

APRIL 1988 \$1.95

Popular Mechanics

**SPORTS
CAR
SHOW
DOWN**



Pontiac Fiero GT vs.
Mazda RX-7 GTU vs.
Honda CRX Si vs.
Toyota MR2

EXCLUSIVE

**NEW
DISCOVERIES
AT THE
SOUTH POLE**

PM Visits Earth's
Last Scientific
Frontier For A
Firsthand Report

**BEST BUYS IN
PERSONAL
COMPUTERS**

IBM vs. The
PC Clones

**WE PICK THE
BOATS THAT
DO IT ALL**

5 Family Cruisers
With Party-Boat
Comfort, Ski-Boat
Speed



BUILD IT! FLY IT!
**200 mph IN
YOUR OWN PLANE**

5 Hot New Designs Push Homebuilt
Performance To The Limit

SPECIAL SECTION

Give Your Home A
**TOTALLY
NEW LOOK**
For More Appeal,
Higher Value



- Roofing
- Entrances
- Decks
- Siding
- Windows
- Driveways





A New

Made especially for menthol

SURGEON GENERAL'S WARNING: Quitting Smoking
Now Greatly Reduces Serious Risks to Your Health.

10 mg "tar," 0.7 mg nicotine
av. per cigarette by FTC method.



Menthol

smokers by Marlboro.

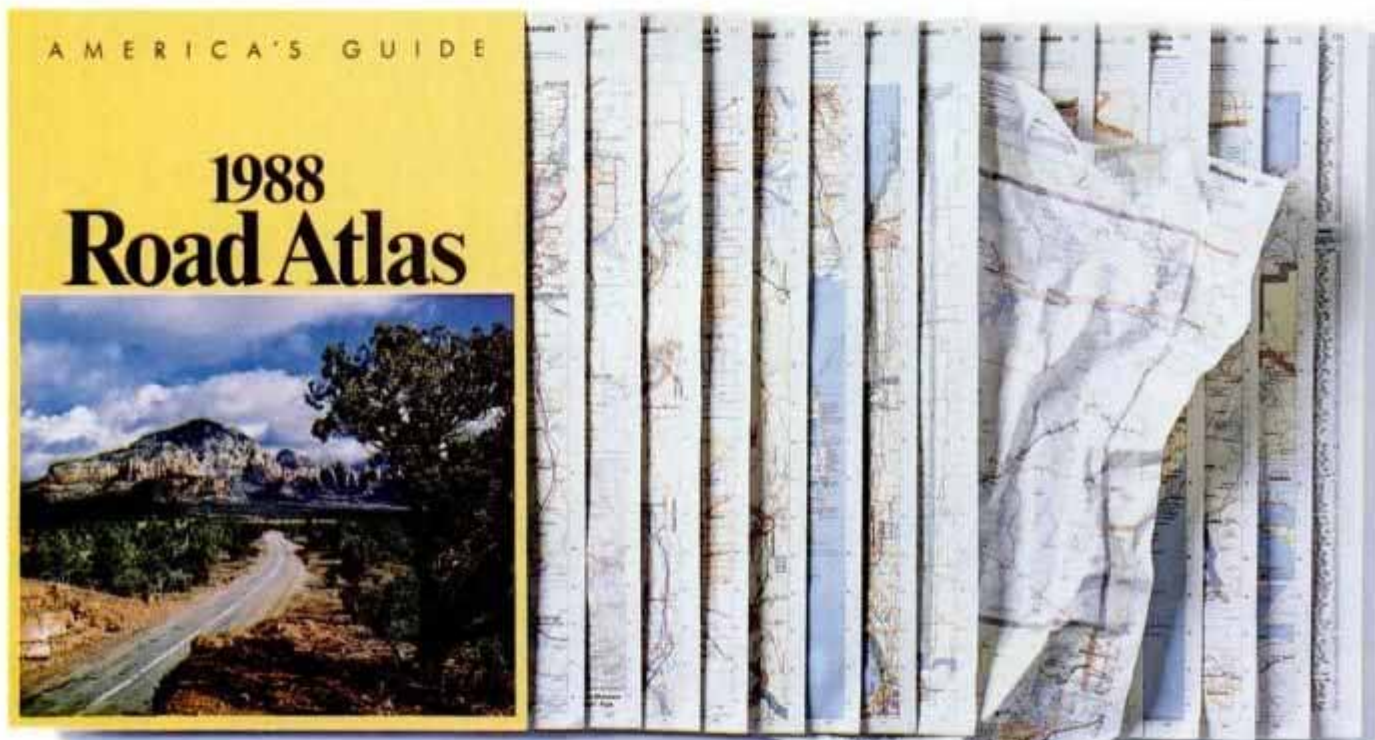
This One



4XSR-UE2-NDK8

© Philip Morris Inc. 1988

THE TIRE THAT CAN HANDLE THE WHOLE BOOK. EVEN PAGE 57.



With a set of Michelin XC All Terrains, you can take on most any kind of road. The good, the bad, and the bumpy.

In places like page 14 (California's San Diego Freeway, where a good pothole is hard to find) XC All Terrains deliver a quiet, comfortable ride.

Their unique tread pattern is designed to put an end to the driveability problem we call "chatter." (You probably call it something else.)

But flip to page 57 (eastern Montana, where the roads look more like the Hallelujah Trail) and XC All Terrains really get to show off. Their beefy block shoulders and self-cleaning tread lugs supply maximum traction.

Come hail or high water.

And if you're willing, XC All Terrains are even tire enough to tackle what may well be the most punishing driving conditions known to man. The dreaded page 65:

New York City.

Not only that, XC All Terrains are built to last a long, long time. After all, they're Michelins.

Will we ever make a tire tougher than this? Only if they ever make a tougher atlas.



MICHELIN
BECAUSE SO MUCH IS RIDING
ON YOUR TIRES.



68 COVER STORY

The new breed of homebuilt airplanes may say amateur-built on their airworthiness certificates, but when it comes to performance, there's absolutely nothing amateur about them.

—PM photo by Budd Davisson



72 South to the Pole



80 Bowrider battle



65 The super clones

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Fast and furious fun with the affordable 2-seaters as we take them out on the track for a full PM road test.

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Part 4 of our "Car Of The Future" series examines the revolution brewing in power delivery systems for the next century.

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The black-tie test is the one that counts in a comparison of these high-rent haulers from Cadillac, Lincoln and Rolls.

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Find out why your engine just quits, and how to fix it so it runs smoothly.

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53 Twos for the money

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A welcome-home deck with a built-in planter.

116 Top Coat

A quick and easy way to reroof your home.

126 Asphalt Answers

Pave your way to a more usable driveway.



Grand entrance for ranch.



NO.1--FORD PICKUPS FIRST IN SALES. FIRST WITH HI-TECH FEATURES. FIRST IN VALUE.

Ford has been the best-selling pickup for 11 straight years.* And there's never been a better time to buy one than right now!

HIGH TECH.

First with rear Anti-lock brakes last year, Ford leads Chevy with multiple-port fuel injection across the line. Gas-pressurized shocks for a smooth ride.

HIGH POWER.

Ford pickups give you a bigger standard Six with 12% more torque than Chevy. V-8's range from the most powerful small gas V-8...to the biggest diesel in any pickup!

BIGGER PAYLOADS.

'88 Fords are built so tough that their payloads exceed Chevy by up to 565 lbs.!

MORE VALUE.

Today's F-150 with a 5-speed transmission

includes many popular "extras" at no extra cost. Special equipment packages are also available on XLT Lariat (above) or XL and Custom models. Add these same features to Chevy 5-speed models...and their price is hundreds of dollars higher than Ford.**





Optional two-tone paint
\$215 MSRP

COMPARE FORD TO CHEVY**

Ford F-150 LWB XLT Lariat—5-Speed Equipment Package 507A \$12,046	Chevrolet C-1500 LWB Silverado 5-Speed, comparably equipped \$12,861	Ford Advantage \$815 less
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Ford F-150 LWB Custom—5-Speed Equipment Package 500A \$11,078	Chevrolet C-1500 LWB Cheyenne 5-Speed, comparably equipped \$11,545	\$467 less
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No charge items on Ford manual transmission packages include:
 Radio, AM/FM Stereo Bright Low-Mount Mirrors
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 Argent Rear Step Bumper Tinted Glass
 Sliding Rear Window Tachometer

Package content differs and savings vary in La., Okla., Texas;
 F-150 prices higher in N.Y. See your dealer for complete details.

6/60 WARRANTY.

Covers powertrains
 for 6 years/60,000 miles
 and body-panel rust-
 through for 6 years/
 100,000 miles‡

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."

*Based on latest available calendar year
 manufacturers' reported retail deliveries.

**Based on manufacturers' suggested
 retail prices of F-150 (2WD) equipped
 with 5-speed manual transmission and
 Preferred Equipment Packages listed
 compared to MSRP of comparably
 equipped C-1500 Chevrolet models.
 Comparisons based on prices available at
 time of publishing, including destination
 and delivery charges and excluding title
 and taxes.

‡Restrictions and deductible apply.
 Ask your Ford Dealer for a copy of this
 limited warranty.

Buckle up—together we can save lives.



FORD PICKUPS

AMERICA'S TRUCK: BUILT FORD TOUGH

EDITOR'S NOTES

Popular Mechanics

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Joe Oldham

Managing Editor
Bill Hartford

Graphics Director
Bryan Canniff

ONLY a few journalists each year are permitted to visit the scientific installations on the continent of Antarctica. The reasons for this are numerous: Even in 1988, living conditions are brutal and accommodations are limited at best. The scientists who are working there have precious few minutes to devote to tours or hobnobbing with people from the outside. And just getting there and back takes about a week each way and you have to depend on the U.S. Navy for a major part of the journey. No wonder the National Science Foundation and the Navy are very particular as to who goes and who doesn't. Each Antarctic summer season, a select handful of people with legitimate reasons to go are given permission. There are no sightseers or casual visitors in the group. In our case, we had to wait almost four years before finally obtaining all the necessary permissions, clearances and waivers. Finally, last fall, our Science/Technology Editor, Tim Cole, boarded an Air Force C-141B cargo plane for the final leg of the long journey to Antarctica. He spent more than a week visiting its many scientific installations so that he could report on the latest activities. His story begins on page 72. The work going on there is truly fascinating. It ranges from studies



Cole plants our colors at the pole.

of the now-famous hole in Earth's ozone layer to the dry valleys of the continent which NASA scientists think resemble the surface of the planet Mars. By the way, there really is a "South Pole", a real pole sticking out of the ice right at the geographical location of the Earth's South Pole. Cole took a few minutes out of his hectic schedule to plant the POPULAR MECHANICS flag at the pole in the name of all PM readers. . . . We've been getting

thousands of letters from readers who say we don't print enough articles on limousines. They told us they were contemplating a purchase and wanted to see one of our incredibly detailed, authoritative comparison road tests of a representative selection of entries in the burgeoning custom limousine field. Beginning on page 62, you'll find the article you've all been clamoring for—a full-bore comparison road test of Rolls-Royce, Lincoln and Cadillac limousines complete with caviar and Dom Perignon in the passenger compartment. I hope you find this special April feature useful and informative. . . . Instead of a conglomeration of unrelated home improvement articles for this year's annual "Home Improvement Guide", Home and Shop Editor Steven Willson and his staff came up with a different tack. The premise: Take a typical tract-built house, circa 1950, and do a complete exterior makeover into an attractive contemporary house for the 1980s. That's what you get in this year's Guide, and it's literally packed with ideas that can be utilized on almost any home. 'Til next time.



Seat-of-the-pants testing is a must when testing limos.


Joe Oldham

Home And Shop

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Joseph Truini, shop and tools editor
Thomas Klenck, associate editor
Norman Becker, Rosario Capotosto,
Steve Toth, Bob Vila,
contributing editors

Automotive

Tony Swan, editor
Jim Dunne, Detroit editor
Mike Allen, assistant editor
Michael Lamm, Norman S. Mayersohn,
Mort Schultz, Rich Taylor,
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Electronics/Photography

Stephen A. Booth, editor
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Fred Mackerodt, contributing editor

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Joe Skorupa, editor

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John Bostonian Jr., art editor
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Art

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associate art directors
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Editorial Offices

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Popular Mechanics

Publisher

Daniel J. Coleman

National Sales Manager
Bud Gilbert

Advertising Offices

New York
224 West 57th St.
New York, NY 10019
(212) 649-3135

Chicago
1 South Wacker Dr.
Chicago, IL 60606
(312) 984-5190

Detroit
2301 West Big Beaver Road
Troy, MI 48084
(313) 649-2981

Los Angeles
3000 Ocean Park Blvd.
Santa Monica, CA 90405
(213) 450-8881

Direct Response Advertising
224 West 57th St.
New York, NY 10019

Eastern

Al Cohen
(212) 649-3140

Midwestern
Austin C. Sass
(212) 649-3142

Business Manager
Agnes P. Maillaro

Marketing Director
Edward Vaquero

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) 649-3127

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NOW YOU CAN CONQUER RUST!



New NEUTRA RUST Gets Rid of Rust For Good!

NOT A PAINT, NOT A COVER-UP, but an entirely new and revolutionary process for eliminating rust. Neutra Rust was originally developed to control the incredible rust on oil rigs in the North Sea and on ships of the Royal Navy. Think of the rust problems they have! Naturally they use vast quantities of Neutra Rust and buy it in huge 50 gallon drums. For a long time that was the only way you could buy it. But at last Neutra Rust is available in smaller sizes for home and shop.

Now you can get rid of rust for good just the way they do at industrial and military installations all over the world!

WHAT NEUTRA RUST DOES
Neutra Rust is like nothing you've ever used

before. It's amazing! No tiresome scraping, wire brushing and sanding to get down to bare metal. Neutra Rust works best applied right over rust! It penetrates the rust. Gets right down there and chemically changes the rust into an entirely new substance—a hard, black, paintable compound called fersoferric. The rust is gone—not just covered up—GONE! For good. It no longer even exists.

NEUTRA RUST IS EASY TO USE

First knock off the loose or scaly rust, but leave the rest of the rust there. (Remember Neutra Rust works *with* rust.) Then just brush Neutra Rust on. Within minutes that rust will be gone and the new surface will be there. That's all there is to it. Clean up is easy, too. Just soap and water.

YOU CAN ACTUALLY SEE NEUTRA RUST WORK!



When you first brush on Neutra Rust it is white. Then, as you watch, it turns pale green, then darker green, then finally a deep, wrought-iron

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about Neutra Rust
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New York Bronze Powder Co., Inc.
481 Doremus Avenue, Newark, New Jersey 07105



LETTERS

Plus Room For A Horse



WE DID IT! After 10 weeks of work and total investment in materials of \$7000, we added PM's Country Barn to our property ("Build Our 'Country Barn' Garage," page 90, Sept. '84). We chose the PM design because of its attractive shell and spacious yet compact design. Our barn deviates from the original plan with a reversed redwood walkway/deck, overhead garage doors and a woodstove for winter heating. We've also added a horse stall, which should be occupied by the time you read this! Currently, we use the lower level as a garage for one car and as a workshop. The upper level is for hay storage and additional workshop space. We are thoroughly enjoying this structure and all the compliments we receive about having built it ourselves!

RONALD J. DOLL
CONIFER, CO

You've built a PM classic, and the first we've heard about that lets you "get a horse!" Plans for the 24-ft. x 26-ft. garage barn (A-1277, \$30) include blueprint-size layout sheets and an 8-page instruction booklet that contains drawings for topping off the barn with a cupola. Order from PM, Box 1014, Radio City Station, New York, NY 10101.



Doll's garage barn has room for more than cars, as the cupola horse weathervane shows.

Ready To Relax

What I like about your chaise ("6 Outdoor Classics In Redwood," page 94, July '84) is that you can use it with or without a cushion. I built mine of pressure-treated stock and plan to use it year-round.

JOHN A. HENSON
LAKELAND, FL

Our chaise is one of six durable patio pieces including a barbecue cart, telephone cad-



Chaise is one of six projects in patio group.

dy, planter, beverage tray and handy table. Plans for all six are included in our Redwood Patio Furniture plans package (A-1013, \$6.95), which can be ordered from PM, Box 1014, Radio City Station, New York, NY 10101.

Not So Fast!

I think Lee Iacocca is wrong when he says the leaders of the automotive industry of the future will be those with great service. The leaders will be those who build cars about which they can say "We don't need service." As owners of Japanese-built cars who have driven billions of miles with only routine maintenance and replacement of wear-out items know, it is an idea that came long ago. "Mr. Goodwrench" is an idea whose time has come—and gone.

DR. MAURICE E. FRIOT
MARCO ISLAND, FL

Lee Iacocca is right in thinking that the next giant leap forward in automobiles will be in the dealerships ("Car Of The Future," page 45, Jan. '88). However, he is mistaken in thinking that it will happen just because of extended warranties. It will happen when a manufacturer produces sellable, reliable vehicles and has a dealer network that will back them up with friendly, competent and honest service.

STANLEY L. DEGEER
ALBUQUERQUE, NM

Lee Iacocca and his peers are living in a vacuum. Just where are we expected to drive their 150-mph rocketships? By 2001 most of our urban highways will be so congested and dilapidated that even 55 mph will seem foolhardy.

JAMES P. SUTHERLAND
BLANDFORD, MA

The January "Car Of The Future" story fails to address a vital issue, the conservation of fossil fuel and reduction of effluents into the atmosphere. The car of the future should get at least 80 mpg



January '88: Start of PM's 6-part "Car Of The Future" series.

and have a top speed of 60 mph. Such cars have been a dream of urban designers for decades and have become a necessity.

DR. MARTIN DOWD
COSTA MESA, CA

As expected, PM's "Car Of The Future" series, which will run through June for a total of six articles, has become a forum, with readers responding vigorously to the ideas presented. In this issue (page 58), Part 4 "Torque Management 2001" offers concepts of hybrid drive-trains that utilize internal combustion and electrical drive.

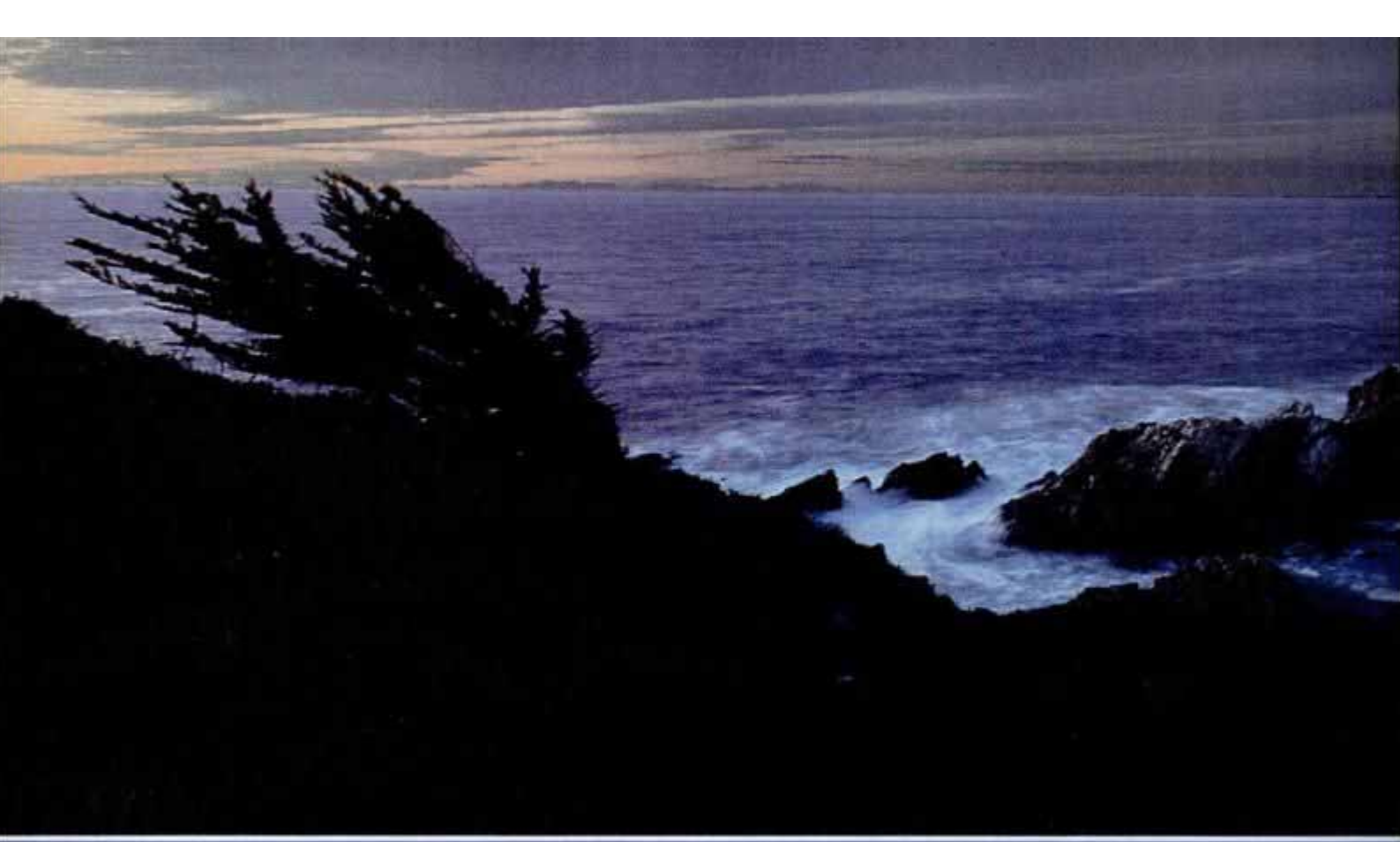
Rough Rider

Thanks for the great adventure in the February issue ("Pan American Express," page 77). It brought back my ride—on a Harley-Davidson 165—from Milwaukee to Rio de Janeiro. It was 1956-57 and the trip took nine months. I'm not in the Guinness Book, but it was still an incredible journey, with memories of bandits in Columbia, rock slides in Brazil, and more! MACK HOFFMAN
SAN CLEMENTE, CA



FORD ANNOUNCES

PEACE OF MIND



Ford maintains that backed by the best Quality

There's a new performance feature built into every Ford Motor Company car and truck. But you won't find it under your hood.

It's a commitment.

A commitment from the Ford and Lincoln-Mercury dealers to make their customers the most satisfied in the world.

You'd probably call that peace of mind.

We call it Quality Care.

Quality Care starts with a 6-year, 60,000-mile power-train warranty.*

And Quality Care is Ford's Lifetime Service Guarantee. This is America's best repair guarantee because it covers thousands of different repairs and guarantees them for the life of your car or truck. And only Ford and Lincoln-Mercury dealers have it.

*Deductible and restrictions apply. Ask to see this limited warranty at your dealer.

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the quality car you buy is now Care in America.

Quality Care is schooled, certified technicians. They're backed with computerized diagnostic equipment to help make "trial and error" service obsolete.

And it's Ford's optional Extended Service Plan, comprehensive long-term protection against major repair costs.

It's also Ford and Motorcraft replacement parts, like filters, batteries, oil and spark plugs. Proven performers on major speedways, every Motorcraft part is designed by Ford engineers to keep the quality that was in your car from the start.

And Quality Care includes follow-up surveys that monitor how we're doing.

Quality Care. It's the difference between just buying a car and owning peace of mind.

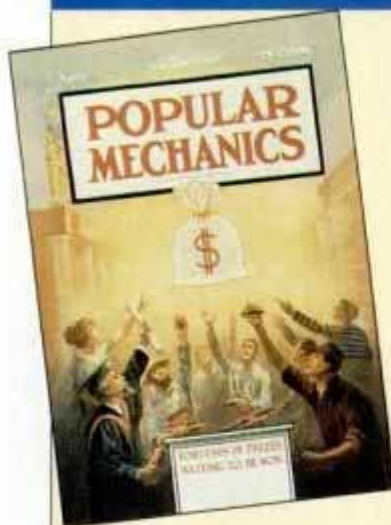
**QUALITY CARE
FOR QUALITY CARS**



FORD PARTS AND SERVICE DIVISION

TIME MACHINE

75 YEARS AGO: April 1913



Thinking for dollars.

Cash Incentives

The breakthroughs of the early 20th century dropped sudden fortunes into the laps of inventors. In April 1913, PM presented a roundup of cash prizes offered for feats of technological creativity. Biggest of all was the \$100,000 offered by an international automobile club for the best gasoline substitute. Another rich offer came from the French Academy of Sciences, which promised 100,000 francs (\$20,000) for the first person to establish communications with any planet other than Mars.

Motor Sled

The world pored over Robert Falcon Scott's diary, which detailed his ill-fated expedition to the South Pole in 1912.

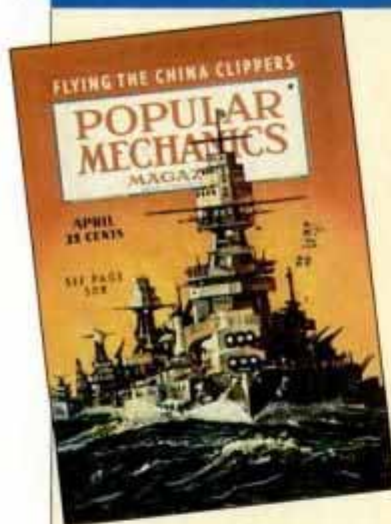
Scott had supplement-

ed dogs and Siberian ponies with motor-driven sleds to haul gear over the thickly packed snow in the Antarctic interior. But the air-cooled motors died in the skimpy atmosphere near the Pole.



Fueling up motor sled for trek across frozen Antarctic plain.

50 YEARS AGO: April 1938



Flexing sea muscle.

Sea Monsters

Fifty years ago POPULAR MECHANICS gave its readers a sneak peek at America's first new battleships in 15 years. With an eye on Europe's quickening arms race and Japan's naval buildup, the U.S. Navy was constructing its biggest ships ever. Stretching over 700 ft. and displacing 45,000 tons, the *Washington* and *North Carolina* bristled with weapons, including nine 16-in. turret guns with 20-mile ranges. The ships would prove themselves in fierce fighting off Guadalcanal and in the Leyte Gulf.

Orient Express



Trans-Pacific flights were a novelty in 1938. Pan American's China Clipper service out of Alameda, California, skipped across the ocean, stopping at Honolulu, Midway, Guam, Wake Island and Manila before reaching Hong Kong. The planes; 26-ton, 4-engine Martin "flying boats." The 9000-mile journey took five days and five hours.



Cruising to China in a "flying boat."

25 YEARS AGO: April 1963



Riding on hot air.

Up And Away

Sport ballooning was about to take off 25 years ago, and our aviation editor tried out a new 1-man rig. Developed as a Navy balloon-pilot trainer, the Vulcoon floated on 200-year-old technology—hot air. Until the advent of the Vulcoon, sport balloonists had to spend many hours filling their military-surplus rigs with expensive helium or natural gas. And once aloft, dumping ballast and bleeding off excess gas made ballooning a constant struggle. The Vulcoon changed all that. The plastic-laminated nylon balloon inflat-

ed in 10 minutes with the help of a portable hot-air blower. You strapped yourself into a seat (later 2-person models had baskets for standing) and simply adjusted valves on two overhead burners to guide your balloon up and down. On-board butane tanks carried enough fuel for a 4-hour flight at about 4000 ft. Borrowing the concept from our automotive department, we included an owner's report as well as details of our hands-on try-out. A nervous first-time balloonist, our man reported a "most pleasant and exhilarating ride."

Three-Wheel Sled

Take a steering column and handbrake from a bicycle and three wheels and an axle from a cart, and you've got the parts to keep a sled moving after the snow has melted. This wagon-trike hybrid was a 1963 home shop project. **PM**

Sledding into summer.



Implantable Hardware Mends Hearts

NEW YORK, NY—Cardiologists and engineers are teaming up to counter the threat of heart disease with innovative implantable technology.

A 10½-ounce cardioverter-defibrillator, recently introduced by Cardiac Pace-

makers, Inc., may save up to 20,000 American lives a year. The device delivers a 750-volt countershock to a heart in the throes of fibrillation, the rapid irregular heartbeat that often triggers sudden cardiac death.

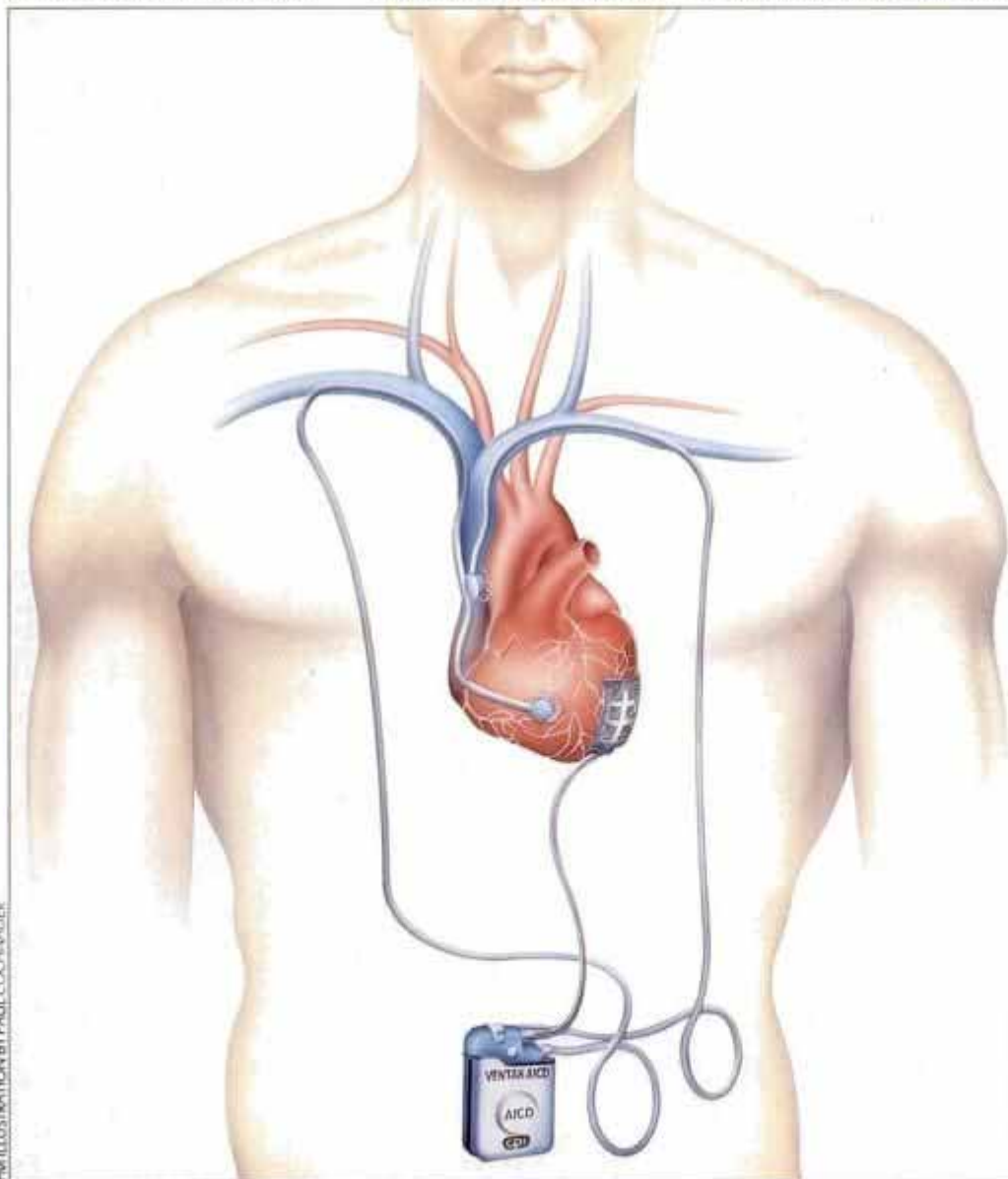
Electrodes implanted on

the heart are connected to a pulse generator in the abdomen. When the electrodes sense an abnormal heart rhythm, the pulse generator charges itself and delivers the jolt, which patients describe as a kick in the chest. If the first shock doesn't

quell the arrhythmia, the generator can send three more jolts. The device's batteries must be surgically replaced every three years.

Planned refinements include further miniaturization and more customized shock therapy.

Meanwhile, a French group is developing an artificial heart radically different from the Jarvik VII that made headlines several years ago. Known as CORA, the heart runs like a rotary engine, with an elliptical rotor powered by a small electric motor. The rotor sweeps blood out of the entire heart cavity, preventing the blood clots that plagued Jarvik patients. The implant's microporous exterior allows cells that coat the natural heart to colonize its exterior. Moreover, energy is transmitted to the motor through the skin by an external belt-worn bat-



PM ILLUSTRATION BY PAUL COCHRAUER

In CPI's Ventak automatic implantable cardioverter-defibrillator (AICD), button-shaped electrodes monitor heartbeat, and patch-shaped electrode transmits shock when arrhythmia occurs.



FITRO PHOTO

CORA is made of biocompatible carbon-silica and titanium.

tery system, which gives a patient free movement for up to 20 hours.

The French group is currently experimenting with a microcomputer/sensor system inside the body that would monitor blood flow and fine-tune the heart rate according to the patient's circulatory needs.

(Please turn to page 16)

Editor: Tim Cole
Assistant Editor: Gregory T. Pope
Contributors: Richard Thiel,
Josh Eppinger, David Lampe.

"If it's tough enough for the Guinness Book of World Records..."

It was a truly incredible journey. From Tierra del Fuego to the Arctic Circle — from the southern tip of South America to the northern tip of North America.

Garry Sowerby made this adventurous, record-setting trip in just 23 days, 22 hours and 40 minutes. And oh, the stories he could tell.

Naturally, to set a world record, Garry Sowerby didn't take chances — he took a Sierra, GMC Truck's ultimate full-size pickup. The comfortable, reliable Sierra Insta-Trac 4 X 4, with standard anti-lock rear brake system (operates only in two-wheel-drive mode on 4 X 4s), not only survived, it thrived. For 15,000 grueling miles — from mud to snow, through jungles and over mountains.

If the Sierra is tough enough to handle a trek like Sowerby's, imagine how well it can handle your everyday needs.



Quality Network



...it's tough enough
for you."

Garry Sowerby
— Garry Sowerby

You don't have to go for a world record to appreciate all the qualities the Sierra has to offer. The Sierra is much more than a full-size pickup — it's a GMC Truck full-size pickup.

Its toughness and reliability are evidenced by Garry Sowerby's record-setting journey. Its aerodynamic good looks speak for themselves. Its 4' X 8' bed and standard GVWR of 5,200 pounds (including passengers, cargo and vehicle) show its capacity to take care of business.

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Sharp Scope

CAMBRIDGE, U.K.—The hottest new tool in biomedical research may be the confocal microscope, which offers crisp images of cells in action.

Developed by the United Kingdom Medical Research Council, the microscope features a 25-milliwatt argon-ion laser beam. Thanks to a diffraction-limiting spatial filter, the beam illuminates only a 1-micron-deep layer of specimen at a time. An imaging lens focuses on that same layer. Anything outside the layer shows up black, rather than out-of-focus. The result: high-contrast images without blurry backgrounds.

A computer-coupled system made by Bio-Rad Microscience converts a conventional microscope into a confocal system. In operation, its laser beam scans back and forth across the illuminated layer, exciting fluorescent dyes that have been taken up by various cellular



Confocal microscope allows optical sectioning of samples.

structures in the specimen. A photomultiplier tube picks up the image, which can be processed and digitally enhanced before display on a computer monitor. Focusing is controlled through the computer, allowing either horizontal or vertical sections through the specimen. Image-processing software allows 3-dimensional reconstruction of the specimen.

The system's advantage is that it makes unnecessary the physical sectioning of specimens and allows the observation of living tissue. Resolution is also higher. The technology will lead to direct examination of tissues in human patients.

Listening To The Big Bang

GREENBELT, MD—Scheduled for Delta rocket launch next year, this 5000-pound spacecraft will probe radiation left over from the birth of the Universe.

COBE (for Cosmic Background Explorer) will orbit 560 miles above Earth for a year. The craft will aim away from both Sun and Earth and float along the line between

night and day in a spiraling pole-to-pole orbit.

Crucial to COBE's success is the liquid-helium cryogenic system that will chill the craft's instruments. Its detectors—paper-thin diamonds coated with gold—can respond to the passage of a single cosmic ray.

COBE will look for unevenness in the radiation's intensity, evidence for lumps in the early Universe that later became galaxies.



Skirt shields COBE's instruments from radiation sources.

Big Island Blast Off

MAUNA LOA, HI—The Hawaiian volcano would be a prime spot for an electromagnetic space-vehicle launcher powered by superconducting coils, according to Orbital Transport Services, a Phoenix-based company.

OTS has proposed a launch facility that it claims could charge one-tenth of the cost of a rocket or Shuttle launch. The design calls for a 5-mile launch tube buried along the volcano's shoulder. Wrapping the tube like rings on a finger are superconducting electromagnetic coils. When charged in rapid succession the coils induce a wave of magnetic flux that pushes magnets on the payload vehicle. Acceleration reaches 1000 Gs in 2 seconds. The vehicle exits the muzzle end of the tube at 21,000 miles an hour climbing at a 12° angle. Fifteen seconds later it reaches a 500-mile altitude, where an on-board booster kicks it into a circular orbit.

Providing the needed electrical muscle has hampered previous electromagnetic launch efforts: The system calls for 10,000 kilowatt-hours of electricity delivered in a second. The answer may lie with superconducting magnetic energy storage coils that would absorb energy from a local utility during low-consumption periods. New high-temperature superconductors could bring down the cost of magnetic energy storage.

Ice plays a big role in the OTS concept. Lowered to cryogenic temperatures until the instant of launch, ice keeps the on-board magnets superconducting. Because of its high specific heat, ice would be an ideal heat shield during passage through the atmosphere. Moreover, a payload of ice delivered to an orbiting water-dissociation facility would provide in-orbit liquid oxygen/hydrogen fuel for spacecraft. (Please turn to page 21)



Electromagnetic launch charged by three magnetic storage coils.

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Pictured left: Walk mower with optional catcher. Inset: With optional Pac-N-Sac.®
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See riding mower inset



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Pictured right top: Rider with optional twin bag. Inset: Twin bag. Bottom: Lawn tractor with optional twin bag. Inset: Decks.

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Bridge Test

DURHAM, NC—Two Duke University professors have created a device which diagnoses a bridge in much the same way an electrocardiogram reads a heart.

How a bridge shakes naturally reflects its overall health. The inspection system requires one engineer to pound one end of the bridge with a sensor-tipped hammer. A sensor, about the size of a tin can, picks up the vibration at the other end. Should that vibration hit a major structural flaw—such as a crack in a girder—the frequency signature will change. Both the hammer and sensor are wired to a



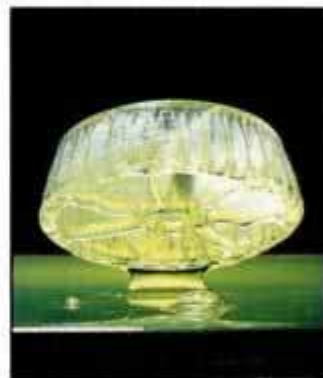
Duke researcher Moy Biswas hammers plastic bridge model.

computer which will quickly analyze the two frequencies with an artificial intelligence program. The computer calculates where the problem lies. The device's developers say most monitoring methods used today rely on visual inspections that don't reveal the total health of a bridge. The acoustic system may help prevent the spectacular bridge collapses that have highlighted America's weakening infrastructure.

Instant Model

SAN GABRIEL, CA—Translating a computer design into a 3-D model is a 1-step process with stereolithography, developed by UVP, Inc. The key is a liquid plastic that hardens when hit by ultraviolet light. A UV laser beam, guided by cross-section specifications from the computer, scans the surface of a small vat of the plastic. The surface solidifies and is

lowered slightly into the vat so a thin film of liquid plastic is exposed to the laser. Cross section by cross section, a model is built up. The system may save thousands in prototype-tooling costs.



Finished model lifted from vat of liquid plastic.

Supercomputing Advances



Superchip, dwarfing normal chip, will run 1990s military spacecraft.

NEW YORK, NY—The personal supercomputer may be a hot consumer item in the next decade if hardware breakthroughs keep up today's pace.

As usual, military requirements are propelling the leading edge. Contracted by the Defense Department to develop Very High Speed Integrated Circuits (VHSICs), TRW and Motorola are taking the "superchip" approach. Each superchip, about the size of a credit card, contains millions of transistors instead of thousands.

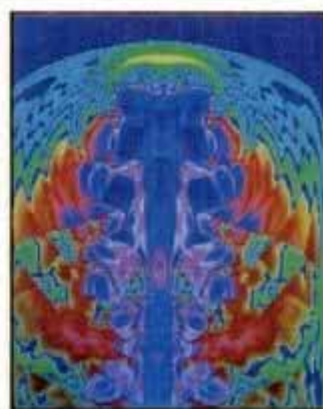
In the program's final phase, the devices will be half a micron wide—a hundred times thinner than a human hair—and will be carved with electron beams because light waves are too wide. The circuits will include self-diagnosing devices that can isolate malfunctioning regions on the chip and replace them with on-chip spare macrocells. Self-repairing, redundant circuitry ensures a long lifetime—important for space applications.

Magnetic disks have already reached the 1/2-micron

milestone. Engineers at IBM's Almaden Research Center trained an electron beam on a 3.5-in. disk and etched tracks a 1/2 micron wide out of a cobalt-alloy thin film. They then recorded, read and erased 1/2-micron-sq. bit cells, magnetized regions along the tracks. At these dimensions, a 3.5-in. disk could hold 10 billion bits of information or 620,000 double-spaced typewritten pages. Meanwhile, the fastest and most powerful un-



Superdisk being mounted on IBM's test equipment.



ETA-10 will animate fluid dynamics images.

classified number-cruncher on the planet—the ETA-10—is being brought up to full speed at the John von Neumann Center in Princeton, New Jersey. The first Class VII supercomputer, the ETA-10 will eventually handle 10 billion operations per second. The fastest nonmilitary Cray supercomputer hits 2 billion at its peak. Not to be outdone, Cray Research is working on a machine at 20 billion operations per second. And this year Silicon Valley-based Dana Computer, Inc., is expected to introduce its new single-user supercomputer for under \$100,000. The days of desktop supercomputing may be close.

(Please turn to page 24)

Novel Telescope

MAUNA KEA, HI—Probing the most transparent skies in the Northern Hemisphere, the James Clerk Maxwell Telescope is capable of viewing the heavens in submillimeter wavelengths.

To ensure complete sky coverage, the telescope resides in a 150-ton revolving building. The reflector is divided into 278 independently adjustable panels so that the 50-ft. aluminum structure always presents a parabolic profile to the heavens. A plastic cover guards against the Sun's infrared radiation while letting through submillimeter wavelengths.

Falling between infrared and radio wavelengths in the electromagnetic spectrum, submillimeter waves are hard to detect at sea level because water vapor absorbs and scatters them. But the



Telescope's housing gives clear view while blocking winds.

top of Mauna Kea towers over an inversion layer that keeps moisture and pollution miles below the telescope.

In the Milky Way and distant galaxies, clouds of relatively cool gases—infant stars and planets—emit energy whose characteristic frequencies reveal the gases' chemical composition.

The James Clerk Maxwell's instruments can be tuned to specific wavelengths and will give astronomers their first look at this intergalactic energy.

Charged Rotary

MOLINE, IL—John Deere's SCORE (Stratified Charge Omnivorous Rotary) engine offers stratified-charge combustion and 2-step fuel injection that lets the second chamber's fuel mixture be very lean. The engine can use gasoline, diesel, jet fuel, kerosene or alcohol without modification.

Though stratified charge has been used on reciprocating engines like the Honda

CVCC, Deere contends its use in a rotary allows the strata to remain relatively stationary as the rotor moves, providing more complete combustion.

Other SCORE advantages include a modular design and unusual lightness for its rated power. The engine's initial applications will be in military vehicles.



80-hp SCORE could fit in a bowling bag.

LONDON PICTURES SERVICE PHOTO

DEERE & CO. PHOTO

Sweeter Sweet Spot

NEW YORK, NY—Tennis elbow plagues pros and amateurs alike. Shots that miss the sweet spot in the racket's center rattle and twist the racket, straining arm tendons.

Dynaspot Corp., has outfitted a racket with a movable mass to counter the torque of off-center shots. A hollow ring attached to each face of the racket frame contains a viscous fluid. Centrifugal forces induced by an off-center impact send the fluid to the top of the racket for a below-center shot, to the bottom for an above-center shot. The movement counters the twist, reducing the torque to the player's arm and powering more accurate shots. The racket frame, made of lightweight graphite, has had nonstructural ribs removed to make up for the weight of the fluid.

Meanwhile, Swedish inventor Bengt Petersson has devised a system, known as Stringset, that uses elastic tubes applied as sleeves to outside strings. The tubes buffer the racket's frame—and consequently a player's muscles—against the vibrations triggered by off-center shots. Players sidelined by tennis elbow have used Stringset rackets while recuperating.



