

AUGUST 1993 • \$2.50

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Popular Mechanics

**FORD TAURUS:
BEST-SELLING
CAR IN THE U.S.**
Owners Tell Why
It's A Winner

AMERICA'S NOSTALGIA RAIL REVIVAL

GREAT TRAINS RIDE AGAIN

Adventure Guide To 15
Best Steam And Diesel
Train Trips



**ILLUSTRATED GUIDE
TO FURNITURE DESIGN**
Fundamentals Of Character,
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**SUPERCHARGE
YOUR COMPUTER**
Here's How To Add Speed,
Sound And Even Voice
Recognition To Any PC

**EVERYBODY WANTS
A 4x4 SPORT/UTILITY**
But Don't Buy One Until
You Read Our 9-Way
Comparison Test



Illustration: Владимирский, рисунок: Гравюра

Truck buyers decide who

That's why we listen closely to what they say.

It takes more than a test drive to judge a truck. That's why the real experts are the ones who live with their trucks day in, day out. Mile after mile. And that's why we listen so carefully to what they say about truck quality.

We listen when over 14,000 truck owners evaluate the quality of their trucks.

Twice a year a 180-item questionnaire is sent to Ford and competitive truck owners. They're

asked to evaluate the quality of the truck they drive in a soup-to-nuts kind of evaluation covering everything from the tightness of the fit to the responsiveness of the steering. 14,663 owners sent back evaluations.

We listen when 27,000 owners evaluate durability over the years.

Once a year we do a 220-item tracking study that includes trucks that have been in service

for up to ten years. It's the most effective way to determine how

well a truck stands up to the test of time. 27,757 truck

owners evaluated the durability of their trucks and shared what they know with us.

Truck owners have said our full-size pickup is first in quality and durability over the years.

Based on truck owners' responses, our full-size pickups are first in quality* and durability

**Ford Trucks.
The Best Never Rest.™**



makes a quality truck.

over the years.** The Ford full-size pickup has been #1 in quality *twelve years in a row*. And based on owner responses about durability over the years, Ford full-size pickups are first as well. So it's not surprising it's been America's best-selling pickup sixteen years in a row.**

Better yet, we learn ways to improve our pickups.

We also learn what needs improving. And since we're dedicated to making the best-selling full-size pickup in America even better, that's valuable infor-

mation. Even though we've made the Ford full-size pickup much more stylish and more comfortable, the best can't afford to rest.

Ford's New F-Series Preferred Care Program. More proof that The Best Never Rest.™

We've introduced a cost-free customer assistance program for anyone who buys a new 1993 F-Series pickup. Preferred Care provides F-Series owners with a broad range of special services including 24-hour, 7 day-a-week

Emergency Road Service if you run out of gas, have problems with your battery, or lock your keys in your truck.****

Check with your Ford dealer for details.

*Best-built claim based on an average of consumer-reported problems in a series of surveys of all '81-'92 models designed and built in North America. **Based on an overall average of consumer reported problems in a 1992 survey of full-size pickup owners at 1-4, 6, 8 and 10 years of ownership. ***Based on calendar year retail deliveries by Division. ****Certain benefits provided by Ford Auto Club, Inc.



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



This One



AXUW-3CE-9B3G



Francis Caldwell's Small Business Partner (An Unbelievable True Story)

As an outdoor photographer, Francis has gotten into a few scrapes. More than once, his Coleman® lantern has gotten him out. There was the time he used it to fend off a brown bear. The night it lit his path across a log jam. And the night his headlights failed, and he drove home with the lantern tied to his hood. Francis is still shooting photos, and his 47-year-old lantern still works, too.

Neither one shows any symptoms of burnout on the job.



UNBELIEVABLY TOUGH

Popular Mechanics®

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EDITOR'S NOTES

● We finished the restoration of our 1967 Camaro convertible just in time to enjoy it all summer. We've displayed it in a few old-car shows already, and I must say it's great to see a reader recognize the car from 50 ft. away and exclaim, "Hey, that's the car they restored in POPULAR MECHANICS." Yes it is, and we'll continue to enter it in old-car shows right through the end of the season in October. If you see us at a show, come over and say hello and take a look at arguably the most beautiful '67 Camaro convertible in America. . . . Because of the surprise declassification of the Navy's *Sea Shadow* stealth ship, we had to bump our nostalgia train article ahead to this month, as the *Sea Shadow's* startling shape took over the cover in July. To research our great-trains-you-can-still-ride article, Science/Technology Editor Abe Dane rode the rails for almost two weeks, absorbing the sights, sounds and smells of many different routes and types of equipment. His report, plus your own guide to the best railroad rides begins on page 30. All aboard! . . . Last



Contributor Cliff Gromer (right) helps me sell PM subscriptions at the Englishtown, New Jersey, old-car show.

December, Ford Taurus dislodged Honda Accord as the best-selling car in America. Naturally, this made the champagne (domestic) corks pop in Dearborn, but it made us wonder what makes the Taurus so popular. It has been among the top-10 sellers since its introduction. And while it has done okay in our comparison tests, it has never grabbed us by the throat and said, hey, take a look—this is a great car. So we asked Taurus owners to tell us what their experiences have been with the car. They did, they love it and they tell you why in this issue, page 45. . . . If you ever wondered what the heck we were talking about when we published plans for a Queen Anne chair or a Chippendale chest of drawers, look no further than our illustrated guide to furniture design in this issue, starting on page 53. Read this guide, and you'll be able to talk furniture like a pro. . . . As we say on the cover, everybody wants a sport/utility. It's the one really booming segment in car sales right now. If you're thinking of buying, first read our 9-way comparison test, beginning on page 25, to find out what's good, what's bad and what's ugly. Till next time.


