 Pretty patio



68 The Shuttle reborn



64 ReCycles

AUTOMOBILES

- 26 **Inside Detroit**
Our Motor City man brings you the scoops.
- 28 **Car Clinic**
Got a car question? We've got the answer.
- 32 **Imports**
From Alfas to Yugos, we track down the inside story.
- 53 **American Posh**
PM goes express touring with the U.S. luxury cars.
- 61 **Detroit Eye Spy '89**
Our mole in Motown reveals a strong lineup of new and revamped models coming out in the fall.
- 108 **Chrysler LeBaron Owners Report**
Quality of workmanship rates high with owners.

HOME/SHOP

- 20 **Old House Restoration**
Bob Vila drafts some new ideas for some old treasures.
- 83 **Smooth Operators**
Orbital palm sanders may look alike, but are different.
- 88 **Pretty Patio**
Improve a plain concrete patio with wood add-ons.
- 117 **The Better Home**
 - Choosing a water filter • Fixing a problem drawer
 - Homeowners' clinic • Appliance clinic

MOTORCYCLES

- 46 **Motorcycles**
Now there's antilock braking for BMW's big bike.
- 64 **ReCycles**
Collecting classic motorcycles offers all the fun of old cars for a fraction of the cost.

SCIENCE/TECHNOLOGY

- 13 **Tech Update**
The latest in electronics, space, medicine and military.
- 44 **Aviation**
A plane can last "forever" if maintained properly.
- 58 **Catastrophe!**
Why metal fatigue and corrosion are destroying buildings, bridges—even airplanes—all across America.
- 68 **The Shuttle Reborn** **PLUS FREE POSTER!**
NASA's betting that improvements to the Space Shuttle's mission-critical items will put America in space to stay.
- 93 **The Cardinal Of The Kremlin**
An exclusive PM excerpt from Tom Clancy's latest novel.

BOATING/OUTDOORS

- 24 **Outdoors**
Whatever the season, we cover the gear you'll need.
- 40 **Sea Ray Pachanga 22**
Our long-term test finds big muscle in a sleek compact.
- 80 **Fast Fun!**
HydroRunner, PM's you-build-it, 40-mph watercraft.

ELECTRONICS

- 34 **Electronics**
From microchips to megawatts: Understand it all.
- 50 **Video**
New camcorders now offer point-and-shoot simplicity.

DEPARTMENTS

- 6 Editor's Notes
- 9 Letters
- 10 Time Machine
- 82 Hotlines
- 144 Next Month

FORD RANGER BEATS TOYOTA BY ADDING FEATURES AND SUBTRACTING MONEY.

NO WONDER WE'RE MULTIPLYING.



FORD RANGER. THE BEST-SELLING COMPACT TRUCK IN AMERICA.

It's simple arithmetic. Based on 1987 calendar year manufacturers' reported retail deliveries, more people bought Ford Ranger than any other compact truck. Why? Because Ford gave people what they wanted... more truck for less money.

RANGER GOES BEYOND VALUE.

Value isn't the only reason why Ranger has

become so popular. Take the XLT. It's fun to drive wherever you want to drive it with multiple-port electronic fuel-injected power. A big, roomy cab with a great-looking interior. And if you need more space, there's always the Ranger SuperCab.

THE POPULAR XLT.

This XLT special value package has really helped Ranger

become the best-selling compact truck in America. It includes extra features from top to bottom packaged at a sticker price well below the suggested price of

these features if bought separately.*

VALUE THAT TOYOTA CAN'T MATCH.

The box at the right compares Ranger XLT Regular Cab with the



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comparable Toyota Deluxe. Look how much more Ranger gives you—from EFI engine to big outlined-white letter (OWL) tires. And its sticker price still beats Toyota's.**

What's more, Ranger is backed by a 6/60 warranty that Toyota doesn't match. Small wonder it's No. 1!

6/60 WARRANTY.

Covers powertrains for 6 years/60,000 miles and body-panel rust-

COMPARISON

BOTH RANGER AND TOYOTA INCLUDE:

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- Power Brakes
- AM/FM Stereo Cassette
- Sliding Rear Window
- Color-Keyed Carpeting
- Tinted Glass
- Chrome Rear Step Bumper
- Chrome Front Bumper
- Deluxe Wheel Trim
- Cloth Split Bench Seat

RANGER ADDS ALL THIS—AND STILL COSTS YOU LESS!

- Multiple-Port EFI Engine
- P215 OWL Tires*
- Tachometer
- Interval Wipers
- Halogen Headlamps
- Light Group

through for 6 years/100,000 miles. Restrictions and deductible apply. See your dealer for a copy of this limited warranty.

BEST-BUILT AMERICAN TRUCKS 7 YEARS RUNNING.

Based on an average of owner-reported problems in a series of surveys of '81-'87 models

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

*Ranger Package content may vary by state.

**Based on manufacturers' suggested retail prices of Ranger XLT (Special Value Package #864A) and comparably equipped Toyota Deluxe. Title and tax extra.

Buckle up—together we can save lives.



FORD RANGER

BUILT FUN TOUGH

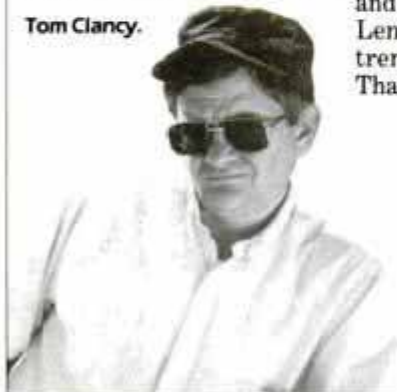
EDITOR'S NOTES

SEEMS LIKE the world is falling apart around us, doesn't it? Bridges collapse on freeways. Other bridges have to be closed because they're about to collapse. Tops are ripped off airplanes in flight. What next? Unfortunately, according to William Hoffer, author of this month's cover story (page 58), things are going to get worse before they get better. Years of neglect, poor or no maintenance, an infrastructure literally rotting away, and metal continuing to fatigue as I write this, add up to a catastrophe looking for a place to happen—without warning. It truly is a hidden nightmare that is not going away. In fact, it gets worse with every minute of time that passes by. Can we do anything about it? Yes. We can commit big bucks to make repairs where needed and maintain what is left. The question is, are we willing to make the commitment? . . . **Just about everyone** loves a good book. In the past few years, some of the best books have been written by Tom Clancy, the 41-year-old insurance salesman-turned-novelist whose *The Hunt For Red October*, *Red Storm Rising* and *Patriot Games* have consistently topped the best-seller lists in recent years. Clancy's books, which have been called techno thrillers, all revolve around Clancy's hero, Jack Ryan, a Central Intelligence Agency troubleshooter who always gets the toughest assignments. And they always involve military hardware—submarines, missiles, computers, satellites and lasers. In other words, all the stuff we write about all the time in POPULAR MECHANICS as part of our regular technology coverage. So when the opportunity arose to publish an advance excerpt from Clancy's latest book, *The Cardinal Of The Kremlin*, we jumped at the chance. It's an extra special bonus for you in this month's issue (page 93). I hope you are as engrossed reading it as I was. . . . **The Space Shuttle Discovery** may or may not be launched several weeks after you read this. As this is written, the scheduled launch date is August 4. No matter. When it goes, Shuttle Mission 26 will mark America's reentry into space. It will also mark the debut of our nation's new, improved Space Shuttle. As our article on page 68 reports, dozens of changes resulted from the *Challenger* tragedy and the new Space Shuttles should be safer and more reliable. One other point we all painfully learned on January 28, 1986—the Space Shuttle is still an experimental aircraft, not an operational one. When the Shuttle flies again, it will be treated as such. . . . **A classic motorcycle** is a tactile sensation. You feel the leather, touch the alloy fittings, smell the oil, see the glints of light reflecting off a gleaming tank. It's nirvana if you're a gearhead like me, which is why I really love our article (page 64) on classic 2-wheelers. There is something so *mechanical* about old motorcycles that makes them special for me. They're special for comedian



Leno and PM's Bryan Canniff.

Tom Clancy.



and "Tonight Show" guest host Jay Leno, too. Leno, who owns 11 classic motorcycles, was extremely helpful in putting our article together. Thanks, Jay. 'Til next time.


Joe Oldham

Editor-In-Chief
Joe Oldham

Managing Editor
Bill Hartford

Graphics Director
Bryan Canniff

Home And Shop

Steven Willson, editor
Joseph Truini, shop and tools editor
Thomas Klenck, associate editor
Norman Becker, Rosario Capotosto,
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John Bostonian Jr., art editor
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Nancy Coggins, art assistant
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Art

Alan Andresen, Larry Sullivan,
associate art directors
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Editorial Administration

Josephine Caronia, administrative assistant
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Editorial Offices

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This One



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Publisher

Daniel J. Coleman

Director Of Advertising
Warren R. Schultz
National Accounts Manager
William T. Duke
Director Of Marketing
Edward Vaquero

Advertising Offices

New York

224 West 57th St.
New York, NY 10019
Brian Broderick, New York Manager
(212) 649-3135
Edward W. Baker, Accounts Manager
(212) 649-3141

Chicago

1 South Wacker Dr.
Chicago, IL 60606
(312) 984-5190
Alan R. Perry, Western Manager
Daniel F. Kellner, Accounts Manager
F. Lee Bishop, Accounts Manager

Detroit

2301 West Big Beaver Rd.
Troy, MI 48084
(313) 649-2981
Laurence E. Lantzy, Accounts Manager
Donald C. Schulz, Accounts Manager

Los Angeles

3000 Ocean Park Blvd.
Santa Monica, CA 90405
(213) 450-8881
Penn H. Jones, Accounts Manager
Austin C. Sass, Accounts Manager

Direct Response Advertising

224 West 57th St.
New York, NY 10019
Bud Gilbert, Manager - (212) 649-3139
Dan Nunziata - (212) 649-3143

Business Manager

Agnes P. Maillaro

Production Manager

Lori Ellwood

Advertising Production

Patricia A. Tanner
(212) 649-3164

Classified Sales Manager

Sophie Gronowicz
(212) 649-3167

Reader Service Department

Gary Frederick, supervisor
224 West 57th St., New York, NY 10019
(212) 649-3128

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Frank A. Benaack Jr., President
Randolph A. Hearst, Chairman
Gilbert C. Maurer, President, Magazines Division
Richard E. Deems, Publishing Consultant

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LETTERS

Real-World Test

I'D LIKE TO challenge your test which uses WordStar to test computer speed ("The Super Clones," page 65, April '88). WordStar depends on the speed of the drive (floppy or hard disk) for a file larger than about four pages. When a file is larger, data are stored on the drive instead of in memory. Therefore, the faster the floppy drive, the faster WordStar will be able to do its reformat and search-and-replace test. This comparison is unfair because hardware can vary from system to system and all hardware does not operate at the same speed.

KEVIN WANG
MORGAN HILL, CA

You're correct about WordStar's partial dependency on disk-drive speed—and that's precisely why we used WordStar, a popular word-processing program, for our real-world evaluation. Our goal was to measure the overall speed of the computers—disk drives included—not only the speed of their microprocessors. Otherwise, a reader might conclude (from the manufacturer's microprocessor rating) that a PC with a 10 MHz engine is always faster than one with an 8 MHz powerplant. This is not necessarily true, as demonstrated when the 8 MHz IBM PS/2 Model 30 completed the tasks quicker than the 10 MHz Epson Equity I+. That's why we call our evaluations real-world tests!

On Plumb

Your June issue, with the "Complete Guide To Plumbing Repair," (page 121), just saved me a \$55 plumber's bill. In your story I learned about a clogged siphon hole. I



Vendex, Epson and Zenith PCs versus IBM in our April story.

had replaced *all* the working parts of the toilet, plus had used an auger, but still had a sluggish flush. This 54-year-old woman has just learned once again, that "it's the little things that count."

DARLENE M. PHILLIPS
PITTSBURGH, PA

Improved Ranch

Here's some ancient history. I bought the plans for PM's Ranch House in 1952 and built

it in my spare time, taking a leisurely four years to complete it. Over the years I've made improvements that other PM readers might want to note on their blueprints:

- I installed two 10-in.-dia. thermostatically controlled vent fans in the roof in place of the fixed vents in the soffit, and since the plywood soffit was continually getting mildewed, I replaced it with perforated aluminum.
- I replaced the louvers under the large windows at the side of the house with glass blocks.
- I dug a deeper cellar area (11 × 18 ft.) under the kitchen.
- I extended the front of the garage 4 ft. for more space at the rear and installed thermal-pane windows throughout.

That's it, so far, but I'm a very active 77-year-old so I'll let you know when I start our next project.

J.R. RICHARDSON
NEW CUMBERLAND,
PENNSYLVANIA



Aluminum soffits are an improvement on PM ranch house.

The PM Ranch appeared in four installments beginning in May '51 and concluding in August. Blueprints (10 sheets) are still available for \$20 from POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101.

PM

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It heats water
for half the cost
of electricity.

GAS. AMERICA'S BEST ENERGY VALUE.

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TIME MACHINE

75 YEARS AGO: AUGUST 1913

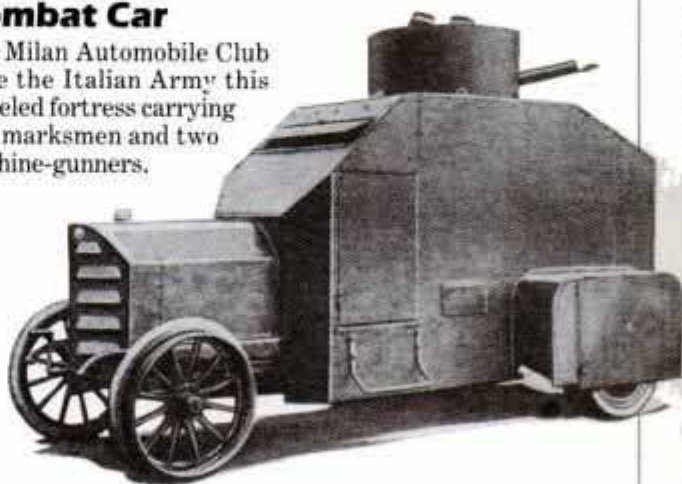


Learning To Lead

It was the summer before hostilities erupted in Europe, and PM ran a series of photo essays on the making of an Army officer. Was West Point life that different 75 years ago? Not really: We saw a rigorous regimen of drills and discipline, academic activity, strictly controlled socializing and athletic rivalry with Annapolis. But unfamiliar to today's cadets would be the focus on horsemanship, a tradition shattered by mechanized war.

Combat Car

The Milan Automobile Club gave the Italian Army this wheeled fortress carrying two marksmen and two machine-gunners.



50 YEARS AGO: AUGUST 1938



Future Festival

Fifty years ago PM previewed the New York World's Fair of 1939. Besides the rocketport that blazed on our cover, we looked at such visual extravaganzas as the man-made volcano and various pavilions devoted to the future. As our August issue hit the stands, construction crews were completing the 200-ft. globe Perisphere and 700-ft. obelisk Trylon—symbols of a \$150-million magic show that still conjures up fond memories.

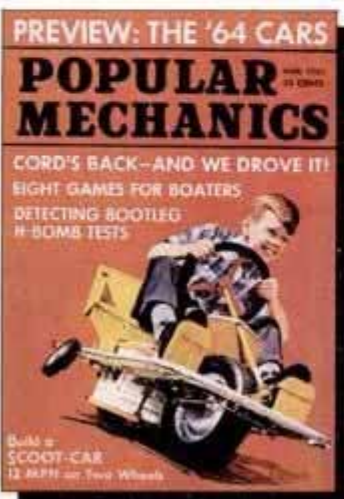
River Racers

Amateur outboard racing was becoming popular in the 1930s, but speedboat design

hadn't caught up. Two-man crews were the norm, and mechanics had to sprawl over decks to keep boats stable.



25 YEARS AGO: AUGUST 1963



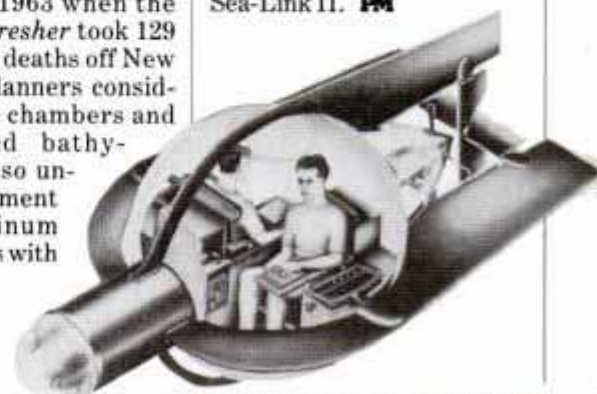
Half-Pint Hotrod

What did our readers like in the early '60s? They liked their tools. They liked their cars. They liked their kids. And their kids liked cars. The logical conclusion? The battery-powered scooter-mobile on our August 1963 cover. Unique PM touches included positive roller-chain drive and a parallel-arm steering gear around the front wheel. The juvenile jolopy was typical of our home and shop projects in the baby-boom years.

Sub Savers

Vessels to rescue submarine crews became a sudden Navy priority in 1963 when the stricken *Thresher* took 129 men to their deaths off New England. Planners considered rescue chambers and steel-walled bathyscaphes. Also under development were aluminum submersibles with

plexiglass personnel spheres—heralds of today's transparent subs like Johnson Sea-Link II. **PM**



POPULAR MECHANICS • AUGUST 1988

VANTAGE

ULTRA LIGHTS

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

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DISAPPEAR ONE WEEKEND A MONTH.

It's a great way to find yourself.

Whether you're in field training, or in a helicopter skimming treetops at 90 miles an hour or building a bridge, the Army Reserve gives you a chance to spend a weekend doing something out of the ordinary.

You'll usually serve one weekend a month and two weeks a year with a Reserve unit nearby. You'll make good friends. Earn good pay and benefits. If you qualify, you can learn a valuable skill in electronics, automotive repair or in



hundreds of other occupational fields, depending on the needs of your local unit.

It's solid experience which could help you advance in any career you choose.

If you're in high school or college, the Army Reserve can offer you a variety of educational and financial assistance programs you may qualify for. With benefits that won't disappear when the weekend is over.

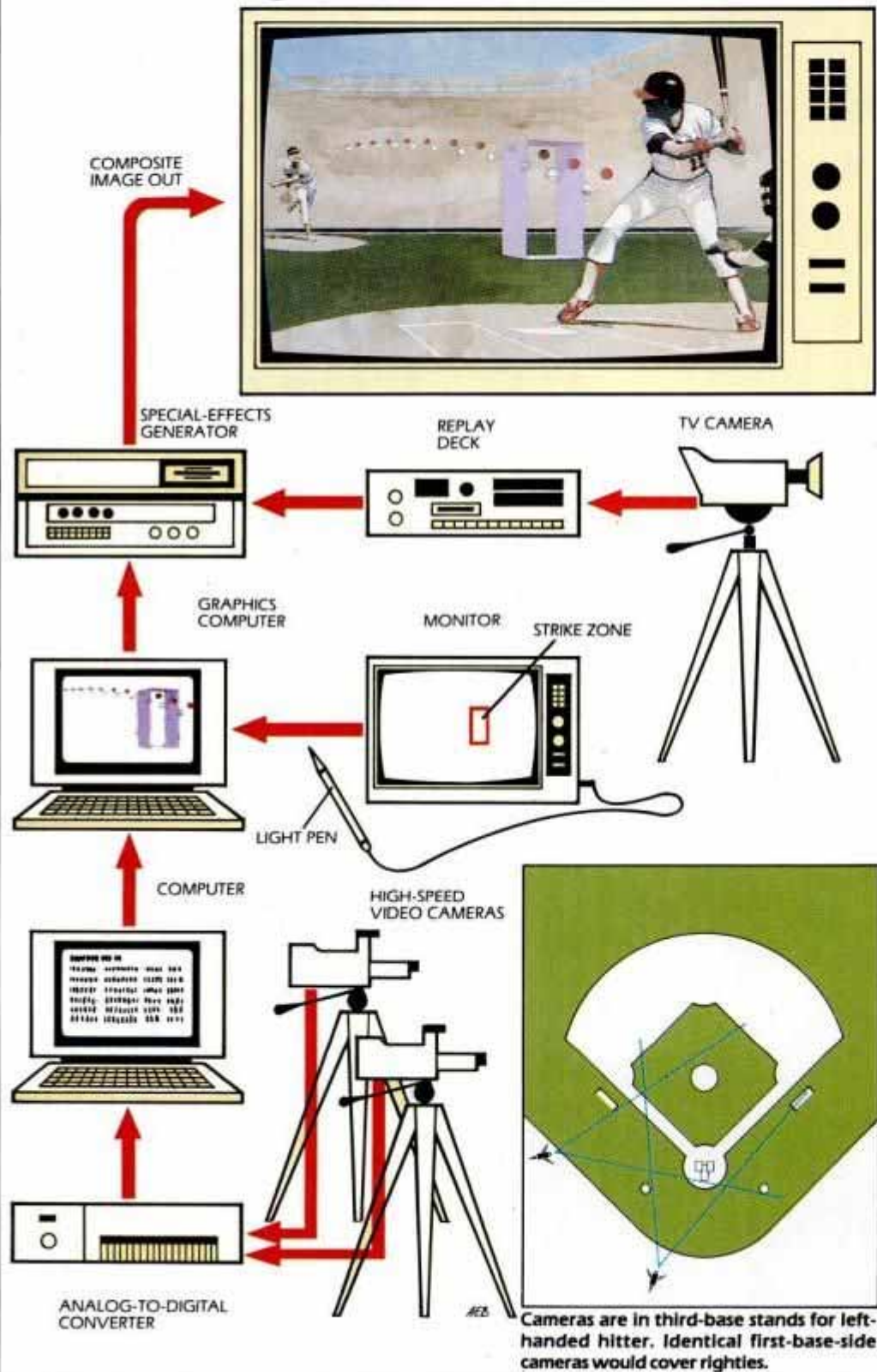
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ARMY RESERVE

TECH UPDATE

High-Tech Pictures Of Pitches



IRVINE, CA—Coaches, scouts, broadcasters and armchair umpires may soon be studying breaking balls with a new computer-graphics system.

Developed by two Canadian engineers, SuperVision links two high-speed video cameras with two computers to generate a graphic representation of a pitched ball's trajectory. The cameras shoot 60 frames a second, and digitized translations of these images feed into the first computer. Calculations of the ball's speed and movement go to a second computer dedicated to graphics. At the same time an operator outlines the batter's strike zone using a light pen—information that also feeds into the graphics computer.

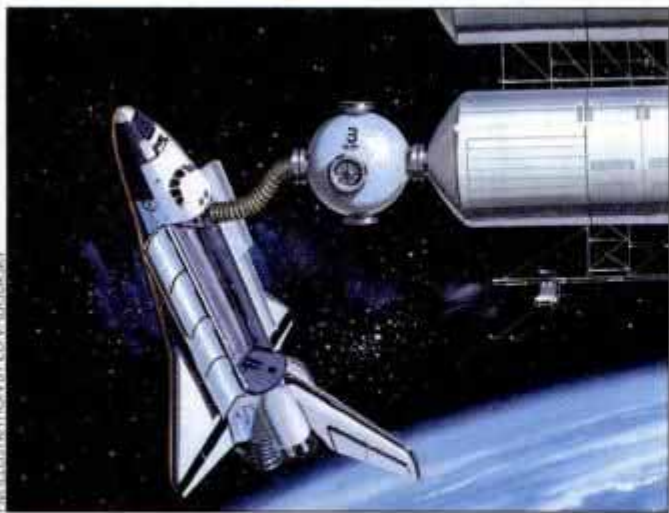
The viewer sees two superimposed trajectories. One shows the ball's actual flight path. The other, called a nominal trajectory, is the flight path projected as if the ball had no break other than that imparted by gravity and air resistance.

Though SuperVision will capture a ball's movement through the strike zone, the inventors say the system won't replace umpires. They hope to sell SuperVision as a training or entertainment adjunct. Among other boons, the system will illuminate the different flight paths of curves, sliders, knuckleballs and split-fingered fastballs—not to mention spitters and scuffballs.

SuperVision components assemble, on top monitor, actual (white balls) and nominal (red balls) trajectory graphics.

Editor: Tim Cole
Assistant Editor: Gregory T. Pope
Contributors: Mike Fillon,
Bill Siuru, Chris Davis

Flexible Shuttle Docking



Pressurized passageway links Shuttle and Space Station.

HOUSTON, TX—A hard docking maneuver between the Space Shuttle and the Space Station could displace the Station, jar sensitive experiments and cause structural damage if mishandled. Instead, Johnson Space Center researchers propose

docking via a passageway attached to a Space Station node. To guide the procedure, sensors around the free end of the passageway would seek out light-emitting diodes (LEDs) surrounding a mating tunnel at the Shuttle's airlock hatch.

Rest For Long-Range Air Crews

TOULOUSE, FRANCE—Flights on Airbus Industrie's A340, scheduled for introduction in 1992, will last as long as 18 hours. Crew rotation and rest have become design considerations.

The pilot's rest area will be located right behind the cockpit. A clear sliding panel allows a view of crew and in-

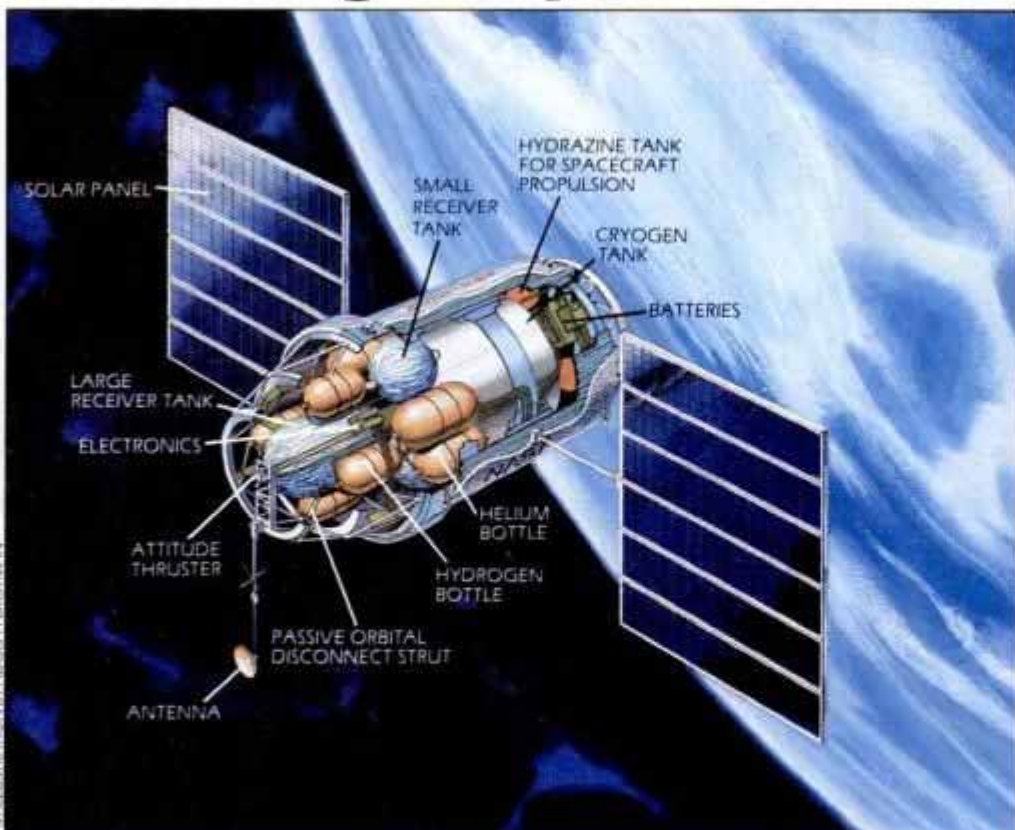
struments for instant response to emergencies. The cabin crew's rest area will be below the passenger cabin and will have beds, changing room, refrigerator and entertainment center.

The A340 will also feature a "flying office," giving both crew and passengers air-to-ground communications.



Airbus A340 model shows subcabin crew rest area.

Cold Storage In Space



COLD-SAT will use helium and hydrogen as propellants to push cryogen into receiver tanks.

CLEVELAND, OH—This spacecraft is called COLD-SAT, for Cryogenic On-Orbit Liquid Depot Storage, Acquisition and Transfer.

Experiments running on COLD-SAT will focus on the problems in storing and transferring cryogens (supercold liquids) in a microgravity environment. Cryogens such as liquid helium, oxygen and hydrogen chill instruments and supply life-support, propulsion and fuel-cell equipment.

NASA will test devices that transfer liquids while screening out gases—vent vapors that form when cryogens evaporate—and chill receiver tanks before transferring cryogens. COLD-SAT will also demonstrate passive orbital disconnect struts (PODS) which support internal tanks during launch but disconnect in orbit to ensure thermal isolation.

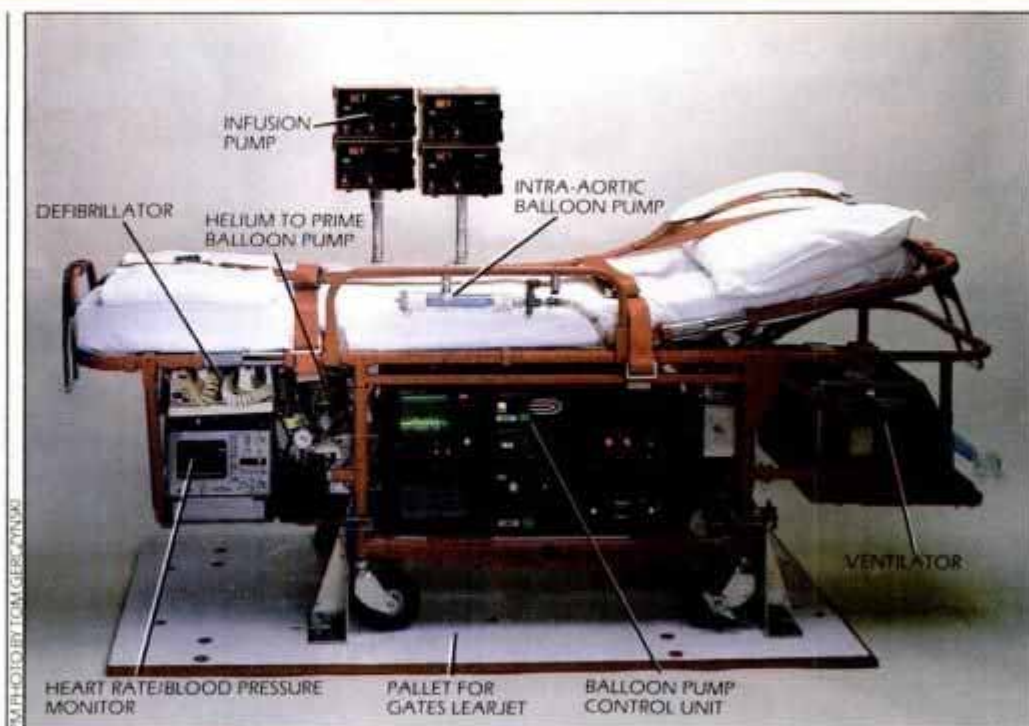
COLD-SAT, scheduled for a mid-1990s launch, will help finalize design of future orbiting cryogenic depots.

Intensive Care On The Run

TUCSON, AZ—Medical teams must avoid disconnecting critically ill cardiac patients from vital equipment during transport. This mobile intensive-care unit, known as MOBI, can bring patients from hospital to ambulance to jet without interrupting life support.

Developed at the University of Arizona, MOBI features infusion pumps to administer drugs, an intra-aortic balloon pump to boost a weakened heart's pumping action, a defibrillator to shock a heart into a normal rhythm, and a ventilator to aid breathing.

FAA-approved for Gates LearJet Series 25 and 35, MOBI may soon be cleared for commercial airliners.



Each piece of equipment runs off self-contained battery pack while MOBI is in action.

Miniature Medical Cyclotron



Cyclotron rotates so healthy tissue is spared the full dose.

DETROIT, MI—Harper-Grace Hospital will house the world's first superconducting cyclotron to be built exclusively for cancer therapy. The cyclotron, which should be operating by 1990, is only 5 ft. across. But thanks to acceleration forces generated by superconducting magnets, ions inside will hit 42,000 miles per second, comparable to large cyclotrons used in physics research.

The ions are charged nuclei known as deuterons and are whiskered by the magnets into ever-widening circles before they slam into their target. The collision releases a beam of neutrons, which is used to irradiate tumors.

The Harper-Grace machine may spur construction of similar low-cost neutron-therapy facilities.

For certain tumors, neutron radiation is more effective than either X-rays or proton beams.

Medical Images On 18 Wheels

EAU CLAIRE, WI—Two Wisconsin hospitals are bringing magnetic resonance imaging (MRI) to rural areas. Inside a custom-built tractor-trailer is a superconducting magnet 2 tons lighter than a stationary MRI magnet. The magnet aligns nuclei in a patient's cells, and then a beam of radio waves causes the nuclei to resonate their own radio signals. Truck's computer constructs images from signals.



Hydraulics move patient through magnet's bore.

First Look At B-2 Stealth Bomber



Air Force now says B-2 has this bat-like silhouette.

PALMDALE, CA—The Air Force is gradually loosening the veil of secrecy surrounding the decade-old project.

B-2 developer Northrop Corp. has revived the flying wing. Developed in the 1940s for enhanced lift/drag ratio, the flying wing also ensures a skimpy radar signature, with fuselage and engine nacelles little more than ripples in a single, broad, flat triangle.

Two rather than four, crewmen will fly the plane, thanks to the advanced flight

controls. These avionics will likely be devoted more to flight stability and less—due to the stealth profile—to electronic countermeasures.

Internal Thermometer

LAUREL, MD—Some researchers at Johns Hopkins Applied Physics Laboratory (APL) have developed an ingestible pill that can monitor human temperatures 10 times more accurately than

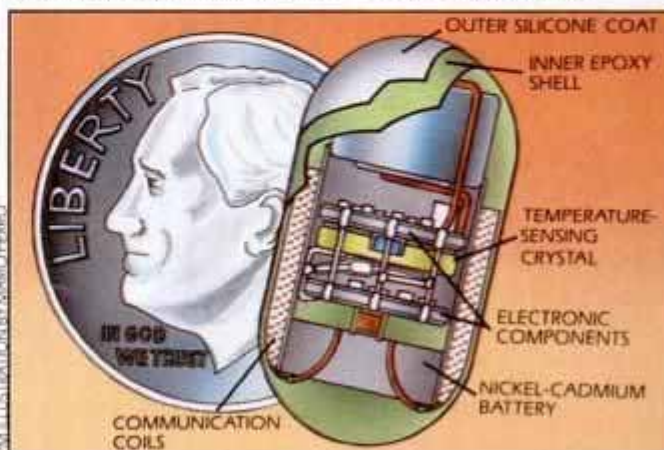
external thermometers can. Inside, a quartz crystal vibrates at a frequency determined by temperature.

Communications coils, miniaturized versions of satellite telemetry units, relay the frequency information to

a belt-worn processor.

Still in the works is a multi-channel pill that reads acidity, heart rate and gastric pressure.

Dime-sized thermometer is protected by two coatings.



Aerocar Dream Still Flying



Aerocar CRX (above) would cruise at 150 knots at 75 percent power. Below right is a 1968-model Aerocar.

LONGVIEW, WA—For 30 years, Molt Taylor has tapped frustrations and fantasies formed on America's traffic-tangled highways.

His first Aerocar—"the car with the built-in freeway"—won Civil Avia-

tion Authority type certification in 1956, but didn't take off, due to lack of capital investment. Twelve years later he tried again, but again investors shied away, and the car didn't meet government regulations.

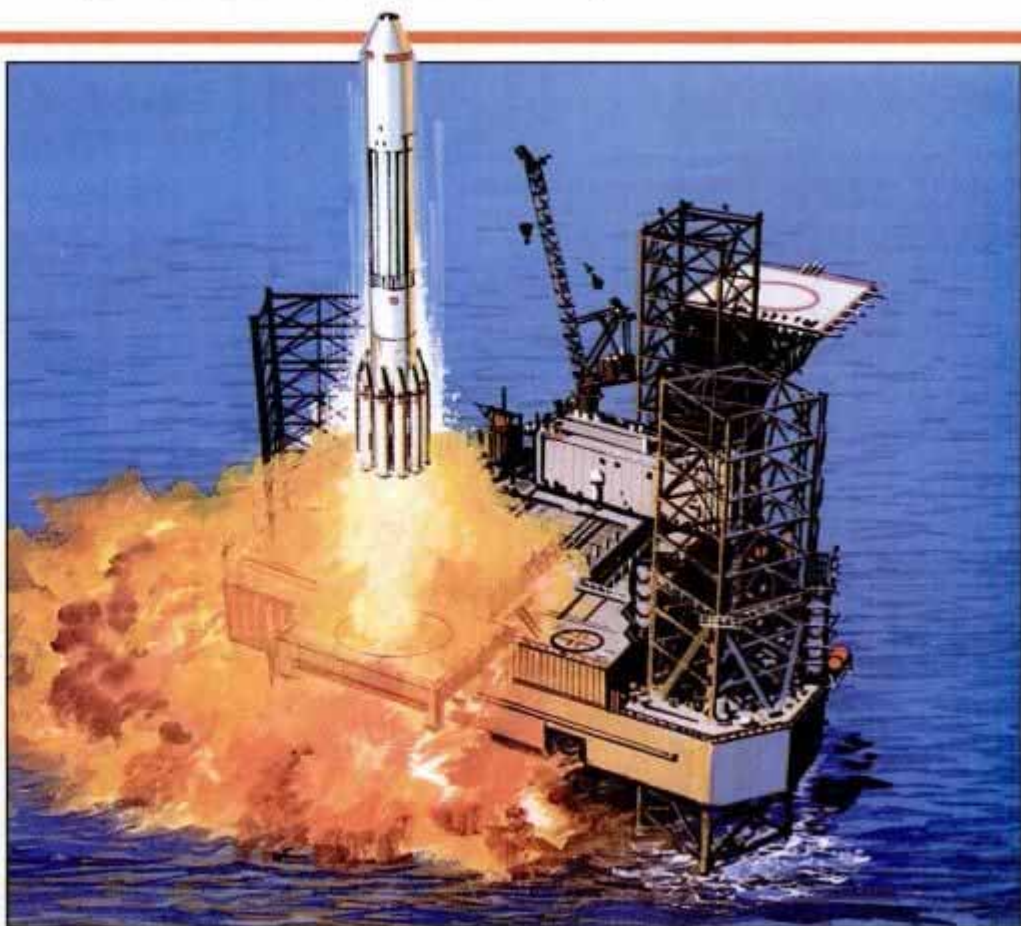
Molt's still at it. The version he proposes today would be based on a standard Honda CRX. To sidestep bureaucratic hangups, Aerocar is seeking certification under FAA's experimental-aircraft kit regulations. **TU**



Offshore Liftoff

HOUSTON, TX—The Air Force and NASA are calling for a modular family of Advanced Launch System (ALS) vehicles—rather than one specific booster—to deploy such weighty cargo as SDI spacecraft. Meanwhile, planners are addressing environmental concerns raised by the tremendous exhaust noise and heat such launchers would generate. A potential solution involves use of a customized mobile offshore oilrig as a launch platform.

One such rig, Rowan Companies' Gorilla, provides a stable platform in water up to 328 ft. deep. Booster-payload integration would take place at a Vandenberg AFB assembly facility. The launcher would be loaded on to a Gorilla and towed out to sea for launch. Offshore launch has already worked for Italy's San Marco satellites that blast off from an Indian Ocean platform.



ALS vehicle would lift off from hardened Gorilla rig 3 miles off California coast.

PM ILLUSTRATION BY ED VALIGURSKY

Bomb With Brains To Find Target



PM ILLUSTRATION BY ED VALIGURSKY

EGLIN AFB, FL—The Navy and Air Force are considering development of inertially aided munitions (IAM), following successful proof-of-concept tests by Boeing and Northrop.

Tail cone kits to be added to standard gravity bombs contain microcomputers that control fin movements as the bombs fall. Before release, either the aircraft's inertial navigation system or Global Positioning Satellites would relay positional information to the bomb's computer. Once released, the bomb's own inertial-measurement unit navigates the bomb to its target. Developers say the IAM modifications will allow greater mission flexibility, because they not only increase bombing accuracy but also permit stand-off targeting from maneuvering aircraft.

Inertial aid allows release of munitions miles from target, improving aircraft survivability.

OLD HOUSE RESTORATION

BY BOB VILA

Removing Wallpaper

WALLPAPER stripping is a task lots of us are good at avoiding. That's probably why we so often find layers of paper, sometimes with a coat or two of paint in between, covering the walls in many old homes.

Stripping down a wall to its base, whether it's plaster or drywall, is a tedious, messy job at best. But unless it's covered with only one layer of good, tight paper, I think it should be done before hanging new material. If you don't know what's under all those coverings, or how well each is adhered to the other, there's more chance for a *failure*—popping seams, buckling and peeling—with the new paper. You've simply added to the top of the pile.

Eventually, you are going to have to remove all that old wallpaper, and now is as good a time as any. There are, however, a few different ways to do this, as well as a *right* way to treat the bare walls before you paper or paint again.

Moisture is the key

The secret to a successful paper-stripping project is moisture. Repeated soaking or steaming of the papered surfaces is the only way to break the bond of the old adhesive holding the layers of wall coverings to the wall.

There are a couple ways to create this moisture. Probably the one that most folks are familiar with is steaming. Using a rented machine created specifically for this purpose, you simply hold a perforated plate, similar to an iron, next to the paper and literally *steam* it until the adhesion breaks and the paper



Removing old wallpaper is crucial to the success of a new papering job.

loosens. The body of the machine is a small boiler hooked up to a propane gas tank. Because of this you must be careful not to tug too hard on the unit which could upset the whole operation and create a fire hazard.

When you are steaming off several layers of paper—especially if they have also been painted over at various times, I find it helpful to score the paper first with a utility knife. This allows the steam to get through the layers easily and thus speeds up the whole job. But the bottom line is that I find it cumbersome to drag a hot, bulky steamer around the room.

The other way uses hot water and either a sponge or garden sprayer. This is a safer method because there's no live flame to worry about.

You can strap the tank to your shoulder and move around the room easily. Although I know some folks remove paper with just hot

water alone (coupled with an extreme amount of patience), the water only reactivates the adhesive. Adding a liquid-enzyme remover to it, which actually attacks the glue and breaks down its molecular structure, will considerably quicken this task. These enzyme formulations are available at wallpaper and paint stores.

Let it soak

A mistake many people make is to steam or wet the paper a bit then immediately try to remove it. They simply don't soak the surface enough so that the moisture penetrates through to the adhesive. Whether your walls are plaster or drywall, don't be afraid to wet them. The mushier you can get the paper, the better off you'll be.

This process can take even more time on an old house where there's four or five layers of extremely dry paper. Just think how much

moisture these ancient wall coverings can absorb! In addition, the adhesive used in many old houses was generally made from wheat paste with molasses added to increase adhesion. If your house was built in the 1920s or before, assume you've got molasses under the paper. This early wallpaper adhesive is more difficult to reactivate than today's pastes.

Another problem particular to very old houses is the tendency that horsehair plaster has, over the years, to separate from wood lath. Since it is loose, it's easy to inadvertently remove chunks along with the paper. The later chalk plaster is a nicer base to work with. Its smooth surface *chalks*, as its name implies, rather than coming out in chunks.

