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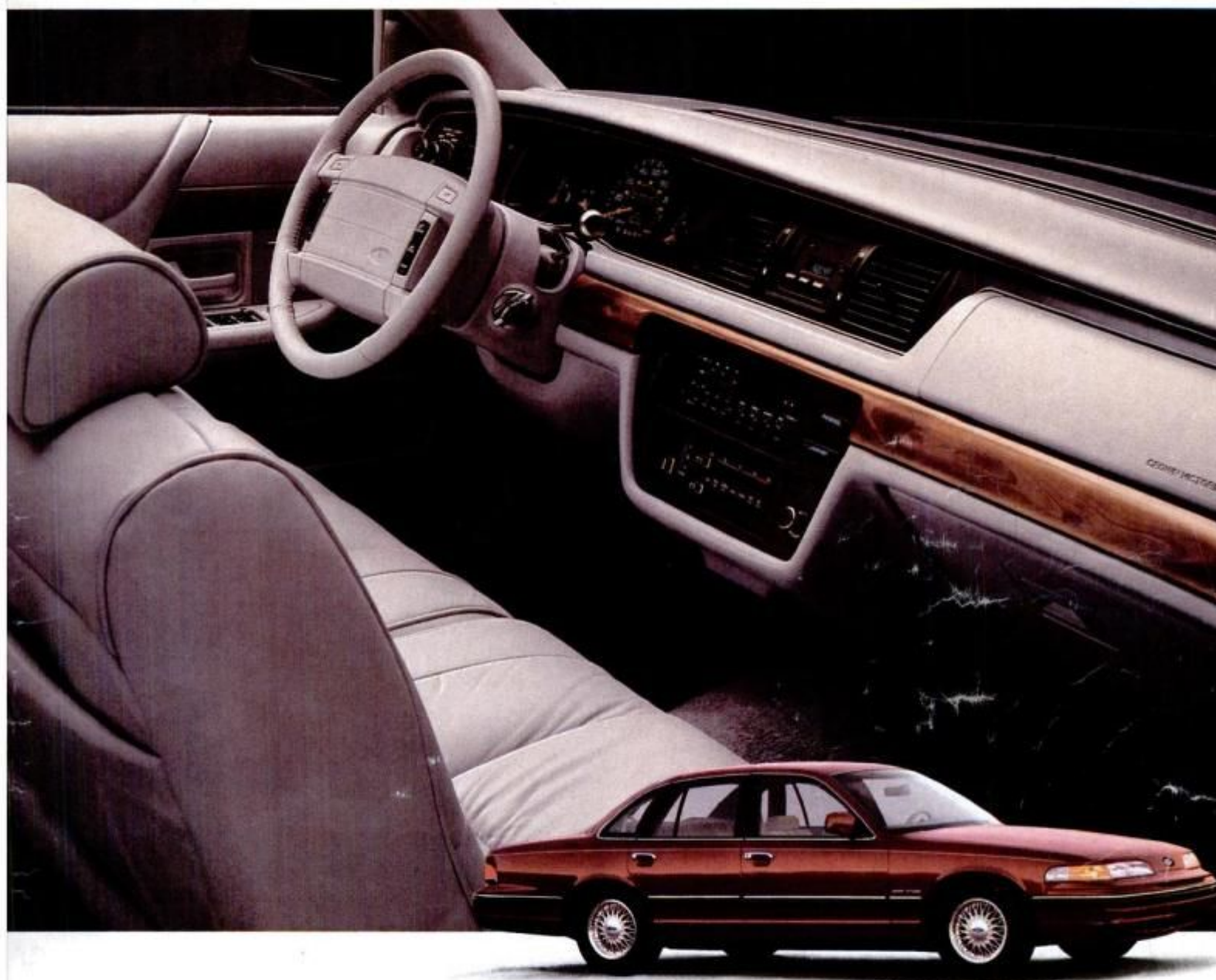
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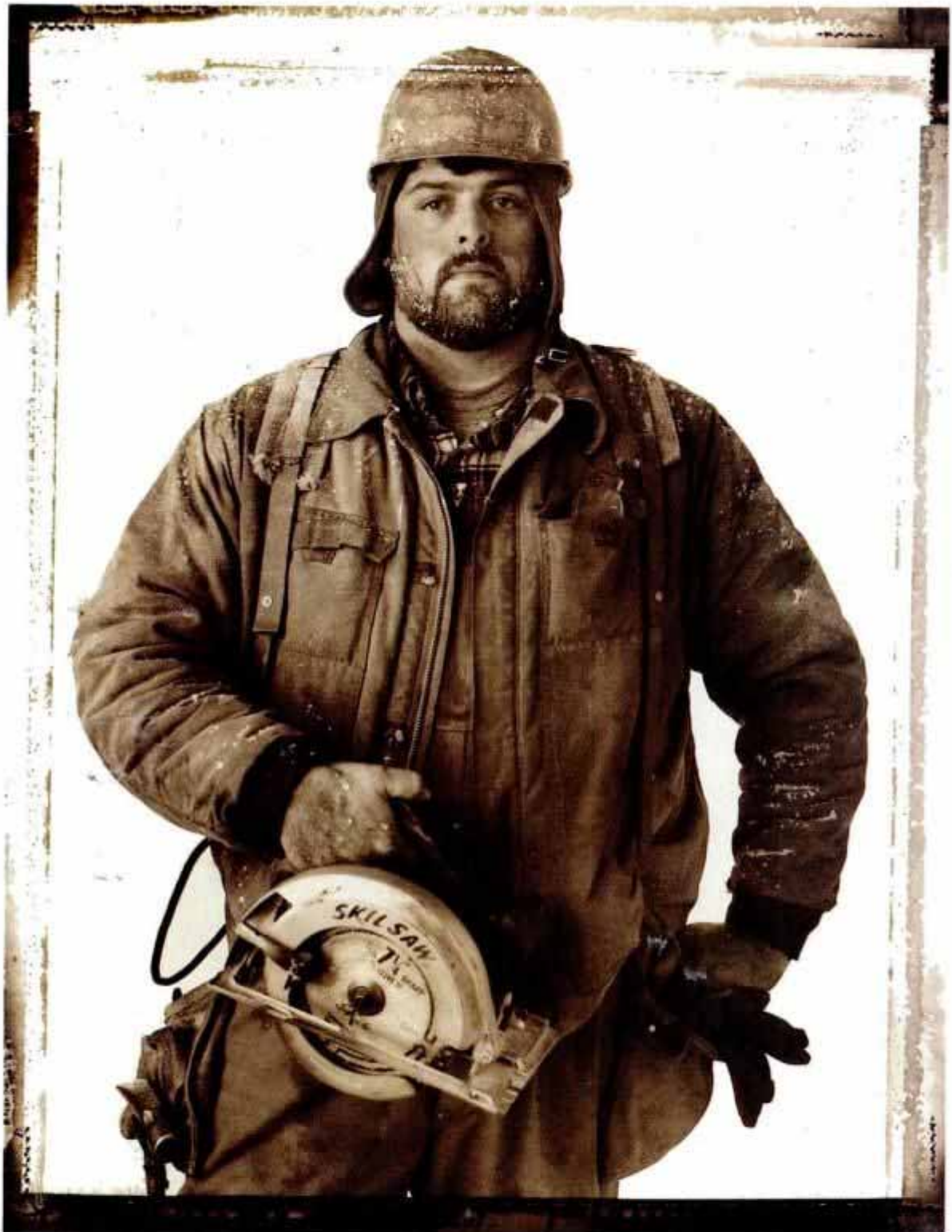
New Crown Victoria

Have you driven a Ford... lately? 



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Popular Mechanics

AUGUST 1991
VOLUME 168
NO. 8

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by Attila Hejja



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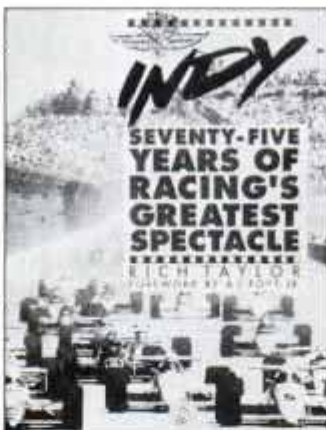


Swan and Allen plan their route.

● They said it couldn't be done. They said no one would ever break Babe Ruth's home-run record. They said no one would ever kick a field goal 63 yards. And they said we couldn't drive from San Francisco to New York for less than a hundred bucks. Well, like Henry Aaron and Tom Dempsey, we proved them wrong. Automotive Editors Tony Swan and Mike Allen drove the almost 3000 miles in under a hundred dollars—\$63.84 to be exact. We don't know what the record is, but if anyone out there has driven coast to coast for less, I'd like to know about it. . . .

The 1991 Indy 500 is over and in the books, but the definitive book on the Indy 500 has just been published. Written by POPULAR MECHANICS Contributing Editor Rich Taylor, *Indy: Seventy-Five Years Of Racing's Greatest Spectacle* (St. Martin's Press; \$39.95, cloth) is a colorful and detailed history that covers the complete story of the speedway and Indy car racing since 1911. It includes the origins of the track, developments in race car technology over the years and the inside stories of those who suffered the thrill of victory and the agony of defeat—or worse—at Indy. The foreword is by all-time great and 4-time winner A.J. Foyt. If you love the race, you'll love the book. . . . Our cover story this month, "Rebirth Of The Blimp," starting on page 30, not only chronicles recent developments in blimp technology but unveils the Navy's new-design blimp that has missile-firing capability so that the aircraft can defend itself while on station. It kind of puts an end to the blimp's image as a benign, friendly giant slowly plying the skies over football stadiums. . . .

Yes, I know it's pretty hot to be in the shop sawing, gluing, routing, sanding and painting. But if you're one of those hardy souls who is at his workbench all year round, check out our nifty oak wagon project in this month's Home & Shop Journal. . . . As you continue west on Interstate 10 a little past the exits for Banning, California, you see them. Seemingly millions of them. Windmills. Looming up from the desert floor, they stretch for miles, literally as far as you can see. For residents of the Coachella Valley, the energy future has already arrived. Managing Editor Deborah Frank's report in this issue details how a spinning propeller atop a 100-ft. tower in the middle of the desert winds up making the power that runs your TV. Till next time.



Rich Taylor's new book.


Joe Oldham

Popular Mechanics

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Editorial Offices

224 West 57 St.,
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Up until now, there was a flaw in power tape design that no one else could put their finger on. The lock button was in an awkward spot.

So we decided to use the human hand as our blueprint and design a power tape that was comfortable as well as functional. With the lock

button on top where your thumb says it should be. And a triple-riveted end hook and bumper system that's virtually indestructible.

With a design concept this intelligent, it's only a matter of time before other tapes follow Lufkin's rules.

Lufkin
CooperTools

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LETTERS

Status Report



Thanks for "The Blackbird Is Back," about the return of the magnificent SR-71 to flight status. One correction, though. We are CAE-Link, no longer Singer-Link. The U.S. military and NASA-oriented operations of Link were acquired in August 1988 by CAE Industries Ltd. Together with sister subsidiaries CAE Electronics in Canada and Germany, we are the world leader in simulation for training.

Following the success of the Blackbird, we were also selected to provide total pilot training for the F-117A Stealth Fighter and are currently developing the B-2 Stealth bomber air-crew training devices.

RICHARD G. ADAMS
BINGHAMTON, NY

Proud To Buy American

I get very tired of how people knock U.S. car manufacturers. I am the proud owner of a 1987 Oldsmobile 98 Regency with 135,200 miles. We returned last summer after an 8500-mile, 5-week trip to the Canadian Rockies and down the coast of California. I never added a drop of oil. (And never

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

have, sticking to 4000-mile oil/filter changes.) I have only replaced wiper blades and a turn indicator bulb.

Care to hear about a friend's Honda Accord where a pin fell out of the steering column at 75 miles and he almost lost control? Or that the radio didn't work at new-car pickup and could only be replaced four weeks later? Or about my daughter's Nissan 300ZX that needed two battery replacements in one-and-a-half years? Hooray for U.S. car manufacturers.

JACK HARTLEY
LAKEHURST, NJ

Never, never question the quality or performance of a Japanese automobile. Why? Because that is the justification that otherwise loyal Americans have for their purchase. Many of these people realize they have contributed to the degradation of American industry and take this defensive attitude.

When the rating organizations wake up and realize this, they will assess purchaser's opinion surveys for what they're worth. Case in point: My neighbor returned his survey with high praise while his Nissan was back at the dealer for adjustments.

JOHN T. HART
NEW HARTFORD, NY

I work hard for my money. So why should I spend it on junk? I'd rather spend it on the best I can get for my money. Right now, that means Japanese for cars.

ROY TANNER
PISCATAWAY, NJ

Lessons

I was elated to finally read a report about Compass Call in "Lessons Of The Black

Box War." I knew it was used in Desert Storm but had not seen much reporting about it—Compass Call was always a hush-hush program. Your article did a great job on it.

I was the original Compass Call program manager at HQ Tactical Air Command (TAC) U.S. Air Force at Langley AFB, Virginia, from the origination of the system's concept until the first aircraft was delivered.

We took the system from concept to operation with crew and aircraft in 42 months, a record for such a complex system. Typical timing would be more like 10 to 11 years. Compass Call was developed using basically off-the-shelf components with a judicious software controller. We were the first to use color CRT operator displays in such an aircraft, just one of our firsts.

GENE SIMMONS
USAF (RET.)
HARVEST, AL

You mentioned the F-15 fighters flying combat air patrol, but forgot the F-14 and its crews which did the same thing. To ignore this

aircraft is to ignore the young men who worked around the clock to arm the plane and keep it flying, and the pilots who flew them.

JULIA ROSS
SEQUIM, WA

I guess you missed November 1990's "America's Enforcer," a cover story on the men of the F-14. —Ed.

Garage Building

I have completed your plans for a "Garage Get-away," with some various alterations. I made the windows all the same size, replaced the dormer with a window, added a 6-ft. double door instead of an 8-ft. garage door, replaced the side door with a window, moved the stairwell to the rear, enclosed the stairwell on the ground floor, made provisions for a shower stall, commode and sink, and insulated and installed drywall upstairs and downstairs.

The downstairs will be used as a workshop and storage for yard equipment, while the upstairs will be used as an office or guest room. This project

(Please turn to page 10)



Reader Paul Moran built this multipurpose garage from PM plans.

Popular Mechanics

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ADVERTISING OFFICES

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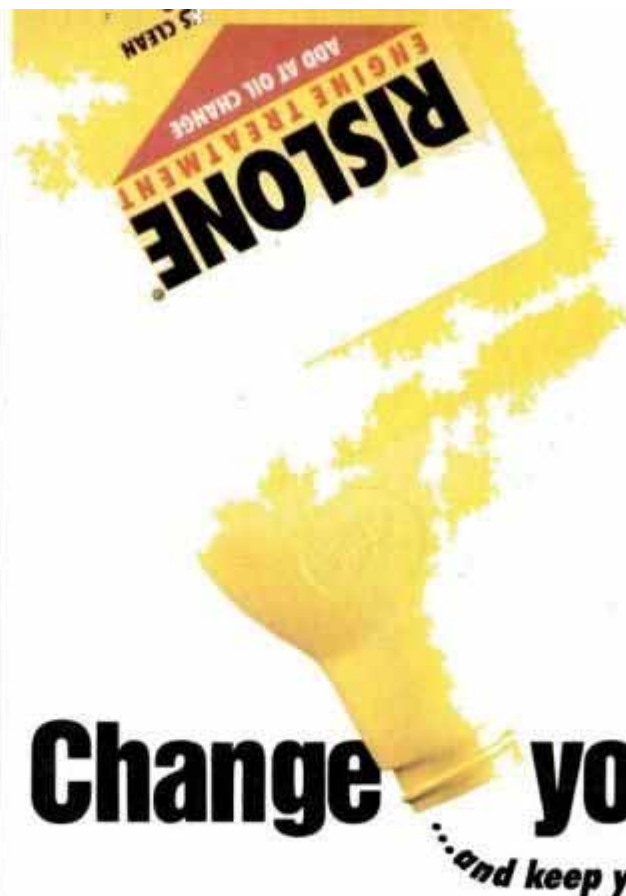
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POPULAR MECHANICS is published monthly by the Hearst Corporation, 959 Eighth Avenue, New York, NY 10019, U.S.A. Frank A. Bennack Jr., President; Randolph A. Hearst, Chairman; Gilbert C. Maurer, Executive Vice President; Victor F. Ganz, Vice President and Secretary; Edwin A. Lewis, Vice President and Treasurer; Hearst Magazines Division: D. Claeys Bahrenburg, President; K. Robert Brink, Executive Vice President; George J. Green, Executive Vice President; Mark F. Miller, Executive Vice President, General Manager; Raymond J. Petersen, Executive Vice President; Thomas J. Hughes, Vice President & Resident Controller; Robert B. Dillingham, Vice President for Popular Mechanics.



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As Seen in

PM
Popular
Mechanics

would not have gotten off the ground without the help of my neighbor, Col. Bill Britt. We started in November '89 and completed it in March of 1990. Some outside help was used on the siding, roofing and framing.

Incidentally, I had built a 10 x 14-ft. Dutch building, from PM plans, on this same spot about 20 years ago. It was moved across the street to Britt's house and placed on a concrete slab. It still looks good.

PAUL J. MORAN
NASHVILLE, TN

Road Warriors

"Road Work" concerning car phones, laptop computers and onboard fax machines for busy executives' cars was interesting. But I was put off by the use of the term road warrior to denote those to whom a car is merely a mobile office.

The real road warriors in our culture are professional drivers like myself who have to cope with these morons while they use the phone, sort pages of copy and do almost anything except pay attention to their driving.

FREDRICK J. DIEKMAN
ST. CHARLES, IL

And Then There Was Light

Thank you for having Appliance Clinic. I read a letter from someone having problems with the light switch in their refrigerator. I had the same problem and had been without light for at least 12 years until I received POPULAR MECHANICS. My husband fixed the switch, and now I have light. It is beautiful.

ELIZABETH WYATT
KENT, OH

Cordless Convenience

I was happy to see the Cobra rate so high on your comparison of cordless phones in "Range War." I love to talk while in bed, and with an antenna sticking out, it's not a pretty picture. Also, the phone company wanted \$75 to install a jack in the garage. So, I bought a Cobra Intenna. It's great in the garage or down the street.

But I was a little disappointed when I saw the price you listed. I paid \$79 for the Intenna, without the speakerphone—nowhere near the \$230 price you quoted. I hope that didn't turn off buyers looking for an excellent cordless phone with many features and capabilities.

DONALD DODSON
ORLANDO, FL

We can only quote manufacturer's suggested list price in the magazine. As each retailer is an independent

businessman, the actual selling price can be anything the retailer wants it to be.

—Ed.

A Missing Convertible

I enjoyed "Sunchasers," which featured all of the convertibles for sale in America. However, I must criticize you for omitting the American-made Avanti convertible. Priced at about \$50,000, the Avanti is hand built to order in any color the customer desires, with any color fabric, suede or leather, together with an optional factory-installed telephone and a color television. The body is formed from space-

age Kevlar and fiberglass, so it'll never get door dings and can never rust. All this, and it can be delivered right to your front door, in an enclosed trailer—just like a pizza.

And why were 20 of the 30 convertibles photographed in red? Are 67% of all ragtops sold in red? Is the average convertible buyer a member of the sheep mentality? I thought the purpose of buying a convertible was to be individualistic.

SANFORD BLOCK
BLOOMFIELD, NJ

People want to be individualistic to a point. Actually, one survey we saw

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said that the actual percentage of red convertibles sold is closer to 80%. So much for individuality. —Ed.

A Matter Of Speaking

Reader Tom Greiner's letter to PM regarding sexism and male chauvinism in "Boating '91" objects to what he perceives as PM's macho tone. What does he expect in a magazine written by and addressed primarily to men? My dictionary defines macho as "exaggerated masculinity." But one person's macho is another's masculine, meaning "having qualities appropriate to a man." I don't think that war-

rants replacing editors Oldham and Skorupa, as Greiner suggests.

And if reading PM makes Greiner so uncomfortable, he should take the advice of the doctor who told a patient upon his raising his arm and complaining of pain, "Don't do that!"

WILLIAM DOOLY
PHILADELPHIA, PA

I read with considerable interest your Tech Update article, "The Envelope, Please..." about the U.S. Air Force's upcoming decision concerning a new fighter. So it came as a surprise to see that PM has quickly coined the oxymoron of the decade, a phrase by

which all future military aircraft are to be judged: "Observers have noted that the YF-23 *appears* faster and *stealthier*, while the YF-22 is more of a high-maneuverability performer."

Now while some people would argue that this phrase exhibits a lack of editorial diligence, I strongly disagree. You see, the alternatives to "appears stealthier" seem to pale in comparison: "the YF-23 appears less apparent," or "the YF-23 is obviously less obvious." Keep up the good work.

THOMAS W. HOENS
WESTFIELD, NJ

Lost At Sea

I read "Salmon And Suzuki" and was shocked to learn the continental drift problem was much worse than I had heard. Earlier this spring, the San Juan and Orcas islands were off the northwest coast of Washington state, not Oregon as the article stated. But I was relieved to read the fishing was still as good as I remember. If I stay in my current home long enough, I may end up with a beachfront home in San Diego.

BOB KEMPER
MARYSVILLE, WA

Home Advice

There were many exceptionally useful ideas in "65 Great Ways To Improve Your Home." However, there is a good possibility that readers will be misled by one of the suggestions. Item No. 31 recommends replacing nongrounded receptacles in older homes with grounded (3-pronged) receptacles. To achieve grounding, you suggest running a pigtail from the receptacle to a clip attached to the box.

You apparently assume that all wiring in older homes was done with greenfield tubing. Nothing could be further from the truth. Many homes prior to the separate ground wire requirement of the National Electric Code were wired with nonmetallic sheathed cable. Connecting a ground wire from the receptacle to the box in these older installations accomplishes nothing other than giving the homeowner a false sense of security.

Some homes in this early period were wired with BX cable (now prohibited), which looks similar to greenfield tubing. However, the metallic sheathing of BX does not provide a reliable, low-resistance ground return. The practice recommended in the article should only be followed if the homeowner can validate that the box is reliably grounded by using an ohmmeter.

JAMES E. LAPORTE, PH.D.
VIRGINIA TECH

Pleasure.

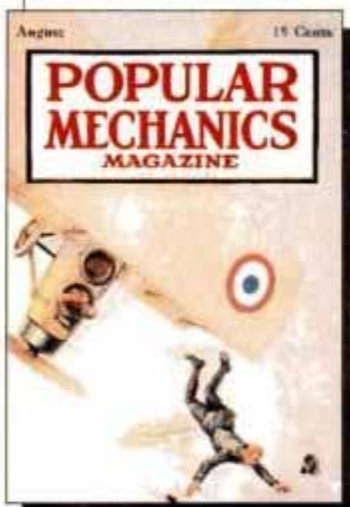


Even shopping for a Moen Touch Control faucet is a pleasure, because you'll find so many affordable styles. In fact, the only difficult part of the process will be selecting the Touch Control faucet you like best. Who knows—you may have to buy more than one (we like to encourage that sort of thing). For information about Touch Control and the complete line of Moen faucets, see your local home improvement store, or call 1-800-347-6636.

 **MOEN**

TIME MACHINE

75 YEARS AGO: AUGUST 1916



Loop De Lore

World War I airmen began the honored tradition of spinning yarns that defied plausibility. Case in point: the French flyer who claimed he had been hijacked after a fog grounded him inside an enemy camp. A German officer forced him at gunpoint to fly a scout mission over French lines, with the officer in the observer's seat. But, noticing that the German had not strapped himself in, the pilot wheeled the plane into a sudden loop, hurtling his kidnapper earthward.



Horse In Buggy

Cars and trucks were invented to put horses out of business, not carry them around. But in some cases, the horses had the last laugh. In Boston, a motor vehicle regularly

gave horses a lift, carting ailing beasts to and from the Angell Memorial Hospital For Animals. The ambulance trailer featured harnesses to keep the animals still and curtains to shield them from rain and cold air.

50 YEARS AGO: AUGUST 1941



Rockin' Wings

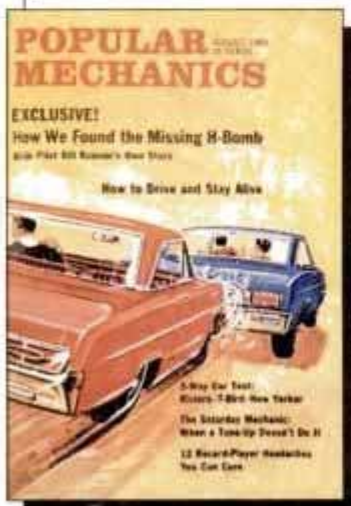
Instead of fiddling with flaps on an aircraft wing, why not have the entire wing move? A Dayton, Ohio, inventor designed a plane with wings that shifted their angle of attack by as much as 9°. They rocked on cantilevered arms that jutted from the fuselage. Working in unison, the wings would bite into the air to slow the plane during a landing. In opposition, they could throw the plane into a bank. But the idea didn't exactly rock the foundations of the airplane industry.

Deep Freight

Britain couldn't build ships fast enough to replace the tonnage that U-boats were sinking. According to American submarine pioneer Simon Lake, only a sub can counter a sub. Lake suggested that 13,000-ton wheeled underwater cargo carriers could creep beneath the Germans. The Germans themselves, he pointed out, had used the *Deutschland* as a freighter during World War I, sneaking cargo in and out of Baltimore under the nose of the British Navy.



25 YEARS AGO: AUGUST 1966



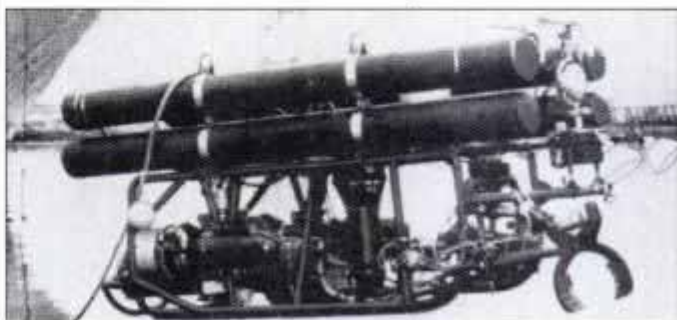
Safe At Any Speed

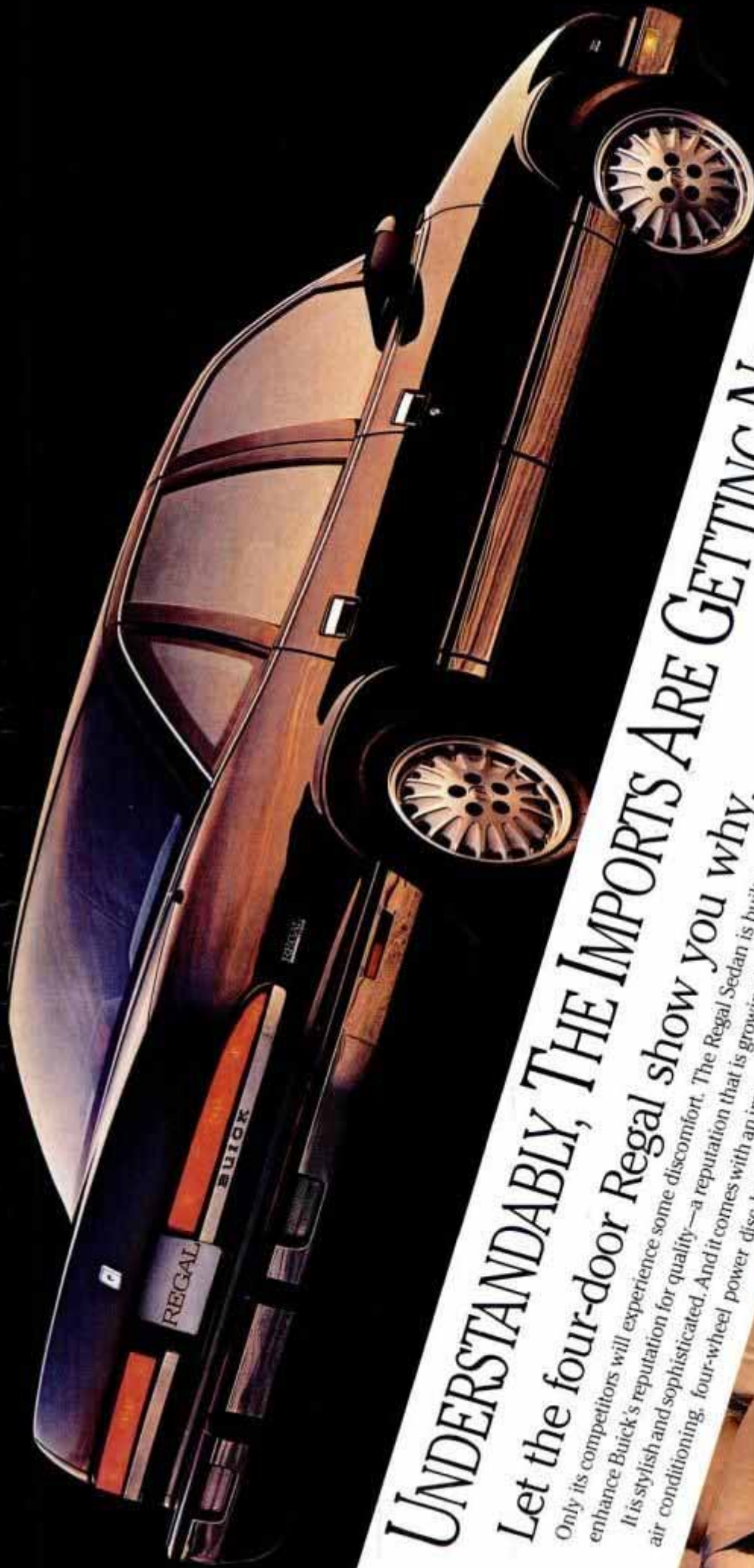
The new 65-mph interstates were slicing through the landscape, and big-block engines roared into popularity. Not surprisingly, nasty traffic statistics were piling up. To pick up high-speed driving tips, we zipped back and forth on the New York Thruway with veteran state troopers. These road warriors detailed the uncanny phenomena of the freeways, like "memory," in which drivers slow to a crawl past the site of a wreck even after the accident is cleared.

Hold Your Breath

Nothing's more embarrassing than losing a 20-megaton H-bomb in 3000 ft. of water. But that's what happened when a B-52 crashed off the

coast of Spain. Finding it was the first real mission for the deep-diving *Alvin*, but it took the Navy's original CURV robot to haul up the weapon. **PM**





UNDERSTANDABLY, THE IMPORTS ARE GETTING NERVOUS.

Let the four-door Regal show you why.

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TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DIMARE

Endothermic-Fueled Jet Could Break Mach 5

HAMPTON, VA—The Navy wants to fly hypersonic jets as much as anyone. But aircraft carriers have no room to store cryogenic fuels. Without these supercold liquids to chill leading edges and engines, a plane won't last long above Mach 4.

The solution: an aircraft designed by NASA's Langley Research Center that's based on a new technique using a separate coolant called Syltherm. What cools down the coolant is the fuel itself, known as methyleyclohexane (MCH).

Liquid MCH first flows through a preheater, where it's vaporized by warm Syltherm returning from the plane's hot spots. The gas

then passes into a heat exchanger/reactor. There, a catalyst sparks an endothermic reaction, which draws in heat from the Syltherm while converting MCH into hydrogen and toluene. These products head to the engines for combustion, while the now-chilled Syltherm cycles back to cool off the plane.

The cooling system calls for some tricky plumbing, including a pump fired by its own oxygen system and a compressed-nitrogen tank to buffer coolant expansion. The whole system weighs about 5 tons, or 13% of gross takeoff weight.

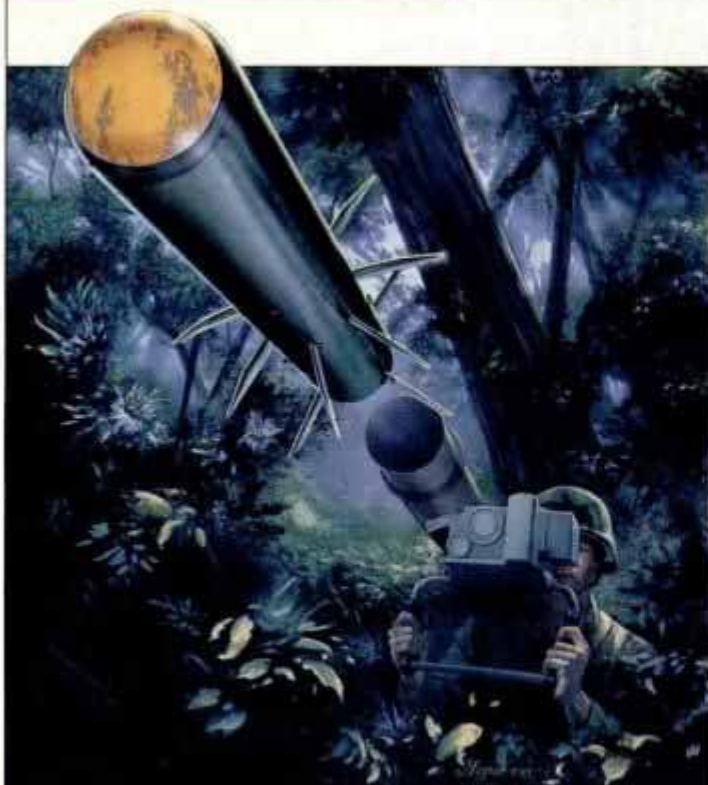
Editor: Abe Danc
Assistant Editor: Greg Pope
Contributors: Mike Dillon, Bob Scheier

Researchers at Langley and elsewhere have tested the chemistry. Flight hardware remains the next goal.

Syltherm (yellow) cools plane, then unloads heat to fuel (green). Fuel and coolant piping intertwine in reactor.

Highlights This Month

- **Easy Target**—Shoot-and-scoot tank-killer fires from soldier's shoulder.
- **Future Shock Tunnel**—Mach-24 blasts will pummel aerospace plane components.
- **Prophet Of Props**—Rutan readies his racer to snatch speed record.
- **Don't Shoot**—Infrared beacon quenches friendly fire.
- **A Swarm Of Drones**—Unmanned flyers proliferate at the Pentagon.
- **Prize Fighter**—YF-22 supercruises off with the ATF title.



Deep-Sea Hard-Rock Drill

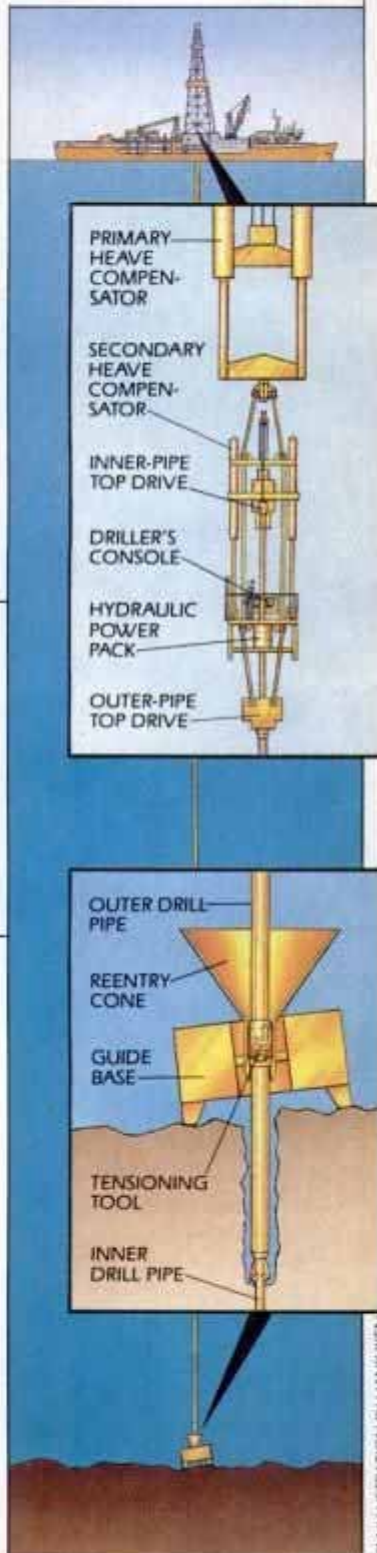
COLLEGE STATION, TX—Geologists and engineers at Texas A&M University have rigged a veteran drillship to bore into hard crystalline rocks miles below the ocean's surface.

The ship, run by the internationally funded Ocean Drilling Program, already has 12 dynamic-positioning thrusters and the world's largest heave compensator, a pair of 20-ft.-stroke shock absorbers. But the ship's drillpipe is tipped with oilfield-type rollercone bits, not suitable for brittle glassy rocks.

The solution was to suspend, inside the ship's standard drillpipe, a slimmer pipe ending in a diamond coring bit. A secondary heave compensator enables drillers to maintain a precisely controlled weight on the bit, vital for coring hard rock. The outer drill gets the hole start-

ed and locks on to a seafloor guide base, then the inner drill cores ahead.

The system will aid exploration of underwater volcanoes and areas of seafloor spreading.



High-speed diamond coring system allows coring of volcanic seafloor glasses.

Fire-And-Forget Tank Buster

LEWISVILLE, TX—For 15 years, the Dragon has been the Army's mainstay portable antitank missile, but using the weapon wracks nerves. To guide it, a soldier must sit in the open and keep the launcher aimed at the target until the missile hits.

That's why the Army's new shoulder-fired tank killer will find its way to the target while the soldier finds his way to cover.

Fire-and-forget AAWS-M pulls target from infrared sight on launch unit, then navigates with its own thermal seeker.

Designated Advanced Antitank Weapon System-Medium, or AAWS-M, the missile will have its own nose-mounted infrared seeker. The missile tube plugs into a command/launch module that transfers a thermal image of the target from its own infrared sight to the mis-

sile's thermal seeker.

Once in flight, the missile swoops down to nail the tank's vulnerable top. Its tandem-shaped charge warhead will penetrate even reactive armor, say developers Texas Instruments and Martin Marietta.

The Army currently hopes to field the weapon in 1995.

X-31 Ready To Paddle

PALMDALE, CA—This fall, the X-31 will start really living up to its title as the Enhanced Fighter Maneuverability aircraft.

A software upgrade will automate its thrust-vectoring paddles, enabling the plane to execute complete rolls at a 70° angle of attack well below stall speed,

among other hair-raising stunts. So far, test pilots have flown the two demonstrators with paddles either held electronically in a neutral setting or shifted manually.

Breaking new ground for experimental planes, the two X-31s will eventually meet in mock combat, exploring how quickly low-speed maneu-

vers at a high angle of attack can swing a fighter around at its opponent. One of the planes will have its post-stall capability disengaged during the dogfights. They will begin at the end of 1992 at the Naval Air Test Center in Patuxent, Maryland.

X-31 takes off for test flight at Rockwell plant with its three thrust-vectoring nozzles attached, but not yet activated.



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Which is why Goodyear has devoted so many years, and so many millions of miles, to the science of wet traction.

It's this unequalled knowledge that has led to the development of 185-plus mph rain tires for some of the world's fastest racing cars.

And to the development of the Goodyear Invicta family of passenger car tires.

The Invicta family is the fourth generation of Goodyear all-season radials.

And it has found favor with some of the world's toughest tire critics: the engineers who develop vehicles like the Lexus LS400,

the Audi Quattro V8, the Honda Accord and the Buick Park Avenue Ultra.

You'll find the Goodyear Invicta GS, GL or GA(L) as original equipment on all of these vehicles.

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Usually, there is a minimum of 22 different points of comparison. Including treadwear, noise, durability. And wet traction.

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F-22 Wins The Big One

MARIETTA, GA—America's next air-superiority fighter, the F-22, will begin rolling off Lockheed assembly lines in 2001.

The final version of the jet will be substantially different from the winning prototype, yielding an aircraft that is more advanced in some ways and more conventional in others. YF-22 cockpit displays had touch-screen functions. They'll be gone in favor of traditional buttons around color liquid-crystal displays. The F-22 will be the first U.S. fighter with an all-glass cockpit.

Meanwhile, tail fins and control surfaces will shrink. Aluminum and titanium will be replaced by composites

Stealth, speed and agility earned the F-22 the right to replace the F-15. Production will peak at 48 planes per year.

over 35% of the airframe. Instead of the experimental pivoting pilot's seat on the prototype, the production plane will have a standard fixed-position ejection seat. The Pratt & Whitney F119 engines, which beat out a more complex design from General Electric, will be fitted with a bigger fan to beef up thrust. The production planes will need the extra

boost because they'll still tip the scales against the Air Force's original 50,000-pound weight requirement.