Joe Oldham

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CLOSE
TO A
GUY,
THE WAY
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SMELLS
IS
IMPORTANT.
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LETTERS

I Love What You Do For Me



To quote Toyota, "Oh, what a feeling!" The same can also be said while being given a barium enema. For the past 20 years, I have been mesmerized by the Japanese quality-control programs in automotive manufacturing, and have owned several Japanese-made cars, including an '84 Camry. But I broke from tradition and purchased a totally (90%) American automobile that can compete hands down with the Toyota Camry. My '92 Saturn SL1 is far superior to the Camry in every department. And the best part is that my purchase dollars stay here in America.

GENE SCHEVE
ECKERT, CO

Your survey shows a most unfortunate trend among American motorists. It indicates that 31% opted for a moonroof while 29% opted for ABS brakes. While a moonroof may be a nice item to have, it's relatively useless. There should be no question of which would be the better choice. The higher-line vehicles should have ABS as standard equipment. I suspect it would be a better safety bet than airbags if one had to make a choice.

ROBERT P. FARISS
PORTLAND, OR

Into The Woods

I was quite dismayed to find plans for a table and bench set that use red-

wood. There has been much debate in recent years concerning the elimination of old growth forests in Oregon and Washington by the timber industry. This industry claims that it performs selective timbering in order to sustain growth. However, these towering redwoods, sequoias, cedars and the like are hundreds and thousands of years old. Regardless of how many new seedlings are planted, these trees will not regrow in our lifetime or the lifetimes of many generations to come. You are encouraging your readers to contribute to the demise of these forests by using one of their byproducts.

TOM VULLO
BROOKLYN, NY

Anti-Honda Rules

My wife has always maintained that automobile racing is a waste of resources. I used to be able to argue that big-league races, such

as the Indy 500, are the testing and proving grounds for new automotive technology—every year featured stronger, more powerful, more advanced engines designed and built to run longer and squeeze more energy out of every drop of fuel. After reading "Indytech '93," however, I can no longer make that argument. Indy-Car racing is a sham these days. It's not about racing anymore. There is no technological competition. America's big engine-makers can't handle it and are afraid of it, and so the rule-makers have destroyed it. The litany of new anti-Honda rules proves this. American automotive technology is afraid to compete head-to-head with the Japanese.

DOUG GREEN
BOULDER, CO

Babes In Toyland

As a female reader, I've gotten use to the "babes" in the boats with very little clothing on and the guys that are fully dressed. But the ad you ran for Liquid Glass in June was tasteless—although, it probably had some saliva glands operating. The least they

could have done was match her hair color to her eyebrows, but who pays attention to details. Next month, let's go for a guy in his jock strap.

J. WATTS
LOUISVILLE, KY

Whizzing By

Loved your story about the



Whizzer motorbike. It was my first motorized vehicle. I had a great couple of summers with it and I subsequently traded it for a 1933 Studebaker—my first car and my first mistake.

LEE LAVALLEE
HOLLYWOOD, CA

Rack 'Em Up

For his high-school wood shop project, my son followed your plans to build a pool table. Needless to say, eyebrows raise and chins drop when friends and co-workers are told the table was constructed by a 17-year-old. The finishing touches, cushion and covering of rails, felting of the table and, most important, leveling of the bed and slate, were contracted to local professionals. The leveling must be done before felting the slate, and we found the benefits of this professional help far outweigh the costs.

FRANK G. SIMEK
ALLENTOWN, PA



Reader Frank Simek proudly displays the pool table his son built.

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

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Nissan 300 ZX 2+2	YES	NO	YES	222	\$34,040
Toyota Celica All-Trac	YES	NO	YES	200	\$28,588
Acura NSX	YES	YES	YES	270	\$69,500
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TIME MACHINE

90 YEARS AGO: AUGUST 1903

Missing Month

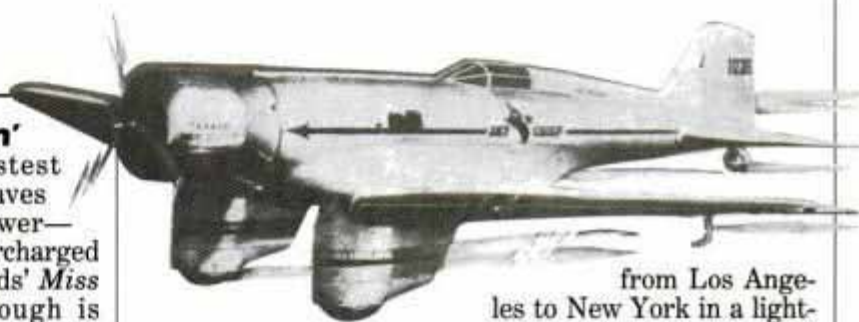
Responding to "urgent and repeated requests from readers," we announced in the July 25, 1903, issue that POPULAR MECHANICS was abandoning its weekly 16-page format. Following an August hiatus, we would reemerge as a 100-page monthly. We also switched to the 6½-in. × 9½-in. size that carried us until January 1975.