Dynaspot racket uses shifting fluid to counter torque.



Stringset tubes frame sweet spot and dampen vibrations.

DYNASPOT PHOTO

TOOLING PROMOTION PHOTO

(Please turn to page 24)



Bayliner's 1500 Capri Bowrider

**IT SHORTENS THE DISTANCE
BETWEEN YOU AND THE WATER**

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**...and even
the trailer
is standard!**

At this kind of price, with this kind of equipment, Bayliner has made it easier than ever to get into boating and out on the water. The 1500 Capri Bowrider is just one of nineteen Bayliner Total Value Packages for 1988: a complete boating outfit, equipped with a boatload of standard features including AM/FM cassette stereo, custom swim platform, canvas top and a power-mated 50 hp electric-start Force outboard...and for effortless towing and launching, a matched Escort galvanized trailer.

Bayliner pioneered the packaging idea, and only Bayliner has the size, experience and commitment to



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make top quality so affordable. Like all Capris, the 1500 features Bayliner's exclusive Unitized Construction, with a rigid stringer system of alaska yellow Cedar...lifetime-guaranteed cleats...marine-grade vinyls and exterior-rated carpeting throughout. All at a price no other builder can match.

No wonder Bayliner has become the world's largest builder of pleasure boats.

Discover for yourself how affordable boating can be, with a visit to your Bayliner dealer. Find him in the Yellow Pages or write for the name of the dealer nearest you.

*Manufacturer's suggested pre-season special price in effect at participating dealers. Actual prices set by dealer. Taxes, license, freight, options and dealer prep charges extra. Prices may change without notice.

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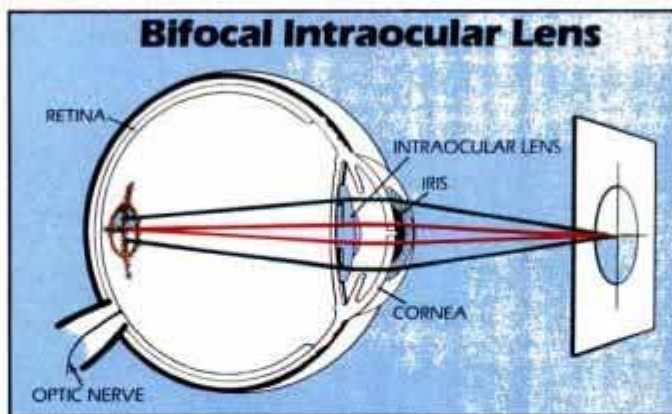
B A Y L I N E R

Manufactured by Brunswick Corporation, Seattle, WA

Bifocal Implant

COLUMBUS, OH—A surgery team at Ohio State University has had success with an artificial lens for cataract patients that corrects for both close and distant vision. Called a bifocal intraocular lens, the implant replaces an eye's natural lens if it is clouded by a cataract.

A bifocal implant features a thicker optical center that focuses light rays from close objects on to the retina. An



Bifocal lens transmits both focused and blurred images.

ILLUSTRATION BY GEORGE REISECK

out-of-focus image also falls on the retina, because light rays that pass through the outer ring of the lens aren't focused as strongly. Conversely, rays from a distant object are focused correctly by the outer rim and overfocused by the center. Yet in each case the brain's circuitry filters out the blurred image: The viewer "sees" only the sharp image.

The next step, says Ohio State ophthalmologist Richard Keates, is a trifocal lens.

High-Tech Help For The Handicapped

NEW YORK, NY—The challenge of engineering devices for disabled persons continues to spark innovations.

Moving around town may never be easier than with Handimobile, the only vehicle in the world that allows a handicapped person to get in and drive away without leaving a wheelchair. The car is made by a division of Yvars S.A., the French manufacturer of bicycles, motorcycles and minicars.

Handimobile comes in two versions: a diesel-powered vehicle that can reach 26 mph or a model with a 2-stroke gasoline engine and a top speed of 42 mph. In both types, the driver wheels in through the rear after lowering the vehicle's floor by re-



INTEXPHOTO

driver turns a stick for acceleration and pushes it in for deceleration and braking.

Although stair-climbing and racing wheelchairs have already captured attention, a new motorized chair may prove more popular because it allows movement without the complex maneuvering of conventional wheelchairs.

Designed by Intex

ALEXIS and one of its roller-rimmed wheels.



mote control. An electromechanical blocking system secures the wheelchair in front of a steering wheel. The

Medical Technologies, the chair—known as ALEXIS—runs on a unique 3-wheeled base. Each wheel is ringed by 20 rubber rollers instead of a single tread, allowing the wheel to move sideways as well as forward and backward. Controlled by a joystick, ALEXIS can also rotate on its own footprint. ALEXIS also features a pneumatically adjustable back support that allows the chair to be fitted to an individual.

Meanwhile, a robotic device may open up new worlds for people who are both deaf and blind. Communication with a deaf-blind person requires the use of tactile fingerspelling, a system in

which the speaker joins hands with the "listener" and spells out words in a sign language. But few people know how to fingerspell and the procedure is fatiguing.

The solution: Dexter, designed by Stanford University engineers in collaboration with the Smith-Kettlewell Eye Research Foundation. Dexter is a pneumatically powered electromechanical



ALVISE/JOHNSONPHOTO

Talking to Dexter.

hand linked to a computer. A speaker types his message in through a keyboard. The computer translates the input into signals that control valves below the hand's wrist. The valves direct air pressure to pneumatic actuators that tug on cables, the tendons of the hand.

The only drawback to the system is the transition from one letter to the next—Dexter returns to a neutral interletter position, slowing down communication. The next-generation Dexter will accommodate a 26x26 matrix of letter-pair transitions. Future systems may be hooked up to telephones also.



GATEAU/PHOTO

Handimobile minicar accommodates wheelchair by lowering floor.

Get enriched quick.

Want a big return on a small investment?

Here's the deal. A cigarette that gives you all the rich, smooth satisfying flavor you want, with even less tar than other leading lights. How do we do it? Enriched Flavor.[™] How do you get in on it? Invest in a pack of Merit.

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INTRODUCING
THE ALL-NEW SHAPE OF
ALL-WHEEL DRIVE.



M E R C U R Y T O P A Z

The engineers who designed the new Mercury Topaz weren't satisfied with conquering the wind alone. So they created a car that also conquers the weather: the 1988 Topaz with optional all-wheel drive. The redesigned shape of the four-door Topaz is more than just a work of remarkable style, it contributes to a remarkable sense of driver control. It directs the force of rushing wind to help keep the car pressed to the road surface. The result?

Improved handling at highway speeds. Topaz has also been dramatically reshaped inside to enhance driver control. The all-new instrument panel puts every analog gauge within your



field of vision, and every control where your hand expects to find it. All to help you keep your eyes on the road in front of you. For times when that road is covered with rain, mud,

snow or ice, the 1988 Topaz offers the all-wheel-drive option.

MERCURY



Just press a switch on the overhead console for a significant increase in traction. (However, this system is not designed for off-road use.) To make you feel even more secure, there's our 6-year/60,000-mile limited powertrain warranty. Certain restrictions and a deductible apply. So ask to see a copy of it at your Lincoln-Mercury dealer. For additional information about the new Mercury Topaz, call toll-free 1 800 822-9292.

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CAR CLINIC

(Continued from page 28)

I like it—I like it, because as you indicated, your experience may be just the answer for others who are facing the same problem. Thanks for telling us about it.

Holy Mackerel

My 1986 Chevrolet Caprice Classic Brougham (305-cu.-in. V8) has a hangup in cold weather. When the temperature hits 10° and colder, the transmission won't shift out of First gear until the engine revs up really high. At warmer ambient temperatures, it shifts normally. This has happened the past two winters. The dealer has installed a new governor. Now he wants to charge me \$100 for a fishing expedition. He says he doesn't know why this happens and will have to do a series of tests. I would appreciate any information I can get on this problem, so I can tell the dealer where to look. Is there a technical service bulletin (TSB)?

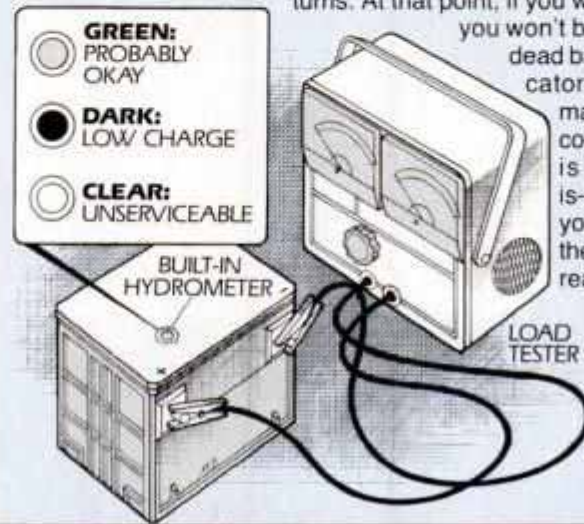
ROBERT CAMPBELL
BURLINGTON, VT

I haven't found a TSB covering this so let's look at other possibilities. First, it's possible the condition may be normal. Automatic transmissions have a tendency to demonstrate a higher 1-2 shift point

Battery Survival Test

Winter's just about over. Did your old battery survive? An inspection and a load test will let you know. Examine the battery for cracks, bulges and loose terminals. Assuming it's a maintenance-free battery equipped with a hydrometer indicator and the indicator shows clear, don't even think about charging it. It's out of water, and could possibly explode if you try. You can, though, keep the battery in service if it still provides sufficient cranking power. If not, replace it. To be on the safe side, also test the car's charging system.

If the indicator is dark, charge the battery. If a green dot doesn't appear, the battery is iffy. Then test it on a carbon-pile load tester. If it delivers just a little less current than spec, you'll probably be able to keep it in service until cold weather returns. At that point, if you want to assure yourself that you won't be left out in the cold with a dead battery, replace it. If the indicator is green and you want to make sure the battery is in top condition—a green indicator is not a guarantee that it is—do a load test. Finally, if your battery has no indicator, the only way to make sure it's ready for the spring and summer is to load test it and, if necessary, charge it.



THE PORTABLE, SPORTABLE, WINCH FROM WARN.

The Portable Winch from Warn is so versatile, you'll wonder how you ever got along without it. Think of it this way... because you can mount the Warn



Portable Winch to the front or rear of your vehicle—or even carry it to an anchoring position completely away from your vehicle—that means your hardest job is going to be giving the Portable Winch a break every once in a while.

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brush to pulling tree stumps to stretching wire fencing, you simply attach it temporarily to the front or rear of a vehicle, put it to work, then pack it up again. Or, because all you need is a power source, you can carry the winch and a standard 12-volt auto battery to places your vehicle can't even reach.

So if ever you needed a good stiff pull to get the job done, whether it's field chores or just fun and games with an off-roader or ATV, the Portable Winch from Warn is what you're looking for. It works harder so you don't have to.

Available by direct mail: P2000 winch, pn22954 \$299.00 + \$15.00 S&H. Send to Warn Industries, 13270 S.E. Pheasant Ct., Milwaukie, OR 97222. For information on other winch models and mounting kits, Call 1-800-225-5965.



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in cold weather. Assuming the cold weather-induced higher shift point is not normal, several areas become suspect. An excellent place to start is by changing the fluid and the filter, using only the proper Dexron II ATF for the re-fill. The wrong type of fluid, contaminated fluid, or some additives could possibly be gumming up the valve body in cold conditions. Towing too heavy a trailer in hot weather may overtax the transmission's cooling, and deteriorate the fluid.

Note: Check for frozen condensation in the vacuum modulator line.

Next is the governor. You've covered that. Another possible culprit is a servo accumulator seal that's being affected by the cold—that is, shrinking and not sealing fully—thereby allowing a loss of pressure which causes the transmission to shift abnormally. Another possibility is with a check ball in the valve body that is sticking because of improper machining of a piston or bore. This will restrict the flow of fluid which in turn can increase 1-2 shifting effort.

It seems to me that the amount the dealer wants is valid, because of the time it may take a mechanic to check out the servo accumulator and the check ball in the valve body. For example, he'll have to test pressure under cold weather conditions to determine if the servo accumulator seal is being affected. And in order to rule out a sticking valve-body check ball, he'll have to pull the valve body.

SERVICE TIPS

■ If you're getting a disturbing reading on your built-in-the-U.S. Chrysler Motors car, van or light truck oil-pressure gauge, an incorrect oil-pressure sending unit may very well have been installed at the factory. Therefore, before your dealer strips the engine down to socks and shorts, he should read what the Chrysler Motors Hot-Line Newsletter No. HL-45-87 has to say about erratic and low oil-pressure gauge readings.

■ Has the paint on a front end panel of your 1987 Skyhawk blistered? According to Buick TSB 87-10-30, the condition may be the result of excessive primer having been applied.

■ Nissan has issued this urgent message to owners of 1986-88 Stanza 4-wheel-drive and 1987-88 Sentra 4-wheel-drive wagons: "It is very important that regular tire rotation be performed according to the maintenance schedules" to equalize tire wear. If the front tires are permitted to wear more than the rear tires, shifting out of 4-wheel drive may become a hassle.

■ It's an even money bet that the cause of intermittent hard starting or missing with a 1987 Jeep Cherokee, Wagoneer or Comanche having a 4-liter L6 engine lies with the distributor stator harness. If your dealer needs verification of this, ask him to check page 8 of the October '87 Jeep Product Information Diagnostic and Service Tips pamphlet.

Synch Sunk

My problem is with a 1987 Mercury Lynx XR3 that frequently grinds its gears when I shift into Reverse. My mechanic said this is normal. Is this true?

YITZCHOK GLATZER
BROOKLYN, NY

Let's see. Start the engine, hold the clutch pedal 1 in. off the floor and count off 2

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.

seconds. Shift into Reverse. If you get a clash of gears, which I don't think you will, you've got a clutch problem like a warped plate or disc, or a bad pilot shaft bushing. If you don't get a clash of gears, which will probably be the case, then your mechanic is right—a clash can be expected if you shift into Reverse too quickly. Reverse gear in this 5-speed manual gearbox is not synchronized. Spin-down time to allow shifting into Reverse without gear clash is 2 seconds. That's the way it is, so get used to it. If you're in a hurry, just put the transmission into a forward gear briefly before Reverse to stop all the whirling about. **PM**



Each boat's hull configuration is engineered to meet exacting performance requirements. Designers think in terms like "reverse chine," "dead rise," "hull lines" and "lifting strakes,"

so boaters and skiers can think in terms like "handling," "optimum wake conditions" and "smooth ride."

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TOOL TEST

Quick-Grip Drill Press Clamp

I RECENTLY discovered a quick and easy-to-use drill press clamping device that is sure to make all drill-press work safer. Called the Hol-Down, it consists of a single cast-aluminum arm that mounts on the drill press column. The clamp sets up quickly and swings out of the way when it's not needed. In fact, the clamp is so easy to use that it discourages a very dangerous, yet common, practice—holding a workpiece by hand while drilling.

The clamp comes in about 75 sizes to fit drill presses ranging in size from 12 in. to 20½ in. Regular size clamp costs about \$105 and it fits drill presses with column diameters from 1¾ in. to 3¾ in. A larger clamp (\$130) fits col-



Single-arm clamping device provides an effective way to secure workpieces to the drill press table. Simply swing the arm over the work, then lower and lock it to the column with the handle.

umns from 3½ in. to 4 in. wide. Note: the Hol-Down can't be used on columns fit-

ted with a rack-and-pinion table elevating mechanism.

Optional accessory kits of-

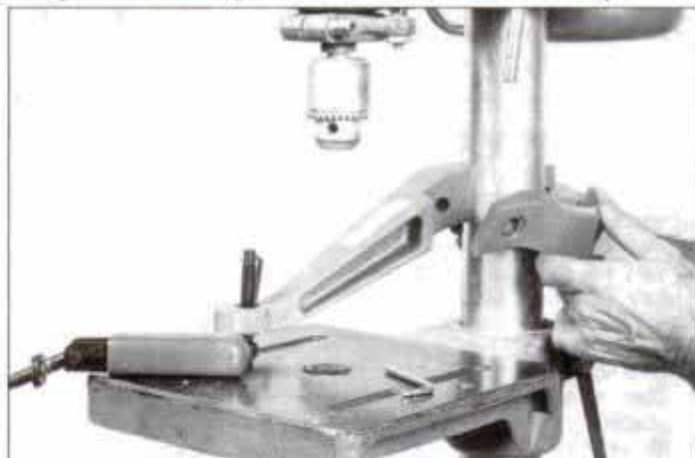
fer add-on components that make the clamp more versatile. The accessories include a screw jack that allows you to increase the clamping pressure, a nonmarring rubber-pad cover, a straight aluminum extension bar, offset extension, and a notched holddown for securing pipe, rod and other round stock.

Each Hol-Down is designed to fit a specific-size drill press. Therefore, it's necessary to furnish the manufacturer with these dimensions: distance from center of spindle to column, column diameter and distance from center of spindle to center of column. Contact Distim Corp., 207 Evesham Rd., Runnemede, NJ 08078. Or call: (609) 227-7904.

—Rosario Capotosto



Hol-Down clamp is shown above with the add-on components from the accessory kit. The cast-aluminum arm comes in various sizes to fit most drill presses with columns between 1¾ in. and 4 in. dia.



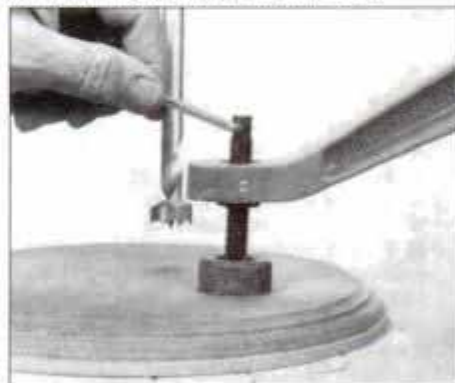
Installing the 2-part arm to the drill press column is easy. The only tool needed is a hex-key wrench. After the arm is secured, install the handle. Handle can be mounted on the right or left side of the tool.



Use the screw jack to increase the clamping pressure. Also, the screw jack allows you to reposition the work without raising the arm.



To securely clamp pipe, tubing, dowel rod and other round stock, use the handy pipe holding accessory that features a V-shaped notch.



To prevent marring wood and other soft workpieces, use the rubber pad. Pad slips onto the swiveling base of the screw jack.



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Power Equipment

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INSIDE DETROIT

BY JIM DUNNE

Diamond Star

IT'S TOUGH to keep a secret. Chrysler recently held a consumer clinic for this 4-place sporty coupe that the company plans to build in Illinois as a joint venture with Mitsubishi.

The clinic was run by a marketing firm that specializes in consumer sampling. A large number of potential buyers are invited to clinics to view new models and give their opinions.

As a rule, secrecy and security are paramount, with guards covering all entrances. In some cases, "wanted" posters of potential spies are passed out to security personnel.

But somebody goofed here. One professional spy photographer caught wind of the clinic and snapped off a dozen clear shots of the new car. Even worse, one of the invitees to the clinic brought



Mitsubishi-Chrysler Diamond Star debuts in '89 with nameplates from Plymouth, Eagle and Mitsubishi.

Insiders at the Jeep Eagle division of Chrysler say that a 4-wheel-drive version of the sport model will be sold under the Eagle logo. In addition, Plymouth and Mitsubishi both have plans to sell variants of this car.

Aerostar Stretch

Compact vans are fine, but more room is always nice. That's why Ford plans to stretch its Aerostar van at least 15 in. next year when it

Why The Thunderbird Will Look Different

Ford will reverse the recent trend in car design when the 1989 Thunderbirds (and Cougars) hit the streets this fall with a much longer wheelbase than the current cars.

Reports say the wheelbase will stretch to 113 in. from the current 104.2 in. However, the overall length of the body will remain close to the 200 in. of the '88 model.

What you will see is less overhang at each end, and a different proportion. This is a turnabout from the practice of shrinking or stretching the wheelbase only in proportion with the length of the car.

A couple of advantages show up, in addition to a fresh appearance. Ride is improved because of the longer distance between front and rear wheels. And, more foot and leg space is added to the passenger compartment.

Note that Ford will keep its rear-drive chassis in the Thunderbird and Cougar next year, even though their prime competitors from GM—Grand Prix, Cutlass Supreme and Regal—have all been switched to front-wheel drive.

V12 Cadillac

More surprises are coming in the Cadillac Voyage concept car. One official says the Voyage will have a 4-wheel-drive chassis, driven by a completely new V12 engine. While details are still secret, the engine is a Cadillac in-house design that uses aluminum for the block and heads. Chassis layout has the engine set in a north-south position under the hood, instead of east-west as in most Cadillac models, owing to the length of the bigger engine.

Chuck Jordan, GM's chief of design, points out that the Voyage is more a Seville type car, though its dimensions are larger than the current luxury 4-door.

"Another thing we've done is drop many of the traditional Cadillac styling cues from this car," Jordan points out. "Taillights, for example, have been emphasized as a strong theme for many Cadillacs. On the Voyage, though, the lights are hidden, so there is no carryover at all."

If and when Voyage does get into production, look for it to compete against the most expensive BMW and Mercedes sedans, pushing

(Please turn to page 36)



New-generation T-Bird rolls with more wheelbase, less overhang.



Ford's Aerostar for '89 has 18 in. grafted on behind rear axle.

along a camera and also came away with some excellent pictures.

What the clinic showed was the new line of Diamond Star cars. Four versions of this model will be built, with a price range of about \$9000 to \$16,000. Differences in the models include trim packages and engine options. The least expensive car will have a 1.8-liter engine. Upscale from that will be a car with a 2.0-liter Four.

A luxury model will have a 3.0-liter V6, while the top sport model will use a 16-valve, turbocharged, inter-cooled 2.0-liter Four.

adds this new model to the line. More storage room for passengers or more work room for commercial vehicles is the goal.

All of the added room will be to the rear of the rear wheels. Rear seats in the passenger van will be moved rearward a few inches to provide more legroom, but there are no plans to add a third seat at the rear.

Look for GMC and Chevrolet to offer stretched versions of their Astro vans next year too, as they join Ford in following the lead of Chrysler's highly successful Caravan and Voyager.

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Save \$1200

Only in a Jeep® Comanche



INSIDE DETROIT

(Continued from page 34)

the \$75,000 price plateau. When is the soonest the Voyage could be in showrooms? No sooner than 1991.

Buick Is First

Of the five concept models shown by GM in January, the one that could spawn the first production version is the Buick Lucerne. The sleek 4-place 2-seater is said to be close in appearance to the next Buick Riviera, which is scheduled for a radical styling change in '91.

Styling is not the only change set for the next Riviera. If the Lucerne concept

is followed, the Riviera will be 22 in. longer at 209.2 in., and ride on a wheelbase stretched 5.3 in. to 113.3 in. Underneath the drooping hood will be a 32-valve V8 engine replacing the 3.8-liter V6 now standard in the flagship model.

Despite its streamlined body shape, the interior of the Lucerne is just as roomy as the current Riviera. The instrument panel still has the TV screen in its center for control of the car's comfort and entertainment functions.

GM Power Plans

While the bigger V8s and V12 of GM's concept cars are undergoing long-range

development, the company is working on injecting more power into its smaller engines. Cosworth Engineering of England, developer of many racing powerplants, is designing multivalve heads for Cadillac's 4.5-liter V8 and Buick's 3.8-liter V6 engines (also used in Oldsmobiles and Pontiacs).

Those powerplants should make their appearance by 1990, if current schedules are kept. With four valves per cylinder, the new engines should eliminate a common criticism of GM's sedans—their general power shortage.

Chevy and Pontiac are closer to production of a multivalve V6 of their own, one of 3.1-liters displacement. It will be the performance option for sporty cars, including Fiero, Grand Prix, Beretta, Eurosport and 6000 STE.

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GEO Tracker

A new name pops up for Chevrolet's 4-wheel-drive utility vehicle of the future. GEO Tracker is a Suzuki-design that Chevy will introduce later this year as a 1989 model.

The Tracker will be built in Japan, but by 1990 Suzuki will have an assembly plant producing in Canada as well. The Canadian plant will supply Chevy and GMC dealers starting that year.

Not as small as the popular Suzuki Samurai, the GEO Tracker fits in Chevy's lineup just below the S10 Blazer and S15 Jimmy. Compared with the Samurai, the GEO Tracker is 7 in. longer, with 7 in. more wheelbase and uses a 1.6-liter engine (versus Samurai's 1.3).

Two models—a convertible and a hardtop—will be built for Chevy, GMC and Suzuki dealers.

Rotary Engines Alive

Mazda has not given up on the rotary engine, judging by the company's MX-04 concept car. A smaller, lightweight rotary was unveiled with the MX-04, one that runs easily at 10,000 rpm.

The new 1.0-liter powerplant weighs 66 pounds less than the 1.3-liter rotary now used in the RX-7 sports car, mainly because of the use of aluminum, rather than cast iron for its case parts.

In the MX-04 front-drive layout, one driveshaft tunnels through the engine's oil pan, allowing the engine to be placed in a lower position.

Escort Holdup

A completely redesigned Ford Escort, based on the Mazda 323 chassis, has been set back from its planned 1991 launch date because of cost problems.

Costs in retooling the car are said to be far more than Ford wants to invest in the Escort, which is a low-profit model. Look for Ford to take a cheaper route, and revise the Escort using an American chassis, similar to the one used for the current model. **PM**

ELECTRONICS

BY STEPHEN A. BOOTH

Phantom Key

IT SEEMS nowadays there's a personal access code for everything. Want cash from your bank account? Tap out your code for the automated teller. Bill a phone call to your home number? Punch in your PAC for the operator.

In this digital age that swaps numbers for your name, it was only a matter of time before you'd need a numerical code to get into your own home. And that's just what the Schlage Lock Co. has drummed up with its Key N' Keyless lock system.

Electronic keyless-entry systems for hotel rooms require you to slip a coded card in a slot. The magic doors and ignitions for some automobiles make you enter numbers on a keypad. But all the Schlage Key N' Keyless wants you to do is turn a doorknob. The top of the lockset panel contains an illuminated display that shows the numbers of your combination as you enter them, by twisting the knob right or left. Once you've dialed in the correct digits, a "U" on the display and an audible indicator advise you that the door's unlocked. You've got 16 seconds to enter before the system relocks. It also locks again automatically after you've shut the door.

In this basic package, Key



Exterior of keyless lock (left) displays code you dial by turning knob. Infrared signal opens deadbolt. Electronics are indoors (right).

N' Keyless costs \$79, but there's more. The \$149 Key N' Keyless Security Set adds a deadbolt and an alarm. When you've entered your code, the Key N' Keyless sends an infrared signal to the deadbolt, enabling you to retract the bolt simply by turning a ring. The alarm issues a warning if there's any attempt to tamper with the lock or break your code.

Speaking of codes, you can roll your own from any of 10,000 possible combinations. And you may select two different codes to be used for entry, and change them at any time. You might, for example, confide the second code to a neighbor who'll be checking your house while

Sonin unit uses ultrasonic waves to measure distances.



you're away, then change the code back after you've returned from vacation.

Key N' Keyless works for up to two years on four AAA cells and one 9-volt battery, according to Schlage. You always retain the option of using a conventional key to enter, and your door opens conventionally from the inside when you wish to exit. Installation is no different from conventional locksets.

Soundings

No, this columnist's mind has not been invaded by an alien from the Home & Shop Department. But if the doorlock has gone electronic, so too has the tape measure.

From Sonin of Scarsdale, New York comes a line of electronic instruments that

measures distance with ultrasonic waves. You simply place the Sonin device against a wall, aim it at the opposite wall and a precise reading emerges on the unit's liquid-crystal display screen. The Sonin unit holds measurements in memory, lets you add and subtract and also compute the area and volume of a space.

Three models are available. The Sonin 60 (\$100) operates indoors up to 60 ft. The Sonin 150 (\$135) and Sonin 250 (\$150) come with an electronic target that returns readings indoors or out up to their respective self-named distances.

Magic Memo

Afraid you'll forget your personal access code or the Sonin measurements you've just taken? You could jot 'em down on a slip of paper. Or you might enunciate them into the Voice Memo (\$30) from Plus U.S.A.

The device is a palm-size audio recorder that uses a memory chip in place of tape to record for up to 30 seconds. Simply press the RECORD switch to leave a memo. When you've finished, an indicator light signals you or someone else that a message is waiting. **FM**



Voice Memo is a tapeless recorder for 30 second messages.



OUTDOORS

BY JOE SKORUPA

Yamaha Stirs Up The Waterways

EXPECT a lot. Yamaha Marine opened its U.S. office with a staff of three. The year was 1983. The place was Cypress, California. The goal was to become a major producer of outboard motors.

The problem was Yamaha had no marine dealers, no distributors and no purchase guarantees from boat builders or anyone else.

One thing it had was competition. The big two superpowers, then and now, were OMC (Johnson/Evinrude) and Brunswick (MerCruiser/Mercury/Mariner), the dominant marine power manufacturers in the world.

Still, Yamaha took the plunge. It had a staff of three, an office and, not unimportantly, a feisty slogan—*expect a lot*.

Despite the modest U.S. startup, no one underestimated Yamaha. Few Americans knew it, but Yamaha was already a major international outboard manufacturer, especially in Asia and Australia, and generally considered the largest smallboat builder in the world. It was, and still is, a conglomerate with tremendous resources.

I remember going to the '83 Chicago Boat Show and sensing an anxious buzz in the air. What's Yamaha going to do? What is the product line? Will anybody buy? What happened was Yamaha introduced a line of outboards with precision-blend oil injection, prop-rated horsepower, microcomputer ignition and standard power trim and tilt. Lower-unit counter rotation was made available in two large V8s and a 2-year warranty was offered on the whole line. At the time, these weren't standard features for production-line, nonracing outboards.



Yamaha's '88 130-hp V4 outboard is a harbinger of bigger things to come.

Today they're commonplace.

And that's the point. Like a straw that stirs a drink, Yamaha was a catalyst that stirred the waterways. It may have been billed as a product introduction in 1983, but it was actually a turning point. A series of events were set in motion that resulted in a stimulated boating marketplace producing better and less expensive boats and motors.

"It is now so competitive," says Phil Dyskow, marketing services manager of Yamaha Marine, "if you stand still you get left behind."

Within weeks of Yamaha's entry in the outboard market, a top executive at OMC directed its R & D department to come up with a new line of sterndrive engines. In June of 1985, the Cobra line was born.

Months after OMC's successful entry in the sterndrive market, Brunswick, the world's largest sterndrive manufacturer, began plans to purchase the country's two largest boat builders, Bayliner and Sea Ray. The massive deal was completed in mid-1986.

OMC answered this by purchasing five boat builders of its own, in early 1987—Four Winns, Stratos, Lowes, Sunbird and Bramco.

Which brings us to 1988. This year will be remembered in recreational boating as the year package boats—motor, boat and trailer

combos—broke through as a permanent feature of the marketplace. The recent flurry of mergers and acquisitions, which also included the purchase of Chrysler Marine (now called Force Outboards), by U.S. Marine Power (a division of Bayliner), has resulted in the unprecedented level of vertical integration within the marine industry. Never before have so few companies controlled distribution of so many boats and motors.

And instead of dampening the competitive fires, boaters are witnessing the marketplace heat up. They're seeing better product at better prices than ever before.

Many features once considered options are now standard. Quality control and warranties are stronger than ever, and the trend toward packages, from what I could see at the New York Boat Show, is gathering new converts daily.

"The advantage of buying a package boat," says Clint Moore, director of MerCruiser Products, "is that the boat company, let's say someone like Sea Ray, will do extensive testing to make sure the right motor is all dialed in with the right boat. This is done in the factory, not at the dealership." Everything on a package boat is a known quantity. It's a completely tested system.

As important as getting perfectly matched equip-

ment may be, a major advantage for the boater is ease of purchase. A complete turn-key, boating rig becomes as easy as buying a car. In many instances it may be possible to take possession of the boat as quickly as financing is arranged.

But the real advantage for boaters, and the one that will un-

doubtedly matter the most, is price. Even though the trend is just now starting to take off, price/value ratios are impressive. Consider the following:

■ Bass Tracker Pro 17 aluminum bass boat, with a suggested retail price of \$4995, includes Mercury 35-hp or Mariner 40-hp outboard, Minn Kota trolling motor, Humminbird LCR 4000 graph and trailer.

■ Sunbird Cuddy Special, a 17-ft. small cuddy, for \$8999, with Johnson or Evinrude 88-hp Special outboard, AM/FM cassette stereo, convertible top, sink, ice chest and trailer.

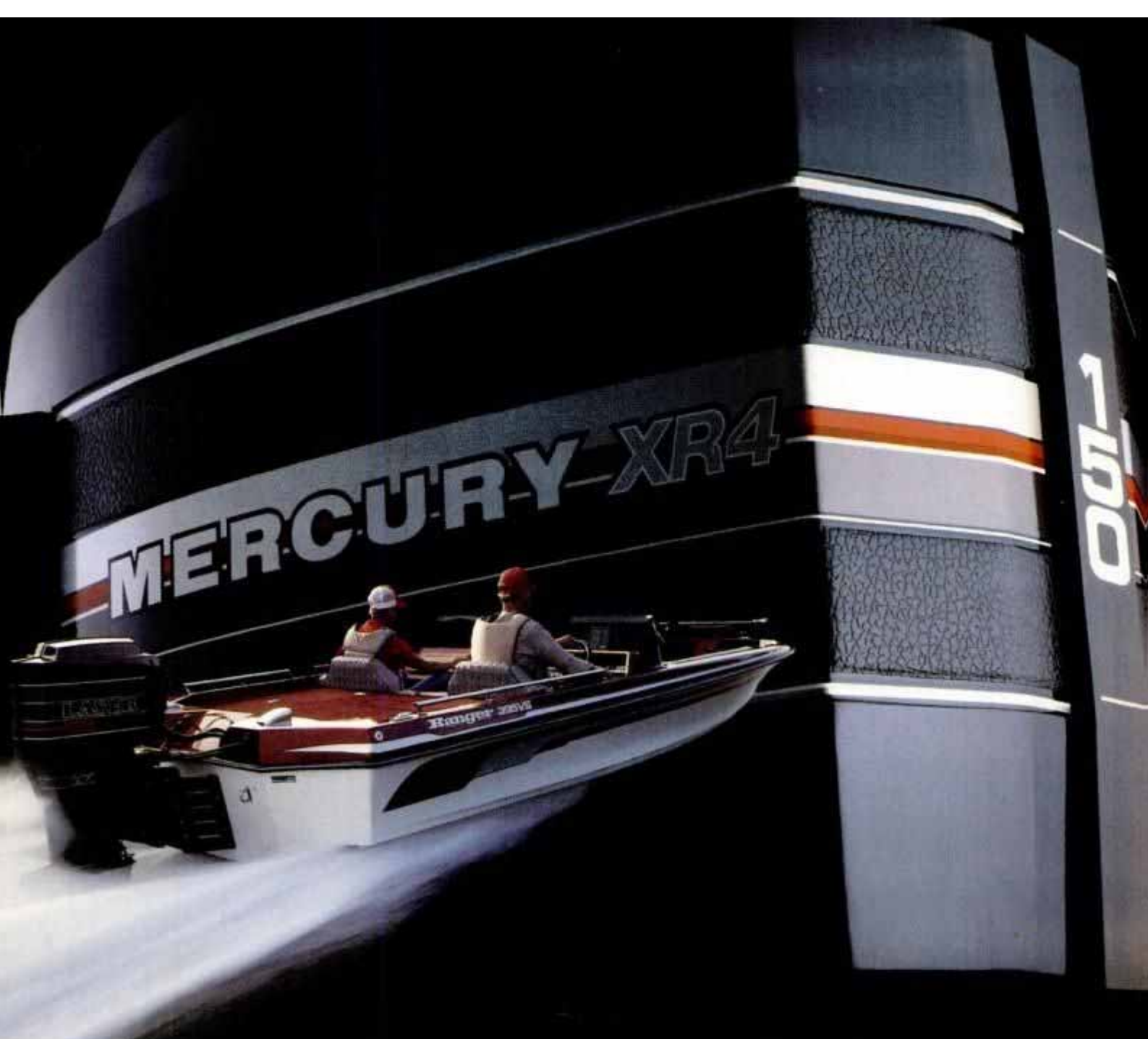
■ Bayliner 1750 Capri, a 17-ft. bowrider, for \$9495, with 128-hp OMC Cobra stern-drive, trailer, swim step and AM/FM cassette stereo.

■ Cajun 168 Sport, a family sport/fish, for \$11,775, with 75-hp Mariner outboard, trolling motor, batteries, instrumentation, trailer, Lowrance in-dash depth finder, swim ladder, ski-tow and canopy top.

Other companies are jumping on the package-boat bandwagon, too. They include Grumman, Monark, Glastron, Maxum, Blue Fin, Lowe, Sea Ray and others.

Tracker Marine and Bayliner, the pioneers in the package-boat field, are still leading the way. For 1988, Tracker Marine offers 24 packages and Bayliner 19,

(Please turn to page 40)



AN UNFAIR ADVANTAGE THAT'S PERFECTLY LEGAL. XR4.

Bass pros are still buzzing about the feats of the legendary Merc 150 XR2. Now its successor promises to propel you even farther ahead of the pack.

SATISFACTION FOR THE POWER HUNGRY.

The Merc 150 XR4 has a dramatically superior power curve, thanks in part to a new, race-bred 2.4 litre powerhead. In fact, on the back of a popular 16½ foot bass boat, it's a full two seconds faster from 0 to 30

than its predecessor—clearly the most responsive package ever harnessed behind a tournament-legal bass boat.

TO BE TOP DOG, YOU NEED TOP END.

The XR4 has been tested a sizzling 5 mph faster at top end than a highly acclaimed competitor. But besides raw speed and power, it boasts Merc's pace-setting Thunderbolt™

ignition for quick starts, dependable single point oil injection, an effortless shift system, and loop charged induction for increased performance and fuel economy.

In addition, only Mercury provides you a 3-year limited anti-corrosion warranty. It's another example of our commitment to deliver the best-built outboards on the water. And another way we intend to continue in the great XR tradition.

**MERCURY
OUTBOARDS**

OUTDOORS

(Continued from page 38)

with 10 of them for less than \$10,000.

And what of Yamaha Marine, the former 3-man company responsible for the current vigor in the pleasure boat market? Today, Yamaha has more than a hundred employees and still creates a buzz at boat shows.

At the fall Chicago Boat Show, Yamaha introduced three new outboard motors: a 3-hp model with loop charging, and forward and neutral shifting, an oil-injected 25-hp model, and a 130-hp V4, which comes with Precision Blend oil injection, integral and remote oil tanks, digital LCD Marine Meter that combines tachometer, trim and oil status lights, stainless-steel propeller, remote controls, tool kit and extra tilt switch on motor pan.

Although these additions to the 1988 Yamaha line are significant, they aren't what sets a boat show through buzzing. OMC displayed its recent King Cobra line of big-boat stern-drives and Mer-Cruiser showcased its high-torque carrying Bravo One outdrive, each of which were highly impressive product introductions.

The outboard that probably grabbed the most attention did so more from cleverness than from any technical ad-



New catalog lists this TV and other appliances you can run off 12-volt battery.

vancement. Suzuki's new Exante V6 outboard has a voice module that actually talks to you. Most motors have audible alarms, this one plays a tape of a female voice when a system needs monitoring. Close but no buzz.

This year's New York Boat Show was different. The buzz was back and Yamaha was causing it. Beginning in model-year 1989 Yamaha and Crusader, the inboard engine manufacturer from Sterling Heights, Michigan, will marinize four General Motors engines to Yamaha's specifications. They'll be marketed under the Yamaha name.

What will this do to present stern-drive builders and the rest of the boat-

ing marketplace? Already there are reports that OMC has signed a deal with Ford Motor Co. to marinize a huge number of new engine blocks for stern-drive power systems. Other rumors, less certain, have OMC and Brunswick poised to purchase additional boat companies.

If the past is a reliable indicator of the future, one thing is for certain—if Yamaha is involved, expect a lot.

Appliances To Go

We all have different concepts of roughing it. For some it means living off the things we carry. For others it means carrying the things we need to live.

A new catalog, put out by 12-Volt Products, 756 Morning Glory Ave., Holland, PA, tells us how to order dozens of handy products that run off 12-volt batteries in RVs, boats and vans. The useful products range from the common to the exotic.

As might be expected, there is a toaster, coffeemaker, hair dryer, heater, air compressor, fan, vacuum cleaner and various lights.

There are also the unexpected items, such as a bug zapper, shaver, air ionizer, broiler oven, clothes/dish washer, color TV, VCR and many more.

Roughing it, for those with a 12-volt battery, will never be the same. **PM**



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But it's so moist, so rich, so full of flavor, most people think it's worth the extra money and extra time it takes to find. Reckon you'll agree.

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**R.L. Polk Registrations, 4x4 compact pickups, CYTD, September, 1987.

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WHO COULD ASK FOR ANYTHING MORE!

IMPORTS

BY BILL HARTFORD

Ferrari Revs Up A Hotter V8

Color it rip-roaring red: Ferrari's new, transverse-V8 348 GTS.



IN A FERRARI—any Ferrari—you back off when entering a 150-mph speed zone. But in some models, you have to back off more than in others. The least adjustment is at the wheel of a 328 GTB/GTS. It comes no

where near flirting with 200 mph like a 12-cylinder, 48-valve Testarossa. But the entry-level, prancing horse model will edge up in mph this year when it becomes the 348 GTB/GTS. A couple hundred more cubic centimeters will tweak the V8.

Less Bounce To The Ounce

Convertible version of Suzuki's '88½ Samurai.



When Suzuki's endearing ute bounced onto U.S. trails and turnpikes, it shook up the whole sport/utility market. Ready to claw into Samurai sales are several more small utes.

To stay ahead, Suzuki has made some running changes.



Upgraded interior shows new dash and steering wheel.

At a glance, you'll notice the new wheels, halogen headlights in a modified grille and new paint colors. Inside is a redesigned instrument panel and other touches. On the road, the smoother ride comes from revised spring rates, and a new Fifth gear reduces drivetrain noise.

Two Volvos Not In The Showroom

Regular, production-model Volvos are claimed to be "bulletproof" in many ways. One ad shows a 6½-ton truck balanced on the roof of a 7-series with no visible crunch at all. Tough cars alright. But if

from all seats, fuel protection and fire extinguisher system and toxic-gas filtration. For more information you can write the company at P.O. Box 99704, NL-2509 GC, The Hague, Holland.



Volvo 760 GLE, rebuilt by Dutch firm, packs heavy defensive gear.

you really want tough, you have to invest in a 760 GLE that has been given the anti-kidnap treatment by Protected Cars Nederland B.V. How secure will you feel? How about staring out the anti-intruder tinted glass while repeated blows with a cleaver are stopped short of your nose? The glass can take it for a minute and a half claims the Dutch company. Other features include run-flat tires, in-grille radiator protection, extra concealed antenna, central locking

Back in March '67 when PM did its story on the new Volvo 144 ("Why Can't American Cars Have Brakes Like These," page 130), the Swedish sedan was priced at \$3200, which included front discs and dual diagonal braking system.

One look at today's basic sedan, now designated the 240 (starting at \$17,000), and you know that Volvo has gotten a lot of mileage out of the old 140 body style. But on the way is a 760-looking successor, seen below. **PM**



New body for the Volvo 240 DL and GL resembles the 7-series cars.

HOME VIDEO

BY FRANK VIZARD

Monocoque Video

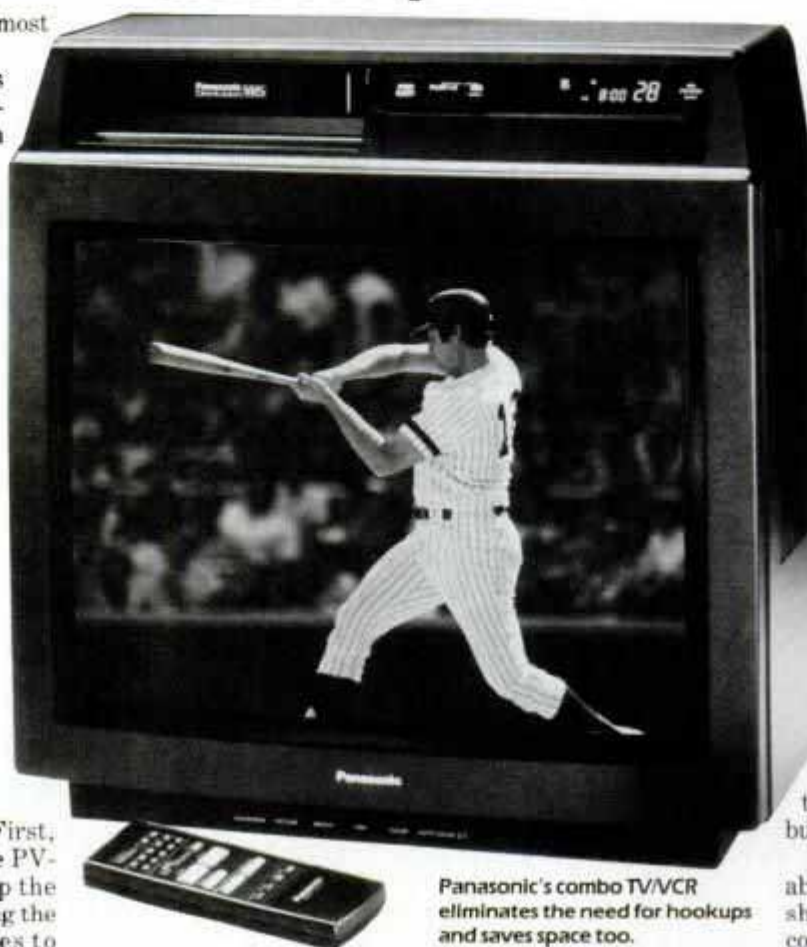
I SUSPECT that most people put their VCRs on shelves beneath the TV or monitor for the simple reason that trying to balance a VCR atop the TV or monitor is just too difficult. But every time I bend to the ankles to load a videotape into my VCR, I do wish there were a way to do it from an upright position.