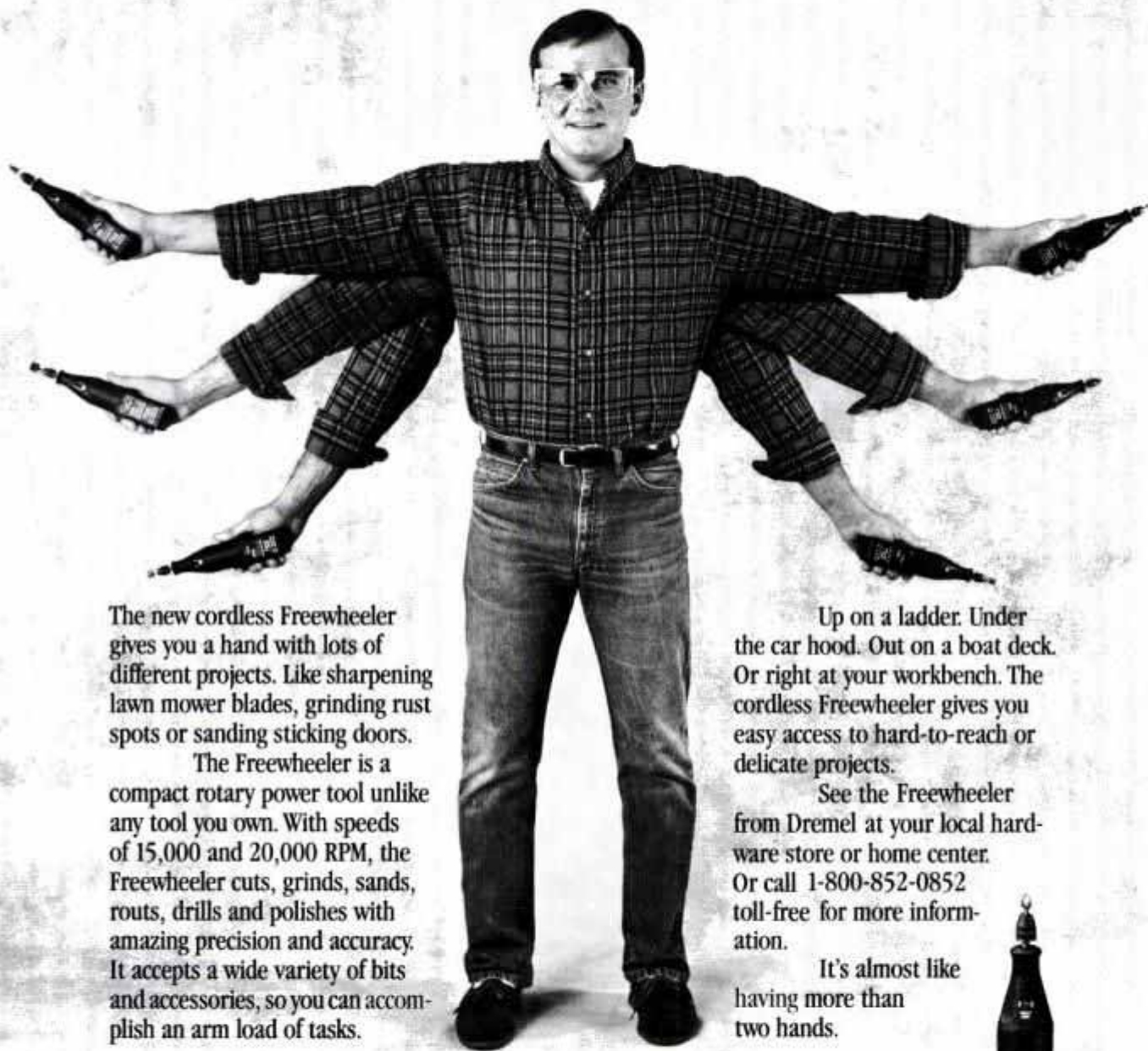
You should be able to pull off the wet paper by hand. If you're dealing with plaster

(Please turn to page 22)

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

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paint or paper. This involves using spackle or joint compound to skim the wall, creating an even surface. Occasionally, folks ask me if it's possible to plaster over this damaged drywall. My answer is no, because I don't recommend plastering to do-it-yourselfers. There's a real art to it. However, some professionals can treat marred drywall surfaces with a bonding agent followed by a finish coat of plaster, and achieve wonderful results.

Paint primers, too, are commonly recommended by well-meaning store clerks to do-it-yourself paper hangers. Although a primer will even out the porosity of a wall, it won't seal anything in. Remember, too, that these products are developed to support the weight of paint, not paper. Chances are you'll have a failure, like seams popping loose, if a primer is used in your wall preparation.

This leaves primer-sealers, which are obviously my choice for proper paper-hanging wall preparation. Not only will a primer-sealer seal any imperfections, like dust, mold, mildew and old adhesive into the wall surface, but these products also prime the surface, creating an even porosity. Because they create a protective coat between the paper and the wall, removal is easier later on.

A lot of professional paper hangers use oil-based primer-sealers. These products should be allowed to dry for a minimum of 8 hours. But 24 hours is ideal. Lots of do-it-yourselfers prefer acrylic- or latex-based products. These are okay as long as you buy one of good quality. Cleanup is easier and the drying time is only 2 hours.

I said at the outset of this article that removing wallpaper is tedious work. With luck, you should be able to strip a 9 x 12 room in a day. Remember, the key to a successful job is moisture. You've got to get the paper good and wet for easy removal. Don't be afraid of wetting the wall underneath. As long as you let the walls dry out completely before treating them in any way, your next wall covering project should be a success.

PM

OLD HOUSE RESTORATION

(Continued from page 20)

walls, use a scraper. Don't use this tool on drywall, since you risk cutting through the top layer of drywall paper.

The newer vinyl wall coverings are much easier to remove. Stripping fabric-backed vinyl is simply a matter of grabbing a corner and pulling the vinyl down gently, keeping it close to the wall. Don't back up while doing this or you may end up removing part of the wall. Only the vinyl layer on the paper-backed material will come off this way. The paper backing will remain and must be removed with moisture just like another layer of wallpaper. Once all the paper is removed, wash down the walls with a strong cleaner, preferably something that contains trisodium phosphate (TSP). Then, let them dry completely—a week is usually sufficient—before you treat them.

The sizing myth

There are different ways to treat a wall to accept coverings: sizing, priming or using a primer-sealer. Ask most folks what should be done to a wall before paper is hung and they'll probably say it should be sized. True, sizing will promote great adhesion by creating a sticky-base surface but, at the same time, it does not protect the wall. This may not matter to you now, but it will down the road—especially if you try to remove the paper someday.

Since there is no protective coat between the paper and the wall, the covering is literally *burned* into the wall. This can be a nightmare on drywall, as you can probably imagine. It's nearly impossible to remove paper that is installed like this without taking some of the drywall's covering paper with you. You're left with a gouged, imperfect surface.

Obviously, the wall must be repaired before you can

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OUTDOORS

BY JOE SKORUPA

Wet & Wild Toys



PHOTO BY SKOP GANDY

Booming personal watercraft scene is flying high this summer, as is Yamaha's WaveJammer.

IF YOU LIKE spills and thrills in the water on a hot summer day, you'll love personal watercraft because that's what these miniwavebusters are all about.

I recently tested a number of these hot, new water toys and was amazed at their diversity. Here's a look at four totally different models tested in the waters around Captiva Island, Florida.

■ **Pumper**, a jet-driven, 2-person prototype by Fun Boats, of Largo, Florida.

We found this preproduction model fast enough to provide thrills and stable enough to inspire confidence. It's powered by a 60-horse, 425-cc engine and is expected to retail for about \$4500.

It topped out at 22 mph with one person and 21.5 mph with two.

The time it took to sprint 100 ft., starting from a dead stop, was 4.33 seconds.

Time on the handling course, a tight figure eight, also begun from a stop, was 42.57 seconds.

The problem, however, was that the experimental craft needed continual maintenance. Still, once the engine bugs are worked out, the 360-pounder will be ap-

preciated by cautious family buyers for its tip-free ride.

■ **Dolphin**, also built by Fun Boats, is a more-established product, but not a textbook personal watercraft. Using the same 200-lb., 10-ft. 4-in. hull as Pumper, Dolphin is equipped with a 35-hp Force outboard, rather than an experimental jetdrive.

It topped out at 25.5 mph with one person and 25 mph with two. Hole-shot time was 3.9 seconds, and 38.15 seconds on the demanding performance course.

Unlike a jetdrive, which can run in inches of water, this soft-riding, 360-pound, V-bottom boat has a 17-in. draft. Price is \$4150.

■ **WaveJammer**, by Yamaha, has been on the market two years but it's interesting to compare it to recent models.

Surprisingly, the 1-person WaveJammer is only about 20 pounds lighter than the 2-person Fun Boats, but look at these performance figures: 33.5-mph top-end speed, 3.94-seconds hole shot and 27.04 seconds in the handling course.

It's a head-snapping, arm-straightening water machine that requires athletic skill and a learning curve to oper-

ate properly. But, in return, it carves tight turns, does spinouts and leaps waves like a marlin.

Power is supplied by a 32-horse, 496-cc engine. Total length is 88 in. and weight is 346 pounds.

The WaveJammer (\$3380) may not be for everyone, but for those seeking adventure, it's hotdogging heaven.

■ **Wave Rider**, by Castoldi Jet, of Milan, Italy, rides more like the QE2 than a true minijet.

The 12-ft. 8-in., 638-pounder is powered by a 1000-cc Fiat jetdrive that pushes out 55 hp and hits 32.5 mph with one person and 29 mph with two.

Because of its enormous size and power, the Wave

Rider can actually seat three and pull a water skier. In addition, its dry, ultrastable ride inspires confidence by cautious first-timers. However, its barge-like handling and upscale price, \$9535, offset some of the allure.

There's no other feeling to compare with the thrill of riding a top-performing personal watercraft. It brings the hotdogger out of anyone.

Rally Drivers Beat Odds

I spoke with Trans Amazon Marathon Rally driver, Al Micallef, recently and he confirmed some gut feelings I'd had prior to the race. One was that the rally would be a spectacular South American adventure. Two was that it would be plagued by disorganization and financial woes.

I was scheduled to cover the portion of the rally from Santiago, Chile, to the finish line in Buenos Aires, Argentina. But, after discovering chaos and uncertainty at rally headquarters in New Orleans on the eve of vehicle departure, I decided that my current duties in the United States needed urgent, personal attention.

"You were right not to go," said Micallef. "We felt like we were going to war every day, and that included the



Ford/TRW team was one of 14 to finish.

PHOTO BY JOE SKORUPA

press. There was little support. The road books were wrong. Rules changed daily and there was a lot of animosity."

Truthfully, now that the event is over, I'm a bit disappointed I wasn't there. Micallef's description, contrary to intent, seems to elevate the rally to the status of a legend.

Rally drivers not only had to conquer South America's most awesome and vicious terrain, but band together to overcome financial problems that nearly derailed the race before it began.

The grueling 8000-mile marathon started on April 22 in Cartagena, Colombia, and crossed the finish line in Buenos Aires on May 17.

Of the original 70 vehicles, 35 dropped out. Only 14 drove the entire course, and of these only seven were qualified finishers. About 30 vehicles made it to Buenos Aires driving their own routes.

Top American automotive finishers were Ron Clyborn, of Seattle, and Ken Walters, of Santa Clara, California, who placed third driving a Jeep Cherokee.

Top motorcycle finishers were both from the United States. Bob Shirly, of Grand Cayman Island, came in first despite breaking several ribs in an accident. He drove a 650-cc Kawasaki KLR. Robin Bennett, from Mason City, Iowa, came in second on an Austrian-made KTM 600.



Binocs for long-range hearing and seeing.

On roads as rugged as these, accidents were expected, and they happened. But on the up side is the story of the Ford/TRW team of Chris Jensen and Bill Sadataki, of Cleveland. Driving a stock Ford Ranger Supercab, the team was one of only 14 vehicles to actually run the entire race route. Although they finished below the top five, they conquered a near miss with a trailer truck, being robbed at knifepoint, and conditions that pushed their vehicle beyond its limits to do something that defeated more than 60 other teams.

Off-road rallying has never caught on in the United States and, admittedly, this intransigence probably caused ESA to run into an estimated \$180,000 of financial difficulties.

Still, this first-ever attempt at a world-class marathon rally in the Amer-

icas may be the spark that lights the fire and those that experienced this once-in-a-lifetime adventure can tell their grandchildren that they were in it.

Telehearing

Jason Empire, from Overland Park, Kansas, has come up with a product that makes me wonder, what took so long? The Jason Discovery Sound Amplifier, which can be mounted on binoculars equipped with a tripod screw, magnifies sound beyond the range normally heard by the human ear. It will magnify inputs as low as 49db and provide output power up to 114db.

The 4-ounce unit features a sensitive, unidirectional microphone that picks up sound as far away as 200 ft. It uses a headset similar to those on portable radios and cassette players and is powered by one AAA battery. Cost is \$50.

Because of the high increase in sound output, firearms hunters are cautioned to turn the unit off before firing weapons. Failure to do so could result in hearing loss or other ear damage.

I had a chance to try the unit out in the wild when the product was first introduced and found its capabilities truly impressive. Photographers, bow hunters and outdoor enthusiasts will be impressed, too, and probably wonder what took so long? **FM**



From the makers of
Jack Daniel's...

INSIDE DETROIT

BY JIM DUNNE

Celebrity 1990

CHEVROLET will replace the Celebrity line with two new models in 1990, a 2-door coupe and 4-door sedan. The new cars will probably carry a different name—Lumina is mentioned for one—and will share GM's GM-10 platform with the Pontiac Grand Prix, Olds Cutlass Supreme and Buick Regal.

All the same technical details of the GM-10 line will show up in the new Chevs, including 2.8-liter V6 engines, automatic and 5-speed manual transmissions, front-drive and independent rear suspension. A high-performance SS model probably will use GM's Quad 4 turbocharged engine. At the same time the new Chevs show up at dealers, Grand Prix, Cutlass Supreme and Regal are also slated for availability as 4-door sedans.

All-New Jeep

In the prototype stage right now is the Jeep of the future, the replacement for the Cherokee line. Code-named the ZJ, the new 4-wheel-drive utility vehicle is scheduled to make its first official appearance as a 1990½ model.



Jeep's all-new ZJ will replace current Cherokee in 1990½.



Chevrolet will market its version of GM-10 platform in 1990. New car will replace current Celebrity.

Chrysler already has ZJ prototypes running at its proving grounds to work out bugs.

Meanwhile, the company is also building a brand-new assembly plant on Jefferson Avenue in Detroit to produce the ZJ, which means the Cherokee will be pulled out of its ancient AMC facility in Toledo, Ohio.

Styling of



Olds Delta 88 for 1990. Scheduled facelift won't change conservative overall theme of its styling.

the ZJ is completely new, but you will be able to recognize its Jeep lineage in the grille design, which features heavy

vertical bars, just like the grille on today's model. Other design changes include more curve in the door glass, a more rounded shape to body panels, and wrap-around 1-piece plastic bumpers, like those used on the newest passenger cars.

Initially, production of the

Olds 98 model and perceptive new-car buyers have made it one of the strongest sellers in the Olds lineup.

Analysts say the 88's popularity has taken sales away from the 98, a theory that is backed up by recent sales figures that show the 88 outselling the 98 by a margin of more than 2 to 1.

The restyled 88 will retain the Olds look in its front end, but the C-post and trunk profile will set it apart from the current styling.

T-Bird V8

Ford's all-new Thunderbird and Cougar lineup comes to market this fall without a V8 engine option, but Dearborn doesn't intend to make this situation the permanent status quo.

For the 1989 model year at least, Ford will only use V6s in the personal luxury coupes. But just as soon as the current 5-liter V8 can be stuffed under the hoods of the new models—or Ford's new 4.2-liter V8 comes on-stream—it will be installed.

Meanwhile, T-Bird and Cougar buyers will choose between the 3.8-liter V6 base engine—the same one used in the Continental—and a 3.8-liter supercharged V6.

"We can't fit the current V8 under the hood," explains one Ford engineer. "We have to make big changes to the top of the engine to lower its

ZJ will be devoted to 4-door models, but by the 1991 model year a 2-door will be added to the line. The reason for that schedule is simple. Almost 88 percent of Cherokees sold in the first part of 1988 were 4-doors. Look for Dodge to get a version of the new ZJ to sell as the Ramcharger II a year after the Eagle Division gets the new Cherokee.

Olds 88 Freshening

Olds will make major changes in the styling of its Delta 88 model in 1990, but the car will hold onto its conservative styling theme.

Built on GM's H-body, the 88 is virtually a technical twin for the more luxurious



1991 Cadillac proto reflects multiple themes.

profile." Should Ford elect to wait until its all-new 4.2-liter V8 is ready, look for an on-sale date sometime in 1991.

Cobbled Caddy

If the proportions of the 1991 de Ville prototype shown with this report look a little bit awkward it is with good reason. Cadillac has a number of different styling themes combined in this test model.

The grille and front end are taken from the 1989 de Ville, while the rest of the body is a 1991 version. In addition, the C-post is thinly disguised by pieces of fiberglass that roughly define what GM is planning in the styling of its post-1991 sedans.

32-Valve Cadillac

GM may move slowly, but eventually the General gets the job done. Take advanced engine design, for example. Although Cadillac still does not have an overhead-cam engine, let alone multi-

valve cylinder heads, plans are in progress to remedy that situation.

In keeping with its aim to be a world leader in luxury-car design, Cadillac will have a 32-valve V8 in its cars by the early 1990s.

The 4-valve combustion chamber will insure more muscle under Cadillac hoods, a feature that has been a point of criticism ever since Cadillac adopted the wimpy 4.1-liter aluminum V8 as its premier powerplant. It takes at least three years, under normal conditions, to get a new engine off the drawing boards and onto the street. Cadillac, in typical GM fashion, is taking a little longer with this project. The 32-valve engine, code-named North Star, may not appear before 1993.

Trip Map

GM is joining a program in California designed to direct drivers around traffic jams. Under the auspices of the California Department of Transportation, the plan will include Oldsmobiles equipped with TV screens and radios which receive traffic tie-up reports. The proposed 3-year study is designed to signal drivers when a traffic slowdown occurs, and direct the driver to the best alternate route.

The faster route is then highlighted on the TV screen, superimposed over a

street map. A 10- to 15-mile stretch of the heavily congested Santa Monica freeway near Los Angeles will be used for the study. The program goal is to come up with a recommendation on the best method to ease the problem of traffic slowdowns.

Lost-Foam Casting

One area where the new Saturn will live up to its high-tech billing is in the fabrication of its brand-new 1.9-liter 4-cylinder engine.

Saturn will use the lost-foam process in casting the aluminum block and head for the engine, a technique that was pioneered in the Oldsmobile 4.3-liter 4-cylinder diesel engine and was a first for a production engine.

In lost-foam casting, a foam insert—made of a material that's closely comparable with a styrofoam coffee cup—helps keep the sand in place when molten aluminum is poured.

The foam also allows the casting to form intricate shapes that are impossible to build without its support. As the molten aluminum flows into the form, the foam inserts vaporize and their places are taken by the aluminum. It's a tricky process, and one of the real advances that the company hopes will make Saturn a less-expensive, high-quality automobile. **PM**

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CAR CLINIC

BY MORT SCHULTZ

Crow's-Foot Blues

I PURCHASED A new, blue Buick Riviera in 1983. Today, the paint on the hood, roof and rear deck lid is cracked. The car is garaged when not in use and has been driven only 33,000 miles. A body shop technician refers to the damage as "crow's footing." Has GM had a problem with this color? Is there a recall?

VINCENT BUZZETTA
ALEXANDRIA, LA

There hasn't been a recall, and my sources tell me there hasn't been a problem with blue. Therefore, the only advice I can offer is that you take the matter up with a Buick field representative. It's unusual for original factory paint to develop crow's feet, which is also called crazing.

The primary reason for crazing is spraying paint when the temperature is too cold. Crazing, therefore, is a condition more prevalent with repainted finishes than with original paint jobs.

However, if the problem is some other form of cracking that the body shop technician has inaccurately termed "crow's footing," it is possible that the difficulty may be the result of an excessively thick film of paint having been applied at the factory.

The affected areas have to be sanded thoroughly, all the way down to bare metal, prepared and repainted. If you do find that an excessively thick film is the cause of cracking rather than some environmental condition, such as acid rain, an appeal

to General Motors may just get you a free paint job. There's no certainty on this, but it's worth a try.

Jolly Cover Cure

Mort, this is in reference to your answer to James F. Beneker of Brookville, Indiana, in the April '88 "Car Clinic" in which he complained about losing wheel covers from the cast-aluminum wheels of his '86 Dodge Aries. Your suggestion that he replace them with aluminum covers made for '87 and '88 K-cars is valid, but I found another way that might also work for him. It's to apply globs of Roof and Gutter Instant Patch Tape made by Mortell Co. at four equidistant points around the inside of the cover. Then, slap 'em on the wheels. Since I did this, I haven't lost a single wheel cover. Before that I lost eight. If Mr. Beneker has trouble finding the product in a hardware store, he can get it from Starcrest of California, 19465 Brennan Ave., Perris, CA 92379.

HARRY JOLLY, JR.
BURLINGTON, NC

Thank you, Harry.

Idle Iliad

I own a 1985 Oldsmobile Delta 88. After only 9816 miles I had to replace the idler arm, which was worn. GM wouldn't cover the repair. The mechanic who replaced the part tells me I can expect more of the same within the next 10,000 miles. I'm disappointed in GM cars and the company's so-called "protection" plan. I think you ought to warn your readers.

M. A. GAJKOWSKI
MYRTLE BEACH, SC

Warning: Watch out for the trap I believe Mr. Gajkowski

has fallen into. There could be more to his story than meets the eye. There's a good chance his car's idler arm was in satisfactory condition, and that's the reason GM wouldn't pay the cost of repair, even though the car was still under the 24-month/24,000-mile warranty. The mechanic who told him that the idler arm was worn may have made his diagnosis in the following manner: He grabbed the part, shook it, felt a certain amount of movement and concluded that the part was faulty.

The problem here is that this method of testing isn't accurate. The idler arm in a Delta 88, as in most cars, is supposed to have some free play. In the old days it wasn't supposed to have any.

Many idler arms in good condition have been condemned to the scrap heap by mechanics who erroneously believe they're doing a heads-up preventive maintenance service by replacing a shaky part.

Let's take M. A.'s Delta 88.

According to the service manual, "The idler arm assembly by design has a moderate amount of lash and should be replaced if, when an up-and-down force of 25 pounds is applied at the intermediate rod end of the idler arm, the vertical lash exceeds 1/8 in." This means the idler arm can be moved by as much as 1/8 in. and still be usable. Furthermore, when you're testing this idler arm, it's necessary to keep the weight of the car on the wheels, rather than using a chassis lift or floor jack.

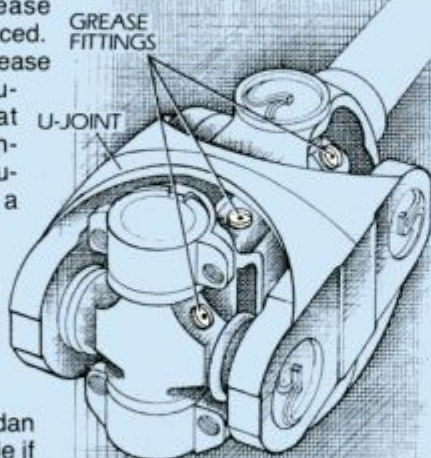
Galant Effort

In your Service Tips segment of "Car Clinic" presented in Feb. '88, you listed two
(Please turn to page 30)

Jumping Joints

It's called a double-cardan universal joint. It's the one at the transfer case end of the front propeller shaft of many 4-wheel-drive vehicles. Some double-cardan U-joints have two grease fittings—others have three. The second and third grease points often go unnoticed.

Failure to apply grease to all fittings of a double-cardan U-joint at the recommended interval is asking for trouble in the form of a U-joint that fails prematurely. Therefore, check your maintenance schedule. You may find that the lube interval recommended for the double-cardan U-joint of your vehicle if it's run off-road is much more frequent—as often as every 3000 miles—than for one in a car driven on pavement.





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Car and Driver	BMW Roundel	Car and Driver	BMW Roundel	Car and Driver	BMW Roundel	BMW Roundel	BMW Roundel	Car and Driver	BMW Roundel	Popular Mechanics	
▶ 1 st Escort Bearfinder Fuzzbuster Double Nickel Hawk Eye Snooper Radar Sentry Super Eliminator Whistler Fox Super Buster X-Kaliber	▶ 1 st Escort Whistler Fox Radar Intercept Fuzzbuster Fox Sidewinder Fuzzbuster Bearfinder Snooper	▶ 1 st Escort Fox Whistler Radar Intercept	▶ 1 st Escort Gul Whistler Fuzzbuster Fox Radar Intercept Snooper	▶ 1 st Escort Gul Bel K40 Radar Intercept Whistler Radio Shack Fuzzbuster Fox Phantom	▶ 1 st Escort Whistler Fox Radio Shack	▶ 1 st Escort Whistler Bel Fuzzbuster Gul Cobra Fox K40 Gul Radar Intercept Radio Shack	▶ 1 st Escort Whistler Bel Fuzzbuster Gul Cobra Fox K40 Gul Snooper Whistler Bel Fox Fox Bel	▶ 1 st Passport ▶ 2 nd Escort Whistler K40 Fuzzbuster Uniden Cobra Bel Sparkomatic Fox Gul	▶ 1 st Passport (Escort not tested) Cobra Uniden Radio Shack Bel Whistler Sparkomatic Fox Gul	▶ 1 st Passport ▶ 2 nd Escort Bel Whistler Macon Radio Shack Uniden Fox Cobra Bel Snooper Fuzzbuster Sparkomatic Sunyong	▶ 1 st Escort ▶ 2 nd Passport Bel Snooper Uniden Whistler Cobra Gul Radio Shack Sparkomatic Macon

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CAN YOUR TOOLS



TINKER. SPRAY. POUR.

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CAR CLINIC

(Continued from page 28)

part numbers for the oil filter Chrysler wants used on its 1987 and 1988 vehicles that have the Mitsubishi 3-liter V6 engine. Those part numbers are MD108063 and 4105409. I bought a 1988 Mitsubishi Galant Sigma with the 3-liter V6 engine, which is the same engine used by Chrysler. My Mitsubishi dealer recommends an oil filter bearing part No. MD097003. A Chrysler dealer tells me I can use filter No. MD108063, which he sells for a considerably lower price. My Mitsubishi dealer cannot find a listing for filter No. MD108063, and the Chrysler dealer can't find a listing for filter No. MD097003.

Can you make sense out of this?

BRIAN J. ALESI
ANCHORAGE, AK

This is one of those cases where appearances can be quite deceiving. The Mitsubishi filter (part No. MD108063) for the Chrysler 3-liter engine has a standard thread.

The Mitsubishi filter (part No. MS097003) for your Galant Sigma 3-liter engine has a metric thread.

Contrary to what the Chrysler dealer, told you, don't mix up the filters and their part numbers.

Truth About Consequences

I recently purchased a 1974 Ford F250 pickup that has a 2-year-old Ford remanufactured short-block engine. Oil is showing up in the coolant, but there's no sign of coolant in the oil.

To my amazement, the vehicle runs fine, the oil level doesn't drop significantly, and there's no excessive exhaust.

I asked the previous owner about this, and he told me that Ford had done a number of things to try to correct the condition, including installation of new manifold and head gaskets, flushing the radiator and block, and testing cylinder pressure.

Tests showed that transmission fluid was not leaking into the radiator and there was no exhaust in the coolant. Ford concluded that oil was indeed invading the cooling system, but that the short block was past the warranty period. I'd like to know if there's anything I can do.

RICK MERCER
MATTOON, IL

And I'd like to know how everyone, including whoever represented Ford, is so positive this is oil. Is it because droplets are floating in the coolant?

If this is the only reason, it seems likely to me that everyone is jumping to conclusions. A sample of the droplets should be analyzed by a laboratory.

You may find that the substance you're seeing is in reality a harmless flushing or coating solution that was used in the remanufacturing of the block and is now being picked up in minute quantities by coolant as it circulates.

However, assuming it really is oil in your radiator, I don't understand why there isn't any water in the oil. Pressure in the cooling system should force coolant back the other way after the engine is shut off.

Unless there's a lot of oil in the radiator, the worst penalty you could face is a possible engine rebuild at some point in the future, if you decide to just live with the problem.

If you really have a problem.

Two-For-One Sale

You're my last resort. My 1986 Chevy Cavalier 2-liter engine is drawing oil from the breather in the valve cover up into the air cleaner housing and leaving an oily residue on the fuel-injection assembly and housing. I've replaced the PCV valve. The dealer calls it normal. The other annoying problem is a squeak from the front sway bar when the weather turns cold. Again the dealer says this is normal. Will you help?

STEVEN HALPERN
WILTON, CT

Some evidence of oily residue, especially anywhere near the PCV connection, is indeed a normal condition. A puddle, or a soaked filter, however, definitely is not.

Has the PCV valve filter been replaced?

Have the PCV system hoses been carefully inspected for bends or leaks that might be negatively affecting the performance of the system?

High crankcase pressure, resulting from a bad head gasket or worn rings or worn valve guides can overwhelm the PCV system's capacity to separate oil droplets from vapor, thus spilling them into the air cleaner and thus into the induction system.

Having a cylinder leakdown test performed will enable you to find any problems of this nature.

As for that cold-weather front stabilizer bar squeak, remind your dealer that the original bushings have since been superseded by Teflon-lined bushings which are designed to prevent just such a noise.

The part number for new bushings to accommodate a 24-mm stabilizer bar is 22532210. If the stabilizer bar shaft diameter is 28 mm, part No. 22532212 applies. **PM**

SERVICE TIPS

■ If your 1988 Chevy Cavalier is suffering a noticeable loss of power, the first thing to check is the hood insulator. It might be sagging, interfering with the air intake. That's what Chevy dealer service bulletin 88-196-10 suggests. It also provides the solution: Remove the section of the insulator blocking the intake.

■ A new cylinder head gasket (part No. E83Z-6051-A) made of a durable graphite composition has been issued by Ford to stop coolant and oil leaks from the cylinder head-to-engine block mating surface. The new gasket is for use on 2.3- and 2.5-liter high-swirl combustion (HSC) engines of 1984-'88 Tempo and Topaz and 1986-'88 Taurus. The leak is most visible in the area below numbers 2 and 3 sparkplugs.

■ A solution for what Chrysler calls "erratic cold-engine idle" in G- and H-body cars equipped with 2.2-liter turbo engines and manual transmissions may be to replace the computer. The computer used in these models—Dodge Daytona and Lancer and Chrysler LeBaron GTS—goes by the fancy name of Single Module Engine Controller (SMEC). The new designed SMEC carries part No. 5233246, except in cars for sale in California, where the part is No. 5234340.

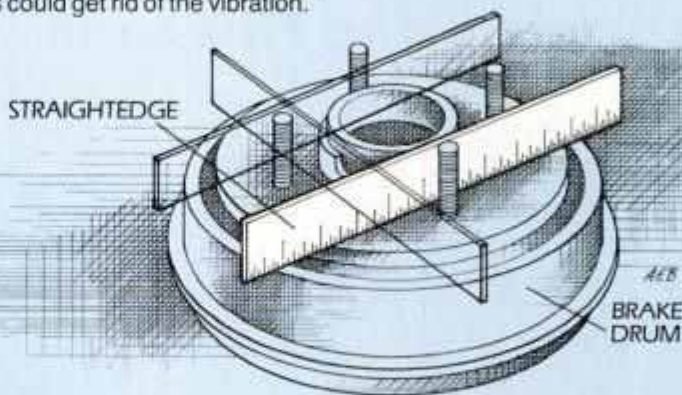
■ Come this winter, if the 2-liter engine in your 1987 or 1988 Olds Firenza happens to foul its sparkplugs, switch to a hotter heat range. Olds suggests using AC R44LTSM plugs gapped to .035 in.

DO YOU HAVE A CAR PROBLEM?

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

Drummer Boy

If you're driving yourself nuts trying to find out why your car is vibrating, look to the rear brake drums to make sure they're true. Lay a straightedge across the wheel-mounting surface in the positions shown in the illustration. If you see daylight between the straightedge and the surface, replace the drum. This could get rid of the vibration.



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IMPORTS

BY BILL HARTFORD

The Future's In The Fast Lane



Aztec roadster and Asgard van (below) are high-speed concept vehicles from Ital Design.

JUST WHEN YOU thought the "Road Warrior" design school had recessed for the summer—maybe forever—along come these way-out concept cars from Ital Design. Shown at the recent Turin Motor Show, the roadster and van look like they should be roostertailing through some future desert with the crazies in pursuit. But this isn't make-believe. The genius of Ital Design, Giorgetto Giugiaro, a mover and shaker whose design talent shines through a lot of sheetmetal, is up to something.

In the case of the Asgard space-wagon, the so-called 1-box configuration is used for his approach to a luxurious minivan.

In Europe, a van—even

a station wagon—is still regarded as a tradesman's workhorse, but the Italian designer is trying to bring his admirers around to the idea of an upscale vehicle that doesn't have to be a traditional notch-back 4-door sedan. But it must look aggressive, says Giugiaro.

Mercedes Of The Minivans

The sedan of the future, according to Giugiaro, is his wagon with the works—full-time 4-wheel drive, at least 200 hp from a mid-transverse engine, and a full complement of luxury-car features.

It seats six in a 3 + 3 arrangement, with an extra seat for two kids facing aft, and has airbags in front.

When it comes to the Aztec, Giugiaro has pulled



out all the stops. The 2-seat spider, which has separate passenger compartments behind their own individual windcreens, should, he feels, outperform any pocket rocket or sport sedan.

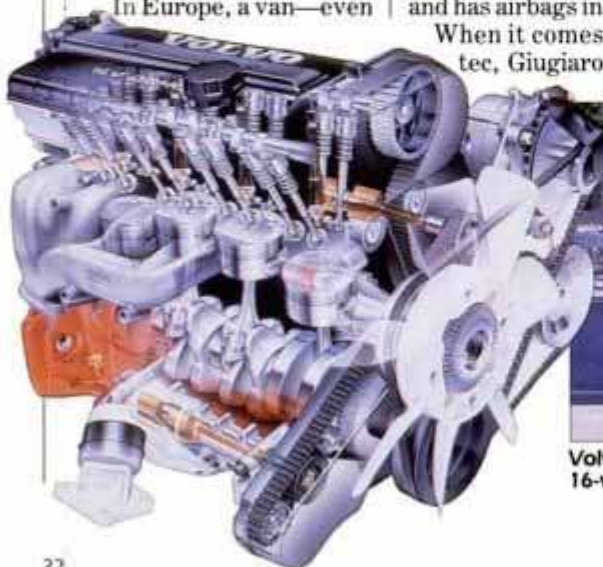
Toward 200 Mph

The sports car must be reinstated in its special place, with extraordinary performance. So, 200 mph should be the target of any sports car that lays claim to the name. The Aztec concept isn't that fast with its 250-hp

Audi Five but it would be if Giugiaro packed in the 450 hp that he considers necessary for a competitive sports car. On the Autostrada and Autobahn, at least, the future's coming fast.

Volvo 16V

When the 1989 740 GLE reaches showrooms next month it will mount Volvo's first multivalve engine. The 2.3-liter Four with four valves per cylinder, twin overhead cams and twin counter-rotating balance shafts generates 159 hp at 5800 rpm. Toothed belts do the job of driving the camshafts and balance shafts, and self-adjusting hydraulic tappets operate the 16 valves. The new catalyst Four uses Lambda Sond to monitor fuel-air mixture and knock regulation is built in. With microprocessor-controlled ignition, the 2.3 is virtually service-free. Just change the oil frequently and plugs every now and then. **PM**



Volvo 740 GLE for '89 will use new, deep-breathing 16-valve, dohc Four that's good for 159 hp.

Frankly, we don't expect you to believe this.

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ELECTRONICS

BY STEPHEN A. BOOTH

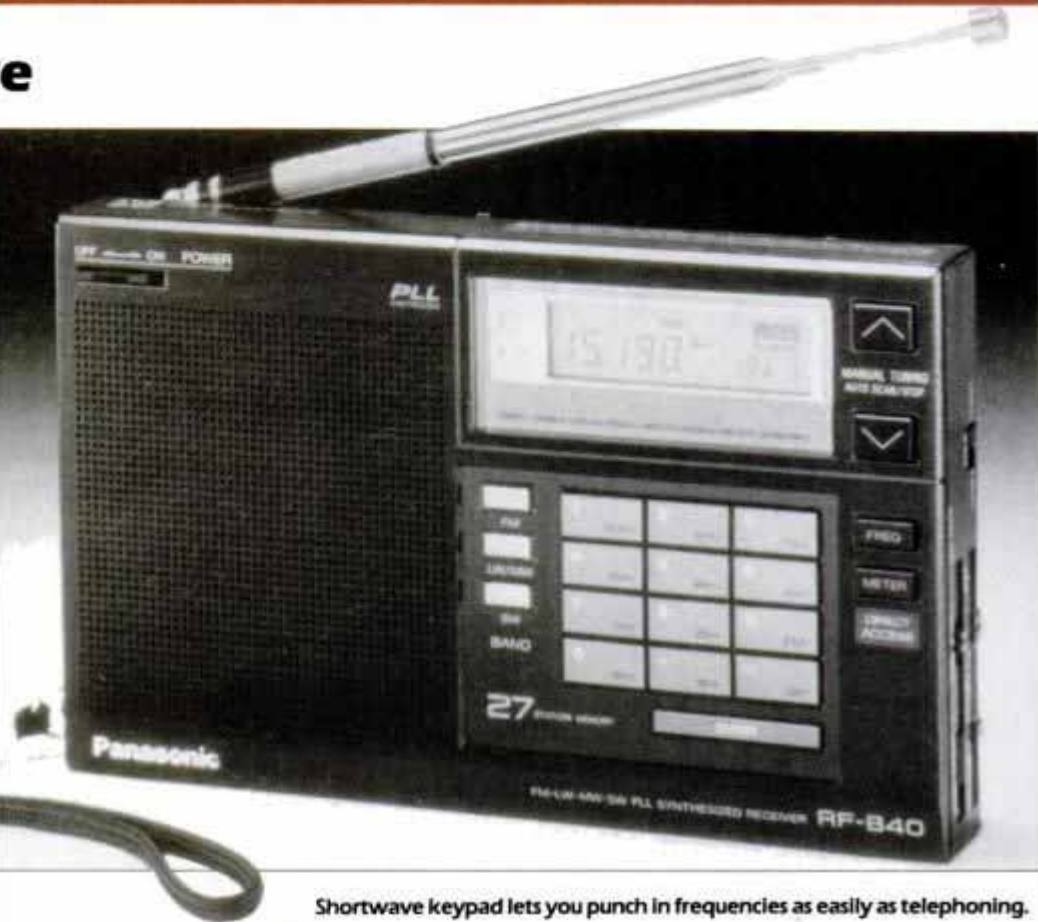
Catch A Wave

IT'S BEEN more than three years since we last visited the realm of shortwave radio ("Shortwave Lightweights," page 84, April '85) and in that time, sales of world-band receivers continue to grow—up about 25 percent last year alone, according to trade sources. Although only 4 percent of the U.S. population now owns a shortwave radio, that figure is expected to reach 20 percent by the year 2000.

One technological innovation that deserves credit for the upsurge in shortwave listening is the development of direct-access frequency tuning, and its incorporation into small, battery-powered receivers about the size of conventional transistor radios. Although purists and advanced radio buffs might scoff, direct-access tuning has made world-band listening more accessible to a wider audience. Instead of having to worry about meter bands, then fiddle with a dial to locate a station on hard-to-read tuning scales, all the user needs to do is punch in the station's frequency numbers, telephone-style, on a keypad.

When we last reported on shortwaves, direct-access portables were relatively new and still somewhat expensive. Suggested retail prices have dropped by about one-third since then, to the \$200 range. (They might have dropped farther, but currency exchange rates now make imported electronics more costly.) That's the price of Panasonic's RF-B40 and Radio Shack's Realistic DX-440, two recent entries in the direct-access tuning field.

In addition to direct-access



Shortwave keypad lets you punch in frequencies as easily as telephoning.

tuning via keypad, the RF-B40 lets you preset 27 stations in memory—nine for the DX-440. If you're not sure of the station's exact frequency but know the meter band it is in, you can select that band, then scan it manually via push-button, or let the radio scan the band automatically for active frequencies. Liquid-crystal display screens give you a readout. Built-in monaural loudspeakers and headphone jacks provide the sound. In addition to 12 shortwave bands, each radio gives you AM and FM.

Shortwave listening can provide many entertaining and educational experiences. Besides live news and the interpretation of news events from overseas, there is a wealth of cultural and sports programming, much of it broadcast in English. You can also bone up on a foreign

language, learn its colloquialisms and train your ear to its accent, by tuning in to stations that broadcast in their country's native tongue. And if you're traveling overseas, a portable shortwave can keep you in touch with news from home, whatever your language. Baseball fans take note—American Forces Radio TV Service carries the playoffs and World Series live. But whether you tune in the game or news by conventional-analog dial (very good portables sell for less than \$100) or by direct-access, the old ballpark maxim holds true: You can't tell the players without a scorecard.

A very handy guide to shortwave listening is the *Passport To World-Band Radio*, published by International Broadcasting Services, Ltd., Box 300E, Penn's Park, PA 18943 (\$16.90). This 400-page man-

ual will give you quick access to the frequencies and broadcast times of more than 1100 shortwave stations. Additionally, *Passport* contains numerous articles and tips on shortwave listening, including buyer's-guide reviews on radio gear. A guide such as this is probably the only accessory you'll ever need for your radio.

Picture This

The 1988 Summer Olympics is just around the corner. The games run from September 17 through October 2, and NBC plans to broadcast the events in MTS stereo sound, the first time ever for the Olympics. Just in time for the Seoul games, the first IDTV receivers will become available at retail stores in the U.S. market.

You'll read more about these digital chassis, im-
(Please turn to page 38)

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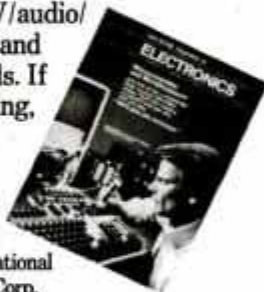
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ELECTRONICS

(Continued from page 34)

proved-definition TVs in this month's "Home Video" column (page 50). They represent an interim step along the way to EDTV (enhanced-definition) and HDTV (high-definition) systems that could be in place by the 21st century. We've reported on these futurevision systems in the past, but until recently, the future has remained just over a horizon that kept slipping farther away. Now, the introduction of super VCRs that deliver better images than broadcast or cable TV ("Super Home Video," page 58, Jan. '88) has prompted some forward progress in the direction of better TV transmission systems. Before long, a variety of committees will begin evaluating proposed technologies for the TV of the future, for the purpose of establishing a single standard of transmission and reception.

The goal set for HDTV is a video display with the quality of wide-screen movie theater images, accompanied by audio soundtracks with the high fidelity delivered by digital compact discs. Compared to the 4-to-3 width to height proportions of today's TV, a 5-to-3 ratio (sometimes expressed as 16-to-9) would be the norm. While the picture gets wider, its makeup would also become less crude than today's, by altering the TV's scanning system. Right now, a TV frame has 525 lines composed of two interlaced fields of 262.5 lines. Motion is conveyed by updating one field, and then the other.

Instead of scanning alternate lines, as in the 2-field system, HDTV will eliminate picture jitter by scanning progressively—an entire frame at a time. And because that frame will have 1050 lines, twice the current number, the picture will appear virtually seamless—without

scanning lines being evident.

Trouble is, the amount of information contained in this 1050-line, wide-screen picture cannot be accommodated within the bandwidth of the 6 megahertz channel now used to broadcast TV signals. That day might come, but when it does, a sociopolitical roadblock remains. Tens of millions of existing TV sets would not be able to display the HDTV signal. Meanwhile, two transmission systems (one for HDTV, one for existing TV) is not feasible. Accordingly, the goal for the future is backward compatibility: Any HDTV system will have to be capable of delivering conventional signals to existing receivers while transmitting improved images and sound to newer high-definition sets.

Although there are HDTV proposals that would satisfy this requirement, they need more than a single 6 MHz channel to do it. Right now, it is not

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certain whether the Federal Communications Commission will allocate additional spectrum to broadcasters for HDTV. One proposal that meets most of HDTV's goals and stays within a single 6 MHz channel hails from the David Sarnoff Research Center in Princeton, New Jersey, formerly affiliated with RCA and General Electric.

Sarnoff calls the system ACTV, for Advanced Compatible Television. It is a form of enhanced-definition TV because, with only 6 MHz to work with, it lacks the 1050-line progressive (non-interlace) scan feature of HDTV. Instead, it opts for the 525-line progressive scanning soon to be available in IDTV (improved-definition) sets, and HDTV's 5-to-3 wide screen.

Digital signal processing within the future wide-screen sets would enable them to receive and display the extra video information encoded in the ACTV

transmission—namely, sidepanel imagery that completes the wide-screen picture, plus additional picture details. Meanwhile, conventional TV sets would simply ignore the extra video information that they are not capable of receiving. According to Sarnoff, the ACTV signal would not affect older sets adversely in any way. Actually, the picture quality they display would be slightly improved, thanks to some pre-filtering at the transmission end that is designed to eliminate shortcomings in the existing broadcast system.

Sarnoff's ACTV, by the way, is capable of even greater resolution (such as HDTV's 1050 progressive scan lines) in the future, should additional broadcast bandwidth become available.

On The Air, In The Air

So much for skygazing at future TV systems. Let's get down to Earth with one

that's already in experimental use—in the air. It's called, appropriately, Airvision. And it's being tested on Northwest Airlines flights between Detroit and Tokyo. The system uses 3-in. LCD-color TV monitors recessed in the seatbacks of the aircraft.

Currently, six channels are available including movies, TV reruns, sports features and news. Passengers receive the audio through headphones.

Airvision is a joint venture between N.V. Philips, the Dutch electronics giant, and Warner Brothers. The Valencia, California, company says that if the system proves popular, Northwest might install the mini screens throughout its fleet.

Airvision might also get a tryout in British Airways and Qantas planes this summer. Additional entertainment programs, including videogames, might be offered at a later date. **PM**

Win a REAL one.



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While you're trying on your new set of Grabbers, grab an entry blank and go for it. A gutsy but gorgeous Ford Ranger XLT heads a list of terrific prizes that includes a trip for two to Las Vegas and the Mint 400, Grabber radials on American Racing Equipment Wheels, Escort Radar Detectors, Monroe Shock Systems, Champion batteries and General Motorsports jackets. Get on your Generals and go.