60 YEARS AGO: AUGUST 1933



Hulls A-Poppin'

The world's fastest boats rode the waves on sheer horsepower—like the four supercharged V12s on Gar Woods' *Miss America X*. Enough is enough, said naval architects, how about some innovative hull designs? One proposal: the No-Vac, which tiptoed on two notched V-shaped planes. The design created a bubbly cushion of water below the boat and diverted the airstream to break up the vacuum behind the transom.

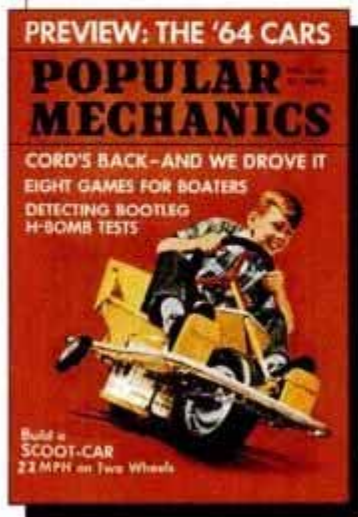


Coast To Coast

Nonstop transcontinental flights no longer seized headlines in an era of non-stop aviation one-upmanship. Neither—even back then—did automatic pilots. But a combination of the two made news when Frank Hawks flew his *Sky Chief*

from Los Angeles to New York in a lightning 13 hours 26 minutes. After 40 minutes of human control, the plane flew on autopilot, cruising at 225 mph, 15,000 ft. above the ground. Even when Hawks became disoriented in the Midwest, he left the machine in charge. Sure enough, it veered faithfully over Kansas City.

30 YEARS AGO: AUGUST 1963



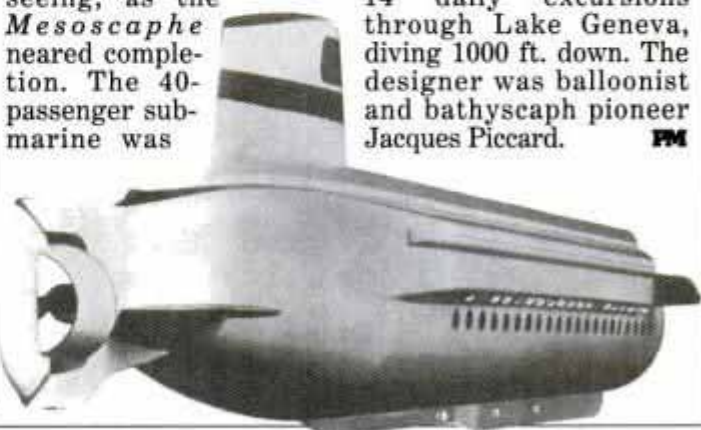
Junior's Jalopy

A pint-size ponycar might have been any kid's dream machine in the car-crazy '60s. We offered the next best thing: the Scoot-Car—a do-it-yourself mix of plywood, semipneumatic wheels, bicycle chain, a car-starter motor and a 6-volt battery. The little front-wheel-drive hot rod featured two outrigger wheels for cornering. Much of the machine came from available parts: The steering wheel, for example, was actually a 10-in. pulley.

Tour Du Lac

This was the dawning of the age of aquatic sight-seeing, as the *Mesoscaphe* neared completion. The 40-passenger submarine was

built for the 1964 exposition at Lausanne, Switzerland, where it would make 14 daily excursions through Lake Geneva, diving 1000 ft. down. The designer was balloonist and bathyscaph pioneer Jacques Piccard. **PM**



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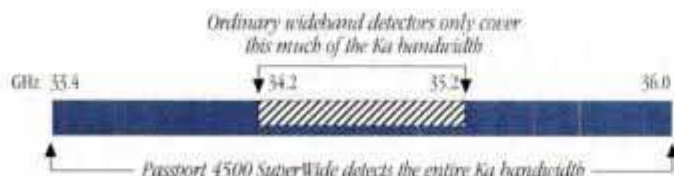
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TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATIONS BY JOHN BENNEY

Commercial Space: Your Ad In This Orbit

ROSWELL, GA—Is it the world's most intrusive billboard, an orbiting product spot? Or an opportunity for corporations, rather than taxpayers, to sponsor needed atmospheric research?

However you view it, a proposal is now afloat to put a vast "graphics platform" in low Earth orbit. Space Marketing Inc. is developing the idea with technical aid from the University of Colorado and Lawrence Livermore National Laboratories.

The spacecraft would consist of an inflatable tubular skeleton with a skin of reflective plastic. A bundle of scientific instruments would cling to its leading edge.

The platform would cruise

for about a month at 180-mile heights. Although air is rare up there, slight aerodynamic forces could still contort the surface because of its unwieldy dimensions—as much as a mile in length. So control surfaces at its corners would flex to keep the graphics facing Earth.

The platform could loom bigger than a full moon if viewed at sunset, when atmospheric diffraction swells the appearance of horizon objects. The plan isn't to put up a sky-high Michael Jordan, says Space Marketing, but rather a simple logo that the sponsor could then li-

Editor: Abe Dane
Writer: Greg Pope
Reporters: Philip Chien, Mike Fillon,
Scott Gourley

cense for ground-based ads. A smaller, cryptic message, would be visible only with telescopes or binoculars.

Inflatable tubes brace thin plastic sheet, bearing sponsor-funded atmospheric sensors and logo-for-hire.