One solution to the video "bends" is to make the VCR as integral to the television as the tuner. Panasonic appears to be taking the lead in single-chassis design with its introduction of the PV-M2027 combination TV/VCR (\$800).

The PV-M2027 has two advantages, you'll notice, that favor the inactive and the lazy. First, the VCR portion of the PV-M2027 is mounted atop the video screen, eliminating the need to bend the knees to load a videotape.

Moreover, the VCR is automatically activated with the insertion of the tape, and after recording and rewinding the VCR automatically turns itself off.

The second advantage the PV-M2027 offers is lack of re-



Panasonic's combo TV/VCR eliminates the need for hookups and saves space too.

sponsibility—you don't have to know how to wire a VCR to a TV.

These are the two major features of the PV-M2027 but there are others. Both the TV and the VCR are operated via a single unified remote control. One-touch control eliminates the need to keep your finger in constant contact with the control unit while scanning. Other features include a 20-in. screen size, 14-day/2-event programmability and a 60-minute sleep timer.

A good idea always breeds competition. Lloyd's also has a combination TV/VCR with almost the same screen size—19 in. The VCR portion of the L960 (\$1100) offers a bit more flexibility in programming with a 14-day/6-event timer. Lloyd's offers the TV/VCR package in a 13-in. screen size, too, but pro-

by Panasonic in two machines ("Home Video," page 38, Aug. '87), is expanding slowly. Panasonic has added the feature to its new SVHS PV-S4764 VCR. Quasar, Panasonic's sister company, also offers bar-code scanning on a couple of machines. Meanwhile, Magnavox has bar-code programming on its SVHS 9668 machine, and Canon has two VCRs with the feature, the VR-HF730 and VR-HF800.

Bar-code programming employs a pen-like LED scanner which you pass over a Bar Function sheet included with the VCR. Once the appropriate time-on, time-off, channel and date information is scanned, the data is transmitted to the VCR at the touch of a button.

Ideally, it would be preferable to bypass the bar-code sheet entirely so that you could program directly from a television guide. So far, only *Cable Guide* offers bar-code programming and even this is limited to an "Editor's Choice" menu.

Bar-code programming is



RCA's 50-in. set gets 14-in. PIP from second tuner.



Panasonic bar-code scanner makes VCR programming easy.

gramming is limited to a 14-day/1-event timer on the L951 (\$900). Emerson is also getting into the act with a 13-in. TV/VCR (\$700). Both companies join Goldstar's ViewMax (\$700) in this TV/VCR market.

TV/VCR models do offer a great deal of convenience but this convenience has its price. These units are fitted with a single TV tuner so you're giving up the ability to record one program while watching another.

Child's Play

Bar-code VCR programming, first introduced

supposed to make programming a VCR so simple that even a child can do it. I love euphemisms. What these companies really mean is that a nontechnical adult now can program a VCR.

Panasonic's development of bar-code programming, in fact, was inspired by a children's toy. We didn't have bar-code programming when I was a child but I remember amusing myself by throwing things such as my father's shoes out the window.

This made me wonder about the replacement cost of the scanner. It turns out the scanner is pretty expensive to replace—about \$120—so you're not likely to put it into the hands of a child, even though you can program the VCR without the scanner.

Double Vision

Electronics companies aren't in the habit of giving away two TV's for the price of one, but RCA appears to be doing exactly that with the introduction of its new 50-in. monitor/receiver (\$3000).

RCA's P50595 rear-projection TV actually contains two television tuners. Digital technology is then used to offer a picture-in-picture (PIP) feature utilizing the extra tuner. The PIP screen, though, is so large that it is like getting an extra 14-in. TV. RCA takes advantage of this duality by adding separate headphone jacks for the audio of the PIP program. So while the rest of the family watches the big screen, Junior can watch MTV. Both tuners have MTS capability so that all parties can listen in stereo.

The RCA P50595 is also one of the first big-screen products to have Y/C connectors for Super-VHS video cassette recorders. The back panel of the P50595, in fact, sports 14 input and output jacks. This gives you a great deal of flexibility in accessing multiple audio and video sources, as well as for dubbing. With a third tuner from a VCR entered into the equation, you can have PIP within PIP ad infinitum—sort of like looking into a mirror while holding a second one behind your head.

Both tuners built into the P50595 receive up to 149 cable and broadcast channels. Conveniently, a single touch of the Auto Program function automatically presets the channels in your area, thereby eliminating the tedious chore of manual programming. The remote control can also operate compatible (read RCA) VCRs and audio components.

Picture quality, meanwhile, is superb. The P50595 uses an integrated 3-tube reflection system coupled with a aspherical-surface lens for short focal lengths.

Each lens is mounted in an aluminum assembly that maintains its stability through varying temperatures. This resistance to "thermal drift" helps ensure

more stable focusing across the entire screen.

RCA also uses a "delay line profile compensation" circuit to eliminate the profile edge sometimes seen on big-screen televisions. This circuit, combined with a comb filter used for sharpness of detail, contributes toward crisp and clear image reproduction.

While the P50595 is an impressive product—watching a baseball game on a 50-in. screen is like sitting in the mezzanine at the ballpark—I would like to have seen better audio specifications. The P50595 uses a 10-watt-per-channel amplifier to drive four speakers. Fre-

quency response is rated at 50 to 15,000 Hz plus or minus 3 dB, a number that just approaches high fidelity. If the P50595 cost less I wouldn't complain. But at \$3000 it hardly seems fair to have to rely on extra hi-fi components to do the job.

Late News

Before this year is out, Sony will begin selling video cassette recorders in the VHS format, which is the largest-selling kind worldwide. Meanwhile, the company will continue marketing Beta and 8mm video gear. Stayed tuned for details.

PM



Radar detectors: Which are really best?

These days every maker says their radar detector is best. Who's telling the truth?

Freedom of the press

If you read movie ads, you know how each one finds a short phrase from a review that makes it sound like "the year's best." Well, some detector makers play the same game.

But we won't play games. Below are the overall results of the three most recent independent tests of radar detectors.

LATEST PERFORMANCE RANKINGS

Car and Driver April 1987	Roundel June 1987	Popular Mechanics July 1987
1 st Passport (Escort not tested)	1 st Passport	1 st Escort
Cobra	BEL Quantum	2 nd Passport
Uniden	Whistler	BEL
Radio Shack	Maxon	Snooper
BEL	Radio Shack	Uniden
Whistler	Uniden	Whistler
Sparkomatic	Fox	Cobra
Fox	Cobra	GUL
GUL	BEL Vector	Radio Shack
	Snooper	Sparkomatic
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Although each staff of experts used different methods to evaluate the detectors, their conclusions were unanimous; Escort and Passport are winners.

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*Details In Store

BY TIM COLE

Antarctic Contemplations



IT'S NOT HARD to develop a profound appreciation for the vastness and the splendor of the continent of Antarctica. All you have to do is stand at two in the morning on the shore of Ross Island and scan across frozen McMurdo Sound to Koettlitz Glacier, metamorphosed by the low-lying Sun into a sweeping amber pathway.

From this vantage point at the foot of steaming Mount Erebus, you can see nearly 90 miles up to the rooftop of Antarctica, virtually unaltered since it splintered away from the megacontinent Gondwanaland 150 million years ago and slid into place at the bottom of the world.

But, as our story on Antarctica in this issue suggests, views can change with the viewer. To the astronomer, Antarctica is a simple platform, a convenient means of positioning sensitive telescopes and cosmic ray detectors. To the marine biologist, Antarctica is a handy way of finding and studying Weddell Seals and Adelie Penguins. To the glacial-geologist, the granites, schists and basalts of Antarctica are a link to the past, a window on the future. A unity of vision begins to emerge only when you have a chance to digest and synthesize the various attitudes floating around America's laboratories at McMurdo Station, our principal Antarctic base. While building our knowledge of the Earth is uppermost, these Antarctic investigators all realize that the shad-

The Sun at 2 a.m. bathes the McMurdo sea ice with a golden light. Below, America's scientific outpost, McMurdo Station, stands rough and ready on the shores of Ross Island.



ow of environmental change could one day creep north from the grip of The Ice. Predicting if and when that happens is a sole preoccupation for some. They realize the severity of a melting ice sheet or the catastrophic consequences of a decaying ozone shield.

However, beyond its role as environmental bell-weather, Antarctica is also a social phenomenon, an experiment in collaboration by a diverse societal mix. Ever since British explorer James Cook sailed south of the Antarctic Circle in 1773, a fascinating cast of polar pioneers have descended on Antarctica from all corners of the world—Russia's Bellingshausen in 1820, Britain's Ross in 1841, France's Dumont d'Urville in 1840, Norway's Borchgrevink in 1900, Australia's Mawson in 1912, Norway's Amundsen and Britain's Scott in 1911. The Antarctic Treaty, formed in 1959 and ratified in 1961,

tossed friend and ideological foe into a rough communion based on the quest for learning. This example of international cooperation is refreshing. But the harsh limits imposed by frigid winds and unending ice make cooperation the only possible means of survival, political or otherwise, in Antarctica. Because it is so inaccessible, the United States and other nations have always felt secure in neither claiming Antarctic territory nor recognizing the claims of others. That's easy to do when you realize how difficult it is to live, work and travel in this land of terrible emptiness.

The optimistic document that governs intergovernmental affairs on Antarctica comes up for review in 1991. Some administrators in the National Science Foundation are confident that well-meaning nations will seek to reimpose the spirit of cooperation that has graced Antarctica for three decades.

Others aren't so sanguine. They suggest that the Antarctic Treaty—and by extension the health of the Antarctic biosphere—could be threatened at any time by the withdrawal of just a handful of the Antarctic Treaty's 25 signatories.

Already, there are signs that the continent may be subjected to environmental pressure in the near future. In January, 37 nations met in New Zealand to establish a legal framework for mining in Antarctica. Japan continues to harvest endangered whales off the Antarctic coastline to satisfy appetites at home. Commercial fishing operations continue to imperil the mighty mammals' food chain by destroying krill, the tiny shrimplike creatures whales feed on. Some countries, notably Chile, have suggested opening the South Pole and other inaccessible areas to tourism—to the consternation of many purists. Arch environmentalist groups like Greenpeace even oppose places like McMurdo Station—highly functional if somewhat unsightly scientific outposts. These militants consider catastrophic any intrusion on Antarctica—regardless of the purpose.

Amidst these diverse views, there's obviously room for compromise. But it's good to remember that the immediate future of this as yet unspoiled region on our soiled and sullied planet will depend not on the vagaries of climatic change, but on the wisdom and strength of man. **PM**

OLD HOUSE RESTORATION

BY BOB VILA

Period Light Fixtures

IF THE ORIGINAL lighting fixtures are still a part of your old house, you're one of the fortunate few. More than likely, these antiques are long gone and have been replaced many times over the years as previous homeowners strived to keep up with the times.

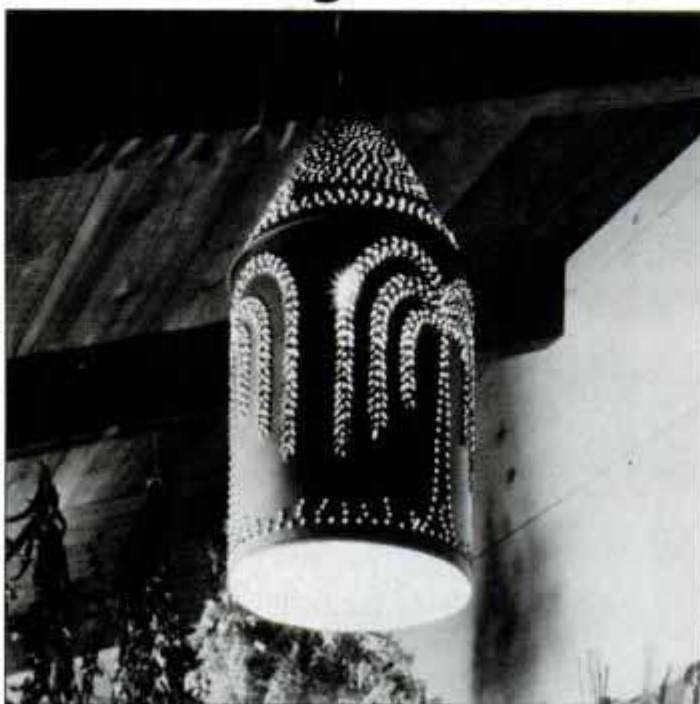
What can you do to bring the proper period lighting back to your home? Fortunately, a small group of reproduction and restoration lighting specialists can fulfill your needs. There's always the antique route, too, but I don't have to tell you how time consuming, and expensive, it can be to find period fixtures this way. Before you begin your hunt for any light fixture, a brief explanation of some of the differences evident from period to period is helpful.

The changing fixture

For the most part, the shape of a fixture is dependent on its function, while its style was dictated by the embellishments of the day. Most of the early chandeliers and sconces popular in colonial times were powered by candles or oil. Candle burning chandeliers were hung by either a chain or hook—the flames were usually left uncovered and most were made of tin or iron which darkened naturally as the fixture aged. Sometimes the metal was painted, as were the turned-wood centers on fixtures in the late 18th century.

Then, lighting changed as technology progressed. Gas lighting became available during the Victorian era and lighting styles, like everything else, became more elaborate. Now chandeliers, called *gasoliers* hung from brass-covered pipes, which

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



Two good examples of reproduction fixtures are the Willow Lantern (above) and Colonial Hall model (below) from Lt. Willard Moses.

supplied gas to the fixture. Ornamentation, often in the form of brass or iron filigree, embellished the upward facing arms. Glassware usually covered the flames.

The advent of electricity—and the light bulb caused other changes. No longer was it necessary for fixture arms to point upward to accommodate a burning flame. Now the arms of chandeliers and other fixtures point downwards. Combination gas/electric fixtures, found in chandeliers and wall lights, were popular from about 1890 to 1920. Designed for both types of power, these fixtures had arms that faced both up and down. (There was a practical reason for this. If the electricity went out, you still had gas as a backup.)

The sinuous Art Nouveau style of which the popular Tiffany lamps are a part, lasted from about 1890 to the start of World War I. This style was mass-produced using metal alloys and inexpensive glass. But today, the

fine work of the Tiffany studios commonly sells for tens of thousands of dollars.

Next, fixtures were hung from chains, with large bulbs facing the ceiling. Art deco's geometric, linear designs, which lasted into the early '40s, continued to use this indirect lighting with large, ceiling-facing bulbs.

Finding what you need

To restoration purists with a real healthy budget, antique fixtures may be the only acceptable way to go. Although harder to find and usually more expensive than reproduction lighting—authentically restored antique fixtures can be found. It has been my experience, though, that some restored fixtures have reproduction parts. To all but the most astute antique buyer, these pieces may not be apparent.

In addition to searching through local antique shops, there are companies that specialize in selling restored antique light fixtures. (A list

of some appears on page 51.) Their stock is so unique and ever-changing that cataloging inventory is usually impossible. Many times, patrons select restored fixtures from photos sent through the mail. Some of these shops also offer custom repair work. But the cost for this type of service can be the same as buying a whole authentically restored fixture.

Trying to forego this expense by searching salvage yards for an original fixture is certainly a hit-or-miss proposition. I've rarely heard of anyone finding a fixture of much value this way. Remember that these places are visited regularly by antique experts who know what they're looking for. If you were lucky enough to find an unrestored light this way, don't forget you'd probably have quite a bit of work to do to get the piece in shape to be used today.

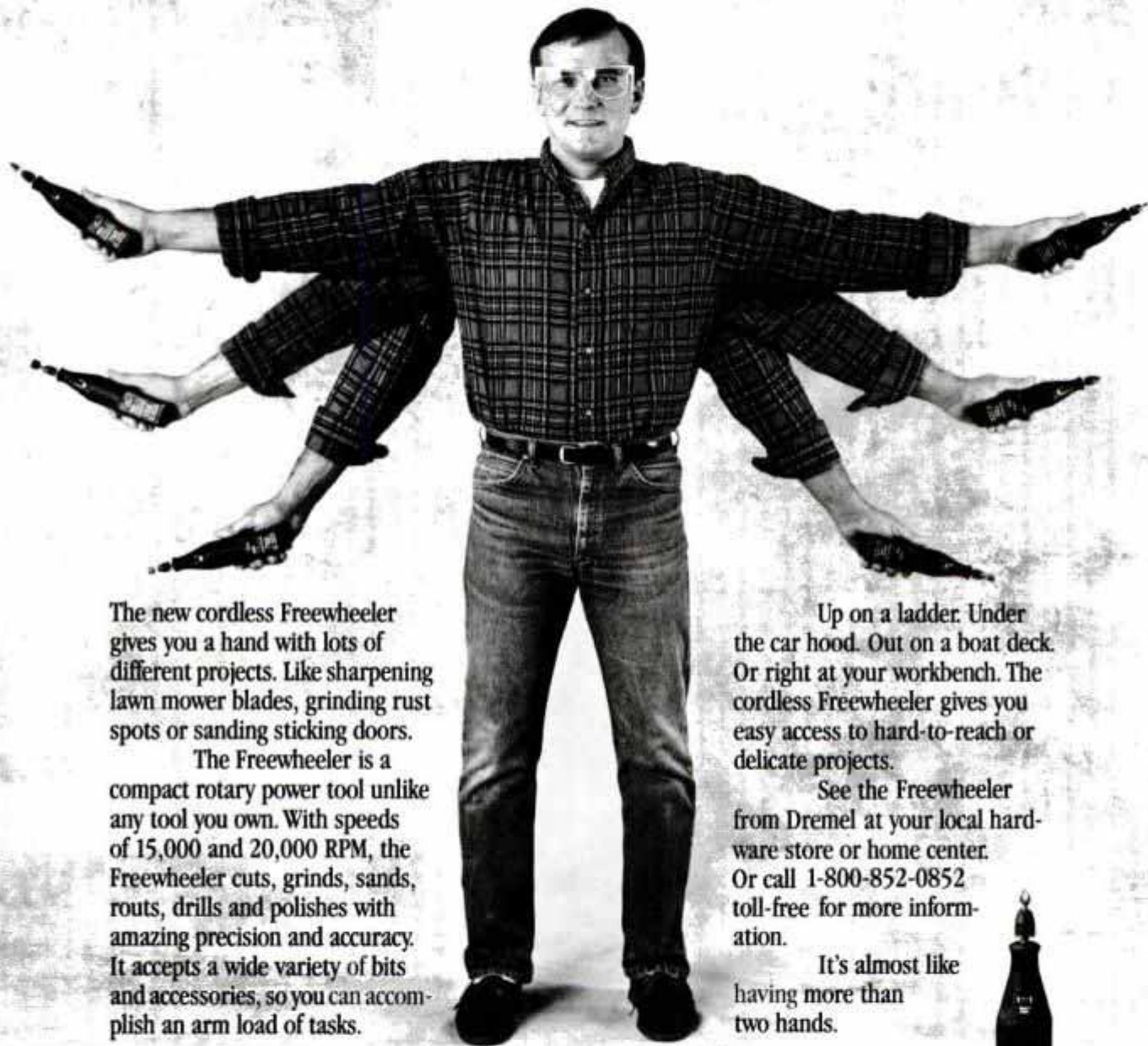
The same is true of an unrestored piece found as is in an antique shop. Add on the cost you'd have to pay to restore it, including the rewiring necessary to bring it up to

(Please turn to page 51)



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OLD HOUSE RESTORATION

(Continued from page 48)

today's standards, and replace any missing pieces, and the final cost may turn out to be more than bargained for.

The lighting manufacturers devoted to reproducing period fixtures have made this process easier—and in many cases, cheaper—for you. Most period reproductions are made by hand in small shops and sold direct through catalogs. (A list follows.) Some of these are accurate reproductions of old fixtures found in museums, private collections or old lighting catalogs. Others may be based on one of these original lights, but adapted in some way to appeal to today's buyer. Still others may be designed with only the feel of a particular period in mind. Since many aren't labeled as such, it can be difficult to tell

Source List

Some of the suppliers of period fixtures:

- A.J.P., Coppersmith & Co., 34 Broadway, Wakefield, MA 01880, (617) 245-1221
 - Art Directions, 6120 Delmar Blvd., St. Louis, MO 63112, (314) 863-1895
 - Authentic Designs, The Mill Rd., West Rupert, VT 05776, (802) 394-7713
 - The Brass Light Gallery, 719 S. 5th St., Milwaukee, WI 53204, (414) 383-0675
 - Brasslight, Inc., 90 Main St., Nyack, NY 10960, (914) 353-0567
 - Classic Illumination Inc., 2743 Ninth St., Berkeley, CA 94710, (415) 849-1842
 - Federal Street Lighthouse, 37 Market Square, Newburyport, MA 01950, (617) 462-6333
 - Heritage Lanterns, 70A Main St., Yarmouth, ME 04096, (207) 846-3911
 - Hurley Patentee Lighting, RD 7, Box 98A, Kingston, NY 12401, (914) 331-5414
 - King's Chandelier Co., P.O. Box 667, Eden, NC 27288, (919) 623-6188
 - Lighting By Hammerworks, 6 Fremont St., Worcester, MA 01603, (617) 755-3434
 - Lt. Moses Willard & Co., 1156 U.S. 50, Milford, OH 45150, (513) 831-8956
 - M-H Lamp & Fan Co., 7231½ N. Sheridan Rd., Chicago, IL 60626, (312) 743-2225
 - Nowell's, Inc., 490 Gate 5 Rd., Sausalito, CA 94965, (415) 332-4933
 - Period Lighting Fixtures, 1 Main St., Chester, CT 06412, (203) 525-3690
 - Price Glover Inc., 817½ Madison Ave., New York, NY 10021, (212) 772-1740
 - Rejuvenation House Parts, 901 N. Skidmore, Portland, OR 97217, (503) 249-0774
 - Renaissance Marketing, Inc., P.O. Box 360, Lake Orion, MI 48035, (313) 693-1109
 - Roy Electric Co., Inc., 1054 Coney Island Ave., Brooklyn, NY 11230, (718) 339-6311
 - Saxe Patterson, Box 15, Salazar Rd., Taos, NM 87571, (505) 758-9513
 - Victorian Lightcrafters, Ltd., P.O. Box 350, Slate Hill, NY 10973, (914) 355-1300
 - Victorian Reproduction Lighting Co., P.O. Box 579, Minneapolis, MN 55458, (612) 338-3636
 - The Washington Copper Works, South St., Washington, CT 06793, (203) 868-7527
- Dealers of restored antique lighting include:**
- The Architectural Antique Warehouse, 1583 Bank St., Ottawa, Ontario, Canada K1P 6H6, (613) 526-1818
 - Authentic Lighting, 558 Grand Ave., Englewood, NJ 07631, (201) 568-7429
 - City Lights, 2226 Massachusetts Ave., Cambridge, MA 02140, (617) 547-1490
 - Gaslight Time, 823 President St., Brooklyn, NY 11215, (718) 789-7185
 - Greg's Antique Lighting, 12005 Wilshire Blvd. West, Los Angeles, CA 90025, (213) 478-5475
 - Half Moon Antiques, c/o Monmouth Antique Shoppes, 217 W. Front St., Red Bank, NJ 07701, (201) 842-7377
 - Illustrious Lighting, 1925 Fillmore St., San Francisco, CA 94115, (415) 922-3133
 - Watertown Pines, Box 1057, Kennebunk, ME 04043, (207) 985-6868
 - Yankee Craftsman, 357 Commonwealth Rd., Wayland, MA 01778, (617) 653-0031

what's what. So, unless you're a historian or an antique lighting specialist, you might not know what you're buying.

Getting help

If you're serious about choosing an authentic fixture, there are two books worth looking at. The Preservation Press (1600 H Street N.W., Washington, DC 20006) plans to publish *Lighting For Historic Buildings* this month. Written by Roger W. Moss, an authority on the subject, the book spans lighting from the 17th century to 1920, and will help you choose appropriate period fixtures. Available at bookstores or di-

rectly from the publisher for \$15.95 ppd.

Another good book that covers fixtures from the 1880s to the present is *Electrical Wiring And Lighting In Historic American Buildings*, written by Max Ferro and Melissa Cook of The Preservation Partnership. It's available directly from the publisher, AFC/Nortek Co., 55 Samuel Barnett Blvd., New Bedford, MA 02745 for \$10.95 ppd.

So, you can see there are many choices to be made when choosing period lighting. Knowing what you're looking for is the first step in making an intelligent decision and choosing a fixture you'll be proud to have in your home. **PM**

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PONTIAC FIERO GT

TWOS FOR THE MONEY

Fast and furious fun with the affordable 2-seaters.

BY TONY SWAN
Automotive Editor

AFFORDABILITY, like good looks, is a concept that's open to considerable interpretation. One man's affordable is another man's unthinkable self-indulgence, and like so many other things in life it ultimately comes down to disposable income.

However, when it comes to sports cars, it's pretty clear that the number of machines most of us might regard as affordable has thinned somewhat since the heyday of the British roadster. Even with a cutoff as high as \$20,000, the list dwindles down to a precious few. We make it to be about a half-dozen, in fact, and a couple of these—the venerable Bertone X/1-9 and Alfa Romeo Spider—represent only a tiny slice of this small segment of the market.

Accordingly, we've grouped the four cars that constitute the heart of

the under-\$20,000 sports car market—the Honda CRX Si, Pontiac Fiero GT, Toyota MR2 and Mazda RX-7—to see just who's who.

Assessed on a basis of power-to-weight and general vehicle concept, we expected this foursome to be quite comparable, despite some fundamental differences in basic design (one front-engine/front-drive, two mid-engine/rear drive and a front-engine/rear drive).

That was the plan, anyway. A real shootout. But what emerged after four days of tire-shredding in and around Santa Barbara, California, was a cross-section sufficiently diverse to make us a bit reluctant to name winners, losers or also-rans.

Each of these cars has its own peculiar set of strengths, each has its drawbacks, and each has its own distinctive character.

2s FOR THE MONEY

Best of all, each seems quite likely to reward its owner with plenty of driving fun. And after all, that's the main reason cars like these exist in the first place.

The combatants are presented here in alphabetical order.

Honda CRX Si

All-new for 1988, the CRX Si represents an improvement on a near-perfect original. Honda's popular super-scooter has a longer wheelbase, expanded interior volume and a potent new 1.6-liter 16-valve engine.

The remarkable design resources that Honda brings to bear in the area of ergonomics and space utilization



MAZDA RX-7 GTU

show to spectacular advantage here. There seems to be more volume inside the CRX than its tidy exterior dimensions can possibly surround. Legroom is capable of accommodating even the tallest drivers, headroom is at least adequate for most and the little Honda's cargo volume is nothing short of remarkable—not to mention the best in this group.

There's a new privacy panel under the rear hatch, a rather flimsy piece that nevertheless gets the job done, and this was the only CRX installation that drew any negative fit-and-finish response, inside or out. Honda's brash little traffic-sorter exudes care and quality from end to end.

Seating, too, drew plentiful praise,



TOYOTA MR2 SUPERCHARGER



MAZDA RX-7 CONVERTIBLE

Variations On A Theme

ALTHOUGH these two cars fell outside the scope of our test group—the supercharged MR2 because its power-to-weight ratio was well beyond the others, the RX-7 convertible because it nudged beyond \$20,000—we'd be remiss to ignore them. So we included them in our general testing, but will only report on the qualities that make them special.

Toyota MR2 Supercharged

Bump engine output by 30 percent and you expect a quicker car, and that's what the supercharged MR2 is all about. With 145 hp at 6400 rpm, the blown MR2 hits 60 mph in about 7 seconds and covers the quarter-mile in just a little over 15.

That's quick, alright. Quick as a snake. But carrying the snake parallel a little further, this car seems able to

do other things quickly, things you don't want it to do. It's not difficult to find yourself with the tail hung out in full opposite-lock oversteer, suggesting that perhaps 145 hp is more than this chassis can handle comfortably.

Mazda RX-7 Convertible

The weight that goes with convertibilization—in this case, about 375 pounds more than the coupe—keeps the RX-7 softtop from being a thrill ride. Nevertheless, it shares the refinement and competency of the RX-7 family, thanks to the designers' concern with chassis rigidity.

However, where the RX-7 ragtop really breaks new ground is with a development called the "wind blocker," a simple little panel that flips up behind the rear seats to baffle the breezes that commonly make convertible drives cold and uncomfortable. The design of the top, with a hard center panel, is also innovative, and the car's top-down appearance is simply a knockout.—T.S.



particularly when the day's activities entailed the unwinding of mountain roads. The Honda's solidly bolstered buckets kept drivers squarely in front of the wheel, regardless of what was going on outside, and if there was any criticism to be made it was for a bit too much enthusiasm: We're sure that some drivers will find their seats to be on the firm side for long hauls.

Typically Honda, all controls are almost perfectly located, giving first-time drivers a sense of instant intimacy. However, visibility, normally another Honda strong suit, was somewhat limited in the rear quarters and the new glass panel, below the hatch opening, is useful only in backup maneuvers. The CRX Si didn't exactly seduce anyone with its looks, either. Though undeniably functional, its lines seemed distinctly offbeat in contrast to the other members of the test fleet, and there were those who said they preferred the jaunty rollerskate look of the shorter original.

However, when it comes to assessing sports cars the critical portions of the anatomy are well below the vision center, and the new CRX Si satisfies these regions double in spades.

Hauled by a new sohc 4-valve engine that makes 11 hp more than the previous Si powerplant, the CRX soon established itself as the quickest member of the primary foursome in quarter-mile runs, even though 0 to 60 times weren't quite as good as we'd expected. The 1.6 pulls manfully across a remarkably broad range—unlike most multivalves, the torque peak is a commendably low 2000 rpm—and isn't as busy-sounding as Toyota's otherwise excellent 1.6.

Handling was a strong point for the original CRX, and it's continued here. The suspension has been revised, with Honda's double-wishbone system front and rear, the wheelbase has been stretched 4 in. and the track is



wider by 1.4 in. front, 2 in. at the rear.

All of this adds up to a package that's wonderfully stable at any speed, as predictable as the seasons and utterly devoid of vices. Though the variable ratio steering has acquired annoyingly high effort, it is as precise as the original, with plenty of feel. Braking performance also measures up to this high level of achievement—again, the best of the group—and if this isn't a combat-ready showroom stock racer right out of the box, we never saw one.

Mazda RX-7 GTU

Though it lost some character and gained some weight in the transition from original to second generation (1986), the RX-7 has also evolved into one of the most user-friendly sports cars you're likely to find anywhere. Its balance rivals the delightful little MR2, though it's a good deal more forgiving and feels generally more sophisticated.

The GTU is the sport edition of the RX-7 family, with slightly stiffer suspension and a little less in the way of luxu appointments. The GTU design-

nation commemorates Mazda's long domination of the International Motor Sports Assn. (IMSA) GTU (for GT under 3.0 liters) racing class, but as the test results indicate, the on-track heritage is well insulated.

Part of the problem lies with this car's engine. Rotary engines are historically anemic in the low-end torque department, and the RX-7's twin-rotor 13B runs true to the breed. It takes some buzzing to get the car launched and a certain amount of rowing around in the excellent 5-speed gearbox to stay in the sweet part of the powerband.

On the other hand, the rotary is among the most pleasant traveling companions devised by man, one of those rare engines that require con-

stant tach checks, to make sure it's still running. Calling the RX-7 smooth is like calling Brigitte Nielsen attractive. It only nibbles at the edges of reality.

The rotary engine is central to a sense of refinement that pervades the entire car. Although the second generation RX-7 is derivative in terms of styling, it is beautifully finished within and without. The seating drew the top rating in this group, for its comfort, appearance and wide range of adjustability, and Mazda's flash orange control markings lend a distinctive appearance to the instrument panel.

Leg and headroom are plentiful, and even though the RX-7 is outclassed by the CRX in cargo volume, it's the only other car in this group that allows the option of more than overnight luggage.

As we suggested earlier, the RX-7 is a gratifyingly precise and predictable instrument for dissecting a stretch of mountain switchbacks. Its rear suspension, consisting of trailing arms, floating hubs and camber control links, is the most sophisticated

2s FOR THE MONEY

setup this side of a full active system, and the combination of the longest wheelbase in the group plus relatively generous travel provides an excellent level of ride quality to go with the good handling.

In a way, the RX-7 seems almost out of place in this group. Amid this bevy of cocky little fighter-plane cars, the Mazda looks and feels more like a Grand Touring machine—quiet, poised and polished. There were episodes in the test where the RX-7 had to work hard to keep up. But if the test had included a run to, say, Topeka, the RX-7 might very well have been the consensus choice.

Pontiac Fiero GT

Since it first appeared in 1984, the Fiero has drawn flak as a pretty face with nothing behind it.

The pretty face part is hard to argue with. While the RX-7's exterior drew generally positive responses, the Fiero's Ferrarinesque packaging was clearly the best-looking shape in the group. Much better, we think, without the optional rear wing.

However, we're also happy to report that the part about no substance can now be consigned to history. Thanks to a total suspension revision, the Fiero now has the underpinnings to go with its seductive exterior.

Fieros previously rolled out with an assortment of undistinguished parts-bin suspension pieces—a Chevette front end, for example, and a modified X-car (Chevy Citation) transaxle adapted for use in the Fiero's mid-engine layout. The rationale for this setup was that the cost of an all-new suspension system would have killed the entire Fiero project.



Although the Pontiac chassis engineers did their best to instill sports car handling qualities into this make-do system, it resulted in extremely stiff ride characteristics, steering effort that seemed intended to provide isometric exercise and uncertainty at the limits of adhesion. It required experience and considerable skill to take liberties with this car on a twisty road.

Equipped with its own suspension components, the Fiero becomes a much more companionable ally for back road blitzes. Handling is improved in every respect—witness the Fiero's performance in the slalom. Steering effort, though still heavy, is down, precision is up and predictability is high.

Although still a bit stiff, due to limited suspension travel, the Fiero's ride quality has also been clicked a notch or two more toward the civilized end of the scale.

Besides being fastest through the slalom, the Fiero was also quickest to 60 mph, despite having the highest curb weight in the group. Though GM's 2.8-liter V6 doesn't compare to the Japanese engines for technoflash

or peak horsepower, it makes plenty of good old American torque, enough to make the Fiero just about as quick as it looks.

It also makes quite a lot of good old American noise, a raspy growl that's pleasant enough at low speeds but with a tendency to become intrusive in extended freeway runs.

Elsewhere, the 1988 Fiero continues to be a mixed bag of goods and not-so-goods. Interior materials are high in quality and the seating is better than average, with decent lateral support. But the cockpit is cramped for elbow room and the ingress/egress index is no better than so-so.

Similarly, the action of the 5-speed Getrag gearbox is positive and glitch-free, but the location—atop the Fiero's massive center section—is an awkward reach at best.

Typical of GM, the sound system is first rate, but the analog instrumentation looks cheap and the absence of a glovebox is irritating.

Luggage storage is the Fiero's weakest suit. Although the official cargo volume is higher than the rival MR2, the shape of this space, most of it contained in a vertical well behind



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)
Honda CRX Si	\$10,195/ \$11,564	L4, SOHC 16-valves 97.0/1590	105 @ 6000 rpm/ 90 @ 2000 rpm	front/ front	5-speed/ manual	90.6/2301	147.8/3754	65.7/1689	F: 57.1/1450 R: 57.1/1450
Mazda RX-7 GTU	\$15,480/ \$18,804	2-rotor Wankel 79.8/1308	146 @ 6500 rpm/ 138 @ 3500 rpm	front/ rear	5-speed/ manual	95.7/2430	168.9/4290	66.5/1668	F: 57.1/1450 R: 56.7/1440
Pontiac Fiero GT	\$13,999/ \$15,874	V6, OHV 173.1/2837	135 @ 4500 rpm/ 165 @ 3600 rpm	mid/ rear	5-speed/ manual	93.4/2372	165.1/4190	68.9/1751	F: 59.7/1517 R: 60.1/1527
Toyota MR2	\$12,808/ \$14,028	L4, DOHC 16-valve 96.8/1587	115 @ 6600 rpm/ 100 @ 4800 rpm	mid/ rear	5-speed/ manual	91.3/2319	155.5/3948	65.6/1666	F: 56.7/1440 R: 56.7/1440

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

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



PONTIAC FIERO GT

the engine bay, isn't very usable. It's hard to imagine where a suitcase could be squashed into this car, and even luggage for a very informal weekend taxes the Fiero's cargo capacity.

On the other hand, cars like this don't pretend to be space efficient. They just wanna have fun. And this is something the latest incarnation of the Fiero knows how to do, better than ever before.

Toyota MR2

If we're going to talk about sheer affordable sports-car fun, though, here's the name that pops to mind first. Compact, balanced and fast enough to get the adrenaline pumping, the MR2 loves to be pitched into hard corners and buzzed on the exits. Though it's a little less forgiving than the RX-7, a touchy balancing act traceable to its short wheelbase, the MR2 was designed for hard driving and delivers the kind of driver/machine unity we usually associate with motorcycles.

The 16-valve dohc 4-cylinder engine is perfectly suited to this sort of activity. Although it tends to sound a trifle busy when it's in the productive

part of the powerband, it revs willingly and delivers plenty of punch from about 3500 rpm on up. Mated to an outstanding 5-speed gearbox with ratios well suited to the 1.6-liter's power characteristics, this rates as the best powertrain in our group (though to be fair, it's almost a coin toss against the Honda).

Rated as a place to be when the scenery starts coming toward you at odd angles, the MR2 measures up quite well—better than the Fiero, though not as roomy as either the RX-7 or the Honda. Still, there's plenty of space for even the busiest driver, which is what counts with this car, and there's also room for a passenger to stretch out quite comfortably.

Like the Fiero, the mid-engine design doesn't leave much room for luggage, though the shape of the MR2's cargo space seems better related to reality. Another similarity—again a function of the mid-engine layout—is noise in the cockpit. The 1.6 makes a substantial amount of it, and the driver becomes a bit too aware of the engine in ordinary cruising.

As you'd expect of a real driver's car, control relationships are excel-

lent, and the analog instrumentation is comprehensive, well located and highly legible. About the only complaint anyone registered concerning the interior appointments had to do with the integrated headrests, which were awkwardly positioned for taller drivers, though the seats themselves were well designed and sufficiently adjustable.

Workmanship is typically Toyota—high quality, inside and out. As for the exterior design, it was initially difficult for us to think of the MR2 as pretty. But after several days of hard driving, we began to feel that the car's looks supplied an accurate portrayal of what lay within—a high-spirited, aggressive little street tiger that's about as much fun to drive as any car on the road today.

Conclusions

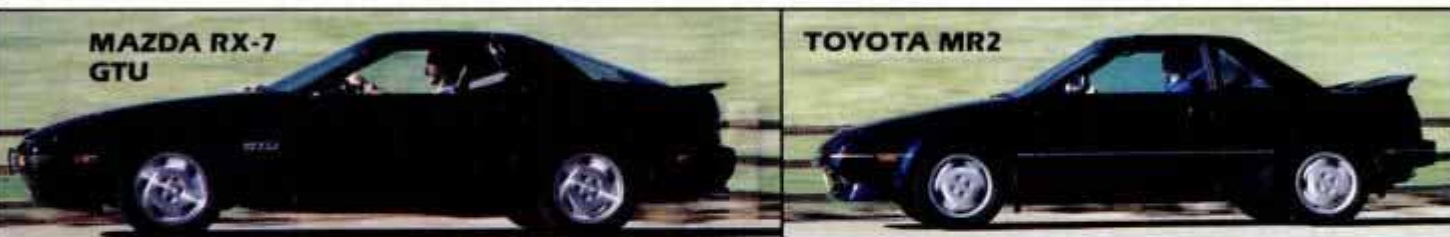
As we noted at the outset, our conclusions are multiple. There are no losers here. All these entries are good at being sports cars. It's just a question of picking out the one that best matches your priorities.

For example, if sheer boulevard flash is high on your list, the Fiero is the winner, hands-down. It's arguably as attractive as anything from the entire world arsenal of sports and GT machinery, and has new competence to go with its good looks.

If you want refinement, elegance and high back-road capability rolled up into one package, the RX-7 stands alone.

If you're into sheer back-road exuberance, the MR2 is tough to top.

But if you want sports-car performance with the astounding bonus of practicality, wrapped up in a tastefully outrageous exterior, Honda's CRX rates as something special. **PM**



MAZDA RX-7 GTU

TOYOTA MR2

TEST RESULTS

CURB WEIGHT (lb.)	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)	CARGO ³ VOLUME (cu. ft.)	INTERIOR ⁴ SPACE INDEX
2017	variable ratio rack-and-pinion/4.1	F: 9.5-in. vented disc/ R: 8.5-in. drums	29/ 24.08	11.39 16.31 @ 85.28	138	59.59	.78	34.13	85.83
2625	power rack-and-pinion/3.6	F: 10.9-in. vented disc/ R: 10.7-in. disc	17/ 12.53	12.41 16.97 @ 82.19	158	55.52	.78	22.92	87.17
2790	rack-and-pinion/3.3	F: 10.2-in. vented disc/ R: 10.2-in. vented disc	17/ 16.15	9.64 16.36 @ 83.56	151	59.84	.81	10.97	87.12
2350	rack-and-pinion/3.2	F: 10.2-in. vented disc/ R: 10.4-in. disc	26/ 23.26	11.78 16.49 @ 83.34	148	56.44	.83	8.73	89.93

3. Indicates maximum cargo volume as determined by EPA calculations with rear seatbacks (when applicable) in normal position.

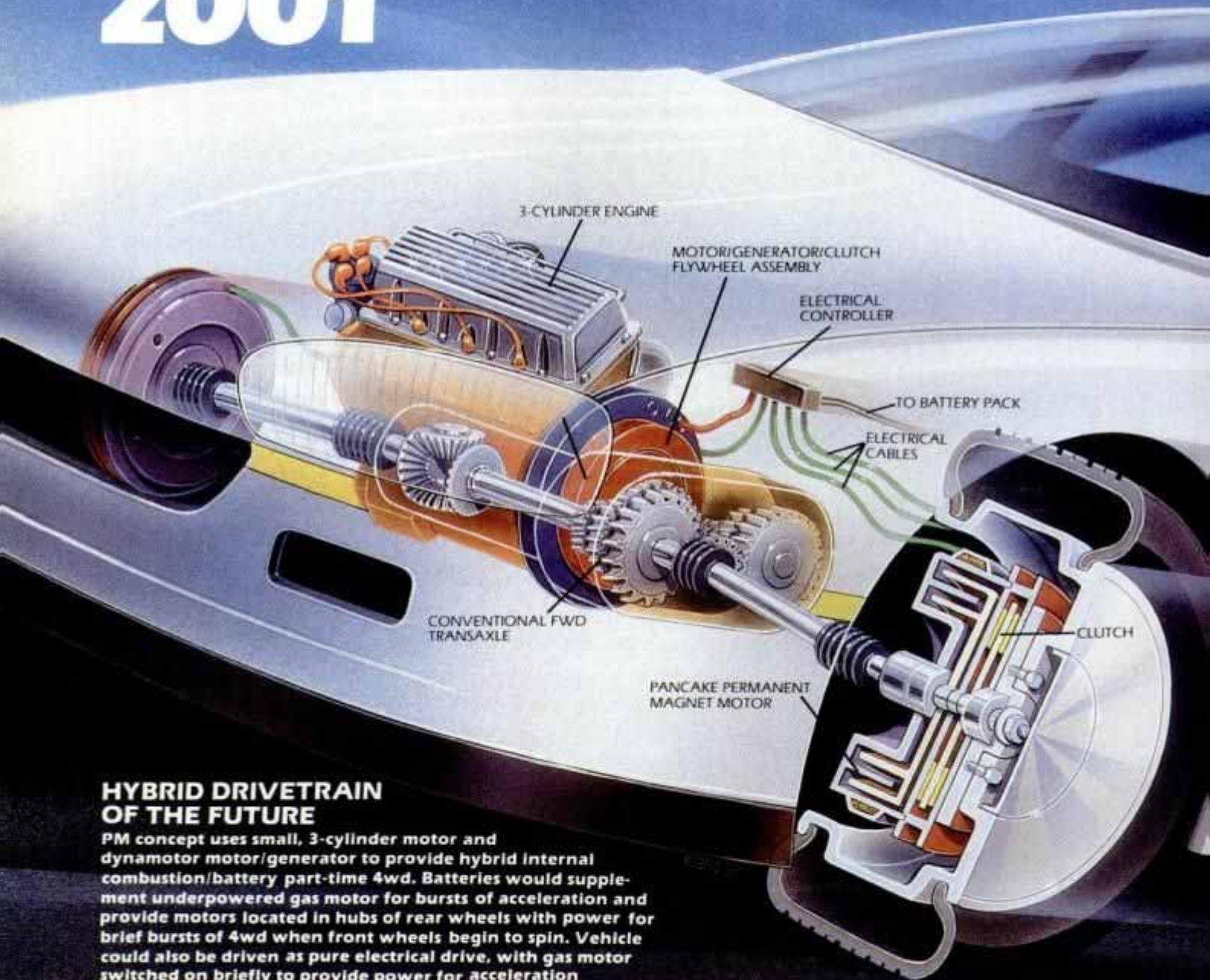
4. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom + 1000.