This fall, a second

YF-22 prototype will begin an aggressive flight-test program that will include ground-hugging high-speed dashes and high-angle-of-attack rolls.

Under plans outlined in April, the first full-scale development version of the plane will fly in 1995, followed by 10 more flight-test aircraft. Four preproduction F-22s will then go to the Air Force for operational tests.

The program will enter the full-scale production phase in 1997 and run until 2014. Total numbers: 648, enough to fill 5½ tactical fighter wings.



Mighty Mite Antenna

ATLANTA, GA—A saucer-size antenna developed at Georgia Tech for the Air Force merges the best qualities of miniature military antennas with a wide spectrum of possibilities for commercial use.

The invention resembles a flat microstrip antenna, the efficient but narrow-bandwidth device found on the



Tiny antenna combines wide bandwidth of spiral devices with flatness and efficiency of microstrips.

skin of a missile, for example. But the Georgia Tech antenna has a spiral of conducting

material on its surface, giving it a bandwidth up to 50 times as broad as a conven-

tional microstrip. And, unlike previous spiral antennas, it can be mounted almost anywhere.

Etched from a thin sheet of copper, the antenna can be slapped on the curved surface of a car, airplane or soldier's helmet without carving out a cavity. The wide bandwidth will add new flexibility to such technologies as mobile satellite communications, Global Positioning System receivers and cellular phones.

Endeavour Rolls Out

PALMDALE, CA—Probably the last of its breed, OV-105, which is better known as *Endeavour* (see Tech Update, page 16, May '91), taxied into the sunlight last April, before riding piggyback on a brand-new 747 Shuttle Carrier to its home at Kennedy Space Center.

The ferry flight marked the first time a Shuttle has taken off from Palmdale. A huge 4-legged crane called the Orbiter Lifting Facility mated the spacecraft with the 747 right at the site. Previously, orbiters trucked 26

New Shuttle *Endeavour* drew a crowd of 2000 as it rolled out of Rockwell's Air Force Plant 42 last April.

miles through Southern California traffic to the Mate-Demate Device at Edwards Air Force Base.

After spending the summer in Kennedy's Vehicle Assembly Building, the new Shuttle will go through an

unprecedented barrage of "first flow" tests. Radiators and Ku-band antenna will deploy, payload bay doors will open and close, actuators will wiggle the main engine gimbals, and control surfaces will flap until testers—and flight crew—are satisfied.

Began in 1987 to replace the

Challenger, *Endeavour* brings the Shuttle fleet up to four orbiters. Although NASA would like a fifth bird, there's little room in its budget.

Endeavour's first mission will come in May 1992, when astronauts will reboost an errant Intelsat satellite.




(More Tech Update on page 22)

4X4

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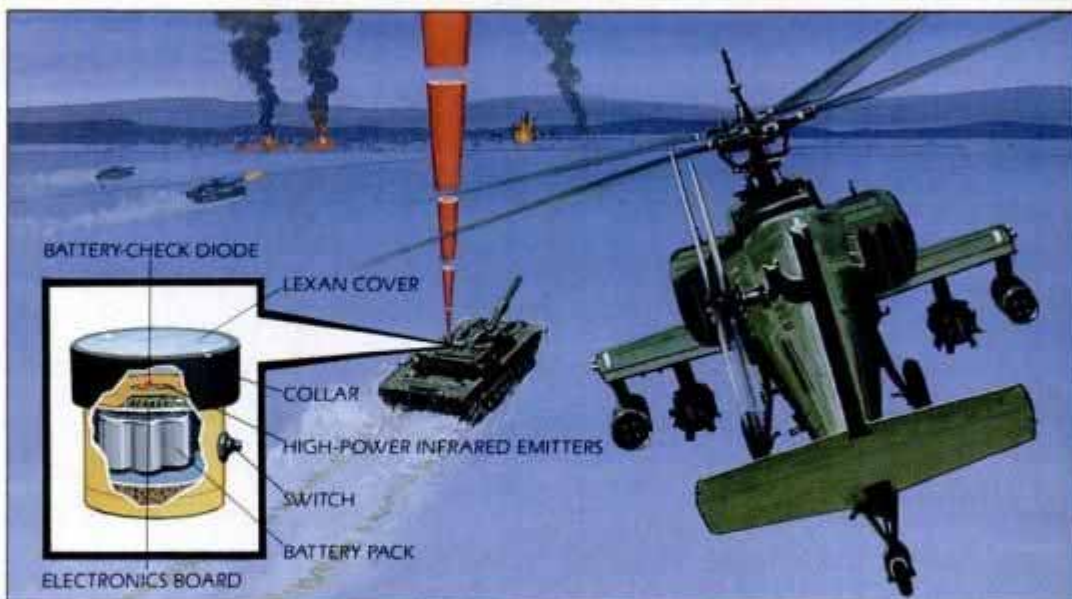
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Friendly Fire Fighter

FORT MEADE, MD—Hoping to shield American armor from American firepower during Desert Storm, the Pentagon ordered 10,000 devices that weren't even invented when the war began.

The antifratricide infrared devices, or AFIDs, came from Test Systems, Inc., a small New Hampshire electronics house that turned a technician's idea into a battlefield accessory in 21 days.

The size of a coffee can, the beacon emits an infrared pulse that can be seen through smoke and swirling sand by pilots wearing night-vision goggles. Coalition air superiority guaranteed that only friendly planes and helicopters could spot the signal.



Simple infrared beacon kept marauding Apaches from friendly armor during Desert Storm tank battles.

Since the war ended, the rest of the order has gone to the new Advanced Systems Concepts Office. There, the

Army aims to develop a beacon that flashes only in response to a coded interrogation—useful in less one-sided

scenarios. The Army Corps of Engineers is also testing the device to monitor ice flows.

PM ILLUSTRATION BY ED VALIGURSKY

Drones Buzz Back Into The Spotlight

WASHINGTON, D.C.—Having earned their keep in the Persian Gulf, unmanned aerial vehicles (UAVs) are enjoying the military's favor, and a new generation of drones is now vying for Defense Department attention.



radio-jamming aircraft in the mid-1980s. Exdrones will also help the UAV Office shape a future competition for a close-range drone.

Among potential candidates for that job is Shadow, a unique drone developed by

Cordray Research for the Air Force's Flight Dynamics Laboratory. The 6-ft.-dia. flying saucer uses a single-ducted fan to boost itself into the air, then diverts thrust rearward like a Harrier and flies as a lifting body.

The Pentagon's UAV Joint Program Office is looking over two candidates for a multiservice short-range drone, which would fly 20- to 100-mile recon and targeting missions. Israeli Aircraft Industries (IAI) has teamed with TRW to produce Hunter, a twin-engine follow-on to IAI's combat-proven Pioneer. Its rival is Skyowl, developed by McDonnell Douglas and Developmental Sciences Corp.

For work nearer the target, the UAV Office plans to acquire a fleet of Exdrones, small batwinged UAVs that did some close-range surveillance for the Marines during Desert Storm. The drones emerged from a classified program to build unmanned

From top: Hunter looks for work as short-range spy-in-the-sky; Shadow lurks as close-range VTOL drone; Exdrone fights electronic-war role.



TOP TO BOTTOM: IAI PHOTO; CORDRAY RESEARCH PHOTO; IAI PHOTO



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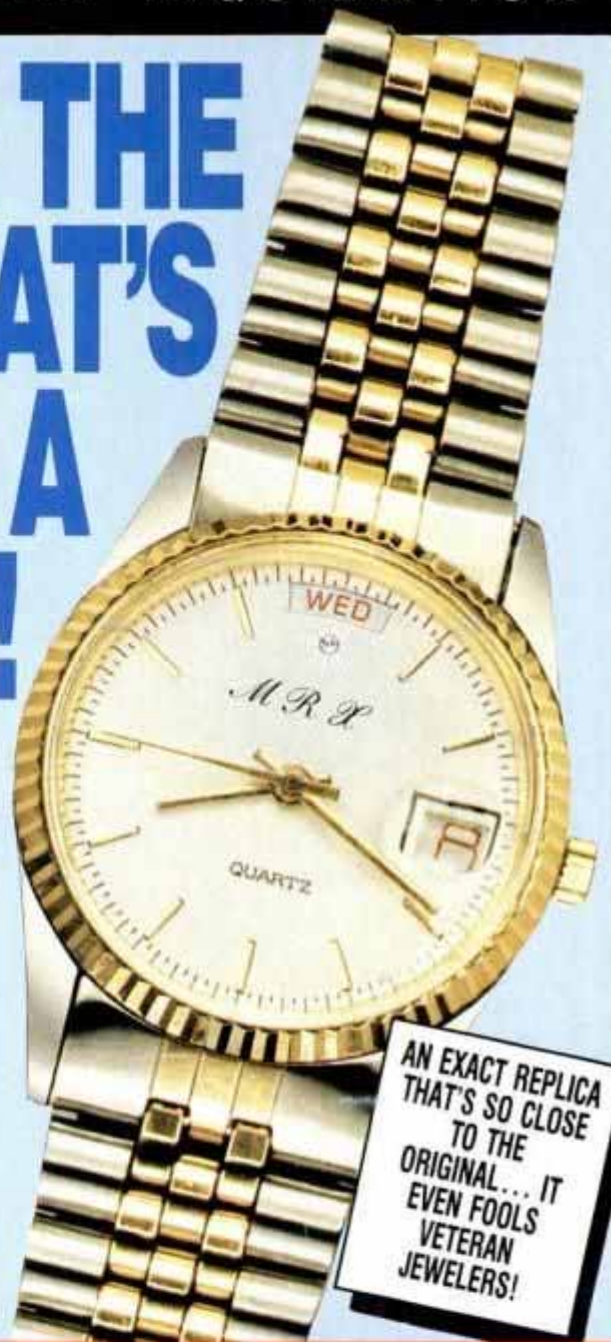
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Rutan's Pond Racer Flies

MOJAVE, CA—From the mind of Burt Rutan and the wallet of warbird collector Bob Pond comes a plane designed to break the current 528-mph speed record for piston-powered aircraft. The Pond Racer (see Tech Update, page 16, Oct. '88), flown by Dick Rutan, took to the air for its maiden flight this spring.

Pond commissioned the all-new plane to stem the conversion of historic combat aircraft for racing. Nothing could be further from a WW II fighter than the Pond Racer, with its twin engine booms, oversize "butterfly" control surfaces flanking the tail fin and its squarish pro-



pellers sculpted to handle shock waves at speeds just below Mach 1.

Rutan plans to probe the

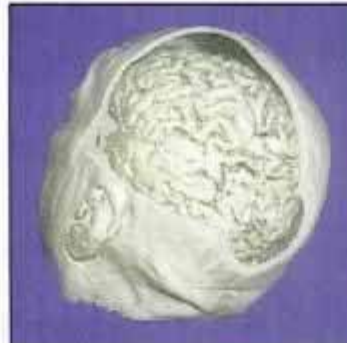
Pond Racer's flight envelope over the summer before entering the Pond Racer in the Reno Air Races this fall.

Rutan pilots from fuselage pod set behind forward-swept wing. Big rear control surface will be reduced for racing.

Brain Surgeon's Viewing Wand

BALTIMORE, MD—Until now, a brain surgeon navigated through a patient's head with X-rays viewed before an operation. But a new system gives surgeons a 3D view of the entire brain as they work.

Radiologists first chart the patient's brain with CT scans and magnetic resonance images. A computer then merges them into a 3D map of the patient's head.



Next, the surgeon touches reference points on the patient's skull with a wand mounted at the end of a 6-jointed arm. Using informa-



Surgeons use 3D image on monitor (left) to guide their efforts, wielding a viewing wand to update their position. patient's head.

Once the operation begins, surgeons probe the incision with the wand. By showing the wand's location on the computer-generated map, the system helps find the safest route through the brain and determine what tissue should be removed.

Monster Mach-24 Shock Tunnel

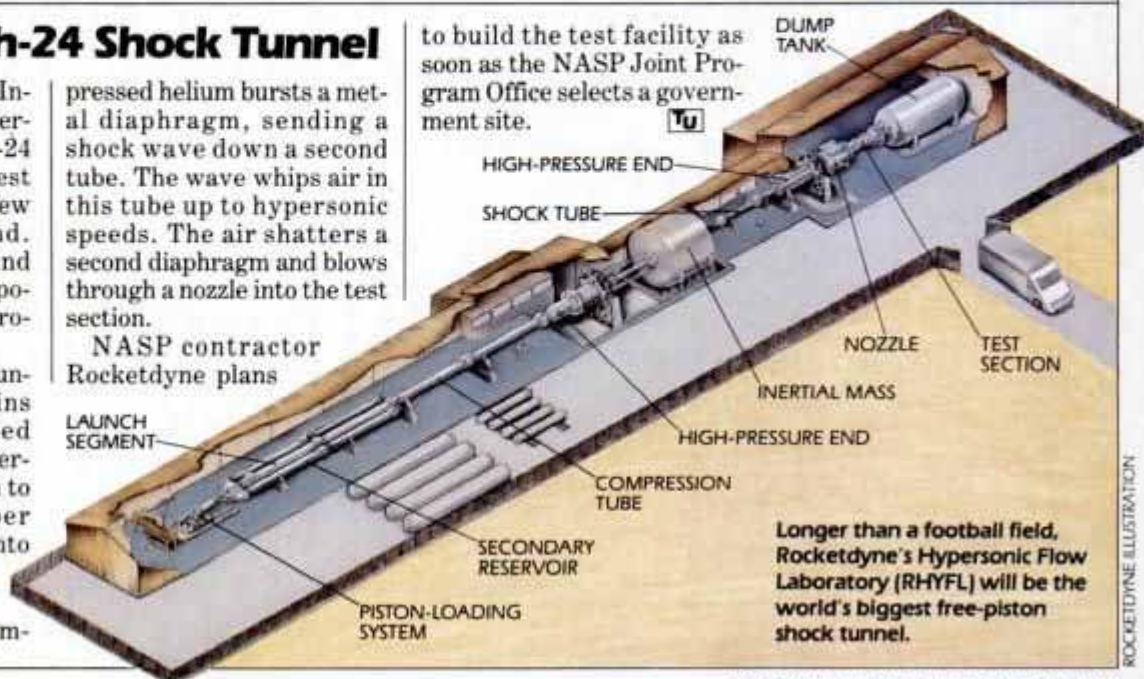
SANTA SABANA, CA—Inside the world's most powerful wind tunnel, a Mach-24 blast of air will assault test articles—but only for a few thousandths of a second. That'll be the best ground testing available for components of the National Aero-Space Plane (NASP).

The free-piston shock tunnel's test sequence begins when nitrogen, released from twin secondary reservoirs, accelerates a piston to more than 600 miles per hour. The piston slams into helium, squashing the gas to 2500 times atmospheric pressure. The com-

pressed helium bursts a metal diaphragm, sending a shock wave down a second tube. The wave whips air in this tube up to hypersonic speeds. The air shatters a second diaphragm and blows through a nozzle into the test section.

NASP contractor Rocketdyne plans

to build the test facility as soon as the NASP Joint Program Office selects a government site.



Longer than a football field, Rocketdyne's Hypersonic Flow Laboratory (RHYFL) will be the world's biggest free-piston shock tunnel.

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And additional tests have also shown a dramatic reduction in fuel consumption.

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So to keep your vehicle on the road longer and drive down operating costs, treat your engine to Slick 50.

Because without it, starting your engine really is a terrible thing to do.

THE PM ECONO CAPER

Coast to coast for \$100? They told us we were crazy.

BY TONY SWAN, Automotive Editor; PM Photos by George Olson



● In 1971, Dan Gurney and Brock Yates drove a Ferrari Daytona GTB-4 from New York to California in 35 hours and 54 minutes, winning the first Cannonball Baker Sea-To-Shining-Sea Memorial Trophy Dash.

Starting at the Red Ball Garage in Midtown Manhattan and slithering to a halt at the Portofino Inn in Redondo Beach, Gurney and Yates averaged just over 82 miles per hour for the distance.

Queried about the kind of open-road speeds required to maintain such an astounding average, Gurney flashed his boyish grin and said, "We never exceeded 175 mph."

The average speed for our cross-country run was a tad slower than that posted by Messrs. Gurney and Yates. We covered the 2993 miles between San Francisco and our headquarters at 57th Street and Broad-

way at a blistering 35.4 miles per hour.

Of course, that included overnights (overnight defined as 3 hours of sleep and a shower) in Winnemucca, Nevada; Cheyenne, Wyoming; and South Bend, Indiana. The Gurney/Yates Ferrari stopped only for fuel. On the road—Interstate 80 all the way—we maintained steady-state speeds between 63 and 66 mph. We never exceeded 75 mph, let alone 175, even on the longest downhill stretches.

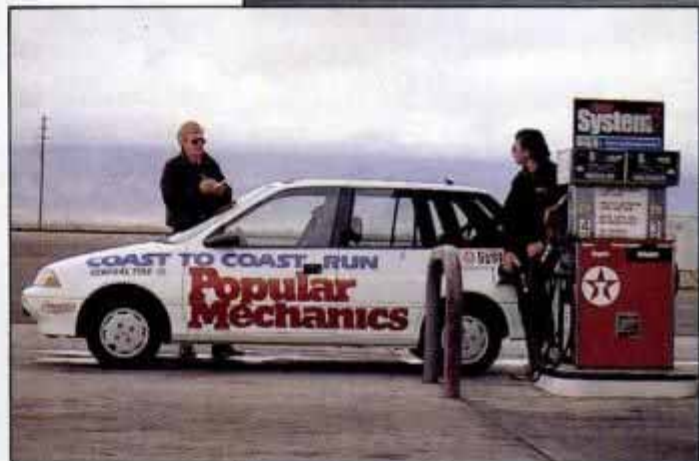
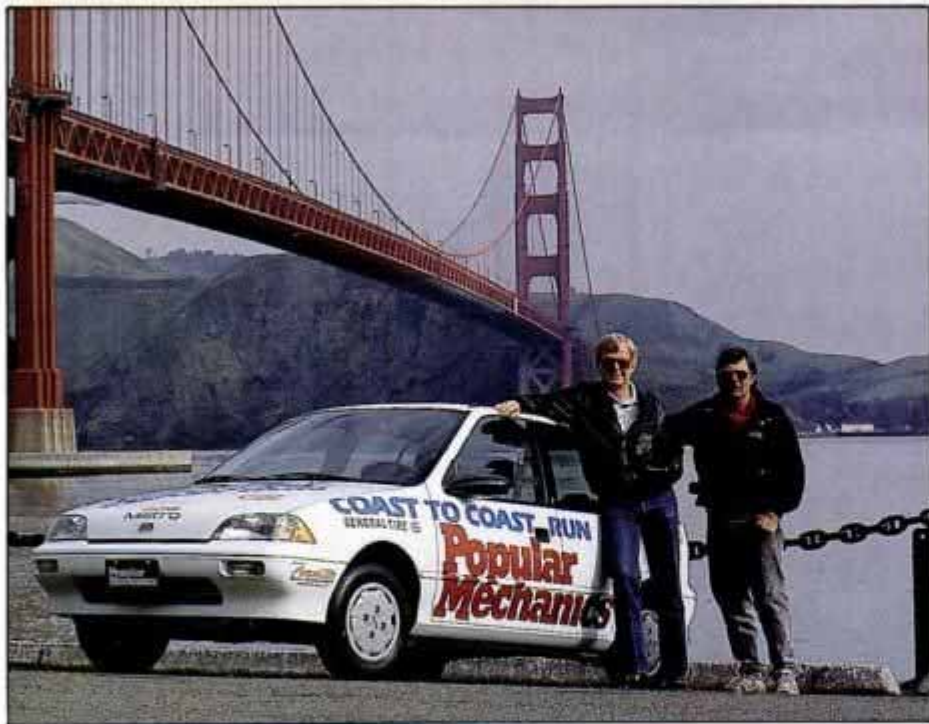
But we didn't need to refuel nearly as often as the Ferrari—eight pit stops between San Francisco and our final fillup in Manhattan. Which brings us to the major point of contrast between that first Cannonball run and this one.

Gurney and Yates averaged 12.5 miles per gallon. We averaged 53.2.



Using I-80, PM economy run covered 2993 miles.

THE PM ECONO CAPER



After San Francisco sightseeing and cable-car dodging, the PM Geo Metro braved mountains, deserts, frequent rain showers and persistent crosswinds en route to New York's George Washington Bridge (far right). The result: 53.2 mpg coast to coast.

Our original idea, conceived when the Iraqi occupation of Kuwait sent gasoline prices spiraling upward, was to drive from coast to coast spending no more than \$100 for fuel.

The choice of vehicles was constrained by fuel prices prevalent at that time—around \$1.50 per gallon—which meant we needed a car capable of about 45 mpg on the highway. This led us to the Geo Metro.

But by the time the dust settled in Iraq, fuel prices had fallen substantially, as low as \$1 per gallon in some places. So we knew that making the run for less than \$100 wasn't going to be as much of a challenge as we'd originally envisioned, even though fuel prices were climbing again when we saddled up in San Francisco.

In fact, it was easier than we thought it would be. The highest

pump price we found for unleaded regular was \$1.26.9, in Goehner, Nebraska. The cheapest was \$0.99.9 in San Francisco, and the average was just over \$1.13 per gallon.

Our total fuel cost was a resounding \$63.84.

In the first leg of the run, from San Francisco to Fernley, Nevada—a stretch that went from sea level to 7239 ft. in the Sierra Nevada—we averaged 50 mpg on the nose. The next leg, between Fernley and Battle Mountain, Nevada, came in at 50.8 mpg. After that we never had a refill to be less than 51 mpg, despite frequent rain squalls and a persistent strong crosswind, most of it dead abeam.

Our best tankful, between Cheyenne and Goehner, was 56.2 mpg. This was particularly interesting because that particular tank of Texaco unleaded was 10% ethanol.

As noted earlier, we chose a Geo Metro for the run, settling on the LSi

Mileage Magic

● To us, the real beauty of this run is that there was no magic. Our friends at Chevrolet handed over a box stock Metro sedan, we bolted on a set of General A/S 210 145/80R-12 tires, changed the oil (to Havoline Formula 3 5W-30) and drove. There were two mission-oriented modifications:

No. 1, and most important, was the installation of an aftermarket cruise-control/trip computer. Not only did

this relieve us from the fatigue-producing business of keeping one foot on the gas pedal, it allowed us to monitor instant fuel economy with 60 updates per minute. Manufactured by Zemco and available through J.C. Whitney, it sells for \$175.

No. 2, we ran the Generals a bit harder than their suggested 32-psi inflation—38 psi, to be precise—to reduce rolling resistance. —T.S.



4-door, with a 5-speed manual transmission and 50-mpg EPA highway-cycle economy rating. There's an even stingier Metro—the 2-door XFI, tops on the 1991 EPA mileage charts at 58 mpg highway—but our earlier experiences with this bare-bones car (“40 Something,” page 39, Feb. '91) convinced us that driving one from coast to coast was beyond the call of duty.

The LSi version, with considerably better seats, proved to be surprisingly comfortable from start to finish. Front-seat legroom was generous, the seat offered enough adjustment to accommodate the substantially varied driving positions of our driving team (Assistant Automotive Editor Mike Allen and the author), and ride quality was far better than you'd expect of a car with a 93.1-in. wheelbase and 12-in. wheels. Comfort gets to be a key consideration in a car that's capable of going more than 500 miles on one 10.6-gallon tank of gas.

Though this car was designed as an urban commutemobile, it can handle long-haul travel very well indeed. There's enough storage space to haul a fair amount of cargo, and our only disappointment was that we couldn't convert the rear of the car into a make-do sleeping area. With the rear-seat cushion removed and the seatbacks folded forward, there's enough room for one guy to stretch out, but not comfortably enough to really sleep. This took straight-through driving out of our plan, but it's hard to fault the Geo/Suzuki design team on this point—blitz driving just wasn't one of the considerations.

We were also impressed by the performance of the Metro's 993cc sohc 6-valve 3-cylinder engine. This is the smallest passenger car engine available in the United States, producing 55 hp at 5700 rpm and 57 ft.-lb. of torque at 3200 rpm. Even though our Metro weighed in at a tidy 1693

pounds, this still results in a power-to-weight ratio of 30.8 pounds/hp, and that's before you add two bleary-eyed guys, a modest toolkit and luggage.

Nevertheless, the little 3-banger hauls along easily at respectable highway speeds. We had to downshift to climb some of the steeper mountain grades of California and Nevada, but most of the way it was straight fifth-gear cruising.

The Geo's tiny Triple is also remarkably smooth at highway speeds. Three-cylinder engines all tend to vibrate, and the Geo's does shake a bit at idle and in the upper rpm range. But through most of the power band, it's unobtrusive and quiet. Suzuki's motorcycle experience shows to good advantage here.

And while our exercise may not be the stuff of legends, à la the Gurney/Yates Ferrari, we think 53.2 miles per gallon is a remarkable achievement by any measurement. **PM**

REBIRTH OF THE BLIMP

Buoyed by ultralight fabrics, new electronics and computerized design, lighter-than-air craft reclaim the skies.

BY WILLIAM GARVEY
PM Illustration by Jeff Mangiat

● After decades of stagnation, lighter-than-air (LTA) flight is booming. An amazing variety of powered, man-carrying vehicles is taking to the air. And not since the days of the fabled Zeppelins have there been flying machines as large as those now being designed for the Pentagon by Westinghouse Airships.

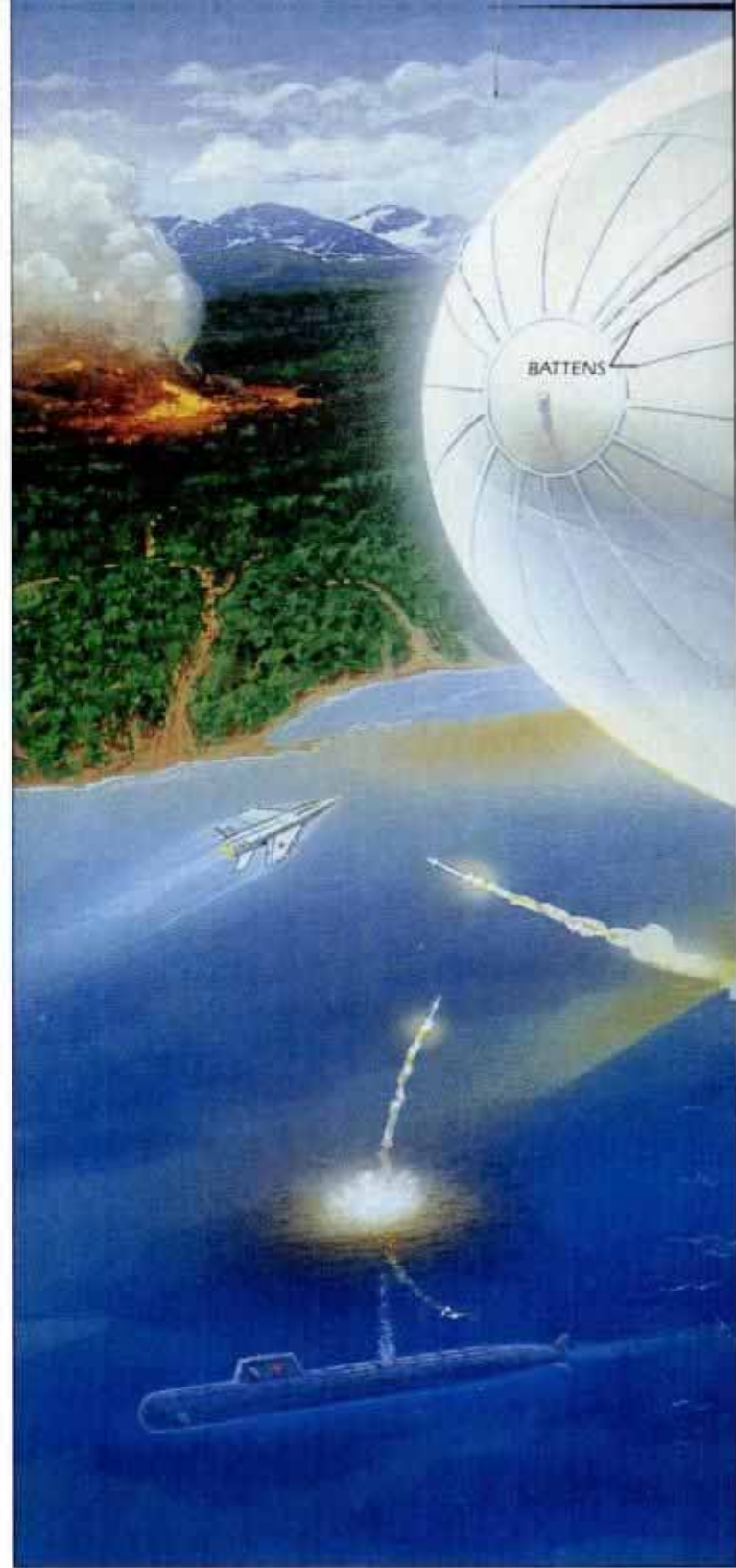
Why all this now, half a century after the end of the golden age of the airships? The days of the 800-ft.-long Graf Zeppelin, Akron and Macon. Those in the business point to the coinciding development of lightweight, high-strength materials and the miniaturization of electronics, plus the growing demand for fuel efficiency. Observed Peter Buckley, chief test pilot at Westinghouse, "The old airships were before their time. They flew around the world, yet they used pigs' intestines [to contain the gas]. All these new developments just shout lighter than air."

The result has been an unprecedented proliferation of blimps. They're hawking an airline in California, beer in the U.K., and catching bad guys in Seoul, Korea. Even the Red Chinese have built one. But the biggest news in the blimp world is taking place in an ex-Navy hangar in Elizabeth City, North Carolina.

Moby blimp

Entering this cathedral-like structure is an almost surrealistic experience. A stark, white craft floats 5 ft. off the floor bathed in floodlights and held captive in a giant net. This is the 222-ft.-long Sentinel 1000—the largest airship in the world. With its Dacron/Mylar/Tedlar envelope, fly-by-light pneumatic actuation control system, automatic venting and stabilization, sidestick controller, vectorable-thrust propellers, X-fin configuration and special instrumentation able to capture 250 different flight-test parameters, it is the most advanced blimp extant as well.

But the 1000 is just a test vehicle for an even larger follow-on craft. When the U.S. Navy takes control of the 1000 later this year, it will begin a lengthy flight regimen to explore its aerodynamics, flight controls



and ground handling, and to develop techniques for replenishing fuel and stores while underway. Meanwhile, if all goes according to plan, construction of the next-generation ship, the YEZ-2A, will begin in earnest before year's end.

This truly gargantuan craft will measure 425 ft. from nose to tail and stand 152 ft. high—that's nearly 200 ft. longer and 100 ft. taller than a 747-400. The vessel's 2½ million cu. ft. of gas will lift a 3-story, pressurized gondola (possibly designed by Burt Rutan's Scaled Composites), a crew of 12 and enough JP-5 fuel to power its twin CRM BR-2/2000 marine diesels and single GE CT7 sprint turboprop for 60 hours. But sensational as this largest-ever nonrigid airship will be to see, it's what's unseen that really matters.



Going up?

The Pentagon has already invested \$80 million and plans to spend that again and more on the project because it needs to get a radar to 10,000 ft., and the YEZ-2A is the cheapest elevator up. The blimp is to be part of the military's Air Defense Initiative, charged with identifying and eliminating airborne threats to the United States. A key element of the ADI effort is a large phased-array, electronically scanned, wide-aperture radar designed to lock on to low, small, fast-moving targets, such as cruise missiles. Planners originally intended to place the test radar, which is still under development, on a Boeing 747, but when estimates for the installation passed \$800 million—excluding the cost of the plane and the radar—they began looking for a bet-

Operational follow-on to YEZ-2A would provide flexible platform to hunt and kill low-flying missiles and planes, find submerged mines, rescue vessels in distress and detect forest fires.

ter way aloft. They hit upon the YEZ-2A.

ADI wants the big blimp to do but one job—serve as a platform for its radar tests. However, many in the Pentagon believe that once the airship is in the military inventory, the services will test it for a variety of roles, such as airborne early-warning, antisubmarine warfare, and mine sweeping and rescue. One concept even calls for a blimp armed with a variant of the Patriot missile system, turning it into a formidable anti-air-warfare platform. Westinghouse is betting that once the Pentagon flies the YEZ-2A, they'll want to order a bunch of them.

REBIRTH OF THE BLIMP



WESTINGHOUSE PHOTOS

Slow and stealthy

Although it seems ironic that the defense of the United States in the 21st century might rely on a type of flying machine that first flew in the 19th, the fact is there is simply no device with an airship's special combination of properties. It is by definition always airborne, and thus can remain on station for days or weeks. Unlike airplanes which need powerful, fuel-thirsty engines to produce lift, an airship can use small engines, reducing thermal signature and crew-numbing vibration. While perform-

ance is modest, the YEZ-2A can, with inflight replenishment, crank out a steady 60 to 80 knots, night and day, over land or sea, in fair weather or foul. Forever. It will get you where you want to go.

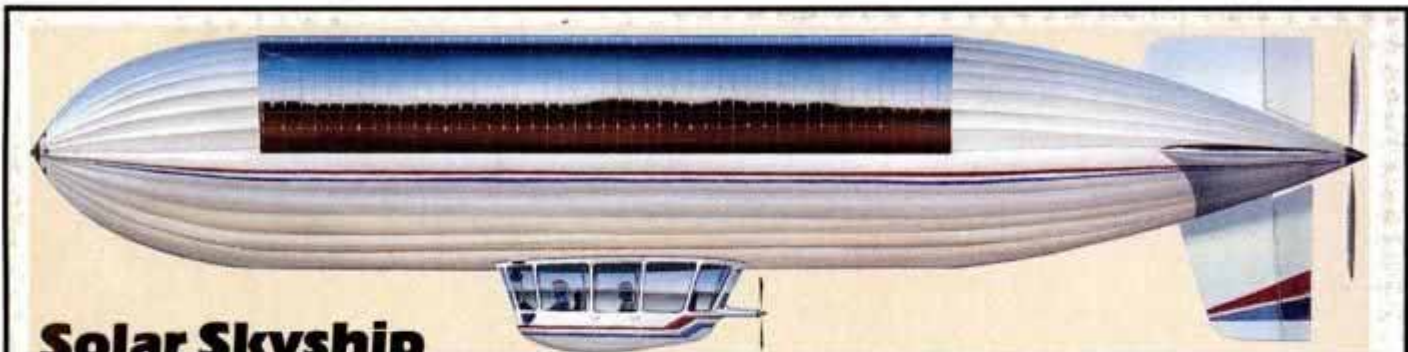
Although vast in scale, airships are surprisingly difficult to spot with an eyeball or a radar. Anyone who has tried locating a blimp from the air as I have knows that haze, low light or a cluttered or sea-gray backdrop can make the thing vanish altogether. One Navy pilot said future airships would be operated well away from

Elizabeth City hangar houses nearly complete Sentinel 1000 (above left), and mockup of YEZ-2A gondola (above).

any carrier because their virtual invisibility would make them a collision hazard to fighter and patrol pilots. Moreover, the ship's skin is literally invisible to radar, and the gondola, fins, engines and airborne radar can be configured to disperse the enemy's signal.

Giant hybrid

While it is certainly the best-known and financed big-ship project, the



PM ILLUSTRATION BY PAUL DIMAKE

Solar Skyship

● While there is theoretically no limit to how long an airship can stay aloft, the need for periodic refuelings has always brought them down to Earth in the end. But now a solution—a solar-powered rigid airship—looks like it may be about to get off the ground.

Eric Raymond, former world hang-glider champion and the designer, builder and pilot of the first solar-powered plane to fly across the United States, has nearly finished plans for the craft, and hopes eventually to fly it around the world.

State-of-the-art materials and construction are the key to his design. The airship's keel and inner support structure will be made of small-diameter aluminum tubing wrapped with Kevlar thread. A thin Kevlar foam sandwich will make up the "cap," or

fitting base for the photovoltaic array that generates electricity for the engines. The rest of the airship's external skin will be of Tedlar, a Dupont product similar to Mylar, but many times stronger and more ultraviolet resistant.

Lift will come from helium contained in six separate bladders taking up most of the envelope's internal space. Batteries or, more likely, hydrogen fuel cells will be mounted along the keel to provide power for night flying.

Current plans call for the craft to be 100 ft. long, but only 18 ft. in diameter. The resulting profile is sleek enough that a 5-horsepower electric motor swinging a 16-ft. prop should be able to push it along at 60 mph. At night, on stored power, cruise speed drops to 40 mph.

The 2-passenger gondola will be built of carbon-fiber sandwich and will contain navigational, communication and emergency sur-

vival equipment. Two electric motors will also be housed there, providing thrust for landing and takeoff, as well as emergency backup power.

Despite the ship's long range, Raymond expects to make numerous stops. Some promotional, some for maintenance. Should bad weather or mishap force an unscheduled stop, the pilot can fire a rocket-propelled anchor into the ground, allowing him to come to rest without a ground crew.

For most of the trip, however, the blimp will be accompanied by support crews and weather teams. The result should be a rather grand expedition, which Raymond hopes will go a long way toward proving that current solar technology can power long-distance aircraft. —Rick Titus



YEZ-2A is not the only aerial Goliath being discussed. This spring, I spent an evening with Michael Arie, an aeronautical engineer who two years ago was named head of a new LTA division within Russia's Antonov Design Bureau. Arie's assignment was to match his nation's needs with emerging airship technology.

His biggest project is the Albatross, an airship of approximately the same weight and dimension as the YEZ-2A, but which features two Mil Mi-8 helicopter rotor systems fitted to an open superstructure slung below the envelope. The idea behind this helo/airship proposal is that with 2.3 million cu. ft. of helium keeping the whole thing airborne, all the thrust from the helicopter rotors can be used for lifting cargo—30 tons of it. (The ill-fated Helistat was borne of the same theory, but Arie says it was the outboard arrangement of four helicopters and not the concept that doomed the Piasecki machine.) That kind of muscle would be a tremendous help in resource development in the Soviet hinterlands where roads, airports and railroads are scarce.

But the Albatross is as expensive as it is complex and, well, there's not much money to go around these days. A search for a Western partner has been unsuccessful and, as a result, the Albatross has not progressed beyond some preliminary (and promising) wind-tunnel tests.

In the friendlier financial climate of the United States, New York entrepreneur and engineer Wendel Wendel is promoting an equally ambitious scheme. He says his team will have the skill and funding to launch and operate an 800-ft. rigid airship by the mid-1990s.

The purpose of the Zeppelin-size

Antonov Albatross uses helicopters and 2.3 million cu. ft. of helium to lift 30 tons of cargo.

vessels—Wendel anticipates a fleet of seven Star*Elite airships—is primarily to entertain. He plans to take well-heeled passengers on air cruises to the North Pole, up the Nile and into the Amazon. Each Star*Elite will hold 120 passengers in plush, state-room comfort.

Meanwhile, the Atlanta-based UP-ship Project wants to build a 900-ft. sightseeing ship in time for the 1996 Olympics. An adjunct to that effort



Whispership ultralight floats its single occupant skyward in near total silence.

would be a large semirigid machine dedicated to harvesting timber in the rain forests without damaging the sensitive environment there.

Little blimps that can

Airships have always inspired grand schemes, perhaps because they are technically capable of delivering on even the most outlandish of them. The trick is doing it economically. Noted Ron Hochstetler, an LTA expert based in Washington, D.C., "In the airship business you never know whether you're a visionary or a crack-

pot until it's too late." Recently, some of the most practical projects have been light and ultralight airships, two types that didn't even exist a few years ago.

American Blimp Corp. in Hillsboro, Oregon; US LTA of Eugene, Oregon; and Thunder and Colt of the United Kingdom are all producing blimps considerably smaller and less expensive to own and operate than the 200,000-plus cubic-footers pitching for Met Life, Fuji, Sea World and, of course, Goodyear (which quit the blimp building business altogether in the late 1980s).

With an overall length of 160 ft. and 138,000 cu. ft. volume, US LTA's 138S is the largest of the threesome and, with a \$3 million-plus price tag, the most expensive. American Blimp's 60,000-cu.-ft. A-60 Lightship is next in size and price at \$1.2 million. Thunder and Colt's GA42 is lofted by a diminutive 42,000-cu.-ft. envelope rigged with a 2-man gondola. Its price is similarly modest: \$650,000.

Each ship has its strong points, but of the three, only the A-60 has two engines—4-cylinder Limback L2000s rated at 80 hp each—and an internal illumination system that causes the transparent hull to glow at night. Meanwhile, all three manufacturers are now scrambling for customers, including advertisers and police forces around the world.