Highlights This Month

- **Pick Your Planet**—NASA's budget solar-system travel packages.
- **The Uncanny X-Wing**—Stopped rotor rethought in new vertical-takeoff concept.
- **Gust Busters**—Unmanned air vehicles shake off turbulence.
- **Hello, Galileo**—NASA sidesteps bum antenna to salvage Jupiter mission.
- **Bring 'Em Back Alive**—Dirt racers and choppers to rescue fallen soldiers.
- **Swimmers And Skimmers**—Robotic roundup of the latest mechanical mariners.

PHOTO ILLUSTRATIONS BY ED VALDEGHEM



Venus Multiprobe Mission will scatter aerobrake-shielded probes into the planet's caustic atmosphere.

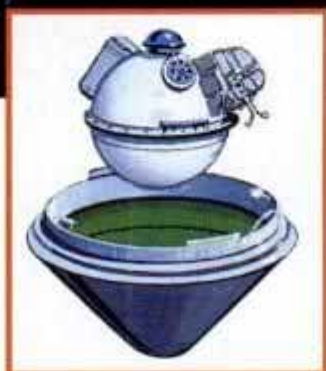
sights into its hot interior. The Orbiter, to be launched in 2002, will circle the planet. Jet Propulsion Laboratory (JPL) is the principle planner.

Meanwhile, Venus will be due for another checkup by the turn of the century. The Venus Multiprobe Mission will scatter sensors across the planet's face.

The probes will plunge through the atmosphere, taking in data on Venus's uncanny winds, which drive clouds 60 times faster than the planet's own rotation. The project is under study by Harvard University, JPL and Hughes Aircraft Co.

Other Discovery craft could visit comets and asteroids, watch Jupiter from Earth orbit, sample solar wind and check out Martian and Venusian atmospheres.

Carrying sensors, Mercury Polar Flyby will whip past the hot planet in solar orbit.



Hermes Global Orbiter, will look closely at the planet's surface, atmosphere and magnetic field, seeking in-

Budget Trips To The Planets

WASHINGTON, DC—Billion-dollar planetary probes won't be Cadillaging into space in the near future. Instead, NASA is downscaling to economy spacecraft under the new Discovery program. Eleven different missions,

each costing less than \$150 million, are on the drawing board. All will harness existing technology and saddle up on Delta II rockets.

Sizzling Mercury, left alone since the *Mariner 10* days (1973-1975), would play host to two spacecraft.

One is the Mercury Polar Flyby, designed by the Lunar and Planetary Institute in conjunction with Boeing. Its mission: to study the planet's newly spotted polar deposits and peek over at the unphotographed side of the planet. After a launch in 2000, the spacecraft will lock into a looping solar

orbit that will swing past Mercury every six months.

The other probe, the



Hermes Orbiter will settle into year-long elliptical Mercury orbit for closeup views.



Frost-Free Furnace

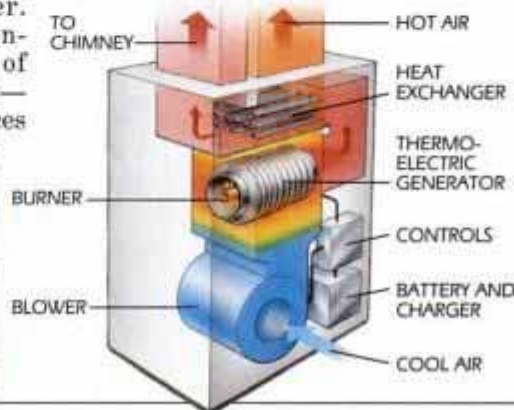
ROCHESTER, NY—What happens to your gas furnace's ignition if an ice storm knocks out electrical service? Unless you have a backup generator, you freeze. But General Electric's R&D Center has built a heater that will keep running even during a long power outage.

The key is a thermo-

electric generator that wraps around the combustion chamber. The device contains arrays of thermocouples—electronic devices



with circuitry that combines two different semiconduct-



ing alloys. If one alloy is kept warmer than the other, the device sets off a flow of electrons. Like other semiconductor devices, thermoelectric generators have no moving parts to break down.

GE's prototype cranks out the electricity needed to operate a gas-fired home heating system, with enough left over to run a TV.