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HYBRID DRIVETRAIN OF THE FUTURE

PM concept uses small, 3-cylinder motor and dynamotor motor/generator to provide hybrid internal combustion/battery part-time 4wd. Batteries would supplement underpowered gas motor for bursts of acceleration and provide motors located in hubs of rear wheels with power for brief bursts of 4wd when front wheels begin to spin. Vehicle could also be driven as pure electrical drive, with gas motor switched on briefly to provide power for acceleration as traffic situations demanded.

Sources of future power may not change much, but there's a revolution brewing in delivery systems.

BY PAUL VAN VALKENBURGH

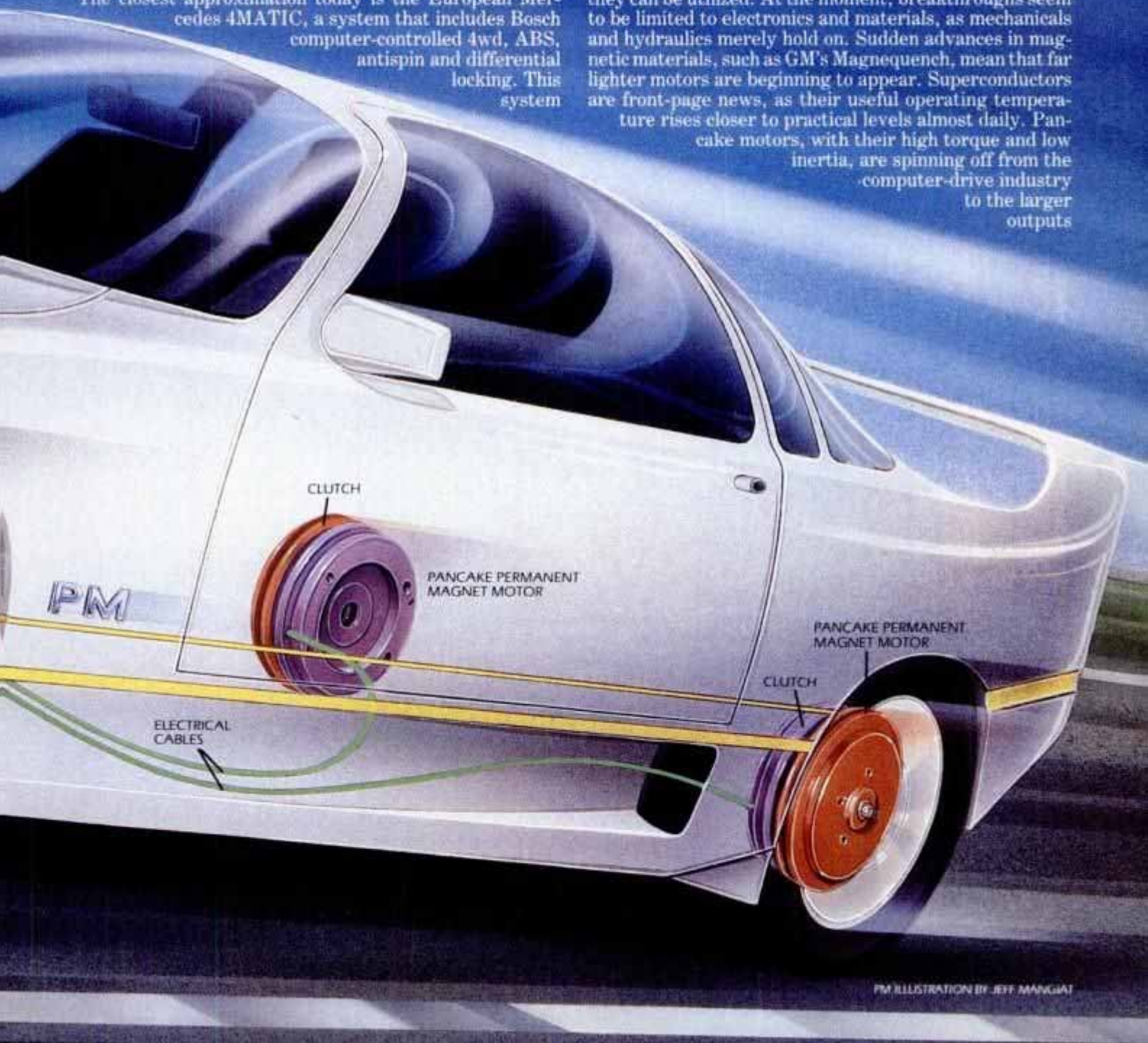
WHEN WE THINK about power delivery systems in the next century, it's hard to get past today. After all, we've already got full-time or driver-selectable 4-wheel drive, 4-wheel steering, anti-lock brakes, antispin, a choice of traction differentials, 5-speed manuals, computer-controlled overdrives, automatics with almost undetectable shift points . . .

Granted, it's hard to get all these features in one vehicle (though it's intriguing to speculate on how many buyers would actually be willing to pay for such a combination). The closest approximation today is the European Mercedes 4MATIC, a system that includes Bosch computer-controlled 4wd, ABS, antispin and differential locking. This system

uses electronic throttle linkage and hydraulically actuated clutches at the differentials to eliminate low-traction control problems from the driver's concern.

However, the market doesn't seem to be driven today by what is asked for, but rather by what is possible, as engineers fight for technological leadership. So we asked around a bit, did a little dreaming, and concluded that there's still some drivetrain magic waiting to unfold.

To divine the future of the automobile, you have to look into other breakthrough technologies, and imagine how they can be utilized. At the moment, breakthroughs seem to be limited to electronics and materials, as mechanicals and hydraulics merely hold on. Sudden advances in magnetic materials, such as GM's Magnequench, mean that far lighter motors are beginning to appear. Superconductors are front-page news, as their useful operating temperature rises closer to practical levels almost daily. Pancake motors, with their high torque and low inertia, are spinning off from the computer-drive industry to the larger outputs



PM ILLUSTRATION BY JEFF MANGIAT



needed for automotive use. And of course, new composite materials are finding a wide variety of automotive applications, from the ordinary, such as carbon-fiber driveshafts, which are now quite common in racing, all the way up to the unique and exotic: high-speed explosion-proof energy storage flywheels. So when you take such new technologies and utilize the best features of each—applications and combinations are almost limitless. The key word to keep in mind is “hybrid.”

Transmissions

After decades of promises, the continuously variable transmission, or CVT, is still lurking just around the corner of universal usage. In Europe and Japan, low-powered econoboxes are available with the vanDoorne steel link-belt running on variable-sheave friction pulleys. And Subaru is expected to be in production with an update on the basic system as early as next year. But even if CVT's do reach widespread application in light vehicles, there are still fundamental limitations that stand in the way of scaling them up to handle engine output capability of much more than 100 horsepower. Add to that the finite gear ratio range—plus the fact that a clutch is still required—and the future of CVT seems a little clouded.

On the other hand, there are attractive CVT alternatives on the near horizon, particularly for performance cars. For years Porsche has been race-testing an experimental automatic-shift 6-speed that's capable of running up through the gears faster than a manual shift. The Porsche auto-shift employs a pair of hydraulically actuated clutches, each clutch coupled to alternate gears (1, 3, 5 and 2, 4, 6). The net result is the absence of power delivery downtime between gears, compared to the 0.1 to 0.2 seconds required for typical clutch and shift time. And what the racer gets is a fail-safe speed shift.

Not to be outdone over here in the U.S.A., Pete Weismann, one of the very few American engineers to be sought after by international Formula One teams, has come up with an even better idea. Calling his concept the “digital shift,” he has found a way to install a clutch in each gear. Put in as many gear ratios as you like, then push a button for each one and “click” . . . in it goes.

The racing application is obvious. Instead of waiting for engine speed to drop off to allow smooth engagement of the next gear, all that rotational inertia is put to work creating a vehicle acceleration surge. Imagine two identical cars racing wheel-to-wheel down the straightaway. At the shift, one lags for an instant, while the other launches itself forward by a car length. Multiply this over the number of shifts made during a race—particularly a road race—and it's not difficult to perceive a winning advantage.

A disadvantage of the system at this stage is that it's

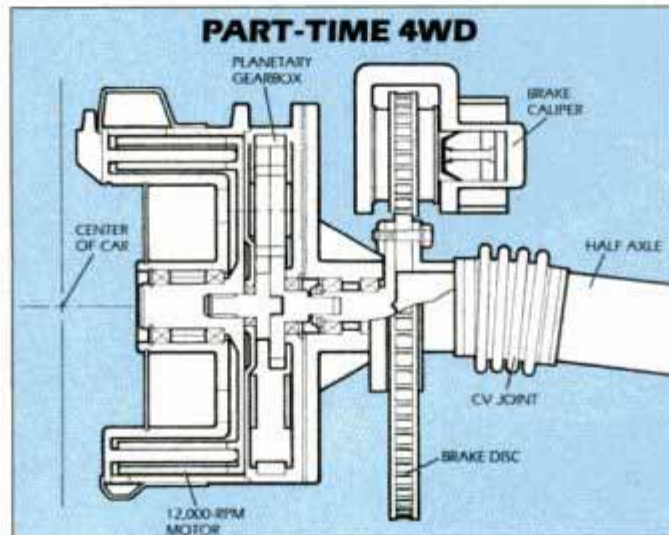
harsh. The first time it was tried at the dragstrip, the driver came in rubbing the back of his head asking, “What hit me?” But after hearing what the digital shift had lopped off his elapsed time, he said, “Well, I guess I'll learn to live with it.”

If neck-snapping gear changes seem too harsh for everyday use, keep in mind that electronic control logic can tailor such shifts to any application. The engagement can be substantially civilized—and with electronic throttle linkage, the engine speed can be modulated to provide shifting that's consistently smoother than humanly possible.

This may not be a continuously variable transmission, but the weight saving, and the potential simplification of shift patterns, means that far more combinations can be made available in the same package. For example, it's possible to get a 9-speed transmission out of two 3-speeds in series, with electronically selected split-shifts. And in theory, using multiple counter-shafts, you could get 27 or even 64 speeds from the same number of gears currently required in a 6-speed box.

Although these transmissions still require clutch slippage to get the car moving, friction clutch technology is not standing still either. The hot item in racing today is the sintered carbon clutch, with multiple drive and driven plates made of this strategic aerospace material. Not only does it have superior hot coefficient characteristics (the hotter it gets, the better it works) and longer life, it also has considerably less rotational inertia. Add the rumored development of an oscillating sander-type of disc engagement system to smooth the application, and you could replace the clutch pedal with an electrohydraulic actuator. Of course, with the potential of new

magnetic materials, it's quite possible that all plate clutches might someday be replaced with magnetic fluid clutches.



Unique Mobility Systems pan-shaped motor, rated at 80 hp intermittent, is shown here driving the rear wheels, with inboard disc brakes and conventional axle shaft and CV joints. Rear wheels might be driven only when traction control unit senses wheelspin on front wheels driven directly by gasoline engine and transaxle.

Fwd/Rwd/2wd/4wd?

Instead of the future belonging to one or two of the above, it may very well be *all* of the above. As for primary drive, fwd will probably be all but universal, thanks to its package efficiencies, though rwd may survive in some high-horsepower performance cars.

But the whole question actually revolves around other technologies, such as computerized active suspensions, more compact engine packages and the development potential of electric power systems.

Consider the future of 4wd, for example. Even though most manufacturers are scrambling to provide it today, ABS and antispin can control wheel rotation on virtually any coefficient.

Likewise, active suspension can be computer controlled to provide stability under any conditions.

There may still be times—low-speed traction on very slippery surfaces, for example—when 4wd is crucial. But

instead of carrying around the heavy and space-robbing mechanical 4wd driveline, we may use light-duty intermittent auxiliary drives at individual wheels. Granted, shaft drive to the two primary drive wheels continues to seem more efficient than any currently imaginable alternative, but in most circumstances when all four must drive, efficiency is usually of limited concern.

Either hydraulics or electrics could be used to drive the other two wheels. Hydraulic motors might be the more appropriate of the two, particularly if the fluid power is already on hand for moving the active suspension up and down.

However, as noted earlier, electric power certainly seems to have a much brighter long-term future. And it's noteworthy that this concept has not been overlooked by either GM—as an original equipment option application for Magnequench—or by aftermarket suppliers as a retrofit 4wd package. Just think, not 4-wheel drive, but 4-wheel *boost*, a no-space-wasted option.

As conceived by Unique Mobility Systems, a broad-based electric-drive development company in Denver, Colorado, the individual wheel drive motors might be mounted inboard, with U-jointed driveshafts. Their unique motor, a spinoff from IBM computer-taped drives, is not a disc pancake motor, but a pan-shaped motor with a sleeve-type permanent-magnet rotor. With its greater diameter and lower weight, this type of motor seems to be especially appropriate for automotive applications.

Unique Mobility's largest current design is rated at 40 hp continuous at 12,000 rpm, with temporary overload capacity up to 80 hp. (As an auxiliary drive, it could be considered an 80-hp motor, since it would likely be switched on only under cold and/or wet conditions.) The motor alone weighs only 8 pounds or so, but that of course doesn't include the mandatory speed controller and a 10:1 planetary gear reduction to translate high output shaft rpm down to reasonable wheel speeds.

Electric drivelines?

Beyond auxiliary 4wd there are other potential applications for electric power, such as full-time 4wd with in-wheel motors. There are significant problems to be conquered with this concept, to be sure. According to Dr. Nady Boules, of GM Research, the wheel is a rather hostile environment for the most advanced motors. The shaking, vibration, dust and moisture are too extreme even for a brushless permanent-magnet motor. And whatever the minimum motor weight it still adds to the various ride and handling control problems that are generally associated with unsprung weight.

Still, the potential advantages of reduced overall weight and reduced driveline complexity make it the kind of development possibility the manufacturing community can't afford to overlook.

Looking even further into the future, anticipated breakthroughs in superconductors, batteries and flywheel energy storage can't be totally dismissed as challenges to the gasoline engine. It's well known, for example, that super-cooled superconductors are capable of producing dramatic increases in electric motor efficiency. And even though the cooling equipment wouldn't be practical in one of today's automobiles, it would be a mistake to discount the possibility of ambient temperature superconductors coming into use as early as the next decade.

Energy-storage flywheels are also well within the realm of possibility, especially in conjunction with the new motor technologies, which make for a good 2-in-1 package. Batteries, the only current technological obstacle to the completely electric car, are also poised on the edge of the "possible breakthrough" category.

In the meantime, Volkswagen has demonstrated a clever hybrid gas/electric vehicle utilizing the best of both. The engine flywheel is replaced by a pancake or sleeve motor, which is clutched to both the engine and the transmission. In this way, it's capable of serving in a number of roles—as a starter motor, an alternator, a motor assist to the primary engine or a vehicle drive motor when declutched from the engine.

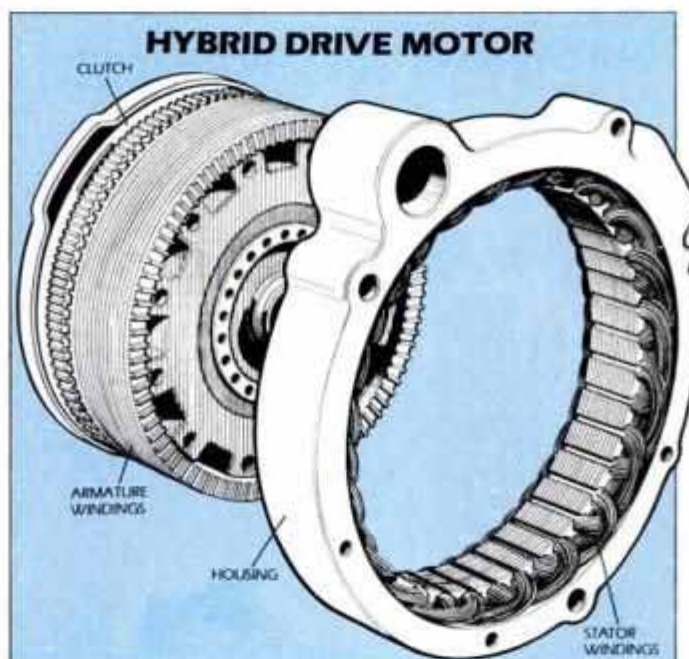
The VW system employs computer logic to determine the most appropriate application at a given time, and there is no risk of "running out of battery," even with a battery pack that is only minimally larger than today's average car battery. So it provides the advantages of both gas and electric power: energy-

storage density, and quiet, smooth acceleration. The engine can be shut off at stoplights or in stop-and-go traffic, and then quietly re-energized for peak power or endurance. Even the weight penalty may be minimal, as neither the gasoline nor electric propulsion system needs to be full size in itself. And as a more realistic consideration, it may be the necessary transition stage for the industry to go from gas to electric.

The technological battle rages between engineers with widely differing special interests. Will we have hydraulic, electric, mechanical or electric clutches, sending power through gears, pumps, motors or torque converters? Will motors be chassis-mounted or in the wheels?

These are all intriguing questions that promise to produce some fascinating answers.

But there's really no question about who will win. We'll all win.



VW/Bosch/Ensa dynamotor serves as generator to recharge vehicle batteries, as motor to supply additional torque, or as primary drive where conditions warrant pure battery/electric drive. Clutch in center of armature is operated by vehicle computer, engages/disengages engine or transmission from dynamotor.

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Testing limousines requires special equipment and preparation.
DRESS COURTESY OF MARSHALL FIELDS

LIMOS AT THE LIMIT



The black-tie test is the one that counts in a comparison of these high-rent haulers.

BY CLIFF GROMER; PM Photos by Humphrey Sutton

WE'VE BEEN saying for the past couple of years that the day of the all-around car is history. In days past, you bought a car that served as the family car, the commuter car, perhaps the sports car, and go-out-on-Saturday-night car.

Today, all that is changed. Now, you own a tiny little car for commuting, switch to a sport/utility vehicle when you go fishing, change over to the minivan when it's time to haul the kids to Little League, jump into the musclecar when you want to sport around a little, and settle into the back of the limo for dinner at the country club on Saturday night. In the reality of the '80s, it's not unusual for a well-wheeled family to own two, three, four or even five cars.

If you're a regular reader, you'll know that we regularly make comparison tests of just about every category of vehicle, from 4x4 sport/utility off-roaders to 4-on-the-floor sports cars. But frankly, we've given short shrift to the limousine segment. And as we realize that more and more of you will be making limousine purchases in the next year, we wanted to make sure you had enough information to make an intelligent buying decision.

With that end in mind, we lined up three of the more

popular model limousines—one based on a Cadillac, one based on a Lincoln, and the *ne plus ultra*, a limo based on a Rolls-Royce. We gathered the vehicles at Union Grove Dragway just outside of Milwaukee, Wisconsin, and ran them through our regular battery of test procedures—with a few exceptions.

Our usual testing procedures were modified somewhat to fit the character and capability of our test machines. For instance, we did not report on the cars' turning circles, simply because they didn't have any. Skidpad figures also are absent because the cars couldn't fit on one. And who cares about those numbers anyway? Thrashing these cars through the corners at several Gs of lateral acceleration is the quick route to reducing all the bar-filled crystal and the sensitive electronics of the auto entertainment center into a heap of worthless rubble. Then there's always the possibility, heaven forbid, of spilling some of the expensive champagne (we insisted on Dom Perignon).

But don't get us wrong. Performance did not take a back seat in our overall evaluation. We did. Since our cars came equipped with the optional chauffeur feature, we did all our testing from the back seat—a procedure

LIMOS AT THE LIMIT



Limo Werks Lincoln (left in top left photo) won drag derby. Rolls (top right) was spectacular in slalom. Rolls interior (above) is done all in leather with classic good taste.

considered controversial by some magazines.

The cars we selected for our test are typical of what the average family would consider in the purchase of a new limousine. The first of our trio is the Rolls Royce from Concept Coach Builders in Milwaukee, Wisconsin. There are two ways you can go here. You can bring in the family Rolls (Silver Shadow, Silver Spirit or Silver Spur), and have the company extend the body and add their luxury package. Or, Concept Coach Builders can provide you with a new model redone to their own specifications.

However, by starting with your own car, the savings are substantial. A custom body on your Silver Shadow chassis will run you about \$45,000. Using your Silver Spirit/Spur chassis runs the cost to about \$55,000. Don't forget to add the cost of the car itself, say an extra \$100,000 or so.

The car provided for our test was a 1981 Silver Spirit, originally a short wheelbase model, priced at \$125,000.

These dollars get you, among other things, a body extension of 51 1/4 in., full-vinyl roof, tinted windows, new paint, dual-battery system with high output alternator, new springs, transmission oil cooler and inspection of the car's many mechanical systems.

The stretched exterior is eye-catching, but it's the reworked interi-

or that really makes the difference. First there's the rear-facing bench seat that promotes family interaction. A power glass divider provides privacy for minor family squabbles, with a solid divider for major battles. A hands-free intercom allows constant audio contact with the chauffeur.

Auxiliary heating and air conditioning controls will keep the family in just the right comfort zone, while Sony remote TV, VCR and CD player should keep everyone entertained.

The Cadillac, an '87 model, and an '88 Lincoln were both provided by Limousine Werks in Barrington, Illinois. Similarly optioned and appointed, both cars featured a 60-in. stretch, the Lincoln emerging as a "long door" version with an additional 6 in. added to the door, glass and trim panels.

Creature comforts of the Limo Werks machines rivaled those of the Rolls. A large number of buttons and switches on the armrest and in the overhead console controlled temperature, power divider window, remote color TV, VCR, AM/FM/cassette stereo, room service and so on.

Mechanical features included transmission cooler, extra radiator fan, heavy-duty suspension and oversize premium tires. Our interest, though, was especially drawn to the walnut cabinetry with its decanters and crystal barware.

Fully equipped, the Lincoln carried a sticker of \$55,000, while the Cadillac was a reasonable \$49,500.

All three cars, chauffeur-equipped, were waiting for us in front of our hotel, with caviar in the snack bins and bubbly in the champagne buckets. We could see we'd have our work cut out for us. We piled into the Rolls and headed for the drag strip.

Enroute we checked the mobile TV system in the Rolls, using the automatic channel scan, and the 22-channel memory presets. Then we switched to VCR mode for some classic Bogey.

Putting the video system through its paces with the remote-control unit still left us a free hand for cranking up the remote-control Sony Discman for our max volume test. There were still a few unpushed buttons when we reached our destination, but it was time for our morning break.

Breaking out the picnic table, tablecloth, snacks and champagne, Great Lakes Dragway looked more like Great Lakes Bistro. But we were actually hard at work, testing the crystal barware. This round went to the Rolls, by virtue of slightly better balanced stemware.

The strenuous test under our belts, we turned to less exhausting activities, on Great Lakes' quarter-mile.

Getting times measurable by something other than a calendar took awhile. The chauffeurs obviously hadn't been trained in the fine art of limo-launching.

When the smoke finally cleared, the Lincoln was the hotrod champ with a 19.12-second elapsed time at 71.42 mph. Not bad when you consider the car's 4975-pound curb weight. The Rolls was No. 2 in our drag fest at 19.826 seconds at 70.36 mph, while the Caddy clocked 20.25 seconds/66.37 mph.

The leisurely quarter-mile runs allowed us to do some additional testing of the various interior appointments while we rolled the power divider window up and down to shout encouragement to the drivers. This was followed by our sprawl-out-on-the-seat test. The Caddy was the hands-down sprawl test winner, while the Lincoln came up with the quickest power divider window time of 3.962 seconds for the full up-and-down cycle—one of the quickest times ever recorded by this magazine.

We were unable to obtain any accurate slalom data because all that rolling around through the pylons made us a bit queasy. We hope to be able to pick this up at some future date and bring you a follow-up report. In the meantime, did anyone remember to bring the Grey Poupon? **PM**

PERSONAL COMPUTING

THE SUPER CLONES

Once again, IBM is setting the pace for its personal-computer rivals. Here's how three top clones stack up against Big Blue's challenge.



IF YOU'VE waited till now to buy a personal computer for your home or office, you've hit the jackpot. Today's PCs offer faster processing speed, better graphics and more memory than earlier machines—at a fraction of the cost. There's a PC for virtually every taste and pocketbook these days, and even the budget class of "clones" compatible with IBM's original PC and XT models offers unprecedented value. **POPULAR MECHANICS** looked at four computers in

BY RON SCIBILIA

the current crop of PC/XT compatibles. Here's what we found.

IBM PS/2 Model 30

Something old, something new, something borrowed—and definitely Big Blue. That sums up IBM's Personal System/2 Model 30, the place hitter in Big Blue's much-publicized new lineup.

Compared to its predecessor, the IBM PC/XT, Model 30 offers many important enhancements. First and foremost, you'll get significantly nimbler performance from an 8 megahertz (MHz), zero-wait-state 8086 processor. Then, there's the convenience and durability of high capacity 3.5-in. disk drives that double data storage to 720 kilobytes (KB) per disk. Finally, the Model 30 offers considerably better graphics display.

IBM's shift from digital to analog

THE SUPER CLONES

video technology heralds a whole new look to PC graphics. The Model 30 can display up to 256 simultaneous colors (from a palette of over a quarter million) in a stunning new video mode that renders VCR-like images at 320 × 200 pixel (dot) resolution. IBM's monochrome monitors can display as many as 64 shades of gray. Also available is a high-resolution 640 × 480 pixel mode. The Model 30's 640 × 400 text mode, a tick better than the 640 × 350 popularized by the Enhanced Graphics Adapter (EGA), offers excellent readability—especially on IBM's new 12-in. color monitor (\$685).

With the introduction of the PS/2 family, IBM has now adopted the 3.5-in. disk format for its entire line. Don't worry about media incompatibility with the older 5.25-in. disks: Virtually every major software vendor offers programs in the 3.5-in. size now that IBM has given the format its support. If you have access to a standard PC or clone that uses 5.25-in. disks, media transfer should still be easy.

There are several quick and inex-



IBM's new PS/2 Model 30 boasts superfast processing and sharp color graphics.

pensive ways to move data from one format to another. IBM offers what it calls the Data Migration Facility (\$33), an adapter that swiftly and painlessly ports programs and data from a 5.25-in. drive to a 3.5-in. drive—so long as the software isn't copy-protected. You're in a tougher spot if you use a 5.25-in. drive at work and the Model 30 at home. In this

case, you'll need to buy either a 3.5-in. drive for the office or a 5.25-in. drive for home (around \$400 from IBM).

Initial setup of the Model 30 is simplicity itself. There are no jumpers or DIP switches to fiddle with, nothing to configure. Gone is the hefty IBM Guide To Operations, replaced by a short user-guide and a starter disk that gives you a brief overview of computing and of your new machine.

Inside there's room for three full-size old PC expansion cards.

But with its graphics controller chips and 640 KB of random access memory (RAM) on the motherboard—plus built-in clock/calendar, serial, parallel and mouse ports—you might find less of a need for system expansion. If you are enhancement-minded, the Model 30's hefty 70-watt power supply ought to handle all but the most power-hungry extra boards.

Where the Model 30 really shows its pedigree is in its mastery of fundamentals. IBM has paid close attention to those all-important aspects of computer use affecting eyes, ears and fingers—aspects that don't appear in spec sheets trumpeting megahertz and kilobytes.

There's the typically solid IBM keyboard with an excellent feel, and easy-on-the-eyes high-resolution video in either color or monochrome. There's a 30 percent smaller system-package whose generous 6-ft. rear-plugging cables permit flexible placement of monitor, system and keyboard. Finally—and a virtue that will be especially appreciated in a home or small business environment—there's a nearly inaudible fan. Couple this with responsive processing—more than twice the speed of the original PC and definitely the fastest in this group according to our real-world tests (see the accompanying chart)—and you have an excellent choice.

All in all, the Model 30 is a class act among the XT-grade compatibles, though not the cheapest way you can compute.

Based on manufacturer's list prices, the Model 30 costs \$2050 for a 2-floppy system with monochrome monitor and PC-DOS 3.3 (which must be purchased separately). Figure about \$2400 with a color CRT, and around \$3000 for a color system with a 20 megabyte (MB) hard disk. This means the Model 30 is competing against not only XT clones, which can be had for less than \$1000 for a basic system, but also against a growing number of more powerful PC/AT-

COMPARISON TEST RESULTS:

IBM PS/2 MODEL 30 (8 MHz)

REFORMAT TEST: 69/REPLACE TEST: 114

EPSON EQUITY 1+ (10 MHz)

REFORMAT TEST: 74/REPLACE TEST: 134

VENDEX TURBO-XT (8 MHz)

REFORMAT TEST: 90/REPLACE TEST: 155

ZENITH E-Z PC (7.16 MHz)

REFORMAT TEST: 114
REPLACE TEST: 192

REFERENCE PC (4.77 MHz)

REFORMAT TEST: 146
REPLACE TEST: 260

PM's comparison tests show how many seconds it takes for the computers to perform two "real world" tasks on an 8000-word document recorded in the WordStar word processing program. In the finishing times shown above, the first number refers to our "reformat" test, in which the computers are asked to change the document's line width from 65 to 40 characters wide. The second number tells how quickly the computers completed our "search-and-replace" test. Here, the computers are asked to find every word "a" in the document and replace it with the word "animal." All times shown represent a computer working at its fastest processing speed, designated in megahertz (MHz). A comparison with the speed of first-generation PC's (which operated at 4.77 MHz) is provided by our Reference PC—an original IBM Personal Computer. For the record, the Epson and Vindex computers can operate at 4.77 MHz, and matched the Reference PC's times in this mode.

compatibles. If you're looking for an XT-level machine, you'll have to decide whether you need the Model 30's extra bang versus its XT-compatible competition, especially in graphics. If you're the type of computer user who requires maximum throughput for your dollars—and are willing to forego the security blanket of the IBM name—you might look at one of the bargain-priced AT clones now on the market.

Epson Equity I+

Epson's Equity I+ is an upgrade of the Equity I, and exhibits the same thoughtful design as its predecessor. Although it weighs more than the IBM Model 30 (19.8 pounds versus 17 pounds), the Equity's taller, narrower system unit is equally at home positioned horizontally or vertically on a desktop. The result is a system that finds room for itself in a home office or small workplace.

The Equity's keyboard—which like



Epson's Equity I+ is almost as fast as IBM.

the Model 30's is a 101-key enhanced AT layout—plugs into the front of the system unit, with a tiny door covering the plug. Keyboard feel is good but somewhat less finger-friendly than the Model 30. Other important controls are easily accessible through small panel doors on the front. The fan on the Equity I+ is unobtrusive, but not quite as low on the decibel scale as the Model 30's. Its disk drives, though, are quieter than IBM's.

Major enhancements to this version include boosting standard RAM to 640 KB. The meager 53-watt power supply of the Equity I has been boosted to a more robust 80 watts. Addi-

tionally, by switching to a dual-speed microprocessor that offers a 10 MHz "turbo" speed (as opposed to the 7.16 MHz or 8 MHz speeds found in most other "turbo" XTs), Epson has made the I+ one of the fastest XT-compatibles available—second only to the Model 30 in our tests.

Like its predecessor, the Equity I+ comes with parallel and serial ports and a clock/calendar all standard. And while purchasers of IBM's Model 30 will have to ante up \$120 for PC-DOS 3.3, Epson's PC comes bundled with MS-DOS 3.2, GW-BASIC and some useful utility programs. There are five internal slots, four of which are free after you install a video display adapter card (which, like a monitor, is an extra-cost option).

Total cost for a medium-resolution color system with two 360 KB 5.25-in. floppy drives will run about \$1800. When fitted out with an EGA video adapter/monitor combination more in line with the display capabilities of the IBM Model 30, an Equity I+ system will cost about \$2200, a price that takes this machine within hailing distance of the Model 30 but still doesn't match that PC's overall performance.

A more cost-effective package might couple Epson's monochrome monitor with the company's Multimode graphics adapter, which offers both medium-resolution, CGA-grade graphics and high resolution, Hercules-compatible graphics. This would cost about \$1650 for the total system.

The Equity I+ scores its best comparative shot against the Model 30 in this basic monochrome version, where it offers computing power nearly equal to a monochrome display Model 30 for about \$400 less. With both machines in high-resolution color versions, however, the price difference doesn't quite overcome the Model 30's advantages in processing speed, graphics, easier setup, a superior keyboard, quieter fan and the inclusion of a mouse port.

Vendex Headstart

Making a strong run at the economy end of the XT spectrum is the Vendex Headstart Turbo 888-XT, a unit that is manufactured by Korea's Samsung to the specifications of Vendex, a Netherlands-



Newcomer Vendex: great value for price.

based marketing conglomerate. The result is a computer that gives other brands a run for their money.

Vendex has done a lot of things right, starting with a well thought-out piece of hardware and including such commendable options as low-cost on-site setup (\$50) and economically priced service contracts. For a list price of \$1295 you get a dual-speed (4.77 MHz and 8 MHz) XT-compatible with 512 KB RAM (expandable to 768 KB). A video display adapter—already installed—provides either me-

(Please turn to page 134)



Zenith's eaZy pc provides simple setup and operation, sharp display and small size.

COVER STORY

SKYBURNERS

The annual Oshkosh Fly-In yields an impressive lineup of high-performance sport planes that you can build.

TEXT AND PHOTOS BY BUDD DAVISSON



Contrast in style: The all-composite, 2-place Lancair 235 (left), and the Rutan-Inspired Velocity. Both airplanes offer a cruise speed of close to 210 mph.



THE CHOPPY surface of Lake Winnebago was painted across the top of the canopy as I hung suspended in my seatbelt. The inverted Glasair III was boring a hole through Wisconsin's hard, blue skies as I did my best to develop visual cues to use in judging when we

were level and when we weren't. I glanced from the nose to the altimeter and back to the nose, my visual scan telling me what attitude to hold when maintaining level flight upside down. Satisfied, I expanded my scan to include air speed—and got the shock of my life. Here we were, dead level, upside down at 6500 ft., power output limited to



The innovative Venture offers an aluminum alternative in a high-performance homebuilt.

about 65 percent—and yet that round gauge with the go-fast needle read 235 mph! Corrected for the same factors that limited our power, that worked out to more than 265-mph true airspeed. In a homebuilt! Homebuilt my foot.

My quick flight in the Glasair absolutely con-

firmed what was easy to observe on the ground at Oshkosh '87: The new breed of homebuilt airplanes may say amateur built on their airworthiness certificates, but there was absolutely nothing amateur about them. Especially when it came to performance. In fact, blow-your-doors-off performance was the keynote of the homebuilt side of

SKYBURNERS

1987's gathering of the clan at the annual Oshkosh Experimental Aircraft Assn. convention. The high-performance part of the formula ran hand-in-hand with not-so-subtle indications that we were witnessing the development of a new era in general aviation. Although still in embryonic form, it would appear the kit plane industry is maturing into an alternative to the traditional source of single-engine airplanes. You could say that kit planes are becoming to Cessna, Piper and Beechcraft what Ferrari, Lamborghini and Maserati are to General Motors. Here are some examples:

Venture

The Venture sprang from the design board of Jim Griswold, the designer of the Piper Malibu. Griswold used a normally aspirated version of the Malibu's Continental engine for the Venture, and the Venture has more than a passing resemblance to the Malibu in the nose. But the similarity ends there.

Forget the fact that it is capable of cruising at 250 mph at 10,000 ft. Ignore the cockpit, which was designed to be wider than a twin-engine Beechcraft Baron. Don't mention the long-range capabilities that let it cruise more than 1100 miles between drinks of 100 octane. And absolutely do not bring up the fact that it is an entirely aluminum airplane that uses stretched form fuselage skins that come as part of the kit.

If you wanted to fit in with the rest of the Oshkosh crowd this year, you'd talk about the way the airplane looked. It looked short. Really short. In fact, most observers referred to it as "The Egg." Actually, the Venture wasn't short, at least not in aerodynamic terms. The airplane's fireplug stature seemed pronounced because the fuselage is extremely wide for such a small airplane.

Although a brand-new design (the prototype had only 50 hours on it when it arrived at Oshkosh), Griswold's company, Questair, is totally tooling up for the airplane and



Two emerging standards: The all-composite Glasair III (top), considered the dean of the homebuilt trade, hits 270 plus. The Wheeler Express (left) also takes aim at the general aviation market with 195-mph, 4-place performance.

was nearly through with its flight-test program at press time. When offered to the public, the Venture will have gone through the exact same structural and flight-test programs the FAA specifies for factory certified airplanes.

Price: \$49,450, including engine and prop. For details, contact Questair, Box 18946, Greensboro, NC 27419, (800) 852-3889.

Glasair III

An outgrowth of the older Glasair line, the III utilizes the older, proven wing, but mates it to a newer, longer fuselage. The added length makes it look sleeker than the older airplanes, but the length was added for reasons other than aesthetics. Like having a 300-horse Lycoming in the nose. Although engines as

small as 250 hp can be fitted, it's doubtful if any will want to build such a rakish airplane and then skimp on the ponies.

Price: less engine, instruments, prop, upholstery, \$32,500. For details, contact Stoddard-Hamilton Aircraft, Inc., 18701 58th Ave. NE, Arlington, WA 98223, (206) 435-8533.

Lancair

The Lancair 235 is one of the fastest-selling, high-performance kit planes in the business. At Oshkosh '87, Lancair unveiled its new 320 model, so named because of the Lycoming O-320, 150-hp engine underneath the cowl.

Almost indistinguishable from the earlier 115-horse airplane, the new model is designed from the ground up to go nose-to-nose with big-en-

gine, high-performance kit planes. The 235's impressive 210-mph cruise speed has been increased to 230 mph, which is even more impressive since it uses an engine much smaller than its competition. Most of the Lancair's performance comes from its compact, sports-car size. Lancair also takes full advantage of the aerodynamic possibilities that composite construction represents.

Price of the 235: less engine and prop, \$16,900. Price of the 320: less engine and prop, \$18,500. For details, contact Neico Aviation, Inc., 403 S. Ojai St., Santa Paula, CA 93060, (805) 933-2747.

Velocity

Another 4-place rarity, the Velocity takes up where Rutan and other canard aircraft



Homebuilding innovations: The Curtiss P-40 replica (foreground) and mini-Reggiane 2002 are custom creations by a pair of very dedicated homebuilders. The E-Racer has retractable gear and a throaty Olds V8 aluminum engine.



builders left off. Although the Velocity obviously has a lot of Rutan's original concept left in it, the aircraft's designers opted for a "family-style homebuilt" rather than a tail-first sports car.

The cabin width is on a par with most smaller single-engine production airplanes, but the performance of 210 mph plus on 180 hp far exceeds factory-built with the same horsepower. This is especially true in range. The airplane carries 73 gallons of fuel, which gives it a theoretical range in the neighborhood of 2000 miles—and that's a big neighborhood.

Price: less engine, prop and avionics, \$18,000. For more information and details, contact Velocity Aircraft, 200 W. Airport Dr., Sebastian, FL 32958, (305) 589-1860.

Wheeler Express

Ken Wheeler's "Express" appeared to be taking direct aim at factory-built airplanes since it didn't depart radically from traditional configuration or styling. The composite construction allowed for very smooth lines and good aerodynamics, giving the airplane a cruise speed of 195 mph at 7000 ft. with only 200 hp.

As homebuilts go, the Wheeler Express is a big airplane with a span of 31 ft. and a max takeoff weight of 2300 pounds. It carries 51 gallons of fuel, which gives it a range of 1100 miles.

Price: fixed-gear model, less engine, prop and avionics, \$19,750. For details, contact Wheeler Aircraft Co., Dept. PM, Tacoma Narrows Airport, Gig Harbor, WA 98335, (206) 851-5793.

E-Racer

Based loosely upon one of the original Rutan designs, the airplane goes where no man has gone before.

In the first place, the composite canard machine is the first known example of the Rutan Long-EZ clones to have fully retractable gear. In the second place, the crowds gathered around it were there to hear the engine as much as they were there to see the airplane. With a 215-cu.-in., aluminum Olds/Buick V8 shoe-horned where the flat-Four Lycoming should be, the E-Racer was the hands-down winner in the Great-Sounding Airplane category. Just idling, the airplane sounded tough, but when developer Shirl Dickey punched it for takeoff, it sounded downright vicious. Dickey is developing

an E-Racer kit. For more details, contact Shirl at Sierra Delta Systems, 11455 S. Mandan St., Phoenix AR 85044, (602) 893-8711.

Minifighters

Oshkosh is the natural gathering place for kit planes like the ones just described, along with tried-and-true aircraft from major manufacturers, warbirds—or one-off, custom-built airplanes from some of North America's most ambitious aviation innovators. Two homebuilders from Edmonton, Alberta, Ross Grady and Bob Tesori, showed the rest of the EAA Fly-In what homebuilding is all about with two finely crafted mounts.

Forgoing the usual kit-plane concept, both builders opted to design and build miniature versions of their favorite World War II fighters. Grady created a Curtiss P-40 and Tesori an Italian Reggiane 2002.

When Ross Grady decided to build his minireplica, he had one thing in mind: to build an airplane that could be mistaken for the real thing. A kit may be in the wind, but Grady will market plans first.

Price: plans only, \$400 U.S. Contact: Ross F. Grady, Grady Construction and Engineering Ltd., 11717 78th St., Edmonton, Alberta, Canada T5B 2J2, (403) 477-2927.

Bob Tesori's airplane is a tribute to what one man can do with metal shears and a rivet gun. And the crowd found the powerplant in Tesori's Reggiane intriguing. He has opted for a tiny radial engine, something seldom seen in homebuilts. A refugee from a Polish STOL airplane, the engine is still in production in Europe and its 260 horses push the airplane at close to 170 mph.

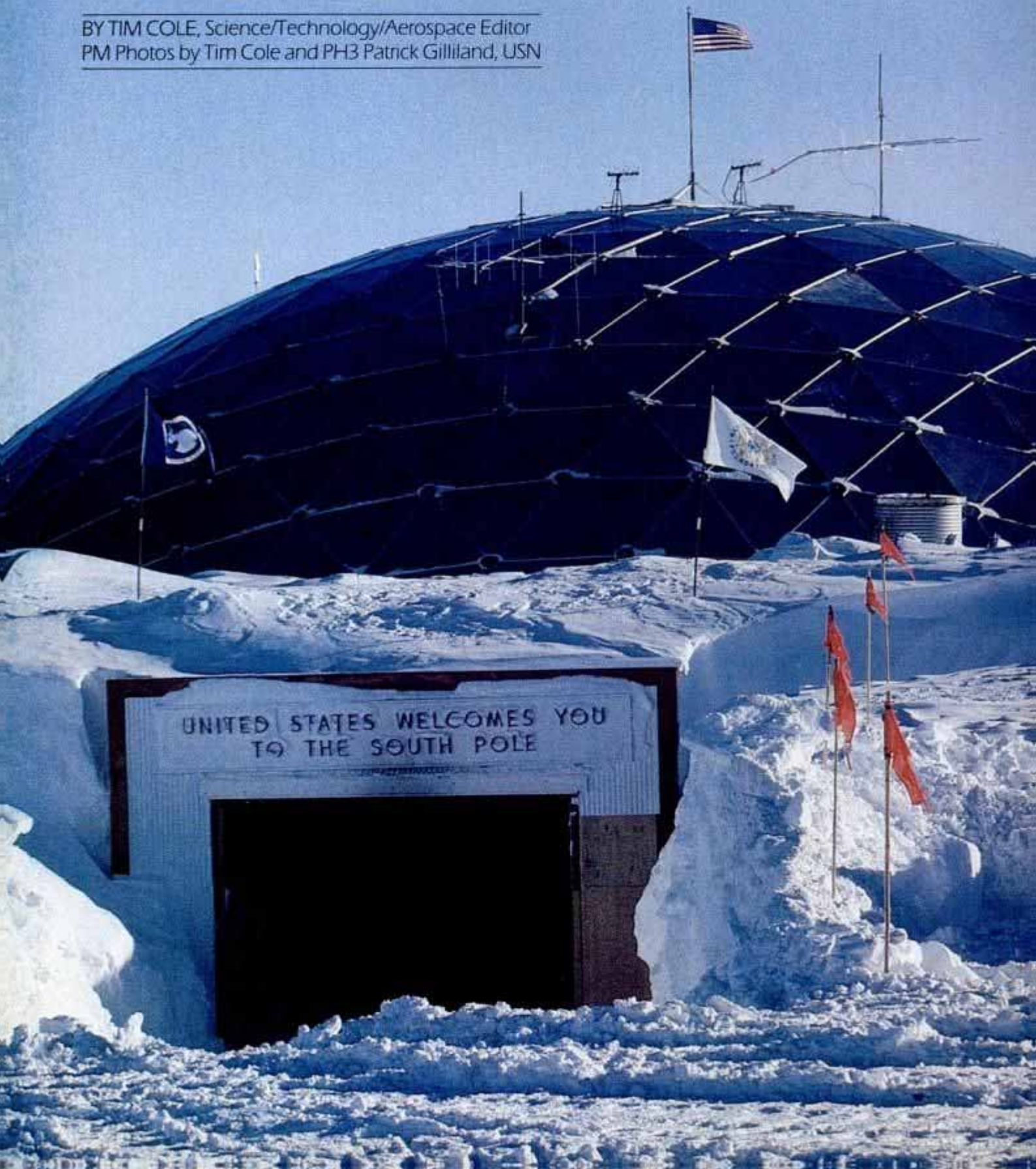
Price: plans only, \$400 U.S. Contact: Bob Tesori, Apt. 1606, 10883 Saskatchewan, Edmonton, Alberta, Canada T6E 4S6, (403) 433-3785.