One Grand Prize—one 1988 Ford Ranger XLT*
One First Prize—one trip for two to the 1989 MINT 400 off-road race
Ten Second Prizes—four General Grabber Light Truck radial tires on American Racing Wheels
Six Third Prizes—one Escort, the Classic of Radar Warning
Thirty Fourth Prizes—one Monroe GAS MATIC® Shock Absorber System
Twenty-five Fifth Prizes—one Champion High-Performance Battery from GNB Inc.
Seventy-five Sixth Prizes—one General Tire Motorsports Jacket.
*Choice of color is based on availability.

Enter and get complete official rules for sweepstakes at your local General Tire Dealer or hand print your name, address and phone number on a 3 1/2" x 5" postcard and mail to: General Tire 1988 Ford Ranger Sweepstakes, P.O. Box 823, Medina, Ohio 44258. Certain participating stores may provide the option of depositing your entry in an in-store ballot box. All entries must be postmarked (or received via in-store ballot boxes) by October 31, 1988. Sweepstakes only available at participating dealers and open only to residents of U.S. and U.S. military bases 18 years of age or older at time of entry. Sweepstakes subject to complete rules. See official sweepstakes rules for specific details on prizes.



GENERAL TIRE





Long-Term Boat Test

SEA RAY PACHANGA 22

Our long-term test finds big muscle in a sleek, compact package.

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

PACHANGA is more than a salsa-flavored dance. It's a lively, spirited mood that Latin Americans have been celebrating for decades. Pachanga is also the name of a boat built by Sea Ray, of Knoxville, Tennessee, and it's no coincidence that this sleek waveburner has a hot, up-tempo nature.

Early last year, the PM test team got its first look at the Pachanga 22 and, after a battery of tests, declared it the winner of a head-to-head, no-holds-barred comparison test. (See "Muscle Boats," page 102, July '87.)

Tested against five of the sexiest water scorches on the market, the Pachanga finished ahead of the pack in top-end speed, fit and finish and total stowage space. It was second on the performance course, third in acceleration and a leader in value, with one of the lowest price tags in the fleet (\$29,395 with MerCruiser 350).

But this was a 1987 model and we only had four days to wring it out, so we asked Sea Ray for an '88 Pachanga 22 for a long-term test and a more in-depth profile.

We picked up the brand-new, blue-and-white muscleboat last summer and used it for six hectic weeks as if it were our own boat. We used it in all types of water and weather conditions—trailer, launching, docking, an-



Pachanga is smooth and sexy at speed and behind the well-laid-out command station.

choring, cleaning, maintaining, waterskiing and family cruising. Overall, we found the boat to be built like a thoroughbred, but we also found a few nits to pick.

On the road

Sea Ray arranged for us to take delivery of the test boat through a local dealer, D & R Boats, in Greenbrook, New Jersey. D & R is one of the largest and best-operated Sea Ray dealers in the East.

After everything checked out, the boat and Load Rite Trailer was hooked up to our 4x4 and we were off. First stop on our test schedule was in upper New York State on Lake George, 250 miles away. After this, it was two weeks on Greenwood Lake,

near the New York/New Jersey border and, finally, two weeks on the Connecticut side of semiprotected Long Island Sound.

Fully loaded with gear, the boat and trailer weighed about 3500 pounds. We drove rainslick roads and jockeyed for position on high-speed highways. We launched at a number of steep and tricky boat ramps and, not least importantly, backed into tight, obstacle-strewn driveways.

In all situations, the boat and trailer were maneuverable and gave a comforting sense of sure-footedness at speed. However, the trailer told us when we were exceeding the limit by wandering and misbehaving slightly. Slowing down immediately corrected all problems.

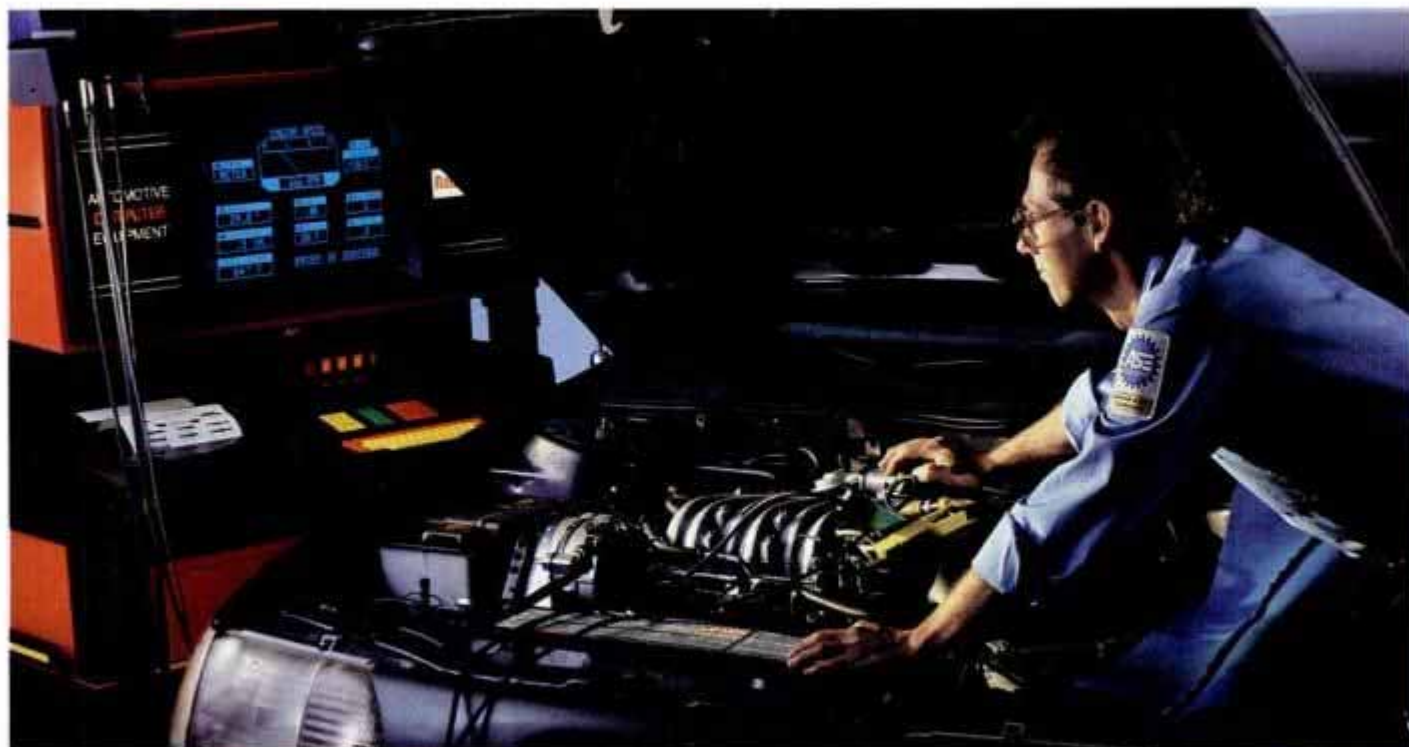
On protected water

The Pachanga, to quote a popular song, was born to run. We equipped it with MerCruiser's impressive 350 Magnum, a 270-horse firebreather that pulls extra power from a big GM block via high-rise intake manifolds. The boat was dialed in to perfection by D & R Boats and required no tuning or major shop maintenance during our test.

On protected water, the Pachanga ripped along at nearly a mile a minute

(Please turn to page 43)

Dealer Service:



Profile in Quality #4: At Ford Motor Company we're committed to building quality cars. And our dealers are working to back this commitment with Quality Care. That's why we offer a 6 year/60,000 mile powertrain warranty* on our cars and light trucks. And our dealers back that up by offering the Lifetime Service Guarantee.**



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*Restrictions and deductible apply. Ask your dealer for a copy of this limited warranty. **On covered repairs. Ask your participating dealer for a copy of this limited warranty. †Based on an average of owner-reported problems in a series of surveys of '81-'88 models designed and built in North America. Buckle up—Together we can save lives.

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WARNING:
THIS PRODUCT
MAY CAUSE GUM
DISEASE AND
TOOTH LOSS

SEA RAY PACHANGA

(Continued from page 40)

and was clearly the fastest boat on both Greenwood Lake and Lake George. Top-end speeds were a consistent 58 mph, with occasional blips on the radar gun at 59 mph.

Acceleration was equally blistering, racing from 0 to 40 mph in just over 10 seconds. This, of course, made it an ideal towboat for waterskiing.

Even more impressive than raw speed and power was how the boat handled at speed, which I believe is the litmus test for all powerful family-oriented boats.

In recreational situations, inexperienced drivers are often behind the wheel. When this happens with the Pachanga, the driver finds a forgiving boat with tight, responsive steering and tremendous cornering ability. The hull showed no signs of chine walking, skittering through turns, porpoising or wandering in straightaways.

Overall, the Pachanga has something for everyone. It's fast enough to provide thrills, wide-open enough to let you soak up the sun, and sexy enough to be a headturner.

But, after hours of scrutiny, it is not surprising that I discovered several shortcomings. Most noteworthy is the small cuddy cabin, which is little more than a crawl space, although its off-center access door offers relatively easy entry/egress.

On the upside, the cuddy had two plexiglass foredeck hatches that allowed in plenty of light and air, especially when the cabin door was open. It's also fully carpeted and has a thick sleeping pad large enough for two to be comfortable out of the elements, although I wouldn't recommend it for serious overnighting.

Also on the small side were the cockpit, sunpad and usable deck space. We actually squeezed five adults and two kids into the two bucket seats and large bench seat, but this was pushing it. The cockpit is built for a maximum of five adult passengers, six if kids are counted.

A cooler space for beverages and food is provided in the cockpit beneath a cutout hatch, but it's designed for a removable cooler of the Coleman variety. A boat with this kind of price tag (nearly \$30,000) and with this much style, should have a built-in, insulated cooler with a hinged hatch. Anyone who wants a portable cooler can always bring one.

On the Sound

A number of superb driving features became evident on the choppy waters of Long Island Sound.

First of all, its deep-vee hull, which has a sharp 22° deadrise at the transom, displayed outstanding rough-water performance. It blasted through a 3-ft. chop with an incredibly soft hull reentry. It was dry, too, with reverse hull chines throwing water well away from the cockpit at all speeds.

The wraparound, tinted windscreen, made of a distortion-free tempered safety glass, is cut low to conform with the Pachanga's Euro-style lines, but so is the helm seat, and wind blast is kept to a minimum. Forward visibility is excellent.

Helm features I especially liked were visibility and accessibility of gauges and controls, padded sport wheel, circuit breakers on padded dash, lots of legroom, grab rails and dash-mounted AM/FM tape unit.

Beyond the helm, standout design touches were the powerlift engine, hatch and the full-length integrated swim platform.

The 22-ft. Pachanga, which has a trailerable 8-ft. beam, comes equipped with a long list of standard equipment. Notable are the ski-tow ring, swim ladder, Halon fire system and stainless-steel prop.

The only options on the long-term test boat were the two foredeck hatches. These weren't installed on

the '87 comparison test boat and they were sorely missed. Without them, the cabin is dark and musty. They are highly recommended.

Fit and finish throughout was superb, with stout hardware, smooth gel coat, plush vinyls and fabrics, concealed fasteners and overall craftsman-like detailing.

However, one element did puzzle me. A taut cable ran down the centerline of the bow, which was a rough attempt at providing a courtesy handhold. Since the windscreen does not open up, and climbing onto the bow is rare, it seems to me this is a superfluous feature.

If a grab rail were necessary, then it should be a firm one made of stainless steel rather than an ineffective halfway measure.

But all criticism of the Pachanga 22 is slight. Overall, it is a mini-offshore muscle machine that looks as hot as it runs. It may not have an overabundance of cockpit and cabin room, but space isn't what this boat is all about. Would you complain that a Corvette isn't roomy?

After a summer's worth of hard use, the Pachanga 22 confirmed what we discovered in our muscleboat comparison test. It's a superior boat, with great value, and a craft the PM test team would love to own. **PM**

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The Ageless Airplane

BY FRED MACKERODT, Contributing Editor

NO ONE IS MORE safety conscious than the U.S. Air Force. And that service recently began to extend the life of two '50s-era training aircraft—the primary T-37 and the supersonic T-38. Along with the DC-3,

and even my own Piper Aztec, the T-37 is a great example of good American design being relatively ageless even in the high-tech world of aviation. Both the T-37 and T-38 will be close to 50 years old when they are finally retired some time after the turn of the next century.

The T-38 program has been underway at the San Antonio Air Logistics Center, Kelly Air Force Base, Texas, and the T-37 program should be beginning shortly.

When the twin-jet T-37 was first built by Cessna in the mid-'50s, the design goal was for a life of 8000 flying hours and 20,000 landings. This was subsequently extended in the early '60s to 15,000 flight hours and 37,500 landings.

With a current service life limit of 18,000 hours, the updating will nearly double the T-37's life by adding an additional 15,000 hours.

To assure that the T-37 hangs together during its ad-

Fifties T-37 trainer, seen here in A-37 dress, will serve past year 2000.

ditional years of service, the Air Force uses an inspection process called Damage Tolerance Analysis. DTA relies on new principles of fracture mechanics and crack-growth analysis, backed up with testing. Previous safe-life methods of maintaining structural integrity assumed that materials and structures begin life without flaws. The damage tolerance design philosophy, on the other hand, assumes that all fabricated structures contain cracks or flaws of certain minimum sizes even when the structures are brand new, and that these cracks and flaws grow as the structure ages. Damage-tolerance postulates how large a crack a structure can tolerate without resulting in a catastrophic failure, and predicts when that point will be reached.

This data is combined with a computer analysis of the

entire airplane which allows the Air Force technicians to identify those areas of the aircraft that are the most fatigue critical.

With these new techniques, the T-37 will go from a service life limit, at which point the aircraft is automatically grounded, into an inspect and fly mode.

So far, the T-37's safety record has been admirable, with only one in-flight accident—in 1968—attributable to a structural failure.

The budget for the T-37 life-extension work is \$195 million, a relatively paltry sum when you consider what it would cost to build a new fleet of primary jet trainers. A total of 644 aircraft will be modified.

How can owners of general aviation aircraft approach the care and maintenance enjoyed by the T-37—in effect achieving the eternal airplane? Consider the case of my Piper Aztec N87A.

It is sitting up on jacks in the hangar looking forlorn, even trashed. The cowlings stripped from both engines lie up against one

wall. Its propellers rest on plastic drums in front of the airplane. Ignition wires hang down. Two gaping holes in the right engine mark where cylinders have been removed. Four magnetos lie on the floor under one wing. From tip to tail, round inspection plates hang limply from the airframe.

Inside, the six seats and all of the carpeting have been removed, exposing the shiny aluminum flight deck. And in the rear, the tail cone slumps loosely underneath the stabilator.

It's a depressing sight. The Piper looks to all the world like the victim of an attack, a giant rip-off—like a car left unattended for more than 5 minutes on the shoulder of the West Side Highway in New York City. But rather than having been victimized, the Aztec is undergoing a yearly ritual: Its annual inspection.

It's been a good annual so far, as annuals go. Two exhaust leaks have eroded the aluminum exhaust ports on two cylinders and these have been sent out to be refaced. A vacuum pump is leaking oil on the back of one engine,

800 supersonic T-38 trainers will be 50 years old before retirement.





Appearing stripped and plundered, Piper Aztec N87A undergoes annual inspection.

and the prop seals are doing the same up front. The sparkplugs have seen better days and will be replaced.

All in all, it will take technicians Kevin Sisti and his assistant Scott Lavine a week to perform the annual inspection. In the process, they will perform 215 operations and certify the airplane for another year—or about 200 more hours—of flight.

It's at annual time that I ask myself the annual question: How long will I continue to enjoy my airplane? If it were an average automobile, it would have been on the junk heap nine years ago when it was 8 years old.

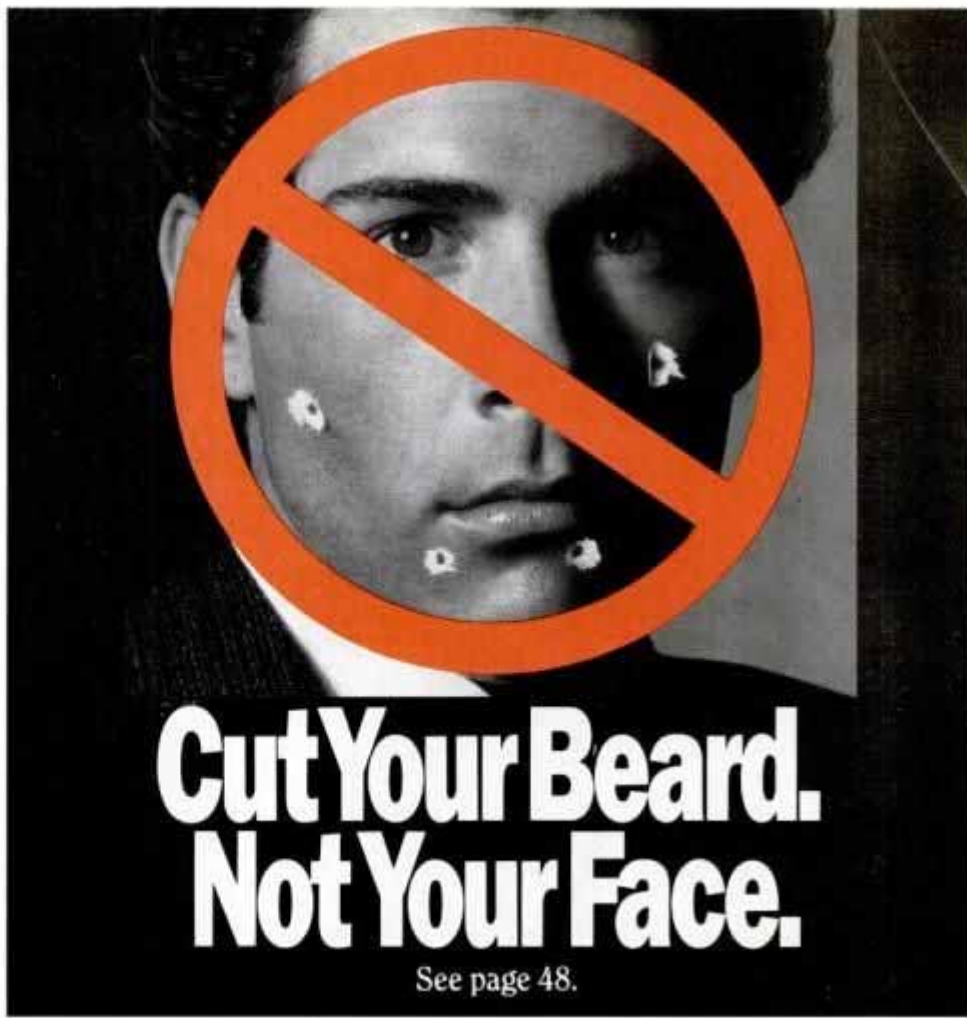
Piper Aztec N87A was first flown in 1971. Since that time it has accumulated 3200 hours and has covered about a half-million miles. Next year at annual time it will get its third set of engines.

While the airplane is old by automobile standards, it is not even middle-aged by airplane standards. Of the 220,000 active general aviation aircraft flying in this country today, my airplane is just about average agewise. The General Aviation Manufacturers Assn. estimates that the average single-engine airplane is 21 years old. Light twins, like my Aztec, average 14 years old.

With the production of new airplanes reduced to a trickle of less than 1000 planes a year due to a variety of reasons, not the least of which are this country's screwed up liability laws, the average age of active general aviation aircraft is increasing every year.

The DC-3 example

So just how long can an airplane like mine last? Unless something unforeseen like an accident happens, my Aztec could probably last forever. Warren Basler would probably agree with me. Basler's business is based on an aircraft which recently passed its 50th anniversary—the DC-3. Based at Wittman Field in Oshkosh, Wisconsin, Basler Flight Service owns and flies 13 of the veteran aircraft, hauling everything from livestock to auto parts almost every day of the year. Other than that, Basler operates a repair and refurbishing center for other people's DC-3s, some of which have flown as many as 100,000 hours.



Cut Your Beard. Not Your Face.

See page 48.

According to Basler, the DC-3 is virtually indestructible. He tells of one DC-3 he acquired from the French Air Force. "It was painted, and when we stripped the paint off, the aluminum underneath looked brand new. The plane looked like it had just left the factory."

The Achilles' heel of the DC-3, says Basler, is its engines. "Those old radials have been rebuilt so many times, they've just about had it, and nobody's building new ones." Basler estimates that 90 percent of the repair work he does on DC-3s is on the powerplants. The airframes rarely present a problem.

To get around the power glitch, Basler is modifying the DC-3 by adding two Pratt & Whitney PT6 turboprops. With the new turboprops and a zero-time airframe, he gets \$2.5 million for the converted airplane. "We recently completed the first example, and it hasn't stopped flying since we wheeled it out the door." Most nights it can be found hauling packages for Federal Express.

"The turboprops are a natural for the airplane," says Basler. "You retain all the good points of the DC-3, with the benefits of lower fuel cost and maintenance, and greatly reduced vibration."

If Warren Basler has anything to do with it, it's entirely possible that the DC-3 will still be hauling freight on its 100th birthday.

But can older airplanes be as safe as new ones? While there is no way to answer this question unequivocally, one thing is for sure.

With new techniques now being developed to inspect and monitor older aircraft, the safety margin is being increased every year. New equipment and good old Yankee common sense are enabling aircraft technicians to do more thorough inspections.

As an example, Jet Aviation in Morristown, New Jersey, uses a portable video-borescope system to peer deeply into an aircraft's innards. A videotape of the inspection is made as it is going on and the operator has voice-over capability so he can give a blow-by-blow of the area being looked at while the work is going on.

With 2.5 magnification and a sharp color resolution, the tapes can be reviewed by groups of experts in the comfort of a conference room.

But there's a downside to all the work being done to extend the lives of America's airplanes. Just think of all those warbird buffs who have been waiting to glom the T-37s when they are retired. Now these people are going to have to wait for the year 2000 before the T-37 begins to appear on the surplus lists.

Sorry guys! You'll just have to make do with all those WWII Mustangs. Life is tough. **PM**

Antilock Brakes At Last

BY NORMAN S. MAYERSOHN, Contributing Editor

TAKE THE same test ride I did—making repeated panic stops on sand-covered asphalt and a wetted-down Royal Air Force runway in Berlin—and you'll certainly want antilock brakes for your motorcycle, too. Even after jumping on the brakes with all the force I could muster, the ABS-equipped BMW K100 simply came to a straight-ahead stop, time after time. Thanks to the electronic ABS system, there was just a slow-speed shaking but no drama, no skidding and no worrying about crashing.

Though ABS is now available on virtually every automobile with a sporting streak in its personality, until 1988 antilock brake systems had never appeared on any production motorcycle. There are good reasons for this: The systems are expensive and relatively heavy, and they need considerable adaptation to function properly on a 2-wheel vehicle.

By the time you read this, however, BMW dealers will have in stock K100 RS models with an all-new system developed specifically for motorcycle use. To underscore the importance of this new technology, BMW invited PM to witness side-by-side demonstrations of ABS and conventional brakes (shown above with safety outriggers fitted). And to verify the system's flawless operation, we rode the ma-



ABS-equipped BMW (left) stops safely, while conventional skids.

chine on specially prepared surfaces a few miles from the BMW motorcycle plant in the Spandau section of West Berlin.

Actually, the need to prevent brake lockup is even more critical on a motorcycle than in a car. Cars don't fall over when the front wheels lock: They just lose steering control. But a cycle almost inevitably crashes due to the

loss of the wheel's stabilizing gyroscopic effect.

Though improvements to brakes and tires have shortened potential stopping distances in recent years, the ability of the average rider to use all the available braking force hasn't entirely kept pace.

For the most part, careful riders don't use nearly all the bike's braking power, even in

an emergency, and they engage the brakes with too little initial force. Also, many riders are reluctant to use their front brake.

BMW terms its system a safety net, meaning that it helps avoid crashes by allowing all riders maximum-force stopping, regardless of

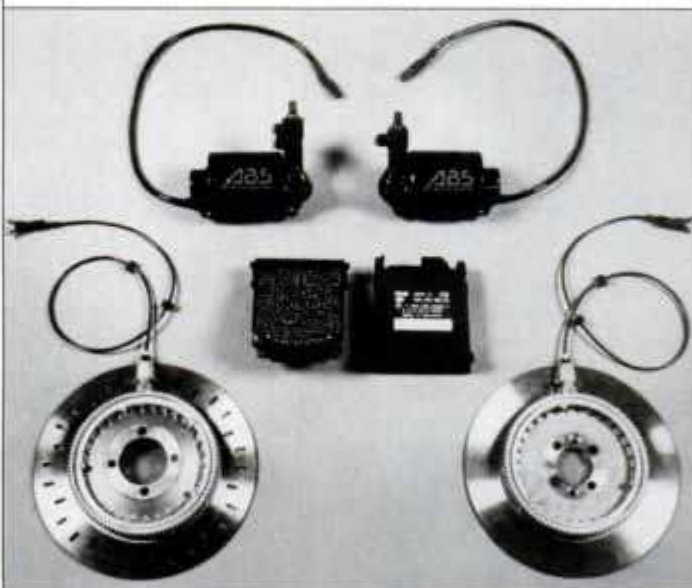
the road surface. Unlike cars, though, even with ABS the brakes still can't be used hard in cornering—the bike will straighten up under braking and refuse to turn.

Control of the antilock mechanism, built by the Bavarian firm of FAG Kugelfischer, is accomplished with familiar hardware. Inductive sensors mounted to both wheels gather wheel-speed information using toothed impulse-generator rings. When a rapid drop in wheel speed indicates an impending lockup, the electronic control unit activates a pressure modulator to interrupt the braking force provided by the rider. As wheel speed builds back up, braking pressure is restored.

This process can repeat up to seven times per second which is slower than current automobile systems.

Separate pressure modulators for front and rear brakes are mounted above the rider's footrest positions.

Some special considerations for the motorcycle application were necessary. Current automotive ABS designs require too much



Antilock hardware adds about 20 pounds to K100 RS motorcycle.

brake-fluid volume and extra components, so this new Kugelfischer system was adopted.

Furthermore, a valve to prevent brake-fluid backflow is necessary to assure that the pumping action of the ABS will not affect the brake lever or foot pedal—there is little of the disturbing sensation found in most car ABS systems. The motorcycle system also operates down to 2.5 mph, to help prevent low-speed tipovers.

Since the weather protection of components is a challenge on motorcycles, the wheel-speed sensors do not use permanent magnets. Instead they are activated only when the ignition is turned on. The impulse-generator rings are aluminum, with a metal spray coating to provide the necessary signal. An electronic control unit is mounted in the tail section, behind the seat, and uses double wiring to each wheel.

While one wire controls or monitors brake operation, the other is being checked by the ECU, and operation is alternated between the two every 10 seconds. In the event of a failure, the system returns to normal braking and lights a dash-mounted warning.

To keep you from being put off by the apparent complexity of ABS, you should know that BMW has provided self-diagnostic ability in the electronics. The installation of the system is quite involved, however, so retrofitting non-ABS bikes is not possible at this point. As customer demand warrants, ABS will be expanded to other machines in the line, very likely starting with the K75 series.

In all, the ABS hardware adds less than 20 pounds to the overall weight of the K100, but the price tag is a heavy-weight, adding about \$1200 in cost. In Europe the system is available as an option on all K100 models.


Here in the United States, ABS will be initially limited to a special K100 RS offered in a striking blue-and-white paint scheme.

When will BMW's competition respond with their own antilock brakes? Soon, we'd bet.

Suzuki is rumored to be working with Bosch on a system, Kawasaki has a unit of its own under development and Honda has long acknowledged study of a hydromechanical ABS setup.

Based on a Lucas Girling design, the Honda unit is fitted entirely within the wheel hub. It senses lockup with a sensitive, built-in flywheel and uses a wheel-driven pump to restore fluid pressure and braking force after lockup has been averted. Its appeal lies in the relative simplicity and low cost, but BMW rejected this design because it did not function at very low speeds and added unsprung weight to the wheel hub.

The Kugelfischer design will find its



Don't Be Rough On Your Face.

See page 48.

way onto cars before long, too. VW is working with a 3-modulator version of the system at the present, and production will probably be slated for 1990.

For BMW, the introduction of ABS braking on motorcycles is a significant return to the technological leadership once enjoyed by the Germans.

The corporate planners concede that there is no point in trying to outdo the Japanese in terms of horsepower so BMW will concentrate on versatile, well-balanced performance machines instead of 2-wheel versions of their M3 performance models.

The ABS braking, as well as the rumored introduction of 4-valve heads for the K-series, and a redone Boxer Twin to meet the upcoming EEC noise and emissions regulations, verifies BMW's commitment to motorcycling.

Roadside Savors

That heady feeling of freedom on a motorcycle tour is fast converted to vulnerability when mechanical mayhem strikes far from home. No doubt many of us keep up auto club memberships of some sort, but most of those are of little use when you travel on two wheels, unless the problem is a simple lack of gasoline. So it's refreshing to hear that Cross Country Motor Club (270 Mystic Ave., Boston, MA 02115) is not only delighted to have our business, but they're also

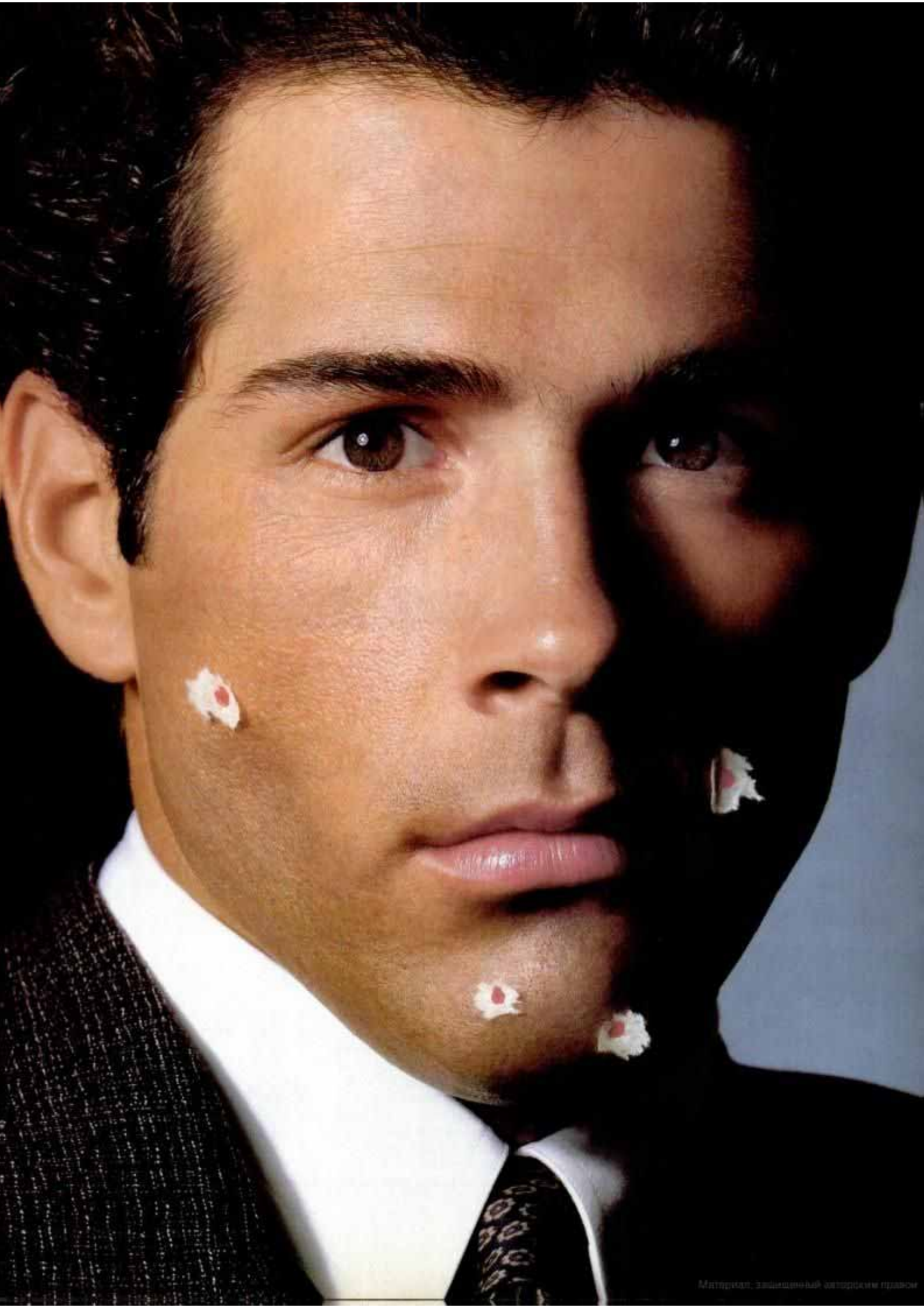
sufficiently well respected to maintain road service for one major motorcycle manufacturer.

Cross Country provides the emergency road service for a number of prestigious car companies, too, but the important news is their arrangement with Yamaha to provide motor club services to buyers of the Yamaha Extended Service Contract Plan. All the usual perks are there: computerized trip routing, lost-key return service, theft reward provision and discounts at hotels and car rental agencies.

What's unique, though, is the emergency towing/pickup and wrecker service, and emergency road service. Available through a 24-hour toll-free phone hookup, Cross Country has cataloged facilities that are specifically equipped to pick up motorcycles, and often do repairs as well. **PM**



Motor club benefits now cover cycles, too.



Every day, millions of men leave for work with the morning paper.

But you shouldn't have to be one of them.

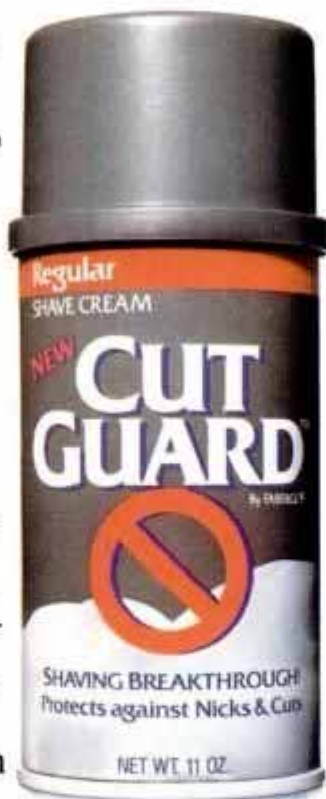
Recently, a group of men tried new Cut Guard™ shave cream for the first time. And the majority of them came to the same conclusion:

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No kidding.

Which didn't really surprise us. Not when you've got a shave cream with a "friction-reducing" system so unique, it's got a patent pending. A lubricant so advanced, it creates incredible glide.

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Video Snapshooter

BY FRANK VIZARD, Contributing Editor

POINT-AND-SHOOT is a phrase most commonly applied to certain easy-to-use 35mm film cameras, but it might as well be used to describe many of the new video camcorders now available. The latest of these are lightweight, simple to use and bring home great movies.

Among the best examples of the new breed is Canon's E70 model. The E70 uses the 8mm video format and, while 8mm does not approach SVHS in video quality, it is at least the equal of, and in some respects superior to, standard VHS.

Weighing just under 3 pounds with the battery attached, the Canon E70 is designed for the person who wants good home movies but does not want to become a dues-paying professional cameraman in the process. I think I can say this is true of most of us—while the hardware can be fun in and of itself, we're most interested in the results.

And the results are very good. Simple operation does not translate into poorer quality. In fact, there are some improvements in the E70. One is a new color-separation filter. This new filter has been keyed to some redesigned internal circuitry for better color reproduction. Canon officials say the improvement is most noticeable in the green, a color some camcorders have trouble reproducing accurately. I gave the E70 a thorough green

test on St. Patrick's Day, an Irish holiday in which more shades of green appear than there are counties in Ire-



Despite its technical sophistication, the E70 camcorder offers point-and-shoot simplicity.

land. The Canon E70 performed very well. That translates into a +32 for you specifications buffs.

The E70 carries a list price of \$1599 which is lower than many of the 8mm camcorders on the market. The most remarkable aspect of the E70, though, is its easy operation. Once you've turned on the power, all you do is pop an 8mm video cassette into the machine, and then press the red button to record. The E70 is designed for right-handed operation so both the power and record buttons are located near where your thumb grasps the machine. The 6x power zoom control is located along the top of the E70 and is easily accessed by your index and middle fingers. Also ranged along the top of the E70 are the various playback controls. These include FAST, FORWARD, PLAY, REWIND, STOP, STILL and EJECT.

Forward of the tape, well on the left side of the E70, are controls for use in special situations. These include auto white balance, a high-speed shutter for fast action, a macro mode for closeups, a back-light compensation control, and a fade button for smooth transitions. There's also a timer control to delay recording for 10 seconds so you can get into the picture. The same button also engages the interval timer, allowing you to record an object for 0.5 seconds in intervals of 10, 20 or 60 seconds for up to 6 hours.

Other features of the E70 are not so obvious because they're internal. Among the most important is the flying erase head which eliminates blanks and video noise between scenes. Flying erase heads are mounted on the rotating head drum along with the video recording heads.

The E70's exposure system is centerweighted to assure proper subject exposure in the center of the picture. The "reading" portion of the system is placed toward the bottom of the frame so light measurement is not affected by the sky. It is also slightly wider than it is high so that the exposure level remains the same even if the subject moves left or right. This exposure system is the same type as that used in Canon 35mm still cameras.

Other specifications include a low-light recording capability of less than 10 lux.

The E70 is powered by a battery pack that supplies 45 minutes of power. Additional batteries—and it's always good to have at least one extra for those moments when recharging is inconvenient—cost about \$40 each. The E70 also plugs into a wall, and a car recharger is available as an option.

Also available is a variety of accessories, including several lenses and microphones.

3-D Delay

The month of May came and went without the appearance of a "Moonlighting" episode in 3-D. Selected scenes in the popular television show and a Coke commercial were set to be filmed using a new 3-D process developed by Nuoptics Associates (see "Home Video," page 36, June '88). Unfortunately, a Hollywood writers' strike disrupted production plans. Studio executives are hopeful that 3-D will be dropped into our Christmas stockings.

Walking TV

A portable television is a walking television. That's how Brian Elliott, an industrial design student, envisions the idea.

Elliott's "Animan" walking TV was one of two winning entries in Sony's recent Design-A-Vision contest. Elliott, a student at the Art Center College of Design in Pasadena, California, says Animan combines the principles of robotic and television design. Animan, of course, can move from room to room without assistance. Animan might also



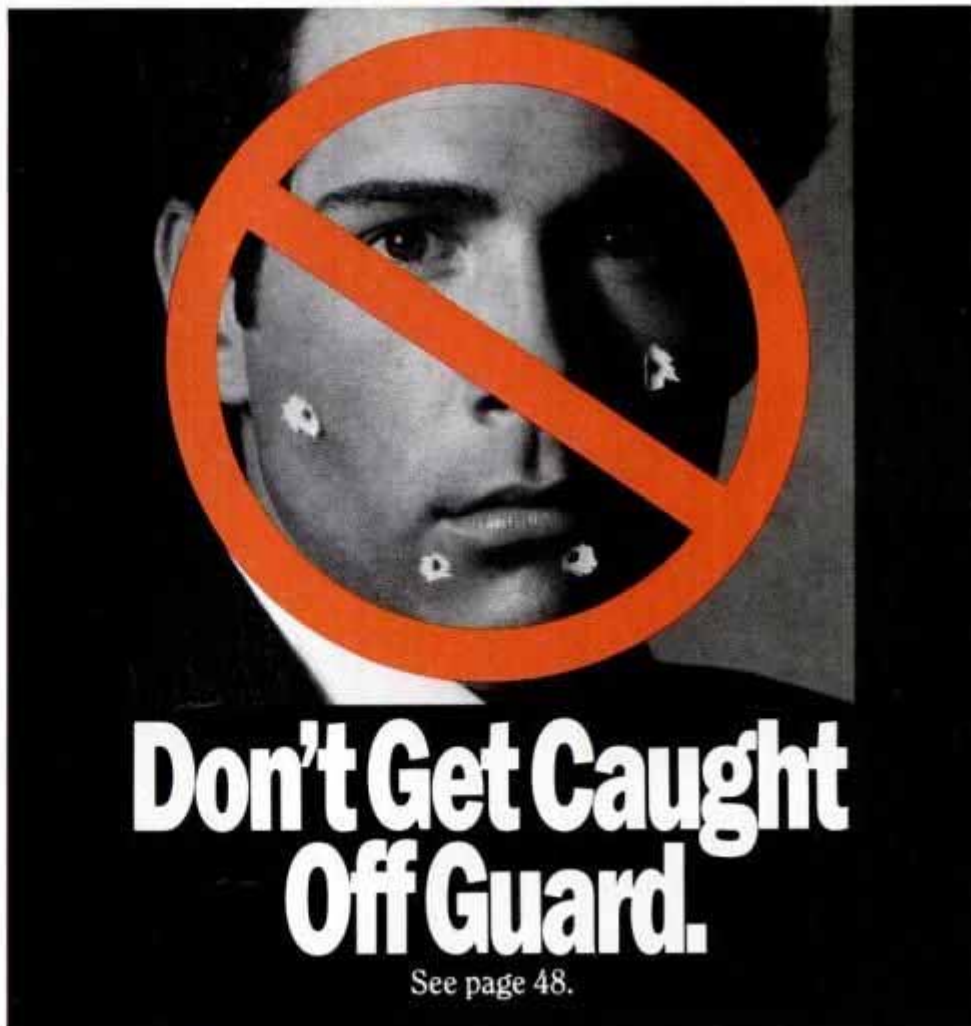
Animan, a robotic TV, is one of several futuristic designs from Sony's contest.

make TV more entertaining—just imagine Animan dancing to a soft drink commercial or leaning into the curve during a chase scene. Animan could also do security work around the house.

While Animan took first place in the home entertainment category, Rusty Snell of Arizona State University won top honors in the personal television category. Snell designed a handheld TV powered by the Sun. "Solarman" has a 2-in. screen that can be adjusted to avoid glare. A reflector panel swivels to



Solarman, a solar-powered 2-in. TV, also took a prize in Sony's Design-A-Vision.



capture the Sun's energy. I also liked the second-best entry, a small TV built into what looks like a kneepad. It straps on for hands-free viewing. The So-Knee was designed by Jason Lee, a student at Brooklyn's Pratt Institute. Happy viewing, futurists!

IDTV Is Here

Sharper and clearer television pictures will be available this autumn on TVs from Philips and Toshiba. Each company is using new signal-processing techniques that are likely to divide televisions into an upper and lower class. The upper class will be called IDTV.

IDTV stands for Improved Definition Television, and the improvement comes from noninterlace scanning.

Conventional TVs have a picture frame comprised of 525 scanning lines. It is created by interlacing two fields of 262.5 lines each, and the fields are scanned in alternating sequence, with each one updated every $\frac{1}{60}$ th of a second. IDTV differs in that it can scan twice as fast, and progressively—without interlacing. Instead of scanning alternate fields, digital memory and line-interpolation within the TV enable it to double the 262.5 lines of a single field to 525 and present them all at once—but in the same $\frac{1}{60}$ th of a second.

By doubling the number of scan lines in each field, the vertical resolution of

the picture can improve 40 percent.

Noninterlace scanning is augmented by improvements elsewhere in the signal processing chain. Philips, for example, combines noninterlace scanning with a digital field-comb filter. This improves luminance and chrominance separation while reducing the number of hanging and crawling dots that sometimes attack a picture.

IDTV signal-processing techniques are most visible when they are used in large-screen televisions. Toshiba's first IDTV model, the CZ2898, will have a 28-in. screen. The first Philips IDTV models will be 27 in. and 31 in.

IDTV models will come loaded with a multitude of features ranging from digital picture-in-picture effects to on-screen programming. They'll also have jacks for plugging in super VCRs.

All of this means that the first IDTV models on the market will be expensive. Toshiba's CZ2898 is penciled in for \$2200. Philips will probably price its first two models above \$2000 as well.

IDTV will likely represent the upper crust of television into the 1990s. IDTV, though, represents only the first step toward even higher definition TVs now under development, but which won't appear in stores much before the year 2000. Until broadcast standards are upgraded, IDTV represents the best that current technology has to offer. **PM**

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Материал защищён патентом

AMERICAN POSH

PM goes express touring with the U.S. luxury establishment.

BY TONY SWAN, Automotive Editor; PM Photos by Humphrey Sutton

WHATEVER happened to the American luxury car? It wasn't so long ago that those three words conjured up a specific image—an automobile that was big, smooth and, most of all, powerful.

But when petroleum temporarily joined the world list of rare commodities, the American luxury car simultaneously became an endangered species. As the domestic industry struggled to respond, belatedly, to a marketplace and a government that demanded fuel efficiency above everything else, the American luxury car lost its identi-

ty. Deprived by Corporate Average Fuel Economy of its leviathan V8 engines, *Lexus Americanus* wandered an unfamiliar wilderness, searching for its lost prestige.