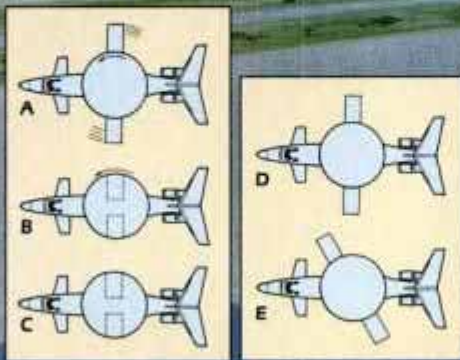
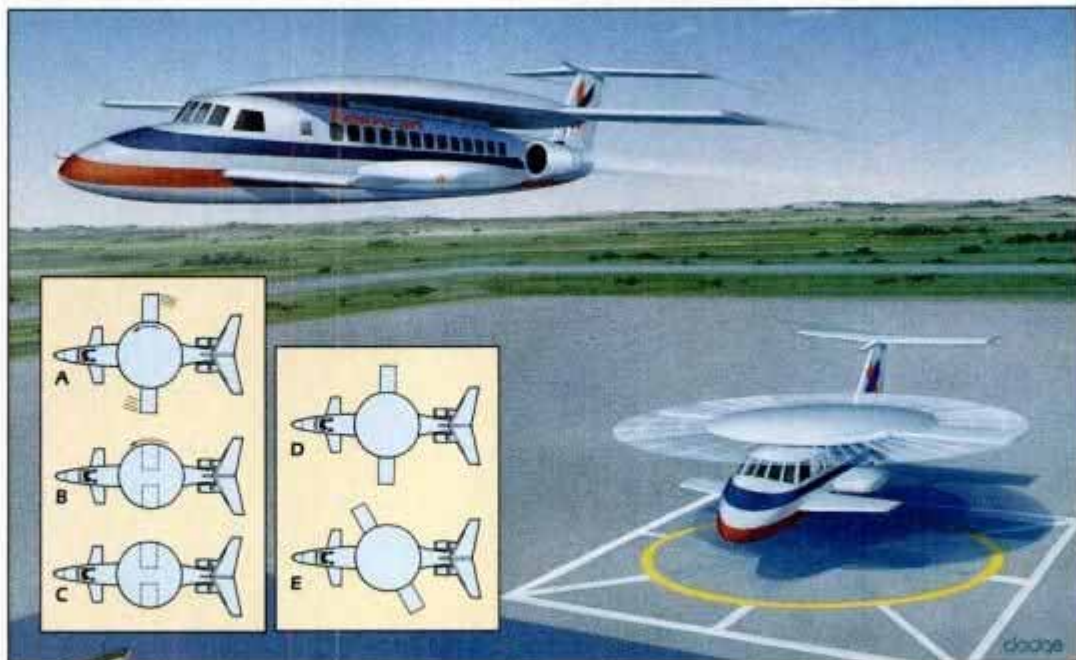
Cool air and hot combustion gases create unequal heating of thermocouples (left photo) to generate electricity.

GE PHOTO: PHOT ILLUSTRATION BY GEORGE BRETHER

X-Wing Turns Into O-Wing

MOFFETT FIELD, CA—Remember the X-Wing? Sikorsky Aircraft's experimental helicopter would have lifted off with rotor awhirl, then stopped its blades to cruise like an airplane. Now NASA's Ames Research Center has taken the concept a step further with a convertible aircraft called the M-85 (for its Mach-0.85 cruise speed).

The M-85 addresses the problem that gave X-Wing engineers fits: the vibrations triggered by the blades when the aircraft halted its rotor at the designated conversion speed. The X-Wing featured a welter of hardware to minimize the rattle.



Blades and hub rotate during hover (A). At conversion speed, blades retract (B), then hub stops (C). Once hub is still, blades reemerge (D) and can shift to oblique angle (E).

The M-85 simply tucks away the blades when it converts.

The key is a circular hub fairing, roughly half the rotor's diameter, that rotates with the blades during hover. Once turbojet engines

have boosted the M-85 to conversion speed, the blades retract into the hub and no longer bear any load. The hub then stops spinning.

Cambered like a wing, the hub itself supplies enough lift to support the aircraft at conversion speed. When the

M-85 reaches cruise speed, the blades reemerge as extra lifting panels.

The concept involves far less machinery and weight than the X-Wing or V-22 tilt-rotor. It could work in an aircraft the size of a DC-9, say Ames designers.



Strike-fighter version of M-85 concept would cruise with blades at oblique angle.

Eggbeater Flies Itself

BLOOMFIELD, CT—Drones may prove to be the prime beneficiaries of the intermeshing-rotor concept (see *Tech Update*, page 28, Apr. '92).

Kaman Aerospace Corp., which has been flying a new eggbeater-type helicopter since 1991, is proposing Spyglass, a 1200-pound unmanned vehicle.

Even with a 200-pound payload, the machine could

hover on station for up to 6 hours, since there's no tail rotor to drain away power. The craft would also fly quietly, because the two main rotors rip through the air at slower speeds than the blades of single-rotor helicopters.

Kaman engineers say the entire aircraft would work without a hydraulic system. Electric servo flaps on the blades would provide aero-



An all-electric unmanned rotorcraft, Spyglass could carry out stealthy reconnaissance missions using intermeshing rotors.

dynamic control.

The company says it could

demonstrate a Spyglass within two years.

Rockin' Ro-Birds

COLLEGE PARK, MD—A new breed of flying robots can feather their way

through turbulence and slow to a fraction of their normal stall speeds without losing control.

Designed by Freewing Aircraft Corp., the vehicles feature rocking wings that isolate the fuselage from wind gusts. While these wings define the flight path, the body can angle itself. Scorpion's wings "weather-vane" through wind while fuselage pivots independently.

self independently so that the propeller provides vectored thrust.

One vehicle—the Scorpion, co-designed by Burt Rutan—features twin tail booms. Held by aerodynamic pressures, the booms stay parallel to the flight path. Meanwhile, the main fuselage body can nose-up sharply, so that the propeller supplies enough lift to allow sub-stall speeds.



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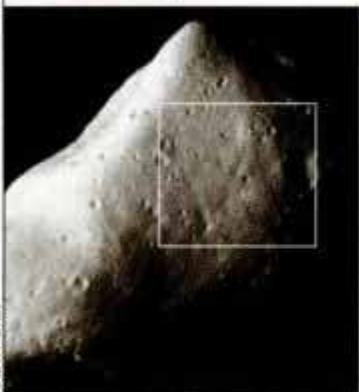
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Messages From Jupiter



NASA PHOTOS

PASADENA, CA—Its high-gain antenna jammed like a cheap umbrella, the Jupiter probe *Galileo* must resort to its low-gain antenna to relay data to Earth—at a speed



JPL used *Galileo's* 1991 asteroid flyby to practice data compression as high as 40:1.