At the very least, Grady and Tesori demonstrated the psychology of innovation that always flourishes at Oshkosh. The official think tanks and skunk works of American aviation may be centered elsewhere. But Oshkosh remains the soul of aviation. **PM**

PM ADVENTURE

SOUTH TO

BY TIM COLE, Science/Technology/Aerospace Editor
PM Photos by Tim Cole and PH3 Patrick Gilliland, USN



THE POLE

Investigating the fate of planet Earth on the frozen continent of Antarctica.

THUGHT of Scott as our ski-equipped Lockheed LC-130 climbed over Beardmore Glacier, which links Ross Ice Shelf to Antarctica's polar plateau.

Robert Falcon Scott and his party of British stalwarts had used Beardmore as a stairway to the South Pole in their 1911 attempt to beat Roald Amundsen to the Earth's last great geographic prize. Incessant cold, lingering hunger and the burden of hauling supply-laden sledges turned

Scott's voyage of scientific discovery into a legend of inexpressible suffering. After Beardmore, Scott and his men braved the featureless waste of the polar plateau—in the thinning air and lung-slashing cold—to arrive at the South Pole two months too late. The penalty for failure? Delirium, then death.

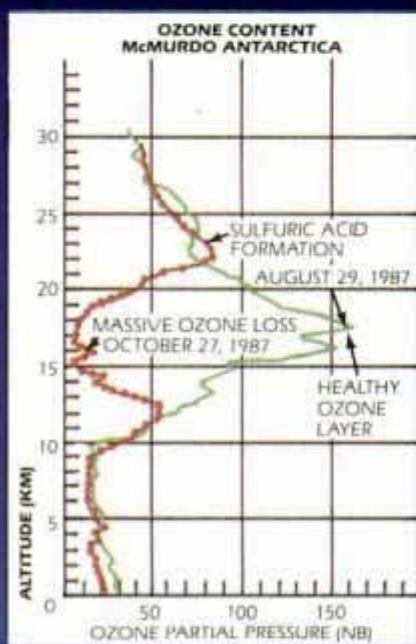
Powerful considerations on a sunlit Thursday in November, 76 years after Amundsen's triumph, more than three-quarters of a century after

Scott penciled his last words: "For God's sake, look after our people."

The LC-130 was making a milk run to America's Amundsen-Scott Station, located at the same place on the map that had beckoned the two polar pioneers. After taking off from the sea-ice runway near this nation's principal Antarctic outpost on McMurdo Sound, we had arced across Ross Ice Shelf—bigger than the state of Texas—and laid a course for the bottom of the world. With crevasse-ridden

Bristling with antennas, America's Amundsen-Scott Station at the South Pole shelters up to 100 scientists in the Austral summer. They arrive by workhorse LC-130 Hercules (below left). Science Editor Tim Cole hoists the PM colors at the geographic axis of the Earth (below right).





David Hofmann of the University of Wyoming [top] has discovered an unsettling byproduct of Antarctic ozone loss. Tiny droplets of sulfuric acid appear to condense above 22 kilometers [graph], and persist despite normal atmospheric dynamics. Measurements are taken by combination ozone/radiosonde [above] lofted by a polyethylene helium balloon [right] that's tracked by radar.



Beardmore twisting angrily behind us through the daunting heights of the Transantarctic Range, a low-lying Sun squinted over the horizon, washing the polar plateau with gold, etching the shadows of wind-blown snow. Surely another planet, Scott must have thought on cresting the icecap—with Beardmore at his back, the pole some 400 miles distant.

High above it all—continuing our 4½-hour, 850-mile flight from McMurdo—scientists, engineers and Navy personnel assigned to Operation Deepfreeze wrestled into their flannel shirts and down parkas. Our pilot, Navy Cmdr. Jack Rector, cranked in a markedly casual rate of descent and soon, we fluttered to a landing at South Pole Station's skiway, completing a journey in an afternoon that had cost men their hearts, their minds, their very lives when this century was new.

They used the word "conquer" when referring to Antarctic exploration back then. Now we know that this place can never be subdued—merely understood, and then only partially. Although this continent of endless ice yields its secrets unwillingly, perseverance has nonetheless revealed Antarctica to be a rather sensitive indicator of the health of planet Earth, a huge laboratory where scientists can learn about the dangerous changes taking place in our atmospheric chemistry, about the future of our marine resources, about climatic phenomenon that could effect global sea levels. Adding to concerns, a piece of the Ross Ice Shelf the size of Rhode Island broke away during PM's sojourn to The Ice. If surface warming were to melt the south polar icecap, sea levels would rise 200 ft. worldwide. Already, drastic reductions in atmospheric ozone—and a resulting increase in radiation—may be affecting the Antarctic ice sheet.

Turning to the heavens, some scientists consider the terrain and climate of Antarctica analogous to what we'll encounter on Mars. Indeed, interplanetary exploration has already begun from Antarctica, a perfect spin-stabilized platform for observing the Cosmos.

The overwhelming difficulty of traveling to this ice-bound continent, and the hardships imposed by winter darkness and climatic extreme, have been eased by modern technologies. Later explorers like Admiral Richard Byrd and Sir Hubert Wilkins learned that the airplane was the key to polar exploration. A trek that had taken

PROFILE OF A CONTINENT

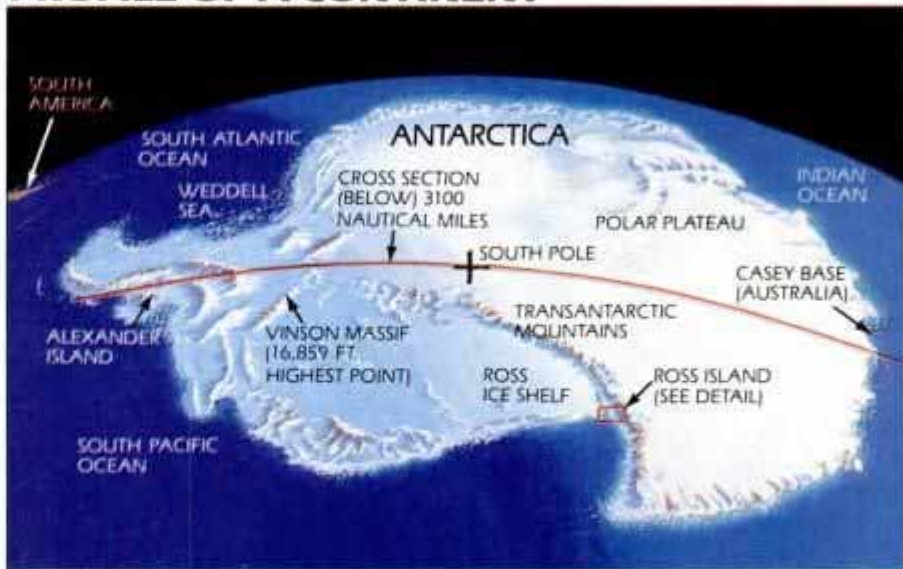
Amundsen and Scott weeks on foot could now be compressed to a matter of hours by Ford Tri-Motor and Lockheed Vega.

Lest we be complacent, traveling to Antarctica is still a strenuous undertaking. After hopping by jumbo jet across the Pacific to Christchurch, New Zealand, you cross the frigid Southern Ocean in a U.S. Air Force C-141B. ("Don't worry," a loadmaster murmurs. "If we ditch, you'll only last about 30 seconds.") After crossing the tip of Antarctica's Victoria land 4½ hours out of Christchurch, the crew from the Military Airlift Command assigned to Operation Deepfreeze guides the 4-engine, high-wing jet to the ice runway carved out of the snow on frozen McMurdo Sound. Engineered by talented Navy Seabees, the 10,000-ft. strip is situated on ice 4 ft. thick over water 600 ft. deep. The runway is used from early October to mid-December, when the ice goes out and replenishment ships, led by a U.S. Coast Guard icebreaker, make their way to McMurdo. Flight operations are then moved to a skiway located on the Ross Ice Shelf off McMurdo, used exclusively by LC-130s. Men and women from the squadron serving Naval Support Force Antarctica haul the freight and move the people who produce the science. An LC-130 crash Dec. 9, during the late Antarctic spring, killed two Navy fliers, accentuating the cost of doing business in this land of savage beauty.

From the ice runway, new arrivals are taken by huge wheeled vehicles called "Deltas" to the tiny village of McMurdo Station, America's primary presence on The Ice since the 1957 International Geophysical Year. U.S. Army personnel, assisted by the Royal New Zealand Army, handle the volumes of scientific cargo.

Form definitely follows function at McMurdo, a jumble of metal garages, tool sheds, dormitories and double-walled canvas Quonset huts called Jamesways. McMurdo's purpose is to support Antarctic science, so much of the space is given over to biology and Earth science labs. The Navy buildings contain meteorological equipment and stores that keep the airplanes and helicopters flying.

The National Science Foundation administers America's polar programs, offering competitive grants to polar scientists from American universities each year. McMurdo Station is the nerve center—acting as a relay to outlying stations such as Byrd Sur-

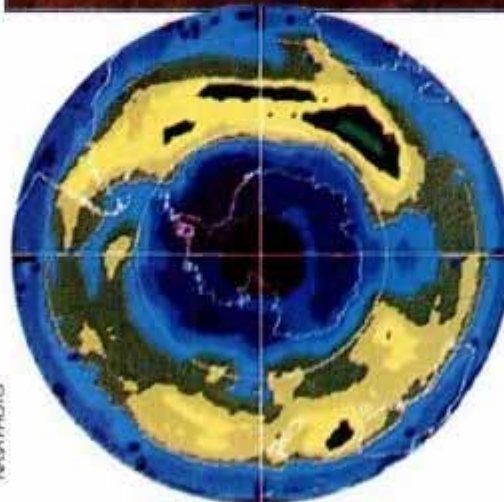
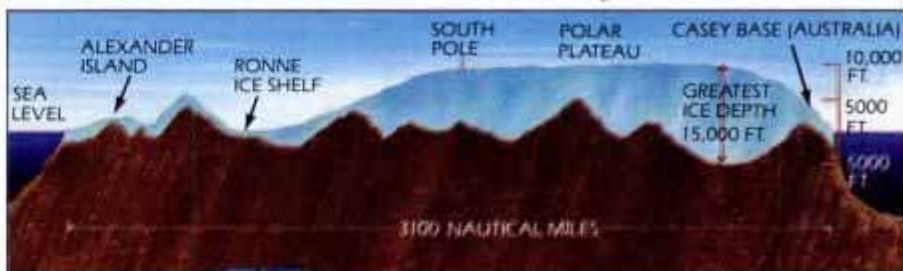


ILLUSTRATIONS BY DEAN ELLIS



A land of brutal beauty, the continent of Antarctica and its permanent floating ice shelves take up more than 5,500,000 sq. miles—one-and-a-half times the size of the United States. An enormous prehistoric ice sheet covers all but 2 or 3 percent of the Antarctic land mass, which, if it were to melt, would raise global sea levels 200 ft.

America's principal base, McMurdo Station, is located on Ross Island, which allows access to both the Ross Ice Shelf and open water from December to March. Used primarily as a staging area to the South Pole and other American installations, McMurdo also serves scientists conducting local investigations of the Antarctic atmosphere, geologic history or life under the sea ice.



NASA PHOTO

Seismic studies, radio-echo sounding and radar have established the thickness of the polar ice cap over underlying mountain ranges.

The Antarctic ozone hole, shown here in a false-color image from an orbiting Nimbus satellite, is a reminder of Antarctica's fragile ecosystem. Ozone depletion broke new records in 1987. Scientists blame the unremitting use of chlorofluorocarbons.

SOUTH TO THE POLE

face Camp, Siple Station, Palmer Station or the South Pole. Officials at McMurdo also host delegations from other Antarctic treaty nations, including Norway, New Zealand, France, the United Kingdom and the Soviet Union. Above all, McMurdo serves as a supply center and way-point for surface parties that embark on scientific expeditions to the Antarctic interior.

As it was in the days of Scott and Amundsen, the South Pole still takes on significant scientific—and psychological—importance. Being the landlord of the only permanently manned base on the Earth's geographic axis gives the National Science Foundation presence and prestige, and the science performed at the pole gives new insight into Earthly dynamics.

One step off the LC-130's airstairs and you know you've entered a dramatically different world. The first breath of polar air chilled to 70° below zero F sears the trachea and stabs the

lungs. Exposed facial skin crinkles like tinfoil. A massive headache caused by high-altitude hypoxia soon hammers at the uninitiated. Central to pole station is the R. Buckminster Fuller-inspired geodesic dome, actually a windbreak that shields insulated living/working modules from outside tempests. A ramp of accumulated snow descends to a tunnel that leads to the small prefabricated dwellings under the dome's alloy structure. The living and working accommodations rest on the ice sheet, and snow between the structures has been ground to the consistency of talcum powder, making movement even more trying. The prefab units—heated to between 75° and 80° F—contain a galley, dormitories with tiny 2-bunk rooms, a lounge, and science, seismology, meteorology and communications centers. The nearby Cosmic Ray Lab has separate facilities that control the cosmic ray detectors located outside, and a well-appointed "Cosray Lounge,"

where pent-up workers can play darts or gaze across the polar expanse. Steel archways branching to the left and right of the dome complete the station's central infrastructure. They contain the base hospital—complete with operating theater—rubberized fabric bladders containing specially refined diesel fuel flown in by LC-130, a garage and parts bay, plus a powerplant where the station's three Cat diesel generators maintain life support. A closed loop of heated ethylglycol supplies warmth to Amundsen-Scott Station in temperatures that can plunge to 100° below zero in the perpetual night of winter.

The 1987-88 season took on special significance for the men and women assigned to our Antarctic bases. Record levels of ozone depletion in the high polar stratosphere underscored not only the fragility of the Antarctic atmosphere—and its potential impact for populations at mid-latitudes—but emphasized Antarctica's role as moni-



Emperor penguins share the sea ice Tarmac with a flock of LC-130s.

Anchors Away In A Frozen Land

IN ANTARCTICA, the U.S. Navy is almost as perennial as the ice. Navy fliers pilot the National Science Foundation's Hercs and Hueys. At McMurdo, Navy cooks prepare the food. Navy doctors tend the sick. Navy technicians operate the desalination plant. Navy engineers build the roads and maintain the runways.

In short, the Navy makes a vital contribution to Antarctic research, a tradition of hard work that began in the '30s when Admiral Richard Byrd established a permanent American presence in Antarctica. Byrd's numerous forays to the frigid south—including the first South Pole overflight from his crude shelters at Little America—not only planted the flag, but set the tone for future scientific exploration.

Three decades of Operation Deepfreeze—characterized by steady improvement in the Navy's capacity to live and work in this most demanding setting—have given American scientists unrivaled reach and presence.

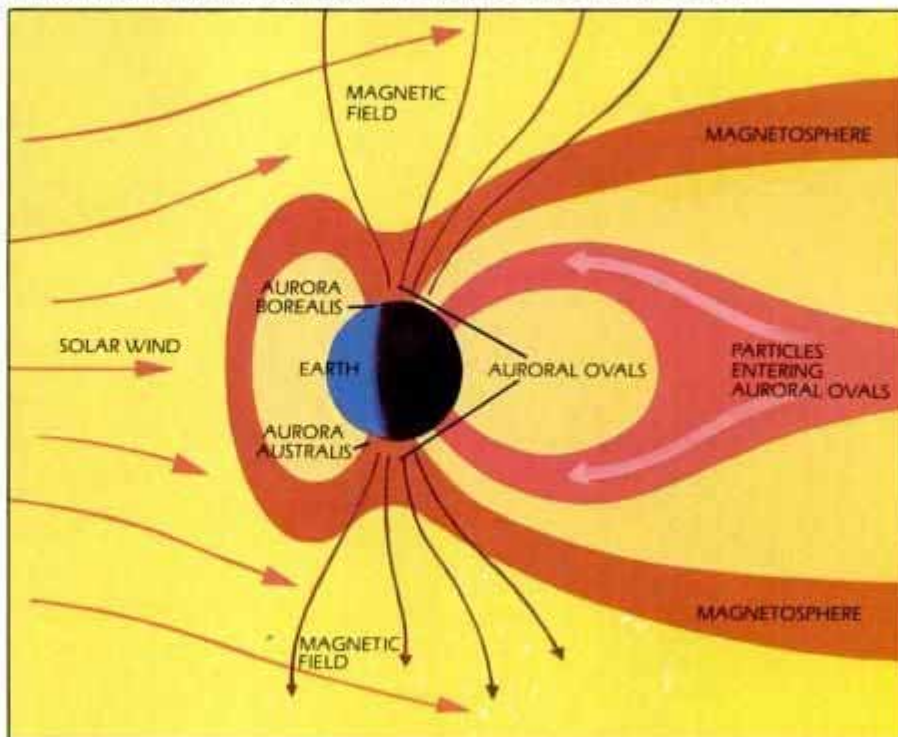
"We'd be dead in the water without the guys in the squadron," says Aquatic Ecology Professor George Simmons of Virginia Polytechnic. "They do more than fly. They take a real personal interest in what we're trying to achieve down here. By anybody's standards, these people are all of the very highest caliber."

But, flying scientists and their equipment into the field is only part of the Navy mission. According to Capt. Dwight Fisher, commanding officer of Naval Support Force Antarctica, "We're here to perform logistics for the National



Dr. Martin Pomerantz has made an annual pilgrimage to the South Pole for 28 years to study cosmic rays and other phenomenon. His work has produced a new understanding of the heliosphere (right), the region around the Earth and Sun characterized by solar wind. The pole's 24-hour daylight and high altitude aid this kind of complex astronomy.

UNDERSTANDING THE HELIOSPHERE



Science Foundation." And that can include construction, demolition, air-traffic control, weather analysis, communications, food service and icebreaking. "We're down here slugging it out," Fisher likes to say, a complex proposition when it concerns Antarctic aviation. In addition to skilled pilots and navigators, it takes a talented staff of maintainers and fuelers to keep the NSF's durable but aging aircraft in the air.

"The APN-59 Bravo radars in these birds are still tube technology," points out Cmdr. Jack Rector, chief of flight operations. That's a rude shock in this solid-state world.

But doing it the old-fashioned way extends to position-keeping. Navigators guide fixed-wing aircraft along preestablished grids—magnetic compasses being of little use—with updates and cross checks from Sun sights. Pilots—particularly the helo drivers who operate up to 100 miles out of McMurdo—are trained to navigate "by feel" through the uncompromising terrain in clear



The Air Force participates with C-141B flights from New Zealand—this one over Mt. Erebus (above left). Cmdr. Jack Rector (above) oversees Navy flight operations. Sun sights are still the favored navigation technique (above right). Seabees (below) mark and measure the sea ice.



recovering an LC-130 that ditched 17 years ago. The effort to dig the plane out and re-equip it with engines and avionics will save the NSF more than \$20 million. But the Navy lost another LC-130 and two people in the attempt.

It's another example of supreme sacrifice in this distinctly Navy domain.—T.C.



weather. "And it's either clear or it's dogmeat," says Rector.

The ultimate challenge, he adds, is when the helo pilots must chase balloon-borne instrument packages into the interior.

Fixed-wing pilots don't have it any easier. In a white-out, onboard navigators often have to talk a plane down by lining it up on a skiway designated by 4-ft. x 8-ft. plywood panels, which return radar signals. Seat-of-the-pants piloting techniques include the "ski-drag," a full-power wheelie used to check for crevasses before landing.

This year, pilots and personnel were tested to the breaking point in

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tor of our planet's vital signs. No other phenomenon has focused as much attention on Antarctica as this "hole" in the sky, appearing mysteriously over the pole each Austral spring.

Ozone farewell

Atmospheric scientist David Hofmann of the University of Wyoming was about to loft his 150th instrument-bearing helium balloon when I visited him in the radar-tracking dome at McMurdo. As the limp polyethylene bag lifted off, I could tell Hofmann's mind's-eye was levitating with it, peering at the structure of the atmospheric molecules between 12 and 22 kilometers high.

It is within this band that Antarctica is losing its life-sustaining ozone shield between August and October. It is here where man-made chlorine molecules from chlorofluorocarbons appear to be disassembling ozone's three carefully knitted oxygen atoms—posing a dramatic threat to life on Earth.

Ozone protects us from ultraviolet radiation, known to cause skin cancer, cataracts and immune deficiencies. Some scientists speculate that increased UV radiation could alter crucial biological molecules like DNA, causing genetic mutations and influencing the evolutionary course of whole species.

First recorded by the British Antarctic Survey in 1985, Antarctica's seasonal ozone depletion has increased at an alarming rate, with some columns of atmosphere suffering more than 90-percent reduction. This massive ozone loss was first thought to be caused by the normal springtime upwelling of low-altitude, ozone-poor air following the bitter polar winter. Also, Antarctica's springtime atmospheric vortex is known to



One of the National Science Foundation's venerable UH-1N "Hueys" (above)—flown by Navy pilots—ferries supplies to a Dry Valleys camp run by University of Maine geology professor George Denton (below).



keep ozone-laden air generated at mid-latitudes from penetrating the cold polar sink.

Contributing to these natural interactions, scientists now conclude that man-made chlorofluorocarbons used as coolants for refrigerators and propellants for aerosol sprays are a chief cause of ozone loss. During The 1987 National Ozone Expedition, scientists used spectrometers, lasers, satellites and balloon-borne ozonesondes to measure Antarctic ozone content. And the news isn't good.

In a simplified scenario, the chlorofluorocarbon's chlorine atom collides with a molecule of ozone. The chlorine steals the ozone's third oxygen atom, forming a chlorine monoxide and O_2 . When the chlorine monoxide finds a free oxygen atom, it yields its own oxygen atom to form additional O_2 . The ozone (O_3) is thus lost forever, and the solitary chlorine atom is free to seek and destroy other O_3 molecules in an almost continuous cycle.

Ozone is generated near the equator, where sunlight breaks apart O_2

molecules that reform into O_3 . Although ozone is thus considered renewable, scientists are concerned that ozone production won't keep up with the stunning decline in ozone content. David Hofmann is in the vanguard of the effort to restore the Earth's atmosphere, and spent last fall analyzing another disturbing phenomenon associated with massive ozone loss—the formation of a layer of sulfuric acid above the ozone hole.

"Sulfuric acid is the only thing that could condense at the temperature we're talking about," Hofmann says. "It seems to form right in the same area where the depletion shuts off, so there must be some kind of relationship." Particularly troublesome, according to Hofmann, is the fact that this atmospheric chemistry in a 1-kilometer band 22 kilometers high shuts down so abruptly. Moreover, the sulfuric acid doesn't appear to dissipate with Antarctica's normal springtime atmospheric movement.

"If air moved up and took the ozone out, as some people have suggested, it would take these tiny high-altitude particles of sulfuric acid with it. But the sulfuric acid just stays rock solid."

What impact will Antarctica's ozone loss have on life at higher latitudes? Hofmann expresses cautious optimism.

"The ozone loss is probably associated with very cold temperatures in the high polar stratosphere, where clouds can form as high as 60,000 ft. The chemistry takes place much faster on the surface of the cloud particles." In other words, a polar stratosphere is instrumental to ozone destruction. And Hofmann concedes that ozone production at the equator



Rocco Mancinelli of NASA's Ames Research Center analyzes the gas content of a sediment core retrieved from a Dry Valleys lake. His work has implications in the search for life on Mars.



will continue resupplying world ozone levels—if man can stop tampering with the ecosphere at middle latitudes. Already, international conventions have curtailed the production and use of chlorofluorocarbons, an encouraging signal. But destruction of the Amazon rain forests, and its interweaving impact on the Earth's total atmospheric budget, does not bode well.

Cosmic quests

While David Hofmann and his colleagues continue to research ozone loss, other polar scientists are looking farther afield.

"The Earth is my spaceship," says Dr. Martin Pomerantz of the Bartol Research Institute at the University of Delaware. Pomerantz, considered the dean of polar research following 28 trips to The Ice, is engaged in the study of solar terrestrial physics. Translated, he and his colleagues observe cosmic rays and other events in

Modern day South Pole visitors have left their own kind of mark (above). George Simmons of Virginia Polytechnic Institute (below) checks a hole melted in a Dry Valleys lake to give divers access.



the heliosphere, that region around our Sun characterized by the solar wind. By observing cosmic ray behavior, Pomerantz hopes to learn more about the nature of the Sun's heliosphere. And since life on Earth is closely tied to the Sun, heliospheric studies can have a wide-ranging impact.

"When these particles enter the he-

liosphere," Pomerantz says, sitting in the delightfully unexpected comfort of pole station's Cosray Lounge, "it changes the direction they move in. By looking in various directions in space at particles that reach the Earth, we can understand something about the large-scale structure of this interplanetary medium. Think of cosmic rays as space probes, albeit very small ones. We use them to look at heliospheric behavior."

The pole's cosmic ray detectors consist of photomultiplier tubes inside light-tight boxes placed on the icecap. The tubes react to the electron shower produced when a cosmic ray enters the atmosphere. The 1987-88 Antarctic season is expected to yield a particularly impressive bombardment of cosmic rays, emanating from Supernova 1987A.

"Cosmic rays can produce a lot of things in the atmosphere," says the sprightly gray-haired Pomerantz.

"Electrons and gamma rays shower down, and the shower has a shape. Sometimes it's bigger and wider. Sometimes it's at an angle. Sometimes it's more vertical. There is a wave form. And if we time very accurately when we sense the wave front, we can determine the direction the cosmic ray came from and its energy. Then we can draw conclusions about the heliosphere that it traveled through to reach us."

Another field that holds Pomerantz's interest involves the ominously titled "helioseismography." He and his associates have created a separate south polar substation 5 miles by tracked vehicle from Amundsen-Scott, where they've placed a charge-couple device TV camera. The instrument takes nonstop observations of the Sun, determining solar oscilla-

(Please turn to page 146)



Gerald Kooyman of Scripps Institute (above) has developed submersible computers (left) worn by Weddell Seals.

BOWRIDER

Ski-boat speed and party-boat design converge in a 5-way showdown.

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

FACE IT. You want to fire up the engine and roar off on a high-speed ski run. Then relax, sunbathing on a tranquil lake. Then take a party spin with family and friends.

In addition, you want to turn heads with a stylish fit and finish. *And* you want it affordably priced.

Most boats are designed to do one thing and do it well. The exception is the versatile bowrider. The PM test team decided to find out just how well bowriders fulfill their multiple roles. So, we assembled a fleet of top models in Stuart, Florida, and ran them through a battery of tests.

The five test boats (plus one in a separate category, see "Ultralux Bowrider" on page 84) were tuned and propped by OMC at the Stuart Marine Center. Four boats were armed with the jackrabbit 205-horse, V6 OMC Cobra sterndrive. They were the Chris-Craft Cavalier 19, Ebbtide Catalina 190, Renken 2000 Bowrider Classic and Wellcraft 190 Classic. Builder of the fifth boat, Starcraft Select 191S, felt the small, 200-horse V8 Cobra better matched the Select's design than the big V6.

The test team concluded the greater displacement of the V8 delivered equivalent power at lower rpm than the V6, which resulted in a slightly smoother ride. Any advantage, however, was offset by additional engine weight, so, ultimately, the engines were judged similar enough to make a valid boat comparison. Performance results bore this out.

We selected a winning boat based on a series of speed tests, measurements and observations, but our ultimate criteria was handling, ease of operation and overall versatility. In truth, the entire fleet impressed us with its performance and overall fit and finish, which set a new standard among affordable boats.

Putting their best features forward (clockwise from bottom left) are: Wellcraft 190 Classic, Renken 2000 Bowrider Classic, Chris-Craft Cavalier 19, Donzi Ragazza R-21 and Ebbtide Catalina 190 XLS.



BATTLE

PM
COMPARISON
TEST





Chris-Craft Cavalier 19

The combination of pinpoint handling, pacesetter speed and sporty good looks makes the Chris-Craft Cavalier 19 the boat our test team would like to own. The test winner hugged the water like a sports car through the performance course and raced like a cheetah through top-end heats, leading the fleet in both categories.

Most impressive were Cavalier's exceptional tracking, cornering and responsiveness in a variety of water

conditions and at all speeds. On the half-mile performance course, which begins from a dead stop, the Cavalier overcame a middle ranking in acceleration to finish ahead of the fleet.

The racy red-and-white hull and upholstery show fine workmanship, although a snap-on carpet in the bow seems like a temporary solution. We were more impressed with cutaway bow rails, molded-in cleat mountings, teak entry/exit steps, and a helm station with handy dash-mounted fuses.

Stowage and usable deck space are sufficient, although improvement could be made in the copilot's and driver's footwells, where there's only a minimum of legroom.

The Cavalier 19 is considered an entry-level boat by Chris-Craft, but it's built to look and run like a winner.

Ebbtide Catalina 190

It's rare to find a bowrider with luxury appointments, the sure handling of a roadster, and an affordable price

TEST PARAMETERS

Each boat was propped and tested by OMC at the test site. All but the Starcraft Select 191S were equipped with 205-horse OMC Cobra V6 stern drives. The Select, at builder's request, chose OMC's equivalent 200-horse V8. Top-end, acceleration and performance course figures are the result of averaging four test runs for each boat with two adults aboard and matched fuel loads.



OVERALL RANKING/MAKE/MODEL	1. CHRIS-CRAFT CAVALIER 19	2. EBBTIDE CATALINA 190 XLS
LOA/Beam/Weight/Fuel Capacity	18'9"/90"/2525 lb./28 gal.	18'9"/92"/2550 lb./36 gal.
Deck Area (sq. ft.)/Seating	81.84/8, a bit tight in jump seats and helm	88.83/8, spacious, includes large sunpad
Stowage (cu. ft.)	34.06, adequate but dash cooler cramps knees	41.72, copious, bucket-seat pockets a nice touch
Engine/Prop	205-hp V6 14 1/4" x 21 stainless steel	205-hp V6 14 1/2" x 21 stainless steel
Top End (mph)/Ranking	49.5/1, trounced the competition	46.8/3, solid feel at speed
Acceleration 0-35 mph (sec.)/Ranking	8.25/3, moderate but sprightly	8.46/4, adequate for skiing
Performance Course (sec.)/Ranking	36.56/1, exceptionally responsive	37.8/3, sure tracking throughout
Handling	Hugged water like a Formula One racer	Cornered as tightly as any boat in fleet
Fit-and-Finish/Ranking	Sporty good looks and appointments/3	Superb workmanship and attention to detail/1
Price as tested	\$16,018	\$16,250
Address	Chris-Craft, 101 Riverfront Blvd., Bradenton, FL 34205, (814) 747-4100	Ebbtide, Box 51, Jones Creek Rd., White Bluff, TN 37187, (615) 797-3193

The jackrabbit 4-barrel carb, 205-horse OMC Cobra V6 pushed out impressive power for a 4.3-liter, V6 stern drive.



Has high instrumentation for good visibility. Dash-mounted fuses are handy. But legroom is minimal.



Bucket seats, racy wheel, dash-mounted fuses and brushed-aluminum panel are nice touches. Gauges are low.





Donzi R-21 sits pretty at speed surrounded by (from left): Wellcraft 190 Classic, Starcraft Select 191 S, Ebbtide Catalina 190 XLS, Chris-Craft Cavalier 19 and Renken 2000 Bowrider Classic.

tag, but the Ebbtide Catalina 190 XLS is such a boat. It impressed the test team with its classic beauty and solid performance.

The Catalina is strong, too, in the traditional marine values of fit and finish, where it led the fleet, and usable deck and stowage space, where it came in second.

Masterly workmanship and attention to detail are evident in its extensive entry/exit system of nonskid footpads, welded stainless-steel bow

and aft rails, and stout hardware.

Marvelous design touches in the helm station include dash-mounted fuses and controls for an automatic fire extinguisher. Positioning of the racy stainless-steel steering wheel, however, caused sightline interference with some of the gauges.

The bold red-and-black hull is contrasted by rich grey upholstery, which covers a deck layout with plush bucket seats, sunpad and bench seat. Copious teak trim appears on hatch

covers, footpads and a swim platform.

The Catalina cornered and tracked as well as any boat in the fleet, but middle-of-the-pack acceleration and top-end results kept it from scoring higher on the performance course. In overall design, quality and value, however, it finished second to none.

Wellcraft 190 Classic

Standout numbers in acceleration and top-end rankings, second in both, make the 190 Classic one of the fastest



3. WELLCRAFT 190 CLASSIC

19'3"/91"/2350 lb./25 gal.

85.14/8, with good legroom throughout

30.19, nominal but sufficient

205-hp V6/14½ x 19 aluminum

47.3/2, impressive speed, less than certain feel

7.91/2, on plane in a flash, good power response

37.88/4, wandered more than most

Skidded corners at speed, especially the 180

Would benefit from more sophisticated detail/4

\$14,425

Wellcraft Marine, 1651 Whitfield Ave., Sarasota, FL 34243, (813) 753-7811

4. STARCRAFT SELECT 191S

18'9"/94"/2465 lb./27 gal.

97.67/9, roominess of a towncar plus a sunpad

45.23, outstanding with seat pouches, dash cooler

200-hp V8/14½ x 19 aluminum

46.0/5, fast enough for family boat

8.9/5, a bit sluggish but adequate for skiing

40.16/5, well off the pace, uncertain feel

Skittered without prop bite in 180s, cornered widely

Euroflair to the max, superb attention to detail/2

\$17,018

Starcraft, 2703 College Ave., Goshen, IN 46526, (219) 533-1105

5. RENKEN 2000 BOWRIDER CLASSIC

19'5"/90"/2200 lb./38 gal.

81.23/7, sufficient for mixed crew of adults, kids

21.29, suffers from lack of gunwale panels

205-hp V6/14½ x 19 stainless steel

46.3/4, in the pack but well behind leader

7.67/1, hole-shot champ, skiers take note

37.43/2, secure at speed, a driver's favorite

Tracked, cornered, responded like sports car

Spartan appearance could be improved/5

\$14,775

Renken Boats, 1750 Signal Point Rd., Charleston, SC 29412, (803) 795-1150

Throttle is mounted high, but rubber-sealed switches, tight gauge pattern and superb legroom are winners.



Digital-style instrumentation is well-positioned for easy viewing. Solid bucket seats give lots of legroom.



Unobstructed gauge visibility and handy dash-mounted fuses, but driver's and copilot's positions cramped.



BOWRIDER BATTLE

boats in the test. A low price tag, due to a lean-and-mean speedster image, is equally impressive.

Certain design elements are exceptional, such as nonskid step pads, plentiful courtesy handles and grab rails, dual teak swim steps, and a helm station with rubber-sealed switches and outstanding legroom.

Despite top-end speeds in the high 40s and quick acceleration, the Classic tracked wider than most during 90° turns and tended to skid through 180s. These traits resulted in performance course times well off the pace.

The layout of back-to-back sun-

loungers and jump seats offers adequate stowage and usable deck space, and the flashy red-and-white of the hull is matched in deep-pleated upholstery. But the overall fit and finish is less sophisticated than most. Pop rivets and screws tend to show, wooden molding holds the command station in place, thin adhesive vinyl covers dash and other surfaces, and a fair amount of naked fiberglass is exposed throughout the deck.

Still, water-burning speed combined with affordability are highly prized qualities, and for this the Classic is an outstanding value.

Ultralux Bowrider

THE RAGAZZA line of small family boats is new this year from Donzi, so we couldn't wait to get our hands on it for the bowrider test. But the Ragazza R-21 turned out to be a breed unto itself. It was longer, heavier and considerably more expensive than the other boats, so a valid comparison couldn't be made.

However, we decided to put it through a battery of tests anyway and report the results. What we found was a Cadillac of the water, a boat that was more like a towncar than a casual family bowrider.

Top-end of 44 mph is swift enough to provide high-speed thrills and acceleration is fast enough to tow skiers—10.16 seconds average time from 0 to 35 mph. But both numbers were somewhat low for a boat made by Donzi. This is probably due to the boat's 21-ft. length and 8-ft., 2-in. beam, which combine with a long list of plush appointments to push the weight of the R-21 to 3100 pounds.

Although the boat rides smoothly through unprotected waters, due to a deep-V hull that slices through

waves, it tended to misbehave on the performance course. It skidded around sharp turns and lost prop bite while skittering through 180s. Uncertain high-speed cornering was reflected in a sluggish time of 41.61 seconds in the handling course.

The R-21 was unsurpassed, however, in attention to detail, workmanship and overall fit and finish. It was easy to see why the ultralux boat, armed with a 205-horse OMC Cobra V6 engine, costs \$22,395.

Of the numerous standout design touches we like are the wraparound windscreen, integrated swim platform, grab rails that disappear into the glass, lockable teak ski hatch, rubber-sealed control switches and dash-mounted fuses.

Even more impressive are the unique windshield wiper, jump seats that raise to form a full-length sunpad, wet bar in passenger-side cooler and fully padded dash. The bright yellow, white and grey markings of the hull and rich upholstery combine to form a headturning appearance that's second to none.—J.S.

Starcraft Select 191S

The Select 191S is the hottest looking bowrider on the water with Eurostyling to the max—Ferrari-red hull, integrated swim platform, plush upholstery and deluxe appointments.

The Select, however, trailed in both acceleration and top-end scores, although it was within striking distance of the rest of the fleet. This is important to note, because Starcraft believes the OMC 200-horse V8, which it installed in the Select, is a better match to the boat than OMC's 205-horse V6, the engine used by the other test boats.

Where it truly lagged, however, was in the performance course. Here, the boat showed a tendency to track widely in sharp turns and skitter without firm prop bite in the 180s.

The Select led the fleet, however, in stowage and deck space, and came in a close second in overall fit and finish. Superb design touches include bucket seats, bench seat, sunpad, contoured windscreen, copious rails and courtesy handles, and rich grey upholstery.

Deluxe attention to detail doesn't come cheaply, but the result is a boat with an upscale sense of Euroflair.

Renken 2000 Classic

The 2000 Classic is a driver's favorite, with a No. 2 finish on the performance course, a good top-end speed of 46.3 mph and a No. 1 ranking in hole-shot, where it decisively blew the doors off the other boats in the test.

Back-of-the-pack rankings in fit and finish, usable deck space and stowage combined to offset the Classic's impressive performance results. On the upside, the boat's spartan approach allows it to sport the second-lowest price tag in the fleet.

Many design elements were exemplary, such as the aqua-and-white hull with matching upholstery, nonskid strips on transom, teak swim step and helm station with glare-resistant dash and dash-mounted fuses.

Others were awkward, such as a cramped copilot's seat, a low steering wheel and a walk-through windscreen that didn't lie flat when open.

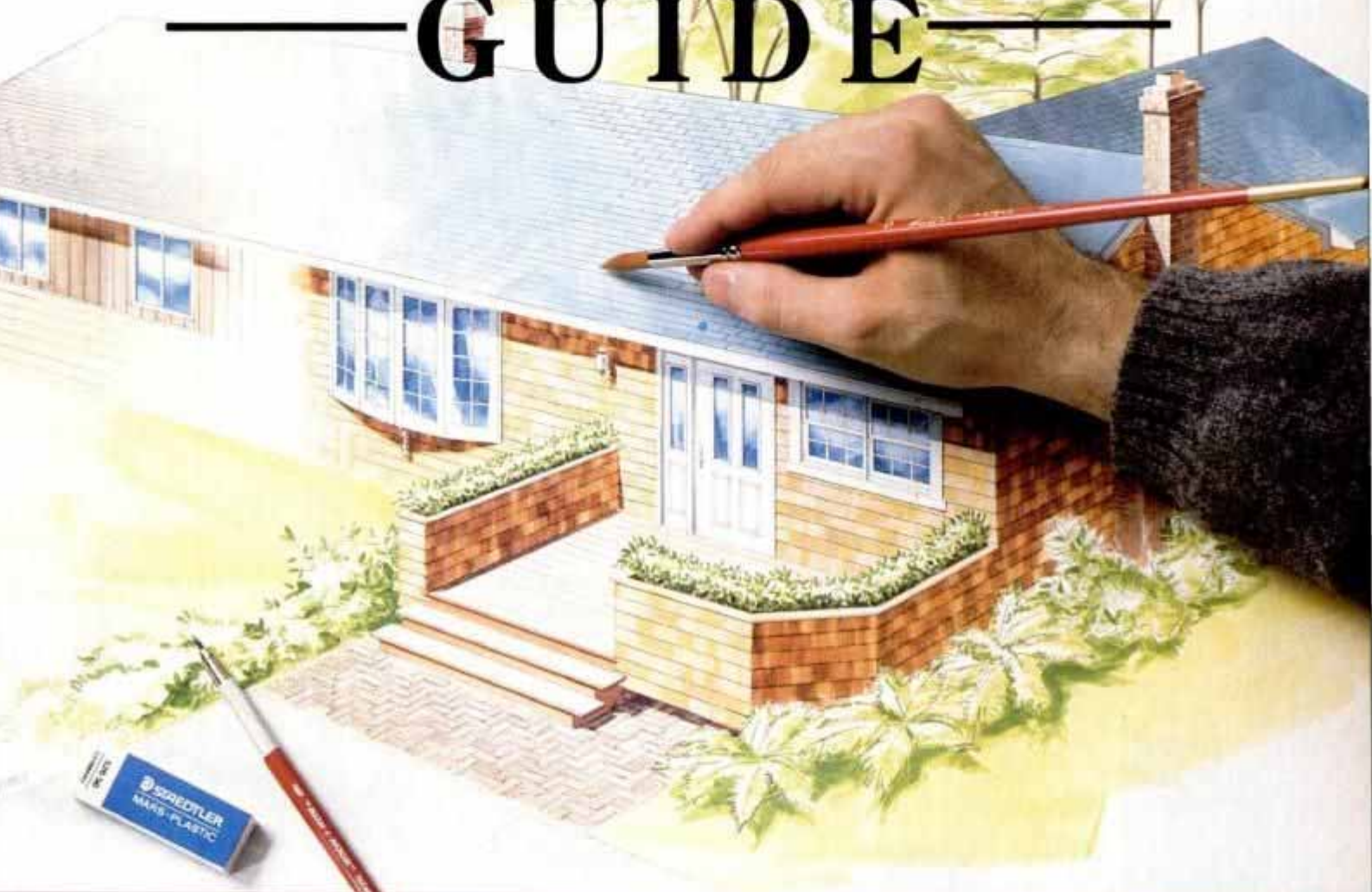
Families looking for an entry-level bowrider will find the Classic a good value and, due to its swift acceleration, a superb ski boat.

Overall, the test boats displayed a level of performance and fit and finish that represents a new standard in pleasure-boat design. A few years ago, it wouldn't have been as easy to assemble a fleet of entry-level boats with such sophistication. Despite certain glitches, the test team believes that family boaters will be delighted with any bowrider in the test. **FM**



RAGAZZA 21

HOME IMPROVEMENT GUIDE



Ranch House Renewal

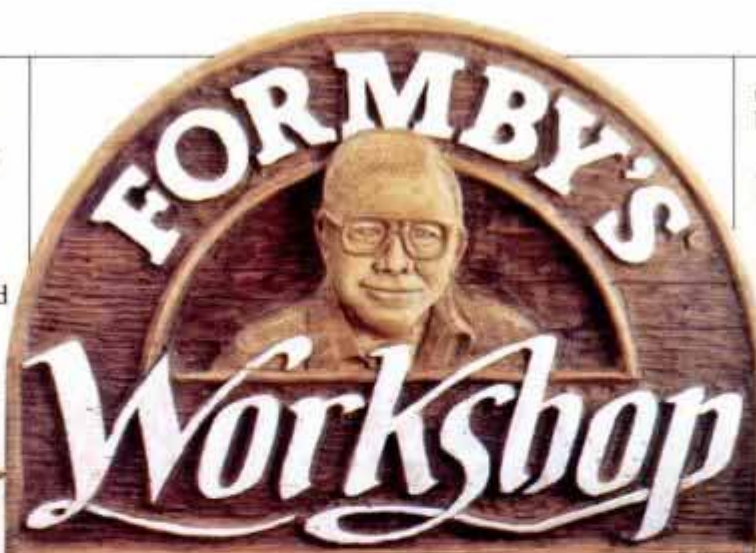
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Curb Appeal

How a Connecticut ranch house avoided midlife crisis.