Perhaps the most pioneering LTA newcomers are the ultralights—aircraft so light, so safe and so simple to operate that neither the machines nor their operators need to be licensed. And with factory-new prices ranging from \$30,000 to \$50,000 for these ultralight blimps, they're the last affordable ready-built flying machines.

(Please turn to page 92)



WORLD RADIO

Do some long-range listening with shortwave radios.

BY FRANK VIZARD, Electronics Editor

● Kuwait, Bangladesh, Baghdad and Berlin are all foreign places that most Americans can now describe better than some U.S. hometowns. With new flashpoints developing around the world all the time, you might want to turn a big ear in the appropriate direction. The big ear is shortwave radio.

With a myriad of worldwide places demanding our attention, a shortwave radio is probably the tabletop radio of the future. Traditional AM/FM—included with shortwave radio models—seems constricting and primitive once you've heard broadcasts from Australia.

Shortwave radio is more than just listening. The hunt for an overseas radio station is just as exciting. While there is no shortage of radio stations to hear, atmospheric conditions sometimes bring in the rare, normally unheard voice. Don't be surprised to hear local insurgents operating in various countries. Clandestine groups have been known to use shortwave within the United States as well.

Unlike the models of years ago, fiddling with the tuning knob is no longer the frustrating task it once was. The newest shortwave radio models feature pushbutton tuning and advanced circuitry to lock onto one of the more than 1100 radio stations that can be heard. Find-



21635: Radio France Internationale

As with other models, the direct-access tuning of Panasonic's RF-B65 makes finding stations easy. List price is \$190.

ing a radio station is as easy as punching in the desired frequency on a numerical keypad. Numerical keypads, once a feature of only the most expensive models, are now included with tiny portable models like Panasonic's RF-B65, which lists for \$190. Direct-access tuning also makes it easy to scan the airwaves for new voices.

You can better appreciate shortwave radio if you have an understanding of how it works. Broadcasters in faraway places aim their signal to reflect off the ionosphere, a region of gases that extends 25 to 400 miles above the surface of the Earth. Depending upon the radio frequency and the angle, a signal can skip or bounce back and forth between the Earth and the ionosphere several times—covering vast distances in the process.

Generally, broadcasters want to use as few skips as possible because the ionosphere is an inherently unstable, often stormy, place. Also affecting shortwave transmissions are sunspots and even the aurora zone over



the North Pole.

Sunspot activity peaks along an 11-year cycle, with last year being the most recent peak. The aurora zone interferes mostly with West Coast listeners of European broadcasts.

Shortwave transmissions are found on 13 bands where applicability depends on both the time of day and the time of year. Skips off the ionosphere are most effective at night so you get the widest range of stations to choose from when the sky is dark. The 31- and 49-meter band are considered the best for year-round night listening. The 25-meter band is best the 2 hours before and after dawn and dusk.

For daytime listeners, the 16-meter and 19-meter bands offer the best reception. A shortwave radio with just these five bands would allow you to listen to English language broadcasts from at least 38 countries on six continents during a 24-hour period.

The 25, 31 and 49 bands carry the bulk of the programming during peak sunspot years, such as last year's, because they are least affected by sunspot activity. Nearly every shortwave radio, no matter how large or small, includes these three bands. Programming is scheduled according to Universal Coordinated Time (UTC), also known as Greenwich Mean Time (GMT), World Time and Zulu Time. UTC, based upon the time in Greenwich, England, is 5 hours ahead of Eastern Standard Time (EST) in the



9580: Radio Australia

Sony packs its SW/1S shortwave radio into a notebook-size package for easy portability. Just plug each element together for instant reception. List price is \$350.



WORLD RADIO

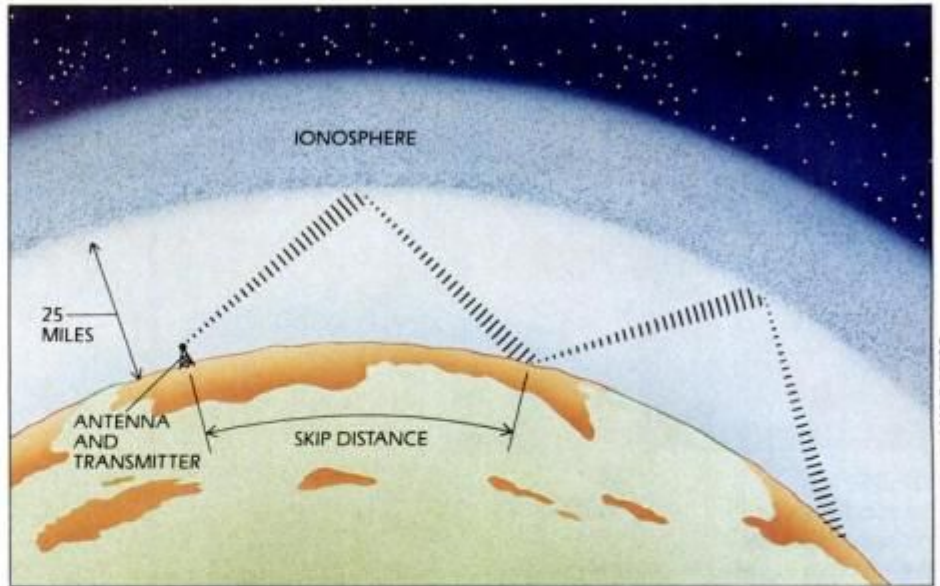
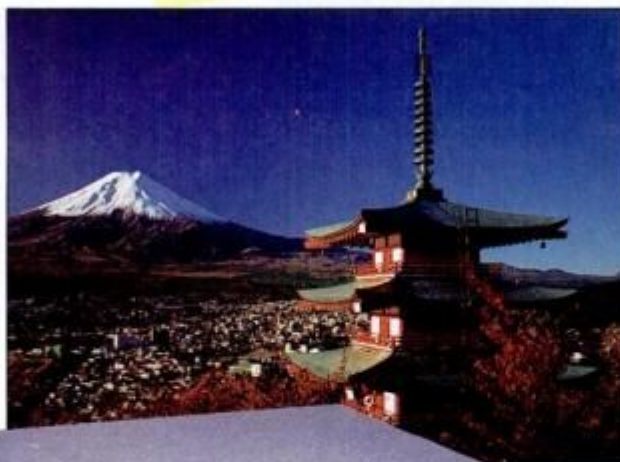
U.S. The UTC is regularly broadcast on five shortwave frequencies. Newer shortwave radio models include clocks so you can see the UTC at a glance. Radios with a signal strength meter are also a good idea so you can tell how well you're receiving the signal.

Radios with shortwave capability offer more knobs and buttons than your standard AM/FM radio. Models vary, but the Realistic DX-440 and its Sangean ATS-803A twin, listing for less than \$200, are representative of the breed. A row of buttons gives you a choice of five radio formats. The FM button accesses normal FM broadcasts. To receive normal AM broadcasts, you push in the button marked MW (middlewave)—the more common worldwide designation for this group of frequencies. The AM button in this instance lets you listen to the entire AM frequency band, a wide range of frequencies that includes ham operators, for example. The LW (longwave) button accesses frequencies used by ships and other commercial operators. SW (shortwave), of course, tunes in the world.

The DX-440 also has some tuning knobs that may be unfamiliar. The RF gain control adjusts the radio's sensitivity. Next to the RF gain control is the beat-frequency oscillator (BFO) knob, which is used in conjunction with the BFO switch below. This control is used to hear Morse code or continuous wave (CW) and single side band (SSB) transmissions. Amateurs tend to use SSB—a part of the radio transmission spectrum that lies to the side of the primary frequency signal.

6120: Radio Japan And NHK

The new R8 tabletop shortwave receiver from Drake can store up to 100 stations in memory. It can also be connected to a computer. List price for the Drake R8 is \$979.



FM ILLUSTRATION BY MARCO FERRO

Broadcasters from all over the world bounce their radio signals back and forth between the Earth and the ionosphere to cover great distances.

Lastly, the DX-440 features a narrow- or wide-band position that helps reduce interference caused by an adjacent radio station. A radio like the DX-440 allows you to store up to nine different radio stations in memory. Unlike other normal radios, memory is more than just a convenience.

Shortwave radio stations tend to change broadcasting frequencies regularly, and stations like the BBC, Armed Forces Radio and the Voice of America broadcast on different frequencies depending upon the time of day. Guidebooks like the "Passport To World Radio," published by International Broadcasting Services, Ltd.

in New York City, are updated yearly. It's best to store signals in memory for easy reference.

If you're the type who wants to prowl the world's airwaves as many DXers (shortwave hobbyists) do, you may want a model with more memory. Grundig's Satellit 500 model, listing for \$70, is about the same size as the DX-440, but allows you to store 42 stations in memory and also label them with either an individual call sign or a geographic designation. Grundig includes a short video with the Satellit 500 to make learning its operation easier. Grundig also operates a shortwave hotline—(800) 872-2228 from 8:30 am to 5 pm PST.

Among the models with the most memory capability is the R8 from Drake, a Miamisburg, Ohio, company reentering the shortwave radio business after a decade-long hiatus. The R8 is a tabletop model with enough memory for 100 frequencies. Aiding reception are five switchable bandwidth filters, as well as internal circuitry that makes it easier to pull in a weak signal. The R8 comes with a RS232C interface so it can be connected to a computer. There's also a built-in timer. List price is \$979. The unit is available through select dealers and direct from the factory at (513) 866-2421. Tabletop models can range high in price. Sony's flagship CRF-V21 lists for \$6500 and includes a fax for receiving satellite photos.

Much smaller is Sony's SW1S listing for \$350. Packed into its own notebook-size case, it can go anywhere. Up to 10 stations can be preset.

Big or small, shortwave radio can put you in touch with the world in a way no other product can. It's the CNN of radio, but with cultural and music programs added. **FM**



OLDSMOBILE SILHOUETTE

Score one for 21st-century styling.

BY MICHAEL LAMM,
Contributing Editor
PM Photos by Ron Hussey

● It's no secret that General Motors wants very much to sell more minivans. It's a corporate embarrassment to trail both Chrysler and Ford in such an important market segment.

Chrysler routinely leads the field in minivan sales. No one else even comes close. This is one area where the Japanese don't compete seriously with U.S. carmakers.

In 1984, Chrysler upstaged VW's Vanagon and started the big American switch from the station wagon into the garageable van.

GM's early entries in the minivan competition were the rear-drive Chevy Astro and GMC Safari. In the first six months of 1990, these twins accounted for just 17% of the market, versus 43% for the Dodge Caravan/Plymouth Voyager clones and 20% for the Ford Aerostar.



It was clear that GM needed something completely different, and one look tells you that the General's GM-200 minivans—Oldsmobile Silhouette, Pontiac Trans Sport and Chevrolet Lumina APV—are just that.

They definitely stand out in an increasingly crowded field.

But there's more to GM's newest minivan than just 21st-century styling. Its chassis and body construction are as radical as its exterior. Welded to a ladder-type frame is an internal skeleton made of thin, lightweight high-strength galvanized steel.

Glued directly to the inner space-frame are reinforced plastic body panels. These outer panels bear some of the body load and add rigidity to the structure. The idea originated with the Pontiac Fiero, although the Fiero panels were bolted on. The Corvette and Saturn also use similar construction and materials.

The critical question, of course, is how does this distinctive new vehicle score with its owners. From a market point of view, it seems clear that it's taking people awhile to get used to the zoomy styling. During the first six months of 1990, the GM-200s captured a mere 12% of minivan sales, still in third place behind the Cara-



Silhouette's 3.1-liter V6 drew complaints from some owners for lack of power.



Owners gave Silhouette good marks for comfort, but some disliked dash layout.



Thanks to easy removability of seats, Silhouette's cargo versatility got high praise.

van/Voyager and the Aerostar.

The Silhouette has been selling more slowly than the Lumina APV and the Trans Sport, partly because Olds has fewer dealers, partly because it starts further upmarket—about \$3000 more than Chevy's base minivan.

As compensation, the Silhouette offers more standard equipment: 7-passenger seating, styled alloy wheels,

electric outside mirrors, intermittent wipers, side-window defoggers and so on. The average price paid by the Silhouette owners we surveyed fell just short of \$18,000.

Standard equipment in all GM-200s, by the way, includes air conditioning, solar-reflective glass, power steering, AM/FM sound systems and quick-release flat-folding seats.

The standard engine is GM's 3.1-

liter V6, offering 120 hp, mated to a 3-speed automatic transaxle. So far, that's the only engine and gearbox available, and it produced some complaints about sluggish performance from our survey group.

Obviously, the Silhouette's strongest suit has been its styling: 65.2% of our owners narrowed their choice down to the Silhouette because of its looks. Styling also scored as the best-

SUMMARY OF 1990-'91 OLDSMOBILE SILHOUETTE OWNERS REPORTS*

Total miles driven:	2,634,032	Interior/seating comfort:	45.3	Front seat comfort:		No	15.0
Average miles driven:	7569	Good ride	36.9	Excellent	70.2%	Dealer service opinion:	
Purchase price:		Handling	35.2	Good	25.3	Excellent	44.4%
Average	\$17,928	Seating versatility	29.7	Average	3.6	Good	43.0
Range	\$13,500-\$24,000	Roominess	25.6	Poor	0.8	Average	9.2
Average miles per gallon:		Specific dislikes:		Rear seat comfort:		Poor	3.4
In town	18.8	Noises and rattles	12.6%	Excellent	45.3%	Number of vehicles owned:	
On the highway	23.4	No complaints	9.3	Good	46.6	This vehicle only	15.7%
Major options:		Poor forward visibility	7.9	Average	7.3	Two vehicles	47.5
Cruise control/power locks	97.8%	Not enough power	7.9	Poor	0.8	Three vehicles	22.8
Power windows	93.6	Fuel economy	7.9	Any mechanical problems?		Four or more	14.0
Captain's seat package	74.4	No storage security screen	6.6	No	74.2%	Principal driver:	
Suspension/towing package	66.1	Hood air inlet traps debris	6.6	Yes	25.9	Female	49.1%
Leather upholstery	40.2	Suggested changes:		Types of problems:		Male	44.3
Why did you choose the Silhouette?		No changes	10.8%	Temperature gauge	21.3%	Equal	6.6
Styling	65.2%	More power	8.9	Noisy, soft brakes	14.6	Owners' age distribution:	
Spacious interior	18.8	More comfortable seats	6.8	Air conditioning	11.2	29 and under	4.5%
Comfort	16.0	Better dash layout	5.5	Electrical	11.2	30-49	50.1
Seating/cargo versatility	14.2	Fewer noises and rattles	5.2	Oil leaks	9.0	50-plus	45.4
Size	9.7	Workmanship rating:		Did you handle repairs?		Based on experience, would the Silhouette be your choice again?	
Ease of handling	9.1	Excellent	52.6%	No	98.9%	Yes	66.2%
Specific likes:		Good	42.9	Yes	1.1	Maybe	29.1
Styling	59.3%	Average	4.2	Dealer repairs satisfactory?		No	4.7
		Poor	0.3	Yes	85.0%		

* Percentages might not equal 100% due to rounding up or insufficient data.

liked feature, followed in order by comfort, ride and handling.

The drivers in our survey, 49.1% of them women, did find some minor distractions in the Silhouette's aerodynamic shape. The distance from the inner windshield base to the instrument panel is about 3 ft., and since drivers can't see where the nose ends, a lot of parking gets done by ear.

According to most owners, three of the Silhouette's biggest pluses are ride comfort, interior spaciousness and the versatility of its seating arrangement. The van's standard seats—34-pound lightweight buckets—are normally set in a 2+3+2 configuration. Buyers can delete the second-row center seat for a \$110 credit.

All five rear buckets have quick-release floor anchors and lift out easily. Removing the two rearmost seats provides 75 cu. ft. of cargo space, and taking out all but the front seats results in a generous 112.6 cu. ft. Although the rear seats don't recline, they do fold flat and have hard plastic backs so that plywood and such—pieces up to 7 ft. long—can be carried without removing the seats.

Tabletop seatbacks

The seatbacks also double as table-tops, complete with recessed cup holders, and there are numerous storage compartments throughout the Silhouette. About the only persistent complaints we registered had to do with the lack of a security screen over the rear cargo area and owners who had difficulty seeing and/or using controls and instruments.

Only about 26% of our respondents listed mechanical problems, mostly minor ones like a stuck-on-hot temp gauge. Most Silhouettes in our survey were early-production models, so a few came through with rattles in doors and windows, and even body panel misalignments. By and large, though, Silhouette owners gave quality high marks, more than half rating workmanship as excellent. Dealer service also got solid praise.

High buy-again

Asked whether they'd buy the same vehicle if they had it to do over again, 66.2% of our Silhouette owners answered yes. That's higher than the response we recorded in our Ford Aerostar Owners Report back in 1986 (63.3% yes). But the Silhouette still can't touch the Caravan/Voyager 79.6% would-buy-again response, recorded back in 1984.

And judging by recent sales figures, Chrysler continues to set the pace. The Silhouette and its cousins might be awhile in catching up. **PM**



Although some owners complained that the Silhouette's long nose and fallaway hoodline made parking a chancy business, styling was this vehicle's best-liked feature. Over 65% of the owners in the survey listed styling as their prime reason for choosing the Silhouette.

EDITORS REPORT

The Virtues Of Versatility

● In the past 18 months, we've spent quite a bit of time driving various GM-200 vans, in particular a Pontiac Trans Sport that was a member of our long-term test fleet for a year. And while we share the enthusiasm of our owner group for the radical styling of these vans (we do think a little more budget could have been devoted to making more distinction between the various divisional offerings), styling wouldn't be our primary reason for buying one of them.

The factor that separates these vans from their competitors—seating and cargo versatility—is something only 14.2% of our respondents cited as a buying priority. GM has done an exceptional job in this area of design, and no other minivan comes close. Snap out the seats, and the GM-200 becomes a mini-cavern, capable of swallowing all kinds of stuff.

Click the seats back in, and you've got a roomy, comfortable station wagon that's also long on style.

We certainly endorse the owners' remarks concerning sluggish performance. The Silhouette and its brethren are adequate around town, but they dawdle in passing maneuvers, and towing just isn't part of the equation.

Although our most recent experi-

ences with a Silhouette were rattle-free, our Trans Sport did have a few squeaks at the end of its term of service. We've also noticed a fair level of wind noise in GM-200 vans at highway speeds, and cleaning the inside of that big windshield is a real project.

On the other hand, after a half-hour of orientation we never had any problems concerning the whereabouts of the nose of a GM-200 van relative to vehicles in front. While it's true that you can't see the end of the hood, we find that you quickly develop a sense of where it is, and we've never had a "parking by ear" experience.

Speaking of parking lots, we've also been impressed with the durability of the plastic body panels, which take all sorts of minor abuse without a trace. And, of course, they're never going to rust.

As for the Silhouette itself, we think Olds has done a good job of pushing up the interior, although without the leather upholstery option the interior distinctions between Silhouette and Trans Sport SE are subtle.

With or without leather upholstery, though, the great appeal of the Silhouette, Trans Sport and Lumina APV is their versatility. Since that's the essence of the family wagon, we think they're tops. —Tony Swan



BLOWING IN THE WIND

By the year 2000, 10% of our nation's electricity may be supplied by the wind. It's already meeting the needs of more than 900,000 Californians.

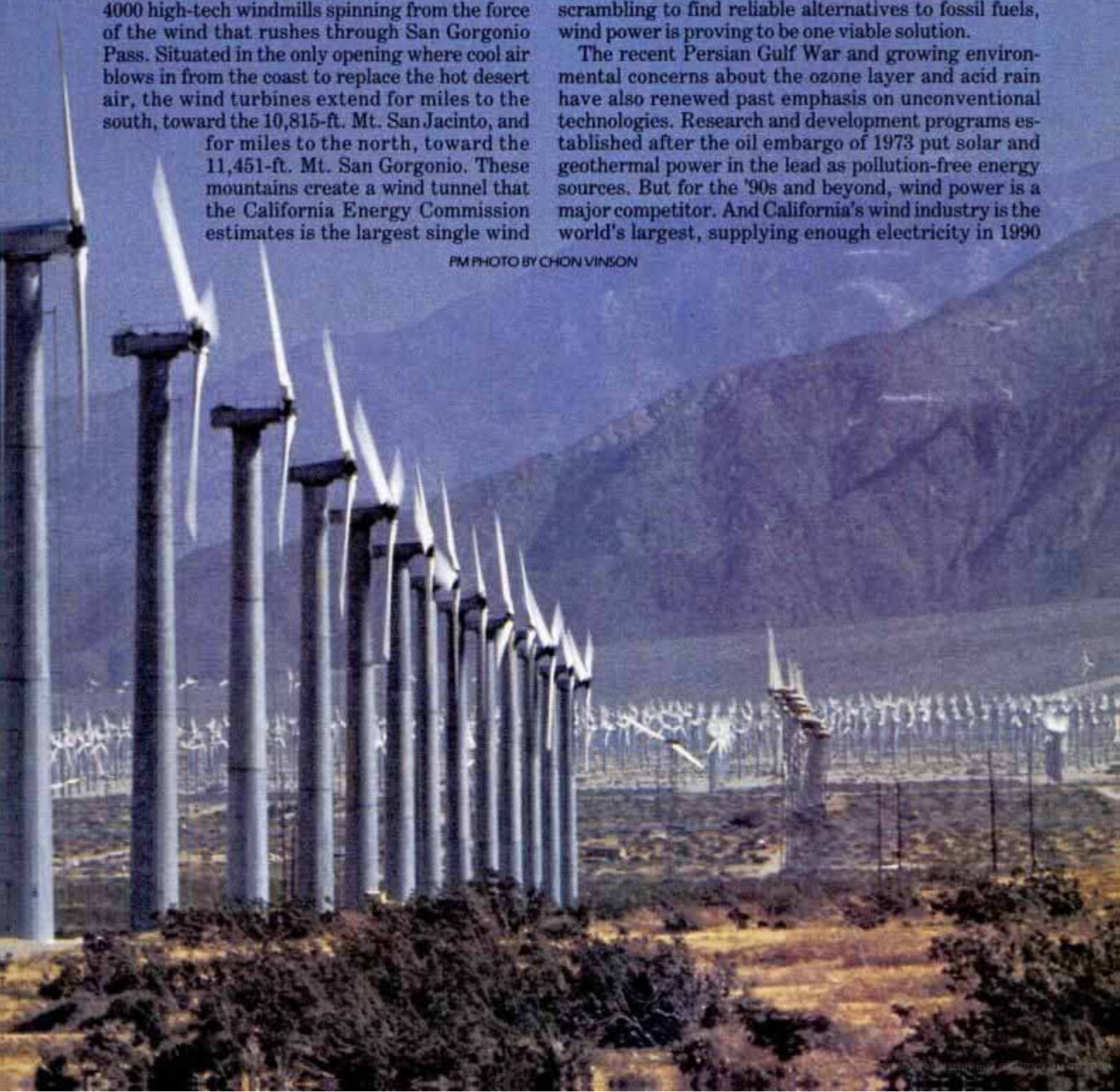
BY DEBORAH FRANK, Managing Editor

● Just northwest of Palm Springs, California, as you drive along Interstate 10, you'll see them—more than 4000 high-tech windmills spinning from the force of the wind that rushes through San Geronio Pass. Situated in the only opening where cool air blows in from the coast to replace the hot desert air, the wind turbines extend for miles to the south, toward the 10,815-ft. Mt. San Jacinto, and for miles to the north, toward the 11,451-ft. Mt. San Geronio. These mountains create a wind tunnel that the California Energy Commission estimates is the largest single wind

resource area in the state, channeling 3300 megawatts worth of harnessable wind power. And with scientists scrambling to find reliable alternatives to fossil fuels, wind power is proving to be one viable solution.

The recent Persian Gulf War and growing environmental concerns about the ozone layer and acid rain have also renewed past emphasis on unconventional technologies. Research and development programs established after the oil embargo of 1973 put solar and geothermal power in the lead as pollution-free energy sources. But for the '90s and beyond, wind power is a major competitor. And California's wind industry is the world's largest, supplying enough electricity in 1990

PM PHOTO BY CHON VINSON



BLOWING IN THE WIND

alone to meet the residential needs of a city the size of San Francisco.

San Geronio Pass is one of three main windfarm locations in California—the other two being Altamont Pass, about 30 miles east of San Francisco, and Tehachapi Pass, about 75 miles northeast of Los Angeles. Altogether, these windfarms have installed more than 17,000 commercial wind turbines, with a peak generating capacity of approximately 1500 megawatts. According to the U.S. Department of Energy, the generation of 1.8 billion kilowatt hours of electricity displaces the equivalent of 3.3 million barrels of oil.

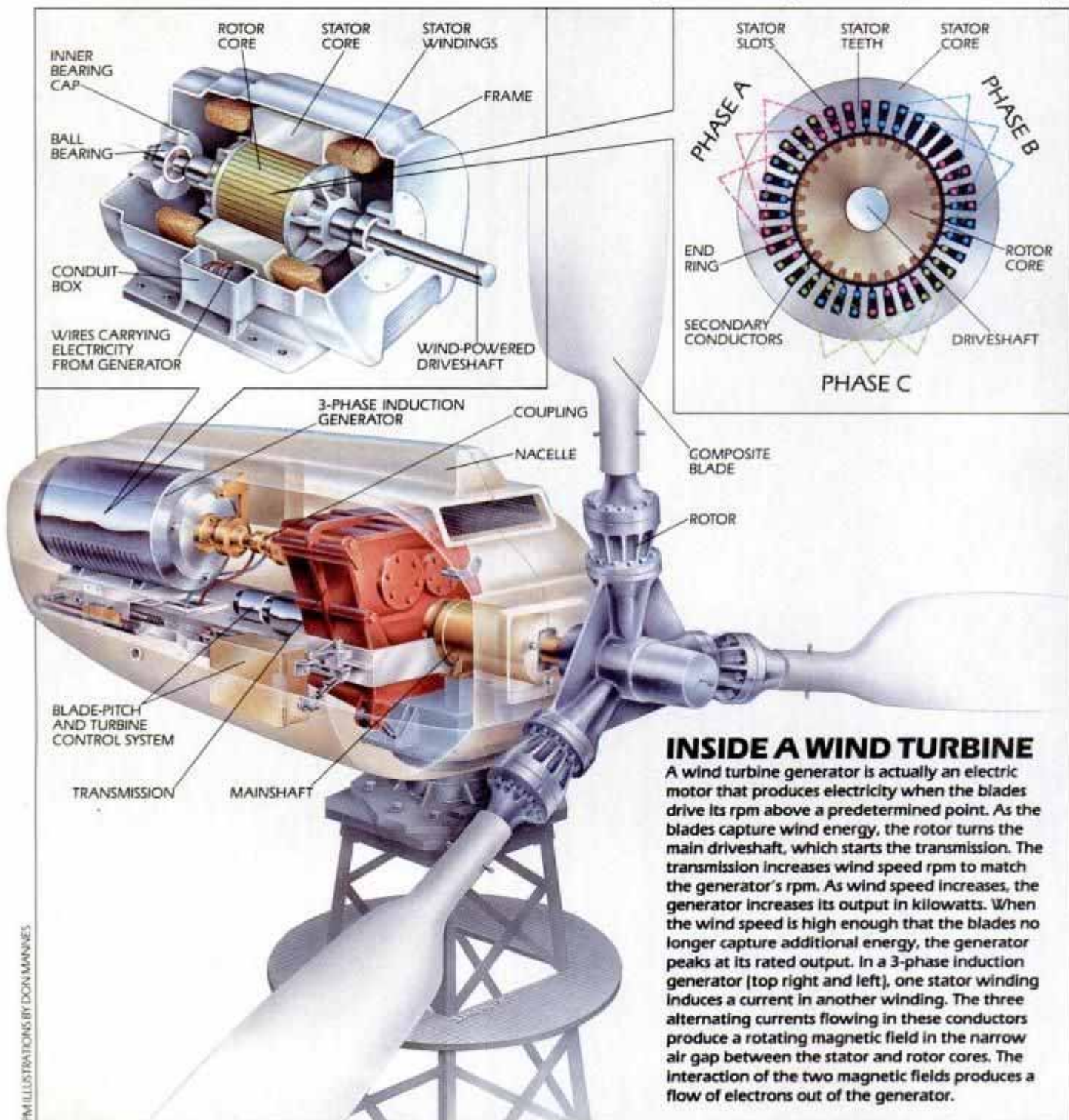
Gale forces

Wind originates with the Sun's uneven heating of the atmosphere, due to the varying topography of the Earth's surface. As hot air rises and cool air sinks, the difference in atmospheric pressure brings cool, dense air flowing inland from the ocean into the low-pressure zones of the hot interior deserts and valleys. As the valleys and mountains heat up and cool off at different rates, they create predictable wind patterns. These patterns help determine the most ideal locations for a windfarm.

High wind speeds occur as the cool coastal air is funneled through the

gaps and mountain passes. Influenced by the terrain, wind speed increases with height as it flows farther away from the surface. Thus, significant changes occur over a ridge or hill, and mountain summits cause the greatest amount of acceleration. According to the Desert Wind Energy Association (DWEA), during the wind season in San Geronio Pass, winds can reach gale force for days. In May 1989, winds exceeded 35 mph for 336 continuous hours.

To maximize output, wind turbines are designed to take advantage of these high wind speeds. Small changes in wind speed result in large

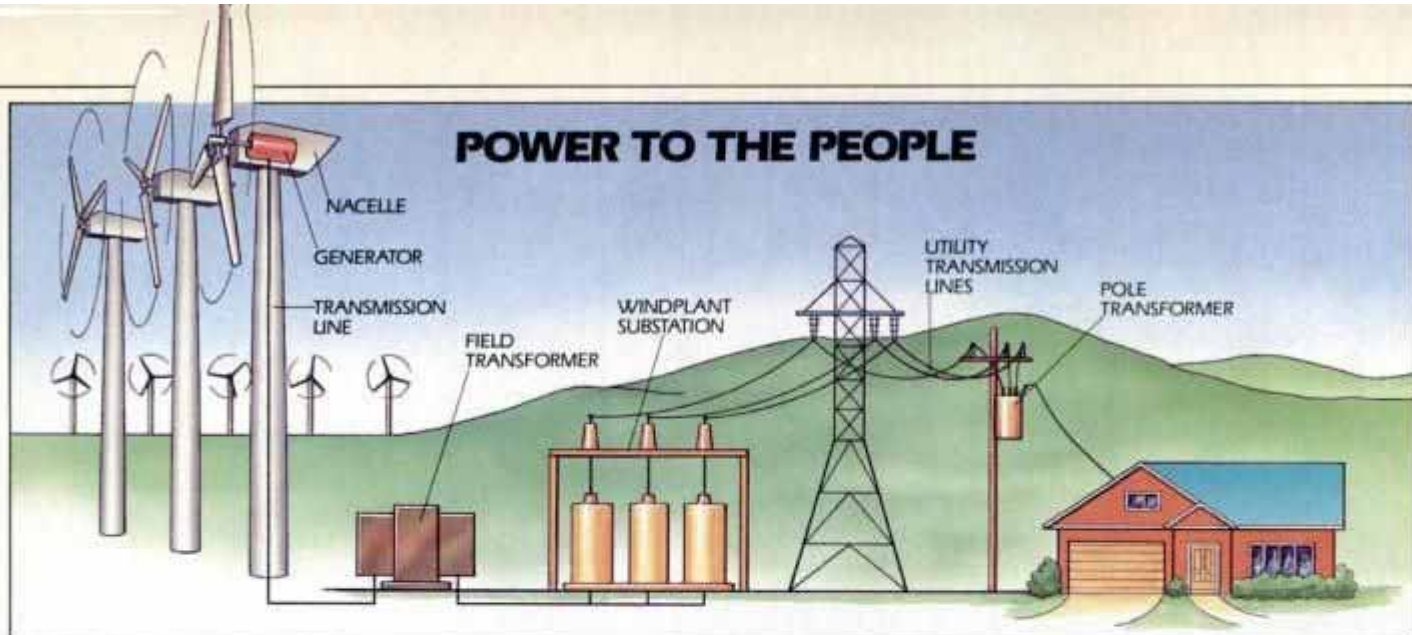


INSIDE A WIND TURBINE

A wind turbine generator is actually an electric motor that produces electricity when the blades drive its rpm above a predetermined point. As the blades capture wind energy, the rotor turns the main driveshaft, which starts the transmission. The transmission increases wind speed rpm to match the generator's rpm. As wind speed increases, the generator increases its output in kilowatts. When the wind speed is high enough that the blades no longer capture additional energy, the generator peaks at its rated output. In a 3-phase induction generator (top right and left), one stator winding induces a current in another winding. The three alternating currents flowing in these conductors produce a rotating magnetic field in the narrow air gap between the stator and rotor cores. The interaction of the two magnetic fields produces a flow of electrons out of the generator.

PM ILLUSTRATIONS BY DON MANNING

POWER TO THE PEOPLE



PH ILLUSTRATION BY HANK IREN

As the blades spin, the generator outputs AC current that travels through a cable down the 100-ft. tower into a field transformer. There, the voltage is increased and sent to a substation that converts it to an even higher voltage. The utility then distributes it over its transmission lines. Before ending up in your home, the voltage is converted to a household current on a pole transformer right on your block.

changes in the kinetic energy produced and, thus, in the power delivered by a wind turbine. If wind speed doubles, the machine will produce eight times as much power. For example, an increase in wind speed of only 2 mph, from 10 mph to 12 mph, represents a 78% increase in power generation. Most turbines in the San Geronio Pass operate when the winds are between 14 and 50 mph.

Cut-in and cut-out

A wind turbine is designed to operate under these varying conditions according to its "cut-in" and "cut-out" speeds. Cut-in wind speed is the minimum speed at which the turbine begins producing power. Cut-out wind speed is the maximum speed above which no power production is expected. The turbine's rotor blades must spin at a steady speed in order to output a constant frequency of 60 Hz so it can tie into a utility's power grid. Extremely high winds can cause structural damage to the turbine because gusts higher than its design speed increase the torsional stresses on the drivetrain. Therefore, essential to a turbine's design is controlling the rotational speed of the blades.

Just like on the wings of a plane, air passes over the surfaces of a turbine's airfoil-shaped blades. The pressure differential between the top and bottom surfaces creates aerodynamic lift. The lift is the force that pulls the blades in a circular motion to drive a 3-phase induction generator housed in the turbine's nacelle. The proportion of the wind's energy being used to generate electricity is controlled by the angle of the blades to the wind. A larger angle captures more wind, allowing the turbine to operate at slower wind speeds. A smaller angle operates it at faster speeds.

Inside the turbine, the transmission increases the driveshaft's rate of 50 rpm to match the generator's 1200 rpm. As the wind increases, the generator increases its output, which is measured in kilowatts. According to Curt Maloy, vice president of the DWEA, the ideal wind turbine would be one without a gearbox. "The transmission is where the stopping forces and the driving forces all meet, putting a strain on the system," Maloy says. "If we do away with the gear-



U.S. WINDPOWER PHOTO

Regular maintenance is vital to keep turbines ready for the intermittent wind.

box, we'll have a straight shaft right into the generator. Research and development is being done on building a generator that can produce electricity at 50 rpm and at 480 volts of AC current to go into the utility grid."

The brakes that control the rotational speed can be aerodynamic, as in tip flaps, or mechanical, as in disc brakes. They are activated by a signal from an anemometer that reads the wind speed or by a centrifugal force that builds up as the speed of the blades increases. The disc brake has rubber couplers that give it some flex as it keeps the rpm constant or stops the system for maintenance. A yaw

system connected to the anemometer and a wind vane keeps the turbine facing in the direction of the wind.

But fixed-speed wind turbines have a low capacity factor when compared to other energy sources because of the intermittent nature of wind and the variability of wind speeds. Taking advantage of only high wind speeds rather than the full range of wind speeds lowers a turbine's potential production capacity. To capture wind energy with maximum efficiency, U.S. Windpower, Inc., based in Livermore, California, has developed, along with a consortium of utilities, a variable-speed, variable-pitch prototype—the 33M-VS. According to Wayne Hoffman, a project manager at U.S. Windpower, the prototype turbine has a sophisticated electronic system that smooths out the peaks of power outputted by its twin generators. This electronic converter allows the rotor and the generators to speed up with gusting or stronger winds. The increased rotational energy is then converted into more electricity without increasing torque on the drivetrain. The converter maintains the 60 Hz output despite the generators' changing output frequency. The system's customized software also adjusts the pitch of the blade to match wind-speed variations.

Going home

When the blades spin faster than the rated rpm, the force is captured as electricity. The turbine's generator outputs this electricity through a cable that travels down the 100-ft. tower to underground cables. They connect to padmount transformers that step up the voltage for delivery to a central collecting area or a substation. The substation is where the generat-

(Please turn to page 95)

THE PRICE IS RIGHT

A sextet of boat-motor-trailer combos you can buy for \$8000 or less.



BY JOHN WOOLDRIDGE, Contributing Editor
PM Photos by Skip Gandy

● No doubt about it, package deals are a good idea if you're getting your feet wet in boating. First-time boaters love them. They're a turnkey buy. They come completely optioned out. And, best of all, they're affordable. What's not to like?

Exactly. Which is why we assembled a fleet of six of the least-expensive package boats we could find. Our boats run the gamut from a sporty bowrider to a tournament-type bass boat to a family-size pontoon platform. Despite obvious differences, they all have one thing in

common: You can drive off a dealer's lot and launch one for \$8000 or less.

Bayliner 1700 Capri

There's no shortage of fiberglass package boats in the \$10,000 price range, but Bayliner, a division of Brunswick Marine, is the only manufacturer to consistently offer entry-level glass runabouts for less than eight big ones.

Bayliner, along with Tracker Marine, is credited with pioneering the package boat concept in the early 1980s and using it to launch a period of explosive growth. Today, it's the largest pleasure boat builder in the world.



BAYLINER 1700 CAPRI

Our test Capri clearly benefits from Bayliner's long experience in this market. The sporty bowrider was one of the two quietest boats in the fleet, the top-end champ and one of the two best on the performance course, with surefooted handling in corners and wheel-lock turns. Acceleration, with a 70-hp Force outboard, was more than capable enough to pull waterskiers.

Fit and finish is equally outstanding. Bare fiberglass is kept to a minimum, and the carpeting is precisely installed. Storage is minimal, but there's room for rods and skis along the sides and a couple of coolers aft. Features of note include a radio/cassette with weather cover, twin swim steps with a pull-out boarding ladder and head-turning good looks.

Affordable family boating doesn't get much better than this.

Fisher 16 Hawk CS

Beyond Bayliner, when you're talking \$8000 or less, you're talking aluminum. And the Fisher 16 Hawk CS, like the rest of our fleet, is an aluminum fishing boat.

The Fisher 16 Hawk locates the helm far forward in the bow to improve weight distribution for a 2-man crew. To clear the deck while fishing, the helm folds flush with the forward casting platform.

Fisher is part of the Brunswick Marine Group, so the 16 Hawk comes with a 40-hp Mariner outboard with power trim/tilt and oil injection. A MotorGuide electric

THE PRICE IS RIGHT



TRACKER BASS BUGGY 18

trolling motor and a Humminbird fishfinder are also part of the 16 Hawk package.

Driving from the far forward position takes some getting used to. In a chop, you're bound to get wet at slow speeds, although it dries out once you're on plane. Around the handling course, the 16 Hawk was predictable, but its flat bottom caused it to slide wide through turns.

Snag-proof carpeting hides a great deal of aluminum, but it's still a spartan skiff that's designed to do one thing—get out on the water and fish.

Grumman 163 SuperPro Fisherman

Now under the mantle of OMC, Grumman is poised to enter the modern era of boating. Years of neglect by its former parent company forced the builder to stamp out no-frills boats deeply rooted in the past.

The 163 SuperPro Fisherman is cut from this mold. It's a no-nonsense, tiller-steered, utility fishing boat with the fleet's lowest sticker—\$5638. It's got a livewell and a Lowrance fishfinder. Rods store in rubber clips along the starboard side.

The test motor was a 40-hp Evinrude that powered the light hull to surprisingly good performance marks.

Passenger-seat placement was inexplicably off center and too far aft. Side flexing, or oil canning, was very noticeable in choppy water. And several sharp interior corners and snag points were left unaddressed. Grumman appears to be working hard to catch up, but still has a way to go.