$\frac{1}{60}$ th that of a typical fax machine! At that rate, NASA might as well write off all but a fraction of the science it had planned for the mission in 1995.

But Jet Propulsion Laboratory engineers say they can salvage at least 80% of the data.

For one thing, improvements to NASA's Deep Space Network antennas should enable the spacecraft to transmit data 10 times faster than planned. Meanwhile, amplifiers soaked in liquid nitrogen will pluck swift-moving data out of background noise.

In addition, programmers can send data-compression codes to the spacecraft's computer, squeezing digital images down to $\frac{1}{20}$ th of their original number of bits.

With these upgrades, the only science that NASA will



have to sacrifice is bit-heavy data such as long-term weather patterns on the giant planet.

X-Rays For Cells

HUNTSVILLE, AL—An X-ray microscope invented at NASA's Marshall Space Flight Center can image carbon-based structures inside living cells.

Existing microscopes, which illuminate objects with light or electron beams, require their targets to be dyed, stained, freeze-fractured or otherwise mutilated. But the Marshall device, derived from an X-ray telescope, shines a beam of X-rays at a wavelength that renders water transparent but carbon opaque. Biomedical researchers can thus watch the chemical machinery of live cells at work.



NASA PHOTO

Zero-expansion composite body houses ultra-precise X-ray microscope.

Rotors And Racers To The Rescue



WASHINGTON, DC—To whisk the wounded from the battlefield, a vehicle must offer speed and comfort. The Army and Air Force both have new ambulances that should fit the bill—ironically, a ground vehicle for the Air Force and an aircraft for the Army.

The Air Force Special Tactics Squadron will evacuate casualties in the R-1 Rescue All-Terrain Transport, built by North American RACECO. The vehicle's roots lie in off-road racing, as the triangulated chassis and progressive-rate spring suspension bear witness. But it also has special-forces features like run-flat tires and infrared headlights.

UH-60Q gives medics critical-care gear and the room to minister to multiple casualties.

The R-1 can carry up to six stretcher patients, two medics and their gear. All this despite its 2600-pound weight, achieved by using aircraft alloys and a 240-pound air-cooled Porsche 914-derived engine. The



vehicle is sized to drive right up into a waiting CH-47 helicopter.

Meanwhile, the Army is evaluating a new version of the Sikorsky UH-60A Black Hawk medevac chopper. A redesigned interior adds the wherewithal to stabilize injured soldiers in the critical first hour.

Instead of the old 6-liter



SAM OSMAN PHOTO

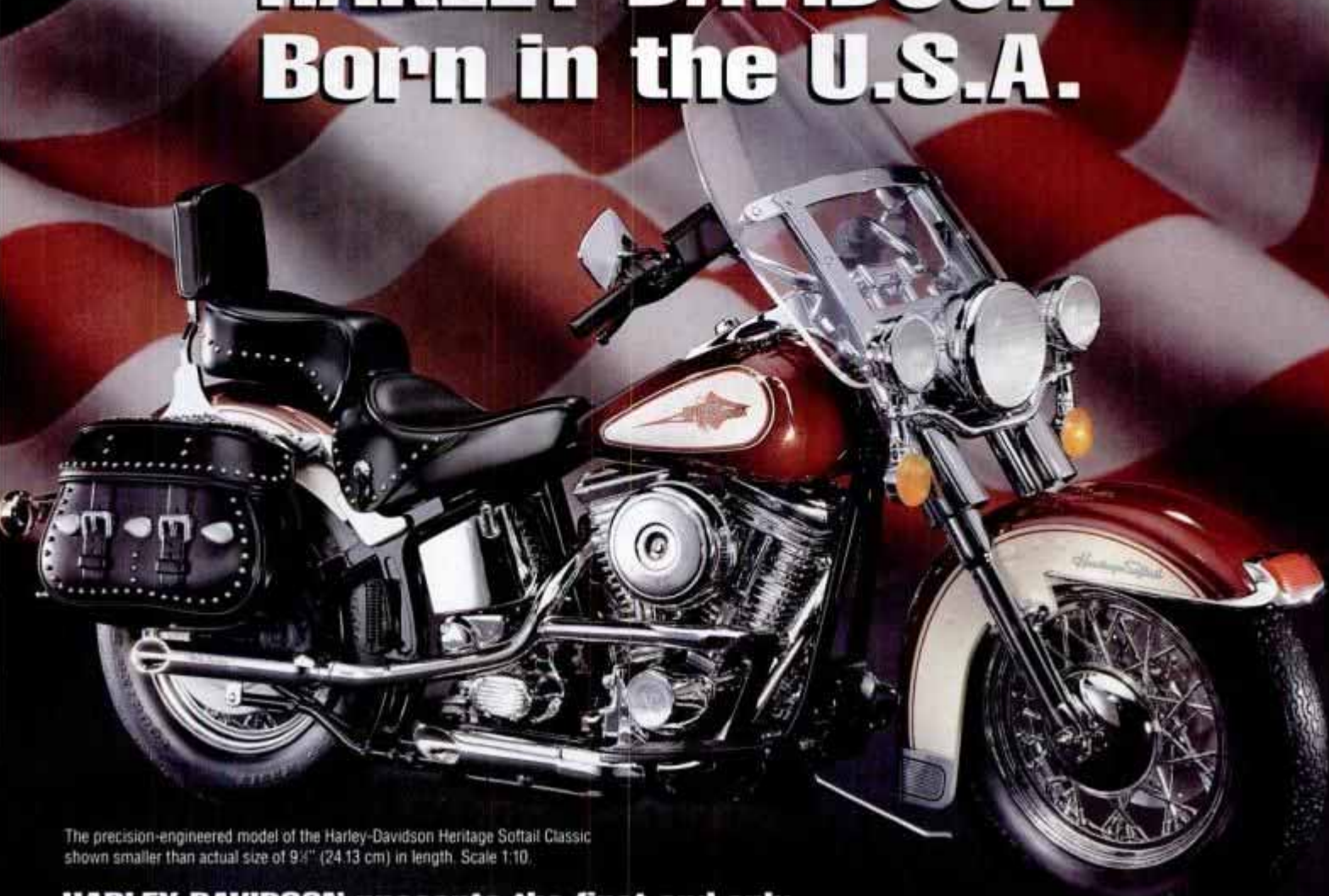
carousel, nine litters flank the walls of the new UH-60Q. Each draws its own oxygen from engine bleed-air filtered through a molecular sieve. Other gear provides intravenous fluids, monitors heart rate and keeps breathing airways open. Denver-based Air Methods designed the aeromedical cabin, based on civilian rescue helicopters.