WE'VE ALL seen those stunning remodeling stories in any number of magazines where a \$200,000 library is added to a stately Georgian mansion, or a heated pool house grows in steel and glass from a summer home in Southampton. Truly impressive stuff, there's no question about it.

Looking at such photos can make us all feel like there's a wonderful world out there bounded only by refinement and taste, where a sensible budget is just as fleeting as a summer breeze. But when most of us think about improving our own homes, we have to limit our horizons to the confines of the real world. This is what we

tried to do in this year's "Home Improvement Guide."

We began by seeking out one of the most common examples of the post-war housing stock, namely, a standard ranch house that was entering midlife crisis. The one we found had undergone many interior changes over the years, which had certainly improved the livability of the house, but had done little to improve what real estate folks call its curb appeal. The owners wanted to upgrade the exterior so the house looked better, improve its energy efficiency, and increase its market value. So, we decided to give the structure a complete exterior facelift, and in the process to show you how some of the most common exterior improvements are done.

Our first stop was designer Dyck Fledderus. We told him we wanted to replace the roofing, the siding and trim, the windows and front door, as well as add a new entry deck and driveway. We needed him to

Project design: Dyck Fledderus
Color photos: Carl Weese

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CURB APPEAL

create a design that would make all these changes work together and at the same time break up the overpowering horizontal shape of the structure. We considered this last requirement crucial to improving the appearance. None of this fazed him a bit. Then we went on to explain that all the improvements, except the driveway, must be designed so competent do-it-yourselfers could tackle the job. *And* our budget for everything had to stay within \$15,000, just a little bit more than the average price of a new car these days..

This figure would not include labor costs because we wanted to show the potential rewards of putting sweat equity into your home. But the budget must include what turned out to be a professionally installed \$2300 driveway. Still he didn't blink. And the fruits of his labor are shown in the BEFORE and AFTER photos above.

He began by choosing a popular design idiom from today's high-end custom homes, called contemporary shingle architecture. Among other things, this idiom employs a very traditional building material—cedar shingles—outlined with plain trim boards, usually painted bright white. By using these substantial casings, the windows and doors occupied more space on the facade which helped to



soften the long horizontal nature of the building. The same is true of the sidelight on the new front door.

Fledderus also specified a wide frieze board, just under the roof overhangs. This blended with the white soffit and fascia to add "weight" to the roof, as did the new dark gray shingles. When these elements were combined with the new entry deck—that moved the front of the house closer to the street—the entire horizontal sweep of the building was broken. The result was a clean, contemporary look that still paid homage to traditional design.

At this point, PM editor Joe Truini took over and specified the products we would use. Among those chosen were three easy-to-install standouts: the siding, roofing and front door. (More about each of these appears in

the individual stories.) But Truini's involvement didn't stop here. With a little help from his friends—and a lot of help from his family—he undertook all the improvements himself. If nothing else, the following stories are a real testament to his grace under pressure!

Of course, most readers will not want or need to do everything we did here. But the tips and techniques in all these stories have relevance for any number of other projects.

When all was said and done, we were very pleased with the results and impressed with the savings from our sweat equity. Certainly, we were forced to make compromises here and there, but the one goal that wasn't sacrificed was our budget. We just made it! And, in some ways that was the greatest satisfaction of all.—S.W.



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Wonder Window

Install an energy-efficient bow window for a great view and sunshine, too.

BY JOSEPH TRUINI, Shop And Tools Editor

YOU DON'T have to be Frank Lloyd Wright to know that a properly sized and placed window will add light to a room and affect your perception and, therefore, use of the space. And, it's not unusual for a window to be the focal point of a room. But still, we weren't prepared for the transformation that occurred after we replaced an old picture window with a new, energy-efficient bow window.

The obsolete picture window, located in a formal dining room, was original equipment—installed when the house was built in 1956. It was an old, drafty, steel-framed, single-paned unit that should have been replaced years ago. (According to the owners, during winter, ice up to ½ in. thick, used to form on the *inside* of the glass.)

For a replacement, we decided against another flat window and instead, chose a casement bow window. The window's slightly curved, bow-like frame adds style and dimension to the long, narrow, 1-story ranch home.

However, to really appreciate a bow window, you must see it from the inside looking out. The window floods the room with natural light from four different angles. The room suddenly became warm and inviting. The window frame, projecting slightly from the house, offers a perch to the outdoors with sweeping views that no other window can match. The seat board presents a quiet place to sit and watch the world—or at least the neighborhood—go by.

The window shown is an Andersen vinyl-clad bow window (model C45). It's made up of four casement windows joined at 10° angles. The two center windows open. The end ones are fixed. Besides the 4-unit-wide window shown, bow windows are also available in 3-, 5-, 6- and 7-unit styles. The wider the window, the more it projects from the house. The 4-unit bow window shown projects about 9½ in. Sizes vary depending on

the manufacturer, but you're sure to find a window that's right for your home.

Andersen offers 25 stock sizes of vinyl-clad bow windows ranging in size from about 3 × 6 ft. wide to 6 × 13 ft., 8 in. wide. The bow window we installed measures roughly 5 ft. tall × 8 ft. wide and costs approximately \$950, though prices vary around the country. For more information, contact Andersen Corp., Bayport, MN 55003.

When purchasing a bow window, be sure to order a head board, seat board and the extension jambs. These don't come with the basic unit. Screens and grilles must be ordered separately, too.

Most window manufacturers also offer a choice of insulated-glass (two panes) or triple-glazing. The bow window shown has Andersen's High-Performance insulating glass. This super energy-efficient glass has a transparent metallic coating bonded to the glass surface between the panes that reduces heat loss during the winter and radiant heat gain during the summer.

Out with the old

The first step is to remove the old window. Using a flat pry bar, carefully pry the window from the house. Be sure to wear long sleeves, gloves and safety glasses. Try to avoid twisting the window frame or the glass may break.

Next, prepare the rough opening to accept the new window. Every window comes with instructions that list the rough-opening dimensions. However, just to be safe, measure the interior frame of the window to be sure that the rough-opening dimensions are correct.

If the bow window is the same width as the old window, but taller, then simply lower the sill plate to accept the taller window. If the bow window is wider *and* taller than the old window, then you must frame-out the entire opening and install a longer header (photo 4). When removing a header, it's necessary to install a temporary wall in the room to support the ceiling until the new header is in place. Make the header from two 2x10s separated by ½-in. plywood. This produces a 3½-in.-thick header to equal the 2x4 wall stud width.

First, mark the sill plate position on the

Color photo: Carl Weese
Black-and-white photos:
Joseph Truini
Window: Andersen Corp.,
Bayport, MN 55003.

WONDER WINDOW

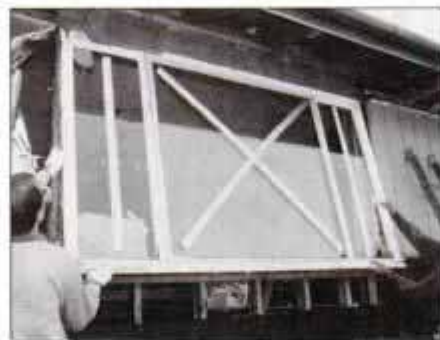
exterior wall. Then, measure down 3 in., the thickness of a double 2x4 sill plate, and snap a chalk line. Use a portable circular saw and then a reciprocating saw to cut through each stud located in the rough opening (photo 2). Try not to cut through the interior wallboard. The short studs left in the wall, called cripple studs, support the sill plate. Install two more cripple studs to support each end of the sill plate. Nail the two end cripple studs to the nearest full-length wall studs. Also, position a double 2x4 cripple stud in the center of the opening to attach the knee brace.

Now, cut a 2x4 sill plate to fit across the bottom of the rough opening and nail it to the cripple studs. Double-up the sill plate by nailing another 2x4 to

the first sill plate. Using a reciprocating saw, trim the exterior sheathing and interior wallboard flush with the sill plate (photo 3).

Next, make up the header and cut it to fit between the two nearest full-

length wall studs. With the aid of a helper, lift the header into place and toenail it to the wall studs on either end. Then, cut jack studs to fit between the header and the sill plate. Nail a jack stud to the full-length wall stud at each end of the header. Toenail two more jack studs—to the header and sill plate—flush with the sides of the rough opening. These two additional jack studs are needed only if the first jack studs are set back away from the opening 1½ in. or more. For example, if the first jack stud is ¾ in. away from the rough-opening edge, then nail a ¾-in.-thick × 3½-in.-wide board to the jack stud to build out the stud and establish the side of the rough opening. Regardless of how you frame out the rough opening, be sure that the jack studs are positioned *under* the header.



1 The first step is to remove the old window. Duct-tape strips on the glass help to prevent shattering if the glass breaks.



2 Make a plunge cut—3 in. below rough opening dimension—into each stud. Use reciprocating saw to cut stud completely.



3 Remove studs and nail down a double 2x4 sill plate. Use a reciprocating saw to cut sheathing and wallboard flush with sill.



4 Install new header, if needed, for the bow window. Make header from two 2x10s separated by ½-in. plywood spacer.



5 After rough opening is framed out, install the window. Two people are needed to hold unit while it's secured from inside.



6 Nail exterior trim along top of window. Cleats attached to soffit provide nailing surfaces. Note insulation behind trim.



7 Nail trim boards along window bottom. Note brace bolted to wall, under center of window, to support projecting unit.



8 Unit has factory-fitted seat board. Apply stain or paint before installation. If needed, rip seat board flush with interior wall.



9 Nail a scrap wood block to jack stud on sides of window. This is necessary to provide solid nailing for extension jamba.



10 Fit extension jamb into pre-routed groove to build out window jamb flush with finished wall. Shim jamb, if necessary.

In with the new

To lift a window this size, you need at least four people. Once it's in place, two people must hold it until it's secured. Move inside and drive cedar shake shims under the window to raise it against the header. Position the shims in several places to support the entire unit. Check that the window is plumb, square and level. Next, nail up through the top platform and into the header with 10d coated or ring-shanked nails. Then, nail down through the bottom platform and into the sill plate. Now move outside and drive 1 $\frac{3}{4}$ -in. roofing nails through the vinyl flange on each side of the window. Fill any gaps under the window with fiberglass insulation.

To support the projecting unit, attach a knee brace to the house under the center of the window. The 4-unit bow window shown needs only one center-mounted brace, but wider windows, which project farther from the house, need two or, in some cases, three braces. Using 2x4s, make an L-shaped brace to fit against the house and under the window. Then attach a 2x4 or 4x4 diagonal strut to the L-shaped brace. Secure the brace with lagscrews. Be sure to screw into the double 2x4 cripple stud.

With the window fastened securely, all that's left is to install the exterior trim and finish the window's interior. The exterior of the window was trimmed with $\frac{5}{4}$ in. \times 5 $\frac{1}{2}$ -in.-wide pine boards painted white. First, install trim around the top and bottom of the window, and then attach the vertical side pieces. Fasten the trim with 10d galvanized finishing nails.

Crosscut the top and bottom trim pieces to a 5° angle so that they will meet at 10° and match the bow of the window. Screw 1x2 wood cleats to the house soffit above the window to provide solid nailing for the trim. Then, fill the area above the window with fiberglass insulation and nail the trim in place (photo 6). Before attaching the bottom trim, screw 2x2 nailing strips to the underside of the window. Install the trim by nailing into the 2x2 strips and the edge of the window platform (photo 7). Now glue rigid insulation, such as Styrofoam, to the underside of the window. Finally, attach the trim to sides of the window.

Interior trim

Start by nailing $\frac{3}{4}$ \times 1 $\frac{1}{4}$ -in.-wide plywood strips around the window's sill platform. Cover the platform with $\frac{1}{2}$ -in. rigid insulation. Be sure to fit the insulation between the strips. Insulate the head platform, at the top of the window, in a similar manner.

Next, install the head and seat

boards which are made of pine-veneered particleboard. The boards come precut to fit either a 5 $\frac{1}{4}$ -in.- or 7 $\frac{9}{16}$ -in.-thick wall. If necessary, trim the boards flush with the interior wall. Slide the seat board into position (photo 8) and secure it with 4d finishing nails. Install the head board in the same manner. Then, nail blocks to the wall studs (photo 9) to provide backing for the extension jambs. Extension jambs build out the window jambs flush with the interior wall. If necessary, trim the extension jambs to fit flush. Fasten extension jambs with 8d finishing nails (photo 10).

Next, install the inside stop moldings and mullion casings that fit around the inside of the four windows. The parts come precisely milled and factory-fitted for easy installation. Simply nail them in place with 4d finishing nails—no cutting is required. Now install casing molding to the wall around the window as the final trim.

Snap-in-place grilles divide each window into 10 panes. The plastic grilles, called Andersen Perma-Fit grilles, feature a special polymer coating on their interior surface that accepts paint or stain. Finish the grilles to match the interior wood trim. **PM**

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Door Prize

Elegant and secure, this steel-entry door and sidelight feature perfect-fit installation.

BY JOSEPH TRUINI, Shop And Tools Editor

TO SAY THAT the front-entry door of this home needed to be replaced, is an enormous understatement. It was an old, weather-worn solid wood door that had battled the everchanging, often brutal New England weather for nearly 15 seasons. It had no windows, known as lites, to emit sunshine—resulting in a dark, shadowy foyer. Cold air howled in from around the ill-fitting door and wind-blown snow formed tiny drifts in the foyer. All and all, it was a rather forgettable door that simply provided a way in and out of the house.

The features that we looked for in a new door were security, energy efficiency and quality construction. Plus, it had to be easy to install. We also wanted the entrance to the house to be more formal and stylish so we decided to install a door and sidelight. The sidelight creates a slightly larger looking entrance while providing another light-emitting window.

The unit shown is an Ever-Strait steel door from Pease Industries. The 3-ft.-wide door (model No. EF88) and 14-in.-wide sidelight (No. SF88) both feature attractive etched glass windows and embossed raised panels. The door's construction starts with solid wood stiles and rails forming the perimeter frame. A sheet of closed-cell polystyrene fills the core of the door and provides insulation. Rust-resistant galvanized steel sheets form the interior and exterior surfaces of the door. The two steel sheets are separated by a thermal break—a rubber gasket inserted in the door's edges—that stops the transmission of cold or heat from one side of the door to the other.

To help create an air-tight seal around the door, the unit is fitted with a magnetic weatherstrip, similar to a refrigerator's, that effectively blocks out wind and rain. A flexible, 5-finger weatherstrip along the door's bottom makes firm contact with an aluminum adjustable sill. The sill has a

unique built-in weep (water removal) system that directs water away from the threshold via an integral pan.

The door comes factory-primed and should be painted within six weeks after installation with a good-quality, exterior-grade paint. We painted the door white with Finnaren & Haley's Trim and Shutter paint—an alkyd enamel formulated specifically for use on primed metal. For details, write to Finnaren & Haley, 2320 Haverford Rd., Ardmore, PA 19003.

The real beauty of this door, though, is its foolproof, perfect-fit installation system. If every rough opening, sill and door jamb were perfectly level, plumb and square, then door installations would be child's play. But in the real world, of course, this is simply not the case. Therefore, Pease designed a system that uses adjustable fasteners, called Jamb-Jacks, that allow you to adjust the door jambs *after* the unit is screwed in place. In fact, with this system, you can easily fine-tune the door's fit next year or in 10 years, if necessary.

A Jamb-Jack is basically a lagscrew fitted with a threaded, cylindrical-shaped head (see photo 9). They fit into prebored holes—three per jamb—and are concealed with push-in plastic caps. A special tool is provided for driving the Jamb-Jacks into the studs with a ratchet wrench. Reverse the drive tool and use its other end to adjust the door jambs in or out.

We ordered the door unit complete with adjustable sill and polished-brass hinges and lockset. As shown, it retails for about \$700 to \$750. For details, contact Pease Industries, 7100 Dixie Highway, Fairfield, OH 45014.

Installation procedures

Start by removing the old door. Wood doors are usually nailed through the exterior casing. Pull the nails and remove the door and frame as one unit. Next, extend the opening to accept the wider door/sidelight unit. Using a level, mark the new rough opening on the house wall (photo 2). Before cutting, measure the new unit just to be sure that the rough opening is correct. Use a portable circular saw to cut through the siding and sheathing. Pull off the siding and sheathing

Color photo: Carl Weese
Black-and-white photos:
Joseph Truini
Door: Pease Industries,
7100 Dixie Highway,
Fairfield, OH 45014.

DOOR PRIZE

and remove the studs and insulation. Then, cut the interior wallboard from the outside using a reciprocating saw (photo 4).

Now install a new header, if necessary, and frame the side of the rough opening that was just cut. On this particular installation, the existing double 2x8 header extended beyond the rough opening so there was no need to replace it. Also, it just happened that a wall stud was only $\frac{3}{4}$ in. away from the edge of the rough opening. Therefore, I was able to close in the opening with a strip of $\frac{3}{4}$ -in. plywood (photo 5). In most cases, however, you'll have to replace the old header with a longer one, add a full-length wall stud and a jack stud. Be sure to fit the jack stud *under* the header (For header in-

stallation details, check the bow window story that begins on page 92). Nail through the sheathing and wallboard to secure the new framing members. Also, build up the sill of the opening, if necessary, flush with the floor. A strip of $\frac{3}{8}$ -in. or $\frac{1}{2}$ -in. plywood will usually do the trick.

With the rough opening framed, it's time to install the door. Note that the door and sidelight come assembled as a prehung unit. First, apply caulking to the sill and then install the unit bottom first (photo 8). Next, use the hex-shaped driver provided to screw in the first Jamb-Jack fastener. The driver fits a 10-mm socket (photo 10) or it can be driven with an electric drill. Note that the ends of the driver are slightly different. A hexagonal hole is milled in one end and the opposite end has a round hole drilled in it.

Use the hexagonal-hole end to drive the fasteners into the studs, and the round-hole end to adjust the jambs.

Install the six Jamb-Jacks in the following order: 1. top hinge side, 2. bottom hinge side, 3. top lock side, 4. bottom lock side, 5. center hinge side, 6. center lock side. Check the door-to-frame alignment. Using the drive tool, turn the Jamb-Jacks clockwise to pull the jamb out, and counterclockwise to move the jamb in (photo 11).

Once the door jambs are adjusted, install the latch and deadbolt, and mortise the strike plates into the jamb. Insert a wood block between the jamb and the stud at the strike plate locations for additional support and security. Then, fasten the strike plates with the long screws provided. Two more long screws are provided for securing the top door hinge. Drive



1 Old wood-framed door was nailed through casing. Use cat's paw to pull nails. Remove door and jamb from opening.



2 Use a level to mark rough opening height of new door unit. Then, draw a plumb line to establish right side of opening.



3 Double check your measurements of the rough opening. Use a circular saw to cut through the exterior siding and sheathing.



4 Cut away the interior wall with a reciprocating saw. Hang a drop cloth on inside wall and execute cut from the outside.



5 Wall stud was $\frac{3}{4}$ in. away from rough opening, so plywood was added to fill void and provide a base for fastening door.



6 Check sill for level. It must be level for door to operate properly. Also, check to be sure sides of opening are plumb.



7 Apply two parallel beads of butyl caulk along the sill and up the sides about 3 in. This will stop air and water infiltration.



8 Position unit in the opening, sill first, and then tilt in the top. Note that door and sidelight come assembled as one unit.



9 Here's a closeup view of a Jamb-Jack. Lagscrew shank is driven into studs and cylindrical head threads into door jamb.

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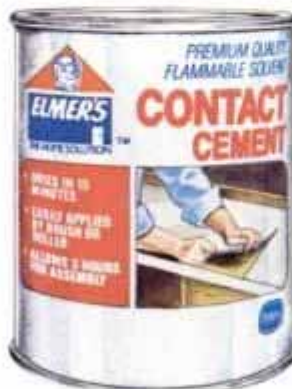
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HOME **IMPROVEMENT** GUIDE

DOOR PRIZE

the screws through the hinge holes located closest to the weatherstripping. These 2½-in.-long screws will help prevent sagging and binding.

Now close the door and check the sill plate. The 5-finger door-bottom cap should fit snugly against the sill to seal out wind and rain. Loosen the screws to raise the sill, tighten them to lower it (photo 13).

Finally, apply two coats of paint to the door unit. Avoid getting paint on the weatherstripping and don't paint in temperatures below 50° F. **FM**



10 Adjustable Jamb-Jacks secure the door. Use a ratchet wrench and special driver (provided) to screw bolt into stud.



11 Reverse the special driver in the wrench and use it to adjust jambs in or out until the door and frame align perfectly.



12 Mark the strike-plate location on door jamb and bore a hole for the dead bolt with a spade bit. Then, mortise the plate flush.



13 Door features an adjustable sill that stops drafts. Loosen screws slightly to raise sill. Then, close door and check the seal.



14 Test sill height with a dollar bill. Close door on bill and tug gently. If the bill can be moved freely, readjust sill for a tighter fit.

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Super Siding

Red-cedar shingles that go up—wow!
—8 ft. at a time.

BY JOSEPH TRUINI, Shop And Tools Editor

LIKE MANY ranch-style homes built in the 1950s, this one was originally shingled with cedar shakes. When it came time to remodel, about 15 years ago, a quick and affordable solution was sought. You guessed it—aluminum siding.

Now maybe we shouldn't blame the aluminum siding entirely, but the house seemed to lose the modest style and character it possessed during the brand-new '50s. It appeared to have a cold, blank stare in its casement-window eyes. Anyway, the deed was done and the house remained tinned-up for almost 15 years.

When we decided to replace the siding, our first thought was to return the house to its original exterior—red-cedar shingles. Shingles aren't particularly difficult to install, but they are time-consuming and since this is a major do-it-yourself project, time is an important factor. We were looking for the advantages of aluminum siding—fast, easy installation—and the warm, natural look of real cedar shingles. What we found was Shakertown cedar siding.

Shakertown siding is a factory-fabricated panel that consists of No. 1 grade Western red-cedar shingles laminated to 1/4-in. exterior-grade plywood panels. There are two courses of shingles per panel and each panel measures 15 in. wide × 8 ft. long. To make installation even easier, the panels are self-aligning. The bottom edge of the panels are rabbeted to fit over the previously installed course. Therefore, there's no need to measure each course to maintain a consistent exposure. And, Shakertown siding comes with its own 8d cedar-colored, ring-shanked nails.

Another convenient feature is prefabricated outside corners. The corners are made of short pieces of siding that have been mitered and then glued and stapled together. The corners are convenient, but they're not required. Outside corners can

be trimmed with 5/4-in. cedar boards, too.

Shakertown offers various styles of cedar shingle panels including rough sawn, barn shake, staggered butt line and 14-in. exposure shingles. The siding shown, called Colonial II, features a double 7-in. exposure, smooth-textured finish and straight butt line. All this do-it-yourself convenience does, of course, come with a price. Shakertown Colonial II siding costs between \$2.60 and \$3.50 per sq. ft. depending on quantity ordered and your area. The savings are in reduced labor, minimum cutoff waste and no need to buy nails since they're furnished. For more details, contact Shakertown, Box 400, Winlock, WA 98596. Or, call toll-free: (800) 426-8970.

The siding comes unfinished ready for stain or paint. As a timesaving step, we stained all the siding *before* installation with Cuprinol's semitransparent stain and wood preservative (color used: Ginger). The stain has a linseed oil base, but it cleans up with soap and water.

The best way to apply the stain is with a pad applicator. We tried a synthetic-bristle brush, but it took too long and didn't distribute the stain very well. Be sure to stain all four edges of each panel. A second coat can be applied once the first coat has dried—about 5 hours. One gallon covers about 300 sq. ft. and costs about \$16. For stain specifics, contact Cuprinol, Darworth Co., Tower La., Avon, CT 06001.

First things first

There's a lot to do before installing the siding. In fact, about 50 percent of this siding job was spent preparing the house. First, remove all existing siding to expose the wall sheathing. The house shown is sheathed, not in plywood, but in a panel sheet product called Celotex. A popular sheathing material of the 1950s, Celotex is difficult to describe, but it's somewhat like 3/4-in.-thick notebook paper. Since Celotex doesn't provide a solid nailing surface, 2x4 blocking had to be inserted in the walls around the windows for nailing the siding.

At this point, we replaced all the old casement windows with Andersen vinyl-clad, double-hung windows. Install each new window temporarily with screws. Next, re-

Color photo: Carl Weese
Black-and-white photos:
Joseph Truini
Siding: Shakertown, Box 400,
Winlock, WA 98596
Stain and caulk: Cuprinol,
Darworth Co., Tower La.,
Avon, CT 06001.

SUPER SIDING

move all the windows and wrap the entire house in Tyvek housewrap (photo 1). Use a knife to slit the Tyvek covering each window opening (photo 2) and install the windows permanently. Tyvek is an energy-saving air-infiltration barrier that helps stop drafts and heat loss. It's made of very fine, high-density polyethylene fibers and comes in 9-ft.-wide \times 195-ft.-long rolls for about \$120. Simply roll out the Tyvek and staple it in place. Avoid wrinkles and overlap second-story sheets by at least 1 ft. Seal the Tyvek seams and around all doors and windows with wide tape such as 3M's sheathing tape (photo 3). For more information and details, contact DuPont, Tyvek Housewrap, Centre

Rd., Wilmington, DE 19898.

Next, nail up the frieze board, rake boards and trim around each window. We used $\frac{5}{4}$ -in. \times 5 $\frac{1}{2}$ -in.-wide pine for these parts. As a timesaver, prime all

the knots and paint the boards before installation. Add a final paint coat after the boards are up, but *before* installing the siding. Install the frieze board first, and then trim out the windows. Start by nailing the horizontal trim board under the window (photo 5). Then, add the vertical boards to each side of the window (photo 6). Note that the bottom trim board extends beyond the side trim by 2 in. on *each* side. With all the windows trimmed out, you're now ready to start siding.

Siding simplified

The first step is to establish a level line around the entire house. Use a transit, water level or line level and string. Mark the level line about 4 ft. off the ground or at any convenient



1 With the windows removed, Tyvek housewrap—an air infiltration barrier—is stapled directly to the exterior sheathing.



2 Then, slit the Tyvek at each window opening from corner to corner. Fold Tyvek into the opening and reinstall the window.



3 For a totally energy-efficient seal, apply 3M's sheathing tape around windows and doors. Use tape to seal all Tyvek seams, too.



4 Apply caulking to the underside of the window prior to installing the trim board. This helps seal out wind-driven rain water.



5 Nail 5 $\frac{1}{2}$ -in.-wide pine trim under the window first. Note: Bottom trim board extends 7 $\frac{1}{2}$ in. beyond window on each side.



6 Install the vertical pine trim to each side of the window. Fasten the $\frac{3}{4}$ -in.-thick trim with 10d galvanized finishing nails.



7 Here's a timesaving step: Stain all the siding before installation. A short-nap pad applicator makes staining quick and easy.



8 Before installing the siding, nail a $\frac{1}{2}$ -in.-thick starter strip along the bottom of the house to build out the first course slightly.



9 Start first course with a prefabricated corner. Be sure corner is plumb on both sides and hangs just below the starter strip.



10 Continue by installing a corner followed by a course of siding. Note: Shims are often necessary to keep the corner plumb.

HOME IMPROVEMENT GUIDE

height. Then, simply measure down from the level line to position the first siding course.

Begin by nailing a 1/2-in.-thick starter strip along the bottom of the house (photo 8). We used a course of cedar bevel siding as the starter strip. Next, nail a prefabricated corner in place (photo 9). Be sure that it's plumb in both directions. Use shims, if necessary. Then, install the first course of siding—8 ft. at a time.

Take great care that the first course is perfectly straight and level. Remember, the subsequent courses will align with the first course. When it comes time to cut a panel, use a portable circular saw and place the panel face down to prevent splintering. To make accurate, square cuts, we used a simple shopmade crosscut guide (photo 12). Test fit each panel and check



11 Position nails 1/2 in. up from bottom edge to catch both siding courses. Note rabbet cut in rear, bottom edge of siding.



12 Shopmade crosscut guide makes it easy to cut 8-ft.-long siding panels. Place siding under guide, facedown, and cut.



13 Use a small brush to stain all cut ends. Stain helps to seal and weatherproof the edges of shingles and plywood backing.



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HOME IMPROVEMENT GUIDE SUPER SIDING

the butt joint. Use a block plane, if necessary, to form a tight joint. Restrain all ends and edges that have been cut or planed (photo 13). This will help prevent the plywood back from absorbing water and delaminating.

Continue installing corners followed by siding courses. Check your progress occasionally with a level just to be sure that the siding remains level. Remember that the rabbet milled in the panel's rear, bottom edge sits down onto the previous panel. Position the nails about 1/2 in. up from the bottom edge to catch the top of the previously installed panel. Leave the siding about 1/8 in. away from the window trim in case of expansion. Apply a bead of caulk between the trim and siding to seal out water. Chances are that you'll have to rip the last siding course to fit. Before installing it, though, nail a 1/2-in.-thick wood strip to the house just under the frieze (photo 14). The strip builds out the top course to keep it on the same plane as the rest of the siding.

There is no easy way to re-side an entire house, but this system makes it a very manageable task for any competent do-it-yourselfer and partner. Finally, we were very pleased with the overall appearance and quality of the siding and glad to see the old house in wood once again. **PM**



14 Before installing the top course of the siding, nail a 1/2-in.-thick x 1 1/4-in.-wide wood strip to house under the frieze board.



15 Install top course. Position nails near bottom edge, and along top edge. Nail through siding and wood backer strip.

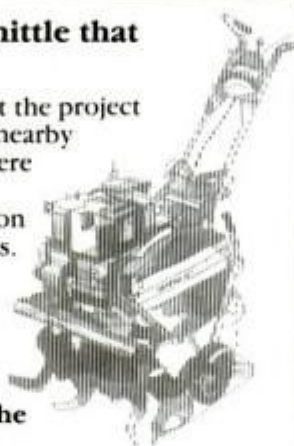
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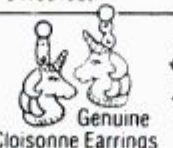
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All Decked Out

A welcome-home deck that provides a place for plants.

BY JOSEPH TRUINI, Shop And Tools Editor



THE ENTRANCES to some homes are very grand and stylish, while others are more functional than impressive. In either case, a home's entrance serves as a bridge from the outdoors to the indoors. It provides a place to greet friends, send off school children and settle accounts for the local newspaper.

Ranch-style homes aren't known for their powerful entrances. For example, the house shown was originally equipped with a concrete stoop in a carport—hardly a design feature worth preserving. Later, a rather plain wood deck, that was more functional than attractive, was added.

So, when the house-remodeling plans were being developed, a lot of time was spent designing the entrance. The idea was to build something that looked like it was part of the house—not simply tacked on the front. Plus, we wanted to show off, not hide, the attractive new door and sidelight.

The entrance had to be large enough to be functional, but if too large, it would distort the house's scale. And finally, the entrance had to be stylish without being grandiose. With these design considerations as guidelines, our entrance deck was born.

The 8½ × 18-ft.-long deck features walls that are covered with the same cedar-shingle siding (Shakertown Colonial II) as the

house. The tops of the walls have an 8-in.-wide trough that accepts flower pots and planter trays. Expansive 9-ft.-wide steps, that are centered on the doorway, welcome you home. A small brick walk connects the driveway to the deck and helps soften the transition from the black asphalt to the stained wood deck.

The deck is built entirely of Wolmanized pressure-treated wood. The understructure framing and steps are made of 2x8s. The planter walls are framed with 2x4s with 1x4 cross braces. For information on working with pressure-treated lumber, contact Koppers, 1050 Koppers Building, Dept. PM, Pittsburgh, PA 15219.

For the deck's surface, we used 2x6 DuraPine pressure-treated decking. DuraPine features rounded top edges and kerfs cut in the bottom surface to prevent cupping (photo 14). DuraPine costs about \$1 more per sq. ft. than regular pressure-treated 2x6s. For details, contact Cox Wood Preserving Co., Drawer 1124, Orangeburg, SC 29115.

The deck was stained with Cuprinol's deck stain and preservative (color used: Sierra Redwood). It contains hard resins that resist wear and stand up to heavy traffic. One gallon of stain costs about \$19 and covers approximately 300 sq. ft. It's worth mentioning that we stained all the decking before installing it. This not only saved time, but it made for a neater, more effective staining job. However, this goes against the recommended procedure that says to wait 8 to 12 weeks (longer if the wood gets wet) after construction before applying stain to pressure-treated wood. It was not practical for us to wait this long and the deck has shown no ill-effects so far.

Deck construction

Before starting construction, check the local building codes and obtain any permits that are required. There are four basic steps to building the deck: Construct the understructure framing and steps, frame the planter walls, apply the decking, and install the siding to both sides of the walls.

Begin by fastening a 2x8 ledger to the house with lagscrews. Be sure to screw securely into the house framing. Nail an aluminum drip cap so that it overhangs the top edge of the ledger. Next, construct the 2x8

Color photo: Carl Weese
Black-and-white photos: Joseph Truini
Technical art: Eugene Thompson
Wolmanized pressure-treated wood: Centerville Lumber, 2320 Whitney Ave., Hamden, CT 06518.
Stain: Cuprinol, Danworth Co., Tower La., Avon, CT 06001.

ALL DECKED OUT

header joist that forms the perimeter of the deck. Use concrete blocks or bricks to support the header until the posts are installed.

The floor joists are joined to the ledger with Teco metal hangers (No. C-28). Nail the hangers to the ledger 16 in. on-center (photo 1). The exceptions to this, are the first and last joists which are located 13 $\frac{1}{4}$ in. from the outside edge of the deck's perimeter to their center (see drawing detail). This is necessary to form the 8-in.-wide trough in the planter walls. To alter the width of the trough for larger or smaller plants, simply reposition these two joists.

Next, dig the four post holes and level the header joist (photos 3 and 4). Then, cut the 4x4 posts to length.

Note that the tops of the posts are notched to fit under the header joist. Nail a 2x4 cleat to each post to extend the notch and provide a shoulder for the second 2x8 that will be nailed to the header joist later. Nail the posts in place (photo 5) and then backfill around each post with compacted soil.

Then, cut the joists to length and drop them into the hangers. Nail the hanger to the ledger first, and then to the joist (photo 6). Secure the other end of each joist by nailing through the header.

Once all the joists have been installed, nail a second 2x8 to the header joist (photo 8). The double 2x8 header is needed only across the front of the deck and on the short, angled wall.

Next, construct the steps. Make the four stringers from 2x8s. Triangular blocks, cut from 2x8 stock, are

nailed to the stringer to support the treads and risers. Use concrete patio blocks as the foundation under each stringer. Each tread is made of two 2x8s. For additional traction, rout $\frac{1}{4}$ x $\frac{1}{4}$ -in. grooves in the treads.

Planter walls

The planter walls consist of pairs of 2x4 studs connected by a 1x4 cross brace. Two 1x2 slats run across the 1x4 braces to support planter trays and flower pots.

The studs on the outside of the walls, are notched to extend down alongside the joist and are then nailed in place (photo 9). The exception is along the double 2x8 header joist where the studs are toenailed in place. The studs that frame the inside of the walls, aren't notched. They are simply nailed flat against a joist.



1 After bolting ledger to the house, nail metal 2x8-joist hangers 16 in. on-center. Nail only one side of metal joist hangers.



2 Nail the first and last joists to end of ledger and then install a metal corner bracket (as shown) to strengthen the joint.



3 A post-hole digger makes quick work of post holes. Dig down about 6 in. below frost line and add 4 in. to 6 in. of fine gravel.



4 With header joist temporarily supported by concrete blocks, shim header level. Then, take measurements for posts.



5 Nail 4x4 post to the header joist with 16d galvanized nails. Note how post is notched to form a shoulder to support joist.



6 Drop the joist into the hanger and nail the hanger to ledger first. Then, nail hanger to the joist with the nails provided.



7 Fasten other end of joist by simply nailing through the galvanized header and into joist end. Use three 16d nails per joist.



8 After installing all joists, nail a second 2x8 to header. Add 2x4 wood cleats to posts to support the double 2x8 header.



9 Prebore the 2x4 studs and then nail them to the joist 16 in. on-center. Note that the stud is notched to fit onto the 2x8 joist.



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HOME IMPROVEMENT GUIDE

When nailing each pair of the studs in place, be sure that the two studs align so that you can attach the 1x4 cross

braces. Before screwing the cross braces in place, plumb the studs with a level (photo 11).

Next, install the decking. Cut each board so that its end falls on a joist and stagger the joints from one course to



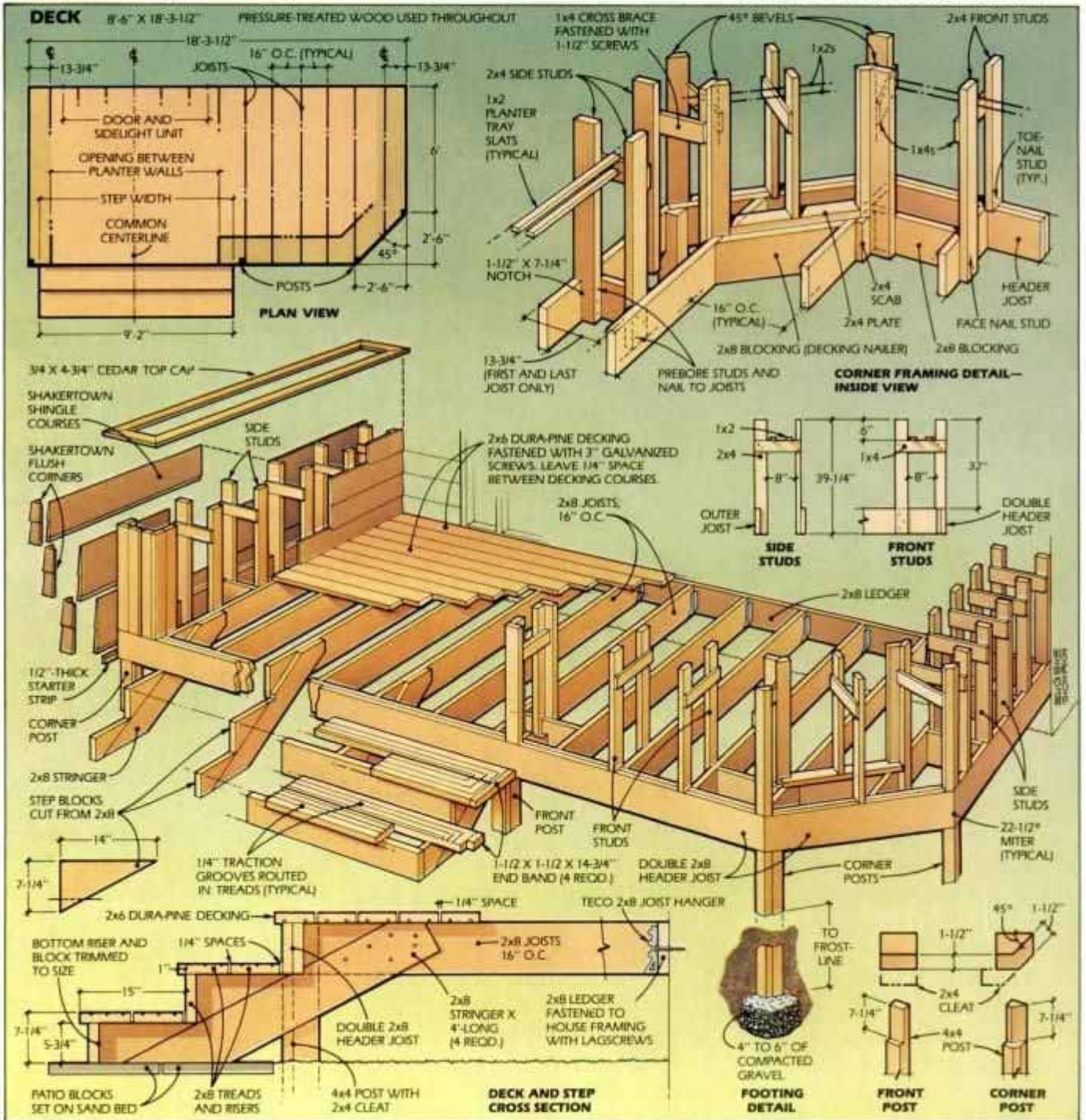
10 Clamp opposite stud in place and level across tops. Inside studs aren't notched, but instead, nailed flat against the 2x8 joist.



11 Screw 1x4 cross brace to outside stud. Then, plumb inside stud and clamp the brace to it. Now screw brace to inside stud.



12 Front studs positioned on double 2x8 header must be toenailed in place. Nail studs flush with outside edge of header.



the next. Instead of nails, we fastened the 2x6 decking with 3-in. galvanized screws. The screws hold better and look neater than nails. Counterbore screw pilot-holes and then drive the screws with an electric screwdriver or drill (photo 15).

Siding the walls

Applying siding to the planter walls is similar to siding the house. Start by nailing a 1/2-in.-thick starter strip around the deck perimeter (photo 16). Next, establish a level line and nail the first siding course to the deck wall. Run the siding across the deck wall and onto the house. This helps to visually blend the deck into the house and make it look less like an add-on. Crosscut the siding at 22 1/2° for the angled section of the wall.

Use Shakertown prefabricated cor-

ners at the ends of the walls. Nail the corners up first and then butt the siding to the corners. Note that additional 2x4 blocking must be added to the wall ends to provide solid nailing for the siding.

Continue the siding around to the inside of the walls. Making tight-fitting joints at the inside corners of the angled-wall section can be tricky.

First, crosscut the siding to 22 1/2° and then use a block plane to trim the siding to fit. The last few pieces of siding butt against the house siding at a right angle. Notch the planter-wall siding, as needed, to fit tightly against the house.

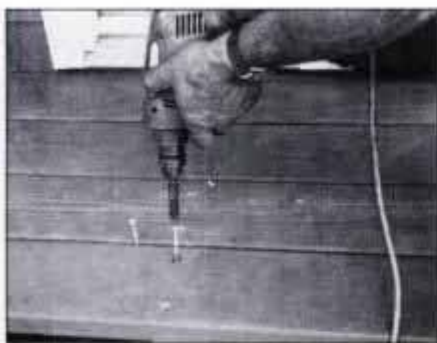
Now nail 3/4 x 4 1/4-in.-wide rough-sawn cedar trim to the tops of the walls (photo 18). Sand the cedar trim lightly to eliminate splintering and then stain it to match the siding. **PM**



13 Add piece of 2x8 solid blocking between joists in front of angled wall. Blocking provides a nailing surface for decking.



14 Special 2x6 Dura-Pine decking has rounded top edges and dual kerfs cut in the bottom surface to reduce cupping.



15 Counterbore pilot-holes and fasten decking with 3-in. galvanized screws. A 16d nail is used as spacer between boards.



16 Before installing siding, nail a 1/2-in.-thick starter strip along the bottom of header joist. Continue the strip onto house.



17 Install cedar siding across the deck walls and onto the house. Cut the siding panels so that all butt joints fall on a stud.



18 Finish top of the walls with 3/4 x 4 1/4-in.-wide rough-sawn cedar. Fasten cedar trim with 6d galvanized finishing nails.



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A quick and easy way to reroof your home. Honest!

BY STEVEN WILLSON, Home And Shop Editor

REROOFING is one of those jobs that gets old in a hurry. Not only are the shingles heavy to carry up to the roof, but it always seems to take forever to nail them down. Thankfully, today's roofing shingles, when properly installed, have such long lives—in some cases, warranties that extend to 40 years—that you won't have to do the job very often.

When we decided to reroof this house, we tried to find the most user-friendly shingle around—and that's how we discovered Georgia-Pacific's Summit III product line. These laminated shingles are made of fiberglass reinforced asphalt, with a heavily textured surface that is supposed to remind people of weather wood shakes. They come in four bundles per square (one square covers 100 sq. ft. of roof) and weigh 300 pounds per square instead of the more common 225- and 245-pound shingles. They cost between \$50 and \$60 per square, depending on your location. Their real advantage, is in their design. By looking at photo 1 on the following page, you'll see that the shingle is laminated in two parts. The lower section is a solid strip and the top layer has irregular tabs to give the shingle its characteristic texture. The two layers are joined at the factory so the shingle functions as one unit.

This design is radically different than a typical 3-tab shingle and has some great do-it-yourself implications. The most important is the lack of slots between the tabs—which have to be aligned precisely or the job will look sloppy. Because the Summit design is more forgiving, the less-than-expert roofer doesn't have to be as careful about layout and alignment. Furthermore, the heavily textured surface and heavy weight of these shingles allows them to bridge the old roofing underneath better.