Lowe 1600

Lowe Industries, another OMC division, builds aluminum boats the old-

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE AS TESTED	ENGINE	ENGINE HORSEPOWER	LENGTH/BEAM/ WEIGHT/ FUEL CAPACITY	TRAILER
Bayliner 1700 Capri P.O. Box 9029, Everett, WA 98206	\$7995	3-cylinder, 75.1-cid Force outboard	70 hp @ 5500 rpm	16'7"/5'10" 1090 lb./6 gal.	US Marine Escort, galvanized or painted
Fisher 16 Hawk CS 7633 E. 63rd Place, Tulsa, OK 74133	\$7895	4-cylinder, 43.9-cid Mariner outboard	40 hp @ 5500 rpm	16'5"/9' 475 lb./6 gal.	EZ Loader, painted
Grumman 163 SuperPro Fisherman P.O. Box 549, Marathon, NY 13803	\$5638	2-cylinder, 44.99-cid Evinrude outboard	40 hp @ 5500 rpm	16'3"/5'9" 625 lb./6 gal.	Kristi Industries, painted
Lowe 1600 2900 Industrial Dr., Lebanon, MO 65536	\$7840	2-cylinder, 44.99-cid Johnson outboard	40 hp @ 5500 rpm	16'6"/ 910 lb./6 gal.	ShoreLand'r, painted
Spectrum 1709 7633 E. 63rd Place, Tulsa, OK 74133	\$7200	2-cylinder, 48.3-cid Force outboard	50 hp @ 5500 rpm	16'7"/5'6" 710 lb./6 gal.	EZ Loader, painted
Tracker Bass Buggy 18 1915-C S. Campbell, Springfield, MO 65807	\$7900	2-cylinder, 44.99-cid Tracker (OMC) outboard	40 hp @ 5500 rpm	18'8"/ 1630 lb./12 gal.	Tracker Trailstar, painted



LOWE 1600



FISHER 16 HAWK CS



SPECTRUM 1709



GRUMMAN 163 SUPERPRO FISHERMAN

fashioned way—with craftsmanlike care. For example, most of the aluminum sides are hidden by carpeted deck structure. Rod holders are mounted on portside braces. A side-mounted steering console comes with full engine instrumentation and a Lowrance fishfinder.

The 1600 is a versatile fishing boat that combines a functional bass-boat layout with a mod-V bottom for good handling in big waters. Although the 1600 is rated to take up to 70 hp, our test boat came with a 40-hp Johnson that still provided snappy hole shots.

It was truly impressive on the performance course, where it exhibited amazing tracking in back-to-back WOT wheel-lock turns.

An aerated livewell, fore and aft casting decks and copious storage are a few of the outstanding features on a boat that sets the aluminum standard.

Spectrum 1709

For the serious bass angler, the Spectrum 1709 features a dedicated bass layout with raised casting decks and fore and aft livewells. An affiliate of Brunswick, Spectrum equips the boat

with a 50-hp Force outboard. A MotorGuide trolling motor and a Humminbird fishfinder are also standard.

Non-slag carpeting covers virtually all inside aluminum. Storage lockers and livewells feature insulated lids and heavy-duty piano hinges.

The 1709's flat bottom, which has only a 7° deadrise, has a tendency to side-slip through wheel-lock turns, but this isn't much of a problem. In choppy water, the ride was dry.

Good news, bad news: Gray non-skid appliqué on the foredeck is effective with wet shoes, but brutal on bare skin. Noteworthy touches include superior detailing of molded thermoplastic helm console and standard radio/cassette player.

Tracker Bass Buggy 18

King of the \$8000-or-less package boat is Tracker Marine. The Bass Buggy 18, a sturdily built and smartly laid-out platform for fishing and partying, demonstrates why.

The fully carpeted 18-ft. pontoon boat came equipped with a 40-hp OMC outboard, which is private labeled for Tracker, the world's largest purchaser of outboard motors. Performance marks were less than dazzling, but the emphasis is on stability and comfort.

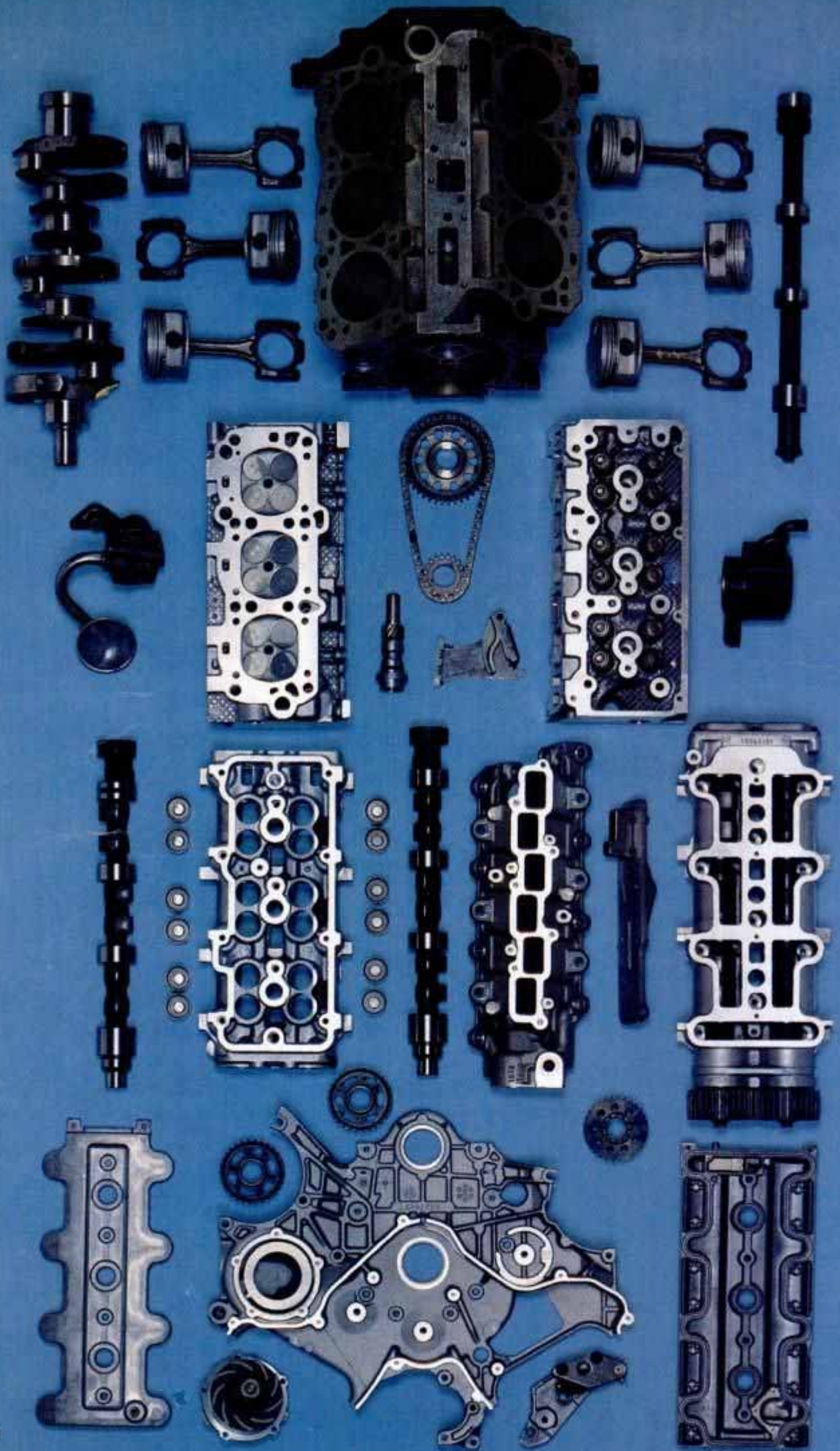
Seating for this price range is impressive. Two swivel seats forward are ideal for casting. A plush bucket seat serves the driver, and two large aft benches, which fold into a sunpad, provide plenty of space for the crew. An aerated livewell, flip-up beverage tray, tach, speedo and fishfinder are just a few of the standard features.

The only nits we could find to pick were the location of the battery, which was open to splashing water, and bare marine-grade plywood under the bench seats. These components didn't seem in keeping with the surprisingly high overall quality.

The package boat concept has matured in recent years. Today, it's diversified. Its standards are high. And best of all, it's affordable. **PM**

TEST RESULTS

TOP SPEED	HOLE SHOT 0-20 MPH	PERFORMANCE COURSE	DECK AREA/STOWAGE SPACE	DECIBEL READING IDLE/WOT	FUEL FLOW @ 1500 RPM/4000 RPM/WOT	FIT & FINISH
37 mph, ski-boat speed	5.94 sec., hull weight a factor	25.1 sec., surefooted cornering	24.63 sq. ft./2.89 cu. ft.	62 dBA/88 dBA	1.5 gph/5.75 gph/9.25 gph	Detailing is slick for this price range
33.5 mph, fast enough for fish	5.77 sec., zero bow rise	29.1 sec., some fishtailing	55.49 sq. ft./4.49 cu. ft.	62 dBA/92 dBA	1.0 gph/3.0 gph/5.0 gph	No-frills skill with sound values
33 mph, strong engine torque	4.16 sec., quick, with bow rise	29.23 sec., needs practiced hand	31.34 sq. ft./2.76 cu. ft.	63 dBA/95 dBA	2.0 gph/4.0 gph/7.0 gph	Spartan with some rough edges
29.5 mph, brisk for small engine	4.22 sec., headsapping	25.39 sec., outstanding handling	54.07 sq. ft./13.07 cu. ft.	61 dBA/93 dBA	1.0 gph/3.75 gph/6.0 gph	Best-dressed aluminum, sturdy construction
29.5 mph, can stray from line	5.02 sec., no vices	30.1 sec., slippin' and a slidin'	60.78 sq. ft./14.14 cu. ft.	63 dBA/90 dBA	1.0 gph/4.0 gph/6.5 gph	No obvious compromises, many fishing features
19 mph, good cruising speed	7.33 sec., not bad for pontoons	40.6 sec., slow but steady	75.69 sq. ft./6.19 cu. ft.	60 dBA/80 dBA	1.0 gph/3.5 gph/5.5 gph	Sound overall, designer's touch



POWER TRIP

A technical analysis of GM's new 3.4-liter dohc 24-valve V6.

BY MIKE ALLEN, Assistant Automotive Editor; PM Photos by G Photo

● General Motors had already established that its engineering staff knew how to design thoroughly modern, 4-valve powerplants, first with the versatile 4-cylinder Quad 4 and later, working through its Lotus subsidiary, with the potent LT-5 V8 used in the Corvette ZR-1. With an extra pair of valves to assist in breathing, multi-valve engines have exceptionally high specific outputs and efficiency.

But GM also had a need for an intermediate-size 6-cylinder powerplant for some of its larger upmarket car lines, an engine that would deliver more peak power and torque, as well as the inherent smoothness of a Six.

GM's normally aspirated pushrod-valve 3.1-liter V6 is a good, reliable powerplant, but retuning it to the level of performance required wasn't really the answer. The 1990 Pontiac Grand Prix Turbo made good dyno numbers, but the sudden onset of power and high cost of the turbo limited its practicality.

On the other hand, the capital investment and long lead-time for designing an all-new engine from scratch were prohibitive.

As a result, GM's powertrain engineers elected to turn the 3.1 into Cinderella. With the bottom end basically unchanged in terms of critical dimensions—the 60° vee angle, bore spacing and bearing diameters—this solution had another attractive advantage. The new engine could be manufactured on the same production line as the 3.1, permitting considerable volume flexibility. If sales of the new engine were slow, the line could still make 3.1s. If the new powerplant was a success, the production mix could be changed almost instantly to reflect customer preference.

Turning a bread-and-butter moderate-tech engine into something on the cutting edge of engine technology was not easy. Very few of the 3.1's components are interchangeable with those of the new engine, which bears an unfortunate name: Twin Dual Cam V6.

Starting with the same basic bottom end dimensions, the new power-

plant uses a 92mm cylinder bore instead of 89mm, increasing displacement moderately to 3.4 liters (207 cu. in.). The cast, nodular iron crankshaft is substantially stouter than the 3.1's, to accommodate the 3.4's substantial increase in peak power and torque.

To reduce lubrication requirements in the bottom end of the engine, the oil grooves in the upper main and con rod bearings are moon-shaped. Normally, these grooves are a simple annular ring, the same depth for 360° around the rod journal. But the moon-shaped



grooves taper to nothing at the ends, where bearing loads are smallest.

In order to keep bearing clearances as accurate as possible, the crankshaft journals are all ground precisely to the same size, rather than following the more common practice of sorting components to different size classes and using appropriately sized bearing inserts to make up the difference.

But the largest change—all-new heads and an overhead-cam valvetrain—required considerable innovation. The 3.1's central camshaft is located immediately above the crank, and operates the valves through long pushrods. Perching the 3.4's four camshafts directly above the cylinders permits direct actuation of the valves, reduces valvetrain mass and

allows higher revs for more power.

Packaging considerations are often a factor in engine design, and the 3.4 was no exception. The new powerplant had to fit into engine bays designed for the original 3.1. Good breathing through the valves required the camshafts to be as close to one another as possible. But there's a limit to how small the sprockets of the camshaft's drivebelt can be. Too small a sprocket engages too few teeth of the cogged belt, reducing longevity. And the limiting factor is the crankshaft sprocket, which needs to have half the circumference of the cam sprockets to achieve the necessary 2-to-1 reduction in gearing between crank and camshafts.

General Motors' engineers found a unique compromise. A short drive chain, with the 2-to-1 reduction achieved in the chain, is used to drive an intermediate shaft riding on bearings formerly used for the 3.1's centrally located camshaft. The intermediate shaft also drives the oil pump through gears, as on the 3.1. This arrangement permits five identical-diameter pulleys to be used for the cam drive.

A straight chain-driven cam system, like the Quad 4, might seem to be a simpler solution. But GM engineers felt the long, complex chain drive simply couldn't be made quiet enough for the type of vehicles that would be using the 3.4.

Noise reduction shows up in other areas of the new engine's design. For example, the accessories are all mounted very close to the engine on a large alloy casting that also serves as the front engine cover. This cover encloses the front of the intermediate shaft/crankshaft chain drive, the rear of the cam drivebelt and the single serpentine accessory drivebelt's automatic tensioner. Close-coupling the accessories to the engine aids in packaging and reduces vibration in the alternator, power steering, a/c compressor and water pump.

The bolts that hold the camshaft carrier covers down are bushed with rubber, isolating valvetrain noise

POWER TRIP



Camshaft lobes are undercut on base circle to make hydraulic lifters rotate slowly and minimize cam noise and lifter wear.



Paired intake and exhaust valves are actuated by lifters riding in cam carrier bolted directly above cylinder head.

from the thin, sound-transmitting cover. The fuel rail is shielded by a sheetmetal cover to prevent the clicking of the electronic fuel injectors from being audible—even at idle with the hood open.

Another major consideration was to have an engine that kept all of its oil inside. And with the many sealing surfaces of an overhead-cam engine, this called for the extensive use of a relatively new technology. Silicone rubber O-rings will provide good sealing, but installation on the production line and in the field can be extremely difficult. Another problem is ensuring that the gasket or O-ring is squeezed just the right amount—not enough to deform, but enough to prevent leaks. The 3.4 uses cast plastic gasket carriers, which hold a rubber O-ring in place. For example, the cam-cover-to-cam-carrier bolts would be tightened until the two metal surfaces bottom out on the plastic, deforming the rubber exactly the right amount for proper long-term sealing.

The real story, though, is how to achieve 210 hp at 5200 rpm, and 215 ft.-lb. of torque at 4000 (more than many 300-cu.-in. V8s) from a 207-cu.-in. Six—without compromising off-idle and midrange driveability.

Camshaft timing is actually very mild—milder than the 3.1. Valve lift, 9.4mm for both intake and exhaust, is less than the 3.1's 10mm intake and 10.4mm exhaust lift. There's a limit to valve size in a 2-valve head—it's when the sum of the valve sizes equals the



Mild pent-roof combustion chamber with central spark plug has 9.25:1 compression ratio, permitting use of 87-octane fuel.



Oil-to-water heat exchanger reduces oil temps under heavy loads, as well as aiding in warmup of oil during cold weather.

bore diameter. And there's a point of diminishing returns to increasing valve diameter. Any valve too near the cylinder wall has reduced flow capacity, caused by the air piling up against the cylinder on the way in or out. A quartet of smaller valves has a much larger annulus than the largest paired valves that can be fitted.

In addition to the mild cam timing, inlet runners are small enough to permit good gas flow velocity at part-throttle and low rpm, further aiding low-speed punch.

Because of the paired intake runners—12 in all—the fuel injectors use a special dual spray pattern, a pair of cone-shaped streams, each one aimed at the back of an intake valve. Otherwise, the injector would have to be located much farther upstream of the valves, before the runner split.

The 3.4 has no distributor of any sort. The crankshaft center main bearing has a large-diameter cheek. Slots are milled into the perimeter of the cheek, and a magnetic sensor screwed into the side of the block reads the slots as they pass by. The computer uses this information to provide ignition pulses to the three separate ignition coils, which fire the spark plugs in pairs. This means that every spark plug fires not only just before TDC on the compression stroke—to provide ignition to the mixture in the cylinder—but also 360° of crank rotation later, near TDC on the exhaust stroke. There's apparently no reason not to do this, and plug



Single throttle body, plenum and upper intake manifold are rubber-isolated from heads by rubber mounts for reducing noise and vibration.

Smaller sprocket on crankshaft drives larger intermediate shaft sprocket, which carries lower camshaft drive-belt sprocket.



life doesn't seem to be affected.

Most engines use a vacuum-operated exhaust gas recirculation (EGR) valve. EGR is used to dilute the intake mixture with hot, spent exhaust gases to reduce the combustion chamber temperatures and lower oxides of nitrogen emissions. Like several other modern multivalves, the 3.4 uses a trio of electrical EGR valves, controlled directly by the computer, permitting very precise control of when and how much exhaust gas to bleed back into the intake.

With 24 hydraulic bucket valve lifters to supply, the 3.4 runs plenty of lubricating oil around the top end of the engine. Concerned about excess oil temperatures, GM engineers added an oil-to-water heat exchanger between the engine block and the spin-on oil filter. Spliced into the heater hose, this serves two functions.

First, it promotes faster warmup of the engine oil, especially during cold weather. Second, when the engine is fully warmed and under heavy load, it will prevent oil temperature from becoming significantly higher than the coolant temp. A more conventional cooler sticking out into the airstream would cool the oil, but might cool it too much in cold weather.

In the metal, the Twin Dual Cam V6 is impressive looking, as well as impressive sounding. There's a dead-smooth idle followed by an authoritative snarl as it climbs through the gears—which it does quite rapidly, thank you.

FM

JOURNAL



SHOP PROJECT

RED OAK RACER

This red oak wagon delivers a freight car full of fun.

BY ROSARIO CAPOTOSTO, Contributing Editor

● Treat a child to a toy that is very rugged, has plenty of character and can be a barrel of fun, namely, an old-fashioned wagon. Our version is built of solid red oak, and has red enamel accents and removable stake sides.

But our fundamental design principle was to deliver durability because kids can really put any toy to the test. Even the wagon's finish and glue are exterior grade, helping it withstand mud puddles, dewy mornings and being left out in the rain. And, with safety in mind, its edges and corners have

all been rounded over and sanded smooth.

This shop project is surprisingly straightforward, requiring no complex joints or shaping. Simply cut the pieces to size, form dadoes where appropriate, and fasten the pieces together with glue and screws.

The metalwork is also easy to make. The handle is bent to shape on a jig, and the handle brackets are made from corner brackets. The only metal working tools you need are a hacksaw and a file.



The wagon's stake sides are removable and interchangeable.

Color photo: Bill Ashe
Black-and-white photos: Rosario Capotosto
Technical art: Eugene Thompson

Building The Bed

Begin construction by ripping and crosscutting the side and end pieces for the wagon bed. Mark off the dado locations, being careful to obtain identical spacing between the sides and the front and back. This keeps assembly simple and ensures that the sideboards can be interchanged.

We simply taped the sides together and marked across them with a square and pencil (Photo 1). You can also clamp the pieces together and mark them. Mark the front and back pieces the same way (though the front and back are not interchangeable).

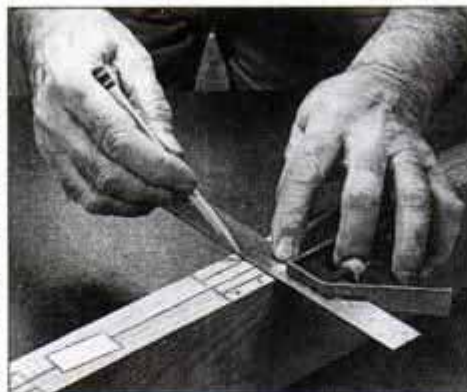
Use a router with a $\frac{3}{4}$ -in.-dia. straight bit to cut the $\frac{1}{4}$ -in.-deep dados and rabbets to receive the bed's front and back pieces. Readjust the router for a $\frac{13}{32}$ -in. cutting depth, and nail together the simple guide to cut the $\frac{19}{16}$ -in.-wide dados for the stake sides.

To make the guide, nail together four lengths of 1×2 stock. The two pieces that form the jig's lower half butt against the edges of the workpiece. The two pieces that the router runs against are spaced as follows. Measure from the cutting edge of the bit to the outside edge of the router base. Double this figure and add the dado width (in this case, $\frac{19}{16}$ in.). Clamp the guide over the dado, and make several passes to form the dado (Photo 2).

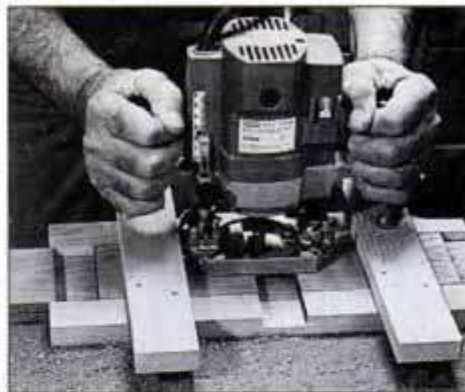
The deck or floorboards are made of $\frac{1}{2}$ -in.-thick stock. If you can't get $\frac{1}{2}$ -in.-thick oak, resaw it from $\frac{3}{4}$ -in.-thick stock on a band saw or table saw. Saw it slightly overthick so it can be planed and sanded to finished thickness.

Temporarily clamp the wagon sides and ends together while boring the screwholes (Photo 3). Note that the upper screws in each pair are covered by the upper trim strip, so there's no need to counterbore for a wood plug. The four lower screwholes are not covered by trim and should be plugged. Counterbore these holes for either $\frac{3}{8}$ - or $\frac{1}{2}$ -in.-dia. plugs cut from a scrap of oak.

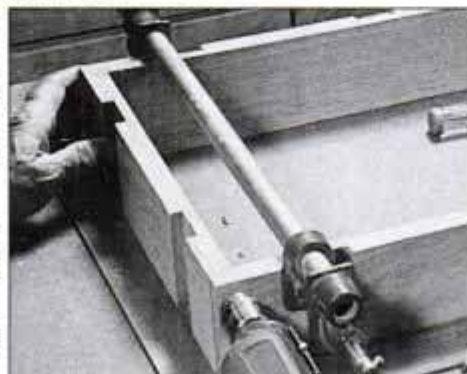
Temporarily drive the screws to hold the rectangle together. Then remove the clamps and bore pilot holes to tack-nail the floorboards in position. Fasten each floorboard with two partially driven brads. And, bore the pilot holes for the screws that fasten the floorboards. When all the holes are bored, disassemble the parts. Cut and sand the curves on the front end of the sideboards and on the floorboards.



1 To mark stake dados in wagon sides, tape or clamp pieces together. Use a pencil and square to draw the dado lines.



2 Clamp wagon side to workbench, and tack down jig centered over dado. Run router against each fence to cut the dado.



3 Position square at corner and clamp sides together. Bore pilot holes. Lower holes are counterbored and plugged.



4 Clamp sides together, and use a router and rounding-over bit to soften the corners at the top and bottom of the dados.



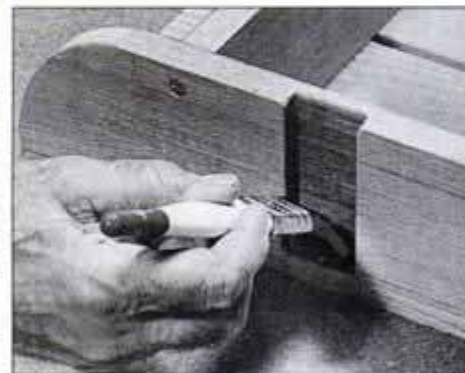
5 Router bit can't reach dado corners, so finish rounding dado edges with 120-grit sandpaper wrapped around a block.



6 Screw together the wagon body using a modest amount of glue. Screw the floorboards to the front and back.



7 Glue and plug lower screwholes in wagon sides. When the glue is dry, pare plugs flush to the sides with a sharp chisel.



8 Before attaching side trim, brush varnish into dados before applying the trim strips that hold the stake sides to the bed.

OAK WAGON

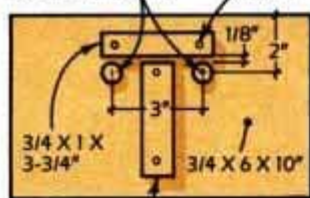
15-1/2" WIDE X 20-3/4" HIGH X 32-7/16" LONG

MATERIALS LIST—OAK WAGON

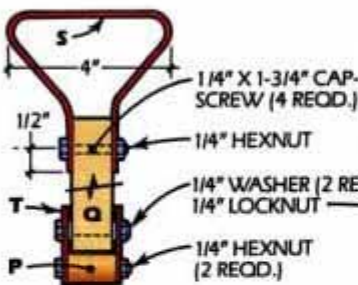
Key	No.	Size and description (use)
A	2	3/4 x 3 1/2 x 32" oak (side)
B	2	3/4 x 3 1/2 x 13 1/2" oak (end)
C	4	1/2 x 3 3/8 x 32" oak (floorboards)
D	2	7/16 x 3/4 x 13" oak (front trim)
E	2	7/16 x 3/4 x 14 1/2" oak (back trim)
F	2	7/16 x 3/4 x 29 3/4" oak (top side trim)
G	2	7/16 x 3/4 x 32 7/16" oak (bottom side trim)
H	12	3/8 x 1 1/2 x 10 1/2" oak (stakes)
I	4	3/8 x 3 x 15" oak (long side slats)
J	4	3/8 x 3 x 13" oak (short side slats)
K	4	3/8 x 3 x 13" oak (end slats)
L	2	3/4 x 2 1/2 x 14 1/2" oak (cleats)
M	1	1 1/16 x 3 3/4 x 11 1/4" oak (front bolster)
N	1	1 1/16 x 4 9/16 x 11 1/4" oak (rear bolster)
O1	1	3/4 x 4" dia. oak (upper disc)
O2	1	3/4 x 4" dia. oak (lower disc)
P	1	3/4 x 3 3/8 x 11" oak (yoke)
Q	1	3/4 x 1 1/16 x 27" oak (handlebar)
R	2	1/2"-dia. x 14 1/2" steel rod (axle)
S	1	3/8 x 3/4 x 11" aluminum (handle)
T	2	3/4 x 4 x 4" flat corner plate (handle brackets)

Misc.: 4 8"-dia. symmetric rib wheels (1 3/8" hub length, 1/2"-dia. bore); 4 1/2" push-type axle nuts; 4 1/2"-dia. fender washers; 1 1/2" x 3 1/2" hexhead capcrew, washer and locknut (for steering axle); 4 1/4" x 1 1/4" capcrew; 3 3/4" hexnuts; 1 1/4" locknut; 2 1/2"-dia. washers; 8 2" No. 10 fh screws; 10 1 1/2" No. 10 fh screws; 9 1 1/4" No. 10 fh screws; 2 1" No. 10 fh screws; 8 1 1/2" No. 10 fh screws; 26 1 1/2" No. 8 rh screws; 8 1 1/2" No. 10 rh screws; 26 1 1/2" No. 8 rh screws; 1/4" 18-ga. brads; 120- and 220-grit sandpaper; McCloskey polyurethane varnish; Krylon white primer; Krylon cherry red spray enamel.

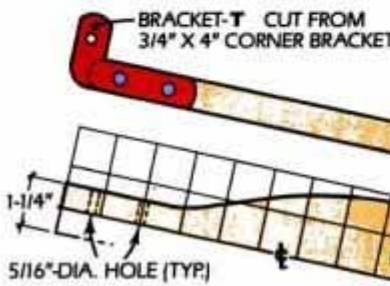
3/4"-DIA. X 2"-LONG DOWELS SET IN 5/8"-DEEP HOLES



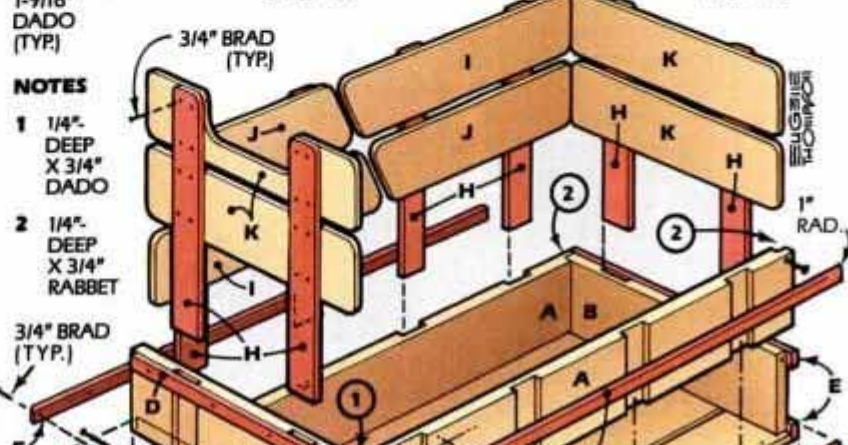
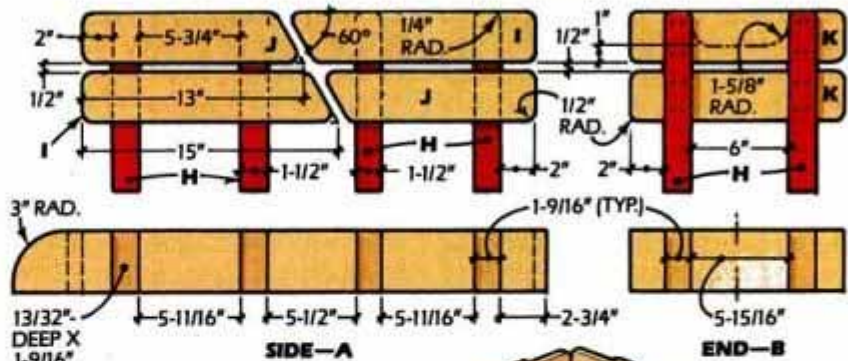
ATTACH BLOCK AFTER INITIAL BENDS ARE MADE
HANDLE BENDING JIG



HANDLEBAR ASSEMBLY

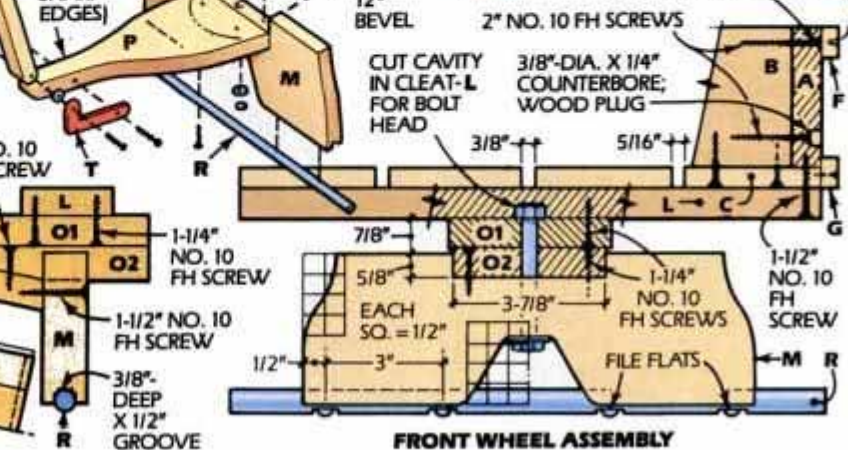
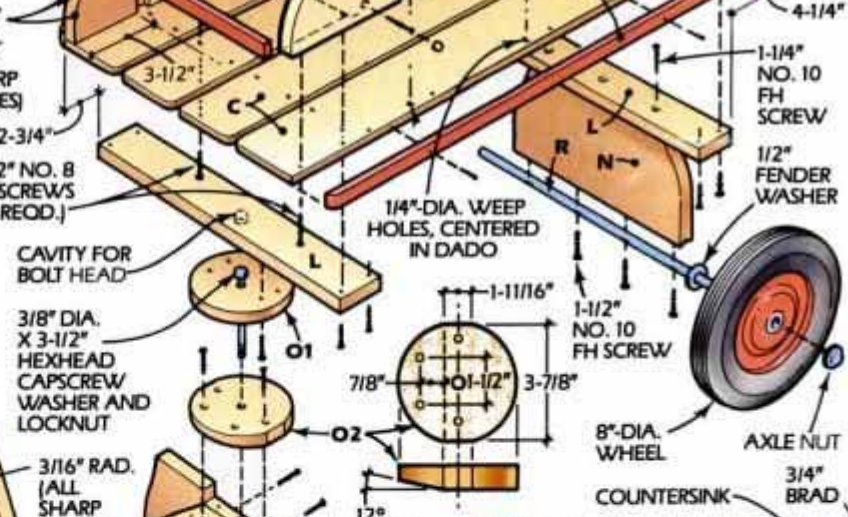


PATTERN-YOKE P EACH SQ. = 1"



NOTES

- 1 1/4" DEEP X 3/4" DADO
- 2 1/4" DEEP X 3/4" RABBET



FRONT WHEEL ASSEMBLY

Use the router and a $\frac{3}{16}$ -in.-rad. rounding-over bit to ease all exposed corners. On the sides, leave the edge square where the side is covered by trim (the edge of the trimpiece is rounded, however). This is neater and prevents dirt from getting trapped in the corner where curved and straight surfaces meet.

The easiest way to round over the top corners of the stake dados is to clamp the sides together, face to face,

in a vise. Make a pass with the router to round the corners (Photo 4). Round over the corners, where the router bit cannot reach, by sanding with a block wrapped with 120-grit sandpaper (Photo 5).

Bore the weep holes in the two outer floorboards, and sand all the parts prior to assembly. Since the wagon often may be left outdoors, use water-resistant plastic resin glue. Remember to work quickly with this glue be-

cause it sets rapidly.

Screw the bed pieces together with a modest amount of glue brushed on the joints (Photo 6). Too much glue will ooze all over. Glue plugs into the screw holes where appropriate. Trim the plugs flush with a chisel (Photo 7).

Since it would be difficult to apply varnish to the stake grooves after the trim has been applied, apply the finish to these areas first with a narrow paintbrush (Photo 8).

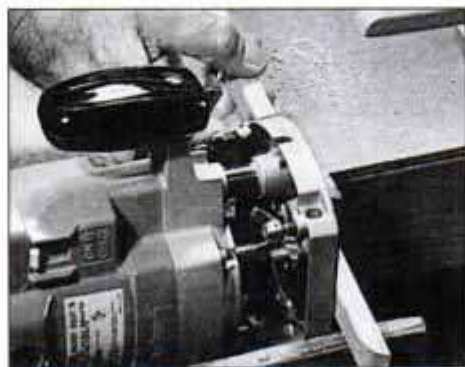
Trim And Stake Sides

Rip and crosscut the trim strips and round their outside edges. You may be able to clamp your router in a vise and feed the trimpieces past the bit (Photo 9). Otherwise, use a router table to ease the edges on these pieces. Tack-nail the trim in place, and sand the rear corners flush at the joints. Carefully remove the trim.

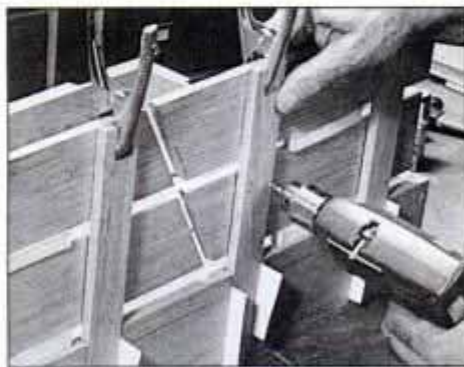
Resaw the slats and stakes, from $\frac{5}{8}$ -in.-thick stock. Plane the pieces to $\frac{3}{8}$ in. thick, rip and crosscut them, then joint the edges of each. Place the stakes in the dados with a cardboard shim on each side (Photo 10). The cardboard shims ensure that an equal space will be left on both sides of each stake. You may be tempted to skip the shims, but don't. They are an easy way to ensure properly fitting stakes.

Clamp the slats to the stakes, and bore pilot holes for $\frac{3}{4}$ -in.-long, 18-ga. brads. Clip the head off a 1-in.-long brad to use as a drill bit. Code the mating pieces before disassembly.

Saw the corner of the slats round, and soften the remaining edges with a $\frac{3}{16}$ -in.-rad. rounding-over bit on a router table (Photo 11). Finish sand the pieces, and assemble the stake sides with brads and glue (Photo 12).



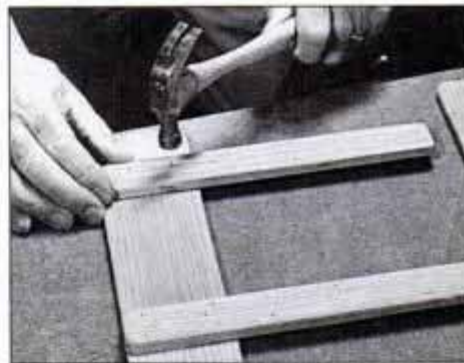
9 Narrow trim strips are difficult to shape. If possible, clamp the router in a vise and feed the strips by the router bit.



10 Place stakes in dados with cardboard shims, and use blocks to position slats. Use cut-off brad to bore the pilot holes.



11 Pull slats against rounding-over bit in router table to ease corners. Leave slat edge square where it mounts to stake.



12 After slat and stake edges are rounded, fasten parts together with glue and brads. Leave brads flush to surface.

Wheel And Steering Assemblies

The wheel and steering assemblies are made of $\frac{3}{4}$ -in.-thick stock, except for the front and rear bolsters which are cut from $\frac{5}{8}$ -in.-thick stock. Rip and crosscut the bolsters, and cut their axle grooves by making stepped kerf cuts on the table saw. Rip and crosscut the cleats and handlebar.

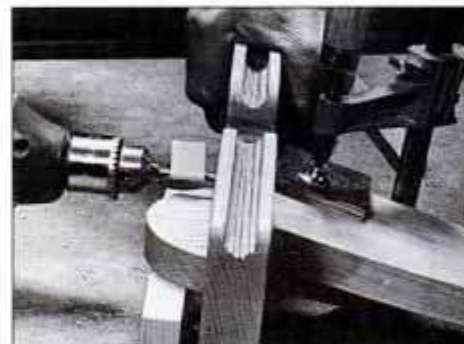
Rip, crosscut and shape the yoke as in the drawing, including the angled face that meets the front bolster.

Crosscut the $\frac{1}{2}$ -in.-dia. axle rods with a hacksaw, then file a flat at each screw location. Dimple the hole centers with a center punch, and bore the holes for the screws. Bore matching pilot holes in the bolsters.

Next, make the pair of discs that house the steering axle. The top disc



13 Clamp the lower disc in a vise, and bevel its face using a hand plane. Use a sliding T-bevel to gauge surface angle.



14 Clamp yoke to disc's beveled face. Position bolster against yoke, and bore pilot holes through bolster into the yoke.

is attached to the cleat, the lower disc is attached to the bolster. Saw the discs to diameter, and form two flats on the lower disc, as shown.

Use a plane to form the bevel on the

lower disc. Test its angle with a sliding bevel gauge (Photo 13). When this is done, varnish and wax the mating surfaces of the disc faces, and screw the lower disc to the bolster. Clamp

the disc to the yoke, and bore the pilot holes through the bolster for the screws that attach the bolster to the yoke (Photo 14).

Next, cut the hex-shaped mortise in the cleat to hold the capscrew (Photo 15). To do this, mark for and bore a hole, then draw in the hexagon around the hole. Chisel the hole into a hexagon-shaped mortise. With the capscrew seated in the cleat, glue and screw the upper disc to the cleat (Photo 16).

Fit the capscrew through the lower disc, and tighten on a locknut (Photo 17). Glue and screw together the yoke and disc.

Bore the screwholes in the rear cleat and wagon bed before attaching the cleat to its bolster. Screw together the bolster and cleat, then glue and screw the assembly to the bed.

Make the handlebar brackets from flat corner plates. Shape them with a hacksaw, and file them smooth, then

test fit them on the yoke (Photo 18).