R-1 ambulance combines sure-footedness with super-lightweight chassis.

SCOTT GOUBLEY PHOTO

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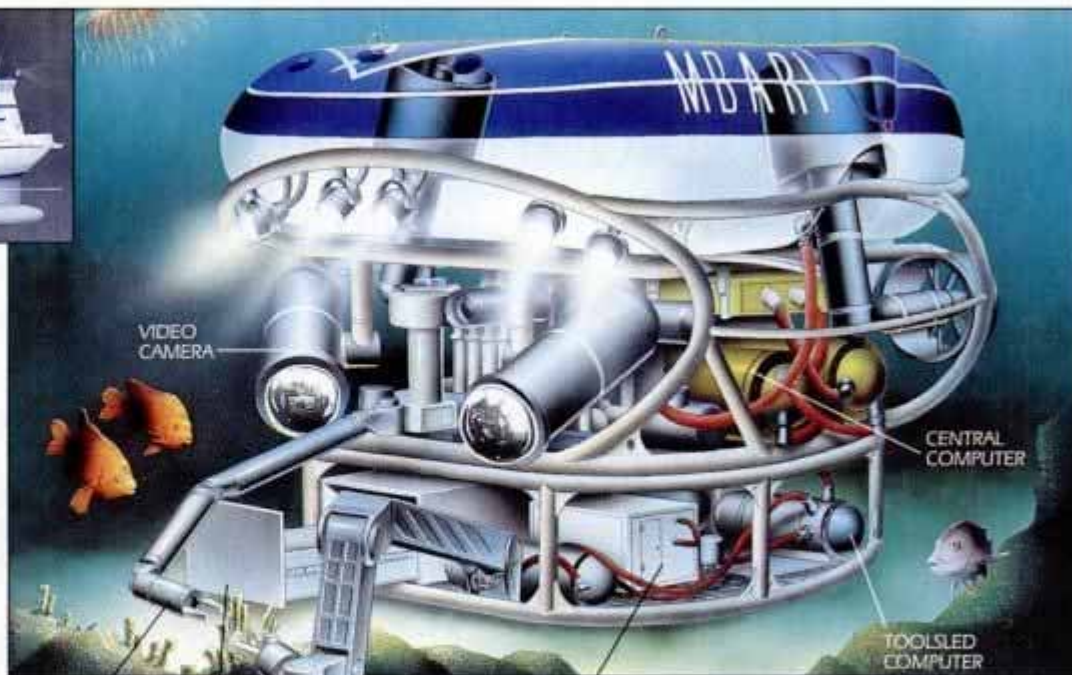
Deep-Sea Stalker

PACIFIC GROVE, CA—Next year, a mechanical diver unlike any other will begin exploring the submarine canyonlands off California.

Monterey Bay Aquarium Research Institute is building the vehicle—the first ever blueprinted as a multi-purpose scientific tool.

A tubular framework carries two levels of equipment. The upper level houses the standard tools: manipulator arm, sensors and cameras.

The vehicle's unique flexibility comes from the lower level, known as the toolsled. This space will hold mission-



specific hardware packages that quickly snap into the vehicle's electrical and mechanical systems.

The vehicle will also be

able to sneak up on skittish sea creatures and film them surreptitiously. A variable-buoyancy system permits silent hovering with

Deployed from SWATH vessel, new robot will carry toolsled for extra equipment like Schilling Titan II arm.

minimal use of thrusters.

MBARI's new SWATH vessel, the *Western Flyer*, will be the robot's mothership.



Industrial Free-Swimmer

SAN DIEGO, CA—The Navy and the big marine-science labs now have autonomous untethered vehicles prowling the deep for them. Why not the offshore oil and telecommunications industries, the biggest users of subsea robots?

Applied Remote Technologies (ART) has developed a testbed for a commercial autonomous underwater vehicle. Called the XP-21, the modular vehicle can stretch from 16 to 24 ft. to suit a variety of payloads, such as sonar, laser scanners

and other sensors.

The machine can dive to 2000 ft. below the surface and do 6 knots. Although it now runs on lead-acid batteries, a new aluminum-oxygen fuel cell will boost its range from 40 to 400 miles.

Vehicles derived from the XP-21 could scout out pipe-

Autonomous underwater vehicle for industrial use can stretch by 8 ft. to accept extended payloads.



line routes, map the geology beneath the seafloor and inspect submerged oil rigs without snagging tethers, says ART.