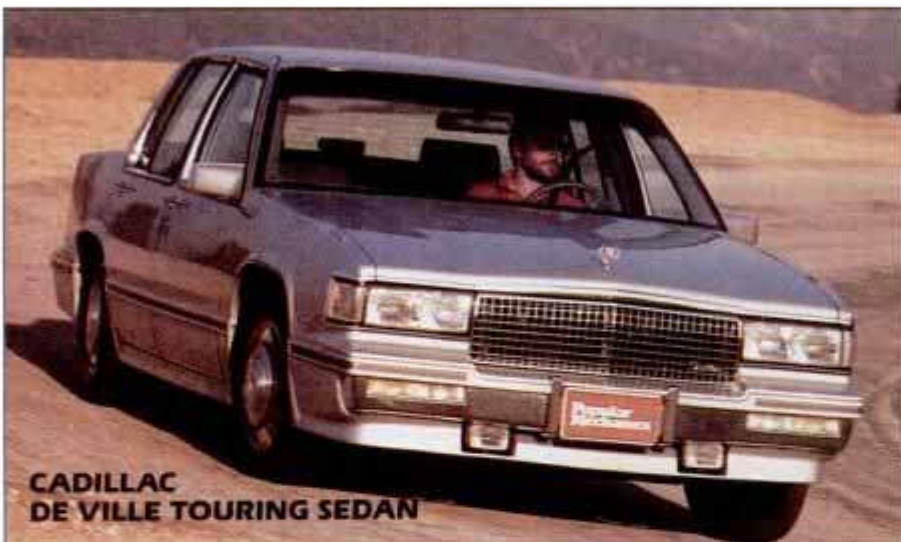
It would be a mistake to say that this wandering is over. Because of CAFE, the American luxu fleet still suffers from horsepower anemia, although new powertrains should correct this in the next few years.

But the five cars in this test do strike us collectively as a positive step toward re-establishment of something quantifiable as an American automotive-luxury statement. They're not trying to be high-end Autobahn



LINCOLN CONTINENTAL

AMERICAN POSH



**CADILLAC
DE VILLE TOURING SEDAN**



For those who would really rather have a V8, Caddy sports an updated 4.5-liter aluminum alloy motor. Despite shared chassis, running gear, it retains distinctive interior.

all design and technological sophistication are factored in, the other cars in this test—particularly the sleek new Continental—have some compelling points.

Buick Electra T Type

Since the introduction of the current GM C-bodies (Buick Electra, Olds 98 and Cadillac Seville/de Ville), the Electra T Type has been the most consistently gratifying performer of its family.

Although suspension tuning is probably a bit on the firm side for mainstream American luxury-car tastes, it's given the Electra a remarkable level of agility. Right out of the box, the T Types have had handling that's favorably comparable to the likes of Saab and Audi.

The additional horsepower and torque that went with the revitalization of GM's corporate 3.8-liter V6 engine this year has given the Electra a decent level of get-up-and-go, although it was a good deal slower than the identically equipped Olds. We see it as one of those mysterious cases of some being more equal than others.

On the back roads of southern California's San Gabriel Mountains, the Electra lived up to the reputation it's made as a driver's car, attacking curves and switchbacks with predictable and sure-footed zeal. Anyone seduced by the concept of Euro-style handling and ride will feel right at home here.

burners, a preoccupation that has afflicted Detroit in recent years, and they're not going to be confused with the new Japanese luxury entries.

It's interesting that these cars produced this one major impression with our test crew, because this quintet embodies a wide range of interpretations on the luxury theme.

The Chrysler New Yorker, for example, seems to be reaching back into a past era, while the Lincoln Continental is smooth and contemporary, in keeping with Ford's family commitment to aero design. The de Ville, which is due for changes in '89, sports an upgraded version of Cadillac's aluminum V8, which means more grunt. And the Buick and the Olds, the most able athletes in this group, also come to the game with more muscle.

Because of their fairly pronounced differences in character, it's difficult to say that one of these interpretations on the American luxury theme is correct and the others fall into the category of also-ran. If we indulged our personal priorities, which place crisp handling and lively engine performance ahead of all else, we'd be inclined to call this a dead heat between the Buick Electra T Type and the Olds Touring Sedan, with the de Ville Touring Sedan just a notch behind.

However, we know very well that

our predilections don't necessarily transfer to the people who buy cars such as these. And when factors like ride quality, quiet operation, fit and finish, amenities, interior room, over-



CHRYSLER NEW YORKER LANDAU



Back-to-the-future with Mr. Iacocca's version of a gentleman's express. Flatiron styling, moderate performance, attractive price should appeal to many buyers.



BUICK ELECTRA T TYPE

Inside, our test car was tastefully turned out in demure gray leather, with small analog instruments squashed into the long, narrow horizontal display. While these are at best a compromise, they're still an improvement on digitronics.

The Electra's seating is comfortable enough in all-around driving, although a little more bolstering would be in order for a sedan with sporting credentials.

Outside, Buick continues the Electra T Type's tastefully understated styling, with little in the way of brightwork and a nicely integrated look overall.

Cadillac de Ville Touring Sedan

The idea of a Cadillac that felt and looked a little more contemporary is something John Grettenberger brought with him when he took over as manager of the division a few years back.

What this worked out to was a little less in the way of trim, a little more in the way of road feel, and quite a bit more in the way of handling capabilities. Like its cousins from Buick and Oldsmobile, the de Ville Touring Sedan is generally stiffer than other de Ville models, again making a small trade in ride quality for a substantial gain in transient response and all-around satisfaction for drivers.

However, the factor that makes this and other front-drive Cadillacs much more appealing to potential customers lies under the hood. Plagued by years of complaints concerning the barely adequate performance of its



Responsive handling, V6 power make T Type one of our favorite driver's cars. Seats could use more support, especially when driving as fast as suspension dares you to go.

4.1-liter aluminum-block V8 engine, Cadillac responded with a number of improvements, including a 4-mm overbore, that increased displacement by 387 cc, torque by 40 lbs.-ft. and horsepower by 25.

While 240 lbs.-ft. of torque and 155 hp may not sound like much in a car that weighs 3397 pounds, the improvement in acceleration in this and other Cadillacs is only a couple clicks short of dramatic.

The de Ville Touring Sedan may not inspire memories of the massive torque that once distinguished cars of this breed, but it's on a much more contemporaneous footing with its competitors, as our data panel indicates.

As we noted at the outset, the de Ville is due for a fairly major facelift for 1989, so we won't dwell on the current car's rather innocuous styling. We did note, however, that our test car's paint wasn't quite up to the standard of the other two GM cars.

Like the Electra, the de Ville Touring Sedan is leather-lined, although our testers weren't particularly en-

thusiastic about the comfort level. Limited enthusiasm also marked our response to the digital speedometer and instrumentation, although Cadillac should get some credit here for going its own way, rather than trying to be an imitation Eurocruiser.

Chrysler New Yorker Landau

Although more than one member of the test crew looked upon this car as an almost unmitigated anachronism, history may wind up telling us that Chrysler's opportunistic marketing and product planning troops have scored yet another coup.

With its bluff bows, angular styling, landau roof and white sidewall tires, the Chrysler New Yorker Landau looks as though it's just popped through a 30-year time warp.

This impression carries through to the inside, digital dash notwithstanding—those plush Mark Cross leather banquettes-style seats could have been uprooted from an old-time steak house.

Obviously, we're talking about per-

AMERICAN POSH



LINCOLN CONTINENTAL



Lincoln's computer-controlled air springs and shocks give a soft ride, but adapt instantly to emergency situations by stiffening up in response to braking or steering.

sonal style here, and what that finally comes down to is who's guessing right and who isn't. It's an aspect of the car business that makes some men executive vice presidents—and others early retirees.

Where we feel the New Yorker can be criticized is in the general area of performance. The obvious intent here was to create a cushy ride at the expense of handling, and as a conse-

quence this is not a very compelling driver's car. From tires—Goodyear Invicta GL 195/75R-14—to spring rates to shock damping to roll stiffness, the New Yorker is a regular festival of understeer and wallow when it's pushed hard.

Engine performance is also subpar. This is not to criticize the new Mitsubishi 3.0-liter V6 that towed our test car, as sweet and mannerly an engine

as Chrysler offers. But sweet doesn't necessarily add up to haste, and the Mitsubishi motor simply doesn't have the muscle needed to give this car some verve.

For all that, it would be a mistake to dismiss this car out of hand. It definitely has a style of its own, and an American style at that. It's happy on the freeway or the boulevard, it's smooth—and it's cunningly priced.

As one well-placed Chrysler insider put it, "this one is Mr. Iacocca's car." And just how often has Mr. Iacocca been wrong?

Lincoln Continental

In the past five years, the Ford Motor Co. has seized the mantle of design leadership from the rest of the domestic industry, and this new Continental reinforces that leadership.

Long, sleek and formal, the Continental makes perhaps the strongest case in this group for the reemergence of an American luxury-car class capable of commanding respect wherever it goes.

In addition to its good looks, the Continental also embodies some remarkable technical achievements. Foremost under this heading is the computer-controlled independent suspension, with air springs and electronic shocks that respond almost instantly to variables in road conditions, speed and cornering loads, changing the Lincoln from soft boulevardier to firm sport sedan in just about an eyeblink. This capability is enhanced by speed-sensitive variable-assist power steering.

The Continental system is just this side of being classifiable as fully active suspension. It's quick—but we did find that it could be defeated in rapid

Three GM cars, although sharing most mechanical parts, managed to retain individual character. All-new Chrysler New Yorker is a modern version of yesterday's definition of success. All-new, high-tech Continental is undoubtedly the harbinger of things to come.



BUICK ELECTRA T TYPE



CADILLAC DEVILLE TOURING SEDAN

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE: LIST/ AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (lb.-ft.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in./mm)	LENGTH OVERALL (in./mm)	WIDTH OVERALL (in./mm)	TRACK FRONT/REAR (in./mm)
Buick Electra T Type	\$20,754/ \$22,801	V6, OHV 231/3786	165 @ 5200 rpm/ 210 @ 2000 rpm	front/ front	4-speed auto	110.8/ 2814	196.4/ 4989	72.4/ 1839	F:60.3/1532 R:59.8/1519
Cadillac de Ville Touring Sedan	\$26,809/ \$30,013	V8, OHV 273/4474	155 @ 4200 rpm/ 240 @ 2800 rpm	front/ front	4-speed auto	110.8/ 2814	196.5/ 4991	71.7/ 1821	F:60.3/1532 R:59.8/1519
Lincoln Continental	\$28,468/ \$30,134	V6, OHV 232/3802	140 @ 2800 rpm/ 215 @ 2200 rpm	front/ front	4-speed auto	109.0/ 2769	205.1/ 5209	72.7/ 1847	F:62.3/1582 R:62.1/1577
Chrysler New Yorker Landau	\$19,989/ \$23,171	V6, OHC 181/2967	136 @ 4800 rpm/ 166 @ 2800 rpm	front/ front	3-speed auto	104.3/ 2649	193.6/ 4917	68.5/ 1740	F:57.6/1463 R:57.6/1463
Oldsmobile Touring Sedan	\$24,995/ \$25,384	V6, OHV 231/3786	165 @ 5200 rpm/ 210 @ 2000 rpm	front/ front	4-speed auto	110.8/ 2814	196.4/ 4989	72.4/ 1839	F:60.3/1532 R:59.8/1519

1. Best speed achieved while weaving through seven cones placed in-line, 100 ft. apart; speeds provide index of transient response.

direction changes, particularly non-rhythmic changes.

On the other hand, few drivers are likely to use this car as we did, and for 99 percent of all driving situations—and drivers—it's superior to anything else in this grouping.

If generous, genteel accommodation counts for much in this market sector, the Continental wins another round. It's the biggest car in the group, and the space dividends that go with front-wheel drive—the first Lincoln ever to use such a system—have been passed along to the occupants, front and rear. We think there's better seating elsewhere in this group, at least better front seating, but the Continental isn't far behind and it provides the bonus of plentiful space.

In the realm of performance, the Continental's substantial curb weight and so-so tires—Firestone 205/70R-15s—left it midpack in the skidpad and slalom portions of the testing. Even so, it turned in the best braking numbers, which is thanks to discs at all four corners and ABS.

If the Continental produces any disappointment, it occurs when the driver tramps hard on the throttle. The 3.8-liter V6 generates decent torque, but there's quite a lot of car to haul here, and the Continental's acceleration can only be called deliberate.

Still, sluggishness notwithstanding, the new Continental seems to set the standard for the new generation of American luxury. It's smooth, serenely quiet and sumptuously comfortable, with perhaps the best sound system in a distinguished bunch. And if you need 0 to 60 in less than 9 seconds, you need some other kind of car to begin with.



OLDSMOBILE TOURING SEDAN



Mysteriously quicker on dragstrip than the Buick with identical drivetrain, Touring Sedan was nearly equal on skidpad and slalom, better than softer-sprung Caddy.

Oldsmobile Touring Sedan

This is just about as posh as you can get, if you're shopping the Olds division product lineup. And if you feel that what you're seeing seems to be the familiar 98 sedan, you're right—a 98 sedan tricked up with plenty of seductive comfort/convenience equipment plus a level of suspension tuning

that makes it all but indistinguishable from the Electra T Type. There are, in fact, subtle differences in the Olds and Buick approaches to sporty handling, but the net effect is essentially the same—limited body roll, aggressive turn-in, diminished understeer and the absence of nasty surprises.

Like the other GM cars in this test, the Olds wore 215/65R-15 Goodyear *(Please turn to page 101)*



CHRYSLER NEW YORKER LANDAU

LINCOLN CONTINENTAL

OLDSMOBILE TOURING SEDAN

TEST RESULTS

CURB WEIGHT (lbs.)	STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (EPA city/PM test)		ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)		BRAKING 60-0 MPH (ft.)	700-FT. ¹ SLALOM (mph)	SKIDPAD ² 200-FT. CIRCLE (G)	EPA CARGO VOL. (cu. ft.)	EPA INTERIOR SPACE INDEX
			19/	15.26	9.55	17.05 @ 78.7					
3378	power rack-and-pinion/2.97:1	F:10.25-in. disc/ R:8.88-in. drum	19/	15.26	9.55	17.05 @ 78.7	161	55.74	.78	16	111
3397	power rack-and-pinion/2.97:1	F:10.25-in. disc/ R:8.88-in. drum	17/	10.10	9.45	10.04 @ 79.43	172	53.73	.76	16	111
3635	var. assist rack-and-pinion/2.52:1	F:10.1-in. disc/ R:10.0-in. disc	19/	15.61	10.3	17.57 @ 77.75	172	49.98	.69	17	97
3276	power rack-and-pinion/2.85:1	F:10.08-in. disc/ R:10.04-in. drum	17/	11.80	11.8	19.1 @ 71.26	153	54.69	.74	19	123
3302	power rack-and-pinion/2.97:1	F:10.25-in. disc/ R:8.88-in. drum	19/	14.40	8.8	16.65 @ 80.71	155	55.12	.80	16	111

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

CATAST



ON APRIL 28, 1988, flight attendant Clarabelle Lansing was serving drinks in the first-class cabin of Aloha Airlines Flight 243, enroute from Hilo to Honolulu, when the cabin suddenly disintegrated, and she was gone. A 20-ft. × 11-ft. section of the upper forward fuselage of the Boeing 737-200 ripped away. Wind blasted

into a depressurized cabin. Passengers sang hymns and prepared to die. Through heroic action, Pilot Robert Schornstheimer and First Officer Madeline Tompkins managed to bring the aircraft down on Maui with one engine in flames.

What remains of Flight 243 has been shipped to Washington, D.C., for intensive analysis by investiga-

tors of the National Transportation Safety Board. The official cause of the accident will not be known perhaps for years. But a preliminary report announced that metal-fatigue cracks were found emanating from six rivet holes in the aluminum skin on the fuselage, which had undergone more than 90,000 takeoff/landing cycles in Hawaii's salt-sea air. The report indi-

PROPHET!

Why metal fatigue and corrosion are destroying buildings, bridges—even airplanes—all across America.

BY WILLIAM HOFFER

Passengers evacuate Aloha Airlines Boeing 737-200 after nightmarish descent from 24,000 ft. with fuselage section missing.



cated that the disintegration might have been caused by "cracking, corrosion or delamination of the fuselage structure."

The tragedy renewed concern over a difficult and perhaps unsolvable issue. No matter how many safeguards, no matter how stringent the quality-control, no matter how conscientious the maintenance and inspection, we

are still subject to occasional and tragic failures of metals, the building blocks of modern technology.

Stressed out

Francis C. Moon, a Cornell University authority on mechanics, has called metal fatigue "one of those unsolved problems of classical physics." As Moon points out, we still do not fully

comprehend why metal deteriorates under repeated stress, nor how to predict or counter its effects. What we do know is that fatigue produces microscopic cracks that invite the occurrence of chemical reactions that can transform the outer surface of metal from the solid state to the solution state: a phenomenon we call corrosion, or rust. The U.S. National

CATASTROPHE!

Bureau of Standards (NBS) estimates the annual cost of corrosion damage in the United States at about \$175 billion.

If rust eats away the fender of your car or corrodes your garage door hinges, the effects can be costly and bothersome, but when it attacks at the more critical junctures between technology and man, it can be deadly. Major tragedies often result from the breakdown of the tiniest components.

Recent lessons

Consider the case of the Mianus River bridge. At 1:30 a.m. on June 28, 1983, a 100-ft.-long suspended span, part of the bridge carrying Interstate 95 over the Mianus River in Greenwich, Connecticut, collapsed, throwing two trucks and two automobiles into the water. Three people died and three were seriously injured.

The bridge was of a common construction. The suspended span had been attached to the bridge structure

Telltale Signs Of Stress



The 500X micrograph of an airframe crack (left) reveals transgranular, or cross-grain, fracture pattern of mechanical fatigue. Striations represent cycles of fatigue, and striation density is a gauge of airworthiness. The 170X micrograph of a failed aircraft component (right) shows a rougher intergranular, or between-grain, fracture pattern indicating corrosion.

by a pin-and-hanger assembly at each corner. Each assembly contained two pins—an upper pin attached to the anchored, shore-side portion of the bridge, and a lower pin attached to the suspended span. A pair of steel hangers, 1½ in. thick, connected each set of pins.

When the cap of the lower pin on the

inboard side was removed during the post-mortem inspection, black rust flowed out. Said one investigator, "... there is no way that I would have ever believed or conceived that the amount of deterioration behind that pin cap would have been there."

At some unknown time, the inside hanger separated from the pin, shifting the entire weight of the corner to the outside hanger. A fatigue crack developed, the outside pin fractured, and the bridge fell into the water.

There are half a million bridges in the United States and some experts estimate that as many as half of them are in need of repair. Help may come from the use of a new portable, computerized, non-destructive testing system developed by NBS metallurgist Edward Escalante and materials researcher Eric Whitenton. The system uses two probes: one to polarize steel and the other to measure voltage changes. Steel with little or no corrosion shows a high polarization resistance, and vice versa.

Steel with little or no corrosion shows a high polarization resistance, and vice versa.

Mystery of flight

While we may take for granted the notion that bridges and buildings will stand forever—a fact that adds to our shock when they don't—fatigue and corrosion have been critical problems throughout the history of manned flight. Their effects are studied at places like the U.S. Air Force's Wright Aeronautical Laboratories in Dayton, Ohio. There, the job of the Structural Failure Analysis Group is clearly defined.

Says materials engineer Fred Meyer, "If a wing falls off of an airplane, we have to figure out why."

(Please turn to page 104)



Connecticut's Mianus River bridge (above) collapsed after corrosion consumed a support pin. New York's aging Williamsburg Bridge (above right) suffers from a litany of abuses ranging from rock-salt runoff to piled-up pigeon droppings. The result: holes in support girders (right) that forced temporary closing.



WORLDWIDE PHOTOS

CORVETTE ZR-1



DETROIT EYE SPY '89

Our mole in Motown gets the scoop on cars of the new model year.

BY JIM DUNNE, Detroit Editor; PM Illustrations by Marc Lacourciere

ALTHOUGH October was once the month for a massive rollout of every new car a manufacturer planned to market in a given model year, that tradition now belongs firmly in the past.

Today, introductions go on through much of the year—and 1989 looks to be solidly in step with this new way of doing business.

Nevertheless, you'll see a strong lineup of completely new and/or revamped models this fall. And later, as carmakers get new assembly lines rolling, other '89s will show up.

America's Big Three will all have strong new models. Ford may have the biggest news with its reengineered Thunderbird. GM will show a \$50,000 Corvette that may be the world performance champ. And Chrysler will have a new line of intermediate family sedans in the Reliant/Aries class.

Specialty vehicles will make news, too. GM's long-awaited All-Purpose Van (APV) will move into Chevy and Pontiac showrooms later in the model

year. And Chevy's GEO line of imports will include Tracker 4x4, a Jeep-type vehicle that slides in below the S-10 Blazer in size and price.

Chrysler

A new intermediate-size car that will replace the Dodge 600 and Plymouth Caravelle models and, eventually, the aging Aries/Reliant lines is set for unveiling late this year or early in 1989. The names are Plymouth Acclaim and Dodge Spirit.

Drivetrains will be essentially the same as those used in Chrysler's K-cars, and will include a 4-cylinder, 2.5-liter engine and a 3-speed transaxle as the bread-and-butter powertrain. Later, a new 4-speed electronically controlled automatic transmission will be added as an option.

The Imperial name returns to the Chrysler lineup in mid-'89 as a flagship 4-door. This car will be built on a stretched New Yorker wheelbase of 110-in., and will have a Mitsubishi 3.0-liter V6 engine. A 4-speed automatic will be standard.

Styling of this car will closely resemble the New Yorker—except for an opera window that will be inserted in the enlarged C-post at the back of the rear door.

Chrysler's TC by Maserati, the hybrid 2-seat convertible that Chrysler plans to sell for \$30,000, is finally in showrooms, making its debut as a 1989 model. There are two versions of this car. One uses Chrysler's own 2.2-liter 4-cylinder Turbo II, the other a Maserati 16-valve Four, based on the Chrysler 2.2.

Look for Chrysler to offer two new models from the new Diamond Star factory operated by Mitsubishi and Chrysler. A sporty 4-seater named Plymouth Laser will compete with Ford's Probe, while the subcompact Eagle Summit, a twin to Mitsubishi's Galant, is set for the small-sedan market.

You can also expect a turbocharged 2.5-liter Four in sporty Chrysler products like the LeBaron and Daytona. Up to now, Chrysler has used turbos only on its 2.2-liter engines.

DETROIT EYE SPY '89

Ford

Thunderbird and Cougar just might be as popular with personal car purchasers as the Taurus/Sable have been with sedan buyers. The Ford twins are all-new for 1989, and the way they shape up spells stiff competition for the GM-10 cars—Pontiac Grand Prix, Buick Regal and Olds Cutlass Supreme.

Most noticeable change in styling is the longer wheelbase, stretched to 113 in. from the current 104.2. However, overall length is virtually unchanged from the 200 in. of the 1988

model. As a result, the car's proportions are different, with a marked reduction in front and rear overhang.

Technical revisions are major, too. The V8 engine has been dropped completely from the cars. A 3.8-liter V6, the same one used in the Lincoln Continental, is standard, while a supercharged 3.8 is the new performance option, available in the T-Bird Super Coupe and Cougar XR-7. In-

sider reports vary, but some say this engine develops more horsepower and torque than the 302-cu.-in. 5-liter V8 of the Mustang GT (225 hp, 300 lbs.-ft.).

What makes the new engine attractive is the fact that positive-displacement supercharging develops high torque at low engine speeds and eliminates the lag associated with most turbocharged engines.

Also, 1989 will be the first time the rear-drive T-Bird and Cougar will have independent rear suspension.

Ford will also have a facelifted Lin-

coln Town Car ready for the 1989 lineup. Changes here consist mainly of a more rounded front end, including grille, bumpers and headlights.

General Motors

Performance sedan shoppers will be intrigued by the Taurus SHO model, the so-called "Shogun." The SHO's engine—a 24-valve, 3.0-liter V6 made by Yamaha—is a stunner. Horsepower and torque ratings should be well above those of the 3.8-liter V6 in the standard Taurus, enough to put the Ford sedan on a par, or even ahead of, European sport sedans in performance. On the SHO's outside are subdued ground-effects panels below bumpers and rocker panels.

Chevrolet will unveil one of the most exciting Corvettes ever when the "King of the Hill" appears as a 1989 option. GM executives believe that the King—officially the ZR-1—will run with the cream of the European exotics and make today's Corvette seem almost tame by comparison.

Under the hood is a Lotus-designed, double-overhead-cam 32-valve V8 that should develop close to 400 horsepower and 400 lbs.-ft. of torque. (Today's top Vette puts out a max of 245 hp and 340 lbs.-ft.) A special European-built 6-speed manual is the only transmission that Chevy will install for the King.

Farther back in the driveline are upgrades to handle the additional power. Rear wheels are 17-in., with



PONTIAC APV



FORD THUNDERBIRD SC

DODGE SPIRIT



1½ in. more tread width, while half shafts and differential are oversize.

Styling changes, by comparison, are slight. King's body is 3 in. wider at the rear fenders than the standard Corvette, to accommodate the wider tread. The cap on the rear of the car is convex (rounded out) instead of concave. Taillights are rectangular, but located in the same position as the round ones of the current car.

Rumors in Detroit say the limited-production King will run you about \$50,000 at your local Chevy dealer.

GM's 1989 APV (all-purpose van) is a revolutionary venture in station wagon design. The front-wheel-drive vans, to be sold by

Chevy and Pontiac dealers, are built with plastic panels in place of steel for the body coverings, a la the ill-starred Fiero. A steel subframe supports the panels.

Look for the APVs to be sold more as 5-passenger station wagons than as commercial vans. Powertrains will be 2.8-liter V6s and 2.5-liter Fours hooked up to 4-speed automatics or 5-speed manuals.

Chevy will also add a 5-door body style to its top-selling Corsica line,

styles—a hardtop and a convertible.

Facelifts are in store for many of GM's N- and A- body cars, the cars that make up the compact and subcompact lines. Among the more notable are the new roofline and grille for the Buick Century 2-door, a new roof for the Olds Ciera 4-door, and a new grille for the Pontiac Grand Am.

Look for more sporty models in those lineups, cars that offer ground-effects panels, aggressively styled wheels and monochrome paint jobs. Also look for a new engine size, the

CHEVROLET CORSICA



making this sedan something of a small station wagon substitute. The hatch door is almost hidden by the shape of the C-post on this model. However, an extra-large rear window is the visual tipoff to this newcomer.

Later in the model year, look for a neat little Suzuki-built, 4-wheel-drive sport/utility vehicle to join the Chevy lineup. Its development name is GEO Tracker 4x4. Bigger than the Suzuki Samauri, but smaller than the S-10 Blazer, the Tracker will be built in two

3.3-liter version of the GM 3800.

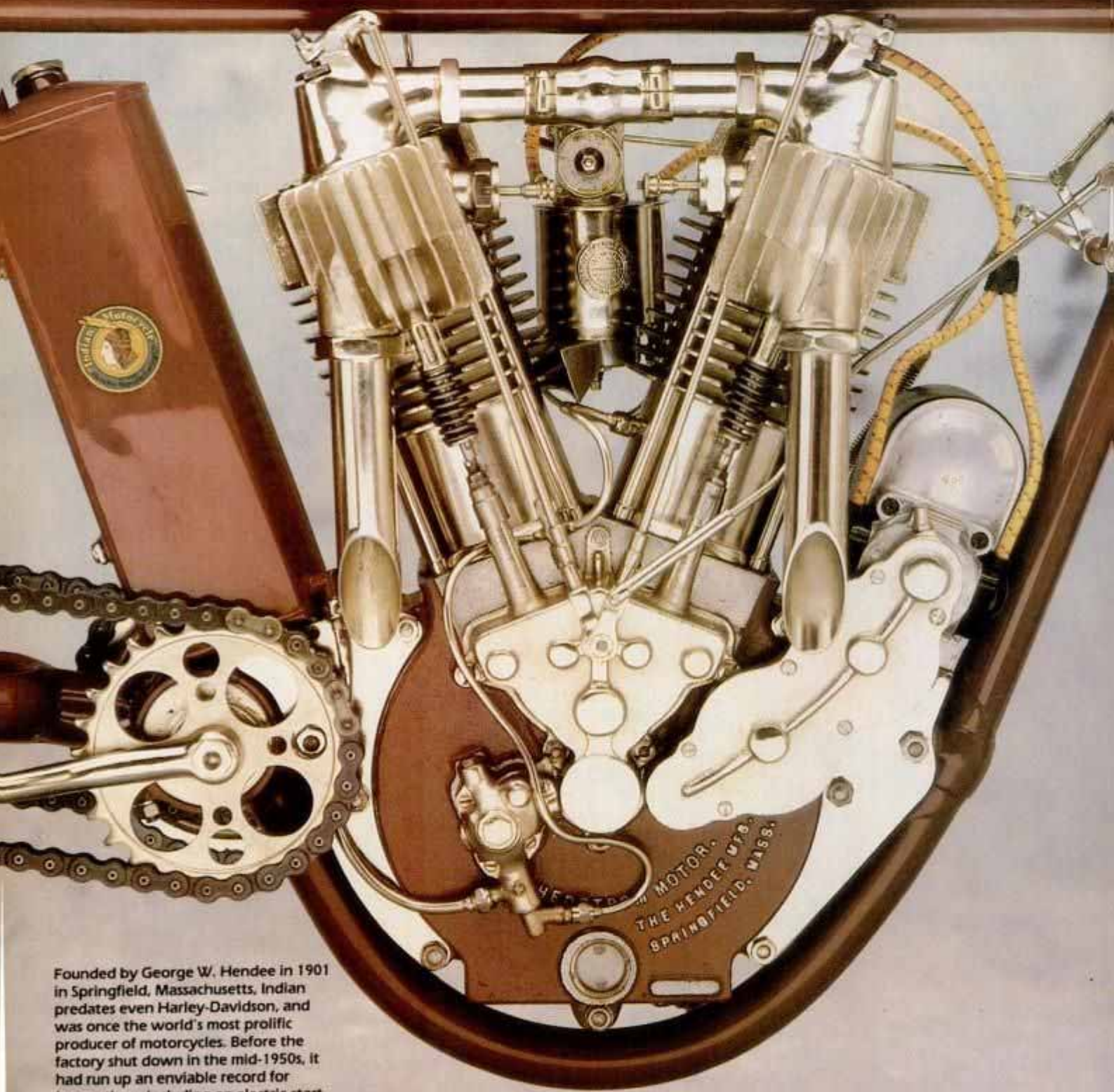
Cadillac continues the freshening of its line with major changes in the exterior of the de Ville. A new grille, new bumpers and a longer body are in store for the luxury sedans next year. The idea behind the changes is to make the de Ville look more like older Cadillacs—more massive, more impressive, more expensive. **FM**



GEO TRACKER

Indian

HENDEE MANUFACTURING CO. SPRINGFIELD, MASS.



Founded by George W. Hendee in 1901 in Springfield, Massachusetts, Indian predates even Harley-Davidson, and was once the world's most prolific producer of motorcycles. Before the factory shut down in the mid-1950s, it had run up an enviable record for innovations, including an electric-start machine in 1914 and a number of different 4-cylinder designs. The engine shown here powers a 1914 racing bike, owned by Steve Wright.

ReCycles

Collecting classic motorcycles offers all the fun of old cars for a fraction of the cost.

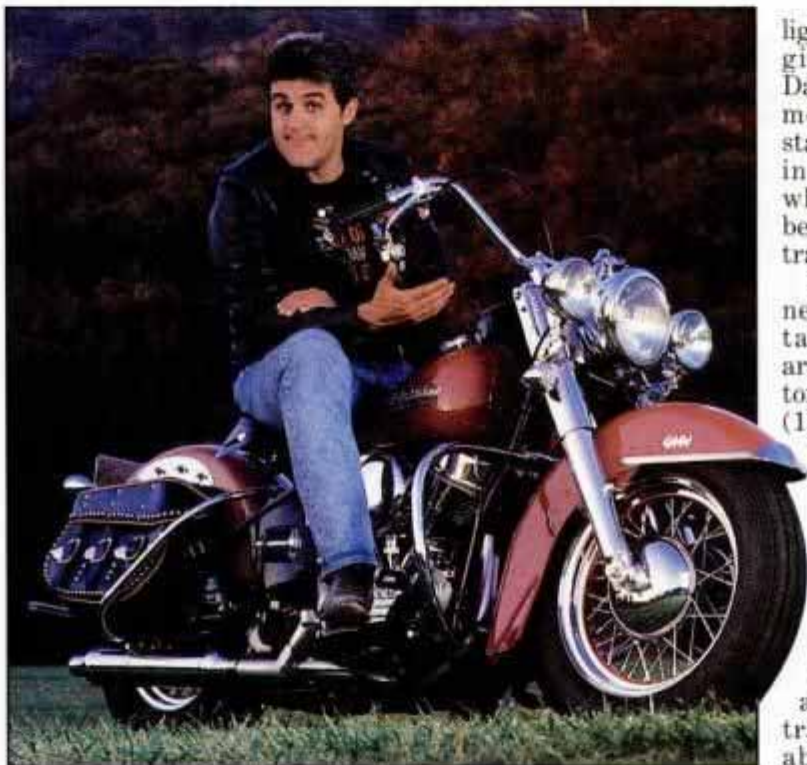
BY TONY SWAN, Automotive Editor; PM Photos by Wayne Williams/Outline Press

THE JOYS of automobile collecting—the thrill of the hunt, the pride that goes with restoration of a beautiful machine—are well known. Too well known, in fact. Americans seem to be taking an interest in car collecting as never before, particularly the bechromed, befinned behemoths of the '50s. That '57 Chevy Bel Air ragtop you couldn't afford when you were a kid can fetch as much as \$25,000 today. Which probably means you *still* can't afford it.

However, if cost escalation is the only thing keeping you away from a hands-on love affair with classic machinery, here's a formula that can satisfy your desires and simultaneously keep you solvent. Simply divide the number of wheels by two and think about applying your mechanic's skills and energies to classic motorcycles.

We don't mean to suggest that this area of collecting is in the innocence of early infancy. It would be a mistake to expect to rush out and find, say, a 1930s' vintage Brough-Superior moldering away in some barn, waiting for the first guy to stumble through the door with \$500 in his hand and a pickup truck idling in the driveway.

On the other hand, it's not unreasonable to expect to find yourself a decent machine of the late '40s or '50s—one that doesn't represent a restoration of career proportions—for about \$2000, and possibly even less. Presuming you don't get bogged down in machining extinct parts, motorcycle restorations aren't nearly as



A collector/restorer in his own right, comedian Jay Leno straddles a '52 Harley-Davidson FL. The Harley is owned by Los Angeleno Chuck Vogel.

complex or time-consuming as cars. And when you've brought the project to completion, you can reasonably expect your investment to be worth all the time and money you've put into it.

As with classic cars, the man who decides to take up motorcycle collecting confronts a wealth of possible projects. Although there is no mass production endeavor to rival the automobile for sheer nameplate volume, the motorcycle industry has spawned plenty of brand names of its own. From Abako to ZZR, the world's motorcycle manufacturers have generated over 2165 brand names for future collectors.

Moreover, a case can be made for the motorcycle predating the automobile. When Gottlieb Daimler and Wilhelm Maybach were working on a

lightweight gasoline engine to propel Herr Daimler's original automobile, they first installed their powerplant in a wood-framed 2-wheeler, replete with belt-drive, tiller bar and training wheels.

However, as a beginner, it would be a mistake to start rooting around in search of historic rarities like a Snob (1921-'25), a Smart (1922-'27), a Flying Merkel (1909-'15) or a Hasty (1930-'34). What does make sense is tackling a motorcycle from the recent past, one sold in sufficient numbers to ensure its relative availability. This translates into reasonable purchase prices (something that doesn't apply to many of the motorcycles pictured here),

and a variety of sources for parts. An additional benefit is that you won't be afraid to ride your machine when you've finished making it new again.

Applying the rule of availability, the best bets for first-time restorers are either American or British, preferably post-World War II up to the early '60s.

Thanks to a continuous history that goes back all the way to 1903, Harley-Davidson motorcycles are about as plentiful as any collectible make you can name, with plenty of supply sources, even for some of the real oldies, as well as plenty of aficionados who know Harleys inside out. Indian motorcycles, another home-grown make, are also relatively abundant, although the firm stopped producing in the mid-'50s.

ReCycles

Among the Brits, Triumphs are the most plentiful, although there are of BSAs and Nortons as well. As with the two famous American makes, the British bikes are all focal points for clubs, which means a strong parts underground and plenty of information available.

Matchless, Royal Enfield, Ariel, Velocette and Vincent are other distinguished old British makes that were in business well after World War II, but these machines weren't as widespread, which makes them less attainable today. This is particularly true of Vincents.

If the legwork and expense of a classic restoration hold limited appeal for you, another route is to anticipate the next wave of collectibles by finding a relatively late-model machine that's likely to become desirable and therefore appreciate in value. A good example of this sort of investment is Suzuki's rotary-powered RE5 of 1975. The Suzuki rotary failed commercially, and because of this the bike is in demand today.

Because of their prolific numbers, Japanese motorcycles will generally take some time to reach collector status—the Suzuki rotary is an exception in this regard. However, a few bikes have begun to attract attention as collectibles. The Honda 305s of 1965-'67 are popular as is Honda's original 4-pipe 4-cylinder 750 of 1969 and the 400F 4-cylinder of 1975.

Kawasaki made a couple of fast 2-stroke Triples—the H1 (500 cc, 1969) and H2 (750 cc, 1972)—that seem likely to acquire value, although their handling qualities were poor, even by the standards of their day.

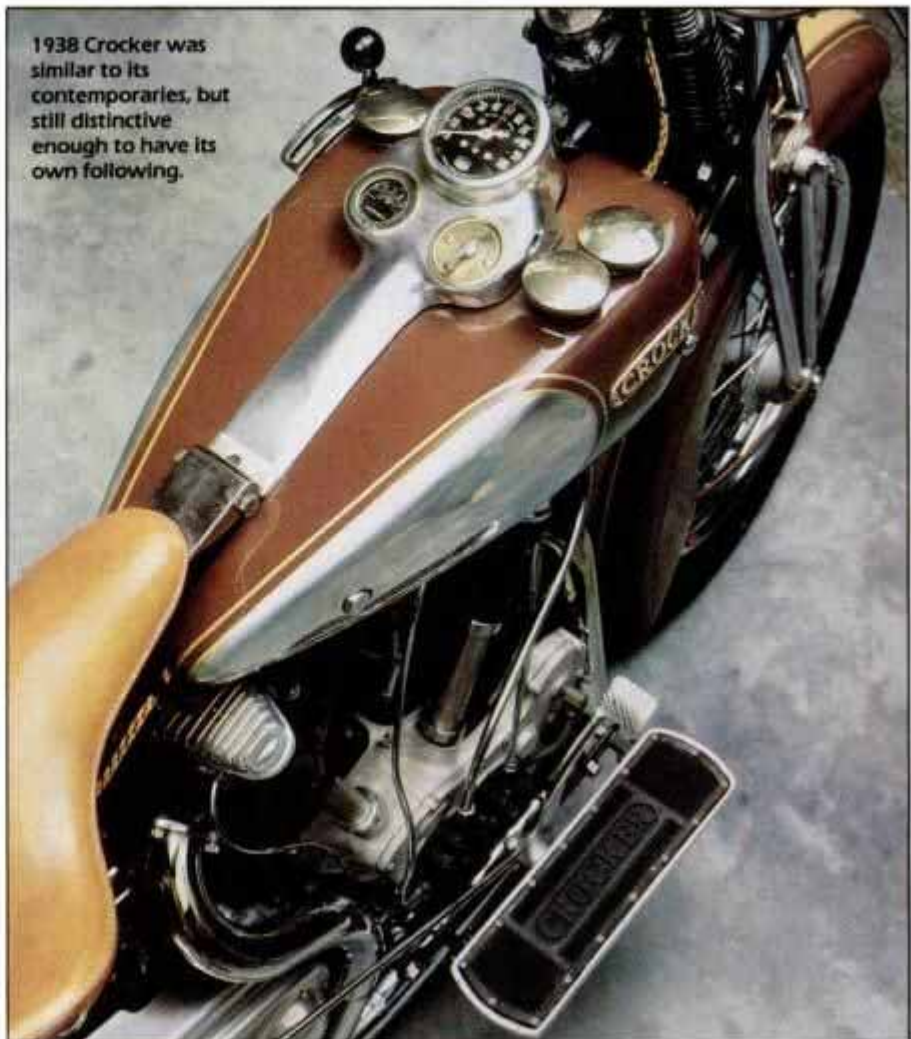
But the Kawasaki most cognoscenti look for is the potent 900-cc 4-cylinder Z1 of 1973, arguably the original superbike.

Racing motorcycles, or replicas of racing motorcycles—Kawasaki's KZ1000 replica of the Eddie Lawson Superbike championship machine or the Kenny Roberts edition of Yamaha's RD400, for example—are good bets, because of their small production runs. This also goes for factory turbocharged models like the Honda CX500, CX650 or Kawasaki Z1R-TC.

Obviously, the list of potential machines is long and tempting. The trick is to get plugged into this fascinating mechanical subculture.

A good first step is to find out what's available and what's going on, and this means reading. *Hemmings Motor News*, Box 100, Bennington, VT 05201, is primarily for car collectors, but it does include a growing

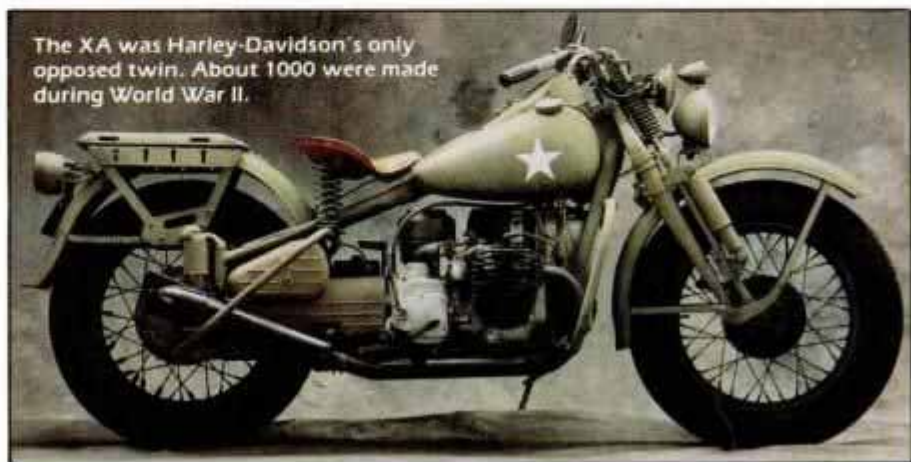
1938 Crocker was similar to its contemporaries, but still distinctive enough to have its own following.

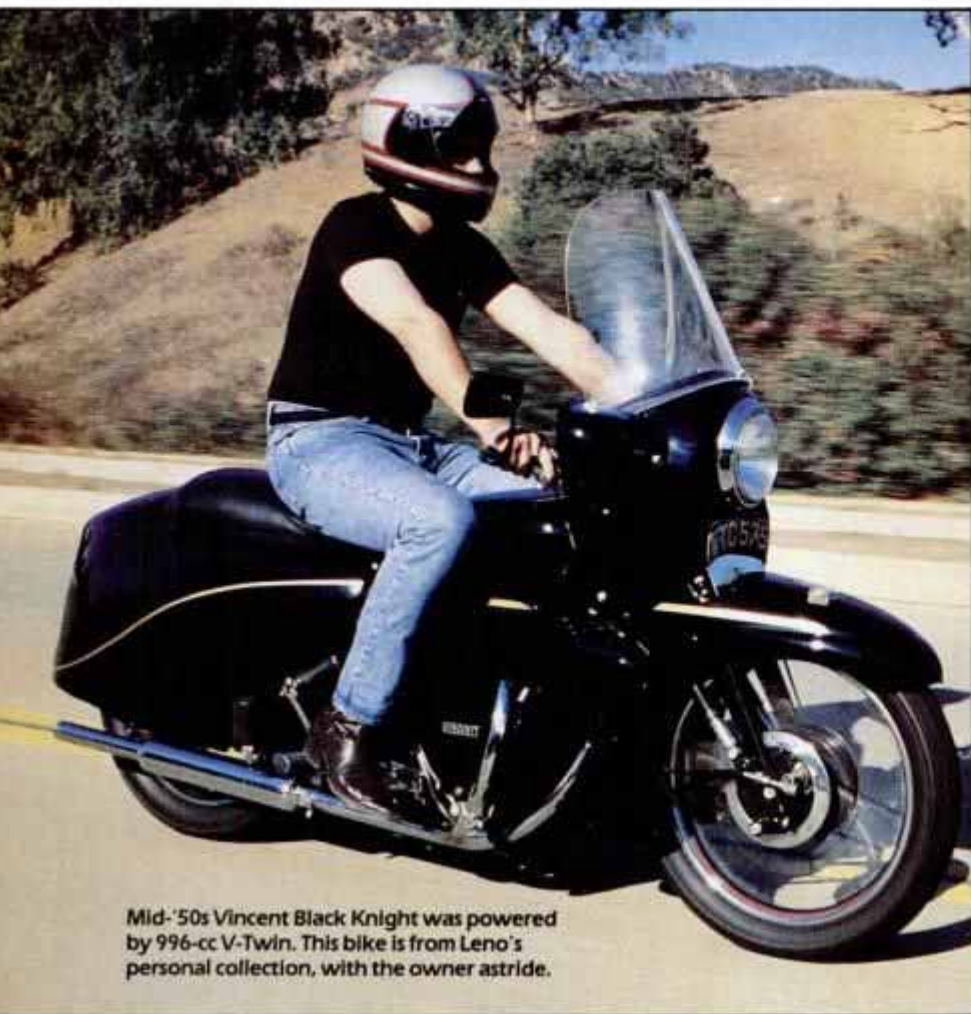


Crocker operated from 1936-'41, buying its big V-Twin engines from Harley and Indian.