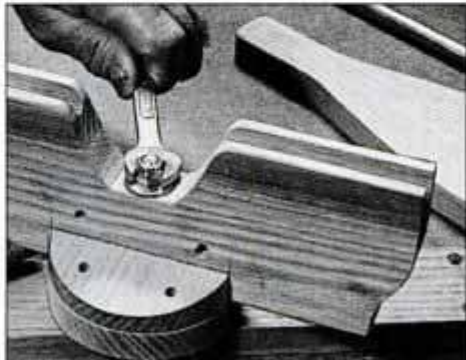
The handle is made from an 11-in.-long piece of 1/8-in.-thick x 3/4-in.-wide aluminum bar stock. It's bent to shape on the jig shown. Clamp the bar against the rear block, and bend it around the posts with a block of wood. Finish bending it to shape with a wood hand screw clamp (Photos 19 and 20). Test fit the handle to the handlebar. Attach the pieces permanently after painting them.



15 Bore a hole in the front cleat, and chisel hole into a hexagon-shaped mortise. Capscrew's hexagon head fits mortise.



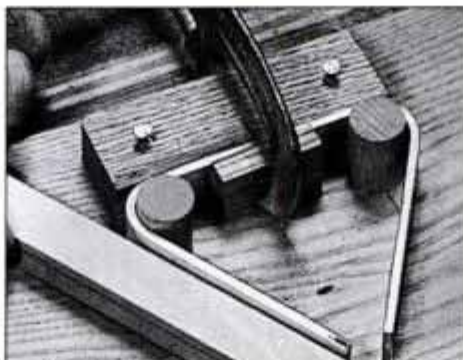
16 To form upper half of the steering assembly, insert the capscrew in disc. Then, glue and screw the disc to the cleat.



17 Slip bolster over the capscrew, and tighten on the locknut. To reduce friction, varnish and wax the faces of the discs.



18 Cut handlebar brackets from flat corner plates. Round off the corners and edges, then check them for fit over screws.



19 Use bending jig to shape handlebar. Slip aluminum band into jig and clamp. Bend the piece using stick for leverage.



20 Complete handle forming by bending it with parallel jaw clamp. Nail scrap block to jig, and bend piece against block.

Applying Varnish And Paint

We finished this wagon with McCloskey polyurethane varnish and Krylon cherry red spray enamel. First, mask off the sideboard slats with tape and paper so that only the stakes are exposed. To mask the wheels, simply apply the tape so it covers both the rim and tire. Then, run a razor knife along the rim to cut off the tape and expose the rim (Photo 21).

Apply several coats of Krylon white primer to wood and metal parts. Apply two coats of red enamel, allowing the first coat to dry before recoating.

Next, attach the trim strips with brads and glue. Go easy with the glue to avoid squeeze out. Drive the brads close to the surface, then finish driv-



21 Prior to painting, tape over the rim and tire. Silt tape between rim and tire with razor knife. Peel off the tape from the rim.

ing them with a drift punch so their heads are flush with the surface.

Apply three coats of varnish to the clear wood and painted areas. Apply only two coats of varnish over the low-



22 When paint on rims is dry, stack wheels as shown and drive axle through both at one time. Fasten axles to bolsters.

er sections of the stakes.

Drive each axle through a pair of wheels as shown (Photo 22). Then screw the axles to the bolsters, and the wagon is done.

PM

APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Needs Peace Of Mind

I have a Whirlpool Design 2000 washer, model No. LA5700XPW4, serial No. C60406896. The drain line from the pump to the standpipe uses a plastic coupler to pass through the washer's back panel. The line from the pump to the coupler has worked its way loose several times, causing severe damage on one occasion. I have replaced the original spring hose clamp with a screw-type hose clamp, but I still have doubts about leaving the washer during drain cycles. Do you have any suggestions that might give me a little more peace of mind?

CHRIS WILKINSON
RICHMOND, VA

Sounds as if you need a hose and connector kit, and the Whirlpool service manual to help you install it because this job is reasonably complex. The kit is part No. 285560, costing about \$14, and the manual costs about \$8. Both should be available through a Whirlpool distributor. The kit contains a new drain hose, drain connector, two clamps and instructions.

Basically, you need to remove the washer's drain hose from the standpipe or washtub. Next, you'll remove the washer's cabinet (per the instructions in the manual) to gain access to the water pump, and then you remove the hose from the pump and from the drain connector. Remove the screws

holding the drain connector. Reinstall a new drain connector, hoses and clamps, and reinstall the cabinet.

Wants To Rewire Range

I have a Tappan Fabulous No. 400 range. It's an older model. The wiring needs to be replaced, and I need a wiring diagram and a manual. I can't find the serial or module numbers. Can you please send me the mailing address of Tappan?

JOHN DREISCH
SHERMAN MILLS, ME

To get a copy of the service manual or wiring diagram for your 1958-to-1968 vintage range, find the model and serial number plate (usually located in the bottom of the pullout burner drawer, under the burners or up on the front of the range between the two oven doors). Send it to White Consolidated Industries, 6000 Perimeter Dr., Dublin, OH 43017; Attn.: Consumer Relations Dept.

If you can't find the model and serial number plate, look for the wiring diagram glued to the underside of the top panel above the control panel. If the diagram is not readable, there may be a part number along the diagram's border.

Needs Booklet

I have a Panasonic "Little Chef" microwave model No. NM 4207A, serial No. AW720200160. The instruction booklet was thrown out by mistake. I have written the manufacturer twice but to no avail.

ALFRED AZAR
BROOKLYN, NY

Write Consumer Affairs Dept., Matsushita Services Co., 50 Meadow-

lands Parkway, Secaucus, NJ 07094. Include the product's model and serial number in your letter.

Needs Heating Units

We have an SU-4G Thermador cook top mounted in our kitchen countertop. Where can we obtain new heating units and switches?

RALPH F. ALLEN
VESTAL, NY

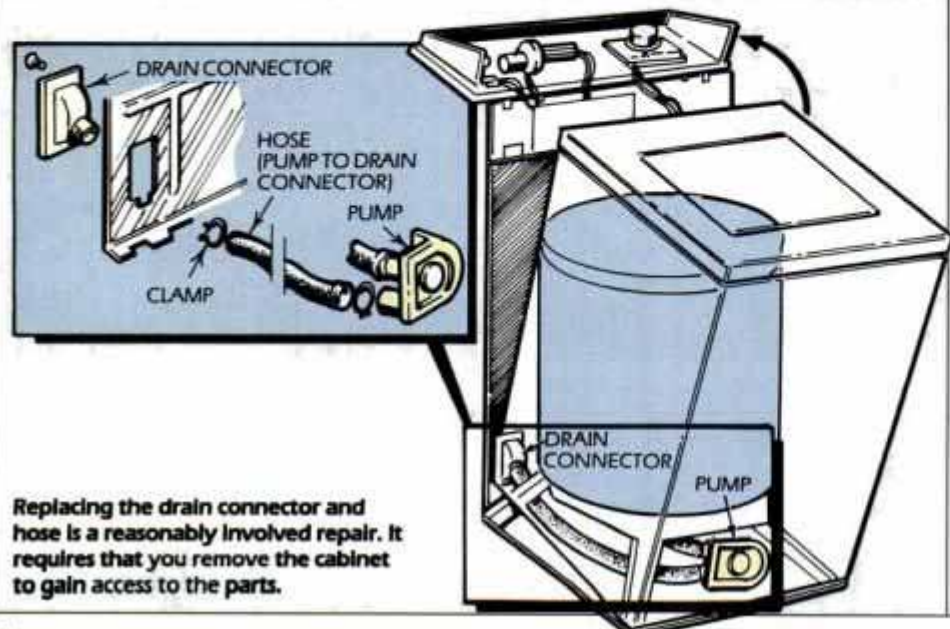
For the location of a Thermador parts distributor in your area, contact Thermador, 5119 District Blvd., Los Angeles, CA 90040; or call (213) 562-1133.

When writing, include the type of appliance, the model and serial numbers, and the name and description of the part. Include your address and phone number.

The company will contact you by mail or phone to tell you whether the parts are still available and the location of your nearest Thermador parts distributor.



PHOTO BY ROSARIO CAPOTOSTO



Replacing the drain connector and hose is a reasonably involved repair. It requires that you remove the cabinet to gain access to the parts.

Service Tip

The handicapped and elderly can find the kitchen, bathroom and laundry rooms inaccessible, an encumbrance to independence. Whirlpool Corp.'s brochures provide ideas to make these areas more accessible.

Single free copies of "Tools For Independent Living," "Designs For Independent Living" and "Universal Design Brochure" are available from AIS, P.O. Box 85, St. Joseph, MI 49085. **PM**

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

MORE THAN A MILLION
HOMEOWNERS HAVE CHOSEN
THIS ELEGANT UPGRADE.

Silent Floor

SQUEAKY, BUMPY FLOORS ARE A THING OF THE PAST. GUARANTEED.



Compared with Italian tile or hardwood cabinets, the Silent Floor® joist system* isn't much to look at. But if you've ever lived with bumpy, squeaky floors, we think you'll agree with more than a million other homeowners. The Silent Floor system from Trus Joist is a beautiful alternative to old-fashioned building materials.

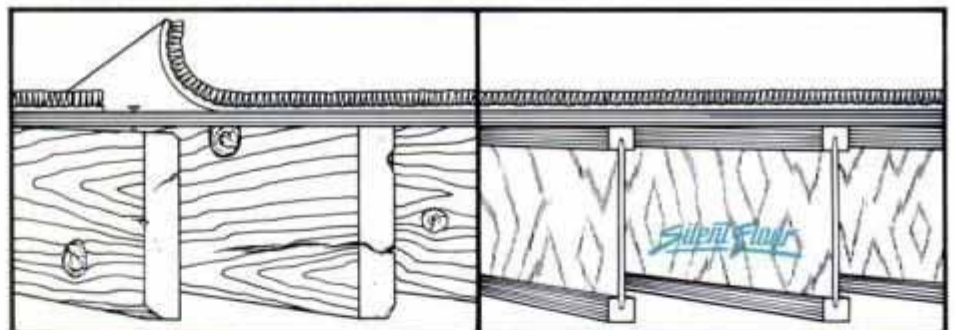
The Silent Floor.

A better way to build a floor.

Ordinary lumber can warp, twist and shrink. When it does, the floor develops bumps. Dips. And squeaks. But the Silent Floor system is engineered to stay flat, solid and silent for the life of your home. Guaranteed.

As strong or stronger than old fashioned lumber.

Pound-for-pound, Silent Floor joists are a whole lot stronger than ordinary lumber. Just like steel



When the floor separates from a warped or twisted joist you've got a problem. Step on that spot; the floor will squeak when it rubs against the nail.

I-beams, they can carry a lot of weight without a lot of mass.


Guaranteed for the life of your home.

Trus Joist invented the original Silent Floor joist more than 20 years ago. Since then it's been installed in more than 1 million homes. Which is why we can confidently guarantee that the Silent Floor system will never develop bumps, dips or squeaks for the life of your home.

Look for the Silent Floor logo. You'll find a quality builder.

If you're thinking of building or buying a new home, ask for the one and only Silent Floor system from Trus Joist. It's an easy and affordable step up. And it's a sure sign that the builder cares about quality on every level.

 **TRUS JOIST CORPORATION**
A division of TJ International

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800-338-0515

*The Silent Floor system consists of TJ® joists and MICRO-LAM® LVL beams.

**NEW PRODUCTS
HOME TEAM**

15 New Do-It-Yourself Products For Easier Home Improvement.

BY ROY BERENDSOHN, Assistant Home Improvement Editor

Small Serving

Now you don't have to buy a whole roll of insulation when all you need is a small piece to stuff around a window, door or air conditioner. Manville's mini package contains a roll of 2-in.-thick, unfaced fiberglass insulation, 16 in. wide x 48 in. long, wrapped in plastic with a built-in carrying handle. It costs about \$3 at home centers. For information, call (800) 654-3103.



Inner Space Is A Better Place

These stacking shelves make better use of the space inside your cabinets, and they are easy to install. The model above right (about \$6) snaps together and stands on 8-in.-tall legs. Its shelf measures 12 in. wide x 18½ in. long. The slide-out drawer model screws to a cabinet's base and comes

in 11-, 14- and 20-in. widths (about \$47 to \$60). Both are made out of coated steel wire and rod, and are sold at home centers and hardware stores. For more information, write Clairson International, Consumer Relations, Dept. PM, 720 S.W. 17th St., Ocala, FL 32674.



Team Effort

Red Devil Paint Co. teams the rich look of enamel with the gloss-retaining toughness of polyurethane in its oil-based polyurethane enamel. The finish can be used on wood, metal or concrete, indoors or out. It's sold in ½ pint, pint, quart, gallon and as a spray can (\$4, \$6, \$9, \$30 and \$5, respectively) at hardware and paint stores. Write to Thompson & Formby, 825 Crossover Ln., Memphis, TN 38117.



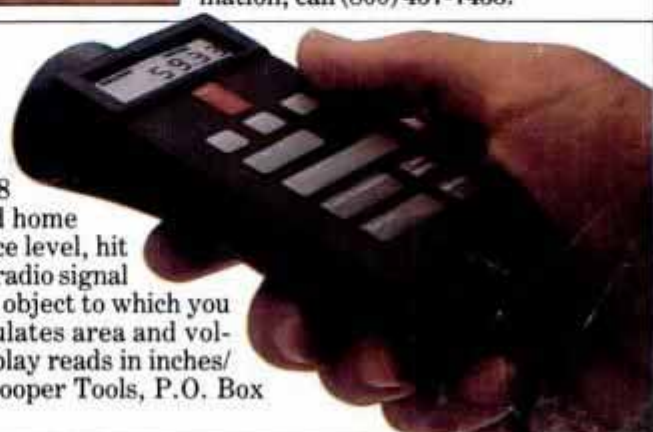
Eco Stripper

Woodfinisher's stripping gels are biodegradable and nonflammable, have very low odor and clean up with water. They contain no methylene chloride, methanol, acetone, toluene or petroleum distillates. Their containers are recyclable plastic and can be returned to the manufacturer for recycling. A \$1 refund defrays mailing costs. One gel strips oil-based and latex paints and lacquer. The other strips polyurethane, shellac, lacquer and varnish. A 32-ounce size of either costs about \$9, and a 64 ounce, about \$15. Both are sold at paint and hardware stores. For information, call (800) 457-7433.



Go The Distance

Measure distances up to 48 ft. with this pocket-size electronic measuring device (about \$78 at hardware stores and home centers). Hold the device level, hit a button, and it sends a radio signal bouncing off the wall or object to which you are measuring. It calculates area and volume, and its digital display reads in inches/feet or metric. Write Cooper Tools, P.O. Box 728, Apex, NC 27502.





Hands Up

Enter a room and turn on a light with your hands up, down or even tied behind your back, because this hands-free light switch is motion activated. The switch operates the light with an adjustable time delay. A manual over-

ride toggle lets you leave the light on or off for as long as you like. You can install a standard cover plate over the switch. It costs about \$15 through the Heath Home Automation Catalog, P. O. Box 8589, Benton Harbor, MI 49022-8589.

A Real Grabber

We tried this toggle bolt and found it has several unique features. The jacket has a pointed tip and a Phillips slot. Just screw it into the drywall without boring a hole. Meaty threads at the jacket's top cut into the drywall locking it in place. Next, thread the sheet-metal screw provided into the jacket. The screw engages the wing enclosed in the jacket and brings it up tight against the wall. What you are fastening to the wall is squeezed between the 1½-in.-long wing and the oversize screwhead in a viselike action. The improved design makes it easy to install and remove. A pair of bolts costs about \$2 at hardware stores and home centers. Write ITW Buildex, 1349 W. Bryn Mawr Ave., Itasca, IL 60143.

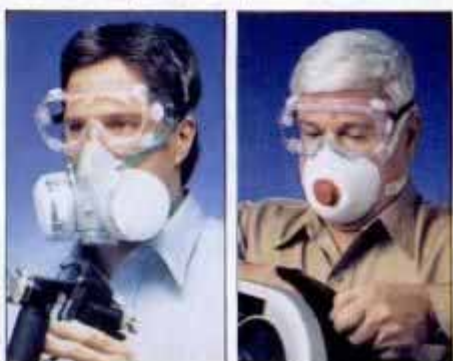


Crystal Clear

The problem with some water-based finishes is that they are milky and have a tendency to lighten the wood they are applied on, especially lightly colored woods. McCloskey seeks to solve this with its water-based Crystal Clear Polyurethane, its Acrylic Finish and its Sanding Sealer. The company says the polyurethane and acrylic build to a suitable finish in two coats, and the sanding sealer dries quickly enough to allow several coats to be applied in a day. The finishes are sold in a range of sizes. A gallon of polyurethane costs about \$45; acrylic, \$38; sanding sealer, \$24; and stain, \$26 at hardware stores and home centers. Write McCloskey Corp., 7600 State Rd., Philadelphia, PA 19136.

Health Insurance

Do-it-yourselfers can protect themselves from a variety of airborne dusts and vapors with these respirators from 3M. The dual-cartridge respirator (about \$35), protects against a number of paint mists, organic vapors, dust and spray. It features a silicone face piece, and it completely disassembles for easy cleaning and repair. Its strap fasteners are made with flexible plastic instead of metal. The lightweight respirator (about \$15) contains a chemical absorbent, and it protects you against wood, iron and lead dust, and metal fumes from welding, cutting and brazing. Both are sold at hardware stores and home centers. Contact Consumer Relations, 3M DIY Division, 3M Center, 515-3N-02, St. Paul, MN 55144.



Stick Around

Goldblatt has introduced what may be the most rugged drywall repair patch on the market—a self-adhering aluminum screen. Stick the screen to the wall as it is, or cut it to shape. Use a taping knife to spread drywall compound over the screen, and when dry, sand smooth. Called the Pace-Setter Repair Patch, it comes in a variety of sizes. A pair of 4-in.-sq. patches costs about \$4 at hardware stores and home centers. Write to Goldblatt, 511 Osage, P.O. Box 2334, Kansas City, KS 66110.





Instant Closet

You can organize your closet space with this kit, or create a closet. It spans spaces from about 5 ft. wide to 7 ft. It attaches to hollow walls with fasteners that are hammered in, so there's no need to drill. The kit includes two 42-in.-long rods, an 80-in.-long support post and assembly hardware (shelf not included). The all-steel components are finished with a baked-on white enamel. It costs about \$22 at hardware stores and home centers. Contact The Hirsh Co., 8051 Central Park Ave., Skokie, IL 60076.

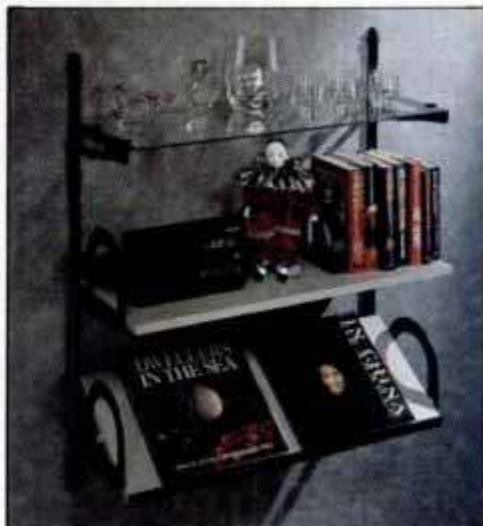
A New Look

Plastic plumbing components take on a new look with chrome-plated 1¼-in.-dia. wash basin traps from Genova (about \$9). The polypropylene components thread together and are installed like their unplated counterparts. They're sold at hardware stores and home centers. Write Genova Products, Inc., 7034 E. Court St., Davison, MI 48423.



Big And "Green"

If you're an ecologically minded remodeler, you can wheel the demolition rubble to the curb in a container made of recycled plastics. Its wheels are made from new plastic, but the rest of Rubbermaid's No. 1334 is made of such things as recycled detergent jugs. The company says the black 31-gallon container will stand up to intense sunlight and sub-zero temperatures. The container is covered by a full 3-year warranty, and it costs about \$24 at hardware stores and home centers. For more information, write Rubbermaid, Inc., 1147 Akron Rd., Wooster, OH 44691.



Variety Show

Knappe & Vogt's Variations shelving is designed to suit any room in the house, and decor from contemporary to traditional. It consists of black- or white-painted steel wall standards and shelf brackets, and tempered glass or steel-reinforced ¾-in.-thick particleboard shelves covered with melamine. The shelving is available in kit form or as individual parts and can be assembled individually or grouped. The kit shown, with a sloping magazine display, costs about \$75 at hardware stores and home centers. Write Knappe & Vogt Manufacturing Co., Grand Rapids, MI 49505.



Including The Kitchen Sink

If you are replacing the kitchen sink, but not the counter, here's a 2-bowl sink designed for that situation, and it offers contemporary styling, too. It's made of a quartz resin composite impregnated with one of six colors—teal, red, gray, black, white and al-

mond. It comes with a central faucet hole predrilled and knockouts for faucet sets and lotion and hot water dispensers. It's about \$440 at kitchen and bath outlets and home centers. Contact Moen, Inc., 377 Woodland Ave., Elyria, OH 44036-2111. **PM**

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Well Water Spurts

I recently replaced the old galvanized storage tank from my well pumping system with one that has an air bag to separate the water from the air. Since then, whenever I turn on the water faucet, air spurts out of the spout along with the water. Do you know what's wrong? KEISHI SUNAKAWA
FORT MONTGOMERY, NY

In all probability, you did not remove the snifter and the drain and Y fitting from your well system when you switched to the new tank.

These valves were installed on well systems that used submersible pumps and a water storage tank with no membrane separating the water and air in the tank. These valves introduce air into the tank to replenish the air lost through turbulence and absorption.

An air cushion at the top of the tank acts like a spring, and as water is pumped into the tank, the air is compressed. The compressed air forces the water from the tank to the spout. Without the air cushion, the tank is waterlogged and the pump performs as if no tank were used, wearing it out prematurely.

In a properly operating system, the pump is stopped by a pressure switch, and the snifter on the check valve opens, allowing air into the pipe. The

water slug between the check valve and the drain and Y valve drains into the well. When the pump is activated, the air slug is forced into the tank.

When a storage tank with an air bag or diaphragm is used, the water and air are permanently separated, so it's not necessary to introduce air into the tank. Since you did not remove the snifter, every time the pump is activated a slug of air is sent into the tank. The excess air escapes every time water is drawn.

Remove the snifter, and see if that solves the problem. Back out the snifter with a wrench and replace it with a pipe plug. If this doesn't work, remove the drain and Y fitting. However, because the drain and Y fitting is 7 to 20 ft. below the well's top, you may need to hire a professional well installer to remove the fitting.

Hot TV Room

I have a TV room in my basement. The room is hot during the summer months. We have a dehumidifier in the room, so we thought the room should be cool. Could you please tell me why it is hot down there?

MRS. LOUIS VENTURI
SPRING VALLEY, IL

The room is hot because of the dehumidifier. A dehumidifier is basically

a small self-contained air conditioner. An air conditioner discharges the heat removed from the circulating air and from its compressor to the outside, but a dehumidifier dumps that heat into the room.

If the TV room is small and the dehumidifier runs continuously, it discharges enough warm air to heat the room. A dehumidifier is not used to cool a room. It makes a room more comfortable by lowering the relative humidity.

You would be better off with a small wall-mounted air conditioner. This unit also removes excess humidity and cools the room. Even though the TV room is in the basement, a section of the foundation wall is generally abovegrade. If it is a concrete-block wall, an opening can be cut in the foundation for an air-conditioning sleeve, or an air conditioner can be installed in a basement window.

Mold Creeps In

I have just noticed this since I had my rooms remodeled. I had them paneled, and I had insulation put on first. Now I find mold spots forming inside glass picture frames on the shelves. My basement is a dirt floor under the living room. Could the dirt floor be causing this problem? Any help would be appreciated.

DOROTHY SPOONHOWARD
IRWIN, PA

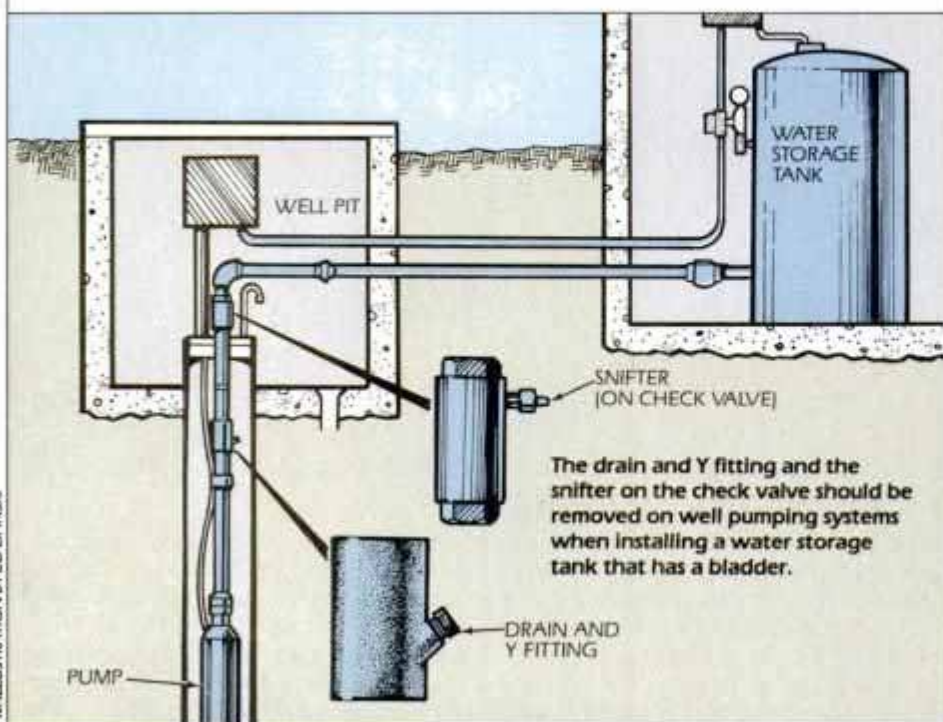
I believe this problem is caused by the dirt floor in your basement. Even when the dirt feels dry to the touch, it wicks up subsurface water, and this is released into the area under the living room and eventually into the living room itself.

Before you remodeled your rooms, there apparently were enough open joints in the walls through which the moisture could escape to the outside. After you remodeled, those joints were sealed causing the moisture to remain in the rooms.

In order to control the moisture buildup, you should cover the dirt floor in the basement with a vapor barrier, such as 4- or 6-mil-thick polyethylene plastic sheets. Overlap the sheets and tape the joints shut. PM

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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



PM ILLUSTRATION BY ED LIPINSKI

**HOME
IMPROVEMENT**

**BUTCHER
BLOCK
FACELIFT**

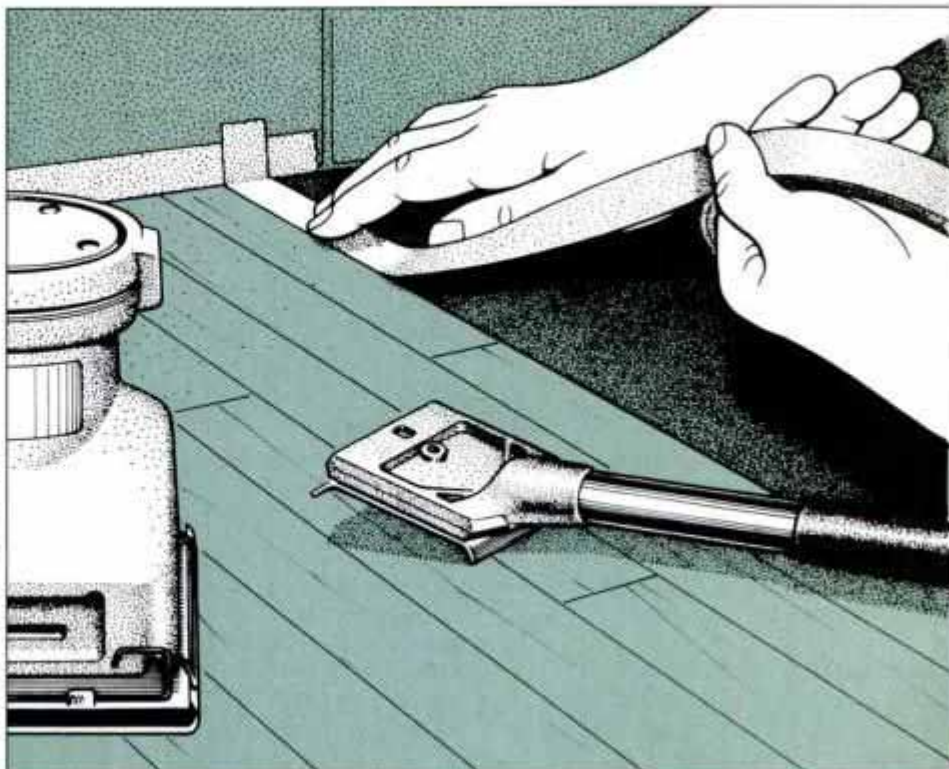
BY GENE & KATIE HAMILTON
PM Illustrations by
George Retseck

● One of the most popular features of today's contemporary kitchen is a solid-wood butcher block cutting surface. Similar in purpose to a small cutting board, a butcher block is the ideal surface for all cutting chores—from slicing bread to chopping vegetables. And, in addition to absorbing knife cuts without dulling the knife edge, a natural-wood butcher block enhances the appearance of the kitchen by complementing the more typical countertop materials with the warmth and character of wood.

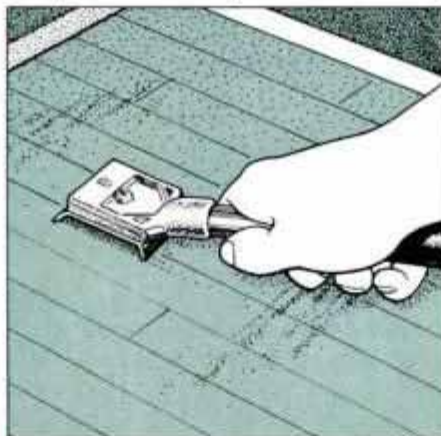
Originally, a butcher block was a massive piece of wood set on end and used by butchers as a chopping block to cut meat. The end-grain surface absorbed knife cuts and cleaver blows without chipping. Today, the term butcher block more often refers to 1½-in.-thick hardwood strips laminated together to form countertop inserts or dedicated cutting tables. Some countertops are made entirely of laminated wood and then varnished or lacquered. In this case, however, the wood is strictly decorative, and the surface is unsuitable for cutting.

If you have a butcher block countertop insert that serves as a cutting board and food preparation area, you may have noticed that continued use has left the wood scarred, dirty and stained. You can give new life to this surface with a lot less work than you might imagine.

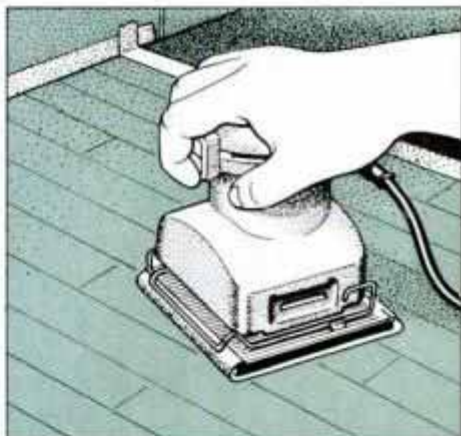
Before you start, be realistic in your expectations. The techniques that we're about to describe handle minor stains, discolorations and knife cuts. If you follow them carefully, you'll be rewarded with a fresh, clean surface and a seasoned look. Deep stains, burns and gouges are much more difficult—if not impossible—to remove completely. If you try, you'll probably sand and scrape away so much wood that the surface will become uneven. Unless you have the tools and experience to either remove



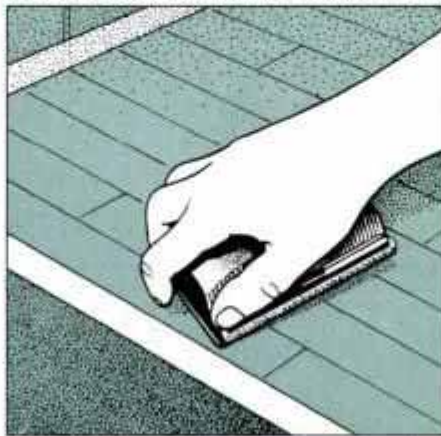
1 A butcher block can be rejuvenated with a few simple tools. The job begins by masking off adjacent countertop surfaces and backsplash with two layers of masking tape.



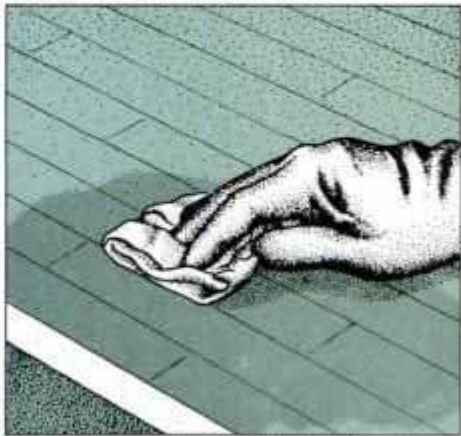
2 Use a hook-type scraper to remove surface grime and get down to bare wood. Pull the scraper with the grain of the wood.



3 After scraping, sand the surface with an orbital sander. Start with 80-grit paper and move to 120-grit to finish the job.



4 Switch from power to hand sanding with a sanding block to clean up areas adjacent to countertop and backsplash.



5 Brighten the butcher block surface by using a cloth to apply ordinary household bleach in a 1-to-1 solution with water.

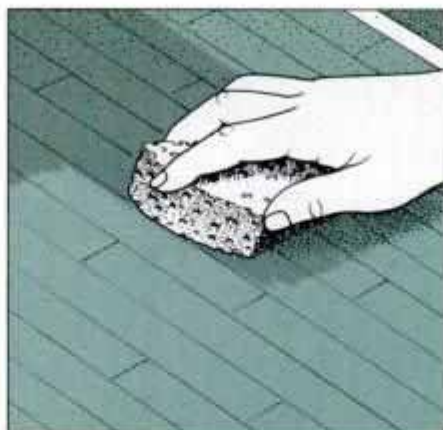


6 For tough discolorations and burn marks, use full-strength bleach. Scrub the areas with a small, stiff-bristle brush.

the butcher block and resurface it—or replace it entirely, it's best to leave this job to a pro.

Preparing the area

The butcher block insert that we worked on fits into a plastic-laminate counter with oak edge trim and a tile backsplash. In addition to the normal accumulation of grime and knife marks, ours had a burn mark from a

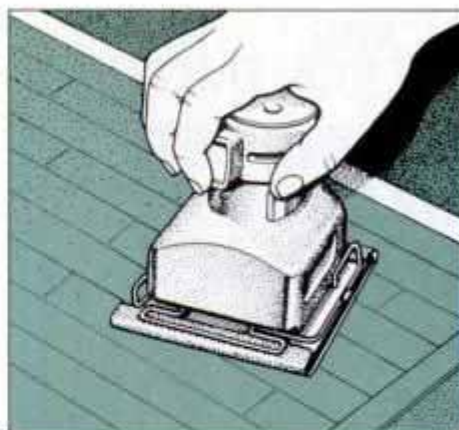


7 After bleaching, neutralize the bleach with an application of white vinegar. Then, wash with water and dish soap.

hot pan. Before starting to resurface your butcher block, protect the adjoining surfaces from the work by carefully masking off the surrounding area. Use a double layer of 1-in., or wider, masking tape. Then, remove all nearby objects (Fig. 1).

Scraping the surface

A hook scraper (also called a wood or paint and varnish scraper) removes



8 Use an orbital sander and 120-grit paper to give the butcher block a final sanding. Hand sand with block near edges.

dirt and any old finish remaining on the butcher block. This type of scraper works much faster than sandpaper, which tends to clog until bare wood is exposed. For best results, use a new blade or make sure to sharpen the old one. Don't use a scraper with a serrated, bent or badly nicked blade because it will gouge the wood.

Hold the scraper firmly with the blade perpendicular to the wood. Press down on the scraper as you pull it toward you in a long, controlled motion. Always scrape with the grain and lift the blade off the wood on the return stroke (Fig. 2).

After you've scraped the entire surface, go back and work on any dark areas and deep knife cuts. To avoid excessive hollowing, scrape the area around the affected spot as well. Remove as much of the grime and old finish to make the sanding easier.

Sanding it smooth

An orbital palm sander, especially one with a dust collection bag, is your best sanding tool because it's lightweight and easy to control. You can also use sandpaper and a sanding block—it'll simply take longer and be more work.

Begin sanding with 80-grit paper, changing the paper often, especially if it clogs (Fig. 3). To prevent marring the adjacent countertop surface and backsplash, use a sanding block near all edges (Fig. 4). When most of the dark areas and cuts are gone, switch to 120-grit sandpaper, and finish the job. Be sure to always sand with the grain.

You'll find that some of the surface blemishes sand out easily, while others, such as deep knife marks that remain after scraping, take time to feather out. As you sand, vacuum the dirt and grit so you can see the true condition of the wood.



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9 Heat mineral oil before applying so it penetrates wood pores. Saturate wood, wipe off excess and buff dry with a soft rag.

Bleaching

Use a solution of household bleach mixed 1-to-1 with water to brighten the whole surface. Wear protective gloves, and generously wipe the solution onto the surface (Fig. 5). For any remaining stained areas and burn marks, use the bleach full strength, working it into the wood with an old toothbrush, wire brush or other stiff brush (Fig. 6). Let the surface dry completely, and then decide if another application is needed—you may have to repeat the process several times to lighten the dark spots.

When you're satisfied (remember, it may be impossible to get out all the dark areas), wipe the surface with a rag soaked in white vinegar to neutralize the bleach (Fig. 7). Wash the area with dish soap and water, and let it dry thoroughly. Then, give the surface a final sanding with 120-grit paper (Fig. 8).

Finish

Because butcher blocks are used as cutting boards, any traditional surface coating will eventually break down and wear away. Also, typical wood finishes contain compounds that aren't suitable for contact with food. Mineral oil is one inexpensive, easy-to-apply finish that's safe to use. Although it won't form a hard surface coating, mineral oil can enhance the appearance of the wood and provide some moisture protection. To apply, set the bottle in hot water for 10 or 15 minutes to heat and thin the oil. Then, use a clean, dry rag to wipe on as many coats as the wood will absorb (Fig. 9).

After the last application, wipe away the excess with a paper towel. For a more typical surface-coating finish that's nontoxic, use Behlen's Salad Bowl Finish. **PM**

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CAR CARE

MAINTENANCE BASICS

REPLACING WIPER BLADES

BY DON CHAIKIN

● If you wait until the next time it rains to discover that your car needs new windshield wiper blades, you may end up needing more than just wiper blades.

You can either replace your wiper blades with exact duplicates from the new-car dealer or with lower-cost universal (or nearly so) replacements from an auto parts store. Depending on the blade, you may be able to replace just the rubber squeegee.