Another time-and energy-saver on this job was a pneumatic nailer. We rented a Stanley-Bostich model N12B with a 3/4-

horsepower compressor and 25 ft. of air hose. These cost \$46 per day but were well worth the money. We estimate that the nailer was at least five times as fast as hand nailing. The rental outfit also supplied the special coiled nails that were required. A box of 7200 nails, more than enough to finish this 25-square house, cost \$72.

As with any powerful tool, common sense dictates some safety precautions. Wear eye protection and keep your hands away from the nail port. Otherwise, the tool is very friendly and will not shoot unless the safety collar around the nail port is depressed on the shingle. If you'd rather hand nail the shingles, use galvanized roofing nails and choose a length that will go through both layers of shingle, and project at least 1/8 in. beyond the bottom surface of the roof sheathing. Normally, 1 1/4 to 1 1/2-in.-long nails will do the trick.

First things first

Working on a roof always involves a certain amount of danger. Because this roof had a 4-pitch—meaning that it rises 4 in. for every 12 in. of horizontal run—and was on a single-story house, it was safe to work without scaffolding or roof brackets. But if you have a steeper roof, or one that's higher off the ground, you should rent safety brackets from a local rental shop. Also, always use a stable ladder in good condition.

The amount of roofing you need is a simple calculation. Just multiply the length of each side of your roof by the width from eaves to the ridge. Then add about 10 percent for waste and divide the total by 100 sq. ft. to find the number of squares you'll need.

Besides nails and roofing, also have several dozen razor blades on hand for your utility knife, and at least 1 gallon of plastic roof cement. For this job, we also bought some white-aluminum edging that we nailed over the ends of the old shingles at the rakes. Although these L-shaped metal strips are not absolutely required, they do lend a nice crisp appearance to any reroofing job. One last caution: Shingle manufacturers will only guarantee reroofing jobs that are applied over a single layer of old shingles. If you have two or more layers, you must remove the old shingles.

Color photo: Carl Weese
Black-and-white photos:
Joseph Truini
Roofing: Summit III
Weathered Wood, Georgia-Pacific,
133 Peachtree St. N.E.,
Atlanta, GA 30303.

TOP COAT

Getting started

Begin at one corner of the roof as shown in photo 1. Align one end of a full shingle with the rake edge and position its bottom edge $\frac{1}{4}$ in. below the eave's drip edge—this serves to hide the bottom edge of the old shingles from view. Nail the shingle in place following the instructions on the shingle package.

Continue across the eave until the first course is done. These shingles did not require a starter strip. But if you are using 3-tab shingles, order a roll of starter strip and nail this in place before any shingles. Because other techniques differ when using 3-tab shingles, read the wrapper instructions carefully for that product.

Begin the second course with an-

other full shingle. But this time, align the roof end of the shingle with the first alignment slit in the shingle below (photo 3). Let other end extend past the rake. Mark the waste on the rake end, turn the shingle over, and cut it using a utility knife and framing square as a guide (photos 4 and 5).

On the second course make a minor adjustment so the ensuing courses are easier to apply: Namely, align the top edge of the cut shingle with the bottom edge of the fourth row of old shingles (photo 6). This will reduce the exposure on your first row of shingles to less than the standard $5\frac{1}{2}$ in. But this minor change will not be noticeable and will allow you to use the layout of your old shingles as a guide to installing the new ones. This saves a great deal of time normally devoted to chalking course lines.

Once you've made this adjustment, nail the shingle in place and finish the second course. Begin the third course in a similar way, abutting the roof end of the shingle to the first available alignment slit in the shingle below. By the time you reach the fourth course, start with a full shingle again and continue the pattern of every third course starting with a full shingle until you reach the ridge.

Once you approach the ridge, stop and remove the existing ridge-cap shingles. Then continue with your full shingles until the ridge is covered. Normally, with 3-tab roofing, you have to cut cap shingles from full shingles. But because of their design, Summit shingles cannot be cut for a ridge cap. Instead, you can buy separate Summit cap shingles and install them as shown in photos 11 and 12.



1 Begin at one roof corner with full shingle. Keep it flush with edging at rake and $\frac{3}{4}$ in. below old shingles at eaves.



2 When course reaches valley, cut shingle to match old valley line. Keep all nails at least 4 in. back from exposed flashing.



3 Begin second shingle course by abutting full shingle to first alignment slot that appears in top edge of shingle below.



4 Mark cut line on first shingle of second course using sharp utility knife. Cut line should be flush with aluminum edging.



5 Turn over shingle and cut off waste with knife and framing square. Cutting back side is easier because it has no surface granules.



6 Align top edge of shingle with bottom edge of fourth course of old shingles. Nail in place along chalked nailing line.



7 Air-driven nailer is a rental item that saves a lot of time and energy. To use, just press nose against shingle and pull trigger.

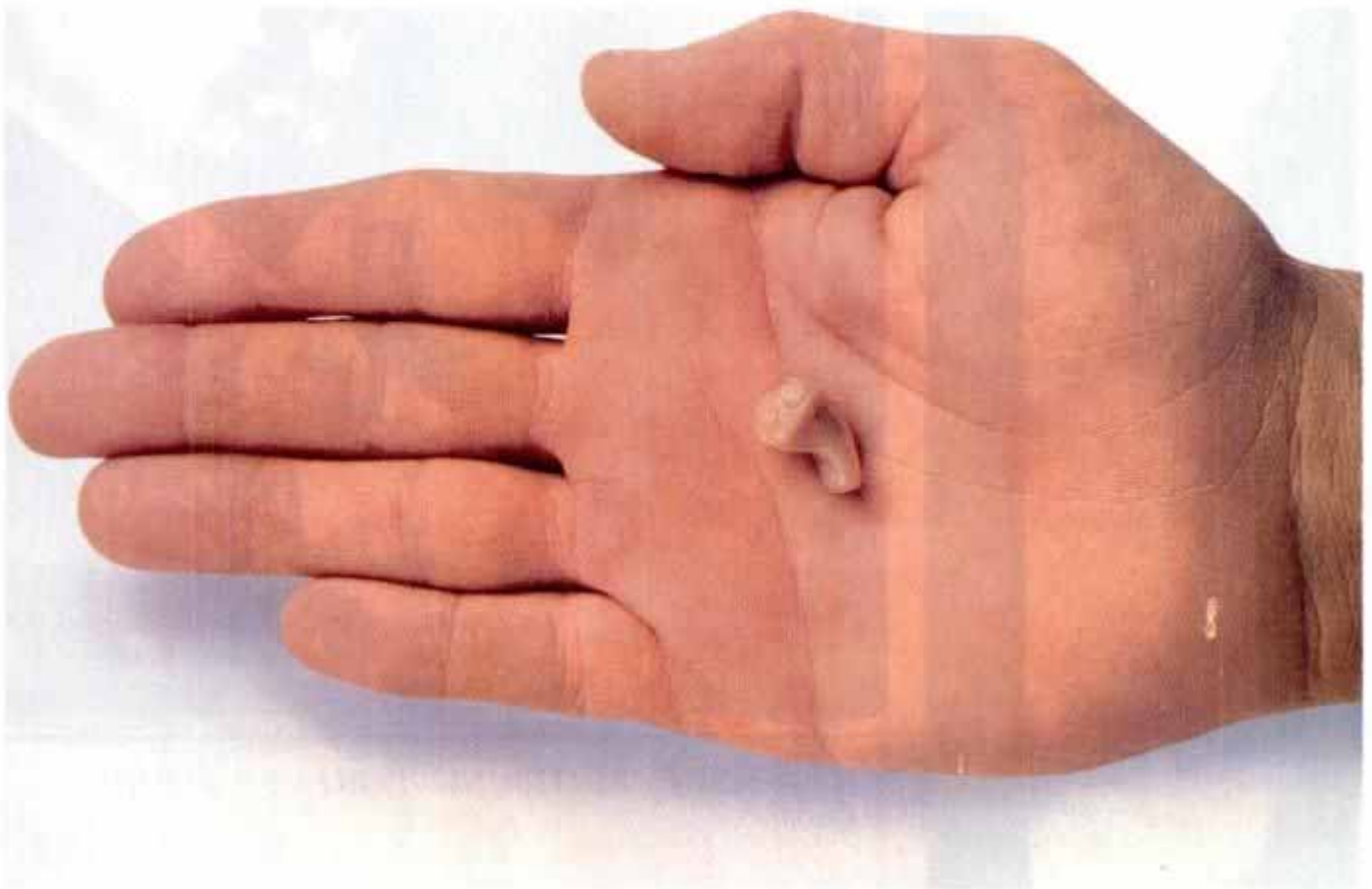


8 When you reach chimney or roof vent, cut and nail first shingle. Cover end, down to nailing line, with plastic roof cement.



9 Cut and nail next shingle over cement, then continue layering cement and shingles until you are past the chimney or vent.

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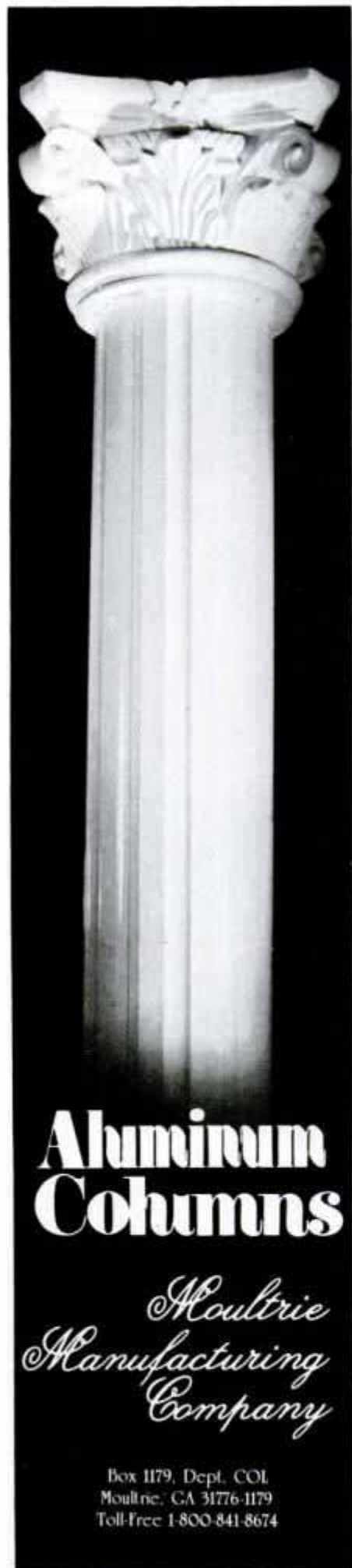
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TOP COAT

Valleys, chimneys and vents

On most reroofing jobs, when you are going over a single layer of old shingles, the flashing in the valleys and around the chimneys, vents and other such projections should be in good shape.

All these elements were sound on this job, so we cut our shingles around these interruptions and used plastic roof cement to seal the areas as shown in photos 8 and 9. If you see any breaks, cuts or wear in your flashing components, repair or replace the flashing.

PM



10 When you reach the ridge with new shingles stop and remove old cap shingles using hammer and nail puller or flat bar.



11 When old cap is removed, continue shingle courses over ridge. Then install new cap using simple, notched alignment block.



12 Nail cap shingles in place with one nail on both sides of ridge. The following shingle should just cover nail heads below.



13 Cut last ridge shingle to fit, then spread roof cement along rake where shingle will fall. Nail in place with four nails.



14 Cover exposed nail heads with dab of roof cement. Then spread some stone granules over dabs so they blend into the roof.

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Asphalt Answers

How to work with a paving contractor to get a more usable driveway.

BY JOSEPH TRUINI, Shop And Tools Editor



WHEN THE home remodeling plans were first submitted, we were surprised to see that they called for a new driveway. What does replacing the driveway have to do with home improvement, we thought. After all, a driveway is simply a place to park the car, right?

However, after studying the proposed design, talking with the designer and, most importantly, discussing the new driveway with a professional paving contractor, we realized that the driveway was as much a part of this home improvement job as the new siding, roof or windows.

The original driveway was rather unoriginal—a straight arm of asphalt reaching out from the road toward the house. It was only 1-lane wide, serving a 2-car family, so the owners had to play a constant, if not amusing, game of find-the-keys-and-move-your-car. This led, not surprisingly, to parking on the grass so as to earn exemption from the car-moving game.

The new L-shaped driveway offered two major improvements. First, a 20 × 20-ft. parking area to accommodate two cars side-by-side. And second, cars are no longer parked directly in front of the house, but instead, are off to the side, partially obscured by a row of shrubs. The shrubs—seven

spreading yews—will grow into a hedge that will block the cars entirely from street view. This helps eliminate the parking lot look that is so common in suburbia today.

The design originally called for a 1-lane-wide driveway leading from the street to the parking area. The paving contractor, however, suggested that we widen the driveway slightly from the standard single-lane width of 10 ft. to at least 14 ft. wide. He felt that the extra 4 ft. would make backing in and out of the parking area much easier and virtually eliminate accidentally driving onto the grass. The final size of the driveway was 14 ft. wide × 54 ft. long. The parking area is dimensioned for two cars and it allows for opening doors. Figure a 10 × 20 ft. spot for each car. If you're tight for space, a 10 × 15-ft. spot will accommodate most cars.

The driveway cost \$2 per sq. ft. This included tearing out the old driveway, excavating the area, 4 in. of processed stone and 2 in. of asphalt. The 1156-sq.-ft. driveway shown cost \$2312. The seven 2-ft.-tall spreading yews cost \$25 per plant. Add around \$15 per plant if you want the nurseryman to plant them.

Test-drive the new design

Installing a new driveway may not be a do-it-yourself project, but there's plenty to do before calling a paving contractor. First, measure the area of the proposed driveway and make a sketch to scale. Don't be concerned with square footage and price just yet. Refine the design as necessary. You may need to shift the driveway to avoid a tree or to improve the approach from the road. Check with the local zoning board about any restrictions regarding how close a driveway can be to the property line, fire hydrant or neighboring building. Also, be sure that the new driveway isn't positioned over the cleanout for the house's water waste pipe. If necessary, ask the water department to locate the cleanout.

Next, using wood stakes and string, stake out the proposed driveway. Then, drive the cars in and out of the "driveway" to check the dimensions. Adjust the strings as necessary to make the approach, parking and departure as convenient and safe as

Color photo: Carl Weese
Black-and-white photos:
Joseph Truini

ASPHALT ANSWERS

possible. Once you've found a design that works, measure the area and determine the square footage. Now call a few paving contractors, get price quotes and references, and check their availability. (They're usually busiest at the very end of summer and early autumn.) Using these price quotes, calculate the cost of the proposed driveway. If it exceeds your budget, then consider ways to reduce the size of the driveway. But, don't readjust or remove the stakes and

lines just yet. Call the paving contractor and let him see the proposed driveway. He should be able to recommend ways to improve the design, if necessary, and satisfy your budget.

At this point, the paving contractor should offer a price quote in writing that includes the square footage of the new driveway. Be sure that the price quote includes everything and that there are no hidden costs.

Most driveways are installed in two consecutive days. The first day is spent tearing out the old driveway, excavating the soil and laying a pro-

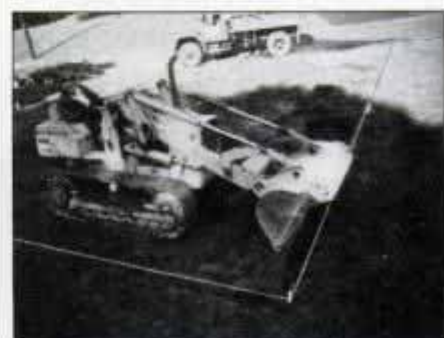
cessed-stone base. On day two, the asphalt is laid.

Day one—preparation

The paving crew arrived early in the morning and within minutes a shovel



1 Track-driven shovel dozer tears out old driveway. Dozer's front bucket scoops asphalt chunks and drops them in truck.



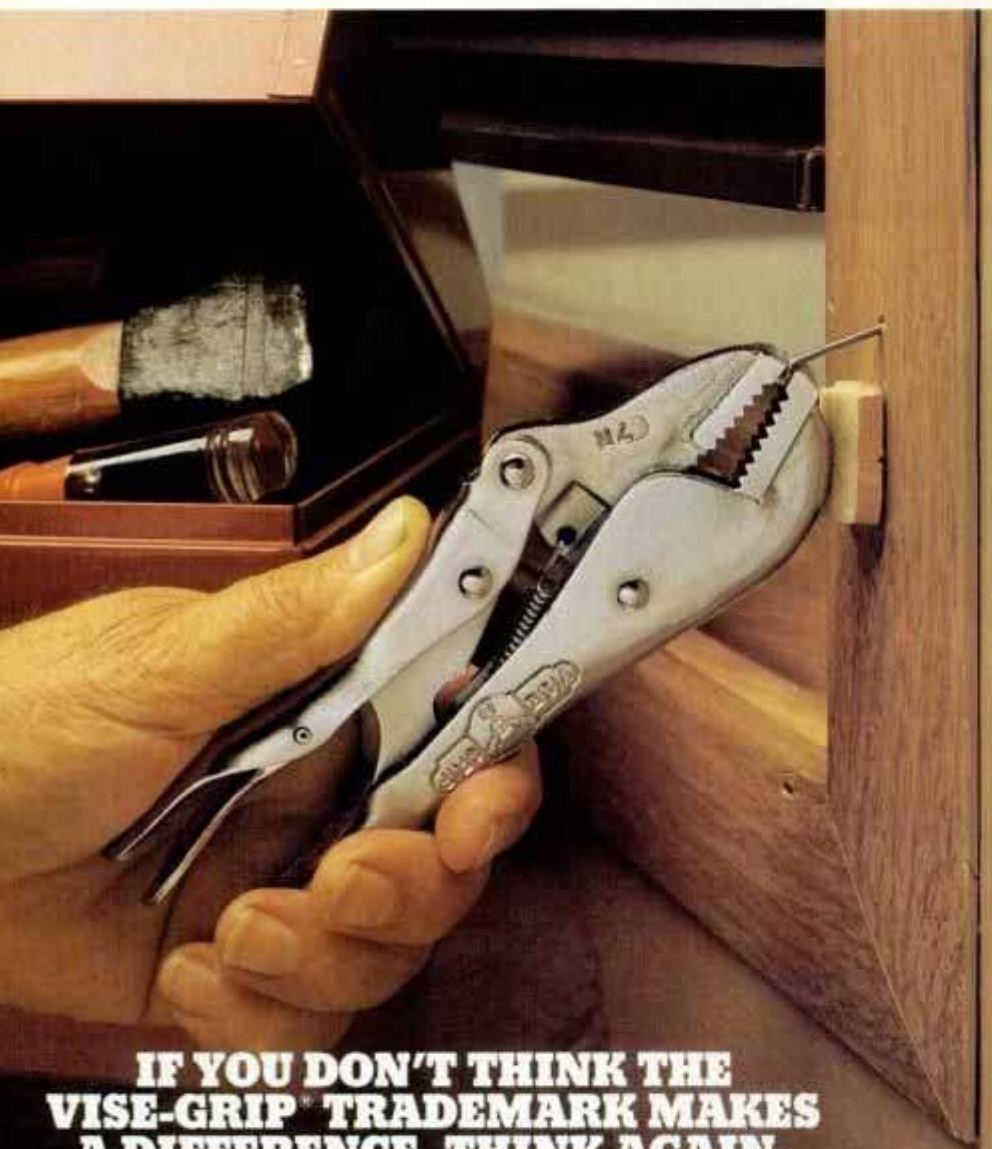
2 Using staked-out strings as guidelines, shovel dozer excavates new driveway. The dozer removes about 6 in. of topsoil.



3 Processed stone—a mix of stone and stone dust—is brought in and dumped by truckload to give a stable base for asphalt.



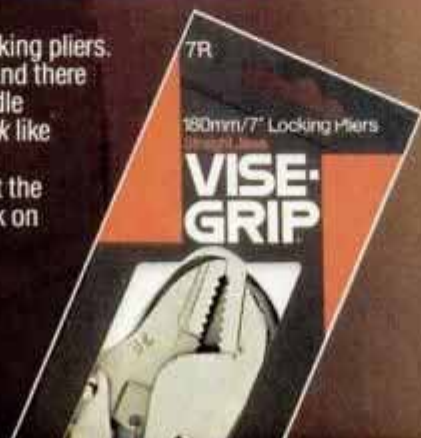
4 Man and machine work together to spread the processed stone evenly. A minimum of 4 in. of stone is required as a base.



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dozer—a large, track-driven machine equipped with a front loader—was busy at work digging up the old driveway (photo 1). The old driveway, reduced to rubble in no time, was loaded into waiting dumptrucks which sped



5 A gasoline-powered compactor—a flat-bottomed, ground-pounding machine—is used to compact processed stone tightly.



6 A grader smooths the processed stone surface by removing high spots and filling low areas. A 1½-ton roller compacts stone.



7 With driveway graded, rolled and ready for asphalt, the Power Box—a self-propelled power paver—is driven off trailer.



8 The paver's hopper and corkscrew auger receive a light coat of lubricating oil to prevent the hot-mix asphalt from sticking.

off to a nearby landfill. Next, the shovel dozer, using the staked lines as guides, excavated the new driveway as shown in photo 2. The excavated topsoil was loaded into a dumptruck, but rather than bringing it to the landfill, we had it dumped at a low spot on the property.

(Later that day, the dozer operator was kind enough to spread out the topsoil, thus saving us hours of shoveling by hand.)

Just as the excavation was being completed, the dumptrucks returned loaded with processed stone that is

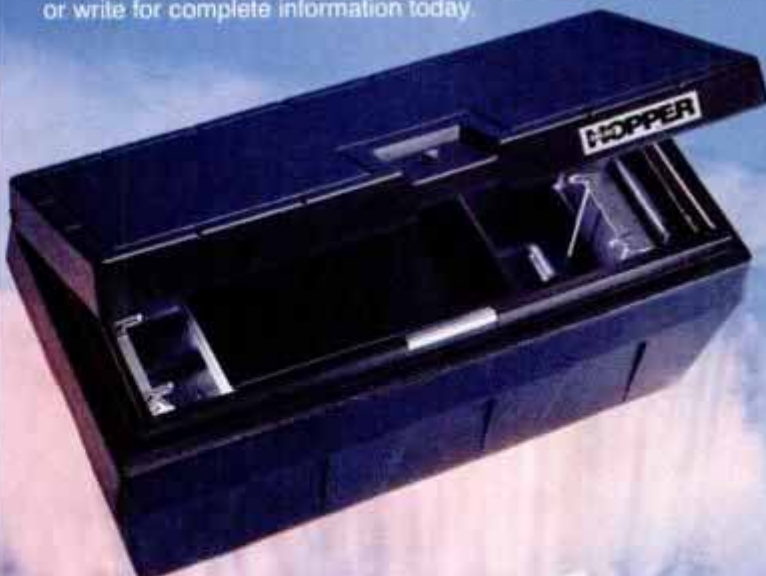
used as a base for the asphalt. Processed stone is comprised of small pieces of stone, up to ¾ in., mixed with stone dust. The dust, known as screenings, is produced when the stone is broken down to size at the plant. When it becomes wet, the dust packs the stone together tightly to form a cement-like base.

Before the stone is dumped, however, the ground is tamped with a compactor—a gasoline-powered machine that pounds the ground flat—to help avoid any settling. The stone is then dumped and smoothed out to about 4

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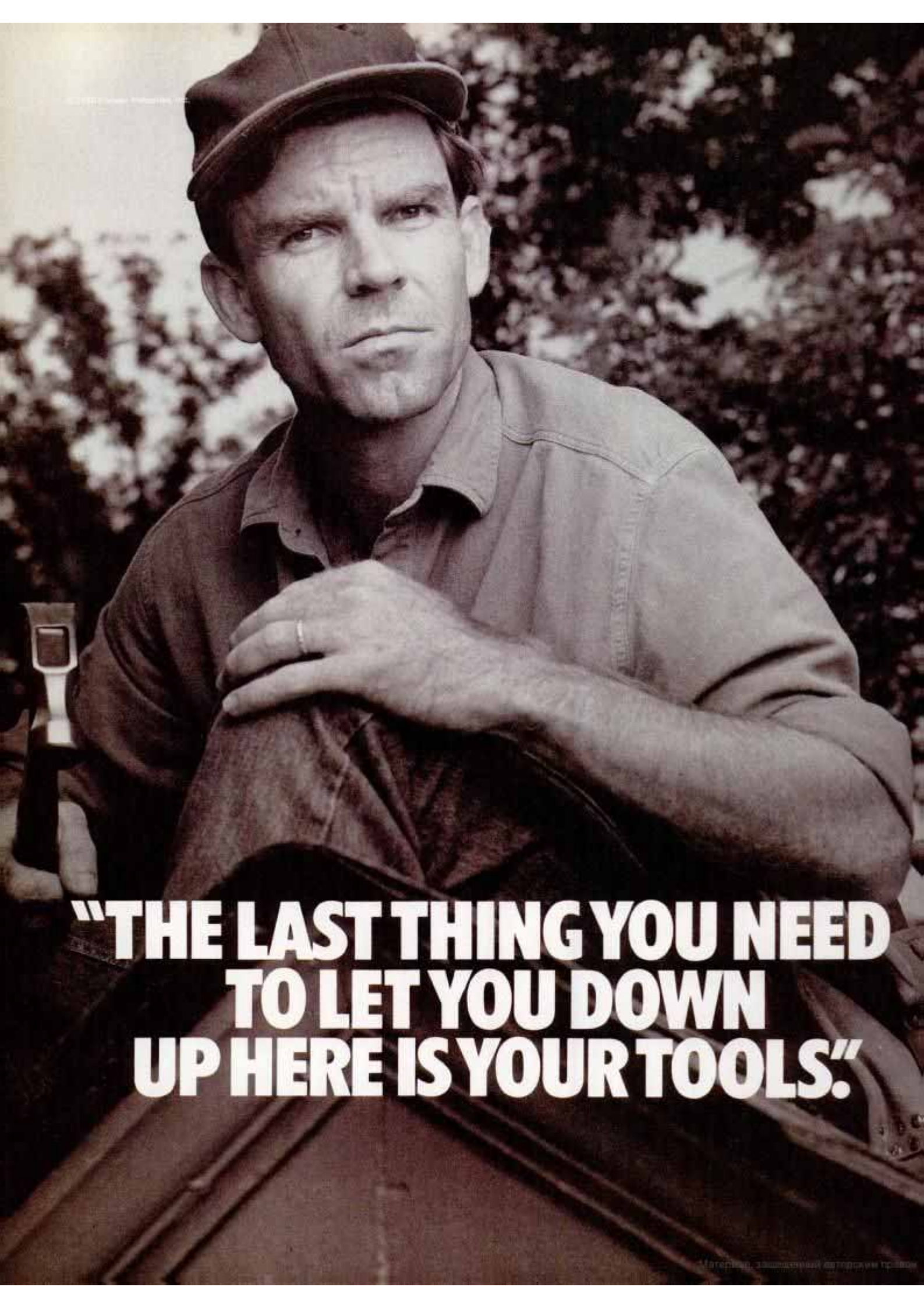
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ASPHALT ANSWERS

in. deep (photos 3 and 4). Again, the compactor is used, but this time, to compact the processed-stone base as shown in photo 5.

Compacting the soil *and* the stone are very important steps, especially if the new driveway is being laid on virgin ground where there had been no driveway previously.

Day two—asphalt arrives

It was another early start as the crew arrived with three pieces of equip-

ment: a grader, roller and paver. As the dumptrucks left to pick up fresh asphalt, the grader was used to smooth the processed-stone base (photo 6). Next, a 1½-ton roller was driven methodically back and forth across the stone compacting it tighter and tighter.

Hot-mix asphalt is laid down by an ingenious self-propelled machine called a power paver. The paver lays down a perfectly smooth bed of asphalt up to 12 ft. wide. The hot asphalt—about 325° F—is dumped into the paver's hopper (photo 9) and then the

paver is driven into position. Starting at the top of the driveway, the paver laid a 2-in.-thick × 10-ft.-wide lane of asphalt (photo 10). A second lane was laid beside the first, and within 15 minutes the 20 × 20-ft. parking area



9 The asphalt, picked up fresh that morning, is dumped into the power paver's hopper. The asphalt is approximately 325° F.



10 As the paver moves along, it lays down a smooth bed of steaming hot asphalt. Two men steer and operate the machine.



11 The paver, continuously refilled by a dumptruck, never runs out of asphalt. Asphalt bed is 2 in. thick and 10 ft. wide.



12 The very end of the driveway—where it flairs out to meet the road—is formed by hand. A wheelbarrow transfers asphalt.

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was installed. The 14-ft.-wide driveway is made in two passes—a 5-ft.-wide lane followed by a 9-ft.-wide lane.

The end of the driveway, where it flairs out to meet the road, is formed by hand as shown in photo 12). Once all the asphalt is laid, the 1½-ton roller is driven slowly back and forth, and up and down the driveway to compress the asphalt (photo 13). According to NAPA (National Asphalt Pavement Assn.), thorough compaction of the asphalt is vital to the driveway's long-term durability.

The driveway can be walked on immediately, but when you can drive on



14 The driveway's edge is compacted and beveled slightly with a tamper to prevent it from crumbling under the car's weight.



13 A 1½-ton roller compacts the still-hot, soft asphalt. Thorough compaction is one of the key steps to a long-lasting driveway.



15 After it's rolled thoroughly, the driveway is sprayed with a garden hose to cool off the asphalt and start it hardening.

it is another question. We were told to wait three or four days. Some contractors say to wait a week. According to NAPA, a properly compacted asphalt driveway can be driven on immediately. My advice is to listen to your contractor.

(For a copy of *Consumers Fact Sheet For Hot-Mix Asphalt Driveways*, send \$1 to NAPA, Box 517, Riverdale, MD 20737.)

Finally, seven spreading yews were planted along the front edge of the parking area (photo 16). Yews were chosen because, as evergreens, they remain green to form a visual barrier all year. **PM**



16 Seven spreading yews, planted along the front edge of parking area, will eventually grow into a hedge to hide parked cars.

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SUPER CLONES

(Continued from page 67)

dium-resolution, CGA-compatible color or hi-res, Hercules-compatible modes at the flip of a switch. Also standard are two 5.25-in. 360 KB drives, and a 14-in. RGB color monitor. An otherwise identical version with high-resolution monochrome monitor is available for \$995.

The Headstart's keyboard has a good, positive feel, though not quite up to the IBM standard. Also on the ergonomic front, the Headstart's fan is noisier than IBM's and Epson's, but its disk drives are uncannily quiet, besting all of its rivals in that area. Despite its space-saving chassis, nearly 1 in. narrower than that of the Equity I+, the Headstart still houses seven expansion slots, five of which are available for extra add-in boards.

Like Zenith's eaZy pc the Headstart needs only one AC outlet for operation (you plug the Vendex monitor into its system unit) compared with two for both IBM and Epson. The Vendex package includes parallel, serial, mouse, light pen and game ports, plus a built-in clock/calendar. Another nice plus: The monitor, like Zenith's, includes a tilt-and-swivel stand as standard issue.

Along with the Headstart package, Vendex has also bundled a generous range of software, including MS-DOS 3.2, GW-BASIC, and two applications programs. A key item in the software package, reflecting a recent trend seen in other popularly priced PC packages (including the Zenith eaZy pc) is what Vendex calls the Vendex Operating Environment.

This menu-driven shell guides you through a broad array of computer functions. Available at the touch of a key are introductory on-line lessons on how to use the Vendex PC, access to DOS utilities, an explanation of DOS functions, a series of pop-up memory-resident desktop programs, system setup, and system configuration changes.

While the Vendex Operating Environment provides an effective initiation to computing, it does eat up RAM, leaving you about 270 KB of free memory—not enough to run some of today's more memory-hungry application programs. Accordingly, you'll have to add some RAM.

In our battery of comparison tests the Vendex scored respectably, chalking up around a 70-percent improvement over the standard PC/XT performance when running at its faster 8 MHz processing speed.

Zenith eaZy PC

Zenith Data System's eaZy pc is aimed at the novice PC user looking for no-nonsense computing in a small, attractive package. Zenith has effectively pared PC design down to fundamentals with this svelte unit: It trades expandability (there are no regulation expansion slots) for easy operation and space-saving efficiency. Physical setup's a snap. This all-in-one system asks you merely to plug in a keyboard and connect a single AC power cord. The keyboard has good tactile response.

The eaZy pc comes with a built-in, 14-in. monochrome (black-on-white) monitor that offers both razor-sharp text and high-resolution graphics with the same 640 × 400 double-CGA resolution that IBM's Model 30 uses for its text mode. Color is not available, but the clarity of Zenith's monochrome monitor should make a lot of users forget color. A tilt-and-swivel stand, something no monitor should be without, is standard issue.

Because there's only one monitor available for the eaZy pc, Zenith has chosen to combine it with the power supply to reduce the system's size. This yields a dead-silent, fanless PC that should be a welcome working companion in close quarters.

The unit's small footprint, the most diminutive of this quartet, is a definite plus. The system measures 13 in. deep

× 13 in. wide × 14 in. high, and weighs only 28 pounds, less than some suitcase-type transportable PCs. Complementing the think thin theme of this PC is Zenith's adoption of the same 720 KB 3.5-in. disk drives used by IBM. As with the Model 30 you'll need new software or a way to transfer your programs and data from the larger disk format.

Slowest of this foursome, the eaZy pc uses a dual-speed 8088 processor with a top gear of 7.16 MHz that nonetheless can still outpace a plain vanilla, 4.77 MHz PC by about 50 percent. The unit arrives with 512 KB RAM, parallel and mouse ports, MS-DOS 3.2 and a new DOS shell from Microsoft called MS-DOS Manager. This shell provides a menu-driven, Macintosh-like interface that should take some of the sting out of using DOS for a lot of A>-averse shoppers. Although Zenith doesn't include BASIC with the eaZy pc, it does provide a tutorial disk covering both the PC's hardware and the new Manager software. Like the Vendex Headstart Operating Environment, Microsoft's MS-DOS Manager makes life at the keyboard easier but exacts the usual price, gobbling up both RAM and disk space. With 720 KB floppies the lost disk space isn't too much of a problem, but the Manager program, when loaded, leaves only about 335 KB of free RAM on a 512 KB system.

Smaller doesn't necessarily mean cheaper: You'll pay a premium for the compactness and convenience of this system compared with more conventional—and expandable—entry-level compatibles on the market.

The eaZy pc comes in a 1-floppy (\$999) or 2-floppy version (\$1199), or with 1-floppy drive and a 20 MB hard disk drive (\$1699). Options for this PC-without-slots are limited: You can pick among a RAM card that expands memory up to 640 KB, or a real-time clock, or a plug-in combo board that adds 128 KB, a 1200-bps modem (with communications software), and a serial port.

Although the eaZy pc won't raise the pulse rate of a power user, it admirably fulfills its design goal as a kind of Macintosh for the MS-DOS set, a simple 1-box computing appliance that does its job with a minimum of fuss.

Conclusion

If you want a good IBM-compatible system you can't miss with any of these units. All four will get you there—and each carries a one year warranty. The question is how—and how much is it worth to you?

The IBM Model 30 provides the most advanced design and performance in this group—along with a commensurately higher price tag

—and should attract those who want superior computing power and the cachet of the IBM reputation.

Epson's enhanced Equity I+, an ergonomically elegant revision of an already desirable PC, is a match for just about any task. Backed by a well-known manufacturer, it's an excellent value—particularly as a monochrome system.

Zenith's eaZy pc packages the basics brilliantly and figures as a sound choice if your needs are satisfied by the unit's fixed design. If you need a PC but are short on space, you'll find this unit especially appealing.

The sleeper in this group is the Headstart from newcomer Vendex. It's a true Everyman's PC that delivers a lot of computing clout, along with considerable flexibility, for its rock-bottom price.

Of course, your computing options aren't limited to these four entries. Other worthwhile PCs in the same class include IBM's PS/2 Model 25, Amstrod's PC1640, and a dynamic duo from Radio Shack/Tandy—the 1000HX and 1000TX. Just remember that when considering any computer, define your needs before you shop, and test drive before you buy. **PM**

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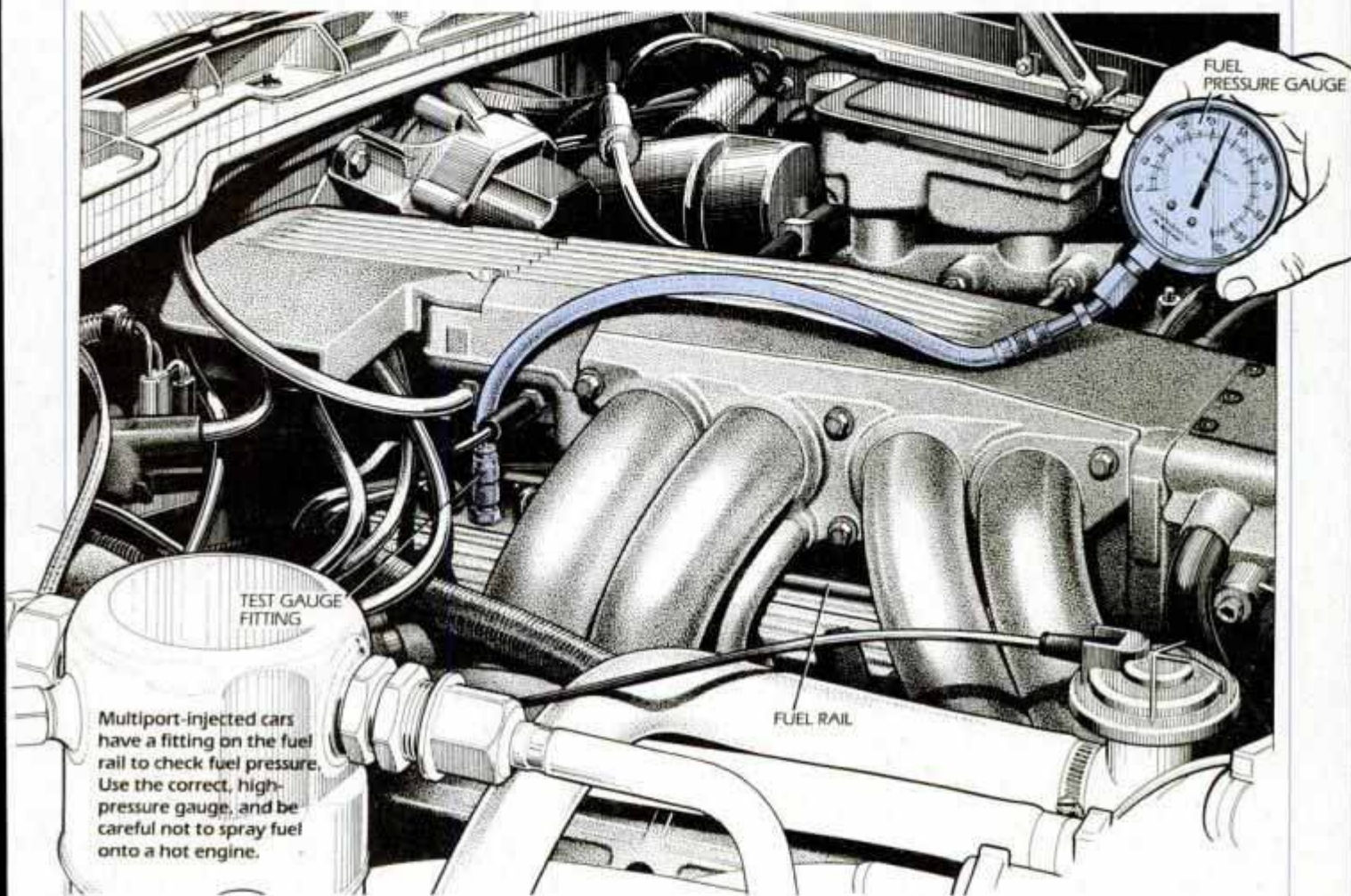
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SATURDAY MECHANIC



Multipoint-injected cars have a fitting on the fuel rail to check fuel pressure. Use the correct, high-pressure gauge, and be careful not to spray fuel onto a hot engine.

STOP STALLING!

ENGINE stalling is more than annoying. Depending on when and where it happens, it can be downright dangerous.

Looking for clues

The circumstances that cause an engine to stall are very important, because they can point you in the right diagnostic direction. So before you start digging under the hood, think about the events that led up to the stalling. We'll cover a variety of different types of problems, explain the symptoms that usually precede the shutdown, and provide some troubleshooting strategies.

On cars with computer engine control systems, including most domestics produced since 1981, the problem

Why your engine just quits, and how to fix it so it runs smoothly.

BY PAUL STENQUIST

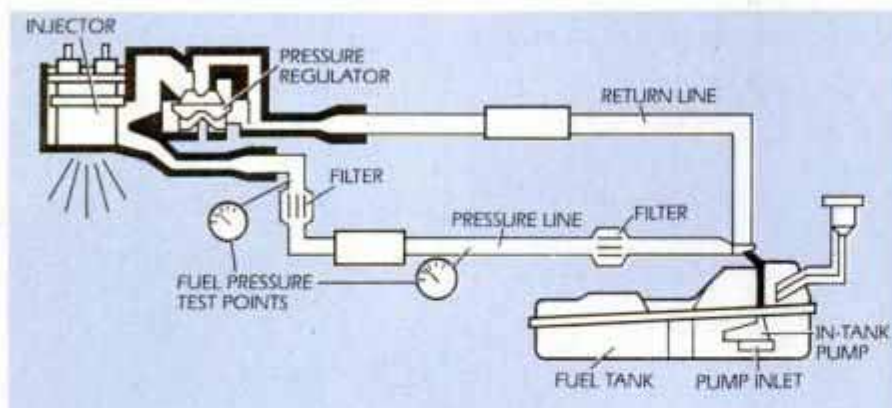
that caused the stalling may have turned on the dashboard CHECK ENGINE light. GM wants you to check the computer system for diagnostic codes before you perform other troubleshooting work. Ford and Chrysler recommend that you first try to find common causes of the engine performance problem, then troubleshoot the computer system only if the problem is not resolved. In any case, you'll find complete instructions for per-

forming the diagnostic routines in GM and Chrysler service manuals. For Fords, you need the Emissions Diagnosis manual for the appropriate model year.

Engine dies as load increases, warm engine

Suppose your engine stalls just as the throttle is opened to crest a hill—when the going gets tough, it quits. In less extreme cases, the symptom may only be a surging.

The most probable cause of this type of failure is fuel starvation. The fuel system is capable of providing adequate fuel under low-load situations but can't keep up when the demand is high. Fuel starvation may be more prevalent when temperatures are



1 Schematic of throttle-body injection system shows several points to meter fuel pressure.

high, but will almost always be affected by load. On fuel-injected engines, fuel starvation stalling may be more sporadic and might not seem to be load sensitive. Diagnosis of a fuel starvation problem differs depending on whether your engine is carbureted or fuel-injected.

Carbureted engines

On carbureted engines, the first thing to consider when you have a fuel delivery problem is the fuel filter. On most carbureted cars it's either in the fuel line or behind the carburetor inlet nut. If it isn't new, replace it before you look for more complicated solutions. Change the filter only when the engine is cold, and place a rag under the filter before disconnecting it.

To start, look for a fuel filter spliced into the fuel line. This type filter is usually attached to the line with short lengths of neoprene hose and replacement is simply a matter of loosening the clamps, and installing the new filter. Be sure to install it with the arrow pointing toward the carburetor.

If the filter isn't in the fuel line, it's probably behind the carburetor inlet nut. Use two wrenches to remove the fuel line from the inlet nut—one to hold the nut and one to turn the fuel line. With fuel line off, remove the inlet nut. Be prepared to grab the filter when the nut is unscrewed, as there is probably a spring behind the filter. Note any difference between the

front and rear of the filter. Many have a check valve on one side. The new filter must be installed with the check valve pointing in the same direction.

If the new filter doesn't solve the problem, pump pressure should be tested. After disconnecting the fuel line at the carburetor, attach a fuel-pressure gauge. Run the engine at idle on the fuel in the carb float bowl and read pressure. For most cars, it should be between 4 and 7 psi. If pressure is too low, replace the pump.

If pressure was up to spec, check the pump output volume. After disconnecting the fuel line from the carb, hold it in a graduated container. Have an assistant run the engine and record how long it takes the pump to deliver a pint. Don't spill fuel on a running engine as it could easily ignite.

At idle speed, most pumps should produce a pint in about 30 seconds. Most V8 engines require a pint every 20 seconds. Check the spec in your service manual. If the fuel is full of air bubbles and output is below spec, there may be a small hole in the line between the tank and the pump.

If the pump pressure was okay, but output is not what it should be, suspect a restricted fuel line, clogged tank, clogged purge canister or tank vent. To see if the fuel supply has been contaminated, transfer the fuel from your pumping test to a clear glass container and examine it for water, particles or other signs of contamination.