The XA was Harley-Davidson's only opposed twin. About 1000 were made during World War II.





Mid-'50s Vincent Black Knight was powered by 996-cc V-Twin. This bike is from Leno's personal collection, with the owner astride.

section on classic motorcycles and motorcycle parts.

Although they don't rival *Hemmings* in circulation, *Old Time Cycles* (monthly, 7923 Janes Ave., Woodridge, IL 60517) and *Vintage Cycle* (bimonthly, P.O. Box 4134W, Sonora, CA 95370) are publications that address the subject more directly.

As you might expect, virtually every make that's spawned collectible bikes has also spawned a club of some sort, and once a particular machine has attracted your attention and/or cash, the applicable club can be an excellent source of info, parts and plain old moral support.

However, there's no need to wait until you actually have that basket case in your shop before you avail yourself of some national organization. The Antique Motorcycle Club of America, with 3000 members in 20 chapters nationwide, has someone somewhere who can help you in your personal cause, even though the AMCA concerns itself primarily with antique motorcycles, which it defines as pre-1954. The club publishes an authoritative quarterly—*Antique Motorcycle*—and hosts eight national meets annually. The AMCA is headquartered at 2411 Middle Rd., Davenport, Iowa 52803.

After that, there's only one other thing to remember: Keep the shiny side up. **PM**



Ultrarare Traub, built in Chicago during the '30s, is valued at about \$25,000.



1965 CL77 and rest of Honda 305 series was instrumental in popularizing motorcycles in the United States.

Entertainment For The Entertainer

Although some collectors have never had grease under their fingernails, comedian Jay Leno enjoys working on his bikes almost as much as riding them. Leno, who grew up in Boston, worked through college as a mechanic, and wrenching still gives him pleasure today. His small collection includes Vincents, a BSA Lightning, a late-model Harley and, the prize, a gorgeous Brough-Superior.—*T.S.*



For Leno, restoring is a hands-on hobby.

THE SHUTTLE REBORN

NASA's betting that improvements to the Space Shuttle's solid-rocket booster joint, landing gear and other mission-critical items will put America back in space to stay.

BY MIKE FILLON

WHEN SPACE Shuttle *Discovery* lifts off pad 39A at the Kennedy Space Center sometime in August or early September, it will look the same as NASA's previous 25 Shuttle launches. On closer examination, however, *Discovery* will be a much different vehicle—having undergone significant modifications in the wake of the *Challenger* explosion 2½ years ago.

The most significant physical changes have occurred in the twin solid-rocket boosters or SRBs, villains of the *Challenger* catastrophe. At a cost of \$450 million, there have been 40 major changes in the 149.1-ft.-long solid-fuel rockets.

In addition, there have been 39 major changes, costing \$200 million, in the Shuttle's liquid-fueled main engines. The orbiter itself has not escaped scrutiny. All told, there have been 68 mandatory modifications and 210 optional changes to the Shuttle itself. The only piece of hardware that remains essentially the same is the 154-ft.-long external tank.

Perhaps the most significant changes have been made in the way NASA does things, particularly regarding safety. In the post-*Challenger* Rogers Report, harsh criticism fell on NASA for a number of things, including not having a safety rep in on the *Challenger* launch decision. Safety will have a vote this time.

Under George A. Rodney, appointed associate administrator for safety, reliability and quality assurance in July 1986, a new safety program has been instituted. According to Gene Thomas, safety director at Kennedy Space Center and flight director for *Challenger*, key ingredients of the program are an anonymous reporting system for tips on problems and a review of all safety procedures. On launch day, one man, Shuttle veteran Robert Crippen, will have sole control



Its mission patch reflecting a new dawn, officials hope *Discovery* (left) will revive America's space efforts.

over blastoff after polling mission managers.

Hot seat

The man in the left seat for STS-26 will be Mission Cmdr. Frederick "Rick" Hauck, a U.S. Navy captain and a veteran of two Shuttle flights. Hauck, who is married and the father of two children, has discussed the risks with his family.

"I have told them this is the safest one we've ever flown. We have had a good test program that I've stayed very close to. By the time the flight goes, we will have had five full-scale engine firings—and a large number of tests."

Beyond these safety issues, how has NASA responded to the Space Shuttle's mechanical problems?

The first recommendation of the Rogers Report called for the formation of a solid-rocket motor redesign team. John Thomas of Marshall Space Flight Center (MSFC) was appointed head of that team.

"The first thing we had to do," says

Thomas, "was postulate what the cause of the accident was and what kind of scenarios and events could lead to that failure."

Thomas says that they knew that cold temperatures cause the O-rings to lose resiliency and if water leaked in and froze, that too could impede the operation of the O-rings.

After the review process, Thomas says that there were 30 to 40 areas where they wanted to make changes. He summarizes: "In the field joint, we increased the O-ring groove size and slightly increased the diameter of the O-ring to get the right squeeze. We added the seal capture feature to stabilize the joint so it would not open at the sealing surface."

In essence, the joint was changed from a tang-and-clevice design to a clevice-and-clevice design, or put more simply, from a tongue-in-groove to a groove-in-groove. It rests between the insulation and the O-rings, and prevents the joint from bulging under the pressure of burning gases.

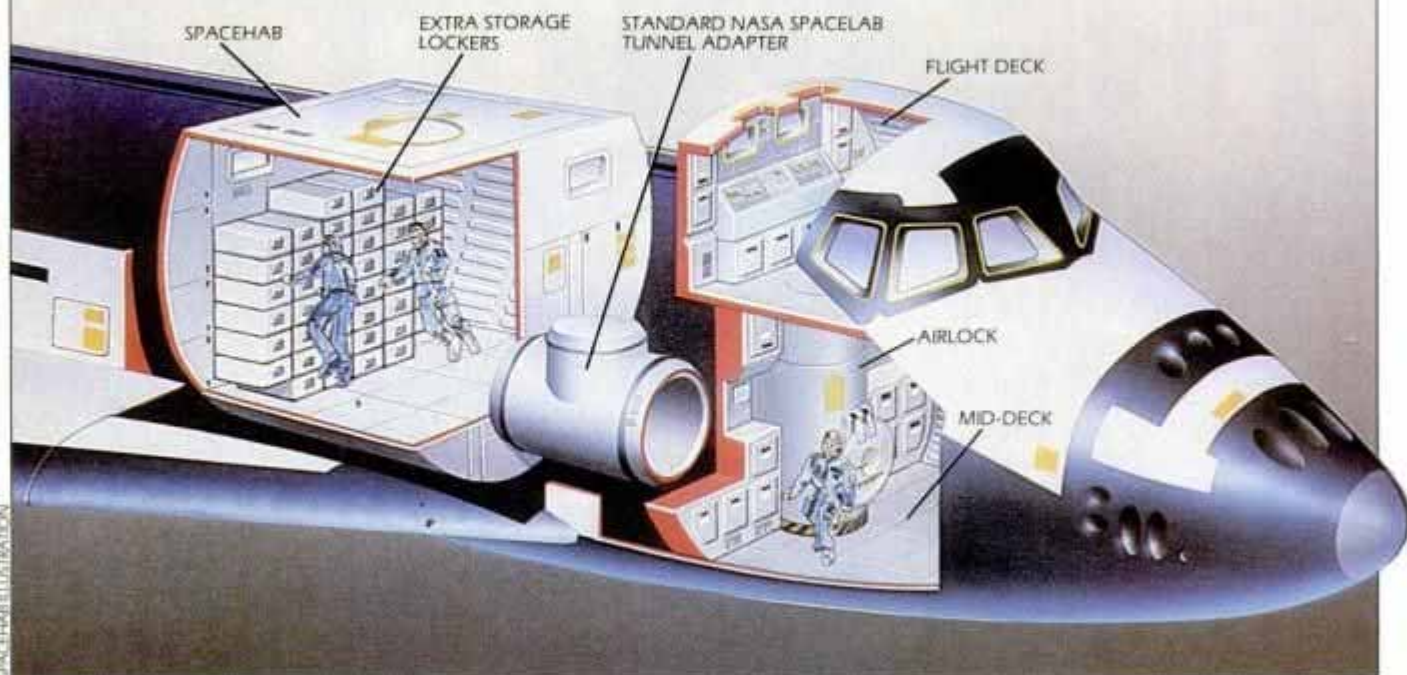
"We added a third O-ring," Thomas continues, "to allow us to check leaks in the capture feature, and we added heaters on the outside to keep the joint at 70°. We also added a weather seal to keep water out of the joint."

Other changes made in the SRB include improved seals on the motor igniter, a more reliable and lighter electric wiring tunnel, and increased capacity for additional instrumentation. Aside from the SRM segment joint, also known as the field joint, the Shuttle rocket-booster component that has received the most attention is the case-to-nozzle joint.

As Thomas explains, "It's the joint where the nozzle mounts onto the back end of the motor. We had experienced more problems there on prior flights than we had in the field joint."

Rocky Raab, manager of external affairs for SRM-maker Morton Thiokol, says that bonded insulation, a

Expanding Shuttle Capabilities



Extending Shuttle's future usefulness, a Spacehab payload insert will allow the vehicle to carry more crew and science experiments.

third O-ring, pressure-actuated flap and leak-test ports were ultimately added to the case-to-nozzle joint. Lastly, Stat-O-Seal washers were added to the radial bolts in the joint to further prevent gas leaks.

In mid-April, the third full-scale test took place using a deliberately flawed engine. Designated Qualifying Motor-6 (QM-6), engineers put a wave defect in the surface of the bonded insulation J-seal. This defect allowed hot gases to penetrate the bonded insulation as far as the capture feature O-ring. Results of the test showed that there was no leaking gas, and the wave defect self-sealed, as designed.

The SRM design that will fly on STS-26, is the same as was successfully tested on Development Motor-8 (DM-8). NASA had high hopes for a more advanced SRM design, which it tested on Development Motor-9. However, after the DM-9 qualification test, inspections discovered material missing from a 140° sector of the outer carbon phenolic ring that anchors a protective boot over the nozzle swiveling joint. Later on, one-third of the material was found inside the motor.

This now infamous part is known as the outer boot ring, a 2-in.-thick sealing washer that protects a flexible bearing that allows the nozzle to swivel and steer the rocket. The test involved slewing the nozzle 7°, the maximum possible angle. During a normal Shuttle ascent, the nozzle

would normally slew only 0.5 to 2.0 degrees. However, to be on the safe side, NASA dropped the DM-9 design for the *Discovery* flight.

During the QM-6 test, the nozzle was swung up to 6.3° without a problem. More than 500 instruments were fitted to the motor to measure acceleration, pressure, deflection, thrust, strain and other conditions.

As of press time, two more tests were being planned in June that would test still further the performance of an SRM with extreme flaws.

Main engine rehab

While work has proceeded on the solid-rocket motors, the Shuttle's main engines (SSME) have also undergone a metamorphosis. Improvements have been made in the electronic engine controller, valve actuators, temperature sensors and turbopumps.

In the high-pressure turbomachinery, turbine blades and bearings have undergone changes for added durability. Engineers have applied surface texture to some parts of the fuel turbine blades to improve performance under hydrogen fuel pressure.

In addition, the main combustion chamber has been made more durable by nickel-plating a welded outlet manifold. Improvements have also been made to the five hydraulic actuators to prevent a loss in redundancy. A temperature sensor, which failed on an earlier flight, has been redesigned

and tested without problems. However, the SSMEs have not escaped their own problems. One of the engines originally scheduled to fly on STS-26, developed a leak in its oxidizer heat exchanger. At the time, officials said the leak was minor, but the engine was pulled from the flight. Defective welds were also discovered on seals in the high-pressure fuel turbopumps at the turbine inlet.

There were problems with the high-pressure liquid-oxygen pumps. After ground tests, vibration caused loosening and the tightening of small screws that hold a retainer ring, which secures a honeycomb seal at the turbine blade. The screws are torqued and staked in with a center-punch. If the 0.25-in. screws are not installed properly, the ring could break apart. After an inspection, the problem does not appear to affect STS-26 engines. "So we have pumps on now that we feel good about," says an MSFC spokesperson.

According to Cmdr. Hauck, the orbiter itself has undergone some significant changes. "We have redone some of the electronic circuitry that controls the auxiliary power units. We have modified some of the tile in the chin area—the area right under the orbiter nose cone. We have beefed-up the payload bay structure and also added new heat-sink material there."

There is also a new emergency egress system that uses a 241-pound aluminum and steel telescoping pole.

FM ILLUSTRATIONS BY JOHN BATCHELOR



NASA engineers have used Shuttle downtime to improve engine components.

The design was chosen over a tractor-rocket extraction system after experiments with both systems earlier this year. The system is designed for emergencies during controlled gliding flight either on ascent or reentry. But Hauck notes that, "it wouldn't help in a *Challenger*-type explosion."

Other changes on *Discovery* include reinforced wings, heftier tires, stronger axles and brakes, and improved nose-wheel steering.

Is there concern about *Discovery* having been grounded so long? "No," says Launch Director Bob Seeke.

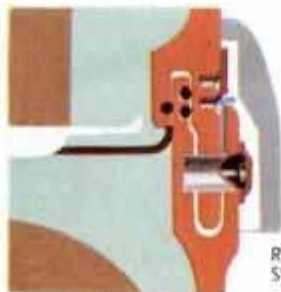
"Even in late 1986 when there was not much work on it, we still had requirements to do, which included inspections. And we have periodically activated systems because of the concern over having the orbiter sit and not fly. Like putting a car on blocks, the smart thing to do is periodically start the engine and pump the brakes." He adds, "Once we started the modifications and the testing over a year ago, there has been extensive work done on *Discovery*. So it has never been totally dormant."

Yes, America's Space Shuttle has changed. No longer will it fly with many of the engineering flaws it previously had. No longer will it deliver commercial satellites. No longer will it land at its Florida launch site—or California's Vandenberg Air Force Base. And, no longer will it be our only access to space. Expendable launchers will be lofting reconnaissance and communications satellites. But the Space Shuttle does remain our only link to the Space Station, to future lunar bases and quite possibly to Mars. When *Discovery* goes into orbit, America's hopes for a future in space go with it.

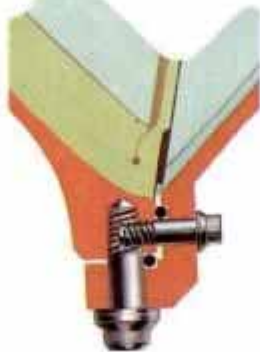
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Challenger's offending SRB joint was a simple tang-and-clevis design.

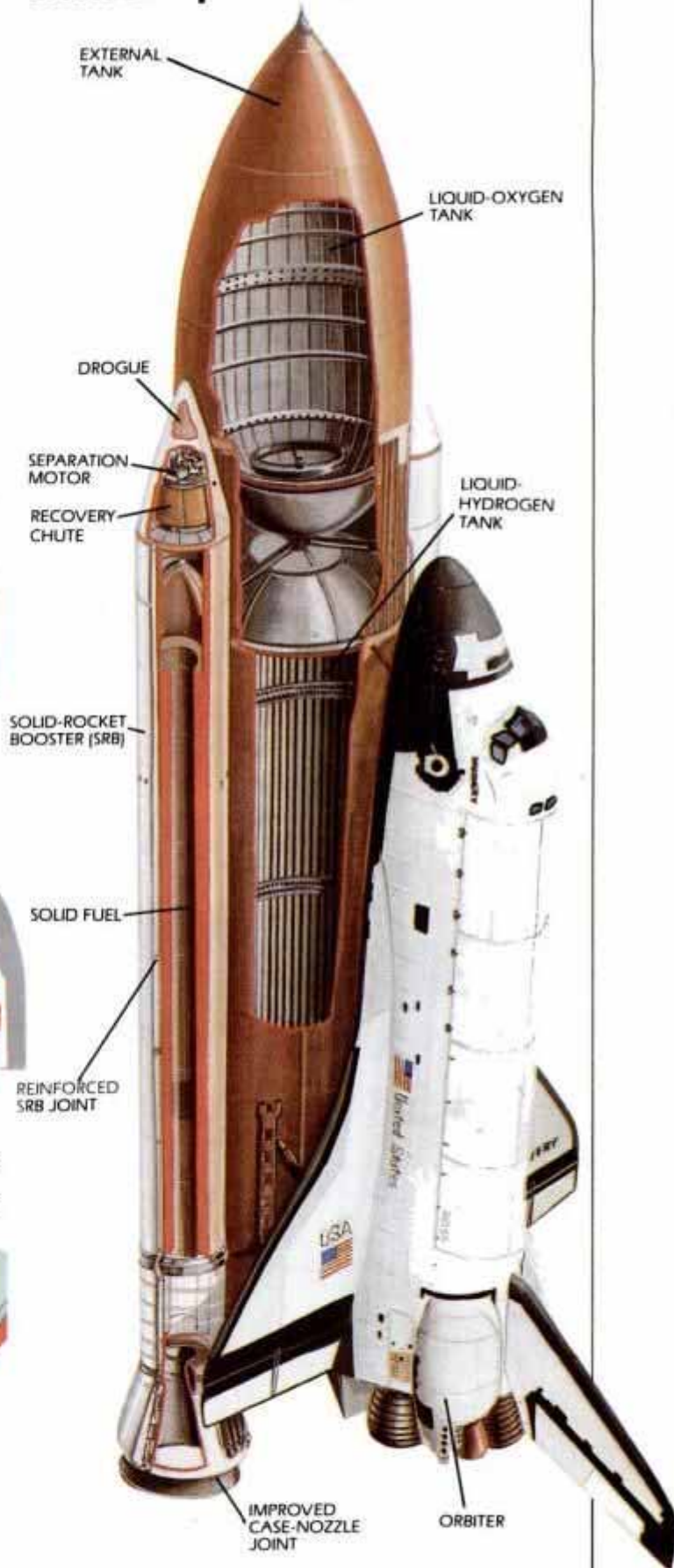


More O-rings, a heater and a weather seal have been added to new groove-in-groove design.



Special washer seals have also been added to bolts in the booster's case-to-nozzle joint.

Shuttle Propulsion Advancements



A key to America's space hopes, the Space Shuttle keeps its basic propulsion design. But NASA says improvements in the solid-rocket booster and in the orbiter's main engines will make the system more reliable.

FAST FUN!

Make a splash with HydroRunner, PM's you-build-it, 40-mph personal watercraft.

BY BOB RILEY; PM Photos by Rich Cox



WHEN you first see HydroRunner, it sits low in the water like a cheetah poised in deep grass. You climb aboard and squeeze the throttle. It springs to life and screams across the water's surface at 40 mph, feeling more like a jet fighter than a water machine.

This is the excitement of HydroRunner, POPULAR MECHANICS' specially designed new-wave personal watercraft that you build.

Power is supplied by any short-shaft outboard motor of 25 to 35 horsepower.

We tested HydroRunner with a 28-hp outboard and it topped out at 40 mph. With a second rider, HydroRunner hit 35 mph for close-to-the-water, high-speed thrills.

Squeeze the throttle and HydroRunner digs in for a solid prop bite, which is followed by an explosion of

speed that rockets the craft from 0 to 40 mph in 5 seconds!

On plane, the tri-hull design reduces drag for all-out, top-end performance. Hole shots are equally blistering because a lifting platform runs beneath the centerline of the hull, allowing HydroRunner to leap on plane instantly.

Slightly over 8½ ft. long with a 4½-ft. beam, the 200-pound hull delivers a surprisingly smooth ride. At idle speed, it carves turns like an ordinary V-bottom boat. As speed increases, the turns flatten out similar to those of a hydroplane.

The hull's not just another pretty body, either. It has function in its form. The outrigger sponsons give it a wide, buoyant beam for maximum stability at speed and also at rest, where you can climb over the side without tipping.

Although the smoothly contoured



Outrigger sponsons make hull beamy and stable.



hull looks like it's made of a molded synthetic, it's actually built of plywood and sealed with a single layer of fiberglass. You can build it at home from easy-to-follow PM plans.

Sitting astride the console, in a kneeling position, the thickly padded cockpit has the feel of a motorcycle. The foam-padded handlebars, connected to the engine with pushrods, have a squeeze throttle on the right. Forward, Reverse and Neutral are controlled by a stick.

A simple dash carries an electric-start ignition switch and an emergency shutoff switch, which connects to the operator with a lanyard.

A unique construction method, eliminating the need for a complex jig, simplifies the project for the first-time builder. This method also results in a totally sealed and compartmentalized hull that will not take on water even if it's turned over.

You can be on the water in HydroRunner for as little as \$500 for materials, less the outboard motor. You should be able to buy an appropriate motor for \$500 to \$800 used and \$1500 to \$1800 new. Figure approximately 150 hours of building time.

PM plans—including six 17-in. ×

22-in. plan sheets and a 36-page step-by-step, photo-illustrated instruction booklet—cost \$15.95. Make your check or money order payable to POPULAR MECHANICS and mail to: PM HydroRunner, Box 1014 Radio City Station, New York, NY 10101. See you on the water! **PM**



Smooth contours look molded, but hull is made of plywood.

ANNOUNCING THE

Popular Mechanics

HOTLINES

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2. Please keep your calls as short as possible. Remember, other readers are trying to get through.

3. You'll have to pay for the cost of the call. No collect calls, please.

4. Before calling, check the list of editors and their special editorial areas. Please call the most appropriate editor. We won't be able to switch you if you don't reach the correct editor.

5. If the line is busy, please try again.

6. Please don't expect our editors to answer complex technical questions over the phone. Remember, we won't have time to look up information in books or other reference sources while you're on the phone.

7. Remember, we have a Reader Information Bureau that is operational five days a week during regular business hours. Our Reader Service Manager is Gary Frederick (212) 649-3127. Please call him, not our editors, for information on back issues, reprints of articles, subscription inquiries, plans offers, etc. It will save us all time.

Other than the above guidelines, there are no rules. Call us about anything - what you like in POPULAR MECHANICS, what you don't like, article suggestions, etc. In fact, we'd like you to call and just say hello. We look forward to hearing from you.
- Joe Oldham

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Steven Willson, editor 212 265-7538
(building, home remodeling)

Joe Truini 212 265-7570
(shop design, tools)

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(furniture making, design)

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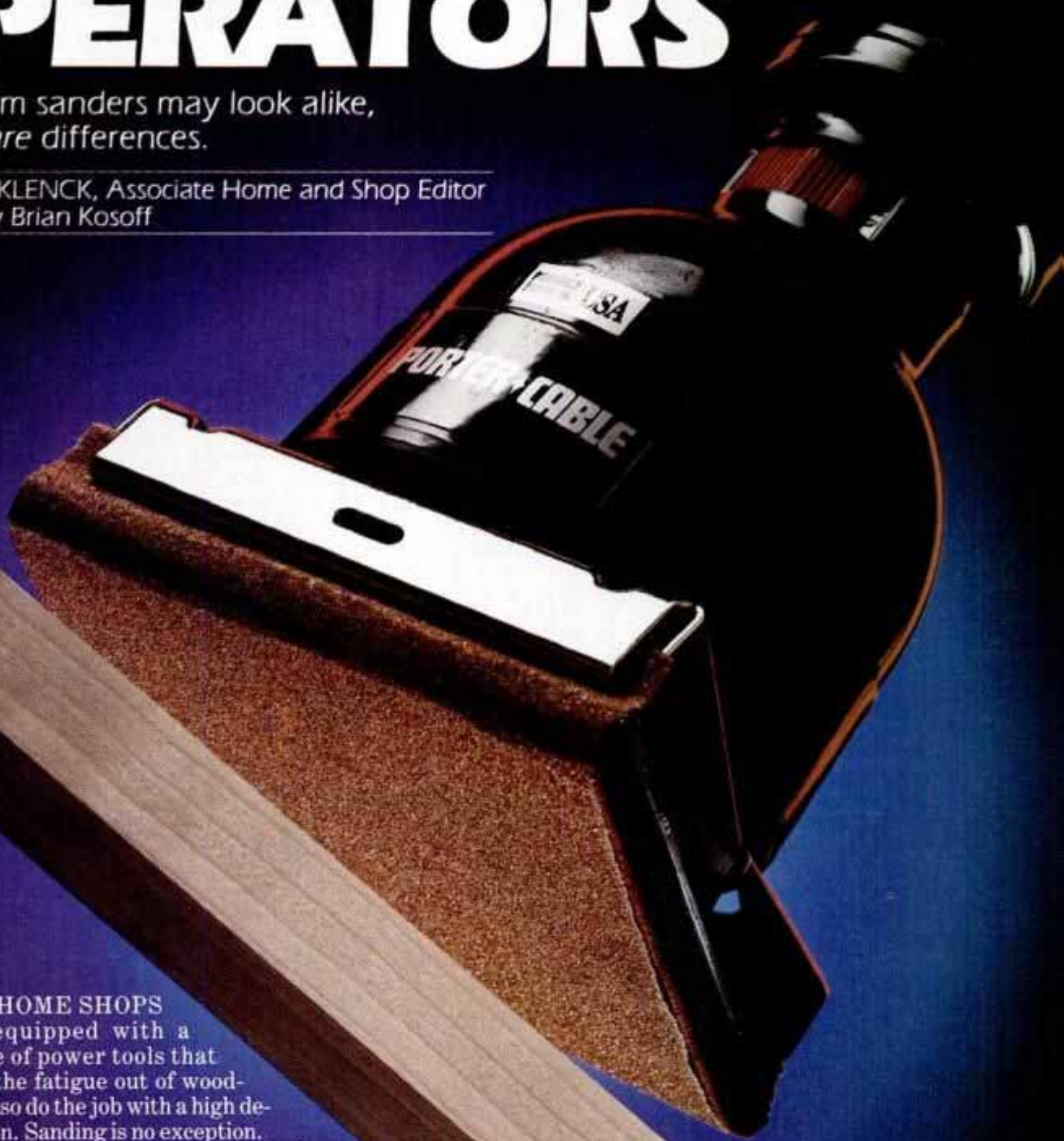
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SMOOTH OPERATORS

PM
COMPARISON
TEST

Orbital palm sanders may look alike, but there *are* differences.

BY THOMAS KLENCK, Associate Home and Shop Editor
PM Photos by Brian Kosoff



MOST HOME SHOPS are equipped with a range of power tools that not only take the fatigue out of wood-working, but also do the job with a high degree of precision. Sanding is no exception.

Orbital sanders are designed specifically for preparing finish-ready surfaces. They're not intended to remove large amounts of material as is the case with belt and disc sanders. In orbital sanding, the sandpaper pad moves in tiny circles, or orbits, while remaining in a relatively fixed position in relation to the housing (see drawing). The combination of small orbit diameter and high speed makes for a tool that sands quickly, but without marring or



gouging the work. One of the most popular types of orbital sanders is the 1/4-sheet palm sander.

We decided that it was time for a close, hands-on look at what the palm sander market had to offer. So we gathered 12 palm sanders representing eight of the major power tool manufacturers. As well as compiling the features of each unit that indicate long-term service, such as ball-bearing construction, heavy-duty sandpaper attachment systems and—where the manufacturer really lays it on the line—lengths of warranties, we noted the kinds of things you don't find out until you've owned the machine for a while. We also put the sanders through a battery of hands-on comparison tests designed to determine differences in actual performance—what you'd learn were you able to own them. We think you'll find the results interesting—and maybe even a little surprising. We did.

Initial observations

The most significant conclusion we reached was that each of the sanders produced an equally acceptable finished surface. Every other aspect of the machines, however, showed clear contrasts. (See charts on pages 86 and 87.) Cutting speed varied as did vibration and noise level. Contact-torque—the tendency for the unit to spin when it touches the wood—also varied from one to the next. As a rule, we found that the hard-to-handle machines actually cut faster than the smooth operating units.

Palm sanders are typically equipped with either a rubber or felt sanding pad. It's claimed that the soft sponge rubber pad is superior for contoured surfaces and the

harder felt is the choice for flat work. We believe that the performance and handling variations between the tools are more significant to the general woodworker than the differences in pad material. If a sander is to be used exclusively on contours, a softer pad would be a plus. However, pad thickness also plays a role. The unusually thin 1/4-in.-thick rubber pad on the Hitachi tool does not have the resiliency of the 5/16-in.-thick Porter-Cable pad. The remaining pads averaged about 1/4 in. thick.

Paper clamping systems

While the makers seemed to have reached a general consensus as to how these tools should look and work, they haven't come to agreement as to how the sandpaper should be attached. Our selection of tools boasted no less than six different solutions to the problem as well as the adhesive-backed sandpaper system. (See photos on pages 86 and 87.)

We found that the most difficult system to operate features swing-arms that must be pushed out and then pried up to open the spring-loaded clamps. Once the paper is in place, the arms are pushed back.

The difficulty with this 3-stage procedure lies in the typically stiff action of the swing-arms. Frequent paper changes are very hard on the fingertips. However, we doubt that the mechanism would ever wear out. This design is found on the Ryobi S-600, Milwaukee and Skil sanders.

The Black & Decker 7443, Hitachi and Sears boast a simple bent-wire clamp system. The wire clamps are disengaged by simply lifting the looped ends out of retaining slots on the base sides.

While the mechanism is fast and

comfortable, its reliability over the long term depends on the ability of the wire to retain its tension. The heavy-gauge wire found on the Hitachi makes it a better bet for longevity.

Two Makita tools in our selection use a twin-arm clamping system. Two short, heavy-gauge wires on either end of the pad are pushed up and forward to lock the spring-loaded clamp in the open position.

With the clamp locked open, both hands are free to align and tighten the paper. The twin-arm system, while not the easiest on the fingers, does represent a step in the right direction.

The Porter-Cable, Black & Decker 7445, Ryobi S-500A and Makita B04530 sanders all have unique sandpaper attachment solutions.

Black & Decker 7443

This sander is the less expensive of the two B & D units we tested and was the only machine in our selection not completely equipped with ball bearings. Its bent-wire clamps are easy to operate, but the wire gauge is on the light side. The wire clamp mounts, however, are positioned too close to the base edge and interfere with installation of the paper. The cord is annoyingly kinky and the somewhat stiff sliding switch is recessed a little too deeply in the housing for easy 1-handed operation.

This unit displayed the highest noise level, highest vibration and was the hardest to control when it touched the wood. Don't condemn it yet though, the B & D 7443 proved to be one of the fastest cutting sanders in our selection.

Black & Decker 7445

Although a near clone in appearance for the cheaper machine, the differ-



ences in performance were like night and day. The Black & Decker 7445 features a single-arm clamp system that is one of the easiest to use. Simply pulling the arm up and back frees the clamping bar which remains open for easy paper alignment. Although the switch and cord are identical to the cheaper unit, once plugged in and turned on this sander displays effortless performance and low vibration.

The model 7445 ranked high in the

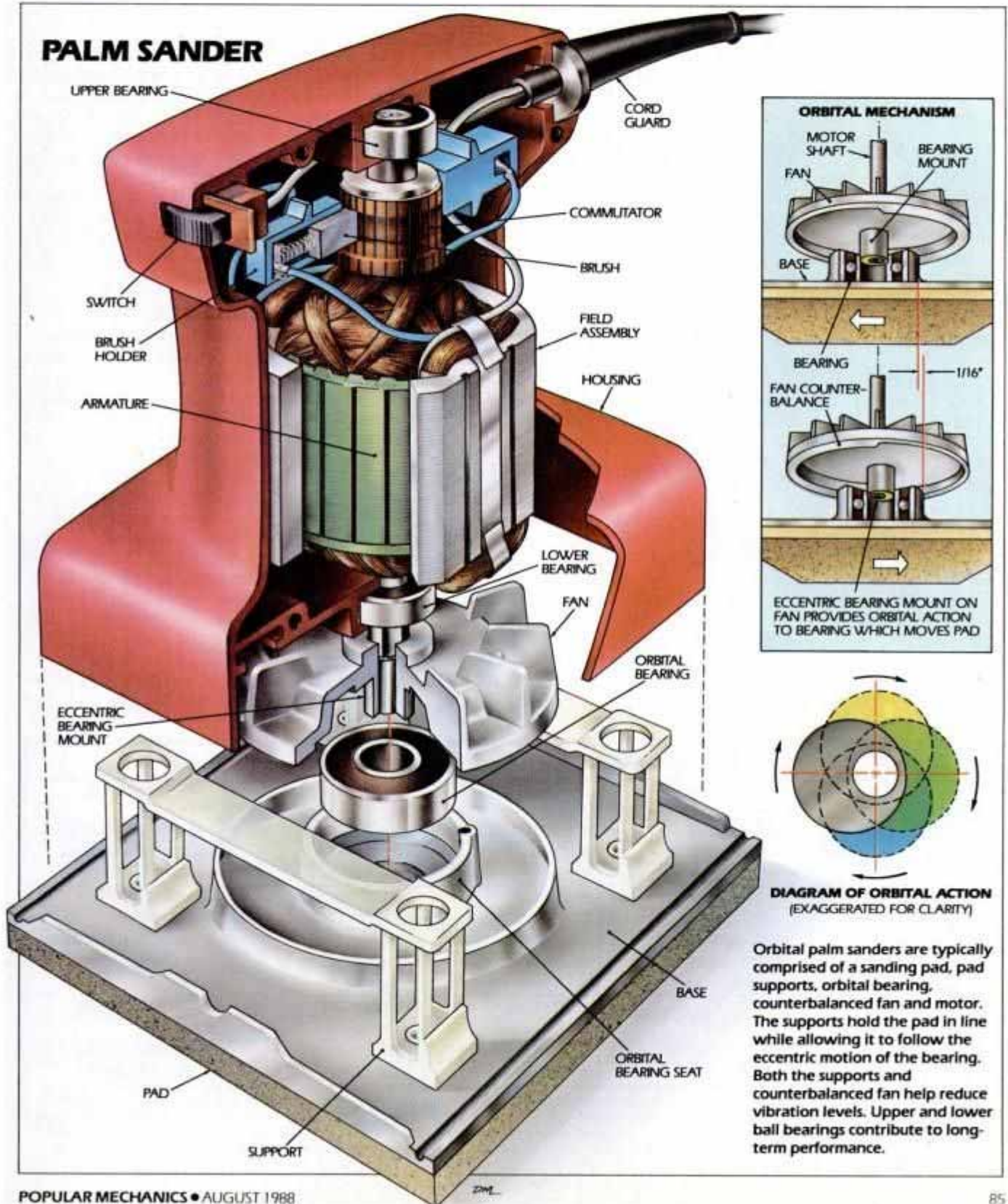
speed trials—just below its less expensive cousin. At 15,000 opm, however, it's not surprising that it's also one of the loudest.

Hitachi SV 12SA

The Hitachi's elongated and completely rounded top makes it one of the most comfortable to hold. On the down side, the toggle switch is too deeply recessed into the housing to start easily with one hand.

Performance, though, is very smooth with little contact-torque when the pad touches the wood. The simple-to-operate bent-wire clamping mechanism features heavier wire than that found on other units.

Like other tools with exceptionally smooth operation, the Hitachi SV 12SA is somewhat slow to remove stock. The unit also has the thinnest pad of the lot. While this can be a real plus for producing uniform, flat sur-





The retractable arm on the swing-arm paper-clamping system is first pushed out. Then, lifted to open the spring-loaded clamp.



The bent-wire system utilizes the spring tension of the wire to hold the paper. One lever on each side controls clamping at each end.



The twin-arm clamp design is opened by pushing the arms up and forward. Clamp is locked open for paper insertion.

faces, it might also be responsible for the unit's very slight tendency to chatter with coarser sandpapers.

Makita M904

The red color represents Makita's line of tools designed for home use. Frankly, in terms of performance, it was difficult to distinguish this machine from those in Makita's standard line.

The vibration and noise levels were on par with the other Makita machines—about average in our selection. Cutting rate was acceptable and we have no real complaints about the housing design.

Makita supplies all its sanders with a similar sliding switch that's fairly easy to operate with one hand. And, the twin-arm paper clamping system is quick and fairly easy on the fingers.

Makita BO4530

This sander is the round-base partner to the standard 1/4-sheet Makita BO4510 that's become the workhorse of many woodworking shops. Its 6-in.-dia. round base utilizes a stick-on sandpaper disc that solves the paper clamp problem by eliminating the clamp entirely.

The system works well, but demands that you buy the prepared discs.

Why a round pad? Other than increasing the sanding surface area and speeding up the work, there seems to be no need for it.

It doesn't seem to get into the corner formed by two boards any easier. And forget it if you want to get near the 3-way corner of a box or drawer. As an accessory, however, Makita offers a square pad designed to accept square stick-on paper.

In terms of actual speed-of-cut, this round-base sander falls in the middle of the pack. It was very difficult to handle—real pressure had to be applied to keep it under control. The noise and vibration levels, switch and housing design were all similar to the other Makita units.

Makita BO4550

Following the trend well underway for many other power tools, Makita's BO4550 represents an attempt to clean up the palm sanders' act.

We found that this sander's dust collection system seemed to improve its performance as a fast cutter. Less dust collected between the sandpaper and the wood, keeping the sandpaper cleaner. But don't expect all the dust to go into the bag. Some remains on the wood just to keep you honest.

The system works by vacuuming the dust up through holes in the sandpaper and pad. Each time a new piece of sandpaper is installed, properly placed holes must be punched through the paper.

Supplied with the sander is a metal punch plate for accurate hole alignment. This machine features the same twin-arm clamping system as is found on the Makita M904.

Milwaukee 6016

We were eager to check out Milwaukee's entry. The brand—synonymous with heavy-duty quality—was sure to have something exciting to offer. What we did find, was a palm sander with solid performance, but only few outstanding qualities.

Cutting speed seemed to be slightly above average with noise level and vibration also running in the middle of the pack. The Milwaukee also showed a high degree of contact-torque which made controlling it more of an effort.

Unfortunately, Milwaukee has chosen to equip their tool with the difficult-to-use swing-arm clamping mechanism. We did feel, however, that Milwaukee's conveniently placed rocker switch makes it one of the few tools that truly could be called 1-

PERFORMANCE COMPARISON CHART

MANUFACTURER	SOUND LEVEL ¹		VIBRATION LEVEL ²		CONTACT-TORQUE ³		CUTTING SPEED ⁴	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	SLOW	FAST
Black & Decker 7443	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Black & Decker 7445	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Hitachi SV 12SA	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Makita M904	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Makita BO4530	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Makita BO4550	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Milwaukee 6016	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Porter-Cable 330	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Ryobi S-500A	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Ryobi S-600	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Sears 11602	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████
Skil 7565	██████████	██████████	██████████	██████████	██████████	██████████	██████████	██████████

1. Relative sound level as measured on dBA scale. 2. Subjective vibration level of tool running but not in contact with wood. 3. Subjective level of tendency to spin when in contact with wood. 4. Tests performed on stained hardwood, softwood and plywood with 80- and 120-grit papers for a fixed length of time. Chart reflects average amount of stain removed. Although every effort was made to apply equal pressure to each sander during cutting speed tests, the harder-to-handle sanders necessitated a somewhat firmer grip. Relative speeds shown are, therefore, indicative of real-use performance. 5. Ryobi S-500A exhibited moderate contact-torque, but excessive chatter.



The most straightforward clamp is found on the Ryobi S-500A. Simply pressing the single lever-arm opens the spring-loaded clamp.



B & D 7445 uses a single-arm design. Spring tension holds clamp open. Pressing lever down forces clamp down on sandpaper.



The Porter-Cable clamping mechanism requires a special tool. It's also easy to operate with an ordinary flat-tipped screwdriver.

handlers. It also has a long (9-ft.) and very flexible power cord. Perhaps the most impressive feature of this tool is Milwaukee's standard lifetime limited warranty—the only warranty in our group with no time limit.

Porter-Cable 330

Markedly differing from the rest of the pack in outward appearance, the Porter-Cable tool is designed so it's held on the side rather than the top—letting the weight of the tool do the work. The Porter-Cable ranked highest for vibration-free running and was topped in quietness only by the small Ryobi S-500A 1/6th-sheet sander.

Although the paper clamp system is fast and easy to use, it does require a special clamp-release tool that comes supplied with the machine. We found, however, that an ordinary flat-tip screwdriver will open the clamps easily. The outstanding feature of the clamp design is that it pulls in the paper toward the center of the tool as the clamps engage so the sandpaper is drawn tight to the pad. The sliding switch is placed somewhat awkwardly—just out of reach for convenient 1-handed operation.

Perhaps a reflection of its low 12,000 opm and the fact that the shape

of this tool discourages pressing hard, it ranked low as a fast palm sander.

However, for fine surfacing, speed isn't everything. The tool excels in fatigue-free operation and the solid feel of quality.

Of all the palm sander manufacturers in our test group, Porter-Cable is the only one that recommended periodic cleaning and lubrication. This signifies that their machine is intended as a serious tool and, with care, is capable of long-term service.

Ryobi S-500A

Whether for reasons of sandpaper economy or the ability to get into small spaces, Ryobi offers a palm sander in a 1/6th-sheet size. While it looks handy, it had its problems.

The rocker switch has a flexible plastic dust cover that interferes with switch operation and the wide top is somewhat awkward. This tool bounced around so much, that it had to be pressed firmly to the wood, making it appear to cut faster than perhaps it would have otherwise.

On the positive side, the Ryobi S-500A exhibits the lowest noise level of all the machines. It also has the most straightforward and easy-to-use clamping mechanism—a good idea be-

cause the small sanding area means having to change the paper often.

Ryobi S-600

In contrast to its 1/6th-sheet version, Ryobi recently introduced its model S-600 1/4-sheet sander. And, the contrast is more than just pad size.

While we did feel that the grip was somewhat wide, the Ryobi S-600 has one of the lowest vibration levels of the group. Its noise level is below average and, when held to the wood, it displays a stability that placed it with the front runners for handling.

It suffers, as do other smooth-operating machines, from slower than average cutting. And, the stiff sliding switch makes 1-handed starting a chore. The big negative in terms of easy use, however, is the swing-arm paper clamp.

But if you can put up with the clamping system, the Ryobi S-600 is a top choice for smooth performance.

Sears

The Sears Craftsman 1/4-sheet palm sander features the convenient bend-wire clamping system. Like the B & D 7443, Sears chose light-gauge wire.

The designers of this machine have

(Please turn to page 106)

PALM SANDER SPECIFICATIONS*

MANUFACTURER	MODEL	PRICE ¹	AMPS	SPEED (OPM)	WEIGHT (LBS.)	SWITCH	CORD LENGTH	CLAMP TYPE	PAD MATERIAL
Black & Decker	7443	\$50	1.5	13,000	1.8	sliding	6'	bent-wire	rubber
Black & Decker	7445	\$61	1.6	15,000	1.8	sliding	8'	single-arm	felt
Hitachi	SV 12SA	\$93	1.7	12,000	3.3	toggle	8'	bent-wire	rubber ³
Makita	M904	\$76	1.6	14,000	2	sliding	6'	twin-arm	felt
Makita	BO4530	\$102	1.8	12,000	2.4	sliding	8'6"	stick-on	rubber ⁵
Makita	BO4550	\$92	1.6	14,000	2.1	sliding	6'	twin-arm	rubber
Milwaukee	6016	\$75	1.8	13,000	2.4	rocker	9'	swing-arm	rubber
Porter-Cable	330	\$97	1.2	12,000	3.75	sliding	7'	clamp w/tool	rubber ⁴
Ryobi	S-500A	\$70	1.5	12,000	2.6	rocker ²	6'6"	lever-clamp	rubber
Ryobi	S-600	\$88	1.6	12,000	2.6	sliding	6'6"	swing-arm	felt
Sears	11602	\$38	2.0	14,000	1.8	sliding	8'	bent-wire	rubber
Skil	7565	\$65	1.8	13,000	3	rocker	9'	swing-arm	rubber

*Sanders feature 1-year limited warranty, all ball-bearing construction, 1/4-sheet pad size and 1/16-in.-dia. orbit except the following: Black & Decker models have a 2-year home-use warranty and Milwaukee has no-time-limit warranty, B&D 7443 has sleeve and ball-bearing construction, Ryobi S-500A has 1/8-sheet pad size and Makita BO4530 has 6-in.-dia. round pad, Porter-Cable, Ryobi S-500A and B & D7443 have 3/8-in.-dia. orbit. 1. Manufacturers suggested retail price—many units are commonly discounted by retailer. 2. Plastic-covered switch. 3. Optional square or 5-in.-dia. stick-on pad. 4. Optional felt or buffing pad. 5. Optional square stick-on pad.

You can easily improve a plain concrete patio by building one or more of the projects shown here. Our freestanding planter (below), tiered planter (middle) and combination planter/bench (bottom) can all accommodate flowers, herbs and other small plants, while our bigger corner planters (right) can handle larger bushes and small trees.



PRETTY PATIO

Five great ways to spruce up a plain concrete patio.