What's what

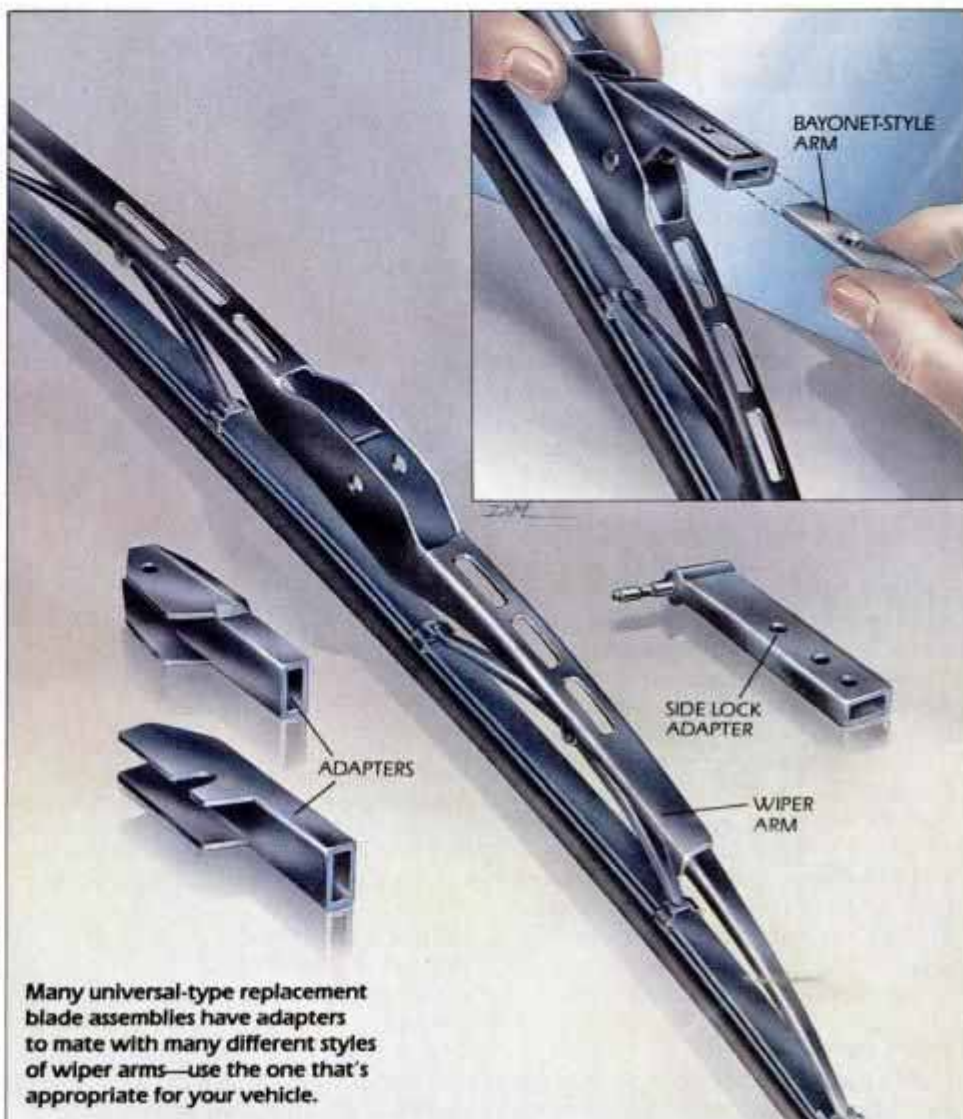
The rubber that actually wipes the water is normally the only piece that wears out. This is called the squeegee or blade refill. The blade is the frame that holds the squeegee in place, and the wiper arm swings the blade back and forth across the windshield.

Before buying replacement blades:

- Measure the length of the blade. Replacements are marked by length, in inches.
- Determine how the blade is connected to the wiper arm.

Depending on the make, model and year of your car or truck, the blade can be attached to the wiper arm in one of several different ways. Universal-type replacement blades are usually packaged with several different types of connectors—match yours when you install the blade. Here are the most common connectors:

- Bayonet-type mounts have the wiper arm going straight into a hinged receptacle on the blade. Release a locking tab and pull the blade straight off the arm.
- Hook-type mounts have wiper arms with a U-shape at the end. The hook goes over a pin or hinged sleeve in the middle of the wiper blade. Flip the blade over the hook, and slide the blade off the hook. Some have a locking tab which has to be released.
- Pin mounts have the blade and arm parallel to each other, attached by a

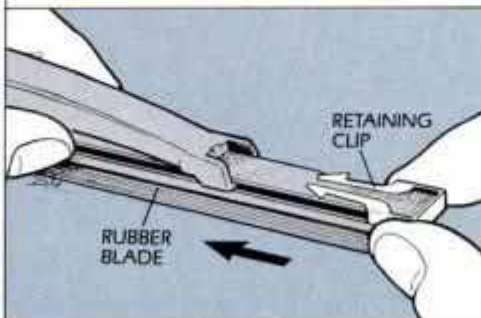


Many universal-type replacement blade assemblies have adapters to mate with many different styles of wiper arms—use the one that's appropriate for your vehicle.

steel pin. Depress the small locking tab next to the pin, and slide the blade away from the arm.

If you choose a duplicate wiper blade from the dealership, reverse the procedure and you're done. If you opt for a universal replacement, select the proper connector adapter and install it on the wiper blade as needed.

If your wiper blade accepts refills,



Replace just the rubber portion by sliding it into the blade until the clip seats.

replace just the old squeegee once you've taken the blade off the arm.

- Most squeegees have locking tabs at one end or the other. Squeeze them closed (pliers are helpful), and slide the refill out of the blade's frame.
- Some blades have a locking tab on one of the blade links. Press in the locking button, and slide the locking link along with the squeegee off the rest of the blade. Remove the locking link from the squeegee.
- Thread the new squeegee through the fingers of the blade frame. Be sure both edges are threaded until it locks in place.

Anytime you're working on the wiper blades, take care not to bend or twist the wiper arms. And always take care not to scratch the windshield—don't operate the wipers on a dry windshield, the grit will etch the glass.

PM

HOW IT WORKS

FUEL INJECTION

BY DON CHAIKIN

• While the future may bring electric-, solar- or hydrogen-driven vehicles, present cars and trucks still have internal combustion engines powered by gasoline or diesel fuel. However, the same concerns that are spurring the quest for alternate power sources demand that today's fuel be used more efficiently than ever.

Drip versus squirt

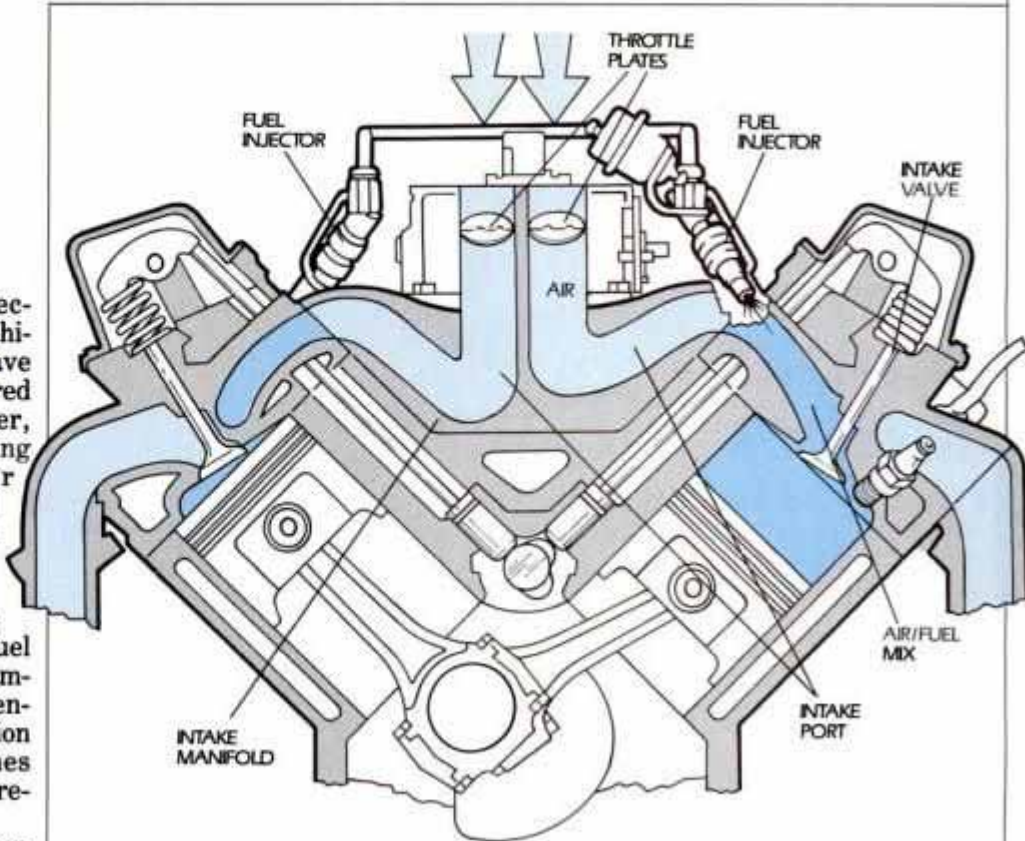
Internal combustion engines ignite a mixture of compressed air and fuel inside a cylinder's combustion chamber to make power. While diesel engines have always used fuel injection to get the fuel in, gasoline engines have traditionally relied on carburetors to mix the fuel with the air.

With a carburetor, the air enters the engine through the carburetor's throat, drawing the gasoline out of small orifices, or jets, in the throat's walls as it goes by. As well as the system works, it's no longer precise enough for maximum fuel economy, good driveability, high performance and emissions-free exhaust.

Port and TBI

Fuel-injection systems replace the carburetor with small, highly accurate spray nozzles, called injectors. The injectors actually squirt, or inject, the fuel into the airstream. While some vehicles have one or two injectors in a throttle-body housing, which resembles a carburetor, most cars now have multiple fuel injectors, with an injector mounted at each cylinder's intake port. Although diesel engines and some older gasoline injection systems use mechanical injectors, most modern cars have electronic injectors.

With an injector at each intake port, the fuel can spray right at the intake valve, minimizing the amount of fuel needed. Equally important, since the fuel is not mixed with the intake air until the last moment, engine designers have great



This engine uses individual injectors. Some vehicles use a single central injector.

freedom in shaping and tuning the intake system for maximum efficiency.

What's needed, when it's wanted

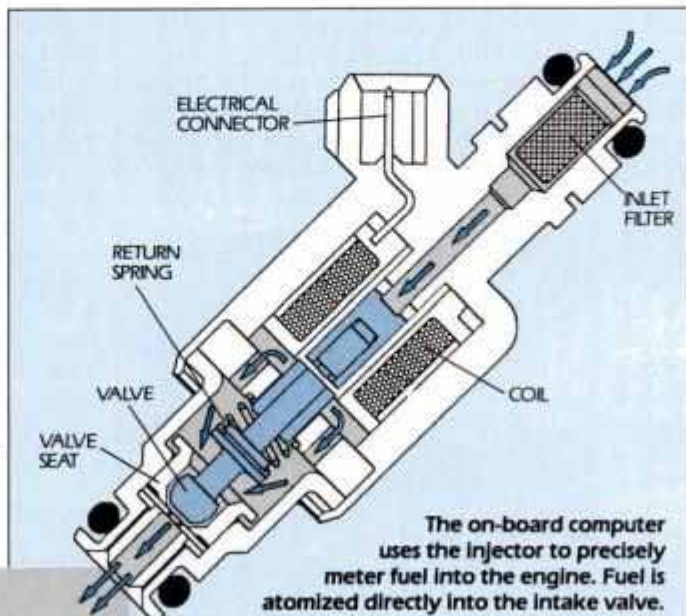
Fuel-injection systems operate under pressure. Typically, the gasoline is kept at 35 to 50 psi by a tank-mounted fuel pump. Somewhere in the line between the pump and injectors is a large fuel filter. To ensure that there's always enough fuel for all conditions, the multiple injectors are con-

nected to a fuel manifold, called a rail. A return line sends excess fuel back to the tank.

Each fuel injector has a solenoid-controlled valve inside its tip. A spring keeps the valve seated tightly against the pressurized fuel inside the injector. The engine computer sends an electric signal to the injector, causing the solenoid to pull the valve off its seat. As the valve opens, it uncovers precisely made tiny holes, called spray orifices, in the injector's tip, allowing the pressurized fuel to spray.

At the command of the engine computer, the solenoid releases the valve, which snaps shut with the help of a return spring.

The amount of fuel that's sprayed is regulated by the length of time the valve is open. The solenoid opens and closes rapidly, and the length of time it remains open is called pulse time. The spray pattern of the injected fuel is determined by the shape and size of the orifices and is mated to the shape and size of the intake port. Engines with two intake valves per cylinder have split spray injectors to spray fuel equally at both valves.



The on-board computer uses the injector to precisely meter fuel into the engine. Fuel is atomized directly into the intake valve.

SATURDAY MECHANIC

SERVICING YOUR COOLING SYSTEM

BY JOHN DECKER

● July. You've driven almost halfway to your first vacation in years. But as you reach the mountains, you notice that when the car begins to climb, so does the temperature gauge. Before long, the gauge is pegged and steam billows from under the hood as you

pull over to the side of the road. And as the Sun sinks slowly into the west, so does your vacation.

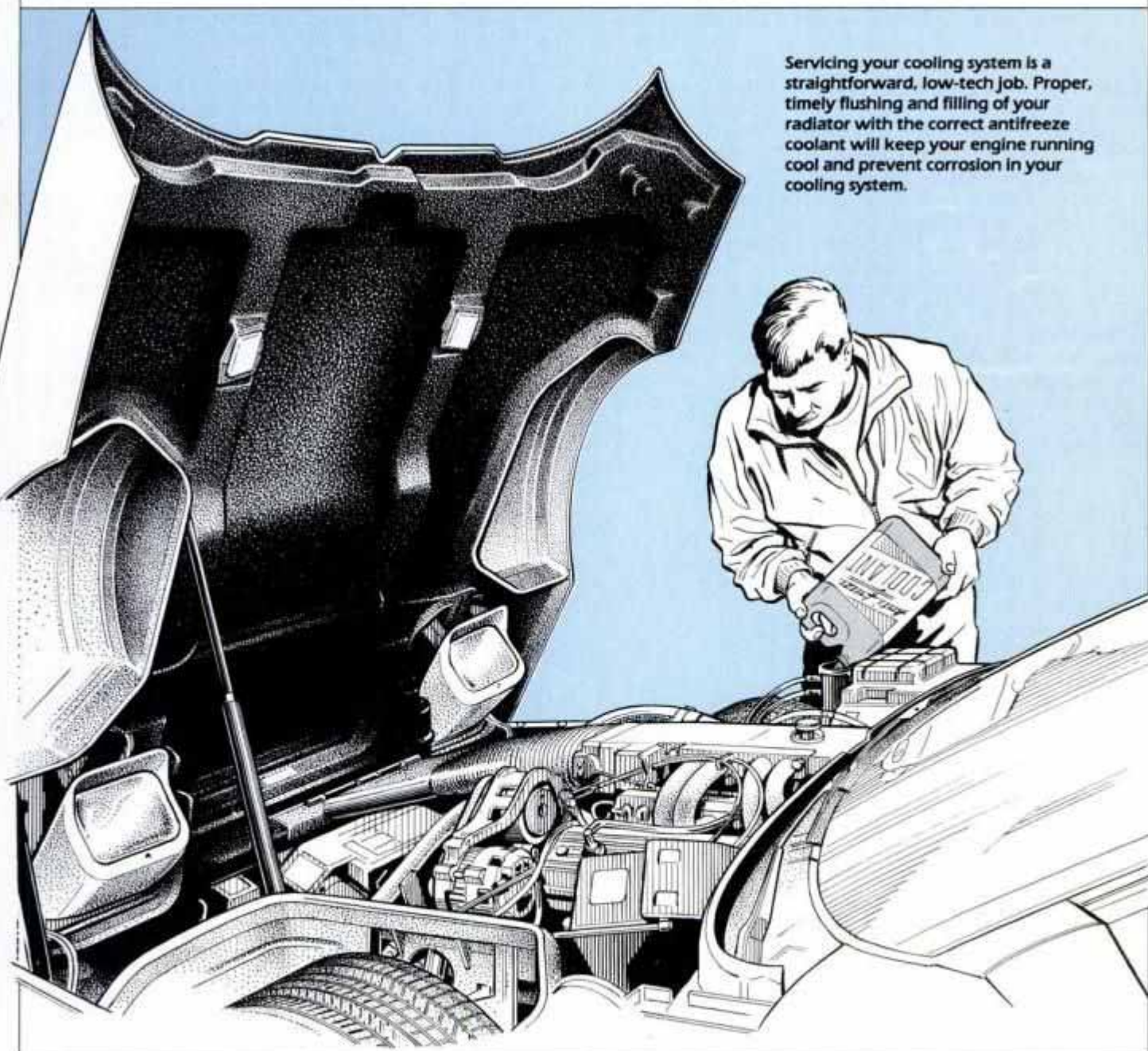
Chalk up this failed cooling system to wear. But the problem is not a worn-out hose or water pump. It's worn-out antifreeze. "A lot of people

don't realize it," says John Conville of Zerex, "but automotive antifreeze does wear out."

Ethylene glycol, which makes up over 95% of the antifreeze, doesn't wear out, but the additive package does. Or more accurately, the additives become exhausted.

One of the additives to get used up is silicone silicate. It protects soft aluminum engine parts—cylinder heads, for example—from the ravages of hot and rapidly circulating coolant. As the engine heats up, silicone silicate bonds to aluminum parts to form an extremely hard protective barrier.

Servicing your cooling system is a straightforward, low-tech job. Proper, timely flushing and filling of your radiator with the correct antifreeze coolant will keep your engine running cool and prevent corrosion in your cooling system.



CAR CARE

Without it, the soft aluminum dissolves into the heated coolant, travels to the insides of the radiator and then sticks to the radiator tubes. Eventually, the tubes plug up and the engine overheats.

The bonding of silicone silicate to aluminum components is not a one-time event. Every time the engine heats up and cools down, some of the silicone silicate loses its bond and falls off the aluminum. Antifreeze makers add extra silicone silicate, and it rebonds to the area immediately. But eventually, the extra silicone silicate gets used up—and the antifreeze is worn out. "It's not how many miles you drive," Conville says, "it's how many times you start your engine, warm it up and then cool it down that determines how long antifreeze lasts."

Conville recommends flushing and refilling the cooling system with a fresh mixture of antifreeze and water every two years—more often for cars that make frequent short trips.

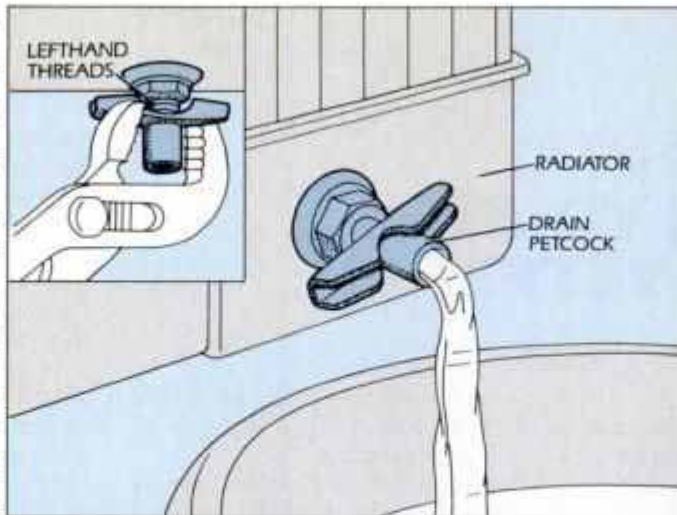
Other additives that protect against rust and neutralize acids also lose their effectiveness over time.

Flushing

Some people mistakenly believe that removing the lower radiator hose and letting as much used coolant as possible drain from the engine and radiator is sufficient before installing new coolant. But that can leave as much as half of the old coolant in the engine, hoses and heater. Some engine blocks have plugs that allow coolant to be drained, but they are often difficult to get to. Even if you find them, they're usually frozen in place.

Removing and replacing half the coolant is better than ignoring the system completely. Unfortunately, installing half of the new antifreeze means you're installing only half of the new additives—which means your cooling system could wind up short of the additives it needs.

The only way to remove *all* of the old coolant, as well as rust, acids and other contaminants, is through backflushing. In this procedure, fresh water is forced through the system in the direction opposite to normal coolant flow. This flushes the old coolant and much of the contaminants backward through the system and out the radiator cap. When the water coming from the radiator cap opening runs clear,



Don't be fooled—the drain cock on your radiator has lefthand threads, and may require more leverage than your fingers to open.

the cooling system is then clean.

The easiest way to backflush a cooling system is to permanently install a flushing tee in the heater inlet hose. The tee allows you to install a garden hose to the heater hose to flush clean water through the engine and radiator. A threaded cap fits over the tee to seal it between flushes. Flushing tee kits are available at most auto parts stores.

Before you start flushing, there are a few words of caution: Never open a warm, pressurized cooling system, or you risk the chance of burning yourself severely. Also, most front-wheel-drive and many rear-wheel-drive vehicles have electric radiator fans that can turn on unexpectedly—even if the radiator is not warm. To be safe, avoid the fan or disconnect it before you start.

To flush the system using a tee, open the radiator petcock and drain the radiator completely. If the radi-

ator doesn't have a petcock, remove the lower hose at the radiator. Draining the radiator lowers the level in the cooling system sufficiently so you can install the tee without spilling coolant all over the engine.

To install the tee, find the heater inlet hose. It travels from the firewall to the engine block. The outlet hose connects to the water pump.

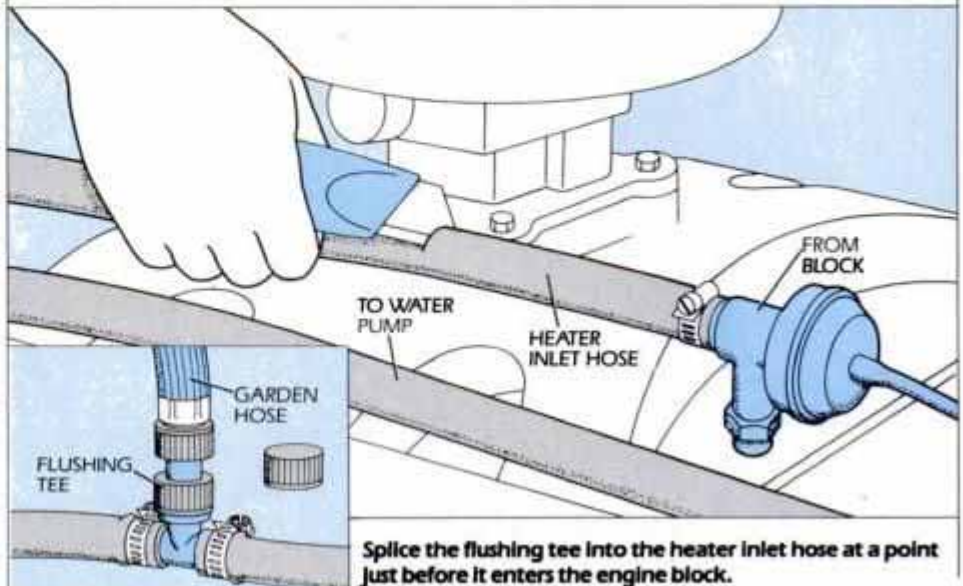
Use a sharp knife to sever the inlet hose in an accessible area, then fit the tee into each end of the hose and secure it with the hose clamps provided with the tee kit.

Next, close the radiator petcock (or reinstall the lower hose), and refill the radiator with fresh water. Then connect the garden hose to the tee.

Before you turn on the hose, install the coolant deflector (supplied with the kit) into the radiator cap opening, start the engine, turn the heater on high and then turn on the garden hose. The old coolant will immediately begin to gush from the radiator. After the coolant is out and the water runs clear for about 2 minutes, shut off the engine, then turn off and disconnect the garden hose.

Most cars today have a coolant recovery tank mounted to the fender well. When backflushing, you should also remove the tank and drain the old coolant.

When you flush your cooling system, keep in mind that antifreeze is highly toxic. It also tastes quite sweet, and pets or small children may try to drink it. For that reason, never leave coolant in drain pans or puddles.



Antifreeze makers recommend discarding coolant in contained sewage systems, such as septic systems or sanitary sewers. Check with your local municipality sewage plant or the local EPA office for their recommendations.

The ethylene glycol, as we mentioned earlier, is not worn out and could easily be recycled by redistilling it to remove contaminants. Unfortunately, we don't know of anyone who does so on a commercial level. But the time will come when antifreeze is recycled as a matter of course, along with engine oil and batteries.

Cleaning dirty systems

If the cooling system in your car hasn't been properly maintained over the years, simple backflushing will not be enough to clean the system. If the old coolant is severely discolored and the radiator tubes and cap opening show evidence of rust and other deposits, consider cleaning.

There are three types of cooling system cleaners on the market. The so-called heavy-duty 2-part cleaners, which consist of a powdered acid-based cleaner, followed by a neutralizer, should *not* be used in an engine containing aluminum components because the harsh alkalis in the neutralizer are too hard on the aluminum. It's especially critical that acid-based cleaners be avoided if your car has an aluminum radiator, since these cleaners can eat through the thin aluminum tubing in a very short time. Ten-minute fast flushes won't hurt aluminum components, and they do a good job of cleaning mild rust and greasy contaminants as well as some of the coarser deposits, but they won't be able to thoroughly clean a severely contaminated system.

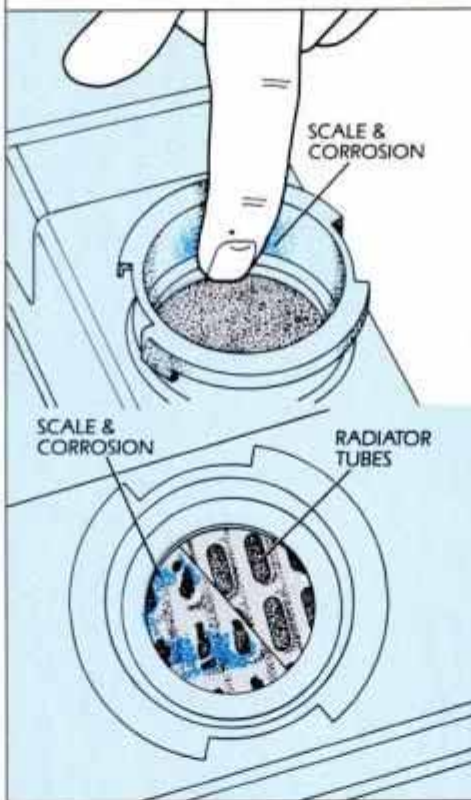
Both the acid-based cleaner and the 10-minute fast flush should be installed before you backflush the system.

Chelator-based cooling system cleaners, such as Prestone Super Radiator Cleaner and Peak Performance Radiator Cleaner, do the best job of cleaning modern cooling systems, especially those with aluminum components. Though they cost slightly more than other cleaners, their effectiveness is worth the added expense. Their only other drawback is that ethylene glycol neutralizes the cleaner's effectiveness, so it must be added to a system that has already been flushed completely with water to assure that all the ethylene glycol has been removed from the system.

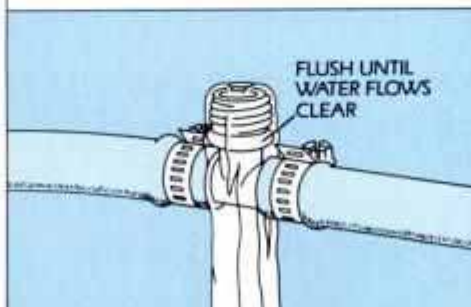
In addition to cleaning rust and scale, chelator-based cleaners also do a good job of cleaning solder corrosion, commonly known as solder bloom. These hard, white deposits



Check the coolant overflow reservoir at least weekly for the proper fluid level.



Check the radiator filler neck and the radiator tubes regularly for signs of corrosion.



Turn on the heater, and flush the system until clear water flows from the tee.

that look a little like flower buds can plug up the radiator tubes if allowed to grow unchecked.

After you've flushed the system, and nothing but clean water is inside, add a quart of chelator cleaner. (Add 2 quarts for systems with 12 or more quarts capacity.)

Because chelator cleaners take time to work, you'll have to drive the car for 3 to 6 hours before the system is clean. However, you don't have to do all that driving at once. When the cleaner has finished doing its job, flush the system a second time to remove the cleaner.

With all cleaners, it's important to remember that coolant flow through the radiator only occurs when the engine needs to rid itself of excess heat. During cold weather, even if the temperature gauge says the engine is at normal operating temperature, most or all of the coolant may be recirculating in the engine block—effectively bypassing the radiator. Even the best cleaners won't clean the radiator unless hot coolant is flowing through it. For this reason, it's best to use cleaners during warm weather. Check the radiator for coolant flow by squeezing the upper radiator hose. When it's hot and pressurized, the coolant is flowing through the radiator.

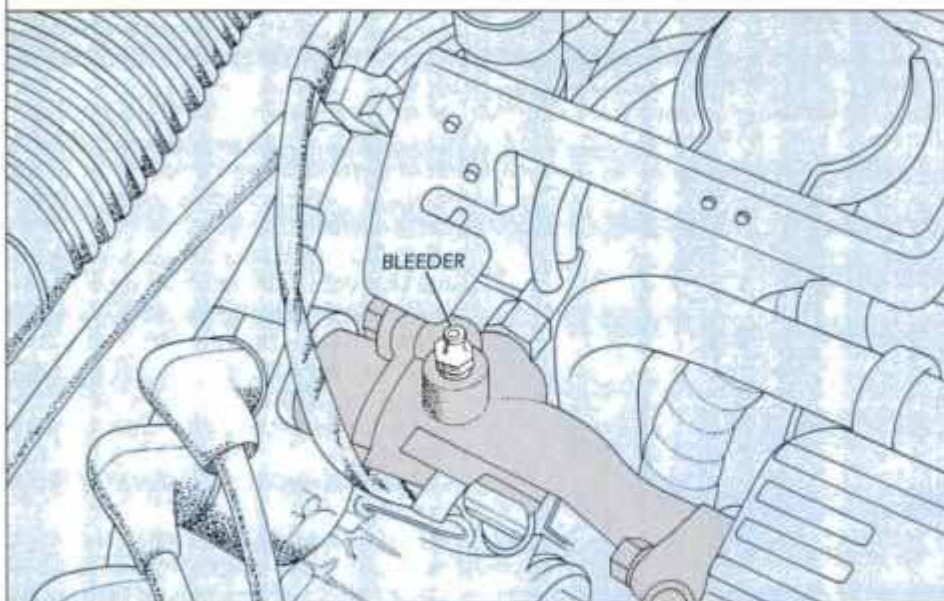
Refilling the system

Coolant is a mixture of antifreeze and water. The more antifreeze you add, the more freezeup and boilover protection you get. So, why not forget the water and fill with pure antifreeze? There are several reasons. First, freezeup and boilover protection begins to reverse itself if you add much more than 70% antifreeze. Pure antifreeze will actually turn to frozen slush at a higher temperature than a 50/50 mix of antifreeze and water. And many of the additives in antifreeze won't become active until water has been added. That means you won't get proper corrosion protection unless the system contains water.

Also, pure antifreeze doesn't conduct heat as well as water, which means that pure antifreeze can't transfer engine heat to the radiator as readily, and overheating results.

For most cars, adding a 50/50 mix of antifreeze and water offers sufficient protection from freezeups and boilover. A 70/30 mix is the maximum recommended concentration of antifreeze in any cooling system.

Typically, a 50/50 mix of good quality antifreeze and water protects against freezing down to -34° F. And



Many vehicles require air bleeding from a fitting on the head. Check your manual.

the boiling point is raised to 265° F if the car has a radiator cap that holds 15 pounds of pressure. With a 70/30 mixture, freezeup won't occur until the thermometer drops to a bone-chilling -84° F, and boil-over is forestalled to 276° F (see Cooling Capacity Chart at right).

To determine how much antifreeze you should add for the freezeup and boilover protection you wish to achieve, consult your vehicle owner's manual for the cooling system's total capacity. For a 10-quart system, you would add 5 quarts of antifreeze to achieve a 50/50 mix. Or add 7 quarts for a 70/30 mix.

Quality pays. You should also make sure to buy a good quality antifreeze. Often, heavily discounted brands are already diluted with as much as 50% water. Read the label.

The rule here is that if the antifreeze costs half the price of others, it probably has less than half the protection. You can verify this by looking at the freeze point chart on the back of a discount brand. At the 50/50 mix point, it may only show protection down to -16° F compared to -34° F for a name brand.

To add antifreeze to a freshly flushed system, first drain the radiator of water and close the petcock. Then, with the flushing tee cap removed, pour the antifreeze into the ra-

diator. As the radiator fills, clear water will escape from the flushing tee. As soon as you see antifreeze escaping from the tee, stop pouring and reinstall the tee cap and radiator cap.

To mix the coolant, start the engine and let it warm up while the heater is set on high. Many modern front-wheel-drive cars, such as Hondas, and midengine cars, like the Toyota MR2, have coolant bleed screws mounted on the engine. These screws allow air to escape from the areas that are higher than the radiator cap.

To bleed excess air, open the screw to let out the air after you first start the engine. When coolant flows from the screw, tighten it.

If you have doubts about whether your car has one or more bleed screws, consult a repair manual. Failure to bleed the system can cause air locks, which can lead to overheating

and boilover. Don't trust that the air will all eventually find its way to the radiator and out the vent. If the manual calls for bleeding and you don't do it, you run the risk of meltdown.

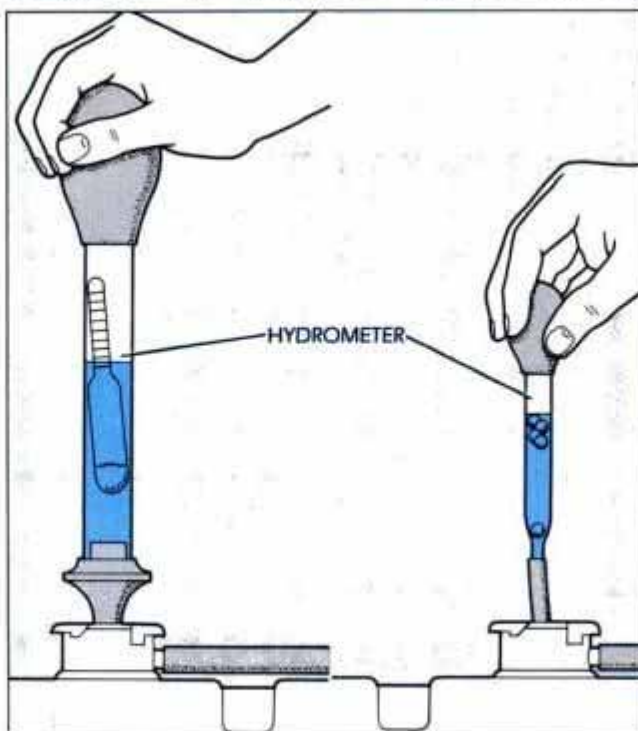
Got the appropriate amount of undiluted coolant into the system? If the system was drained completely, there should be no problem. Or was there enough water lingering to make the system full too soon? If that's the case, let the engine warm up and then cool down completely.

With the coolant thoroughly mixed, drain the radiator partially and then add additional pure antifreeze. Allow it to mix in the engine again. Then, after the engine has cooled down, test the protection level with an antifreeze hydrometer.

There are two types of hydrometers. One has a scale that reads the level of protection. The other has little balls. The number of floating balls indicates the level of protection which is listed on the hydrometer's package.

To use either type of hydrometer, dip the end in the coolant and draw enough liquid into the clear glass tube until the gauge or balls float. Add more straight antifreeze as needed, and repeat the mixing procedure until you've reached the proper level of protection.

Cooling system Capacity (QTS.)	Quarts of antifreeze required									
	3	4	5	6	7	8	9	10		
6	-34°									
7	-17									
8	-7	-34°								
9	0	-21								
(9.5 liters) 10	4	-12	-34°							
11	8	-6	-23							
12	10	0	-15	-34°						
13		3	-9	-25						
14		6	-5	-17	-34°					
15		8	0	-12	-26					
16		10	2	-7	-19	-34°				
17			5	-4	-14	-27				
18			7	0	-10	-21	-34°			
19			9	2	-7	-16	-26			
(19 liters) 20			10	4	-3	-12	-22	-34°		



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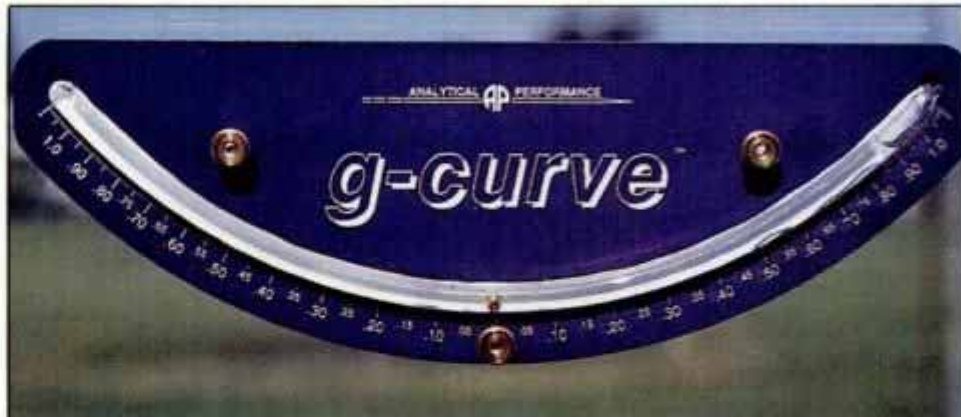
Called the Safety Seatbelt System for Pets, this tether connects to the harness and directly to the seatbelt buckle of your vehicle, regardless of the make. It's available in three sizes, to fit pets from less than 23 to more than 55 pounds. The suggested price is \$29.95. Write to Pet Affairs, Inc., 691 E. 20th St., Tucson, AZ 85719; (800) 777-9192.

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Take It On Home

The simplest home repair job can quickly become a complicated engineering project as you wrestle home 8- or 12-ft. lengths of lumber in your sports car or small sedan. Instead of having them poke out of a window, secure them to the side of your car with this system of padded, lightweight hooks called Timber Tote. One of the bent-tubing metal hooks hangs through the open front-passenger window, the other over the rear fender with the trunk open. The price of Timber Tote is \$24.97. For more information, write Jupiter Products, Inc., P.O. Box 4367, Centerline, MI 48015; (800) 833-9050.



Poor Man's Dyno

Testing cars takes up a lot of time and energy around here, and it uses a lot of sophisticated equipment, too. Analytical Performance's g-curve is an inexpensive tool for determining engine horsepower and torque curves, optimum shift points, cornering potential and aerodynamic drag. This simple-but-accurate accelerometer attaches to your window with suction cups and should let you and a passenger make measurements of your vehicle's

performance to within a few percentage points.

The 68-page user's manual covers techniques for measuring acceleration, and has preprinted worksheets for copying down the data and to aid in the simple calculations necessary to extract horsepower and torque figures. G-curve sells for \$68. For information, send \$1 to Analytical Performance, 3104 E. Camelback Rd., Suite 528PM, Phoenix, AZ 85016. Arizona residents add \$4.38 tax.



Safely Clean

Degreasing your engine, brakes and other parts has always been an important part of good car care. Nowadays, that means effectively cleaning grease and other automotive dirt without fouling the environment and/or exposing yourself to health hazards. Loctite has introduced a line of biodegradable and relatively nontoxic cleaners for the Saturday mechanic. Called the Permatex Enviro-Safe line, it uses citric-based solvents and no CFCs. In addition, the packaging is recycled and recyclable. Prices range from \$5.50 for carb cleaner to \$6.98 for brake parts cleaner, from Loctite Corp., Cleveland, Ohio; (800) 321-9188.

Sensible Sniffer

Long gone are the days of fiddling with your car's fuel mixture. The computer handles that quite nicely now, keeping your car at the edge of best performance and cleanest exhaust. However, the computer's most critical source of information for engine performance, the O₂ sensor, lives in the exhaust stream, and sooner or later suffers the ravages of extreme (1000° F) heat. Then it starts to hamper rather than help the computer. If, despite a tuneup, your car is still sluggish and showing poor fuel economy and emissions, test the O₂ sensor. Replacements for the original are available from Wells Mfg. Corp. at auto parts stores, for about \$35.



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CAR CLINIC

BY MIKE ALLEN,
Assistant Automotive Editor

High Score Loses

I've rebuilt a number of American car engines over the years. I just tackled my daughter's Rabbit last spring, and the rebuild was pretty simple to do.

At least I thought so until it died. One of the circlips that holds the wrist pin in the piston had fractured—with only 1100 miles on the engine. The wrist pin made major gouges in the cylinder wall.

The machinist at the auto parts store who did the cylinder head, block and connecting rods told me I should have used new circlips. But I figured the problem was that one of the rods was bent when I got it back from him—it's sure bent now!

Needless to say, I'd like him to accept some responsibility for this.

JOHN NEEDHAM
TAYLOR, AK

A bent con rod isn't likely to break the circlip—maybe a spun bearing, but not the problem you describe.

I'll take an educated guess here at what happened. You've rebuilt big American V8 engines, most of which use a pressed-pin style of rod. The wrist pin is simply a little bigger than the hole in the piston and has to be pressed in with a hydraulic press. There's no real side force on the pin when it's in the engine, so it never moves. VW (and plenty of others) use a full-floating pin, which is retained by clips in grooves in the piston.

Even with full-floater pins on V8s, circlip breakage is not usually a problem. But on the high-revving VW engine, the clips should be installed with the gap either at the top or the bottom—not at 3 or 9 o'clock. Why? Every time the piston passes top dead center or bottom dead center, the acceleration change flexes the circlip just a little—until it breaks. If the gap is at 12 or 6, there's no flex.

I generally don't replace these clips unless they look damaged.

You might suggest to your daughter that she cool it next time around, and let the motor break in a little before she revs it so high.

Cruisin'

The cruise control on my '87 Olds 98 works fine for about 30 to 40 miles and then disengages. Reset it, and it will work for 2 to 3 miles.



My '79 Olds 98 would do the same thing, with its carbureted engine. Every year or so, I would have to clip off about an inch from the vacuum hose to the carb. This would restore vacuum to the servo for another year or so, at least until the end of the hose got hard and wouldn't seal anymore.