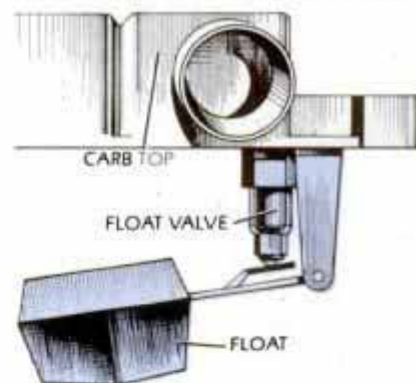
If the fuel supply is contaminated, the tank should be removed and flushed. For safety reasons, this job is best left to a professional who has a fuel-tank evacuation system. If you feel you must do it yourself, run the car completely out of gas first and take care that no flames or sparks are present in the area where the tank is removed. If done in a garage, make sure any pilot lights are shut off. Af-

ter the tank has been cleaned, replace the fuel filter and blow out the fuel line and fuel return line.

Fuel-injected engines

As noted above, a fuel starvation stalling problem on a fuel-injected engine may not always seem as obviously load-related as it does on a carbureted engine. In fact it may resemble an intermittent electronic stalling problem as described below. In less extreme cases it may only result in high-speed surging.

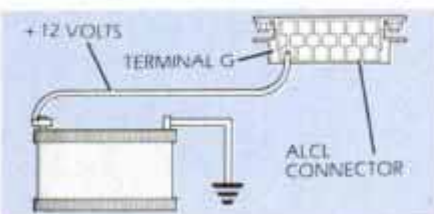
On fuel-injected engines, begin your diagnosis by checking pressure. You'll need a fuel-injection pressure gauge. On GM and Ford engines, the gauge must be connected to the pressure-checking port or gauge point provided for this purpose. In most cases the gauge point is a Schrader valve, similar to that used on tires. On some throttle-body fuel injection (TBI) cars (those with one or two injectors mounted in a central carburetor-looking throttle-body unit) you'll find the gauge point right on the throttle body. On most port-injected cars (those with one injector per cylin-



3 Check float for leaks, or better yet, weigh it to be sure it hasn't soaked up fuel.

der), it's on a fuel rail—the unit that delivers fuel to the port injectors (lead illustration). On 2.5-liter GM engines with TBI, the gauge point is between the fuel filter and throttle body. On 1.8- and 2-liter GM Fours with TBI, it's under the car near the fuel filter (Fig. 1). Attach the pressure gauge to the gauge point.

Because the electric fuel pump won't run without a distributor reference signal, you have to supply electricity to the pump. To do this on GM cars you apply positive battery voltage to the ALCL terminal G. The ALCL connector is under the dash near the steering column on most GM cars (Fig. 2). Ford recommends that



2 Voltage applied to terminal G of ALCL connector will operate fuel pump for testing.

you disconnect the electrical connector to the fuel pump. This connector is located just forward of the fuel tank. Attach a 12-volt jumper to the connector to run the pump for the pressure test. An adapter harness is available for this purpose from Ford. Make sure that there are no fuel leaks before attaching any electrical connectors under the vehicle.

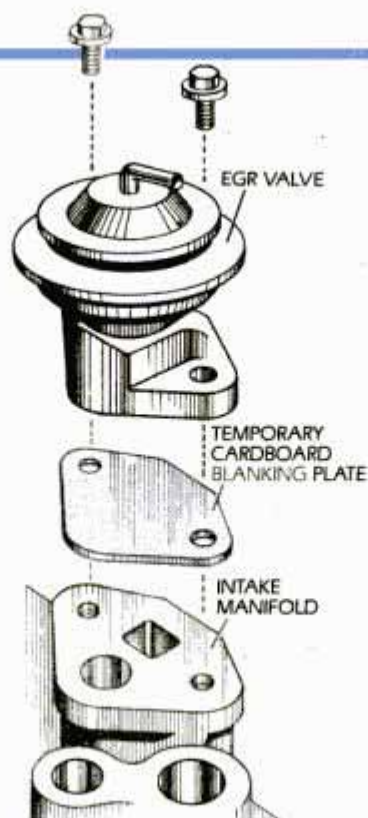
Compare your pressure reading to the manufacturer's specification. Many fuel-injection systems are of the high-pressure variety and should produce 35 to 45 psi. GM specifies more than 40 psi for most of its port-injection systems. Low-pressure systems, such as the GM TBI units, should produce at least 9 psi.

Ford recommends that the fuel pressure measurement be augmented by a check of pump capacity. This is accomplished by disconnecting the fuel return line at the fuel rail and replacing it with a hose. The hose is then inserted in a calibrated container of at least 1-quart capacity and fuel is allowed to flow for 10 seconds. Don't attempt this test without checking specific instructions in your factory service manual. You'll find them in the fuel pump section, group 24 to 35 in most Ford manuals.

To check fuel system pressure on Chrysler products, you must first relieve pressure. To do so, loosen the gas cap and remove the wiring harness connector from any injector. Then ground one injector terminal with a jumper wire and connect another jumper between the second terminal and the battery positive post. After 10 seconds, remove both jumper wires. Measure pressure on multipoint systems at the gauge point on the fuel rail. On TBI systems remove the fuel intake hose from the throttle body and attach the pressure gauge between the fuel filter hose and throttle body.

On both Chrysler systems, you can start the engine to take a pressure reading. TBI systems should provide 34 to 38 pounds pressure, multipoint systems should provide 52 to 55 psi. If pressure of any fuel-injection system is not up to spec, replace the inline filter and recheck. But before doing this or any other parts replacement work on a fuel-injection system, be certain to relieve system pressure following the specific directions for your car as outlined in your service manual. On Chryslers you can relieve fuel pressure as described above.

If fuel pressure is not up to spec af-



4 Replace EGR valve gasket with cardboard shim temporarily to check valve.

ter replacing the filter, block the fuel return line by squeezing off the flexible hose section. Disconnect the injector on GM TBI units. Then check fuel pressure as before and note reading. If it is not up to spec, either the electric pump, the coupling hose (where applicable) or the pump inlet filter is defective. If pressure is now okay, the problem is the fuel-pressure regulator (the fuel meter cover on GM TBI units) or there is a restriction in the line between the pump and gauge.

Engine chuggles, sputters and dies

This condition is typified by a rough blubbering. It is usually at its worst when the engine is idling or at low

speeds and begins to clear up as the throttle is opened fully. The engine may belch black smoke out of the tailpipe, and you will probably smell gasoline. Eventually the engine will die at idle or low throttle. All these symptoms are the result of too much fuel being delivered to the cylinders.

On carbureted engines an overly rich condition is most often the result of a faulty carb float system. Either the float has a leak and sinks to the bottom of the float bowl or the float needle doesn't seal against the needle seat (Fig. 3). To check for a leaking float, remove the carb air horn—the top part—and shake the float to see if it's full of gas. If so, it must be replaced. If it's not a brass float, it may be saturated with fuel. This is also grounds for replacement.

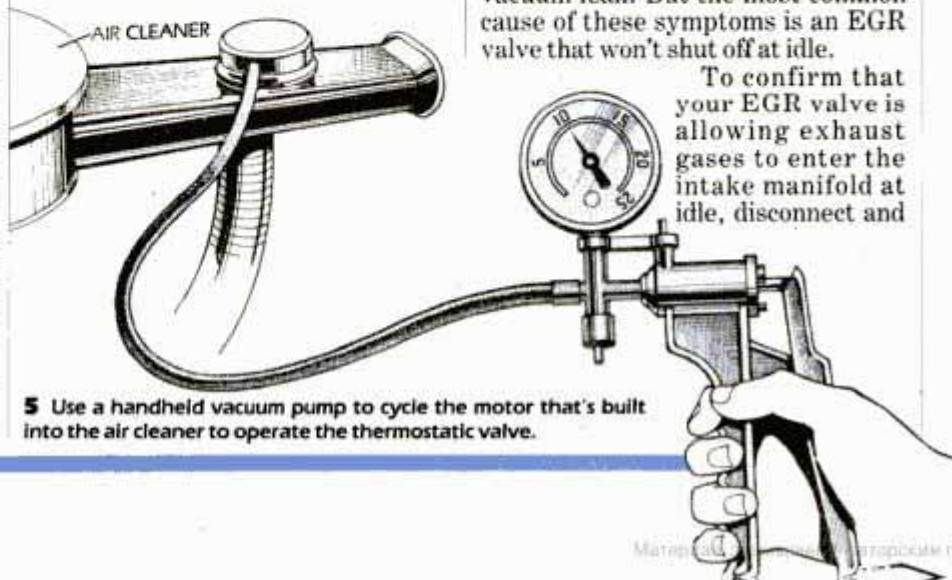
If the float is okay, examine the float needle and seat. Any visible wear is reason for replacement.

On computer-controlled carbureted and fuel-injected engines, the condition will probably set a trouble code. In addition, the control system will compensate for the condition so the symptoms will not be as severe as on a nonelectronic system and will probably not cause stalling but will cause poor economy and ragged operation.

Engine runs rough, stalls at idle

This type of exaggerated misfire condition may seem similar to the overly rich engine described above, but it differs in that there will be no black smoke emissions and no smell of gasoline. In addition, the symptoms are more typified by roughness at idle rather than blubbering. Stalling occurs at idle or just as the throttle is opened slightly from the idle position. These symptoms can be caused by anything that makes the engine extremely lean, such as a substantial vacuum leak. But the most common cause of these symptoms is an EGR valve that won't shut off at idle.

To confirm that your EGR valve is allowing exhaust gases to enter the intake manifold at idle, disconnect and



5 Use a handheld vacuum pump to cycle the motor that's built into the air cleaner to operate the thermostatic valve.

plug its vacuum hose while the engine is idling. If this eliminates the misfire and solves the problem, there is a defect in the EGR control system, possibly a misrouting of a vacuum hose or a bad vacuum switch.

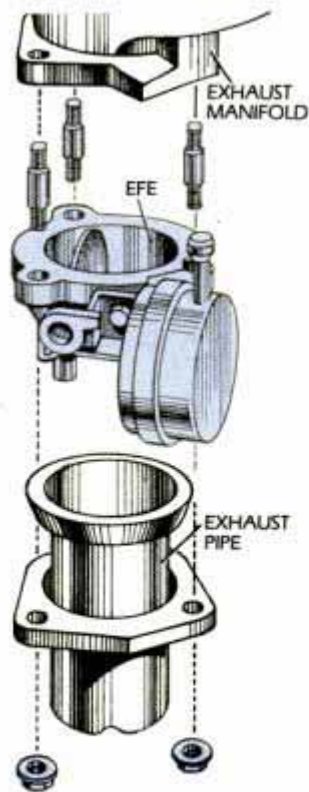
If disconnecting the vacuum hose doesn't smooth the idle, shut the engine off, remove the EGR valve, cut a piece of cardboard that will fit between the valve and the engine to block off its exhaust port and outlet port, and reinstall the valve with the cardboard in place (Fig. 4). If this cures the problem, remove the valve and the cardboard and replace the valve. (If you merely leave the cardboard in place, you'll have other problems, including spark knock that could ruin your engine.)

Engine stalls when cold

An engine that dies repeatedly when cold is suffering from an overly lean cold-start fuel mix, a slow idle or a lack of warmup assistance.

Begin by checking for vacuum hose leaks, then make sure the hot-air tube is connected to the air cleaner of cars that are equipped with a hot-air system. Make sure that the air cleaner is tight and that the air cleaner/carb gasket is in place.

Check hot-air system operation by



6 Early Fuel Evaporation (EFE) valve routes hot exhaust gases through intake manifold.

watching the damper door in the air cleaner as the cold engine is started. It should swing closed and block off outside air. If it doesn't, apply at least 7-in. vacuum to the door's vacuum motor and see if the door closes (Fig. 5). If it still won't close, the vacuum motor is bad or the door is stuck. If it closes, trap vacuum by kinking the hose and see if it will remain closed. If it doesn't, the vacuum motor diaphragm is bad and the motor assembly should be replaced. If the motor checks out okay, the temperature sensor that supplies vacuum during warmup is bad.

On most carbureted engines and some fuel-injected ones, warmup driveability is enhanced by an Early Fuel Evaporation (EFE) system. This system is either a mechanical one that delivers heated exhaust to the intake manifold or an electric one that provides heat under the carb by means of an electric grid.

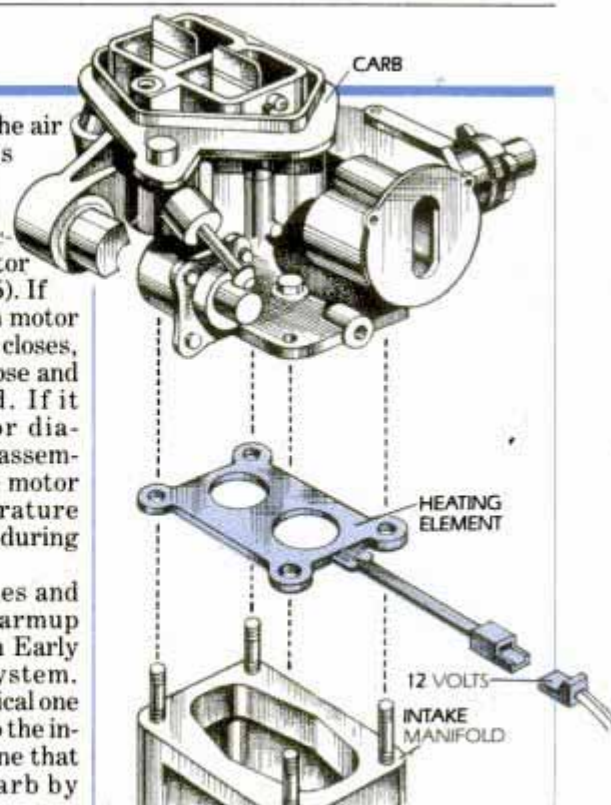
Mechanical systems depend on a valve in the exhaust stream to close and divert exhaust flow to the intake manifold passage. The valve may stick due to corrosion and must be lubricated as part of your maintenance procedure.

In most cases the valve is vacuum actuated. The control vacuum is switched on by a temperature sensor. If you find that the valve won't close, check for vacuum at the supply hose. If it's present and the valve is not frozen in place, replace the vacuum actuator and valve assembly (Fig. 6). If vacuum is not present, replace the temperature sensor and/or check the vacuum hose for serious leakage or obstruction.

On electric systems, check for voltage between each side of the heater switch and a good engine ground when the engine is cold and the ignition is on. You'll find the heater switch somewhere in a coolant passage and connected to the electric grid with a wire.

If there is voltage at both sides of the heater switch, check for voltage where the heater grid connects to the harness to make sure the wiring is okay. On systems with a ground wire, check for voltage across the two terminal connectors.

If there is voltage between the connector and a good engine ground but not between both sides of the connector, the ground wire is bad. If voltage is present across the connector, the grid is probably bad (Fig. 7).



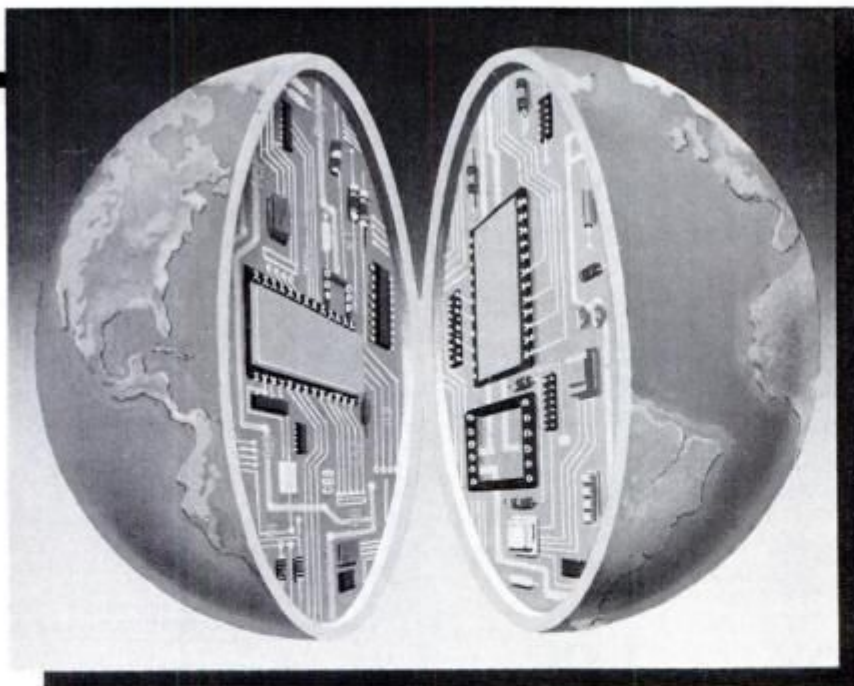
7 Some manufacturers use electrically heated grid to warm fuel in cold engines.

Random and intermittent stalling

Usually there are no symptoms other than the very annoying tendency of the engine to suddenly die. This condition is almost always due to an electronic failure, but because it usually cures itself soon after it happens, it is difficult to diagnose. If you're lucky, it will set a failure code in the engine computer system of late-model cars, giving you a head start on tracking it down. For example, if it sets a no distributor reference signal code, the problem might be in the distributor pickup coil or Hall-effect sensor, depending on which your engine has.

In general, the troubleshooting charts for the various codes won't help you locate the specific source of an intermittent because it may not be present while you're performing the diagnostic routines. Sometimes you might have to make an educated guess, replace a part and hope for the best. The parts counterman at your dealership might be able to tell you what the most likely cause of a specific intermittent trouble code is.

Sometimes you may find that intermittent failures occur more often when temperatures are high. In some cases, these are caused by faulty electronic ignition modules. If, for example, the module of a GM HEI distributor was installed without proper application of insulating silicone lubricant, it may fail intermittently. **PM**



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SOUTH TO THE POLE

(Continued from page 79)

tions and other anomalies.

"We call these oscillations 'harmonics.' What it really means is that the Sun wiggles like a bowl of Jell-O. We use the camera to measure the Sun's rate of expansion and contraction at various specific regions."

There is only one place where Pomerantz and his colleagues can accumulate sufficient data in these highly complex fields—the South Pole.

"The first time I came down here I saw so many fabulous things. Foremost, the Sun goes around and around in the sky without the day/night cycle. I can't tell you how important that is. We really need to get an uninterrupted stream of data for periods lasting up to 10 days.

"We're also at an extremely high altitude which means reduced atmospheric pressure and water vapor content. All of these conditions promote quality astronomy."

Next season, Pomerantz will continue his long-term polar studies by trying to detect background radiation in the Cosmos, searching for the beginnings of our Universe.

Predicting the next Ice Age

Unlike Martin Pomerantz's interstellar contemplations, George Denton's work on Antarctica is very much down to Earth. The tall, thoughtful scientist from the University of Maine collects rock samples in the Dry Valleys, about 70 miles west of McMurdo Station. Experiencing negligible precipitation each year, the Dry Valleys are Antarctica's desert. Lava fields and volcanic debris cover the rocky highlands instead of snow and ice, offering one of the few glimpses of Antarctica's geologic and fossil history.

Denton and his band of paleomagnetists, vulcanologists, surveyors and rockhounds use laser theodolites and other tools to map the area and retrieve samples. I caught up with them at their camp in Taylor Valley positioned atop a 2.8-million-year-old congealed lava sheet—their double-walled Scott tents quivering in the rotor wash from our chopper.

The issue, Denton says, involves finding the cause of a global climatic change that occurred 2.5 million years ago. This prehistoric cataclysm sparked the 100,000-year cycle of ice ages—the last one in North America was called the Wisconsin—that have visited Earth's surface. And will one day return.

The genesis of this great climatic event—and predicting if it will ever recur—is what interests Denton.

"We know that something dramatic

happened back then. It has only been in the past four or five years that we've realized when this cycle of ice ages began. So there are really two problems. The first is why they began. The second is what causes the 100,000-year oscillations within them. And what effect will humans—as masters of climate—have?"

There is speculation that atmospheric pollution may have already contributed to global warming—with damaging consequences for the south polar icecap. Denton and other scientists who work in this area of the Royal Society Range have noted over the past decade a diminishing thickness of the ice that covers the glacier-fed lakes in the Dry Valleys, with an attendant rise in lake levels. The phenomenon is another indication that Antarctica is warming.

"We're looking for evidence of that time 2.5 million years ago that will give us a clue of what we can expect. Our work involves the character of glacial sediments—and evidence of climatic change that we've traced right to the tops of the Transantarctic peaks."

Interplanetary Impact

Farther down Taylor Valley, George Simmons from Virginia Polytechnic Institute and his band of divers are searching for the last known naturally existing organisms in the Earth's biosphere before the lifeless icecap. They have turned up an astonishing assortment of lifeforms at the bottom of Lake Hoare at the foot of Canada Glacier—cyanobacteria, or blue-green algae, heterotrophic bacteria, diatoms, protozoans, all conjoined in a microbial mat on the lake bottom.

As Bob Wharton, a scientist and diver with the Desert Research Institute in Reno, explains, "The lake is supersaturated with gases because the ice doesn't permit the gas to escape. We're interested in the kind of life that can exist in this toxic environment, but more importantly, we're finding that the organisms that exist here are the modern analog of the oldest fossils, called stromatolites."

This knowledge could lead to the discovery of life on Mars. Wharton's colleague, Rocco Mancinelli of NASA's Ames Research Center, explains that data from Martian probes Viking and Mariner suggest that the surface of Earth and Mars were very similar 3½ billion years ago, when stromatolites existed. Since then, the Martian atmosphere escaped. But it is indeed possible that stromatolites also existed on Mars during this period, and if so, Wharton and Mancinelli argue, why couldn't the organisms found in the lakes of the Dry Val-

leys—the stromatolites' distant cousins—also exist on Mars in this day and age?

Wharton and Mancinelli hope their work beneath Lake Hoare will help them understand how to design experiments for future Martian probes.

"If life evolved there," Wharton says, "it is probably tied up in the Martian lake sediments." They hope their research will convince NASA planners to one day send spacecraft to Valles Marineris, a Martian canyon containing evidence of liquid water sediments, hints of past biological activity on our planetary neighbor.

Life of a different sort

While Wharton and Mancinelli ponder the scheme of things on Mars, Gerald Kooyman of Scripps's Institute builds our knowledge of marine life closer to home. Kooyman has traveled to Antarctica over the past 20 years, developing new insight into the physiology of seals and penguins.

I traveled by tracked vehicle out to Kooyman's lab, located 6 miles from McMurdo on the sea ice. He and his associate Michael Castellini had just welcomed "Max," an obliging Weddell Seal, back from a long dive, and were anxious to retrieve their tiny computer from his back.

"We found Max at a colony near the ice edge and brought him here to help us. We've drilled only one hole within a few miles, so we know he'll come back after he has collected our data," Kooyman says. "We'll take him home when we're finished. Essentially, this is an entirely new project. We're learning more and more about blood-flow control in these animals."

The knowledge may have an effect on the human species one day when we're forced to adapt to a changed and changing world.

Seals like Max can hold their breath for up to 40 minutes on a routine dive, says Kooyman, and the record is 73 minutes. Scientists once thought that Weddell seals could only dive to 400 meters. Now they know that 600 meters is not out of the question for a seal with incentive.

"Seals like Max have shown us that their lungs can collapse and there can be very little gas exchange during these record dives. We've found out that their hemoglobin stores—where the blood keeps oxygen—are much greater, and they have a greater ability to extract oxygen from blood."

With brothers Ed and Paul Ponganis, Kooyman has transformed the science of collecting data by designing light unobtrusive devices that average-size seals and penguins can wear as they swim under McMurdo's sea

(Please turn to page 150)

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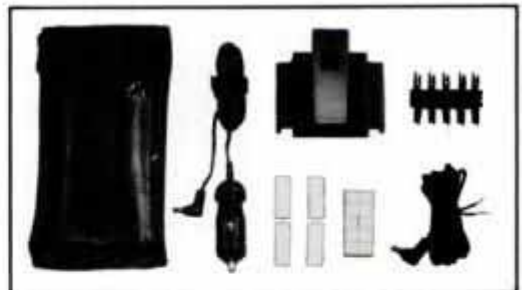
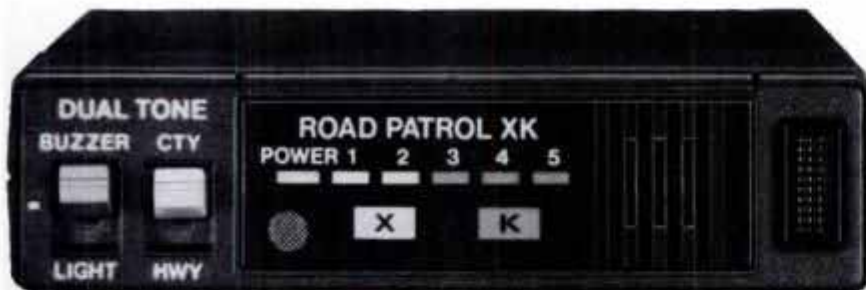
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I knew TUFOIL was a superior product. After all, I've been working on the problems of dispersing Teflon or Fluon-like colloids in oil since the early 1970's and getting patents all over the world. But here was confirmation from on high!

My reaction was, "Wow! TUFOIL's slipperier than Teflon!"

Their test data showed a steel on steel 4-ball surface friction of .029 with remarkably low wear. I rushed to my library, grabbed a lubricant handbook to see if my memory was correct. Sure enough! Teflon was listed at .04.

TUFOIL is not just a little slipperier than Teflon. It's a lot slipperier than Teflon. There was the handbook data right in front of me!

People ask, "Why don't the oil companies use or recommend TUFOIL?" It's simple. The big oil companies' profit comes from gasoline, not lubricants. The auto companies' comes from car sales. Just think. Some of our test cars are pushing 200,000 miles. If Detroit recommended TUFOIL, they might cut their sales in half... not likely! Some of our customers' cars are well over 200,000 miles, with their engines purring like kittens.

Historically, the most important inventions have been made by independent inventors working alone. They do not and have not come from large well financed research labs or institutions. The best creative inventors have always chafed under the restraints of bureaucracy.

So it's up to you to decide for yourself, just as tens of thousands of our customers already have!

Customers send us letters raving about improved starting, smoother operation, spectacular acceleration, gas savings and much longer trouble-free engine life.

TUFOIL has been written up in prestigious scientific journals, newspapers such as the Wall Street Journal, Boston

Globe, New York Times and Christian Science Monitor and tested in Universities and laboratories all over the world. The results are overwhelming! As far as we can see, TUFOIL has the lowest friction and wear of any known lubricant. We're making history!

For the last few years, we've been running full page award-winning ads in NASA Tech Briefs. In them, we call TUFOIL, "The Transistor of Lubrication." Our competitors are way back in the vacuum tube era with products primitive by comparison.

We're occasionally asked about lubricants that claim to be one-time engine treatments. The answer is simple! There is no record in the scientific literature that we've seen so far, that a one-time treatment by any lubricant will last the life of an engine. So don't believe it!

What can TUFOIL mean to you, your car or your machine? Big savings, that's what! So rush your order now and get those marvelous benefits.

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- Protects your engine for longer life

Here's what some of our customers say. This customer wrote a beautiful 4-page letter raving about gas savings, easy starts. He went on...

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... R. W., Yarmouth Port, Ma.

This customer got fantastic fuel savings...

"The use of TUFOIL in my autos has been so successful that I purchased a gallon of TUFOIL and now use it in my 3 lawnmowers, garden tiller and shredder."

... D. W., Seattle, Wa.

When POPULAR MECHANICS tested TUFOIL, it reported "TUFOIL is absolutely spectacular!"



How To Use TUFOIL®

Just add one 8-oz. container of TUFOIL to your standard crankcase. (It'll treat 4 to 5 quarts of engine oil.) If you want to super treat your engine, add two bottles! You will see the results in less than 1,000 miles. Once your engine is broken in on TUFOIL, add 4 ounces (½ bottle) with each oil change to keep new performance levels. Use TUFOIL repeatedly over the life of your engine to help keep it purring like new!

TRY ONE 8 OZ. BOTTLE OF TUFOIL FOR 30 DAYS OR 1000 MILES

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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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U.S. Patent No. 4,284,518

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SOUTH TO THE POLE

(Continued from page 146)

ice. Old-generation data collection required heavy, mechanical harnesses that collected only such basic variables as dive time and depth.

Kooyman's tiny 8-bit submersible microprocessors—lightly glued to an animal's back—can measure temperatures at various depths and dive duration based on input from tiny sensors. The addition of a miniature paddlewheel gives Kooyman and his associates swimming velocity. A harmless catheter allows the team to monitor blood gases at various depths, contributing a new understanding of the animals' metabolic activity during a dive.

How does this new instrument work? As Ed Ponganis explains, "The 8048 processor has an analog to digital converter chip and a finite 8K memory. The microprocessor polls the sensors at programmable times. The memory is filled with data and we download to a PC when we retrieve the device."

After two decades, Kooyman has noted not only an improvement in data collection methods, but some significant improvements in the ability of the scientific community to live and work on The Ice.

"You can get down here a little quicker with better commercial flight service across the Pacific," he says, "and the helo flights have dramatically changed the way we work. It's just so much easier. But the biggest improvement for animal biologists working on the sea ice is in the National Science Foundation's new knack for drilling ice holes.

"It sounds simple, but I can't tell you what that means to us. They have a huge tracked vehicle with a hydraulic auger that can cut through 10 ft. of ice in an hour that used to take two days to complete." Camp gear has also improved, along with the comforts of Kooyman's tiny ski-equipped plywood shack that he hauls out to his test site by tracked vehicle. He and Castellini can live and work on station, with a gas generator powering their trusty Apple II.

These seemingly minor refinements in the way men and women have learned to operate in Antarctica have only come through NSF's many years of experience in the world's most unforgiving place. Through the decades, the irony of Antarctica has remained clear, an underlying truth that no doubt burned in the hearts of Amundsen and Scott. Understanding the future of life on Earth requires an understanding of this grand and desolate environment.

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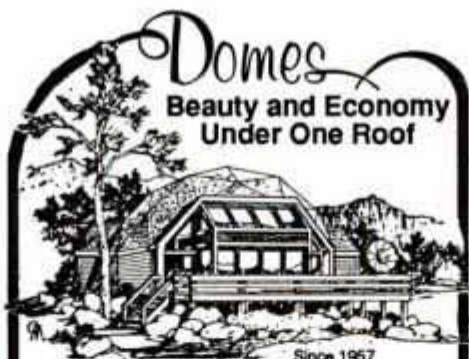
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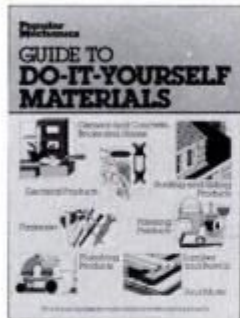


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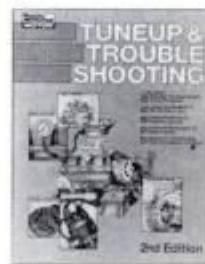
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Rather than the traditional, complicated hydraulic control system, this 3-speed transaxle uses solenoids and an electronic controller to change ratios. It should prove to be easy to repair, and be long between repairs because of the few, simple, internal parts. But we vote for programming that will let the engine rev a little higher.

The engine itself, a 2.2-liter inline ohc 4-cylinder, tends to vibrate at idle, common to large Fours without balance shafts, but smooths out considerably above idle. Engine compartment layout is clean, without the ship-in-a-bottle routine being necessary to perform most routine maintenance tasks. Partly this is because the engine sits longitudinally rather than sidesaddle, making for a larger engine compart-

ment than transverse layouts. Initial mileage in urban commuting has been 22 to 24 mpg, touching 30 on longer trips.

The seats, which nobody liked initially, are a peculiar combination of hard foam and soft springs, yielding substantially when you place your weight on them. They're upholstered with a velour that tenaciously holds dirt and dog hair forever, or until the first day you're wearing a dark suit.

Our initial impression of the Medallion changed during a drive from New York to Detroit in bad weather. We had scheduled something a little more glamorous, but plans changed at the last minute, and all that was left was the Medallion. Surprise! The long-



Calais has 4-cylinder economy, V8 power.

legged transmission was fine once onto the straight and narrow of Interstate 80. The cruise control was smooth and surge-free, a welcome change from several of the newer electronic ones we've driven of late. And after 12 hours, the editorial hindquarters felt ready for another 1000 miles or so.

Make no mistake, this is a French

(Please turn to page 160)

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

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

"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

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

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases 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.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

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

Only One Treatment Necessary

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

Works with Most Oils

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

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)

3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine

4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

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Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

For purchase or further information call toll-free 1-800-525-8624, ext. 4 (in California 1-800-233-9559) or send to: Progressive Energy Corporation, 255 South Bent Avenue, #B-1, Dept. PM488, San Marcos, California 92069.

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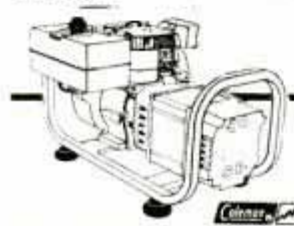
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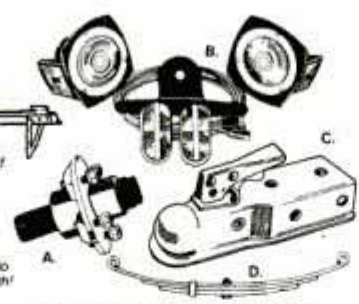
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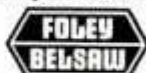
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LONG-TERM CAR TESTS

(Continued from page 154)

car. Chrysler, as you'll recall, recently acquired AMC, and will be marketing some Renault vehicles in the U.S. under the Jeep/Eagle nameplate. So, last year's Renault is this year's Eagle. It has all the bizarre French touches like the horn button in the turn signal wand along with the headlight switch, guaranteeing that you'll honk the horn every time you turn off the headlights. The suspension is typically French as well, with soft springs and plenty of travel. Roads in France near Renault's proving grounds must be nearly as bad as Manhattan's West Side Highway, because we found that the Medallion is capable of hurtling along the edge of the Big Apple without losing its composure, leaving a wake of irate, bouncing taxi drivers.

So, we've come to regard the Medallion as a pretty nice car, and find ourselves looking forward to driving to a lot of other places besides just the long-term parking lot at JFK airport.

With a base price of \$10,479, our Medallion cost \$12,847 delivered, with auto transaxle, a/c, cassette stereo, cruise control and power door locks.—*Mike Allen*

Dodge Grand Caravan

Front-wheel drive makes a lot of sense in minivans, for several reasons. The whole idea of a van is to get the most interior volume for the least exterior, and the packaging economies of fwd reinforce that. Secondly, rwd vans tend to be rather skittish over rainy or snowy roads unless they're laden, and fwd eliminates that problem as well.

Dodge's Grand Caravan is a prime example of both principles at work. Fitted out with acres of glass and seating for seven adults, there hasn't been much we haven't been able to get into the interior. That includes more than seven adults, full-sized couches, and in one instance, a Corvette motor in a crate. Removing the two rear seats is as simple as flipping a lever and sliding them forward. The front seats in our van were power adjustable about nine different ways, and remarkably comfortable and easy to get into and out of.

Because of the front-wheel drive, the overall profile is low, making for a low floor and a short step up into the interior. Fuel mileage on the turnpike was near 22 mpg, dropping to 18 or so commuting through heavy traffic. Earlier versions of the Caravan came with a 2.6-liter, inline Four, but the new 3.0-liter V6 delivers 136 hp, 40 hp more while actually improving EPA

mileage 1 mpg. There's enough torque to actually spin the tires in Drive away from a traffic light, impressive for a vehicle with fwd and a heavy front weight bias. Traction in poor weather is still ample even with a heavy load sitting next to the lift-up tailgate.

Servicing the engine will be a flat-rate mechanic's nightmare, but simple items like checking or changing the oil, or replacing a belt will be possible. Changing the plugs is another story, so be prepared to do that task by Braille.

Base price of the long-wheelbase Grand Caravan is \$12,502. Delivered with the popular equipment package, alloy wheels, auto trans and V6, rear defrost/wiper, a/c, power door locks, power windows and seats, heavy-duty suspension, tilt wheel, and optional full-sized spare, it came to \$16,813.

At \$660, the V6 motor is well worth the price, and Chrysler says you can pull a 4000-pound trailer. Grand Caravans are 14.6 in. longer than the regular Caravan, and will hold the requisite 4x8 plywood sheet when the seats are out. Regular Caravans are not only shorter, but just narrow enough to require angling the plywood over one wheelwell.

The optional heavy-duty suspension doesn't feel especially taut, making this a good choice for a vehicle to be used for daily commuting, rather than just for a work vehicle. The interior is nice enough to take a date out to dinner in, too.

So far, we like the Grand Caravan a lot. Our only complaint is the windshield washer fluid warning light blinking furiously after only about a cupful of fluid has been used. We covered it with tape as an expedient.

—*Mike Allen*

Olds Calais

Things are changing at Olds. Bland is out. Performance is in. And the difference this new climate has produced in the Cutlass Calais is remarkable.

The heart of any car's excitement quotient, of course, is its powerplant, and at Olds these days that means the new 16-valve Quad 4. Installed in the Cutlass Calais, it lends spice to a package that was once all vanilla—along with the capability of dishing out a few surprises in the light-to-light traffic game.

We were impressed with this change in the character of the Calais when we first encountered the Quad 4 last summer, and our respect for this new engine grows as our experience with it mounts. The Quad 4 Calais is capable of 0-to-60 acceleration in the 8-second bracket, and is responsive

across a broad operating range.

It also delivers good fuel economy, even when piloted by enthusiastic drivers in free-for-all traffic (that is, New York City). Over our first couple thousand miles with the car (1960.3, to be exact), we averaged 25.5 mpg.

Though we picked the car up at Olds headquarters in Lansing, Michigan, most of this mileage was accumulated in the New York metropolitan area, which makes the mpg count quite impressive.

On the open road, the Quad 4 does even better. We saw a little more than 30 mpg on the trip back from Lansing, and with this sort of average the car's fuel range is more than 350 miles.

While its power characteristics are excellent, even when compared to its many Japanese competitors, the Quad 4 has drawn some criticism for noise. So far, we're of two minds on this question. The engine's growly blend of intake and exhaust sounds will please those who appreciate music made by fine sporting machinery.

On the other hand, the combination of Quad 4 and Calais chassis sets up a peculiar resonance that can become intrusive in freeway cruising. GM is working on this idiosyncrasy with its N-car fleet (Calais, Buick Skylark, Pontiac Grand Am), and it isn't expected to be a problem in other Quad 4 applications—the '89 Cutlass Supreme, for example.

Our Calais is a member of the new Olds International Series family, which is the division's top-of-the-line sporty trim level. That means 5-speed gearbox as standard equipment, BBS-lookalike wheels with 215/60R-14 Goodyear Eagle GT+4 tires and a generally stiffer suspension setup.

It also means a moderately spiffy gray cloth interior with plenty of comfort/convenience goodies (AM/FM/cassette stereo, a/c, leather-wrapped wheel, power windows, remote but nonpower mirrors, power seat adjustments).

The bucket seats provide adequate lateral support and are reasonably comfortable in all-around use, but the Calais and its cousins from Buick and Pontiac can't be called roomy.

On the other hand, fit and finish quality in our Calais seems exceptionally good. The seams match up nicely, the wine metallic finish is satin smooth and we have yet to encounter any squeaks or rattles.

The Olds Cutlass Calais isn't what you'd call inexpensive. It bases at \$10,320, and the International Series starts at \$13,695, which includes the Quad 4 as standard equipment (it's a \$600 option on other editions). As equipped, our Calais stickers at \$14,985.—*Tony Swan*

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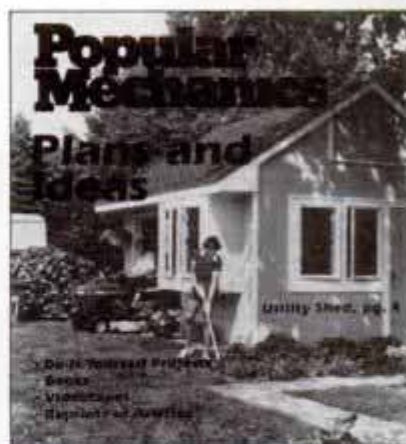
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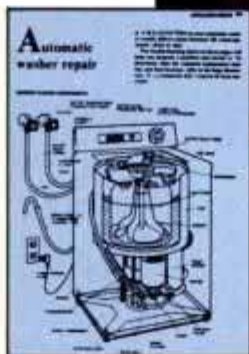
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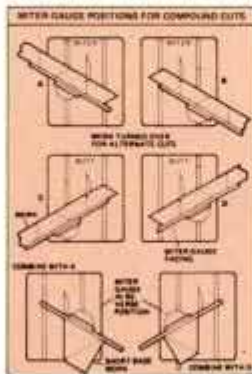
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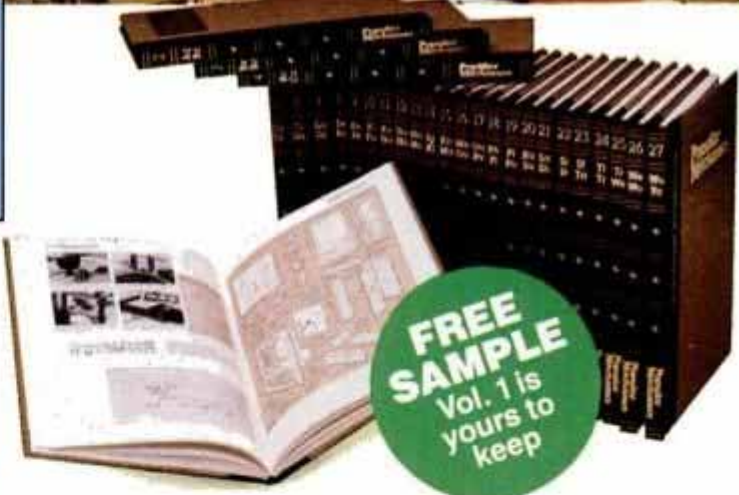
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COMING NEXT MONTH

Racer Paul Newman is at Indy this month and we see what he's up to.

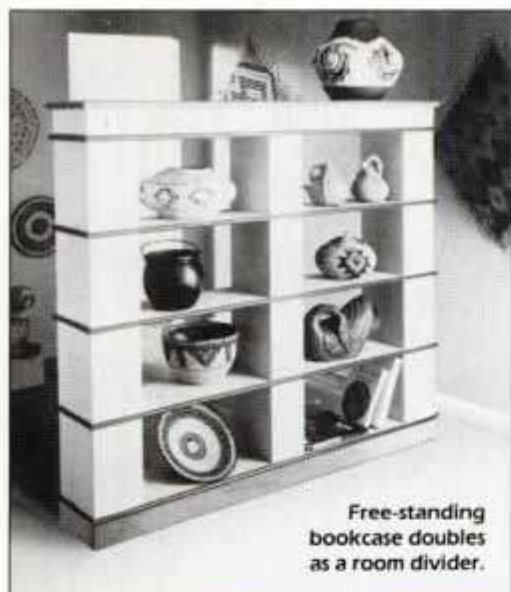


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Free-standing bookcase doubles as a room divider.



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Paul Newman: Race Driver

This consummate actor is also a leading man on the track. We take an inside look at the car he's fielding for the upcoming Indy 500.

Very Easy Bookcase

This free-standing bookcase project also serves as a room divider. And it goes together easily using just a few shop tools.

Car Care Extravaganza

It's all here—from performance tuning to suspension and wheel upgrading, to exterior and underhood add-ons for your car.

BMX Explosion

BMX bikes are the hottest things on two wheels. Here's the latest in high-tech designs and all the lingo for the equipment used.

Sneaky Tanks

These stealthy, low-silhouette pieces of light armor for the 21st century have rapid-fire guns and are easily air-lifted to battle.

Foul Ball!

We examine baseball's "dirty tricks" and reveal the scientific reasons why loaded bats, rabbit balls and other tricks really work.

**Chevy beats Ford.
And USAC tests prove it.**



THE
Heartbeat

OF AMERICA  **TODAY'S CHEVY TRUCK**

In official tests by the United States Auto Club, Chevy beat Ford. Standard half-ton to standard half-ton, both with half-ton payloads, both with the best automatic transmissions* available, the full-size Chevy pickup beat Ford.

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Let's get it together... buckle up.

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Best-backed Chevys ever. 6-year/60,000-mile powertrain warranty protection and 6 years or 100,000 miles of body rust-through protection. Solid proof of the quality built into every new full-size Chevy pickup.

*Tests conducted with Chevy C1500 equipped with standard engine and available 4-speed automatic, and Ford F-150 equipped with standard engine and available 3-speed automatic.

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Honda was first to introduce a system which allows the user to stop the mower's blades without disengaging the transmission. Other mowers now have similar systems.

Honda was first to introduce the ergonomically designed curved handle. Many other mowers now feature one.

Honda was first to introduce the easy on/easy off grass bag attachment. This feature can now be found on other mowers.

Honda was first to introduce non-binding sealed aircraft cables. Other mowers are now using them, too.

Honda was first to introduce a dependable blade brake clutch. Years later, similar systems were required by law.

Honda was first to introduce the Overhead Valve engine and shaft drive. Today, other manufacturers have similar configurations.