BY STEVEN WILLSON

IF YOUR home is like countless others built since World War II, it shares a feature that is both a blessing and a curse: namely, a backyard concrete patio.

The wonderful thing about these slabs is that they are a convenient

place to relax or entertain during the warmer months.

But they also share a major shortcoming. Simply put, they aren't very attractive or comfortable.

One great way to make a concrete slab perform better is to simply cover



it with a full-scale wood deck. This allows you to build-in all sorts of amenities, from benches to tables to planters. Such a job also can include a trip to the bank for financing!

Another approach is to outfit the patio with a full complement of outdoor furniture, which will dramatically improve livability but will have to be stored away when the weather gets bad.

In the hopes of finding a middle

ground between the red ink and a garage full of furniture, we contacted the Southern Pine Marketing Council and the folks at Samsonite Furniture Co. We asked them for some ideas that would not only catch the eye, but also be affordable and require a sensible amount of time and effort to complete. The result of these efforts is shown above.

The primary seating area was created with furniture, but the overall

Photos: Staff Davis
Lumber: Pressure-treated southern pine from William E. Fay Enterprises
Furniture: Samsonite Furniture Co.
Technical art: Eugene Thompson

ambiance was defined by the various planters and other structures that give this patio its custom look.

All these add-ons were built with pressure-treated lumber and were selected for their versatility. The free-standing planters and planter/bench

PRETTY PATIO

combination can be used anywhere: on a patio, a wood deck and even on the ground.

On the other hand, the built-in corner planters—with steps between—and the tiered planter, were included to give this specific patio its custom look.

If your patio is a different size, shape or location, you may have to change the overall dimensions of these structures, but the basic building techniques will remain the same. Following are instructions for building these projects, which should be used along with the technical artwork that begins below.

If you would like to obtain plans for other outdoor structures, send for a free catalog to: Southern Pine Marketing Council, c/o SPPA, Box 52468, New Orleans, LA 70152. Be sure to include a stamped, self-addressed legal-size envelope and ask for publication No. 410.

Tiered planter

Although our tiered planter does abut one side of our slab, clearly it can be built anywhere you like. Just keep in mind that if you choose a spot along your house or garage that has wood siding, it's a good idea to line the back-side of the planter with 10-mil-thick polyethylene plastic. This will protect your wood siding from prolonged exposure to moisture. Also, remember that the size of this planter can be adapted easily to different conditions. We chose a convenient 4 x 8-ft. size which made the most efficient use of our material.

Begin by laying out the position of the planter by driving stakes at all four corners. Make sure that both outside corner stakes are the same distance from the house and are square to the inside corner stakes driven beside the house.

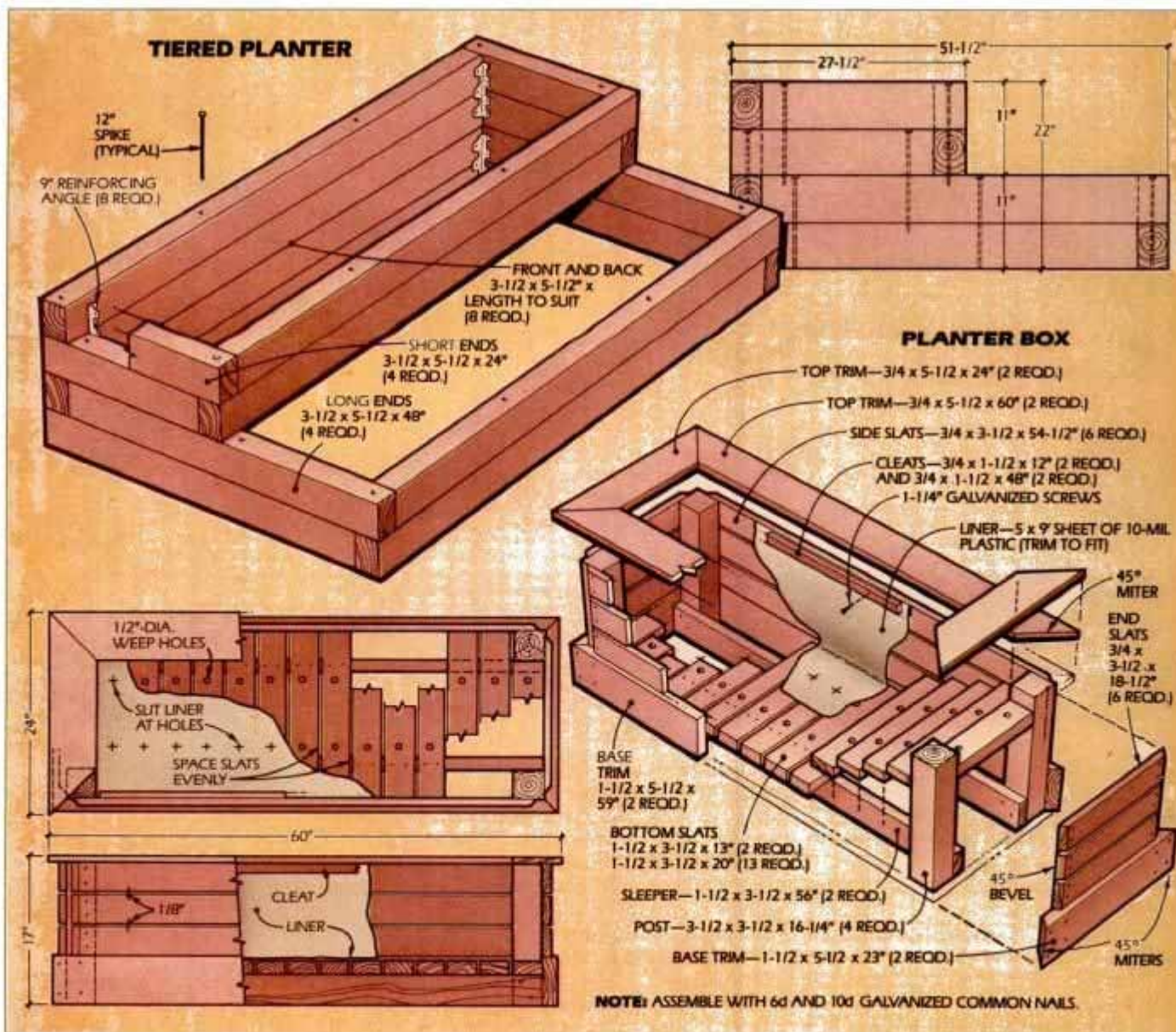
Next, attach a mason's string to the stakes, about 6 in. above the ground, to form three sides of a rectangle. The fourth side, of course, is defined by

the house wall. Using a spade, cut through the turf on the perimeter and then remove the rest of the turf within the rectangle. Plan on taking out about 2 in. of turf and topsoil.

Once the turf is removed, check the perimeter of your hole for level. Continue to excavate the perimeter, if necessary, so you have a uniformly level 6-in.-wide trench on all four sides. Next, cut your 4x6 pressure-treated timbers (actual dimensions are $3\frac{1}{2} \times 5\frac{1}{2}$ in.) to the sizes shown in the drawing.

Place the first base timber along the house wall. As you can see from the drawing, all the corners are staggered to achieve interlocking joints. Because of this, make sure to push the right end of the timber to the edge of your excavation. This will leave at least 6 or 7 in. on the left side to accommodate the left end timber.

At this point, check the timber for level. It may well require some adjustment, either by removing or adding soil underneath in various areas.



PRETTY PATIO

are slightly bowed or twisted, straighten them by nailing into the ends of the bottom slats.

Once these are in place, cut the side slats to length and bevel both ends of each board.

Beginning with the bottom board, place it directly on top of the base trim boards. Make sure that the point of each beveled end falls $\frac{3}{4}$ in. in from the outside corner of each post.

Nail the bottom slat into the corner posts and then add the remaining slats in similar fashion, maintaining a uniform $\frac{1}{8}$ -in. spacing between the courses. As you work, be sure to check frequently for square so the posts and sleepers form a perfect 90° angle.

Next cut the plastic liner to size and fold it into the box. Try and keep the corners as neat as possible and be sure to install the holddown cleats between all the posts as shown in the drawing.

Once the cleats are attached, slice the plastic over the weep holes in the bottom slats to allow water to drain through.

To complete the planter, cut the top trim boards to size, miter the ends and nail into the posts.

Planter bench

The planter bench unit is another freestanding structure that can be used anywhere and built anywhere.

The construction techniques for this planter are the same as described above. The only difference is size. This unit measures 17 × 24 × 48 in. The bench, however, is designed to mate with the planter and look like the two were built as one unit.

Complete the planter first, then begin building the bench by cutting the 2x12 base members to length and nailing them together with 10d galvanized nails. Make sure to check for square as you work.

Next, cut and nail the cross-members onto this support box as shown. The ends of each cross-member should extend $1\frac{1}{2}$ in. beyond the base members below. This overhang creates a nice floating look to the benchtop and gives you clearance for your heels while sitting.

Next, cut and nail the outside trim boards in place.

Keep in mind that the free end of the bench receives a 2x4 trim board but the end that abuts the planter uses a 1x4 board.

Once this 1x4 is nailed in place, cut and nail the small filler block in place as shown in the drawing.

This filler has one beveled end that is designed to mate with the beveled edge on the side slats of the planter. This creates the impression that a 2x4 trim board was used on this end too, and that the planter was notched to receive it.

With the trim boards in place, pre-

cisely align the bench with the planter as shown in the drawing and lagscrew the two together from the inside of the bench base.

Complete the bench by nailing the seat boards in place, maintaining a uniform $\frac{1}{8}$ -in. space on the sides and ends of all boards. Use 10d galvanized nails for this job and be sure to set the nail heads at least $\frac{1}{16}$ in. deep to prevent these nubby nails from tearing your clothing. Stain the structure if you choose, then fill the planter with soil and you are done.

Corner planters

The neat thing about these corner planters is that they not only create the feeling of a bigger patio but they also break up the harsh rectangular shape of a typical concrete slab.

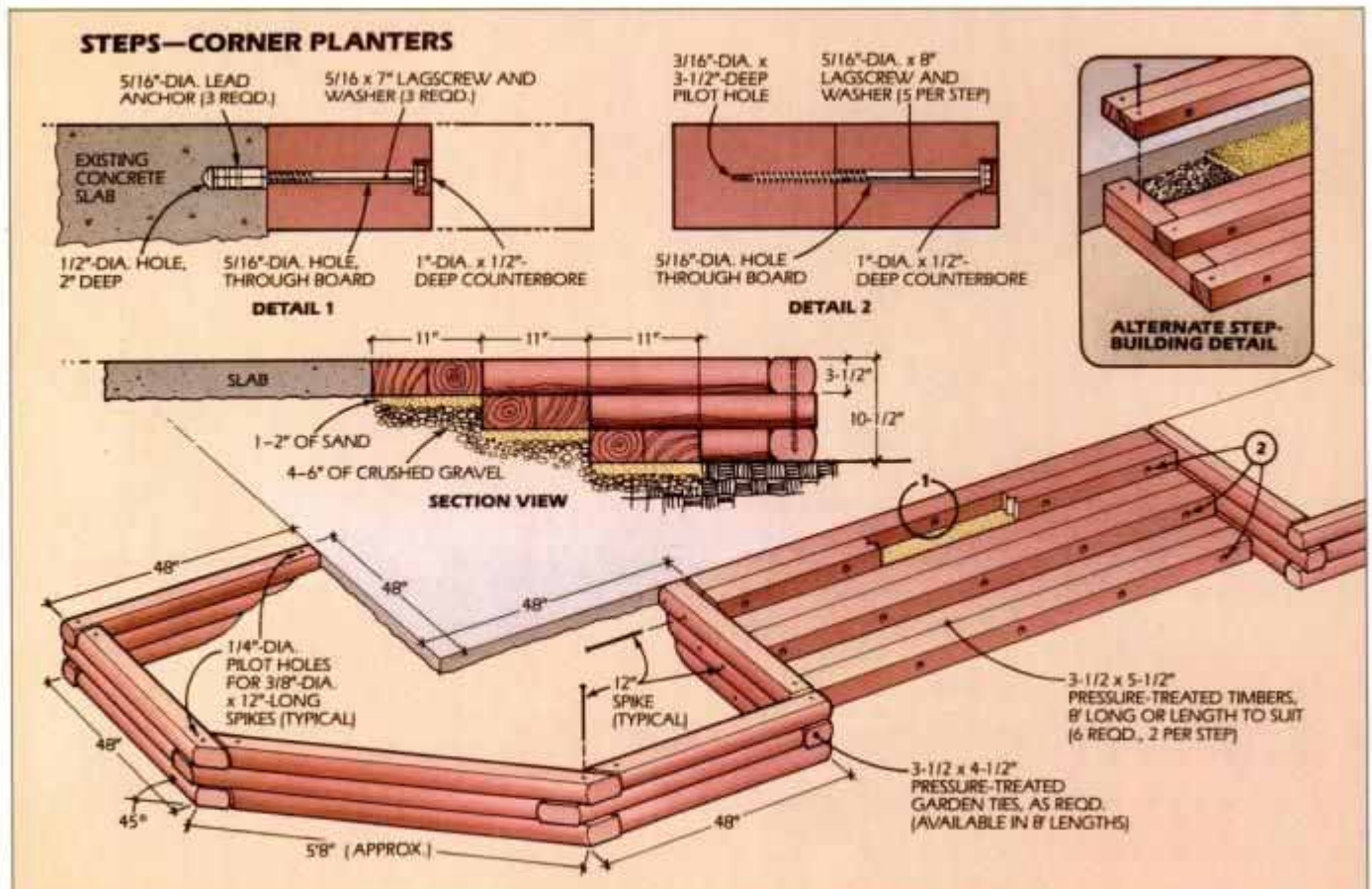
Begin construction by laying out and excavating the area where you want the planter. Follow the same basic procedure explained in the tiered planter section on page 90.

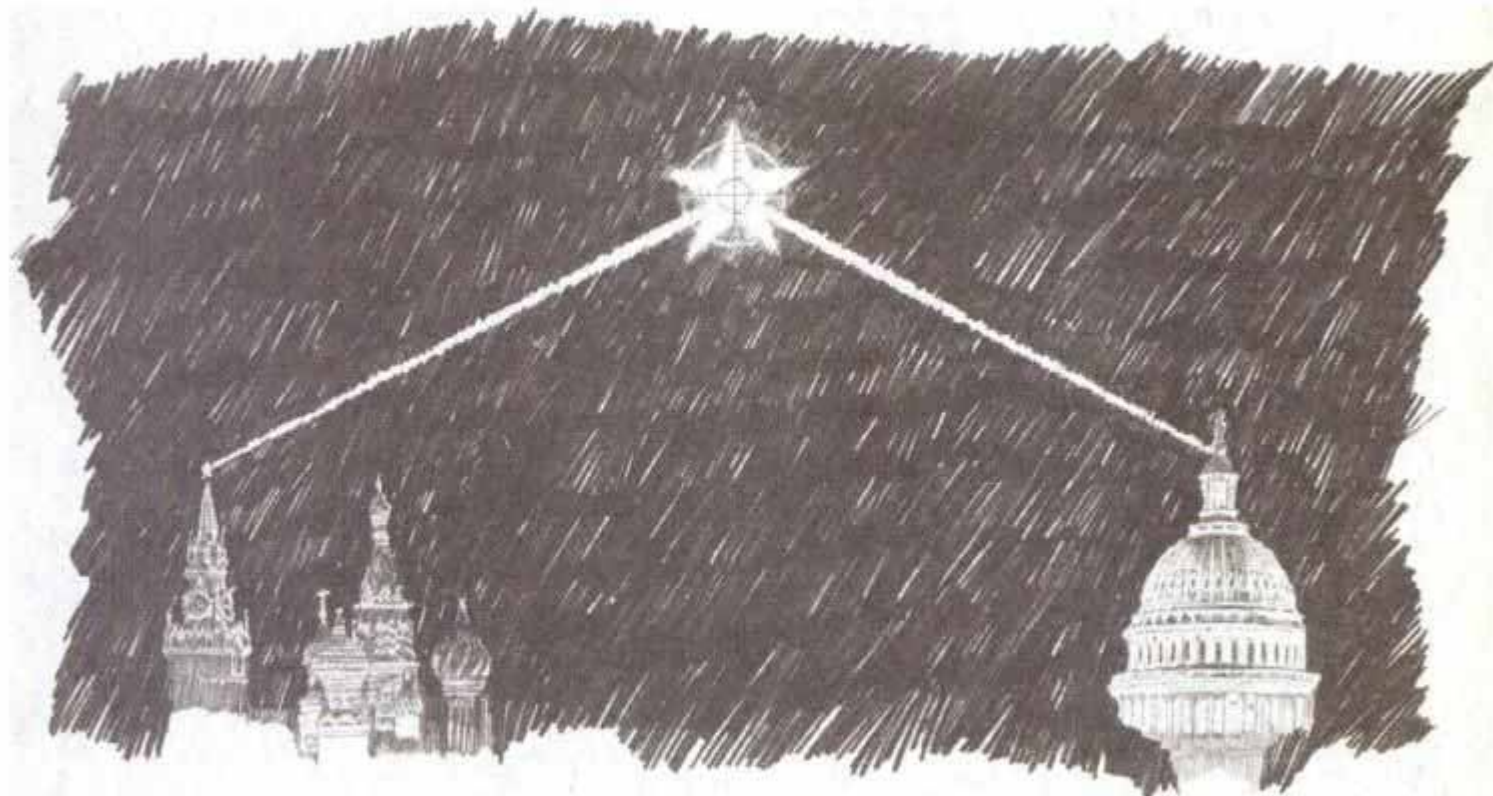
Keep in mind that we installed three courses of garden ties because the ground surrounding our patio was sloped slightly away from the slab. If your surrounding ground does not slope as much, you may need only two courses.

Of course, the same thing is true for the number of steps described later.

For this job, we used commonly available pressure-treated garden

(Please turn to page 102)





THE CARDINAL OF THE KREMLIN

BY TOM CLANCY

In a dramatic race to take the technological high ground of the 21st century, America and the Soviet Union each stand on the threshold of creating a space-based defense against intercontinental ballistic missiles. The question is: Who will get there first?

In this exclusive POPULAR MECHANICS excerpt, American scientists laboring over the Strategic Defense Initiative manage the delicate task of testing a new ground-based laser. They are unaware that their counterparts at Dushanbe in the Soviet Republic of Tadzhikskaja are making significant strides on their own version of a ballistic missile defense, code named "Bright Star." Jack Ryan, the brilliant CIA analyst from Hunt For Red October and Patriot Games, returns in Cardinal Of The Kremlin to uncover the secrets of the Soviet Union's own SDI.

Excerpt from The Cardinal Of The Kremlin by Tom Clancy to be published by G.P. Putnam's Sons. Copyright © 1988 by Jack Ryan Enterprises Ltd.

RYAN WAS SURE that he'd been in government service too long. He had come to—well, not actually to like flying, but at least to appreciate the convenience of it. He was only 4 hours from Washington, flown by an Air Force C-21 Lear Jet whose female pilot, a captain, had looked like a high school sophomore.

Getting old Jack, he told himself. The flight from the airfield to the mountain top had been by helicopter, no easy feat at this altitude. Ryan had never been to New Mexico before. The high mountains were bare of trees, the air thin enough that he was breathing abnormally, but the sky was so clear that for a moment he imagined himself an astronaut looking at the unblinking stars on this frigid night.

THE CARDINAL OF THE KREMLIN

"Coffee, sir?" a sergeant asked. He handed Ryan a thermos cup, and the hot liquid steamed into the night, barely illuminated by a sliver of new moon.

"Thanks." Ryan sipped at it and looked around. There were few lights to be seen. There might have been a housing development behind the next set of ridges. He could see the halo-like glow of Santa Fe, but there was no way to guess how far off it might be. He knew that the rock he stood on was 11,000 ft. above sea level (the nearest level sea was hundreds of miles away), and there is no way to judge distance at night. It was altogether beautiful, except for the cold.

"Seventeen minutes," somebody announced. "All systems are nominal. Trackers on automatic. AOS in 8 minutes."

"AOS?" Ryan asked. He realized that he sounded a little funny. It was so cold that his cheeks were stiff.

"Acquisition of Signal," the major explained.

"You live around here?"

"Forty miles that way." He pointed vaguely. "Practically next door, by local standards." The officer's Brooklyn accent explained the comment.

HE'S THE ONE with the doctorate from State University of New York at Stony Brook, Ryan reminded himself. At only 29 years old, the major didn't look like a soldier, even less like a field-grade officer. In Switzerland he'd be called a gnome, barely over five-seven, and cadaverously thin, acne on his angular face, his deep-set eyes were locked on the sector of horizons where the Space Shuttle *Discovery* would appear.

Ryan thought back to the documents he'd read on the way out and knew that this major probably couldn't tell him the color of paint on his living-room wall. He really lived at Los Alamos National Laboratory, known locally as "The Hill." No. 1 in his class at West Point, and a doctorate in high-energy physics only two years after that. His doctor's dissertation was classified TOP SECRET. Jack had read it, and didn't understand why they had bothered—despite a doctorate of his own, the 200-page document might as well have been written in Kurdish. Alan Gregory was already being talked of in the same breath as Cambridge's Stephen Hawking, or Princeton's Freeman Dyson. Except that few people knew his name. Jack wondered if anyone had thought of classifying *that*.

"Maj. Gregory, all ready?" an Air Force lieutenant general asked. Jack noted his respectful tone. Gregory was no ordinary major.

A nervous smile. "Yes, sir." The major wiped sweaty hands—despite a temperature of 15 below zero—on the pants of his uniform. The kid had emotions.

"You married?" Ryan asked. The file hadn't covered that.

"Engaged, sir. She's a doctor in laser optics, on the Hill. We get married June the third." The kid's voice had become brittle as glass.

"Congratulations. Keeping it in the family, eh?" Jack chuckled.

"Yes, sir." Maj. Gregory was still staring at the southwest horizon.

"AOS!" someone announced. "We have signal."

"Goggles!" The call came over the metal speakers.

"Everyone put on their eye protection."

Jack blew on his hand before taking the plastic goggles from his pocket. He'd been told to stash them there to keep them warm. They were still cold enough on his face that he noticed the difference. Once in place, however, Ryan was effectively blinded. The stars and Moon were gone.

"Tracking! We have lock. *Discovery* has established the downlink. All systems are nominal."

"Target acquisition!" another voice announced. "Initiate interrogation sequencing . . . first target is locked . . . autofiring circuits enabled."

There was no sound to indicate what had happened. Ryan didn't see anything—or *did I?* he asked himself. There had been the fleeting impression of . . . what? *Did I imagine it?* Next to him, he felt the major's breath come out slowly.

"Exercise concluded," the speaker said.

Jack tore off his goggles. *That's all?* What had he just seen? What had they just done? Was he so far out of date that even after being briefed he didn't understand what was happening before his eyes?

"The laser light is almost impossible to see," Maj. Gregory explained. "This high up, there isn't much dust or humidity in the air to reflect it."

"Then why the goggles?"

The young officer smiled as he took his off. "Well, if a bird flies over at the wrong time, the impact might be, well, kind of spectacular. That could hurt your eyes some."

Two hundred miles over their heads, *Discovery* continued toward the horizon. The Shuttle would stay in orbit another three days, conducting its "routine scientific mission," mainly oceanographical studies this time, the press was told, something secret for the Navy. The papers had been speculating on this mission for weeks. It had something to do, they said, with tracking missile submarines from orbit. There was no better way to keep a "secret" than to conceal it. Every time someone asked about the mission, a Navy public-affairs officer would do the "no comments."

"Did it work?" Jack asked. He looked up, but he couldn't pick out the dot of light that denoted the billion-dollar space plane.

"We have to see." The major turned and walked to the camouflage-painted truck-van parked a few yards away. The 3-star general followed, with Ryan trailing behind.

Inside the van, where the temperature might have been merely at freezing, a chief warrant officer was rewinding a videotape.

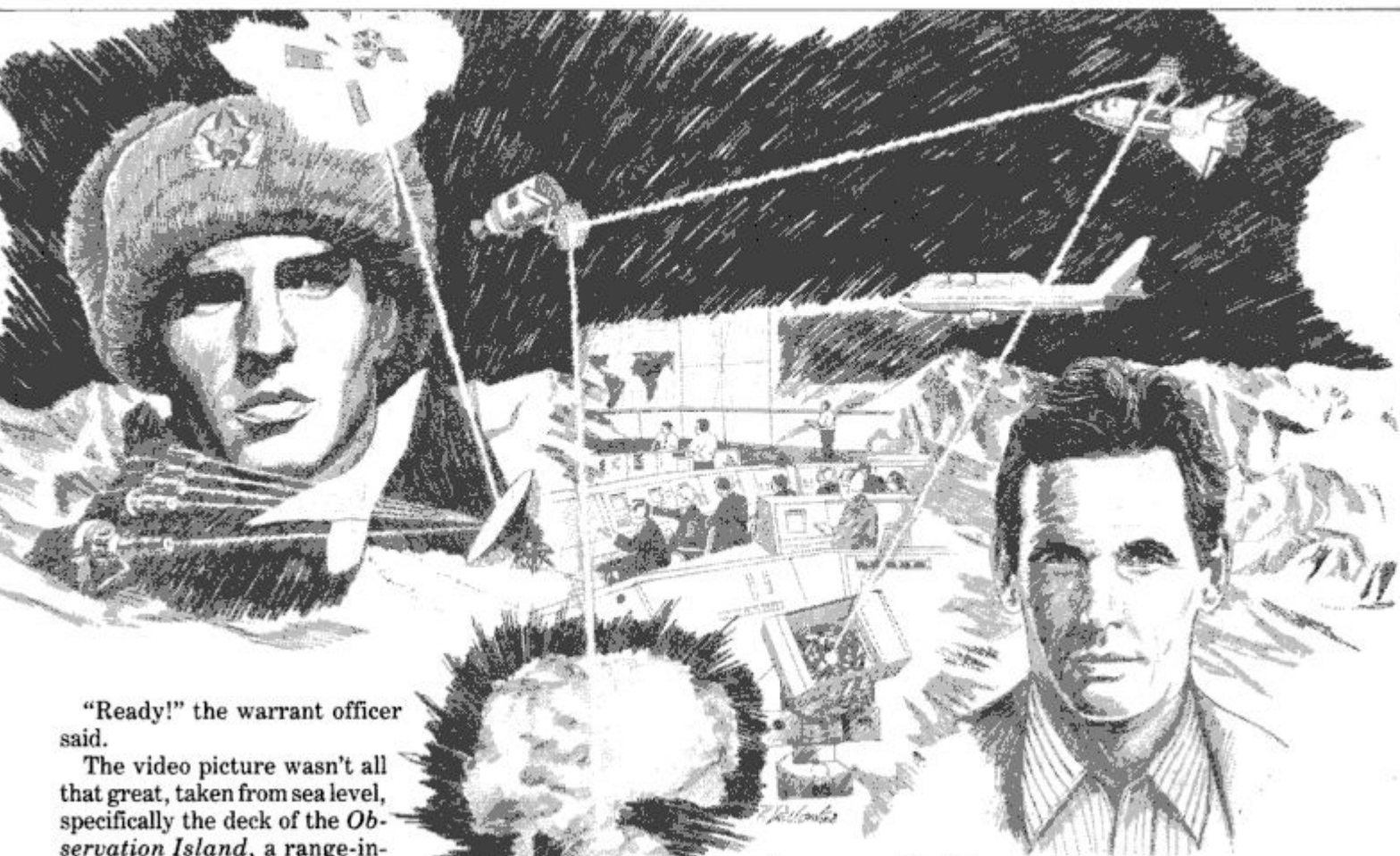
"Where were the targets?" Jack asked. "That wasn't in the briefing papers."

"About 45 south, 30 west," the general replied. Maj. Gregory was perched in front of the TV screen.

"That's around the Falklands, isn't it? Why there?"

"Closer to South Georgia, actually," the general replied. "It's a nice, quiet, out of the way sort of place, and the distance is about right."

AND THE SOVIETS had no known intelligence-gathering assets within 3000 miles, Ryan knew. The Tea Clipper test had been timed precisely for a moment when all Soviet spy satellites were under the visible horizon. Finally, the shooting distance was exactly the same as the distance to the Soviet ballistic missile fields arrayed along the country's main east-west railway.



"Ready!" the warrant officer said.

The video picture wasn't all that great, taken from sea level, specifically the deck of the *Observation Island*, a range-instrumentation ship returning from Trident missile tests in the Indian Ocean. Next to the first TV screen was another. This one showed the picture from the ship's Cobra Judy missile-tracking radar. Both screens showed four objects, spaced in a slightly uneven line. A timer box in the lower right-hand corner was changing numbers as though in an Alpine ski race, with three digits to the right of the decimal point.

"Hit!" One of the dots disappeared in a puff of green light. "Miss!" Another one didn't.

"Miss!" Jack frowned. He'd half-expected to see the beams of light streaking through the sky, but that only happened in movies. There wasn't enough dust in space to denote the energy's path.

"Hit!" Only one was left. "Miss."

"Miss." The last one didn't want to die, Ryan thought.

"Hit!" But it did. "Total elapsed time, one point eight-zero six seconds."

"Fifty percent," Major Gregory said quietly. "And it corrected itself." The young officer nodded slowly. He managed to keep from smiling, except around the eyes. "It works."

"How big were the targets?" Ryan asked.

"Three meters. Spherical balloons, of course." Gregory was rapidly losing control. He looked like a kid whom Christmas had taken by surprise.

"Same diameter as an SS-18."

"Something like that," the general answered that one.

"Where's the other mirror?"

"Ten thousand kilometers up, currently over Ascension Island. Officially, it's a weather satellite that never made

its proper orbit," the general smiled.

"I didn't know you could send it that far."

Maj. Gregory actually giggled. "Neither did we."

"So, you sent the beam from over there to the Shuttle's mirror, from *Discovery* to this other one over the equator, and from there to the targets?"

"Correct," the general said.

"Your targeting system is on the other satellite, then?"

"Yes," the general answered more grudgingly.

JACK DID SOME numbers in his head. "Okay, that means you can discriminate a 3-meter target at . . . 10,000 kilometers. I didn't know we could do that. How do we?"

"You had four hits and four misses—eight shots in under 2 seconds, and the major said the targeting system corrected for misses. Okay, if those had been SS-18s launched off of South Georgia, would the shots have killed them?"

"Probably not," Gregory admitted. "The laser assembly only puts out 5 megajoules. Know what a joule is?"

"I checked my college phyzzies book before I flew down. A joule is 1 newton-meter per second, or 0.7 ft.-lbs. of energy, plus change, right? Okay, a megajoule is a million of them . . . 700,000 ft.-lbs. In terms I can understand."

"A megajoule is the rough equivalent of a stick of dynamite. So, we just delivered five sticks. The actual energy transferred is like a kilogram of explosives, but the physical effects are not exactly comparable."

"What you're telling me is that the beam doesn't actually burn through the target—it's more of a shock effect." Ryan was stretching his tech knowledge to its limit.

"We call it an 'impact kill,'" the general answered. "But,

THE CARDINAL OF THE KREMLIN

yeah, that's about it. All the energy arrives in a few millionths of a second, a lot faster than any bullet does."

"So all that stuff I've heard about how polishing the missile body, or rotating it, will prevent a burn-through—"

MAJ. GREGORY giggled again, "Yeah, I like that one. A ballet dancer can pirouette in front of a shotgun, and it'll do her about as much good. What happens is that the energy has to go somewhere, and that can only be into the missile body. The missile body is full of storable liquids—nearly all of their birds are liquid fueled, right? The hydrostatic effect alone will be to rupture the pressure tanks—*ka-boom!* No more missile." The major smiled as though describing a trick played on his high school teacher.

"Okay, now, I want to know how it all works."

"Look, Dr. Ryan," the general started to say. Jack cut him off.

"General, I am cleared for Tea Clipper. You know that, so let's stop screwing around."

Maj. Gregory got a nod from the general. "Sir, we have five 1-megajoule lasers—"

"Where?"

"You're standing on top of one of them, sir. The other four are buried around this hilltop. The power rating is per pulse, of course. Each one puts out a pulse chain of a million joules in a few microseconds—a few millionths of a second."

"And they recharge in . . . ?"

"Point zero-four-six seconds. We can deliver 20 shots per second, in other words."

"But you didn't shoot that fast."

"We didn't have to, sir," Gregory replied. "The limiting factor presently is the targeting software. That's being worked on. The purpose of this test was to evaluate part of the software package. We know that lasers work. We've had them here for the past three years. The laser beams are converged on a mirror about 50 meters that way—" he pointed "—and converted into a single beam."

"They have to be—I mean, the beams all have to be exactly in tune, right?"

"Technically it's called a Phased-Array Laser. All the beams have to be perfectly in phase," Gregory answered.

"How the hell do you do that?" Ryan paused. "Don't bother, I probably wouldn't understand it anyway. Okay, we have the beam hitting the downside mirror . . ."

"The mirror is the special part. It's composed of thousands of segments, and every segment is controlled by a piezoelectric chip. That's called adaptive optics." We send an interrogation beam to the mirror—this one was on the Shuttle—and get a reading on atmospheric distortion. The way the atmosphere bends the beam is analyzed by computer. Then the mirror corrects for the distortion, and we fire the real shot. The mirror on the Shuttle also has adaptive-optics. It collects and focuses the beam and sends it off to the Flying Cloud satellite mirror. That mirror refocuses the beam on the targets. Zap!"

"That simple?" Ryan shook his head. It was simple enough that over the previous 19 years \$40 billion went into research, in 20 separate fields, just to run this test.

"We did have to iron out a few details," Gregory acknowledged. These little details would take another five or more years, and he neither knew nor cared how many additional billions. What mattered to him was that the goal was now actually in sight. Tea Clipper wasn't a blue-sky project anymore, not after this system test.

"And you're the guy who made the breakthrough on the targeting system. You figured a way for the beam to provide its own targeting information."

"Something like that," the general answered for the kid. "Dr. Ryan, that part of the system is classified highly enough that we will not discuss it further without written authorization."

"General, the purpose in my being here is to evaluate this program relative to Soviet efforts along similar lines. If you want my people to tell you what the Russians are up to, I have to know what the hell we're supposed to look for!" This did not elicit a reply. Jack shrugged and reached inside his coat. He handed the general an envelope. Maj. Gregory looked on in puzzlement.

"You still don't like it," Ryan observed after the officer folded the letter away.

"No, sir, I don't."

Ryan spoke with a voice colder than the New Mexico

night. "General, when I was in the Marine Corps, they never told me that I was supposed to like my orders, just that I was supposed to obey them." That almost set the general off, and Jack added: "I really am on your side sir."

"You may continue, Maj. Gregory," Gen. Parks said after a moment. "I call the algorithm Fan Dance," Gregory began. The general almost

smiled in spite of himself. Gregory could not have known anything about Sally Rand.

"That's all?" Ryan said again when the youngster finished, and he knew that every computer expert in Project Tea Clipper must have asked himself the same thing: Why didn't I think of that?! No wonder they all say that Gregory is a genius. He'd made a crucial breakthrough in laser technology at Stony Brook, then one in software design. "But that's simple!"

YES, SIR, BUT it took over two years to make it work, and a Cray-2 computer to make it work fast enough to matter. We still need a little more work, but after we analyze what went wrong tonight, another four or five months, maybe, and we got it knocked."

"Next step, then?"

"Building a 5-megajoule laser. Another team is close to that already. Then we gang up 20 of them, and we can send out a 100-megajoule pulse, 20 times per second, and hit any target we want. The impact energy then will be on the order of, say, 20 to 30 kilograms of explosives."

"And that'll kill any missile anybody can make . . ."

"What you're telling me is the thing, Tea Clipper, works."

"We've validated the system architecture," the general corrected Ryan. "It's been a long haul since we started looking at this system. Five years ago there were 11 hurdles. There are three technical hurdles left. Five years

... the energy arrives in a few millionths of a second . . . A ballet dancer can pirouette in front of a shotgun, and it'll do her about as much good."

from now, there won't be any. Then we start building it."

"The strategic implications . . ." Ryan said, and stopped. "Jesus."

"It's going to change the world," the general agreed.

"You know that they're playing with the same thing at Dushanbe."

"Yes, sir," Maj. Gregory answered. "And they might know something that we don't."

Meanwhile, Soviet researchers prepare to energize a ground-based laser for a test shot at a disused Cosmos reconnaissance satellite. Little do they realize that a U.S. Army airborne infrared telescope is observing the same target satellite as the aircraft carries out a practice mission over the Pacific Ocean.

THE CONVERTED Boeing 767 had two names. Originally known as the "Airborne Optical Adjunct," it was now called Cobra Belle, which at least sounded better. The aircraft was little more than a platform for as large an infrared telescope as could be made to fit in the wide-bodied airliner. The engineers had cheated somewhat, of course, giving the fuselage an ungainly humpback immediately aft of the flight deck that extended half its length, and the 767 did look rather like a snake that had just swallowed something large enough to choke on.

What was even more remarkable about the aircraft, however, was the lettering on its vertical tail: *U.S. ARMY*. This fact, which infuriated the Air Force, resulted either from unusual prescience or obstinacy on the part of the Army which even in the 1970s had never shut down its research into ballistic-missile defense, and whose "hobby shop," as such places were known, had invented the infrared sensors on the AOA.

But it was now part of an Air Force program whose cover-all name was "Cobra." It worked in coordination with the Cobra Dane radar at Shemya, and often flew in conjunction with an aircraft called Cobra Ball—a converted 707—because Cobra was the code name for a family of systems aimed at tracking Soviet missiles. The Army was smugly satisfied that the Air Force needed its help, though wary of ongoing attempts to steal its program.

The flight crew went through its checklist casually, since they had plenty of time. They were from Boeing. So far the Army had successfully resisted attempts by the Air Force to get its own people on the flight deck. The copilot, who was ex-Air Force, ran his fingers down the paper list of things to do, calling them off while the pilot and flight engineer/navigator pushed the buttons, checked the gauges and otherwise made ready.

The worst part of the mission was the weather on the

ground. Shemya, one of the western Aleutians, would close most reputable airports, and what they called bad weather here made the Boeing crew wish for Amtrak. It was widely believed on the base that the only reason the Russians sent their ICBM test to the Sea of Okhotsk was to make life as miserable as possible for the Americans who monitored them. Today, the weather was fairly decent. You could see almost to the far end of the runway, where the blue lights were surrounded by little globes of mist. Like most flyers, the pilot preferred daylight, but in winter that was the exception here. He counted his blessings: There was supposed to be a ceiling at about 1500 ft., and it wasn't raining yet. The crosswinds were a problem too, but the wind never blew where you wanted up here—or more correctly, the people who laid out the runway hadn't known or cared that wind was a factor in flying airplanes.

"Shemya Tower, this is Charlie Bravo, ready to taxi."

"Charlie Bravo, you are cleared to taxi. Winds are two-five-zero at 15." The Tower didn't have to say that Cobra Belle was No. 1 in line. At the moment, the 767 was the only aircraft on the base. Supposedly in California for equipment tests, it had been rushed here only 20 hours earlier.

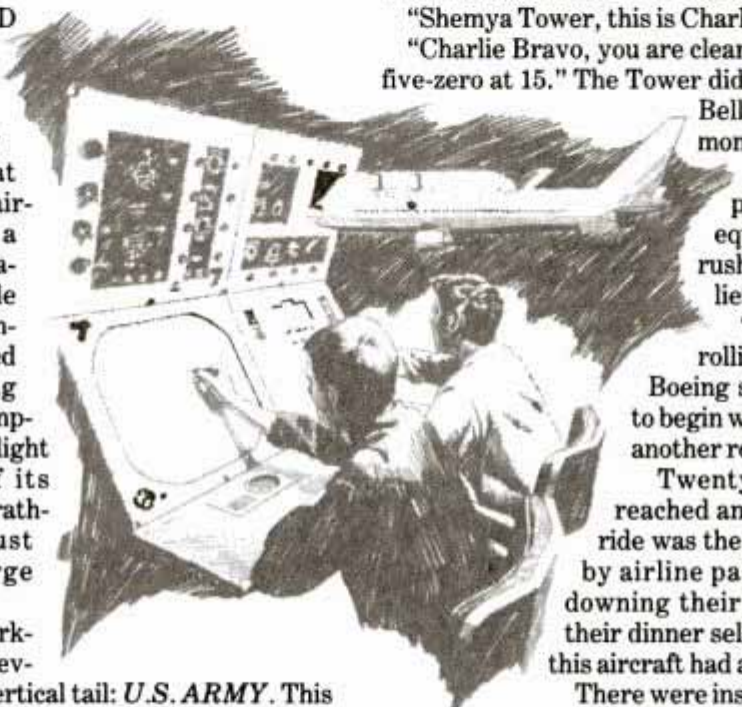
"Roger. Charlie Bravo is rolling." Ten minutes later the Boeing started down the runway, to begin what was expected to be yet another routine mission.

Twenty minutes later the AOA reached an altitude of 45,000 ft. The ride was the same smooth glide known by airline passengers, but instead of downing their first drinks and making their dinner selections, the people aboard this aircraft had already gone to work.

There were instruments to activate, computers to recycle, data links to set up, and voice links to check out. The aircraft was equipped with every communications system known to man, and would have had a psychic aboard if that Defense Department program—there was one—had progressed as well as originally hoped. The man commanding it all was an artilleryman with a master's in astronomy, of all things, from the University of Texas. His last command had been of a Patriot missile battery in Germany.

WHILE MOST men looked at airplanes and wish to fly them, his interest had always been in shooting them out of the sky. He felt the same way about ballistic missiles, and had helped develop the modification that enabled the Patriot missile to kill other missiles in addition to Soviet aircraft. It also gave him an intimate familiarity with the instruments used to track missiles in flight.

The mission book in the colonel's hands was a facsimile printout from the Washington headquarters of the Defense Intelligence Agency (DIA) telling him that in 4 hours and 16 minutes the Soviets would conduct a test firing of an SS-25 ICBM. The book didn't say how DIA had obtained that information, though the colonel knew that it wasn't from reading an ad in *Izvestia*. Cobra Belle's mission was to



THE CARDINAL OF THE KREMLIN

monitor the firing, intercept all telemetry transmissions from the missile's test instruments, and most importantly, to take pictures of the warheads in flight. The data collected would later be analyzed to determine the performance of the missile, and accuracy of its warhead delivery, a matter of the greatest interest to Washington.

As mission commander, the colonel didn't have a great deal to do. His control board was a panel of colored lights that showed the status of various on-board systems. Since the AOA was a fairly new item in the inventory, everything aboard worked reasonably well. Today the only thing currently "down" was a backup data link, and a technician was working to put that back on line while the colonel sipped his coffee. It was something of an effort for him to look interested while he had nothing in particular to do, but if he started looking bored, it would set a bad example for his people.

He decided that he had to do *something*. He unstrapped from his command chair and went to the flight deck forward.

"Morning, people." It was now 0004-Lima, or 12:04 AM, local time.

"Good morning, colonel," the pilot replied for his crew. "Everything working in back, sir?"

"So far. How's the weather in the patrol area?"

"Solid undercast at twelve-to-fifteen thousand," the navigator answered, holding up a satellite photograph. "Winds three-two-five at 30 knots. Our nav systems check out with the track from Shemya," she added. Ordinarily the 767 operates with a crew of two flight officers. Not this one. Since the Korean Air 007

flight had been shot down by the Soviets, every flight over the Pacific was especially careful with its navigation.

THIS WAS DOUBLY true of Cobra Belle; the Soviets hated all intelligence-gathering platforms. They never went within 50 miles of Soviet territory, nor into the Russian Air Defense Identification Zone, but twice the Soviets had sent fighters to let the AOA know they cared.

"Well, we aren't supposed to get very close," the colonel observed. He leaned between the pilot and copilot to look out the windows. Both turboprops were performing well. He would have preferred a 4-engined aircraft for extended over-water flight, but that hadn't been his decision. The navigator raised an eyebrow at the colonel's interest, and got a pat on the shoulder by way of apology. Time to leave.

"Time to observation area?"

"Three hours, 17 minutes, sir; 3 hours 39 minutes to orbit point."

"Guess I have time for a nap," the colonel said on his way to the door. He closed it and walked aft, past the telescope assembly to the main cabin. Why was it that the crews doing the flying now were so damned young?

Forward, the pilot and copilot shared a look. *Old fart doesn't trust us to fly the goddamned airplane, does he?* They adjusted themselves in their seats, letting their eyes scan for the blinking lights of other aircraft while the autopilot controlled the aircraft.

MOROZOV WAS DRESSED like the other scientists in the control room, in a white laboratory coat adorned with a security pass. He was still going through orientation, and his assignment to the mirror-control team was probably temporary, though he was beginning to appreciate just how important this part of the program was. In Moscow, he'd learned how lasers work, and done some impressive lab work with experimental models, but he'd never fully appreciated the fact that when the energy came out the front of the instrument the task had only begun. Besides, Bright Star had already made its breakthrough in laser power.

"Recycle," the senior engineer said into his headset.

They were testing the system calibration by tracking their mirrors on a distant star. It didn't even matter which star. They picked one at random for each test.

"Makes one hell of a telescope, doesn't it?" the engineer noted, looking at his TV screen.