Does the fuel-injected engine in my new car have a vacuum hose too? Or is there some sort of electronic module that does this?

GENE RAY
GRANBURY, TX

Find your cruise control's vacuum servo by following the actuator cable from the throttle plates. It'll be to the left of the engine, above the transmission end cover. This servo should look familiar, as it should be very similar to the one on your '79. From the servo, trace the vacuum hose back to the manifold and check for vacuum leaks there.

You may want to trim or replace the hose—but I suggest using a vacu-

um gauge and looking for other leaks as well.

Alternatives

I have an '85 Escort. I've replaced the alternator seven times. The rebuilds seem to last a couple of months, or about 2000 miles, before they seize up. Are rebuilt alternators really that bad? Do I have to spend \$320 at the Ford dealer? Or maybe I should just junk the car?

L.E. ERICKSON
GRANADA HILLS, CA

Well, don't junk the car.

If you were having an electrical failure, I'd tell you to do some serious diagnosis of the remainder of the electrical system. But if these alternators are seizing up, then either you've had a string of really awful rebuilds—which I consider unlikely—or there's something else wrong.

Rebuilt electrical parts are something of a crapshoot. Quality can be as good as new. Or not, depending on

CAR CARE

the rebuilder. But if you're seeing a consistent pattern here, I suspect it's something about your car.

Your Escort has a serpentine belt—a single flat belt that operates all the engine accessories. Be certain that all of the pulleys line up properly. If the alternator isn't aligned fore and aft with all the others, there could be a substantial end thrust on the alternator's armature bearings, and those bearings weren't designed to carry much end load.

Alcohol Blends

I have just started teaching high school chemistry, and my students were discussing the use of methanol as a dry gas and a gasoline substitute.

What must be done to prevent methanol from damaging the catalytic converter?

Which alcohol is preferred? Why?

HENRY J. BARTOSIK
KERHONKSEN, NY

In reverse order:

Ethanol, or grain alcohol, is an acceptable additive to gasoline, in concentrations as high as 10%. This mix is marketed as gasohol in many Midwestern states where the alcohol is made from corn. Higher concentrations of ethanol may cause driveability problems.

Only trace amounts of methanol are permissible in current cars. Methanol is very corrosive to metal, plastic and rubber parts. Some gasoline driers contain methanol to soak up water contaminating your gas tank—but the concentration should remain very low, under 0.25%. Otherwise, you'll have serious corrosion problems in a few weeks.

Methanol can be used very successfully as a motor fuel in vehicles that have fuel systems designed for it. And the methanol-powered prototypes I have driven have used conventional catalytic converters without any damage.

Hole In Van

The VW mechanic wants to cut a hole in the floorboard of my 1979 van in order to fix the gas gauge. Isn't it possible to repair this in the dashboard?

BILL TREVENA
JACKSON, TN

If the sender is bad, there's nothing to be done about fixing the gauge itself. If the gauge's sender is bad, it'll have to be removed for inspection and/or replacement.

(Please turn to page 80)

Poker-Faced

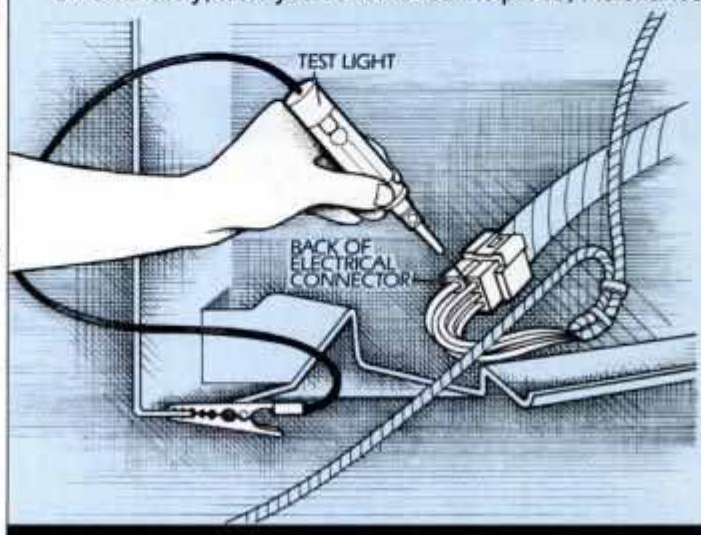
● If you're chasing loose connections, be careful you don't introduce more problems as you go poking around your wiring.

Whether you're using a test light or a volt-ohm meter, the temptation is to use the test probe to mate with the female end of connections. The tip of the probe can be forced into the connector for a snug fit, letting you dangle the probe and turn switches on and off without needing three or four hands.

Unfortunately, after you've removed the probe, the chance of the male connection making a reliable junction is greatly diminished.

One alternative is to make a short jumper with the appropriate connector on one end and an alligator clip on the other.

Too much trouble to make this? Then just probe the back of the connector. Wedge the probe between the crimp on the connector and the plastic shell.



PM ILLUSTRATION BY ADOLPH E. BROTHMAN

WITTEK HOSE CLAMPS

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IN THE

HAWAIIAN
SALES BLITZ

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CAR CARE

Volkswagen neglected to leave any access to the sender, which is installed on top of the tank. The tank is underneath a bulkhead in front of the engine. The manual says to remove the engine to access the tank, not chisel a hole in the sheetmetal.

Removing the engine is pretty simple to do (honest)—a couple of hours should have it out, the sender replaced and the engine back in—but you may want to save a couple of bucks and elect for the surgery.

I wouldn't. Before I'd opt for that type of butchery, I'd just forget about the gas gauge, and use the trip odo and a pencil to keep the tank full.

Truth Or Dare

I am considering buying an external paper-element filter for my car which is about to have a remanufactured engine installed. The filter manufacturer claims that it will extend the life of my engine five times.

They also claim that it will eliminate the need to change the oil forever. Is this too good to be true?

RON BROWN
TULSA OK

It's too good to be true.

These aftermarket filters, which use either some sort of proprietary filter cartridge or a canister that holds a roll of common toilet tissue, have been around for a long time.

They will remove a certain amount of abrasive particles from your oil, the ones that are too small to be trapped in the original oil filter's paper mesh. The stock filter lets a certain amount of these smaller particles through in order to prevent restriction to oil flow as the oil gets dirtier late in the oil change interval.

These auxiliary filters are bypass filters—they only filter a small

amount of the oil while all of the oil pump's output goes through the stock filter. So the original filter must remain in place.

However, the abrasive particles they catch are small—typically 5 microns or less. And engine manufacturers feel that they are too small to contribute to engine wear, as they are thinner than the oil film separating the bearing and journal. So any reduction in engine wear is debatable at best.

There are more reasons to regularly change your oil than removing dirt particles. Oil is constantly being diluted with partially burned or raw gasoline, contaminated with moisture and subjected to enough heat to break down the molecular structure of the hydrocarbons.

Additives and viscosity index improvers are exhausted or break down as well. The only way you can remove the contaminants and add fresh additives is to change the oil and filter.

The claims of fivefold engine longevity are inflated at best. Never change your oil again? Not my car. These filters will keep your oil cleaner, and soak up a certain amount of water and acids. So I'll give them a limited endorsement—but you should stick to a 3000-mile oil and filter schedule.

I know, I know—between the industry standard 7500-mile oil change interval and the generally high cost of everything, there's plenty of reasons to want oil drain intervals to be extended. Not to mention environmental concerns about used oil. But there ain't no such thing as a free lunch—and this gadget is included. If you really want to try one, it probably won't hurt anything. **PM**

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

- Late-model Aerostar and Ranger owners who experience upshifting problems may want to remove the automatic transmission's oil pan to look for bronze metal shavings, as per TSB 90-22-17. If you find any metal shavings, the TSB recommends removing the transmission to replace the No. 4 thrust washer and high clutch drum assembly.
- If the headlights are dim, the low battery warning light is on or the horn is weak on your 1988-'90 Crown Vic, Continental or Grand Marquis, check the connections in the 10-way connector in the engine compartment. TSB 90-21-10 suggests that there may be something loose inside the connector and recommends how to go

about replacing individual connectors in the plug.

- Chrysler TSB 18-11-90 details proper procedures for working on a flooded engine. If the oil is heavily diluted with gasoline, change the oil and filter, being careful to dispose of these fluids where they can't start a fire. Similarly, disable the ignition system before removing the plugs, or the pooled gasoline in the cylinders may catch fire when the engine is cranked to clear it.

- Some 1990 3.3-liter Chrysler engines may exhibit oil leaks at the area of the rear crankshaft flange. This is a result of improper machining of the untapped holes in the crank—they were drilled too deep. TSB 09-03-90 details repair procedures.

What does it take to be the world's best aerobic exerciser?

It takes a total-body exerciser.

A machine capable of exercising all the major muscle groups in your body, not simply your legs like treadmills exercise bikes and stairclimbers.

It takes a cardiovascular exerciser.

A machine that utilizes enough muscle mass to readily exercise your heart, not simply specific muscle groups like weight machines.

It takes a weight-bearing exerciser.

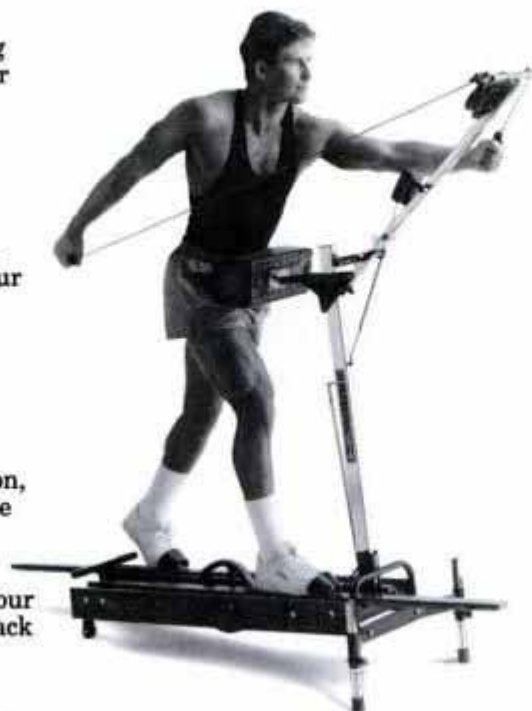
A machine that utilizes the standing position to exercise the joints and long bones of the skeleton, not simply a few muscle groups like sit-down exercisers.

It takes a safe exerciser.

A machine that can't damage your knees like stairclimbers, or your back like rowers, or throw you off like treadmills.

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OLD HOUSE RESTORATION

RESTORING OLD BARNNS

BY BOB VILA, Contributing Editor



THE BARN PEOPLE PHOTO

● There's lots to fall in love with when you decide to make a barn your home. But two of the biggest reasons why people undertake this project must be their love of space, coupled with their affection for beautiful aged patina of old post-and-beam timbers.

Although it is certainly possible to transform an old barn into a beautiful living space, before you embark on a project like this I must remind you of one important fact: Remember that barns were originally constructed to house animals and hay—not people. They were never heated or cared for like old houses would have been. Because of this, they can be a good deal more trouble to make habitable—and bring up to current building codes.

The inspection

Looking for a barn to call home can be the most fun of this project. Depending on where you live, weekend jaunts into the countryside may turn up an old structure ripe for this kind of

work. Or you may choose to buy an old post-and-beam barn frame and resurrect it on your lot. But before you get too involved, make sure the structure is sound enough to withstand the rigors of restoration.

If you're looking at a newer barn, one built after the turn of the century, it's probably balloon framed with nailed 2 × 6s. If your plan involves disassembling the structure to move it to another site, it's best to scratch this particular structure from your list. It's one thing to pound the pegs out of a post-and-beam frame, and quite another to remove nailed timbers. The latter is much more difficult to do successfully and probably not worth the headaches in the long run.

The condition of the frame must also be evaluated. Some of the major damage I've seen to these old timbers comes from insect infestation, namely ants, powder post beetles and, depending on how far north you live, termites. Since the roofs of many of these old outbuildings weren't maintained properly, it's not unusual to find deterioration and rot in timbers

Restoring an old barn to use as a home can challenge even the most ambitious restorers. But the results, like those shown here, can be spectacular.

due to years of rainwater leakage. In most cases, the sills are rotted and must be replaced. Some of the rafters may need to be replaced along with the bottom ends of posts. Make sure any damage hasn't progressed to the point where it just doesn't make sense to try to salvage the structure. Otherwise, all you're likely to end up with is a pile of old timbers.

Barn frames

Once you're assured that the timbers are sound, it's time to have the barn moved, if necessary. And there's a good chance it will be. Oftentimes, these structures accompany an old farmhouse and must be moved off the owner's land. Or the building may simply be too far away from civilization to suit your modern needs. At the very least, it may be too close to the road and simply need to be moved back a bit to a different location on the

"Home Again With Bob Vila" is the title of our contributing editor's new TV show.

property. If that's the case, it can usually be jacked up and moved in its entirety. Otherwise, barns are often moved: piece by piece (see "Old House Moving," page 46, Nov. '89). The frames are carefully dismantled, numbered or labeled in some fashion, then painstakingly reassembled on a new lot and foundation.

There are companies who specialize in selling restored barn frames, like The Barn People, Inc., P.O. Box 217, Windsor, VT 05089, (802) 457-3943; and Great Northern Barns, Inc., RFD No. 2, P.O. Box 927C, Canaan, NH 03741, (603) 523-7134. Oftentimes, their work includes dismantling the original structure, cleaning and sometimes fumigating the pieces, then reassembling the frame on a new site. They usually have barns in stock, so if you haven't found your own, you can choose from the ones they have for sale.

Since many of these old structures are still standing, it's best to make the trip to see them in person, so to speak, rather than just viewing a pile of beams and using your imagination as to what the finished frame will look like. Sometimes, too, this barn-frame shopping is done via the mail with

drawings and photos. It all depends on where you are and with whom you're doing business.

Home sweet barn

Perhaps the hardest part of turning a barn into a home is dealing with the placement of windows. If you're trying to keep the structure looking like a barn, where you decide to put them is very important. There are lots of tricks to doing this.

One way is to keep to a minimum the number of windows on the side of the barn that faces the road and on the gable ends, provided these aren't the sides that face the Sun and/or the view. The side of the barn that's away from the road, and facing the Sun and a scenic view, is then transformed into a wall with lots of modern glass. This serves to open up the interior space with a great deal of light, while retaining the look of the original structure. Of course, there are many other ways to update an old barn. That's why it's so important to choose an architect who shares your enthusiasm for this project and understands your concerns.

Aside from the frame, it's nearly impossible to salvage enough of anything else to reuse in the new struc-

ture. The roof, of course, is usually shot. And so is most of the siding. I have seen interesting reuse of salvageable siding on a few barn homes. Sometimes, the siding is attached to the frame with its unweathered side facing the living space, creating the same look as the original wall. Insulation is then added to the outside, often in the form of stress-skin panels that are sandwiched between the old boards and new exterior wood siding.

The interior design choices are virtually limitless. For example, where sleeping space is concerned, you can opt for open loft space or closed rooms for privacy. Most folks choose to keep the main living area cavernous and open—retaining that wonderful feeling of space that brought you to this project in the first place. If you're serious about making a barn home, it's a good idea to check out some of the books written on the topic before you begin yours. Your local library is always a good place to start.

Aside from the uniqueness of a barn home, there is one more important benefit to choosing this type of housing. Essentially, you've saved an old barn frame from demolition, and in the process, helped preserve one more important piece of the past. **PM**

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COMPUTERS MADE EASY

BY FRANK VIZARD, Electronics Editor



Works 2.0 also allows you to work with eight files on screen at once. List prices for the Smith Corona Acer line range from \$1000 to \$1900. On-site service is offered for 12 months, and there's also a toll-free telephone number for assistance.

CD-ROM

Magnavox, meanwhile, is using a CD-ROM drive to give away the software store. The company's HeadStart 386SX-20CD model trades in the 5.25 floppy disk drive for a CD-ROM drive. Packed with the computer is a sizable number of disks that give you access to all kinds of information. The CD library includes Grolier's Encyclopedia, PC Globe Pack, a computer game and a number of programs from Microsoft—Bookshelf, Small Business Manager and Stat Pack.

You can also connect the 386SX-20CD to a stereo system if you want to listen to music while you work. List price is \$2099.

Magnavox is also selling stand-alone CD-ROM machines. Unlike many other CD-ROM players, you don't need to insert the disk into a caddy before playing it. One basic model, the CDD50BK1, lists for \$399.

For another \$100, you can get the CDD461RS, a machine that can be used as both an audio player or CD-ROM drive. The CDD461RS model comes packaged with an assortment

● More computer manufacturers are introducing machines that avoid the dreaded "C:" prompt. The idea, pioneered by IBM and Tandy among others, is to offer computers with easy-to-use software already loaded. Set-up becomes a breeze, and there's no complicated commands to learn. Users just access the appropriate icon or graphic representation to run the desired program.

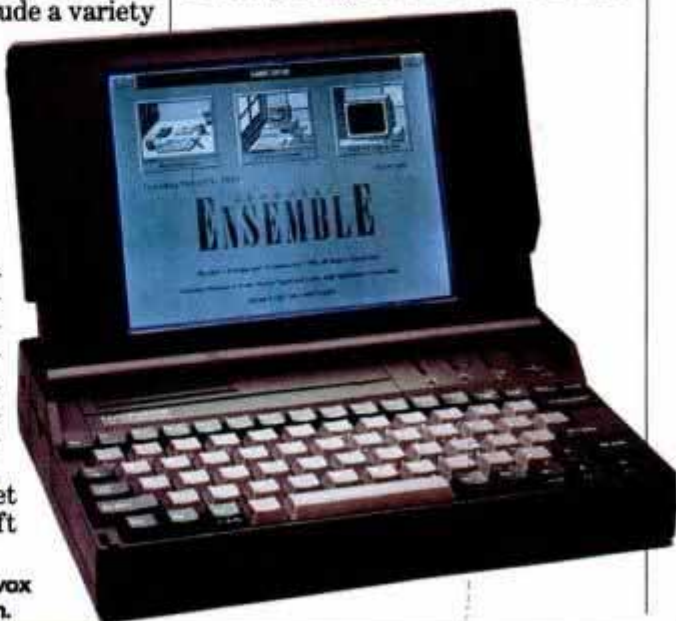
Those who follow the world of hackers probably recognize the influence of Windows, a software program made by Microsoft that made icons the darlings of MS-DOS computer operating systems.

Windows 3.0, in fact, is included as part of the new Sensor computers made by Samsung. Windows, though, is only a small part of the software package being offered. In the top-of-the-line SP-386SX, for example, additional programs include: Toolworks Office Manager, a program which includes word processing, a spell checker, spreadsheet and file manager; GeoWorks, a desktop publishing pro-

gram; and Prodigy, the on-line subscriber information service. Other maintenance-type programs are included as well. The SP-386SX lists for \$1995. Lower-priced and less-powerful Sensor machines include a variety of software packages as well.

Another new line of computers with built-in software comes from teaming Smith Corona and the Acer Group. The Smith Corona Acer line includes a word processing program, a desktop reference system and Microsoft Works 2.0—an integrated package that includes word processing, communications, database and spreadsheet capabilities. Microsoft

Samsung Sensor and Magnavox laptop have software built-in.



of CD-ROM titles.

Sony, meanwhile, is packaging an external CD-ROM disk drive with six disks for a list price of \$699. Called the Laser Library, the six disks include Compton's Encyclopedia; a reference disk with a dictionary, thesaurus, world almanac and more; a National Geographic disk on mammals; a world atlas; a key-word language translator; and a children's game. Additional titles are available through a catalog, and they range in price from \$44 to around \$400. Sony says it will introduce CD-ROM titles on its own this year. Titles will be supplied by other companies as well.

An internal CD-ROM drive is available from Tandy for a list price of \$400.

Magnavox is also entering the notebook PC market with a 6.9-pound model listing for \$2699. The Metalis/286 comes packaged with the GeoWorks Ensemble software program. Two prime features include the ability to change batteries without shutting down and rebooting the system, and a small mouse pen that requires only 3 in. of space to operate.

The power position in laptops, though, belongs to Zenith. The company is the first to introduce super-powerful 486SX microprocessors in laptops. List prices for Zenith's 486 laptops are \$8899 and \$7499.

The big stir in small computers is the 95LX made by Hewlett-Packard. The 95LX weighs 11 ounces and measures 6.3 x 3.4 x 1 in. in size. The 95LX comes loaded with the popular Lotus 1-2-3 spreadsheet program. There's also a phone number and address registry, a basic text editor and a calculator.

List price for the 95LX is \$699, perhaps its strongest feature. Power is supplied by two AA batteries. Screen size is 16 lines by 40 characters. The 95LX uses memory cards rather than floppy disks to store information. Hewlett-Packard says the 95LX uses an infrared link for transferring data between machines. In the future, the 95LX will be linked to a Motorola paging system so it can receive messages.

More computing power is available for those little electronic personal organizers that are becoming the rage

among businessmen. Royal claims it now has the most powerful personal organizer on the market. The DM2160 packs 160K of memory into its diminutive body.

The DM2160 uses an 8-line by 26-character display. Three different modes can be used to access 24 different functions. List price is \$300.

More power is also the theme of a new upgrade software package from Apple. Designed to increase the capabilities and ease of use of Macintosh computers, the System 7 package offers a wide range of enhancements for operators. The System 7 package lists for \$99.

Car Tunes

If you want to dress up your off-road vehicle, you might consider purchasing Jensen's rather radical looking cassette receiver. The JS-9400 comes dressed in a sporty yellow for a distinctive look.

The JS-9400 is more than just looks. The cassette receiver is probably the most environmentally conscious machine of its type. The JS-9400 features indicators that warn you when the unit is too cold to play properly, displays short-circuit warnings and has gold-plated connectors for better reliability. The front panel is sealed with weather-resistant tape for protection. And the pull-out handle acts like a bumper. An internal amplifier sends 15 watts of power through each of four channels. List price is \$320.

Another new cassette receiver of note is Alpine's 7618 model. While the 7618 is feature-packed at a list price of

\$600, it has one feature that should be more widely adopted. The 7618's computer memory remembers the bass and treble settings for AM, FM, cassette and compact disc play so there's no need to readjust bass and treble every time you switch sources. The 7618 can also control a trunk-mounted CD changer.

Flat TV

About \$4000 will buy a television that you can mount on a wall like a picture. In fact, these televisions come already framed.

Sharp is selling in Japan a line of liquid-crystal-display televisions that come in a variety of frames. The televisions have a screen size of 8.6 in. These LCD televisions are currently the biggest that can be made using LCD technology.

While these LCD televisions have more of a decorative function than anything else for the time being, television makers have high hopes for LCD technology. One TV executive told PM that he expects all televisions 20 in. and below in screen size to be made with LCD technology by the end of the decade.

Sharp, meanwhile, is taking an innovative step in another direction. It is introducing a downsize VHS camcorder weighing just under 4 pounds. The VL-L50U plays standard-size VHS cassettes, even though the camcorder itself is rather diminutive. Other features include a 12X zoom, a 4-position high-speed shutter for fast-action closeups and very low-light sensitivity. List price is \$1249. **PM**



Jensen's JS-9400 cassette receiver is designed for use in off-road vehicles.

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Next-generation Firebird, due for 1993, will be an evolutionary update on the current car.

Engineers expect handling to be competitive.

Electronic VIN

Vehicle Identification Number (VIN) tags are fine for now, but electronic implants will be even better.

That's the thinking behind the idea to place electronic VIN tags in every new vehicle. According to a study by Siemens, an electronics supplier to the auto industry, an electronic ID chip buried in the chassis of each car will have a number of uses.

First, it will help the manufacturer trace the car from the assembly line, to the shipping yards, to the haulaway truck and then to the dealer. Later, police will be able to identify stolen cars as they pass, simply by checking their electronic signature.

The chip could also make stopping for toll booths a thing of the past. The chip's number will be recorded at toll checkpoints as the car rolls through, and the owner will be billed later.

LH Times Three

Chrysler plans to build three versions of its all-new LH sedan model—one each for Dodge, Eagle and Chrysler.

Based on the Optima show car, the new LH models will be the first American cars to utilize the cab-forward design concept, with the base of the steep windshield extending over part of the engine compartment.

The design will give the sedans an aggressive appearance and also create more room inside the passenger compartment.

Differences between the three 1993 model cars will be more than badge deep. Dodge and Eagle will share the same 108-in. wheelbase, but will have individual grilles, taillights and roof profiles. Chrysler versions of the LH model will have all these differences plus a longer—by 3 in.—wheelbase. Look for the Chrysler nameplate to offer a formal rear window design, similar to that of its current full-size New Yorker and Imperial.

New Skin, Old Pony

After dismissing a number of alternative plans as too expensive, Ford will

Futurebird

● Pontiac will have a number of surprises for Firebird buyers when the 1993 model is introduced a year from now. Certain body panels will be plastic, while others will be made from traditional sheet steel.

Like Saturn, Pontiac will use plastic for vertical panels and steel for horizontal parts like the hood and roof. Pontiac pioneered the use of plastic body panels with its ill-starred Fiero, and the practice is expected to continue its spread through other model lines.

There are likely to be surprises under the hood, as well. Pontiac insiders are talking about a supercharged 3.8-liter V6 as a new top-performance engine, with a smaller V6 and the current 5.0-liter V8 as other choices.

The engine/drive layout, though, will be familiar. GM abandoned its front-drive F-car replacement program a few years ago, and the new Firebird and Camaro will continue to be front-engine/rear-drive, with a live rear axle.

Although some GM product planners are concerned that the new F-cars will be technologically dated when they hit showrooms, chassis en-



Due in '93, Chrysler's all-new LH sedans will carry three divisional nameplates.

definitely continue the Mustang through the 1990s in its current form.

That means rear-wheel drive, high-performance engine options and a price low enough to attract younger, less-affluent buyers.

Some Ford executives waffled on the rear-drive idea as late as a year ago, arguing that a front-drive chassis like the Probe would be ideal for the popular muscle car.

Another plan called for adapting the current Thunderbird/Cougar platform for the smaller Mustang, but the car would have been too heavy.

Accordingly, Ford will continue with the current platform, covered with new sheetmetal. Look for the restyled Mustang, with the proven 5.0-liter V8 as an option, to make its appearance as a 1993 model.

4.3 V6 Overhaul

Look for Chevy and GMC to put a more powerful V6 in compact utility vehicles next year.

The current 4.3-liter V6 will get a power boost from the current 170 to 200 hp for the 1992 model year. In addition, GM will install a much-needed balance shaft to smooth out the engine, eliminating the noise and vibration that plague the current edition.

Plans call for the new 4.3 to go in S-10 Blazers and S-15 Jimmys. GM hopes these refinements will help its compact sport/utility vehicles keep pace with the newest Jeep and Ford powertrains.

Domestic Distinctions

The influx of Japanese manufacturers building cars in the United States may not threaten the American labor force, but it's likely to take a bigger chunk of the domestic auto market.

According to a recent Arthur Andersen survey of executives connected with the automotive industry, transplant manufacturers will account for about 15% of all U.S. sales by the end of the century.

The executives forecast a corresponding slide by GM, Ford and Chrysler to about 57%.

Probe Plans

Although Ford's sporty Probe has lost its early sales momentum, product planners think the next-generation design will rekindle interest.

Due for '93, the new Probe, which shares the same platform as the Mazda MX-6, will be bigger than the current edition, with a wider stance.

A new Mazda 2.5-liter V6 is expected to join the current engine offerings. Both Probe and MX-6 are manufactured at Mazda's Flat Rock, Michigan, plant. **FM**

**IF YOU'VE FALLEN
IN LOVE WITH
A MACHINE
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AUTOMOBILES

NEW CARS



SVX—A Sportier Subaru

● It's sleek, quick, comfortable, and it handles like a dream. It's built by a company famous for strong, reliable and somewhat boring cars. It's a Subaru—but it thinks it's a BMW, only better.

In general, Subaru has always produced cars that are oddly styled, uniquely detailed, technically sophisticated and designed for all-around utility. But the new SVX is an enthusiast's car—a car with the hardware, versatility and even the looks to make it a star.

Riding a 102.8-in. wheelbase, the SVX offers full-time all-wheel drive with fully independent suspension and 4-wheel-disc brakes with ABS on the Touring model.

The suspension subframe assemblies are designed to insulate both road noise and vibrations, and also control suspension toe and camber deflections.

This is a goal that usually loses in execution, but not here. The SVX is one of the best handling-to-comfort compromises we've driven.

Handling magic

A great deal of the handling magic lies in the SVX driveline components. The 4-speed automatic is electronically controlled and works in balance with the computer-controlled multi-plate transfer clutch as part of the all-



Swoopy styling and excellent cockpit layout help make new Subaru SVX a serious contender in the sports-coupe derby. New dohc 24-valve flat Six engine produces 230 hp.



wheel-drive system. The normal torque split is 60/40 front/rear, but by comparing information from two wheel-speed sensors, the computer detects slippage at either end and adjusts the front/rear torque split accordingly.

This system is further enhanced by a limited-slip rear differential with a viscous clutch, and is tied together by a microprocessor linked to the ABS braking sensors.

All-new for the SVX is the horizontally opposed 3.3-liter 6-cylinder engine. The torquey flat Six has twin overhead camshafts, 4 valves per cylinder and electronically controlled sequential fuel injection.

It's smooth, quick and rugged, with enough torque—224 ft.-lb. at 4400 rpm—to hustle the car's substantial bulk (3525 pounds) to 60 mph in less than 8 seconds.

Much of the SVX design theme is centered on its unique greenhouse. The official description calls it "the window within a window," and while the visual effect is odd, particularly with the sectioned windows (only part of each window rolls down), the design is effective in terms of its goal—creating a sense of more interior space.

About the only drawback is the extended A-pillar—a function of the 24.5° windshield rake—which intrudes on the driver's field of vision.

Overall, we like the SVX styling. It's clean—even cleaner without the optional rear wing—and delivers a surprising amount of interior and trunk space.

Base priced at \$25,000, with a fully loaded Touring model topping out at \$28,000, we think the Subaru SVX looks like a solid value, as well as an impressive performer.

But will the Subaru name get proper recognition in the sporty market segment? Time will tell. —Rick Titus



Ford Redesigns Big Van Series

Realizing that the world has changed over the past 17 years, Ford finally decided that the time has come for an update on its popular line of full-size vans. So for 1992, there will be a totally redesigned Econoline/Club Wagon series. As before, the Econoline is a cargo carrier aimed primarily at the commercial market, and the Club Wagon is a people carrier.

And while most things vehicular have shrunk during this time span, these goliaths have actually grown. Thanks to an increase in the length of the frame rails, the new vans are 5 in. longer than the old on the same 138-in. wheelbase. Most of the extra length went into front overhang, designed as crush space. Anticipating that passenger-car safety standards will be in effect for trucks before the vans get redone again, Ford has in-

Subtle but extensive restyling updates appearance of Ford's full-size vans for 1992. New window sealing system reduces wind noise dramatically. Ride is also improved.

corporated several important safety features, including a driver's airbag on vans with a gross weight of less than 8500 pounds and a (very) high-mounted stop light.

Improved aero

Ford also made some styling updates, albeit subtle ones. After all, the past several years saw these vans going out the door at about 225,000 per year. It was clear to the design team that radical changes were unnecessary. The result is more in the way of an evolutionary update.

The new vans are smoother, more aerodynamic and much more stylish than before, complete with flush headlights and a chin spoiler on some versions. But they also continue to look squat and brawny, with blistered

wheel flares and a nice curve from the belt line to the roof.

The smooth lines and improved window sealing work acoustically as well—the new vans are much quieter than the old, eliminating one of the few persistent gripes about these popular workhorses.

Besides better aero (the big van has a Cd of 0.39), the Econoline's ride quality has been refined through extensive suspension and body-mount tweaking. The wheels are still held to the road by Ford's tried-and-true twin-I-beam axles with coil springs in front, and leaf-spring and solid axle in the rear. But Ford's engineers performed some minor magic with the suspension bushings, especially the ones that mount the body to the frame.

Surprisingly, given the nature of the beast and what's under it, the handling has been substantially improved, too. Though no one is likely to call this van nimble, steering feel, long a weak point of Ford power-steering units, is markedly better than before, and response is crisper. Brakes are still discs in front and drums, with antilock, at the rear.

The drivetrain is essentially unchanged, with customers having a choice of one of four gasoline engines, from a 4.9-liter inline Six to the muscular 7.5-liter V8, as well as the torquey 7.3-liter diesel V8. Behind the engine is either Ford's electronic 4-speed automatic or the automatic overdrive.

Civilized interior

Improvements abound inside, with a new clear dashboard sporting round analog gauges and simple, functional controls. The redesigned seats are much more comfortable, and the distribution of heated and chilled air, even to the multitudes sitting in the rear seats of Club Wagon models, is more balanced than in previous editions of the vans.

The hinged 60/40 split side door promises to make it a good deal easier

(Please turn to page 90)

Getting Straight

● Traditionally, frame rails used by body shops have been about as technologically sophisticated as a blacksmith's anvil. Ricochet off something solid enough to distort your car's frame, and you're at the mercy of a technician who may have nothing more high-tech at his disposal than a tape measure and some highly calibrated eyeballs.

Genesis, from Chief Automotive, brings modern technology to bear by using lasers to measure a number of selected points on the car's chassis, displaying the coordinates on a computer screen.

The distance each of these points has been displaced by the accident is monitored continuously, and far more accurately.

Unlike a technician using a tape measure and a series of successive approxi-

mations, Genesis also tracks reference points on the vehicle in three dimensions, reducing the possibility of moving a part of the car the right amount but in the wrong plane.

Then, with hydraulic rams and pullers, the technician can selectively bring the frame back to its proper dimensions while he monitors the progress of the operation on his screen.

Instead of having to push and shove, crawl into or under the car and measure, and then repeat the process, the technician can bring the chassis back to straight and true

with his fingertips.

Not only will this aid in more accurate repairs, but reduced labor costs should help reduce insurance premiums. Genesis systems are currently being installed around the country.

—Mike Allen





Available in two sizes, Mitsubishi Expo and smaller Expo LRV (left) are available with all-wheel drive. Folding seats offer versatile cargo capabilities. Power from 1.8- and 2.4-liter engines is modest.

for those multitudes to get in and out, and the neatly designed tray and console atop the engine cover offers enough storage for life's necessities so you won't have to bother anyone behind you for toll money, tape cassettes or that all-important cup of java.

—Don Chaikin

Mitsubishi Expo Lineup Alters Minivan Definition

With its new replacements for the Vista wagon, Mitsubishi has effectively taken the minivan into the next century eight years early. The Expo and Expo LRV totally blur the line between small cars, minivans and station wagons.

The Expo is the larger of the two, with minivan-style seating for seven and 4-hinged doors, station wagon style. The Expo LRV, which stands for Light Recreational Vehicle, is smaller, seats five and has a sliding door on the passenger side.

Package efficiency

While both are certified as passenger cars, they look more like mini-minivans than cars. Both Expo and Expo LRV are narrow, tall and not overly long. Their short sloping snouts are a trifle longer proportionally than, say, a Dodge Caravan. It's clear that these wheeled boxes were developed to maximize interior volume in a small package. And the space inside is used both interestingly and effectively.

The Expo has two bucket seats up front, a split-back 3-passenger bench center seat that folds, reclines and slides fore and aft, plus a rear 2-passenger bench seat that also folds. With the two rear seats folded, there's a raised flat floor and a 75-cu.-ft. cargo area. The seats can be reclined to make up into somewhat bumpy beds and have seatbacks that

also can be used as tray tables.

The new Expo LRV has a rear bench seat that can accommodate up to three passengers. The seat reclines and can also be folded to expose the flat floor. To exploit the maximum cargo capacity—79 cu. ft.—the bench seat is also removable.

Vertical volume

All of this volume is a product of clever space utilization and a tall roof line for such a narrow vehicle. The Expo LRV has a wheelbase of 99.2 in. and an overall length of 168.6 in. The LRV is only about 6 in. longer than a Honda Civic station wagon, but it's also more than 6 in. taller.

The larger Expo is deceptively long. With a wheelbase of 107.1 in. and a total length of 177.4, the Expo is actually a couple of inches longer than a standard-size Dodge Caravan, even though its wheelbase is nearly 5 in. shorter. The Expo is 64.4 in. tall, the Caravan is 66 in.

Unfortunately, the Expos have a relatively narrow track (57.5 in.) for their height. In order to gain the benefits of scads of internal height, the Expos trade off some of the handling benefits that go with a low center of gravity.

The result is that both Expo and Expo LRV feel a little tippy in emergency maneuvers. Once you get used to the body roll, which is exaggerated by the high seats, the handling is predictable, with a solid dose of understeer—these vans don't like to be hurried. The ride is carlike, with good jounce control to reduce pitching.



Modest power

Of course, with only 113 hp available in the smaller Expo LRV and 116 hp in the Expo, the two rigs weren't intended to be sports cars. The engine in the LRV is a brand-new sohc 16-valve 1.8-liter 4-cylinder. The larger Expo has Mitsubishi's venerable sohc 2.4-liter Four. Aside from that, there's no choice of engine. (Chrysler will make both engines available in the Expo LRV, the only model that will bear the Plymouth badge.)

There is a choice of transmissions and drive layouts for both. The Expos can be equipped with either a 5-speed manual—which makes a big difference in performance—or a 4-speed automatic. And both vans can be ordered with Mitsubishi's all-wheel-drive system. Both come with the same basic disc/drum brakes, and an all-disc antilock system is optional.

The two Expos also share the same analog instrumentation and thoughtful interior appointments.

To minivan watchers, these two newcomers may look very much like a renewal of the little Nissan Axxess, which failed to attract enough buyers to survive. But the differences in interior space utilization and all-around versatility should be enough to give these new Mitsubishi minivans a long lease on life.

—Don Chaikin

AUTOMOBILES

THE ALTERNATE FUEL REPORT:

PROPANE-POWERED BUICK

BY JOE OLDHAM, Editor-In-Chief



● We've all read and heard quite a bit in recent months about alternate fuel cars. Cars of the future, we read, will run on gasohol, methanol, ethanol, electricity, propane, natural gas, even hydrogen. And at PM, we've published several articles dealing with this topic.

That's all fine and dandy. Like everyone else, we're all for lower emissions and we all want to save our Earth. But there are practical questions here, too. What will these cars be like to drive? Will they whine, buck, smoke or smell bad? Will they be slow, fast, small or large?

In other words, you may be wondering what we're all going to be in for as drivers.

That's what we wanted to know, too. So we asked the car companies to let us drive various alternate fuel vehicles and report to you what it's actually like to be behind the wheel of, say, a propane gas-powered car or an electric car.

Here is the first of our reports.

Car: Buick LeSabre Fuel: Propane

Propane, or more properly, LPG (liquefied petroleum gas) is the stuff you use in your barbecue gas tank. So if you're on the road with an LPG car,



LeSabre's V6 required only a special LPG carburetor and pressure regulator valve for dual fuel use. Standard ECM controls metering.

you can stop and fill up at any of the places that sell propane for cooking and heating.

Though this doesn't make an LPG fillup as easy as stopping at the nearest gas station, it does make propane viable as an alternate fuel right now, instead of many years down the pike.

The advent of computerized engine control systems allows a lot more flexibility in switching from one fuel to another than was previously possible.

In the LeSabre, the electronic control module and the oxygen sensor remain stock and merely read which fuel the engine is running on. The car's electronics then adjust such parameters as fuel pressure, fuel-injection

richness and timing, as needed.

One of the neat things about our test LeSabre was that we could switch back and forth between propane and gasoline with the mere flip of a rocker switch on the dash. To allow the car to run on propane as well as gasoline, Buick engineers had to install a special propane carburetor (made by IMPCO), a pressure regulator valve, a fuel shutoff valve and, of course, a special fuel tank to hold the propane. With both the gasoline and propane tanks full, our test car had a phenomenal driving range of about 700 miles.

Since we were able to switch freely between gasoline and propane, we could directly compare engine performance and over-the-road manners in both modes.

No tradeoffs

And the comparison was, well, boring. After a couple of days, we got tired of the game because the news is, there is no news. We simply couldn't detect any differences at all in driveability, acceleration, idle, engine smoothness or anything else. From a driver's point of view, there just isn't any perceivable performance tradeoff when the car goes from gas to LPG.

(Please turn to page 92)

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REBIRTH OF THE BLIMP

(Continued from page 33)

Within this sure-to-grow category, the Whispership, built by the Blimp Works, in Statesville, North Carolina, and Memphis Airships' Zephyr stand out. Both machines are single-engined. A 5-hp Honda pushes the Whispership at a withering 32 mph, while the Zephyr gets 43 mph from its 24-hp Konig. But whereas the Zephyr's mill is housed in the rear of the small 1- to 2-man gondola, the Whispership's sits on a gimbal at the envelope's tail, so far from the gondola that there's a microphone wired from the engine to the car to let the pilot confirm the engine's turning.

Curiously, pilot comfort was not at all a consideration for the first Zephyr to exit the Memphis hangar. It was destined for service in Sasselite, an acronym for "small aerostat surveillance system, low-intensity target exploitation." Put simply, Sasselite is a Pentagon program experimenting with little blimps as remotely piloted vehicles. The military thinks there's a future in LTA, and is using Sasselite to stay abreast of the technology and apply it to its own needs.

Currently, the Sasselite blimp is fitted with various sensors, a color video camera and a control system all linked to the ground operator via microwave. In time, it may be tested as a battlefield communications relay or for some EW role. The potential roles are limited only by the military's imagination.

Brave new blimps

To that end, Louis Foltzer, a Westinghouse Airships executive, can lend some stimulation. You see, he's done a little preliminary work on the airship of the future.

It would be a monster, maybe 4 million cu. ft. or more, housing sensors sensitive enough to pick out gnats in a swamp. Nuclear powerplants would give this ship a limitless range and could keep it on station anywhere in the world for as long as necessary, be that weeks, months or years. Manpower would not be a problem because it would be remotely controlled via satellite. When maintenance became necessary, technicians would be helicoptered aboard, do their job and then leave. The airship might never return to land. In effect, it would be an infinitely mobile low-flying satellite costing a fraction of the spaceborne kind.

The dream of a visionary or just another farfetched scheme? We'll have to wait to find out. But regardless of what's to follow, the blimp is back right now. **PM**

ALTERNATE FUEL REPORT

(Continued from page 91)



Pressurized LPG tank consumes a sizable portion of LeSabre's generous cargo space.

Power from the LeSabre's 3.8-liter V6 is virtually identical on either fuel. Under full throttle, our LeSabre left the line with a little chirp of the tires, whatever fuel we were on. Even in cold-weather testing in a late-spring snowstorm, where we had heard that the propane would suffer in power production because of its much higher volatility, we could not detect any differences.

Odorless combustion

We can smell the propane gas when we light up our barbecue, and we thought we would be able to detect similar odors coming out of the LeSabre's tailpipe. Nope. In fact, we literally stuck our nose into the tailpipe and could not detect any malodorous LPG bouquet.

Another big plus for LPG is its inherently clean combustion. Besides being much lower in emissions, which makes exhaust gas cleanup much easier to manage, it's lower in nasty combustion byproducts. As a consequence, it's generally kinder to engine internals.

Even though the gasoline refinement process has improved considerably in the last decade, burning LPG still produces less in the way of corrosive leftovers.

Pistons and rings, in particular, benefit, and less foreign material finds its way into the engine oil. While we still recommend a 3000-mile oil-change interval, we'd expect the oil coming out of an LPG car to be generally cleaner.

So what are the negatives? The large propane tank took up a goodly portion of the trunk. And there's always the thought that you've got this tank of gas in a pressurized steel tank somewhere close behind you. It's a little unnerving. But it's something we may all have to get used to. **PM**

BOATING

THE WET VETTE

BY JOE SKORUPA, Boating/Outdoors Editor



● Some things never change. The speed of light? 186,000 miles per second. The world's highest mountain? Mt. Everest. The king of sports cars? Chevrolet Corvette. That's just the way it is. Always was, always will be.

The interesting thing about the Corvette, as opposed to other forces of nature, is that its place at the top is by no means guaranteed. To maintain its position, it ceaselessly goes where no sports car has gone before, out on the leading edge of technology.

This is especially true for the top-of-the-line ZR-1 Corvette, which is equipped with the highly advanced LT-5 engine. This 4-valve-per-cylinder, double-overhead-cam, sleeveless aluminum engine makes the ZR-1 the fastest car in America.

Ever since its introduction a couple of years ago, boaters have drooled over the high-tech LT-5. And why not? The LT-5's built by MerCruiser at its plant in Stillwater, Oklahoma. Think of the possibilities: a lightning-quick engine mated to a lightning-quick boat. Mystique and charisma zoom off the chart.

Well, technicians from Mercury Hi-Performance finally did it. They wrestled an LT-5 block off a back-ordered assembly line and took great pains to modify it for the marine environment. The process required tremendous co-

operation between Merc, GM and Lotus Engineering and took months of hard work. But in the end, the ultimate muscle boat emerged—the Wet Vette.

Smoke on the water

I first saw the anxiously awaited Wet Vette at the recent Miami Boat Show, where it attracted a large crowd of warp-speed aficionados. It's an impressive beast, inside and out.

The boat itself was built by Baja Boats at its plant in Bucyrus, Ohio. It's a customized version of the newly introduced Baja Bandit, a 24-ft., deep-V sportboat.

To help dramatize the point that Merc builds the engine that powers the king of sports cars, the Wet Vette

was displayed alongside a shiny new ZR-1. Both awesome speedsters had their engine covers flipped up and enthusiastic crowds buzzed around like flies. More than a few must have imagined that exotic automotive technology will be the next wave in racing and muscle boats. But they'd have been mistaken. What works on land doesn't necessarily work on the water. More on this later.

Right now, it's time to be

dazzled by a Corvette-inspired dream machine.

The first components that catch the eye are the custom-built stainless-steel headers and standard 16-runner intake manifold. Both have a story to tell. The water-cooled headers are a masterwork of welding. The set of complex curves and angles which are required to meet detailed specs provided by Lotus were formed by placing dozens of pieces in position and precisely welding them together.

The intake manifold was a bit easier to deal with. A pair of intake runners feeds air to each cylinder. In automotive applications, one runner per cylinder is open most of the time. Only at full throttle does the second runner

(Please turn to page 94)



The exotic LT-5 powers both land and water Vettes.



Start with a Baja Bandit. Add an LT-5 engine, then boil the water at hair-raising speed.

kick in. In marine applications, however, the engine spends most of its time at wide-open throttle and there's no need for the linkage and butterflies that cover the secondary intake ports so they were eliminated.

The biggest nightmare facing Merc technicians was reprogramming the computer software for the engine management system. Decisions had to be made as to which sensors could be used, such as those dealing with temperature and air/fuel mixture, and which could be eliminated, such as those affecting the headlamps and emissions control.

To further complicate matters, the GM wiring harness wasn't up to handling the marine environment. One had to be created and put in place that would plug into a standard Merc control harness.

In the end, the Wet Vette LT-5 cranks out 420 hp, which is 45 hp more than a standard ZR-1 engine. Much of this increase is attributable to elimination of the muffler, the catalytic converter and other emissions control equipment.

On the water, the Wet Vette turns in a blistering 71 mph equipped with a 14½ × 25-in. Mirage prop. This is about 100 mph less than top speed in a ZR-1, but there's really no comparison. Here's why.

Aero versus hydro

"The constant drag of water is so much higher than the rolling drag of tires on pavement," says Fred Kiekhaefer, president of Mercury Hi-Performance, "that the exotic technology of car engines pays very few dividends in boats."

Kiekhaefer knows whereof he speaks. Not only is he the man ultimately responsible for the Wet Vette, but he's the driving force behind the engines used on the fastest boat racing circuits in the world—the MerCruiser and Mercury Hi-Performance series of engines.

According to Kiekhaefer, the Wet Vette is a one-shot fantasy in fiberglass. You can't buy it, and future models aren't planned.

Cost is a big deterrent. A marinized LT-5 engine costs roughly \$30,000, which is more than double the sticker of a tricked-out big-block engine. But there are other drawbacks.

"The main factor affecting a sports car is wind," Kiekhaefer explains. "For a boat, it's water. Aerodynamics versus hydrodynamics. The effect this has on an engine is extreme. An engine pushing a boat through the water needs to generate tremendous torque throughout the power band. This is similar to driving a fully loaded truck up a mountain. The engine's at full throttle all the time."

Automotive engines, even high-performance mills, aren't built to run at full throttle for their entire operating lives. The technology is advanced, but the emphasis is in a different direction.

As Kiekhaefer noted, performance characteristics for marine engines are similar to those in trucks. Interestingly, this is exactly where high-performance boat engines come from. The most common marine high-performance engine, the 454-cid, big-block Chevy V8, is only offered as a manufacturer-installed standard or optional choice in pickup trucks, vans or sport/utility vehicles.

Nothing beats cubic inches for a fat torque curve, and nothing beats thick, cast-iron cylinder walls for maximum durability. These are the main strengths of the big-block 454 over the 350-cid aluminum LT-5. Also, the 454 works at a slower, less destructive pace than the LT-5, which runs at 7500 rpm to generate its peak power.

Finally, in automotive applications, the main benefit of exotic engine technology is in downsizing. The LT-5 and other advanced sports car engines are incredibly light and small for their power output. This is important in high-performance cars where the engine is about 20% to 40% of the vehicle's total weight. In a high-performance boat, the engine accounts for only about 5% to 10% of the total weight.

So, despite the incredible lengths

Merc went to marinize the LT-5, the Wet Vette isn't likely to have any ripple effect in the world of high-performance boating. The Chevy big-block is still king of the water. Always was. Apparently, it always will be. Some things never change.

Best Boats

Yamaha made news recently with the introduction of its 7.4-liter sterndrive engine. This intro is news for several reasons. One is that with the addition of the big-block engine, Yamaha enters the ranks of the full-line sterndrive engine builders, along with MerCruiser, OMC and Volvo Penta.

Perhaps more significantly, Yamaha's new outdrive features something unique to the marine industry—the Hydra-Drive automatic transmission. For the first time, a sterndrive engine will use a hydraulic clutch system that offers smooth, shockfree shifting. There are other benefits to the Hydra-Drive, as well as many new features on the engine, but they will have to wait for a future column.

The sterndrive I tested at Yamaha's New Orleans' intro was a hand-built prototype. Its performance was impressive, but modifications are planned before the engine emerges from the assembly line. I'll wait to test one of the finished products before my writeup. In the meantime, I thought I'd pass along some other information presented at the intro.

Which are the top-rated boat companies in the country in terms of ownership satisfaction? According to Marine Matrix, a marketing survey firm based in Evanston, Illinois, they are the following: 1. Ranger, 2. Grady-White, 3. Harris-Kayot, 4. Boston Whaler, 5. Lund, 6. Four Winns, 7. Cruisers, 8. Crestliner, and 9. Tracker Marine.

The Marine Matrix list measures owner's satisfaction as a combination of two factors—quality of product and quality of service. As far as I know, this is the first such ranking in the marine industry. The company based its findings on an analysis of more than 6000 questionnaires.

No doubt the Marine Matrix list will generate controversy. The dozen writers present were amazed by some of the names on and off the list. The word *amazed* will be too tame to describe the reaction by proud boat companies not listed.

This kind of marketing data has existed in the automotive industry for many years, and the marine industry, for its own good, should catch up. If the results of the Marine Matrix Top-9 list cause controversy, then let the debate begin.

ed electricity ties directly into a utility's main grid system.

The utility monitors the grid of the windfarm to make sure it is compatible with its own grid. When the two grids match with identical voltage and power factor, the electricity passes from the windfarm into the utility's electrical system. Power flows into the substation at either 12,000; 21,500 or 34,500 volts. It is sent to the utility's overhead lines at either 34,500; 115,000 or 230,000 volts, depending on the local transmission voltage.

A pole transformer converts these volts to a household current of 120 or 240 volts. The high voltage level is needed to lessen the loss of volts as the electricity is transmitted.

The substation also has metering equipment that determines the amount of electricity produced by the windfarm. The utility must pay windfarm developers based on the amount delivered. The rate of payment is government regulated through a 30-year power purchase contract. The power bought is at the utility's "avoided cost." That is, the cost the utility would otherwise incur in generating an equal amount of electricity from a fuel-fired plant.

The payment rate is currently between 5 to 9 cents per kilowatt hour. One kilowatt hour is equal to the amount of electricity necessary to power a 100-watt light bulb for 10 hours. The average U.S. household uses about 7000 kwh per year. In the San Geronio Pass, wind turbines range in size from 17-kilowatts capacity to 500-kw capacity. This means they can produce from 17 to 500 kilowatts each hour of operation.

Most wind turbines will operate more hours per year than the average car will during its entire lifetime. The 100,000-mile lifespan of a typical car equals 2000 hours of wind turbine operation at 50 mph. Each year, wind turbines operate approximately 3000 to 5000 hours. Maintenance is vital to keep these machines ready and running at maximum efficiency when the wind decides to kick in. According to Neal Emmerton, president of Sea-West Services, Inc., a wind energy development, management and maintenance company, "Standard maintenance is similar to the maintenance required by a car. Just as you must have a tuneup after a certain amount of miles, the wind turbine also needs periodic maintenance after a certain amount of generator-run hours." Every three months, maintenance crews conduct a minor checkup of all the equipment, such as checking the brake pads to make sure they are not worn, installing retrofits and making

any necessary adjustments. Computers hooked up to about half the turbines in a windfarm are accessed through office PCs. They provide performance data and help notify maintenance when a turbine breaks down. The turbines require about two major maintenance jobs a year.

Toward the future

So if windfarms are so great, why aren't there more of them all over the country? For one thing, the fatigue life of a turbine's major components is only about five years. And the components are extremely costly to replace. According to the DOE, a major challenge to producing wind turbines that are cost-competitive in more parts of the country is to improve turbine designs so they last 20 to 30 years. Advanced technology for more efficient airfoils, better controls and long-life drivetrains are being explored.

Wind technology's greatest promise in the United States is as a centralized supplier of electricity. Many prime wind sites in the Great Plains and Rocky Mountains are not close to population centers. These wide-open areas of unused land make it easier to install wind turbines that need about an acre of land each. Being spaced far apart from each other allows the wind to rebuild its strength. The large spacing also allows wildlife to flourish in its natural habitat. In these areas, the turbines can have easier access to utility transmission lines that would connect them to the national grid network. According to the American Wind Energy Association, the states in order of greatest wind power potential are North Dakota, Texas, Kansas, Montana, South Dakota, Nebraska, Wyoming, Oklahoma, Minnesota, Iowa, Colorado, New Mexico and Idaho. The DOE estimates that one particular site in Montana could provide 17 times California's current wind generation.

Jim Dowty, vice president and general manager of windfarm operations for Wintec Ltd. in Palm Springs, says his company is looking into developing windfarms in South Dakota, North Dakota, Montana and Wyoming. "There is more wind energy in those four states than there is oil in all of Saudi Arabia," Dowty says.

Emmerton believes the utility companies will end up just like the telephone companies, having to give up their monopoly on the national grid and let independents transmit their energy using existing wires. "We will actually be able to supply electricity 24 hours a day because when wind is not blowing in one place, it's blowing in another." **PM**

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WHY THE DINOSAURS DIED

BY ABE DANE, Science/Technology Editor



WILLIAM K. HARTMANN PHOTOS

● It was a perfectly ordinary day in the Cretaceous Period when a 5-mile-wide hunk of rock came screaming out of the sky. Traveling at roughly 150,000 mph, it burned through a shallow ocean, burrowed 25 miles into the sea floor and vaporized in a flash. With a thousand times the power of all the world's nuclear arsenals, it sent a 3-mile-high wave rolling outward at hundreds of miles per hour, and shot thousands of cubic miles of debris skyward, casting the entire planet into darkness for months or possibly years to come.

It was not a good time for life on Earth. Without sun, plants withered, climate fluctuated, and soon the dinosaurs were gone, along with many other species that had characterized the Cretaceous. But for a few, particularly the adaptive little mammals, it was the opportunity of the eon, setting the stage for warm-blooded dominance that has lasted up to the present day.

This is not a new explanation for the catastrophic demise of the dinosaurs, but lately so much evidence has fallen together in support of it that a growing number of scientists consider it nearly certain. Many now believe it

won't be long before the 65-million-year-old dinosaur disappearance mystery is cleared up for good.

The trail heats up

The latest flurry of breakthroughs began with close study of a thin layer of silt that settled over the Earth around the time of the dinosaurs' disappearance. Called the Cretaceous-Tertiary (K-T) boundary layer, this slice of clay is found all over the world. It marks the transition between two geologic periods and two radically different sets of life forms. While some species are found both above and below the boundary, the dinosaurs, along with toothed birds, ammonites and countless others, did not make it across into the later Tertiary Period. No one was sure why.

In the late 1970s, geologist Walter Alvarez and his father, physicist Luis Alvarez, analyzed the boundary and found that it contained surprisingly high levels of the heavy element iridium. Normally rare on the Earth's surface, the iridium most likely came either from deep below, through volcanic action, or from space, through the fall of meteorites. Further study showed that the concentrations of

iridium and other elements in the boundary layer gibed better with the meteorite scenario. What's more, there appeared to be a good chance that all the iridium came from a single tremendous impact, either by an asteroid or part of a comet.

The boundary thickens

With the first solid evidence for the meteorite theory in place, a worldwide hunt commenced for a crater big enough to match the mammoth collision. The search narrowed in 1985, when geologist Jan Smit found signs of a nearby impact in the North American boundary layer. Here, the layer tended to be thicker than elsewhere—averaging about $\frac{3}{4}$ in., compared with as little as a millimeter in other areas. And whereas the worldwide boundary consisted of only a single layer of whitish clay, North America's had a second, greenish layer of clay underneath the first. Known as the ejecta layer, this underlying part of the boundary was probably the result of a rain of molten rock that fell over an area stretching 3000 miles from the impact. The whitish layer above was made up of finer pieces of material, which would have fallen over a period

of months after being spread evenly through the stratosphere.

In 1990, University of Arizona graduate student Alan Hildebrand followed the ejecta layer to its thickest point. In Haiti, where ejecta deposits up to 4 ft. thick had been found, Hildebrand dug up samples that contained strong evidence of a nearby impact. Embedded in the clay were the remains of tiny glass spherules, evidence of molten droplets that had cooled in midflight. Also, there were grains of shocked quartz, bearing microscopic striations, or lamellae, which could only have resulted from a tremendous impact. "Once you found the ejecta layer, you knew it was within 1000 km," Hildebrand concludes.

A massive search through existing geologic data turned up two candidate craters in the vicinity—one in the Colombian basin and another on the northern edge of the Yucatan Peninsula. A preponderance of the evidence now points toward the Yucatan. "It's the smoking cannon," says Eugene Shoemaker, a research geologist with the U.S. Geological Survey.

The Yucatan area first sparked curiosity in 1978, when geophysicist Glen Penfield stumbled on a semicircular magnetic anomaly there while surveying for oil. He verified the finding against gravitational data from the 1960s and published an abstract in 1981, but it provoked little interest. Over the past year, however, Hildebrand's findings have led all sorts of supporting data out of the woodwork.

For starters, at a little more than 100 miles across, the crater is the right size, and so far, its age appears to be in the right range. Drilling into the crater has found shocked quartz embedded in rock that melted at the time of the impact. Furthermore, sediments washed miles ashore all around the Caribbean Sea, apparently by a giant wave, match those in the Yucatan area, as do minerals deposited around the world in the boundary layer. And most recently, data from Landsat 5 has been published, providing the first surface evidence of the crater rim's shape. "This information all fits together like a jigsaw puzzle," says Charles Duller, a researcher at NASA's Ames Space Flight Center and interpreter of the Landsat data.

The recent crystallization of new and old evidence has steadily chipped away at rival extinction theories, particularly those based on volcanic action. "All my work has been fought tooth and claw," Hildebrand says. But now, "The opposition has been slowly crumbling and others have been jumping on the bandwagon." **PM**

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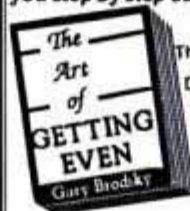
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PHOTOGRAPHY

THE WIDE VIEW

BY GEORGE SCHAUB



PHOTO BY GEORGE SCHAUB

● Have you ever stood on the rim of the Grand Canyon, brought your camera to your eye and wondered, "How am I going to get all this into one picture?" While no one camera or lens can recreate the feeling of being there, now you can at least get a lot more in the picture than you used to with the new breed of 35mm "panorama" cameras. These cameras don't rely on super-wide-angle lenses to do the job. Rather, they deliver images that seem to stretch the horizon line without adding loads of sky or foreground to the picture, an effect you'd normally get with a super-wide lens.

Kodak introduced the first mass-market version of the wide-view 35, appropriately called the Stretch, to the U.S. market last year, and now many other camera manufacturers have jumped on the idea.

The Stretch, renamed the Panorama 35, is a single-use camera—after you expose the film, you leave the whole package at the photo-finishing counter. The latest batch of panorama cameras—such as the Minolta Freedom Vista (used to take the picture above) and Samsung AF400, to name only two—are more conventional in that you send in only the film and get to keep the camera.

What makes a so-called panorama 35 different from a regular lens/shutter 35? Generally, it's defined as a camera that produces an image on film with an aspect ratio (relationship between height and width) of at least 1-to-3. For example, a frame of 35mm

film is 24mm high \times 36mm wide—a 2-3 ratio—which when printed translates roughly to the standard $3\frac{1}{2} \times 5$ - or 4×6 -in. print. When you print a picture from a panorama-camera-produced negative, you get one that's quite a bit wider than it is high.

Three types

Panoramic cameras, in various configurations, have been around since the early days of photography.

Today, there are three main types. So-called slit cameras rotate on a base and/or transport film through as it is exposed. Some can be used to take pictures with a full 360° angle of view. In fact, if you shoot without ducking, you'll be included in the picture. Fixed panorama cameras that use film larger than 35mm—professional-size 120, 220, 4×5 -in. or even 8×10 -in. sheets—have either a wide film back or mask the negative to create the high-aspect ratio. These two types are usually very expensive and are used mostly by professionals.

The third type are the recent ones—the popularly priced lens/shutter and single-use 35s. Purists would argue that these aren't true panorama cameras, but I'm not that fussy. When a picture is made with these cameras, only a 12×36 mm portion of the film frame is actually exposed. You see this proportion when you look through the viewfinder, so composing for the wide view is easy.

Some 35mm SLRs, such as the Minolta Maxxum, have an optional pan-

orama adapter kit, an easily installed masking setup for the viewfinder and film plane. Some new panoramic 35s, such as the Korean-made Samsung AF400, allow you to change from panorama to conventional pictures with the flick of a switch. However, you can't do this midroll.

When film from a panorama 35 is printed by special labs, you get back $3\frac{1}{2} \times 10$ -in. prints, pretty impressive stuff when you're used to seeing regular prints. You can also order black-bordered standard-size prints, save some money on the first set and then reorder the best in panorama size.

Some 1-hour labs are beginning to offer panorama print service, but you're more likely to find it available from camera stores or bigger film-processing dropoff stations. Check before you leave the film.

Do you really need a panoramic 35 camera to get those stretched-out prints? Not necessarily, but they do help when composing. In fact, you can use any camera, with virtually any lens, and simply shoot with the vista effect in mind.

For example, let's say you take a conventional 35mm negative and have an 8×10 -in. print made. To get what a panorama-camera-created negative delivers, just cut $4\frac{1}{2}$ in. from either the top or bottom of the picture, or a little bit from both.

If you think you'll be taking lots of panorama pictures, get a panorama camera, as going the 8×10 route can be expensive. A $3\frac{1}{2} \times 10$ -in. reprint



The Samsung AF400 and the Minolta Freedom Vista are two new 35mm cameras that are designed especially for taking panoramic photos.

from a panorama-produced negative costs about \$1.95, while an 8 × 10-in. print usually runs \$3.95 or more. However, you needn't be worried about quality differences between the two, as they're both printed to nearly the same magnification from the same size 35mm negative.

Can you ask a lab to make a 3½ × 10-in. print from a standard 35mm negative and forget about the whole panorama camera thing? Yes, but only if the image area you're interested in sits dead center inside the standard panoramic mask. Not many labs will want to fool around with the negative, giving you a custom panoramic print, at least not for anything but custom prices.

If you do try it, you'll be better off at your neighborhood lab, rather than trying to describe what you want to a clerk who'll send the film off to a big lab elsewhere.

Should you get one of these panoramic 35s? There's no question that they're a hit with dedicated photographers and snapshoters alike. Their appeal comes from the new ways in which they help us see, and how they make us consider composition and the world around us in a special, fun way. And, they do allow us to make pictures we couldn't quite capture before. Though we still can't get the *whole* Grand Canyon into one frame, these new and affordable cameras certainly give us a wider point of view than we've ever had before.

Black-And-White Film Revisited

While colorprint films are by far the most popular for snapshots and vacation photos alike, many people are beginning to rediscover the charms of black-and-white photography. There's something special about the way black-and-white films render a portrait or landscape, and even if you still prefer color prints, you should

give black and white an occasional whirl to awaken your eye and your photographic instincts.

Film manufacturers have spotted a trend and are responding with some new films that make black and white more accessible than ever before. To begin with, nearly all black-and-white films are DX-coded, which means that even basic lens/shutter cameras can read the film's speed and deliver correct exposures. This includes popular black-and-white films such as Kodak Tri-X, rated at ISO 400, and Fuji's Neopan 1600, a very fast film that allows you to shoot indoors without flash. Neopan 1600 gives you a great way to get candid shots of your family indoors without a flash. It can also be used at night baseball games and indoor sporting events where most films are too slow to stop the action and you're sitting so far away that your flash won't reach to illuminate the subject.

Two new films from Ilford, an English manufacturer that's been in the

black-and-white business for years, are of particular interest. The company's new ISO 400 film, dubbed Delta 400, is geared toward true camera enthusiasts who will take the time to develop and print their own film. Delta 400 has a very subtle richness of what shutterbugs call tone and has very fine grain as well.

The other Ilford film is called XP-2, a "chromogenic" black-and-white film that can be developed using the conventional machinery of the local 1-hour photo lab. Chromogenic means the image is formed with color dyes. XP-2 is like regular color-print film but lacks the color recording layers you'll find in films like Kodacolor.

The advantage of XP-2 is that you don't have to wait the normal one to three days it takes to get black-and-white film back from the lab. Just shoot the film and pop it into the 1-hour shop for prints in a snap. Because the prints are made on a color-print paper they may have a slight color cast, but this can be rectified later when you or the lab make prints on conventional black-and-white paper. XP-2 is also DX-coded so it can be used in virtually any camera. **FM**



This dark interior shot was taken with no flash using Fuji Neopan 1600 B&W film.

LAST-MINUTE RACING

BY TONY SWAN, Automotive Editor



PM PHOTOS BY HUMPHREY SUTTON

● When you watch big-time racing teams on TV, they look buttoned up, don't they? Totally prepared. One-two-three.

This might lead you to presume that the same level of readiness extends to racing at all levels.

Ha. More disassembly and re-assembly goes on at your average Sports Car Club of America race than at the Morgan factory in an entire year. Not to mention scurrying around in search of brake pads, spark plugs, wheel bearings, master cylinders, clamps, hoses, brake fluid, etc.

It's not at all uncommon to find some guy doing a top-end job on his engine an hour before he's due on the starting grid. It's even more common to encounter wild-eyed desperadoes rushing around the paddock in search of the one wrench that stands between them and making the race.

Here's why. The guys you see on TV race for a living, and they're backed by professional crews.

The men and women who contend for trophies at SCCA club events race for fun. Their weekdays are devoted to real jobs, which doesn't leave a lot of time for preparing a race car.

Our experiences in the first two outings with the PM Olds Quad 442 are typical of this last-minute frenzy. We had the basics covered. The car had its safety equipment—a roll cage, 5-point racing seatbelts and a fire ex-

tinguisher. We had a handle on tire pressures after a brief test session (our thanks to John McGill and staff at Nelson Ledges, Ohio), and we knew the car didn't like tight corners.

With this in mind, we slurped on plenty of Loctite, snugged the used bolts tight and limited our qualifying efforts to five laps. This gave us the 32nd spot in a 42-car grid. We were pleased to salvage a fifth in class.

One-time bolts

We thought we were in better shape two weeks later at Nelson Ledges—until we checked the brake pad inventory. This led to a day-long scavenger hunt, which netted enough pads to get us through the weekend.

Even so, the arrival of a first-class

inventory of Matco tools made us feel ready for any remove-and-replace operations we might need to do. Matco operates with a system of independent dealers, and you may see one at your local track soon. We were impressed with the quality of these tools, and only wish we'd made more use of them before the event—to change rear wheel bearings, for example.

Ha again. Halfway into our race, the left rear bearing shaft snapped. The wheel went left, and the rest of the car went right. Not so good.

For all this, we think our Olds Quad 442 will ultimately give a good account of itself in a class dominated by turbocars. We were less than a second off the best SSA qualifying time, and the Quad 4 can run with the tall dogs in the straight places.

Wheel-bearing blues

We'll be ready for the next round. Stay tuned.

Stay tuned.

Stay tuned.

Stay tuned.



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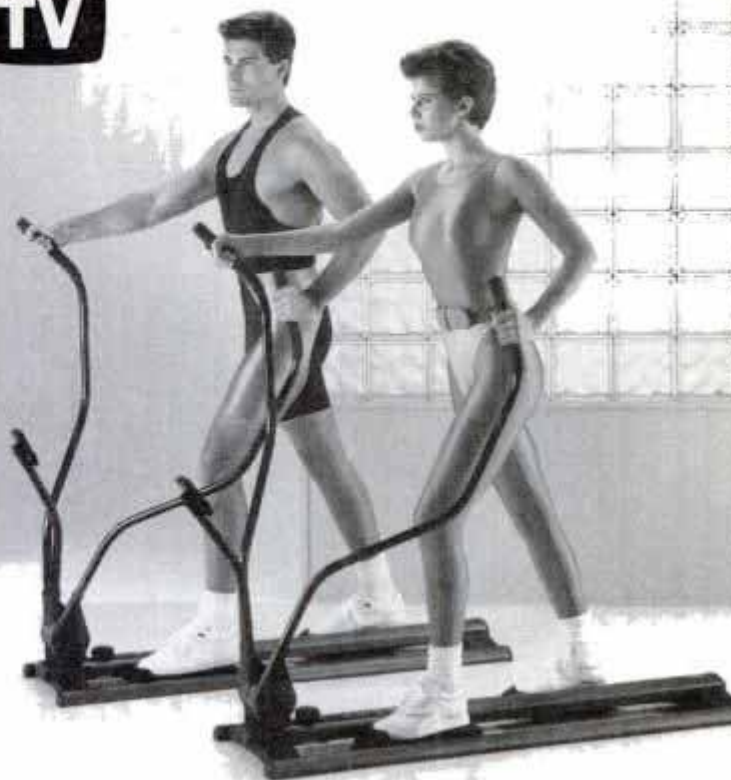
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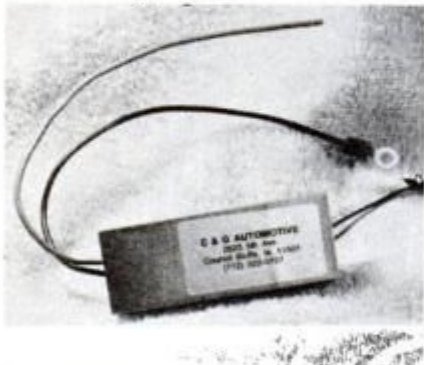
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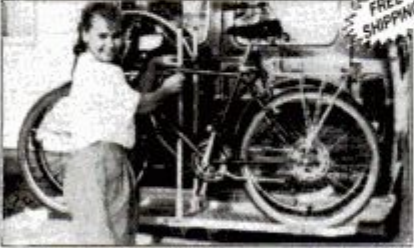


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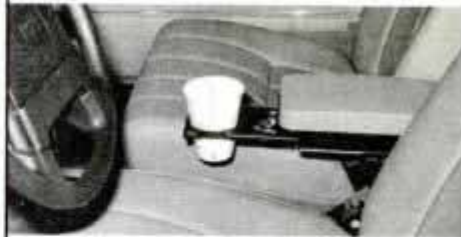
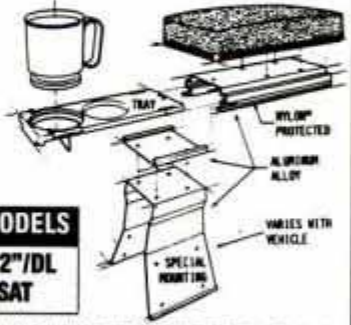
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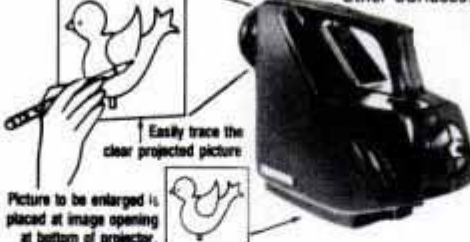
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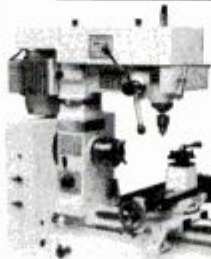
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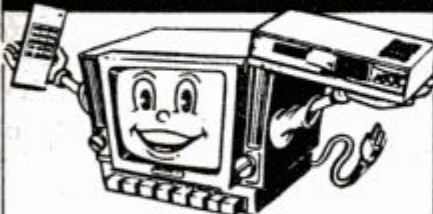


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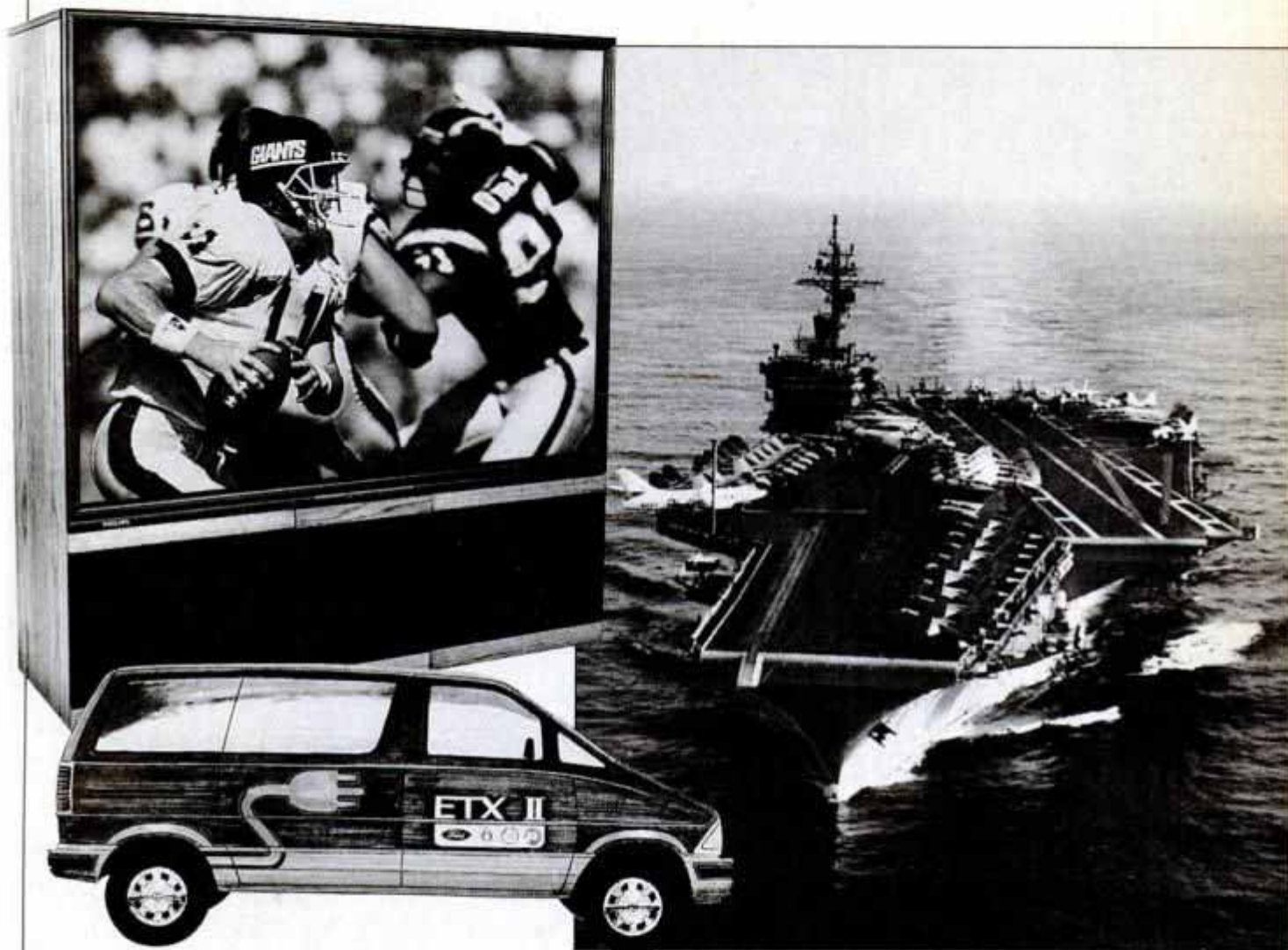
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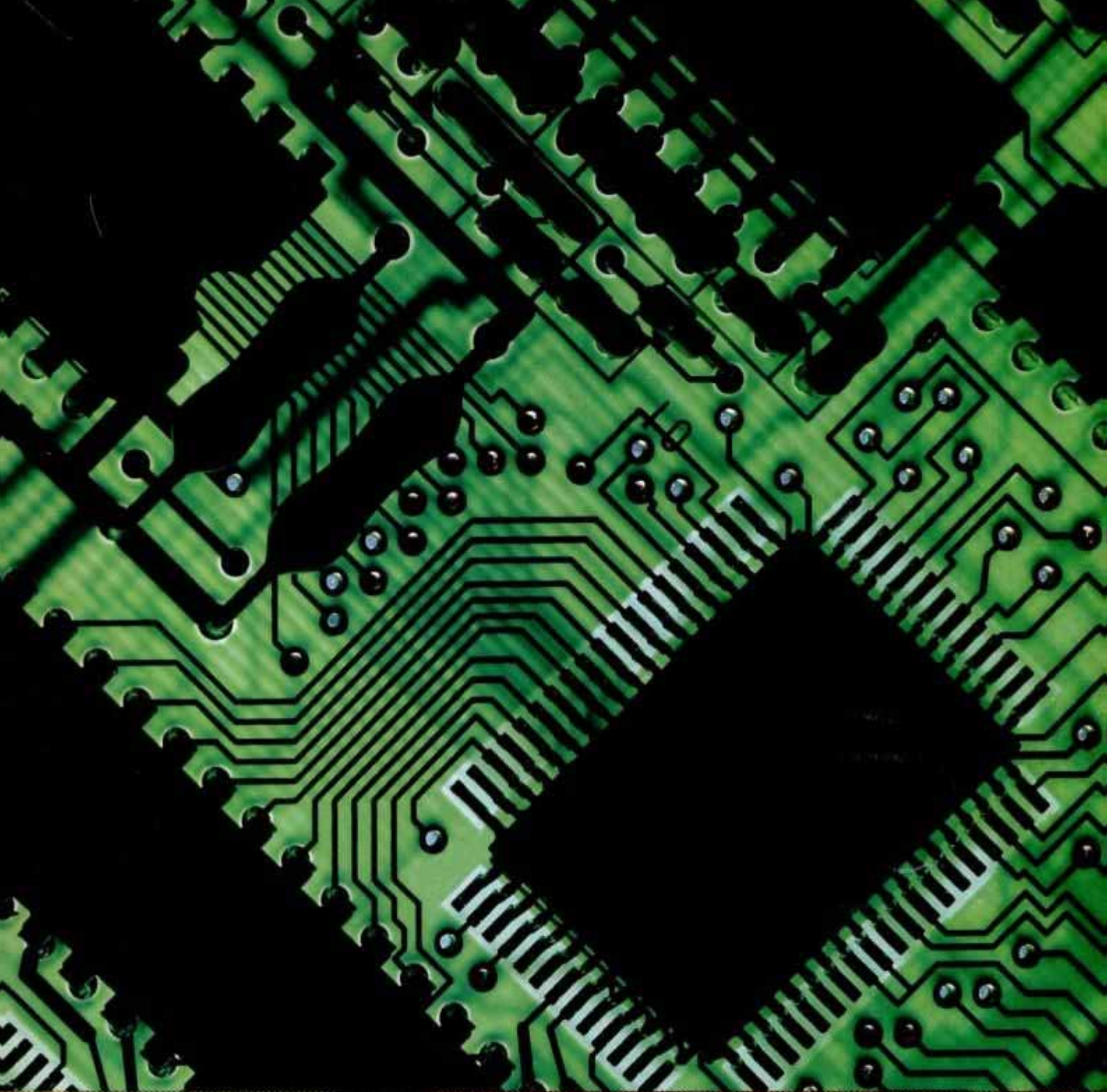
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