"You were concerned about system stability. Why?"

"We require a very high degree of accuracy, as you might imagine. We've never actually tested the complete system. We can track stars easily enough, but . . ." he shrugged. "This is still a young program, my friend. Just like you."

"Why don't you use radar to select a satellite and track on that?"

"That's a fine question!" the older man chuckled. "I've asked that myself. It has to do with arms-control agreements, or some such nonsense. For the moment, they tell us, it is enough that they feed us coordinates of our targets via land-line. We do not have to acquire them ourselves. Rubbish!" he concluded.

Morozov checked the clock—63 minutes until the test began. One by one, the technicians were drifting off to the restroom. He didn't feel the need, nor did the section chief, who finally pronounced himself satisfied with his systems, and placed everything on standby.

At 22,300 miles over the Indian Ocean, an American Defense Support Program satellite hung in geosynchronous orbit over a fixed point on the Indian Ocean. Its huge Cassegrain-focus Schmidt telescope was to provide first warning that Russian missiles had been launched at the United States. Its data was downlinked via Alice Springs, Australia, to various installations in the United States. Viewing conditions were excellent at the moment. Almost the entire visible hemisphere of the Earth was in darkness, and the cold, wintry ground easily showed the smallest heat source in precise definition.

The technicians who monitored the DSPS in Sunnyvale, California, routinely amused themselves by counting industrial facilities. There was the Lenin Steel Plant at Kazan, and there was the big refinery outside Moscow, and there . . . "Heads up," a sergeant announced, "we have an energy bloom at Plesetsk. Looks like one bird lifting off from the ICBM test facility."

The major on duty this night immediately got on the phone to "Crystal Palace," the headquarters of the North American Aerospace Defense Command—NORAD—under Cheyenne Mountain, Colorado, to make sure they

"The colonel had just had the privilege to witness something that few men in human history ever saw. He had just seen the world change . . ."

were copying the satellite data. They were, of course.

As they watched, the bright image of the missile rocket exhaust started turning to an easterly heading as the ICBM arced over into the ballistic flight path that gave the missile its name.

The major had the characteristics of all Soviet missiles memorized. If this were an SS-25, the first stage would separate right about . . . now.

THE SCREEN bloomed bright before their eyes as a fireball 600 yards in diameter appeared. The orbiting camera did the mechanical equivalent of a blink, altering its sensitivity after its sensors were dazzled by the sudden burst of heat energy. Three seconds later, it was able to track on a cloud of heated fragments, curving down to Earth.

"Looks like that one blew," the segments observed unnecessarily. "Back to the drawing board, Ivan . . ."

"Still haven't licked the second-stage problem," the major added. He wondered

briefly what the problem was, but didn't care all that much. The Soviets had rushed the 25 into production, and had already begun deploying them on rail cars for mobility, but they were still having problems with the solid-fuel bird. The major was glad for it. It didn't take a great degree of unreliability in missiles to make their use a very chancy thing. And that uncertainty was still the best guarantee of peace.

"Crystal Palace, we call that test a failure at 57 seconds after launch. Is Cobra Belle up to monitor the test?"

"That's affirmative," the officer on the other end replied. "We'll call them off."

"Right. Night, Jeff."

Aboard Cobra Belle, 10 minutes later, the mission commander acknowledged the message and cut off the radio channel. He checked his watch and sighed. He didn't feel like heading back to Shemya yet. The captain in charge of the mission hardware suggested that they could always use the time to calibrate their instruments. The colonel thought about that one and nodded approval. The aircraft and crew were new enough that everyone needed the practice. The camera system was put in the MTI-mode. A computer that registered all the energy sources the telescope found began to search only for targets that were moving. The technicians on the screens watched as the Moving-Target Indicator rapidly eliminated the stars and began to find a few low-altitude satellites and fragments of orbiting space junk. The camera system was sensitive enough to detect the heat of a human body at a range of 1000 miles, and soon they had their choice of targets. The camera locked on them one by one and made its photographic images in digital code on computer tape. Though mainly a practice drill, this data would automatically be forwarded to NORAD, where it would update the register of information on orbiting objects.

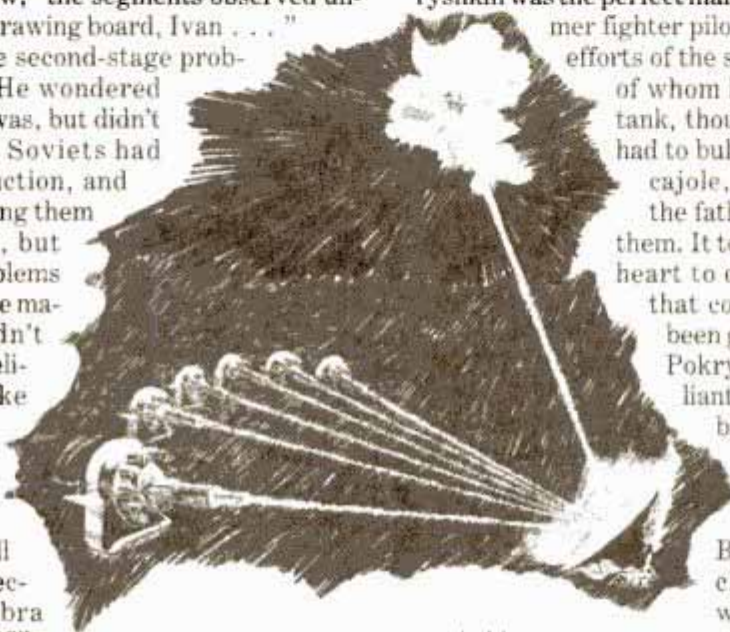
"The power-output breakthrough you've made is breathtaking," Col. Bondarenko said quietly.

"Yes," Gen. Pokryshkin agreed. "Amazing how that happens, isn't it? One of my wizards notices something and tells another, who tells another, and the third says something that works its way back to the first, and so on. We have the best minds in the country here, and still the discovery process seems about as scientific as stubbing your toe on a chair! That's the odd part. But that's what makes it so exciting. Gennady Losifovich, this is the most exciting thing I've done since I won my wings! This place will change the world. After 30 years of work, we may have discovered the basis of a system to protect the *Rodina* against enemy missiles."

Bondarenko thought that was an overstatement. Pokryshkin was the perfect man for this job, however. The former fighter pilot was a genius at directing the

efforts of the scientists and engineers, many

of whom had egos as large as a battle tank, though far more fragile. When he had to bully, he bullied. When he had to cajole, he cajoled. He was by turns the father, uncle and brother to all of them. It took a man with a large Russian heart to do that. The colonel guessed that commanding fighter pilots had been good training for this task, and Pokryshkin must have been a brilliant regimental commander. The balance between pressure and encouragement was so hard to strike, but this man managed it as easily as breathing. Bondarenko was watching very closely how he did it. There were lessons here that he could



use in his own career.

THE CONTROL ROOM was separated from the laser building itself. Everywhere were digital counters. Most showed the time. Other counters showed the precise coordinates of the target's satellite, Cosmo-1810, which bore the international satellite designator 1986-102A. It had been launched from the Cosmodrome at Tyuratam on December 26, 1986, and was still up because it had failed to de-orbit with its film. Telemetry showed that its electrical systems were still functioning, though its orbit was slowly decaying, with a current perigee—the lowest point in its orbit—of 180 kilometers. It was now approaching perigee, directly over Bright Star.

"Powering up!" the chief engineer called over the intercom headsets. "Final system check."

"Tracking cameras on line," one technician reported. The wall speakers filled the room with his voice. "Cryogen flows nominal."

"Mirror tracking controls in automatic mode," reported the engineer sitting next to Morozov. The young engineer was on the edge of his swivel chair, eyes locked to a television screen that was as yet blank.

"Computer sequencing in automatic," a third said.

Bondarenko sipped at his tea, trying and failing to calm himself. He'd always wanted to be present for a space-rocket launch, but never been able to arrange it. This was

THE CARDINAL OF THE KREMLIN

the same sort of thing. The excitement was overpowering. All around him machines and men were uniting into a single entity to make something happen as one after another announced the readiness of himself and his equipment. Finally: "All laser systems are fully powered and on-line."

"We are ready to shoot," the chief engineer concluded the litany. All eyes turned to the right side of the building, where the team on the tracking cameras had their instruments trained on a section of the horizon to the northwest. A white dot appeared, coming upward into the black dome of the night sky . . . "Target acquisition!"

Next to Morozov, the engineer lifted his hands from the control panel to ensure that he wouldn't inadvertently touch a button. The "automatic" light was blinking.

Two hundred meters away, the six mirrors arrayed around the laser building twisted and turned together, coming almost vertical with the ground as they tracked after a target sitting just above the jagged, mountainous horizon. On the next knoll over, the four mirrors of the imaging array did the same. Outside, alarm klaxons sounded, and rotating hazard lights warned everyone in the open to turn away from the laser building.

On the TV screen next to the chief engineer's console sat a photograph of Cosmos-1810. As the final assurance against mistakes, he and three others had to make positive visual identification of their target.

THAT ONE'S Cosmos 1810," the captain was telling the colonel aboard Cobra Belle. "Broken recon bird. Must have had a reentry-motor failure, it didn't come back down when they told it to. It's in degenerating orbit, should have about four more months left. The satellite's still sending out routine data. Nothing important, far as we can tell, just telling Ivan that it's still up there."

"The solar panels must still be working," the colonel observed. "The heat came from internal power."

"Yeah, I wonder why they didn't just turn it off . . . Anyway, the on-board temperature reads out at, oh, 15° C or so. Nice cold background to read it against. In sunlight, we might not have been able to pick out the difference between on-board and solar heating . . ."

The mirrors in the laser-transmitter array tracked slowly, but the movement was discernible on the six television screens that monitored them. A low-power laser reflected off one mirror, reaching out to find the target. In addition to aiming the whole system, it made a high-resolution image on the command console. The identity of the target was now confirmed. The chief engineer turned the key that "enabled" the entire system. Bright Star was controlled wholly by the site's main computer complex.

"There's target lock," Morozov observed to his senior. The engineer nodded agreement. His range readout was rapidly dropping as the satellite came toward them, circling its way to destruction at 18,000 mph. The image they had was of a slightly oblong blob, white with internal heat against a sky devoid of warmth. It was exactly in the center of the targeting reticle, like a white oval in a gunsight.

They didn't hear anything, of course. The laser building was fully insulated against temperature and sound. Nor did they see anything on ground level, but watching the television screens in the control building, 100 men balled hands into fists at the same instant.

"What the hell!" the captain aboard the AOA exclaimed. The image of Cosmos-1810 suddenly went as bright as the Sun. The computer adjusted its sensitivity, but for several seconds failed to keep pace with the change in the target's temperature.

"What in hell . . . sir, that can't be internal heat." The captain punched up command on his keyboard and got a digital of the satellite's apparent temperature. Infrared radiation is a fourth-power function. The heat given off by an object is the *square of the square* of its temperature.

"Sir, the target temperature went from 15° C to . . . looks like 1800° C in under 2 seconds. Still climbing . . . wait, it's dropping—no, its climbing again. Rate of rise is irregular, almost like . . . Now it's dropping. What in the hell was that?"

To his left, the colonel started punching buttons on his communications console, activating an encrypted satellite radio link to Cheyenne Mountain. When he spoke, it was in the matter-of-fact tone that professional soldiers save for only the worst of nightmares. He knew exactly what he'd just seen.

"Crystal Palace, this is Cobra Belle. Stand by to copy a Superflash message."

"Standing by."

"We have a high-energy event. I say again, we are tracking a high-energy event. Cobra Belle declares a Dropshot. Acknowledge." He turned to the captain, and his face was pale.

At NORAD headquarters, the senior watch officer had quickly to check his memory to remember what a Dropshot was. Two seconds later, a "Jesus" was spoken into his headset. Then: "Cobra Belle, we acknowledge your Dropshot. Stand by while we get moving here. Jesus," he said again, and turned to his deputy. "Transmit a Dropshot Alert to the NMCC and tell them to stand by for hard data."

The watch officer next lifted a phone and punched the code for his ultimate boss, Commander in Chief of North American Aerospace Defense Command.

"General, this is Col. Henriksen. Cobra Belle has declared a Dropshot Alert. They say they have just seen a high-energy event."

"Have you informed NMCC?"

"Yes, sir, and we're calling Doug Welch in also."

"Do you have their data yet?"

"It'll be ready when you get here."

"Very well, colonel. I'm on the way. Get a bird up to Shemya to fly that Army guy down."

THE COLONEL ABOARD Cobra Belle was now talking to his communications officer, ordering him to send everything they had via digital link to NORAD and Sunnyvale. This was accomplished in under 5 minutes. Next the mission commander told the flight crew to return to Shemya. They still had enough fuel for two more hours of patrolling, but he figured that nothing else would be happening tonight. What had taken place to this point was enough. The colonel had just had the privilege to witness something that few men in human history ever saw. He had just seen the world change, and unlike most men, he understood the significance of it. It was an honor, he told himself, that he would just as soon have never seen.

"Captain, they got there first."

Dear God.

FM

AMERICAN POSH

(Continued from page 57)

Eagle GT+4 tires, the new all-weather variant of the more performance-oriented GT. The Olds generated the best skidpad number with this rubber, while the Buick took the slalom title, but all three GM entries showed better adhesion than either the Lincoln or the Chrysler.

Discounting the difference in acceleration times between 98 and Electra as an aberration, we'd be inclined to give a tiny edge to the Olds on the strength of its excellent 6-way power bucket seats, which were unequivocally the best in this group. We also favor the Oldsmobile's more legible analog instrumentation.

Like its GM siblings, the Oldsmobile's exterior treatment is tastefully subdued, though there's a little more brightwork here than on the Electra T Type. Cross-laced alloy wheels and a modest front air dam help distinguish the Touring Sedan from the other 98s, as do color availabilities. Our test car was done up in a platinum metallic that made it all but invisible, a quality that will undoubtedly be appreciated by drivers who cover substantial distances in short time.

If there was any inconsistent note to the Touring Sedan's exterior, it was the two small cornering lights mounted below the front bumper. Instead of being faired into the air dam, they simply jut down below the bumper, looking very much like an afterthought, a note that's inconsistent with the rest of this car's tastefully executed trim.

Conclusion

As we suggested, there are several ways to indulge yourself here. The Lincoln Continental is clearly a harbinger of things to come, the Cadillac, Buick and Oldsmobile have all brought a new level of athleticism to this once-turgid class and the New Yorker maintains a solid link with the roots of tradition.

If we had to pick one of these cars for all-around driving, it would probably be the Olds or the Buick, though the Continental would be a serious contender with 35 or 40 more hp.

The New Yorker's plush, traditional living-room ride normally makes sporting drivers cringe. It also makes it a bit more difficult to pull off an emergency maneuver cleanly. Some prefer it, however, and the Mitsubishi V6 makes the going very smooth indeed.

However, whatever the choice, we liked the promise implicit in this comparison: The American luxury car is not dead.

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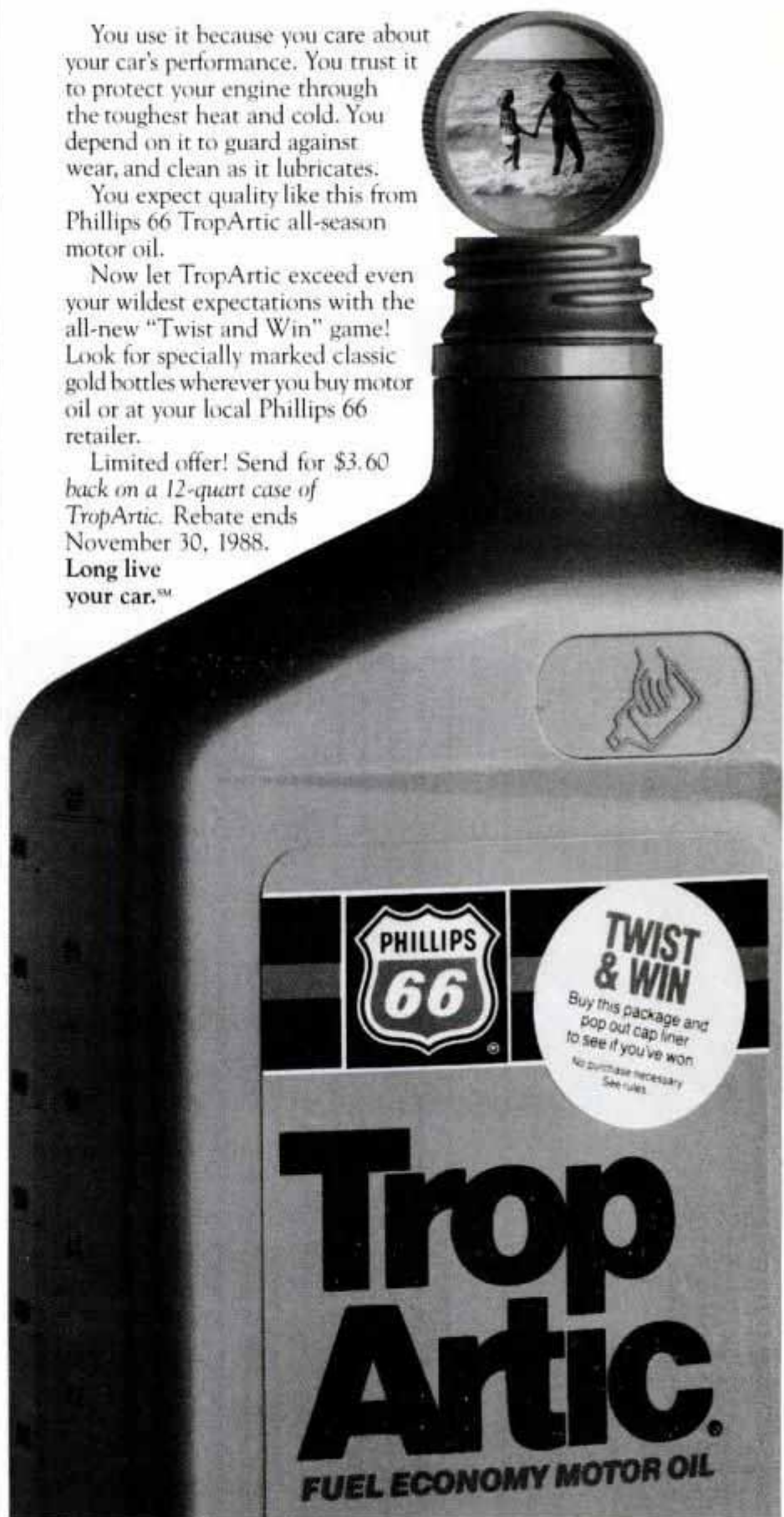
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PRETTY PATIO

(Continued from page 92)

ties. These measure $3\frac{1}{2} \times 4\frac{1}{2}$ in. and are rounded on the corners to look more like logs.

Except for the difference in the shape of the logs (and the overall shape of the planters) the construction procedures are the same as the tiered planter: Be sure to level your base ties in place carefully, backfill around the bottom ties, and then cut and nail the remaining courses in place.

Because many of the ties require an angle cut at the diagonal ends, it's a good idea to cut these timbers a little oversize, and then put them in place and scribe the proper angle before you make the finished cut. When the corner planters are complete, it's time to build the steps.

Steps

The system for building these steps is very straightforward, especially if you are placing them between the corner planters as we did. However, the drawing does show an optional method if you want to build only the steps and not the planters.

Begin your layout and excavation as explained earlier. Next drill three holes in the edge of the slab as shown using a $\frac{1}{2}$ -in.-dia. masonry bit and a portable drill. Make the holes about 2 in. deep and insert a lead anchor into each hole. Then cut the back timber of the top step to length and bore and counterbore bolt clearance holes to match the location of the anchors in the slab. Attach this timber with lag-screws as shown.

Once the first timber is attached, use it as a reference point for determining the exact depth of the bottom step. The section view on the drawing shows this clearly.

Next, cut the rest of the step timbers to length and bolt them together in pairs, as shown.

Make sure you excavate deep enough to accommodate the gravel and sand base that is required under each step.

Then level the bottom step in place, backfill it with gravel and sand, level the second step in place, backfill again and finish off by bolting the outside timber of the top step to the back timber already attached to the slab.

Stabilize the steps by driving 12-in. spikes through the inside of the corner planters into the ends of the step timbers.

If you'd rather use the alternate step method, just study the drawing carefully and build the steps in much the same way that the tiered planter was constructed.

PM



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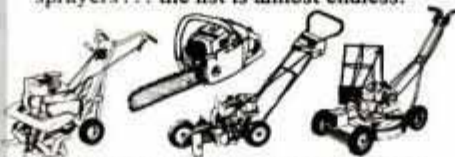
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CATASTROPHE!

(Continued from page 60)

During the past 25 years the "why" has changed. Earlier airplane structures were often victims of general corrosion, sometimes caused by grease leaks, hydraulic fluid leaks, or even faults in the lavatory drainage system. But such problems have been generally engineered out. "What we see now are stress corrosion problems, maybe because a particular component was not heat-treated properly," says Meyer.

The aluminum alloys used in today's aircraft contain quantities of copper, magnesium and zinc that not only increase the strength of the structure, but also the tendency for corrosion to occur. Today's major defenses are improved epoxy or polysulfide primers and a polysulfide sealant to fill in joints.

Construction of an aircraft surface is an intricate procedure that must be conducted with extreme care to prevent corrosion. A typical aluminum panel, once machined, may have to be oiled, deburred, hot-formed, cleaned, anodized and sealed, among other things. Any irregularities in the process could result in disaster later on. The increased use of composites also calls for some concern.

"When you couple graphite epoxy with an aluminum airframe and steel fasteners you have a great potential for corrosion," Meyer says. "Drill a hole and you might leave a residue of graphite fibers sitting against aluminum. Moisten it and you've got a galvanic cell."

Big bangs

Over the years Harry McHenry, Ph.D., of the Boulder, Colorado-based Fracture and Deformation Division of NBS, has studied many well-known incidents of structural failure, such as suspected defects in the Alaska Oil Pipeline and the tragic 1981 collapse of the overhead walkway in Kansas City's Hyatt Regency Hotel, which killed 113 people. Most recently he investigated the July 1984 explosion of a tank at the Union Oil Company's Chicago refinery.

The 60-ft.-high tank, with a diameter of 8½ ft., held more than 20 tons of two counter-flowing liquids: One was a propane-rich process stream and the other was an aqueous solution of monoethanol amine used to absorb hydrogen sulfide from the process stream. Internal pressure of 200 psi was held in check by 1-in.-thick steel-plate walls.

The tank conformed to all applicable specifications, yet it suddenly exploded. The top 40 ft. of the tank lifted

off like a rocket, landed more than half a mile away, and dug a 12-ft. × 20-ft. crater. The explosion and its associated fire left 17 dead and 17 injured, and caused more than \$100 million in damages.

Debris was shipped to McHenry's lab in Boulder, where a lengthy investigation revealed that the tank's steel walls had gradually become more brittle as a result of exposure to hydrogen sulfide. Cracks occurred, with the worst located at the heat-affected zones near repair welds. One of the cracks had penetrated 90 percent of the way through the skin.

The most sobering part of McHenry's findings was this conclusion:

"There are hundreds of similar amine-stripping facilities in operation all over the industrialized world."

Awareness is the solution

Our technological society requires much of metals, and they generally perform so well that we have a tendency to expect them to maintain their specifications. Over time, we grow careless, and we may not pay sufficient attention to the demands placed upon building materials. "This is a significant problem that will likely rear its head from time to time," warns Dr. McHenry.

What can we do about it?

First and foremost, we must plan for failure. Engineers need to design adequate fail-safe mechanisms, so that when metal does wear out, its effects will not be catastrophic. For example, a chemical storage tank can be designed so that it will leak—conspicuously—long before it explodes.

Second, the assembly-line worker must keep in mind the importance of even the most mundane task. Remember the case of the worker who, sometime in 1968, inadvertently put a tiny gouge in a lockbolt fastener hole near the rear of the fuselage of a Douglas DC-9. Eleven years and 26,816 flights later, the tail assembly fell off of the aircraft over Boston, as a direct result of the minor manufacturing slip-up.

Third, the nation must demand more adequate inspection procedures. In recent years, budget-cutting has severely taxed the abilities of inspectors, with sometimes tragic results. Inspectors are human, too, and daily routine sometimes dulls their effectiveness.

In the case of the above-mentioned DC-9, fatigue cracks were clearly visible in X-rays taken six months prior to the failure.

In sum, we must somehow increase our sensitivity to the improbable—and brace for what may increasingly become the inevitable. **PM**

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SMOOTH OPERATORS

(Continued from page 87)

gone a little overboard with the easy-to-use switch idea. The sander actually turned itself on several times as the paper was being installed. While the instruction manual reminds us to have the unit unplugged when changing the paper, we felt that the sliding switch was simply too loose.

This machine is a fast sander, but displays the handling problems that plague some of the other quick-cutting models. The Sears also ranks as one of the noisier machines.

Like the Black & Decker 7443, this unit would be fine for occasional use where speed is a priority. Its all-ball-bearing construction and slightly better handling characteristics, however, give it the edge.

Skil 7565

The Skil 7565 bears an uncanny resemblance to the Milwaukee unit in both appearance and specifications. It has the same flexible, straight cord and easy-to-use rocker-type switch. Its noise and vibration level are about average and it performed well during our speed trials. However, when pressed to the limit, the Skil unit stalls more easily than the Milwaukee. On the other hand, the Skil seems slightly easier to handle.

The only real difference in outward appearance is the detail of the housing. Unfortunately, Skil's version features a vent configuration that makes it more uncomfortable to hold.

The sander for you

After weighing the pros and cons of each machine and selecting the one that seems to suit your requirements best, you'll probably be interested in the dent it will make in your bank account. Keep in mind that the retail power tool market is very competitive. It pays to check out several distributors and catalog tool dealers to find the best price.

If you're interested in a machine with solid, smooth performance and all the earmarks of heavy-duty quality and reliability, then the Porter-Cable and Hitachi followed closely by the Ryobi S-600, are good candidates. However, if sheer cutting speed is your priority, and vibration and noise are of no concern, look closer at the B & D 7443 and Sears sanders.

The Milwaukee, Skil and Makita sanders all appeared to be well-constructed tools. However, Milwaukee's common-sense approach to its warranty is certainly a bonus—you'll be covered regardless of how long you own the tool.

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

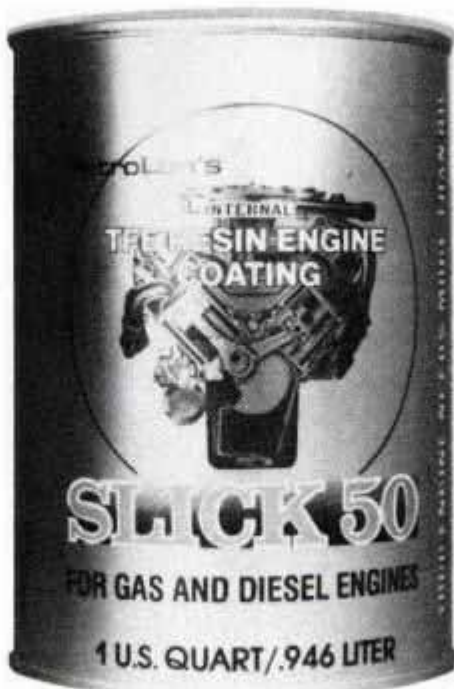
TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

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

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

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

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



It's Easy to Treat Your Engine

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

Only One Treatment Necessary

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

Works with Most Oils

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

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine.
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund—no questions asked.

Profit from Selling Slick 50 Yourself

Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

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Owners Report

Chrysler LeBaron

BY MICHAEL LAMM, Contributing Editor
PM Photos by Humphrey Sutton

LEE IACOCCA'S not kidding. Judging from recent Owners Reports, Detroit has truly turned the corner on quality. Chrysler and the other two major American carmakers need no longer make excuses. That's how it looks from the vantage point of comparing new and older Owners Reports.

As evidence, take the current Chrysler LeBaron in its sedan, wagon and coupe body styles (the convertible hadn't been introduced when we mailed our questionnaires). We asked owners to rate LeBaron workmanship, and 94.4 percent unflinchingly scored this aspect of their cars *good to excellent*. That's just a touch below

such consistent world quality leaders as Toyota and Mercedes.

These statistics show an encouragingly consistent satisfaction with quality among buyers of recent American automobiles—a satisfaction that didn't exist a few years ago.

Regarding the LeBaron specifically, a Michigan accountant called "Quality much improved from five years ago." A Wisconsin plant manager told us, "No paint blemishes or spots. Everything functions the way it should." Very few owners found fault with the way their LeBarons were put together. A Florida retiree pointed out, "The 7-year warranty plus eight years of K-Car road experi-

ence . . . I figured Chrysler had time to work out all the bugs!"

Chrysler's 7-year/70,000-mile warranty prompted 10.3 percent of our respondents to buy their LeBarons and was a powerful influence on nearly all other purchasers.

Most LeBaron owners expressed total satisfaction with warranty service, typified by the experience of a New York quality assurance analyst: "My car had a noisy exhaust where the manifold joins the header pipe. The shop took me in right away and gave me a loaner for the day at no charge so they could replace the gasket. This exhaust noise apparently

(Please turn to page 111)



Styling and appointments of LeBaron Coupe pleased most owners.



Chrysler 2.2 turbo was potent enough for 88 percent of respondents.

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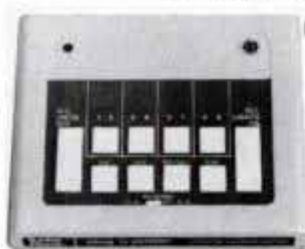
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These are the same sports optics currently being nationally advertised by us in leading media throughout America. **GFX DIMENSION-4 AMBER OPTICS** are as different from ordinary sunglasses as a Concorde Super-Jet is from a World War I Curtiss "Jenny"! Exciting scientific optical technology permits you to see and distinguish objects more clearly, sharply and distinctly than ever before—even through fog, haze and mist. This same startling development also gives your eyes needed protection from potentially harmful sun rays.

We've named these remarkably different sports optics **DIMENSION-4 AMBER OPTICS** because they seem to extend vision within the accepted three dimensions of height, width and depth. While ultra-violet rays are long known to be hazardous to eyes, optical scientists today have become increasingly concerned about effects of "blue light" rays. **DIMENSION-4 AMBER OPTICS'** UV/blue ray filtration blocks out BOTH types of potentially harmful rays. (Incidentally, many conventional "sunglasses" expose the eyes to more of these dangerous rays by forcing the pupils to open wider to overcome reduced light transmission.)

MAKES YOU SEE CLEARER, SHARPER, MORE DISTINCTLY

Blue light has been likened to radio-TV sound interference and has been referred to as visual "noise". Particles of dust and

moisture in the atmosphere diffuse this blue light, interfering with the eye's ability to perceive objects clearly, especially at distances.

In much the same way as an electronic filter blocks out unwanted interference that distorts and blurs voices and music (and shows up as "snow" on TV screens) **DIMENSION-4 AMBER OPTICS** block out this visual "noise". So, the green and red portions of the light spectrum focus clearer and sharper on the eye's retina. Distant objects previously blurred by particles in the air come more clearly into view. *Everything appears more distinctly clear and better defined.*

Drivers see road signs, hazards more clearly in haze, fog and mist. Tennis players see balls in bright sun more sharply defined. Skiers, on cloudy days, can better judge moguls, steepness of downhill runs. Golfers can more accurately determine distance to the pin, "lies" of greens. Boaters can sight other craft, buoys easier in overcast weather.

DIMENSION-4 AMBER OPTICS will *not* be sold at this or any price by the company in any store. There is a limit of two (2) pair per address, but if you order early enough (before Sept. 25) you may request up to five pair. Each pair is covered by the company's full one-year money-back guarantee.

To order: Mail your name and address (on a sheet of paper) and \$5 for each pair of **DIMENSION-4 AMBER OPTICS**. Add only \$2 shipping regardless of the size of your order. (New York residents add sales tax.) Allow up to 6-8 weeks for shipment. **IMPORTANT:** specify regular style (Item R54260) or "clip-on" style for eyeglass wearers (Item R54262). **One size fits all. Make check payable to RBM Ltd. Mail to: RBM, DIMENSION-4, Dept. 114-122, Box 1784, Hicksville, N.Y. 11855. (R54271)**

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LeBARON OWNERS REPORT

(Continued from page 108)

plagues many Chrysler vehicles." It does, and Chrysler has instituted an assembly-line fix.

The only grumble we heard about the 7/70 warranty was from owners who weren't given loaners. Only 25.7

percent, however, required repairs of any type—a low figure in relation to other makes we've surveyed.

While 12 percent of our respondents suggested making a more powerful engine available—either a V6 or a turbocharged version of the 2.5-liter Four—most were pleased by their cars' combination of performance and

fuel economy. A Tennessee jewelry supervisor wrote, "Even though I'm a grandmother, I love a good, fast car, and this LeBaron premium coupe will flat-out run! It also gets excellent gas mileage—25/27 mpg—so I haven't been disappointed in any way."

Styling attracted the majority of

(Please turn to page 112)

SUMMARY OF CHRYSLER LeBARON OWNERS REPORTS*

Total miles driven	1,098,420	Chrysler LeBaron?		Workmanship opinion:		No	21.2
Average miles per gallon:		Styling	58.1%	Excellent	48.7%	Dealer service opinion:	
2.2-liter Four		Past experience	22.6	Good	45.7	Excellent	30.3%
In town	23.7	Price/value	16.7	Average	3.8	Good	54.2
On the highway	29.3	Handling	11.5	Poor	1.7	Average	9.0
2.5-liter Four		Comfort	10.7	Comfort opinion:		Poor	6.5
In town	22.4	7/70 warranty	10.3	Front seats:		Number of vehicles owned:	
On the highway	28.6	Specific likes:		Excellent	57.5%	This car only	43.7%
Turbocharged 2.2-liter Four		Styling	64.1%	Good	37.7	Two cars	35.2
In town	20.8	Comfort	39.1	Average	4.0	Three cars	13.0
On the highway	26.2	Handling	36.8	Poor	0.8	Four or more cars	8.1
Body-style choices:		Economy	25.9	Rear seats:		Makes of other cars owned:	
4-door sedan	58.7%	Riding qualities	20.9	Excellent	24.0%	Ford	24.5%
2-door coupe	38.1	Specific dislikes:		Good	53.3	Chevrolet	17.3
4-door station wagon	3.2	No complaints	12.6%	Average	18.3	Chrysler	15.8
Engine choices:		Noises and rattles	9.3	Poor	4.4	Dodge	14.4
Turbocharged 2.2-liter Four	38.7%	Harsh ride	8.7	Had any mechanical trouble?		Plymouth	12.9
Nonturbo 2.2-liter Four	37.9	Lack of power	8.7	No	74.3%	Would you buy a LeBaron again?	
Nonturbo 2.5-liter Four	23.5	Lack of rear-seat legroom	7.7	Yes	25.7	Yes	56.7%
Transaxle choices:		What changes would you like?		What type of trouble?		Maybe	34.7
3-speed automatic	97.5%	No changes	28.1%	Air conditioning	16.1%	No	8.6
5-speed manual	2.5	More powerful engine	12.0	Electrical	14.5	Would you buy Chrysler again?	
Option choices:		Fewer noises and rattles	7.5	Exhaust system	8.1	Yes	65.1%
Air conditioning	94.0%	Smother ride	6.5	Transmission	8.1	No	18.3
Sport/handling suspension	24.8	More comfortable seats	6.5	Did you repair it yourself?		No	16.6
Mark Cross trim	18.4	How much did you pay?		No	98.4%	Age distribution of owners:	
Leather upholstery	12.4	Average	\$13,856	Yes	1.6	Under 29 years	7.1%
Sunroof	1.6	Range	\$10,000-\$18,000	Dealer repairs satisfactory?		30-49	36.1
Why did you choose the				Yes	78.8%	50-plus	56.8

*Percentages might not equal 100% due to rounding or an insufficient amount of data.

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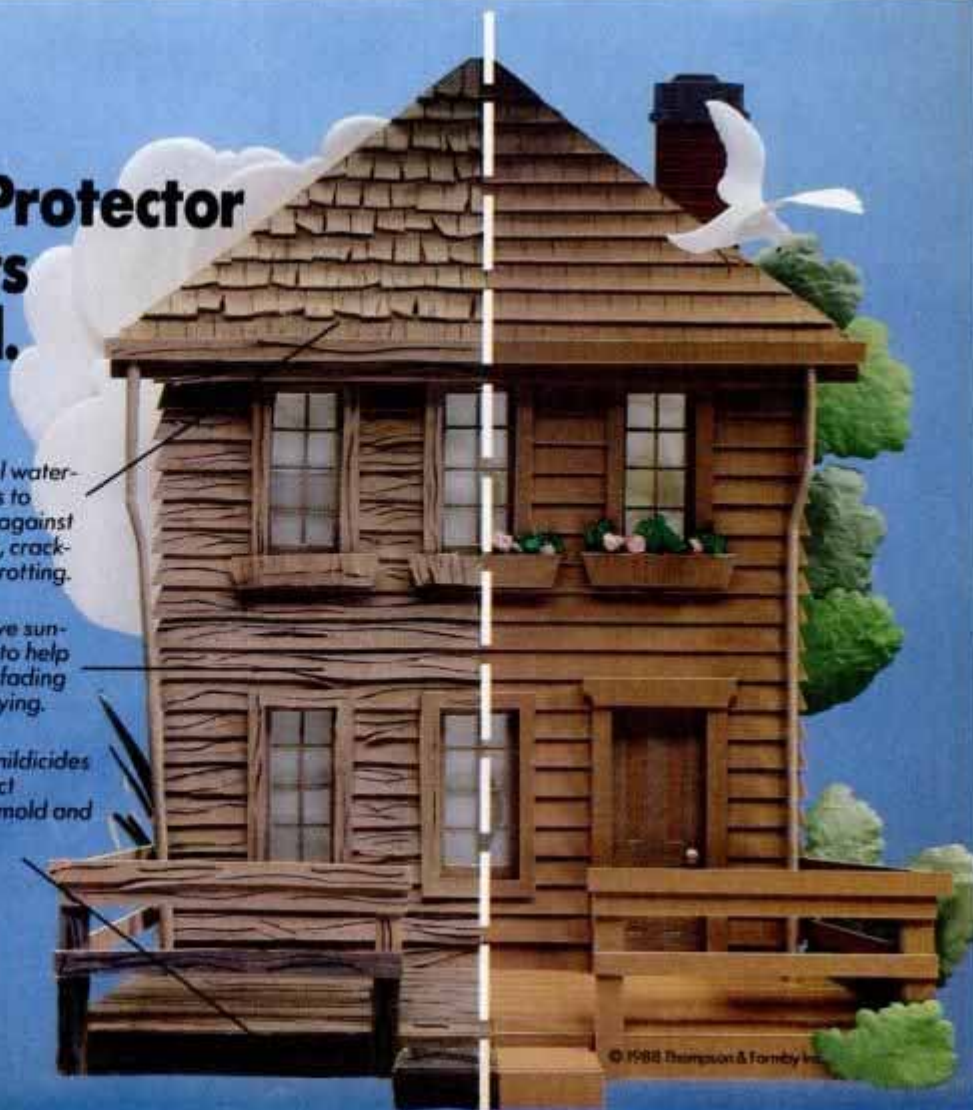
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15-H-8

LeBARON OWNERS REPORT

(Continued from page 111)

buyers initially, especially to the LeBaron coupe but also to the sedan and wagon. Regarding the coupe, a Michigan teacher's aide proclaimed, "It's sporty yet very luxurious."

Nearly a quarter of all LeBaron buyers had owned Chryslers before. Previous ownership became the second strongest reason for buying. A New York subscriber relations manager remarked, "I previously owned a LeBaron GTS sedan and was very happy with it. When the new coupes came out, I was impressed with their styling and amenities."

As to comfort, a Texas banker said, "We took a 3300-mile road trip and found the coupe extremely comfortable." Some owners, though, felt a little cramped. "Like all small cars," said an Illinois crane operator, "this coupe could use a little more legroom in the back seat." Nor was that opinion heard only for the coupe—sedan owners felt the same way.

The LeBaron's optional sport suspension came in for mixed reviews. An Ohio physician felt: "Slightly stiff ride. Car feels bumpy over rough roads, but it handles very well, especially in bad weather."

A Texas attorney, who hadn't ordered the sport suspension for his sedan, mentioned, "The standard shocks weren't stiff enough, so I replaced them immediately with the heavy-duty type and added new front and rear stabilizer bars. Now it's an exceptional-handling little car."

Among minor gripes for the LeBaron, taller drivers complained about their knees touching window and hazard switches at odd times. Doors with only one detent—in the full-open position—also caused some consternation. A Nebraska diesel mechanic pointed out that, "The oil filter, which stands high on the engine, causes a mess each time I change it."

Dealers fared well in our survey, with buyers expressing satisfaction in the areas of both sales and service. A Kentucky supervisor told us, "If I were in the car business, this is the caliber of salespeople I would want. They're young and dynamic." A Texas college professor: "Impressed with the salesman. He was, and has continued to be, most helpful." Yet a credit manager from Michigan disagreed. "I felt that, because I'm a woman, they treated me like I was dumb. When my husband came in after I'd chosen the car, the dealer acted like I wasn't even there! Yet I'm the person who makes the car payments."

Summing up, an Illinois meeting
(Please turn to page 115)



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LeBARON OWNERS REPORT

(Continued from page 112)

planner had this to say: "If I could design a car from scratch, I couldn't do better than my LeBaron. It's a wonderful car." And a Florida telephone supervisor: "Without sounding as if I own stock in Chrysler, may I say that I love this car. It's perfect. I've never had it so good!" **PM**

PM Perspective

I'D LIKE to have a LeBaron—specifically, a LeBaron convertible—just to leave parked in front of my house. The LeBaron tanning machine gets the most sweived heads per mile of any domestic. Its timeless elegance makes you want to dress up and go out to dinner just so you can impress the kids in the valet lot.

A lot of our respondents, almost two thirds, chose the LeBaron for its styling. Small wonder.

However, one survey number strikes me as odd—fully 40 percent of LeBaron Coupe buyers are over 60, which I find astounding. Older buyers are supposed to want 6-seaters with tall, formal-roofline pilothouses, not zippy little 2+2s with bucket seats and a Jell-O-mold body. Go figure.

Nearly one buyer in eight (11.5 percent), listed handling as one of the reasons for choosing LeBaron. With its dated K-car chassis parts, I'd classify the handling as not much better than "adequate." Maybe the good looks led me to expect more, but suspension bits intended for a bottom-line family sedan of a decade ago aren't doing the job the LeBaron deserves. It seems less refined than other personal coupes, with a rubbery feeling in the steering and a tendency to bottom out over big dips.

On the other hand, the LeBarons are price competitive, particularly the Coupe, which undercuts the Ford T-Bird and the new GM-10s (Pontiac Grand Prix, Olds Cutlass Supreme, Buick Regal) by a couple thousand bucks. And the '88s we've driven have improved somewhat in the handling department.

Also, Chrysler has made significant improvements in noise isolation and harshness, with upgraded sound barriers and more insulation, addressing one of the problem areas identified in our survey. The convertible remains as noisy as any ragtop, but seems to avoid the "hinge-in-the-middle" sensation that's a problem with other topless cars.

I vote with the fellow who uprated his suspension. He's got a great car. Other LeBaron owners have only got a good one.—Mike Allen

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How To Choose A WATER FILTER

BY LEE GREEN; PM Illustrations by George Retseck



1 One of the most common types of filters uses a replaceable activated-charcoal cartridge (inset). This unit mounts to spout and can be bypassed when filtered water is unnecessary.

WATER has long been a symbol of cleanliness, purity and health. But, today's modern world of technology has changed this. The practice of dumping industrial wastes into convenient nearby streams is probably as old as industry itself. Until the last century, though, there just wasn't enough industry to have a noticeable effect on the quality of the nation's water. Over time, increased industrialization and a boom in population combined to challenge

the assumption that there was plenty of good water for everyone.

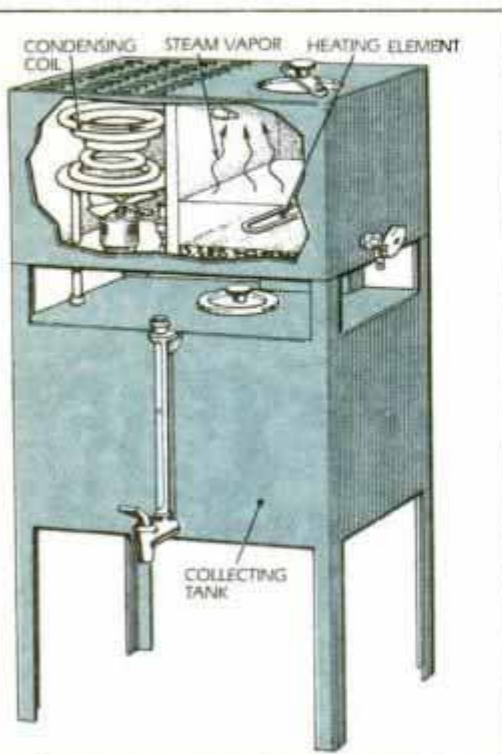
A recent EPA study found that 30 percent of the water systems serving communities with populations of 10,000 or more, were contaminated with industrial chemicals. A Cornell University study concluded that 66 percent of the households that were researched had substandard water.

The solution? Ultimately, the problem must be dealt with at the source by joint efforts of government and industry. Many homeowners, however, are not prepared to wait and are di-

recting their attention to immediate ways for treating the water in their homes. This is a complex task. The scope of the problem demands a variety of filtering systems—each suited for specific contaminants.

The pollutants

To date, over 70,000 different water contaminants have been identified. These contaminants can be divided into five general classes: biological impurities (largely bacteria, but may include viruses and other microscopic parasites), dissolved organic com-



2 Distillation condenses clean water vapor and leaves impurities behind. Storage tank collects water to be gravity fed.

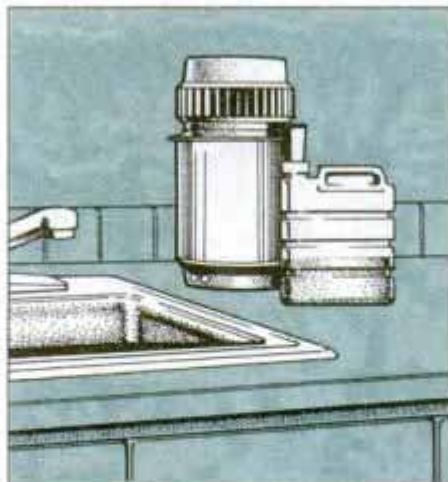
pounds (including PCBs and other halogenated compounds), heavy metal salts (such as lead and mercury), dissolved gasses (primarily radon, which usually only appears in private wells) and suspended solid particles (such as asbestos fibers).

One obvious solution for clean drinking water, is to buy bottled water. However, bottled water typically costs about 70 cents per gallon. And, it's certainly not as convenient as drawing water from your kitchen tap. Treating your own water is not only cheaper, but offers you the assurance that the job is being done properly.

Any attempt to treat a water supply must begin with an investigation into what contaminants are actually present. (See Information Source List on page 120 for information on water testing). Choosing a water treatment system designed to remove bacterial contamination, for instance, would be useless and unnecessary if your water is bacteria free but contains other industrial wastes. (See chart, right.)

Basic treatments

Perhaps the simplest filtering system is one that screens out suspended particles in the water such as asbestos. Sediment filters are graded as to the



3 Smaller capacity distillation units are available for countertop use. One to 1½ gallons can be produced in about 7 hours.

size of particle they will allow through and can range from 5 to 25 microns. Many filtering systems use a sediment filter as a prefilter to remove large particles that may damage another part of the system.

Chemical treatment for eliminating bacteria, such as the addition of chlorine, is usually performed at the municipal water supply.

The most recent water-pollution problem to hit the headlines is radon—a naturally occurring radioactive gas that is soluble in water. When

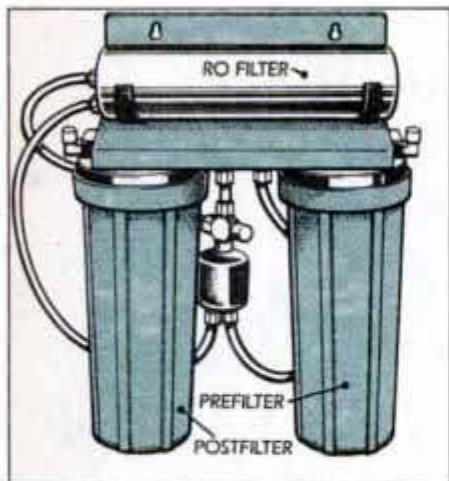


4 Countertop charcoal filters are connected to cold-water pipe. Replace elements as recommended by manufacturer.

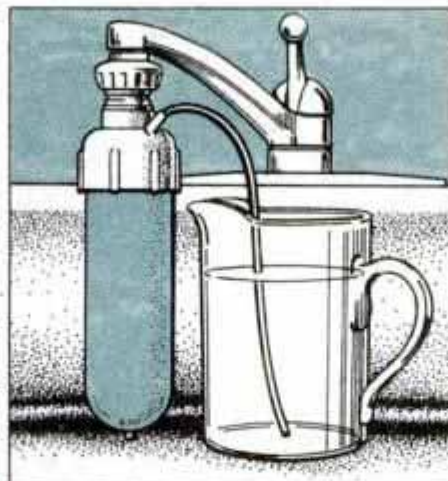
water containing radon leaves the tap or shower head, the radon dissipates into the air creating an unexpected air pollution problem. For this reason, treating for radon contamination means not only treating the drinking water, but treating the entire water supply for the home. One way of dealing with water containing radon is through outdoor-mounted aerators that allow the radon to dissipate harmlessly into the atmosphere. Radon contamination, like bacteria, is handled at the municipal level.

Water Treatment Chart*	Reverse-osmosis	Distillation	UV radiation	Activated charcoal	Ion-exchange	Aeration	Sediment filter	Chemical treatment
	Bacteria ¹			●				
Lead	●	●						
Mercury	●	●						
Arsenic	●	●						
Nitrates/Nitrites	●	●						
Sodium (salt)	●	●						
Organic chemicals	●			●				
Pesticides	●			●				
Radon				●		●		
Hard water					●			
Iron					●	● ²		●
Odor				●		●		
Asbestos							●	
Cloudiness							●	

* Chart lists some common contaminants and methods of treatment.
 1. Activated-charcoal adsorption may be required after UV or chemical treatment.
 2. Ion-exchange plus aeration.



5 Combination RO unit features a charcoal postfilter and sediment prefilter in separate canisters for simplified servicing.



6 Small tap-mounted RO filter can be used at home or on the road. It's capable of producing up to 12 gallons of water per day.

Charcoal filters

The most common type of water treatment uses an activated-charcoal filter to remove such contaminants as pesticides and organic chemicals, or to eliminate odors.

Activated-charcoal filters are also effective in removing radon and other dissolved gasses.

Activated-charcoal has the ability to *adsorb*, or bond strongly to, the impurities rather than simply absorbing them like a sponge.

After a period of time, a charcoal element will become loaded with contaminants and must be changed.

Because most contaminants can't be easily perceived in the water, you'll have to set up a schedule for filter replacement to ensure that your water is always clean. Base this on the manufacturer's instructions. Some units are equipped with automatic metering devices that gauge the amount of water that has passed through the filter.

Charcoal filters are not effective against biological contaminants. In fact, these units can act as incubators for bacteria when left unused. Because of this, it's a good idea to let the water run through a charcoal filter for a few minutes after a long weekend or vacation.

Activated-charcoal filters come in a variety of sizes ranging from those that connect directly to the tap (Fig. 1), to those that are connected to the pipes that supply drinking water (Figs. 4 and 8). Prices can range from about \$25 for the smaller units to \$300 for large-capacity in-line models. The large units generally require less frequent filter changes.

Distillation systems

Traditionally, one of the most reliable methods for removing impurities in water is distillation. First, an electric heating element boils the water. Then, the steam is condensed and collected in a storage tank (Fig 2.). Metal salts and suspended solids don't vaporize and are removed. However, the distillation process will also remove desirable additions to the water such as fluoride. Distillation units give mixed results with dissolved organic compounds. Chemicals with high boiling points may be left behind when the water vaporizes, but others may boil off with the water and remain in the condensed product.

Distillation is a slow process that consumes considerable energy. A typical home-sized unit with a storage capacity of 3 to 25 gallons can take 2 to 3 hours to produce a gallon of distilled water. Small countertop models collect distilled water in a separate container and can take 7 hours to produce a gallon (Fig. 3). The cost to produce a gallon of distilled water can range from about 20 to 30 cents.

These units are independent of the house plumbing and are generally placed where the water is needed. Because the water is not under pressure, the unit must be high enough for convenient gravity-fed operation. Water stored for an extended length of time can become recontaminated with airborne bacteria. If the still's out of use for a while, drain and clean the storage tank before using.

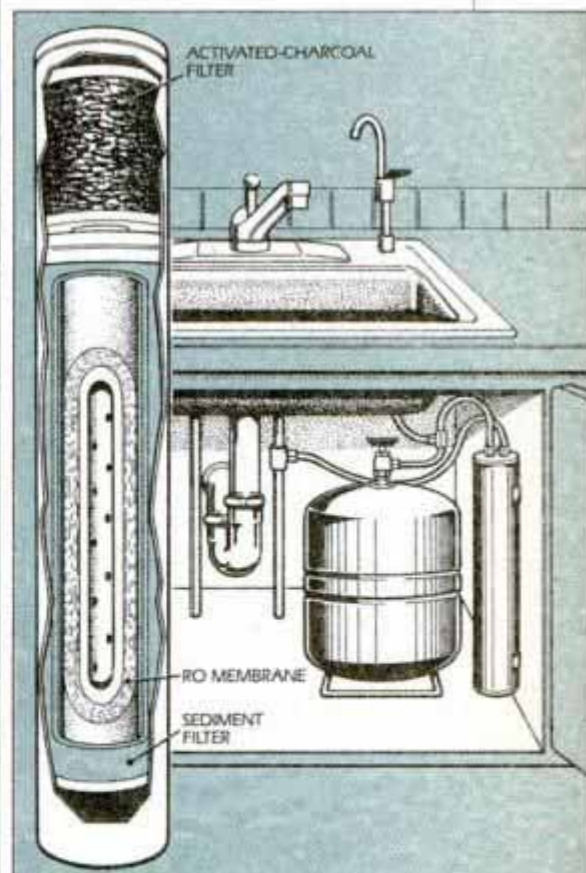
Distillation units are also fairly expensive to buy, ranging in price from \$200 to \$600 depending on capacity and features.

Ultraviolet irradiation

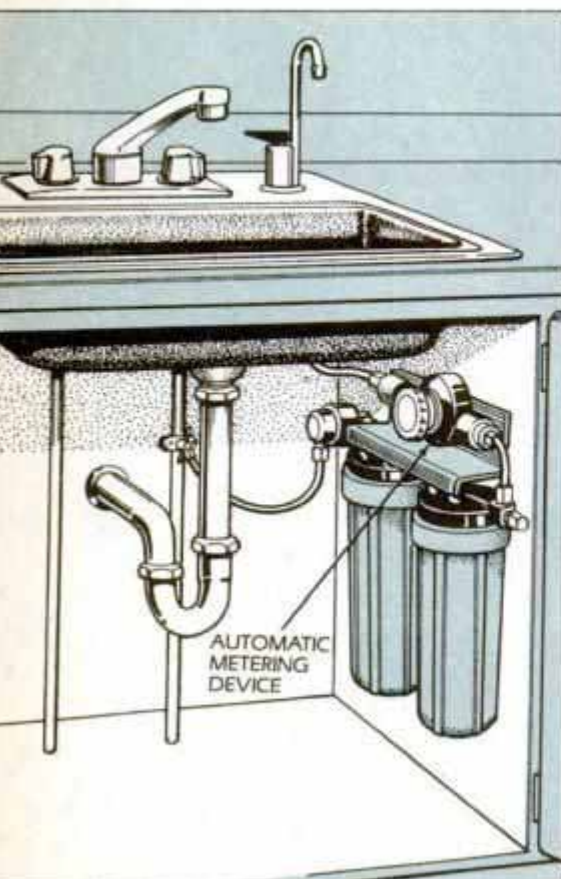
Ultraviolet irradiation (UV) water purifiers are quite effective against bacterial contamination. They are not, however, useful for any of the other types of pollution. They operate on the principle that exposure to intense ultraviolet light will destroy most microorganisms. These units are of particular value where water is obtained from a private well. Homes serviced by a municipal water supply usually receive water already treated for biological contamination. UV purifiers are usually installed in combination with other filters.

Reverse-osmosis units

Reverse-osmosis (RO) units employ a cellophane-like membrane as a filter. When water is forced against the membrane, a portion of it passes through leaving the impurities behind to be carried away by a waste stream. These filters can be effective in dealing with dissolved salts, suspended solids and dissolved chemicals. RO units are commonly paired with an activated-charcoal filter to handle dissolved gases and assist in the removal



7 RO units often use a pressurized tank to hold water until it's needed. This unit combines charcoal, sediment and RO filters.



8 Combination charcoal and sediment filter is connected to cold-water line. Unit has a metering device to signal filter changes.

of organic compounds. A sediment prefilter is commonly included to remove suspended particles before the water reaches the RO membrane (Figs. 5 and 7).

When shopping for an RO unit, take note that two types of membrane are available. One is designed to be used

with chlorinated water where bacteria has been eliminated because the bacteria can damage this type of membrane.

Those who have unchlorinated water should use the membrane designated for that purpose—it's not bothered by bacteria, but will be damaged by the chlorine.

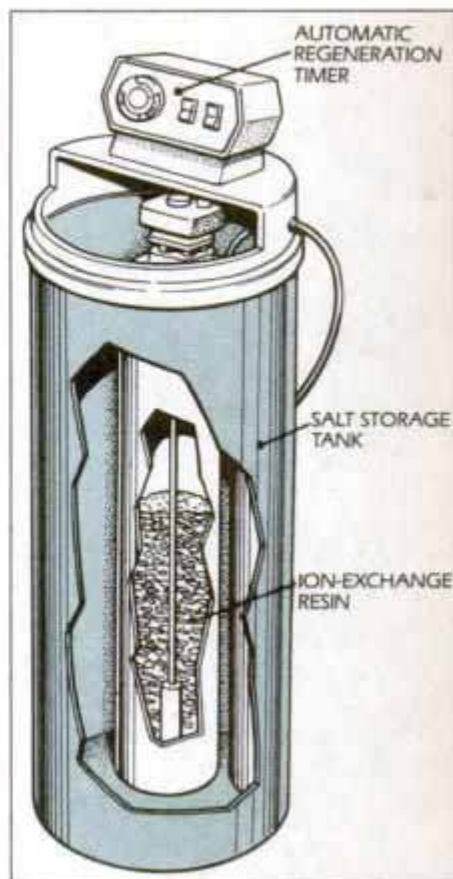
Maintaining an RO filter may include periodic replacement of the membrane. Some units claim adequate cleaning through an automatic back-flush cycle.

An RO unit is typically connected directly to the plumbing system and is often set up to service several taps. Because some of the water entering the filter becomes a waste stream for carrying the contaminants away, RO units usually make use of a storage tank to keep an ample supply of clean water on supply. While operating costs are low, average size units may range from \$500 to \$1000 in price. Small, tap-mounted units (Fig. 6) are also available.

Dealing with hard water

Aside from the contaminants that should be removed for health reasons, there are an assortment of chemicals that can make life otherwise difficult. Hard water contains sulfates and bicarbonates of calcium and magnesium. These calcium and magnesium bicarbonates can break down when the water is heated, leaving scaly deposits inside boilers, pots, coffee makers and irons. And, hard water can also interfere with the sudsing action of soap.

While it can help to replace soaps



9 Regenerating water softener has central canister containing ion-exchange resins. Salt-water cleans the resins.

with synthetic detergents and to use cleansing products that contain softening additives, the most direct way of handling the problem is by treating the water with a water-softening unit that uses ion-exchange resins.

These resins are in the form of small beads. When hard water passes through the unit, the calcium and magnesium bond to the resins. After a certain period of time, the resins become saturated.

A salt-water solution is then flushed over the beads, removing the calcium and magnesium and replacing them with sodium. When the regeneration process is complete, the unit is ready to go to work again.

Depending on the type and make of the unit, the saturated resins may be replaced periodically by a service company.

Other machines are self-regenerating and vary in the degree to which they're automatic (Fig. 9).

Be aware that because an ion-exchange unit replaces the chemicals that cause hard water with sodium, it's not advisable for those on sodium-restricted diets to drink water from this unit.

Water Treatment Equipment Manufacturers

- Advanced Filtration Technology, 2424 Bates Ave., Concord, CA 94520 (AC, RO, SF)
- Ametek Inc., Plymouth Products Div., 502 Indiana Ave., Sheboygan, WI 53081 (AC, RO, SF)
- Aquatron International, Rt. 1, Box 638, Rosethorn Rd., Marrero, LA 70071 (AC, RO, SF)
- Clean Water Systems, 4959 Durnam Ave., Woodland Hills, CA 91364 (AC, UV)
- Continental Water Conditioning Co., 320 Edward Ave., Harahan, LA 70123 (AC)
- Culligan International Co., Northbrook, IL 60062 (AC, RO, SF, UV, C, IE, AE)
- Cuno Inc., 400 Research Pkwy., Meriden, CT 06450 (AC, RO, SF, C)
- Durastill Inc., 4200 N.E. Birmingham Rd., Kansas City, MO 64117 (D)
- Ecology Sales Corporation of Florida, 7447 Salisbury Rd., Jacksonville, FL 32216 (AC, C)
- Everpure Inc., 660 N. Blackhawk Dr., Westmont, IL 60559 (AC)
- General Ecology Inc., 151 Sheree Blvd., Lyonville, PA 19353 (AC)
- Inaqua Enterprises Inc., 6265 Sawgrass Rd., Sarasota, FL 34278 (AC, RO, SF, C, IE)
- Kiss International, 520 S. Andreason Dr.,

- Escondido, CA 92025 (AC, RO, SF)
 - Nimbus Water Systems Inc., 2316 Vinyard Ave., Escondido, CA 92025 (RO)
 - Rainsoft Water Conditioning Co., 2080 Lunt Ave., Elk Grove Village, IL 60007 (AC, RO, SF, IE)
 - Sears, Dept. 703 Sears Tower, Chicago, IL 60684 (AC, SF, C, D, IE)
 - Superstill Technology Inc., 888 2nd Ave., Redwood City, CA 94063 (D)
- Key:** AC: Activated Charcoal; RO: Reverse-osmosis; SF: Sediment Filter; AE: Aeration; C: Chemical; Treatment (chlorination and ozonation); UV: Ultraviolet Radiation; D: Distillation; IE: Ion Exchange
- Water Testing Information Sources**
- Water Quality Assn., 4151 Napierville Rd., Lisle, IL 60532, (312) 369-1600
 - Department of Public Affairs, EPA, A-107, Washington, DC 20460
 - Water Test Corp., 33 S. Commercial St., Manchester, NH 03101, (800) 426-8378
 - Sears offers free test kits (No. 39 Y 7037). Call (800) 426-9345.
 - Your local State Health Department

How To Fix A PROBLEM DRAWER

BY PAUL BARRETT; PM Illustrations by George Retseck



Many modern kitchen cabinets feature drawers hung on ball-bearing-equipped tracks. A simple cleaning and screw tightening may be all that's required to improve performance.

WHILE many homeowners feel confident in tackling a poorly fitting door, and might not think twice about freeing a stuck window sash, when it comes to cabinet drawer trouble, it's easy to start getting nervous. After all, drawers are carefully fitted components and their smooth sliding and neatly fitting appearance demand adherence to close tolerances.

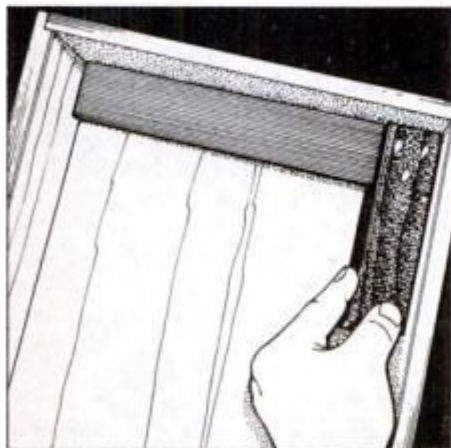
Over time, however, drawer rails can loosen, components can become misaligned and it's not unusual to find some drawers that are ignored simply because they're much too difficult to operate.

There's really nothing mysterious about the workings of a drawer. And, restoring one to like-new performance is well within the abilities of the average homeowner.

Types of mounting systems

At its simplest, a drawer is nothing more than a box that slides on a flat panel in the cabinet.

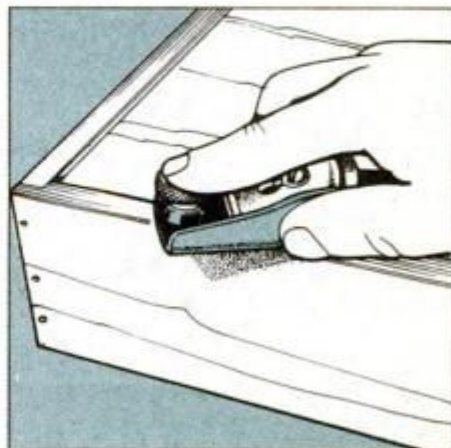
Drawers can also be mounted on wooden runners with guide strips on the sides and some drawers feature a groove in each side that slides over narrow wooden support rails on the inside of the cabinet. If the cabinet is a modern one, it may feature ball-bearing-equipped metal tracks.



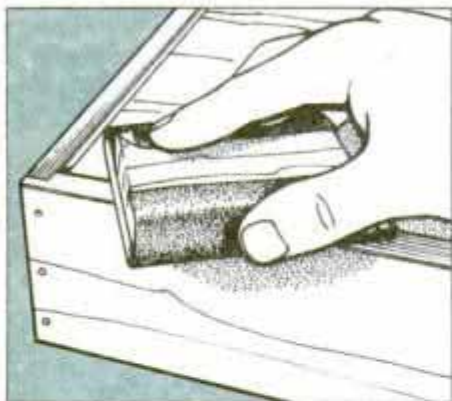
1 Use a tri-square to determine whether an out-of-square condition is causing a problem. If necessary, reglue drawer square.



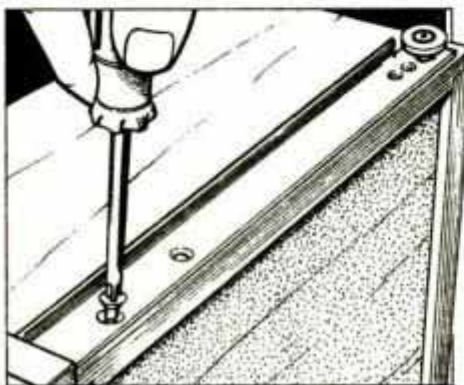
2 If the drawer is warped, lay it on a flat surface and scribe a line around the base while holding the drawer perfectly still.



3 Use a block plane to trim the drawer bottom to the line. Drawers with flush bottoms must be disassembled and reglued.



4 Follow the planing by uniform sanding with 120-grit sandpaper. Then slide the drawer in the cabinet for a test fit.



7 After boring pilot holes in drawer side, re-attach track with 3/8-in. No. 6 fh screws. Be careful not to bore completely through side.

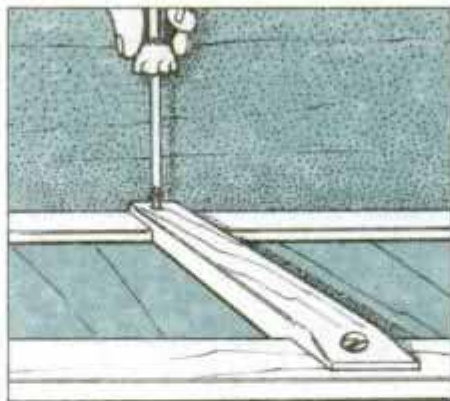
Inspecting the drawer

Begin by inspecting the drawer for loose joints and check that it's flat and square (Fig. 1). If the joints aren't sound, carefully disassemble the drawer and scrape away all the old glue. Apply glue sparingly, reassemble the drawer and clamp it until the glue sets. If you don't have clamps, then use 1-in. wire brads to hold the parts together. Make sure that the drawer is square and flat before the glue begins to set.

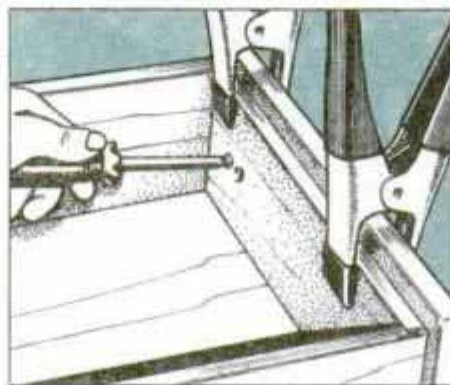
If the drawer is sound, then check it for flatness by laying it on a flat surface. If it rocks on two corners, then it's not flat and must be trued. This is especially important if the drawer slides on a panel in the cabinet.

With the drawer resting on the flat surface, carefully scribe a line around the drawer bottom (Fig. 2). Then, turn the drawer over and plane to the line with a sharp block plane (Fig. 3). Sand the edges with 120-grit sandpaper (Figs. 4) and coat with a solid lubricant such as Door Ease or Castille Soap for smooth sliding.

If your drawer has a bottom that's flush with the bottom edges of the



5 Check guide strips in cabinet for misalignment and replace any loose screws. This central strip controls side-to-side movement.



8 Alignment of drawer front face can be adjusted if face panel is screwed to drawer front. Clamp in position and install screws.

sides, and it's not flat, the only solution is to disassemble the drawer and reglue it properly.

Wooden tracks

Problems with drawers that slide on wooden rails, but are sound, flat and square, can often be the result of loose tracks or misaligned parts in the cabinet. Inspect the drawer supports and cabinet framework.

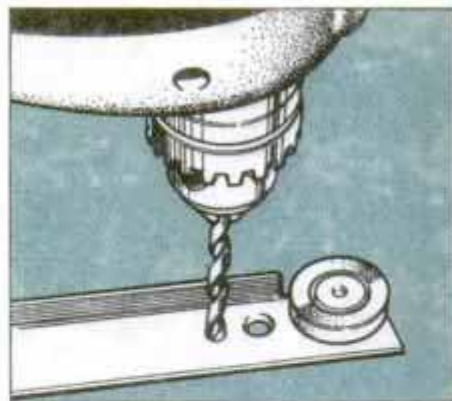
Some systems use a central guide strip that keeps the drawer in line side-to-side. If this has come loose, the drawer will tend to jam when pushed in. Remove old screws and install new larger-diameter screws to resecure (Fig. 5).

Check side-hung wooden track systems for looseness and repair where necessary. Sand and lubricate both the guide strips and grooves in the drawer sides.

Metal tracks

Modern furniture and kitchen cabinets often feature ball-bearing-equipped metal tracks.

While these are usually very reliable, problems can arise from dirt ac-



6 If screws that secure metal tracks have loosened, drill new holes near old. Countersink so screwheads will be flush.

cumulation or a loosening of the screws that secure the tracks to the drawer and cabinet sides.

If you find stripped screwholes in the wood, it's best to install new screws through new holes that are drilled next to the old stripped holes. First, mark the exact position of the track on the wood. Then, remove the track and drill the new screwholes (Fig. 6). Follow with a countersink so the screwheads won't interfere with track operation. Lay the track in place on the wood, bore for 3/8-in. No. 6 fh wood screws and reinstall the track (Fig. 7).

If the slides and bearings are dirty, clean them and sparingly apply a light spray lubricant.

It's possible that the tracks may be worn to the point where they must be replaced. If so, remove the tracks and try to buy an exact replacement set. If you can't find the same make, you may be able to substitute a different brand.

Be aware, however, that the new track length and side clearance must match the old hardware.

Follow the instructions supplied with the new tracks when installing. Slide the drawer in place and check that it's properly aligned. Many drawers have a face panel that's screwed to the actual front of the drawer. If this is the case, then you can correct a slight misalignment by removing the face panel and reinstalling it in the correct position.

With the panel removed and the drawer in place, apply double-sided tape to the drawer front and gently press the panel in place. Then, carefully remove the unit and clamp the panel to the drawer front. Bore new holes for the screws and resecure (Fig. 8).

PM

Homeowners' Clinic

BY NORMAN BECKER, P.E.

Sink Sprayer Problems

We have a kitchen faucet with a spray attachment. When we try to use the sprayer, only a light stream comes out with no force and most of the water comes out of the faucet. Can you tell us how to fix the sprayer?

HAROLD W. PANEBAKER
BALTIMORE, MD

First, look beneath the sink to see if the hose is kinked. If it is, and the kink can't be corrected, then replace the hose. Make sure you get either an identical replacement or one with an adapter to fit your faucet.

If the hose is okay, then remove the sprayer head nozzle and clean it if necessary. The nozzle is usually screwed into the spray head. With the nozzle off, flush the spray head by turning on the water and depressing the spray handle.

If you still have a problem, then it's time to check the diverter valve. First, remove the faucet spout. The valve can then be lifted or screwed out and cleaned. The diverter area in the faucet body should be flushed at this time by slowly opening one of the faucet handles. If the problem is not corrected after you reinstall the diverter valve, the valve is defective and should be replaced.

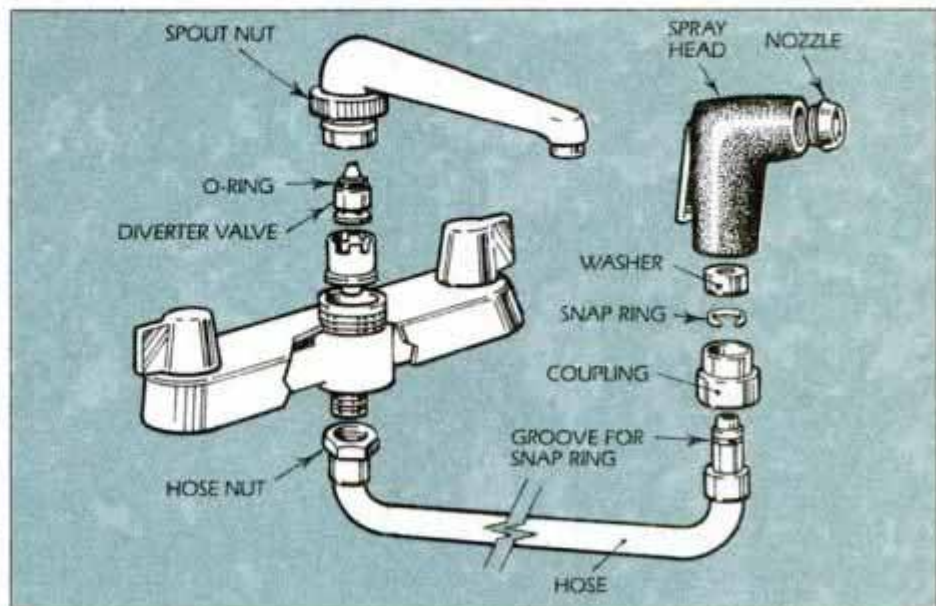
Short-Lived Bulbs

The light bulbs in my house are burning out more rapidly than usual. Do you know what could be causing this?

RICHARD MANDELL
TARRYTOWN, NY

Light bulb life, as rated by manufacturers, is based on averages obtained by testing thousands of bulbs in real-life situations. Many bulbs actually fail before they reach the rated life, while others burn for a longer length of time. If you occasionally have a bulb that burns out prematurely, then it's possible that you've simply bought a bulb that's on the short-lived side of the mortality curve.

However, if you have many bulbs blowing before their rated life, then you may have a problem with over voltage. Most standard light bulbs are designed to operate at 120 volts. It's possible that you're being sup-



When troubleshooting a spray attachment, first look for a kink in the hose. Then, clean the nozzle, flush the spray head, and check the diverter valve.

plied with a voltage slightly higher than the rated voltage. A bulb operating at just a few volts higher than its rated voltage will have a drastically reduced life expectancy.

For those with mathematical inclinations, the actual life of the bulb can be determined by applying the following formula:

$$\text{Actual life} = \text{Rated life} \times (\text{Rated voltage} / \text{Actual voltage})^{1.5}$$

If, for example, you're using a 120-volt bulb rated to last 750 hours and the actual voltage it's running on is 125 volts, then you can only expect the bulb to last 440 hours.

To have your electrical supply voltage checked, call your local power utility company. They can adjust it if necessary.

Lead Solder Joints

I've used lead solder for years when installing copper pipe. I've heard that the lead can be hazardous. As I'm just about to build a new home, should I be using plastic pipe?

GRANT LITTS
NORWAY, MI

If plumbing joints are sealed with 50/50 tin-lead solder, it's possible that the water, when not flowing, could pick up trace quantities of lead. As a result, the EPA recommended to the government that solder contain-

ing lead be prohibited from use in potable water systems. In June 1986, the recommendation was adopted and a 2-year period was allowed for the law to be implemented and enforced throughout the country.

If your local building code allows the use of plastic pipe for hot and cold potable water, then it's perfectly acceptable for your new home.

However, you can use copper pipe by using a lead-free replacement solder such as 95/5 tin-antimony or tin-silver.

You can use the same torches, fluxes and joint preparation that you've been using with traditional solder. However, the replacement solder melts at a slightly higher temperature and you'll have to hold the torch over the joint for a slightly longer period of time.

Whereas tin-lead solder (50/50) melts in the range of 361° to 421° F, tin-antimony (95/5) melts in the range of 452° to 464° F and the melting range of tin-silver (95/5) is between 430° and 473° F. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH

Gurgling Water Heater

My 9-year-old hot-water heater has been making gurgling noises as the water is heated. The installation manual says that sediment accumulation can cause this noise. I've been draining the tank periodically. Is there any other method for removing the sediment or eliminating the noise?

JOHN J. CARTER
BAKERSFIELD, CA

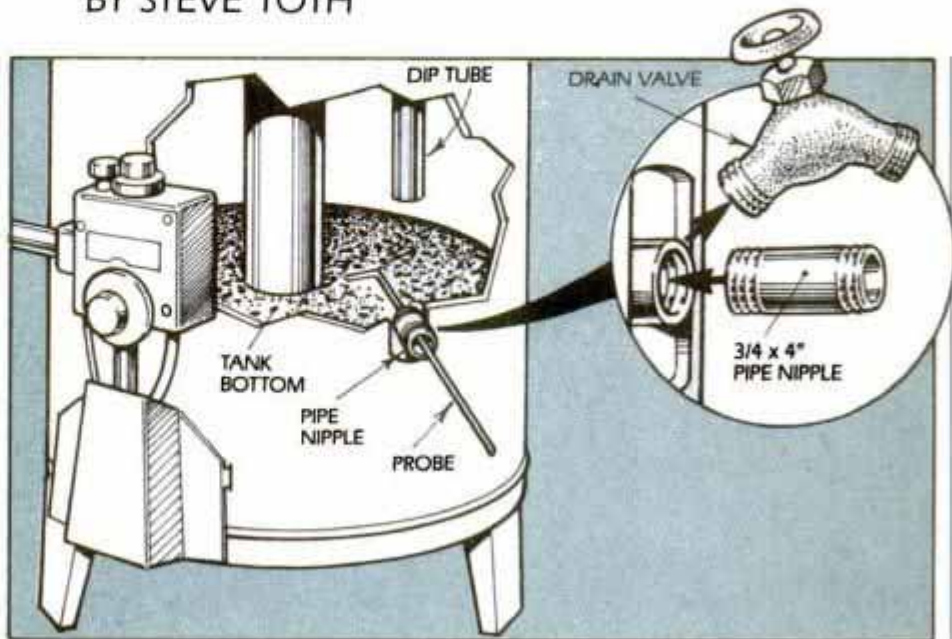
The noise that you're hearing results from boiling water trapped within a sediment layer on the bottom of your tank. This sediment is formed when minerals in the water settle as the water is heated. As the water under the sediment boils, the escaping steam makes a rumbling noise. If you don't remove this accumulation, it will continue to build up and insulate the bottom of the tank. This means that the tank bottom must be heated for a longer period of time to heat your water and, therefore, your operating costs will increase. It can also shorten the life of your heater.

There are several ways that you can remove the mineral buildup. Plumbing supply outlets offer a variety of chemical cleaners that dissolve the sediment which is then flushed away. Be sure to follow the instructions supplied with the product.

You can also scrape the sediment out. First, shut the valve that supplies gas to the heater. Shut the cold-water supply valve and open a hot-water faucet nearby. Drain the tank and place a shallow pan under the drain valve. Remove the drain valve with a pipe wrench and install a $\frac{3}{4}$ x 4-in. pipe nipple in the opening.

Straighten a metal coat hanger, or length of heavy wire, and bend one end down for scraping the bottom of the tank. After scraping, open the cold-water supply valve to flush out the loose sediment. Shut off the water and continue scraping. It may take four or five scrapings to remove the buildup. You can examine the tank bottom by shining a pen light through the valve opening.

When the bottom has been cleaned to your satisfaction, flush the tank, reinstall the valve and close it. Refill the tank and shut the hot-water faucet



To remove sediment buildup from a hot-water tank, first shut off gas and drain water. Install pipe nipple in place of drain valve, scrape sediment with wire probe and flush.

... you opened earlier when water begins to flow from it. Finally, turn on the gas and light the pilot.

Cooking In The Dark

The light bulb in my Samsung microwave, model No. RE515D, serial No. 18031417, is blown and I don't know how to change it. Can you help?

MARGARET R. BENNETT
PORT RICHEY, FL

Unfortunately, the bulb in your model microwave oven can only be changed by removing the entire outer cabinet. This is not a job for a consumer to take on.

Samsung recommends that you take your oven to an authorized service center to have the bulb replaced. There are several reasons why you shouldn't attempt the job yourself. First, by removing the cabinet you may void your warranty. Next, there is a danger of severe electrical shock and, if the cover is not reinstalled correctly, there's a possibility of microwave leakage. An authorized service center will check for leakage when they reassemble the unit.

The average cost to have a light bulb replaced in your model can range from about \$37 to \$50. For the Samsung service center nearest you, phone (800) 447-2882. **PM**

Service Tip

If you own a Sears gas or electric dryer and have noticed that the drum seals are worn, the unit makes noise when the drum turns, or the drive belt has begun to fray, then the Sears Dryer Preventive Maintenance Kit may be just what you need.

Designed to give a new lease on life to an older machine, the kit contains new drum seals, two drum supports, drive belt, complete idler assembly and easy-to-understand instructions. There are two kits available—one for the regular-capacity dryer manufactured from 1968 to 1985 (part No. 279435), and the other for all large-capacity dryers manufactured from 1974 to 1985 (part No. 279436).

Check the back of your dryer to determine whether it's a standard or large-capacity unit. If you find a protruding or extended panel, you have the large-capacity machine.

Either kit costs about \$40 at any Sears service or parts center in your area.

If you have a problem with any appliance, send your question, with the model and serial numbers to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

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Platinum Technology Guarantees Mileage Increase By 22%

Platinum technology in automobiles has finally been put to a good use, helping the consumer's pocketbook. A device called "Platinum GaSaver," patented by National Fuelsaver Corp., increases the efficiency of your combustion so effectively that your mileage is guaranteed to increase 22% in gasoline engines.

Unlike its cousin the catalytic converter, Platinum GaSaver *increases* performance. As stated on the package itself, "The Injector itself takes only minutes to install, while the platinum entering the engine increases the percentage of each gallon burning in the engine from the normal 68 percent to 90 percent.

"Normally, that 22% would only burn when it came in contact with the platinum-coated surfaces of the catalytic converter. But with the GaSaver introducing the platinum into the engine, platinum catalysis can now burn that fuel in the engine where the release of that heat and energy is harnessed to drive that vehicle.

"With 22 percent more of each gallon burning in the engine, 22 percent fewer gallons are required."

Although this product is fairly new to the public, industry has been using this knowledge for years. Many large oil companies use the same technology to increase their refinery profits by millions per year.

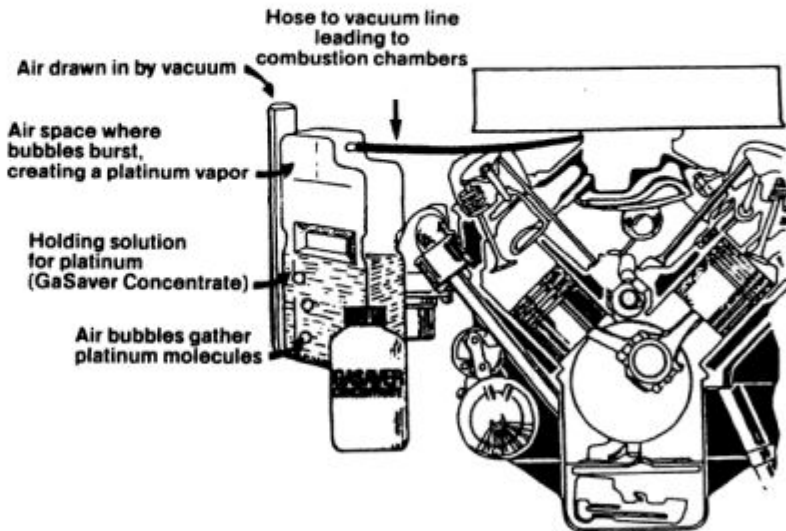
Now that the consumer is aware that large companies profit from this catalytic process, it is time the consumer profit as well.

Believing in the public interest, Joel Robinson of National Fuelsaver Corp. developed this simple device. After years of research and development, along with overcoming extreme obstacles, National Fuelsaver Corp. now offers their product nationwide.

Platinum GaSaver is not only cost effective, but conforms to all Federal and State pollution standards. Enclosed with each device is helpful printed material including confirmation by the federal government that the product meets and exceeds mileage claims made. A copy of the test results accompany each unit.

Acting as a brochure, we have included several displays in this article for your review.

After reading all of the information offered to you, call the number below so you too can save with platinum technology.



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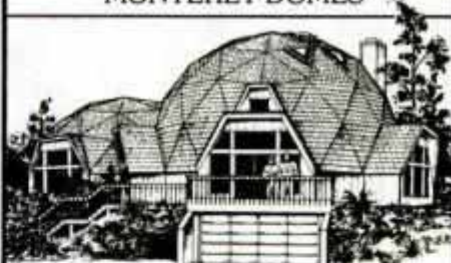
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These are the same GFX-16 Headphone Radios nationally advertised by us in leading media throughout America. *Similar headphone radios have been sold by others for much higher prices. Now, during this nationwide publicity campaign, you can have our nationally advertised GFX-16 for only \$5, if you act promptly.

Lightweight (just 6 ounces!), with foam-cushioned earphones and adjustable headstrap, it's comfortable enough to wear *all* day long! But what's more, these Headphone Radios contain a performance-oriented AM/FM radio. Now, take your favorite music, news, talk shows or play-by-play sports action wherever you go! Its convenient hands-free operation lets you listen while you run—jog—work—cook—or clean. No dangling cords, no bulky unit to carry in your pocket! And, best of all, your own "personal" preferences or moods in programming won't disturb family, friends, co-workers or anyone around you.

Because its construction utilizes state-of-the-art electronic technology, it packs a **p-o-o-o-owerful** receiver in an ultra-

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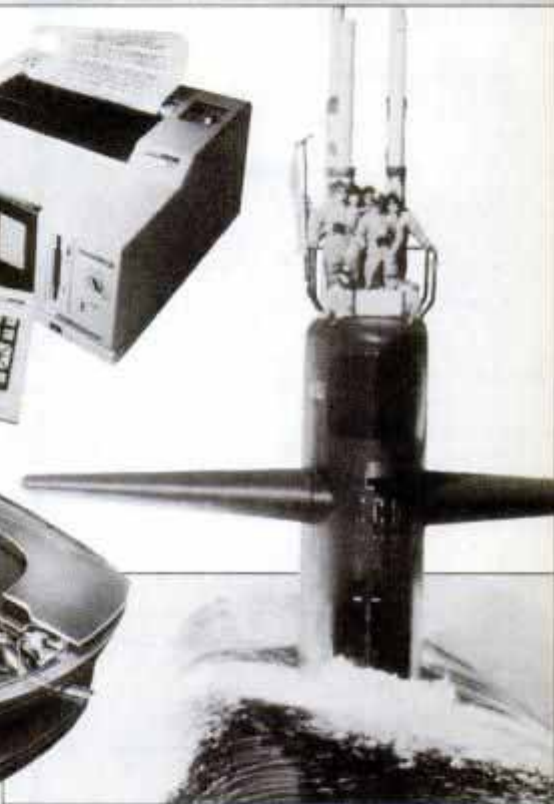
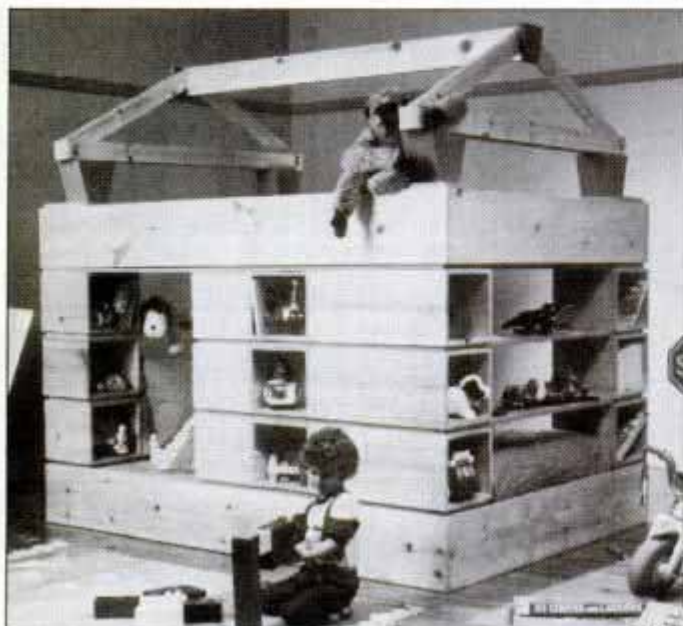
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