Stealthy Ro-Boat

PANAMA CITY, FL—With unmanned aircraft, ground vehicles and subs proving themselves, it's inevitable that the Navy would begin testing a miniature robotic surface vessel.

International Robotic System developed the *Owl*, a 10-ft.-long craft that scoots along at more than 35 knots, its sculpted underbelly dip-

ping only 4 in. into the water. The *Owl's* remote oper-

ator can sit hundreds of miles away, watching the



Owl's movements trace across a digital map, thanks to a Global Positioning System (GPS) receiver.

The vehicle can carry sensors, weapons, spotlights or even a public-address megaphone. During the current trials, the Navy also plans to have the *Owl* haul a sled full of mine-clearing apparatus.

Robotic watercraft can flit across waves faster than 35 knots, pushed by jetdrive.

MBARI ILLUSTRATION (LEFT); PM ILLUSTRATION BY VAN LIDELL (RIGHT)

APPLIED REMOTE TECHNOLOGIES PHOTOS

INTERNATIONAL ROBOTIC SYSTEMS PHOTO

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1. This hood emblem was used on what make car in the 1950s?



A) Studebaker. B) Oldsmobile. C) Packard. D) Mercury.

2. Synthetic motor oils have no natural base stocks in them.

A) True. B) False.

3. In the late 1940s, General Motors was America's largest automaker. What company was Number Two?

A) Ford. B) Nash. C) Chrysler. D) Studebaker.

4. What was the first production car to be turbocharged in the 1960s?

A) Olds Starfire. B) Chevy Corvair. C) Neither A nor B. D) Both A and B.

5. The camshaft rotates how many revolutions for every rotation of the crankshaft?

A) One-quarter revolution. B) One-half revolution. C) One revolution. D) Two revolutions.

6. Higher octane fuel permits:

A) Higher compression ratios. B) More spark advance. C) Slower combustion. D) All of the above.

7. A long block can be made from a short block with the addition of:

A) Cylinder heads and valve train. B) Intake and exhaust manifolds. C) Oil pump, oil pan and timing chain cover. D) Fuel pump, carburetor and air cleaner assembly.

8. America's oldest automaker is:

A) Buick. B) Cadillac. C) Oldsmobile. D) Ford.

9. How many revolutions does the engine of today's typical Top Fuel dragster turn in the course of a quarter mile run?

A) 600. B) 6,000. C) 10,000. D) 15,000.

10. Who was the founder of General Motors?

A) Louis Chevrolet. B) Alfred P. Sloan. C) Ransom E. Olds. D) William C. Durant.

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1. B 2. A 3. C 4. D 5. B 6. D 7. A 8. C 9. A (The run lasts only about five seconds) 10. D

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IN A
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TECHNOLOGY

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HAVE YOU DRIVEN
A FORD LATELY?

Why We Race

DUST BUSTERS



JEEP GRAND CHEROKEE LAREDO

Jeep's Grand Cherokee gets down and dirty with the cream of the compact sport/utility crop.

BY TONY SWAN, Automotive Editor; PM Photos by Mike Gaspar

● As off-road driving environments go, California's Anza-Borrego Desert is relatively tame. It doesn't present much in the way of true peril—the kind of relentless cliff-hanging that distinguishes expert-only runs like the fabled Rubicon Trail. The Rubicon requires serious off-road experience and savvy. Anza-Borrego, for the most part, requires only common sense.

On the other hand, the Anza-Borrego Desert is a long way from your average suburban street, which is where most sport/utility vehicles spend most of their time.

Anyway, we didn't need mountain-goat terrain to answer the basic question of this test: Given their emerging role as America's new station wagons, are the 4-door sport/utes getting soft? Are they

short on sport and long on ute? Or can they still play dirty.

Goaded by this burning issue—and the lure of the best spring wild-flower display in a decade—we gathered a flock of the leading compact 4-door sport/utes and headed for Borrego Springs, right in the middle of the 900-sq.-mile Anza-Borrego Desert State Park.

After a week of pelting down desert roads, thrashing through dry washes, scrabbling up rocky slopes and cruising lonely stretches of 2-lane blacktop, we came home with an answer.

DUST BUSTERS

We also came home with a clear consensus winner. Beyond that, though, our unanimity broke down. Accordingly, the balance of the field is presented in alphabetical order.

Compelling Competence

Before we reveal our tester's choice, a couple observations about our quest.

First, we don't think there's much doubt that all of these vehicles are intended primarily for pavement use. Their 2-door counterparts—those that have them—are generally set up

stiffer, since they're much more likely to go off-road. In that sense, the answer to our burning question is yes. These are family-oriented vehicles, designed for utility and comfort.

However, considering the comfort/convenience compromises, we think the off-road capabilities of all our testers are remarkable. While we would have liked a little more ground clearance here and a little better tire choice there, the all-around level of off-road competence was high.

We were particularly impressed

with the various 4-wheel-drive systems in our test fleet. Even the humblest on-demand system was easy to use, and all were equal to the moderately severe demands placed on them. The state of the art in 4wd has come a long way in the past five years.

Jeep Grand Cherokee Laredo

If you think we were seduced by the Grand Cherokee's optional V8 engine, you're only partly right. The 5.2-liter V8 offered more low-end grunt than anything, and low-end grunt is what you want for broken field running. Ditto for towing.

If our Grand Cherokee tester had come with the standard-issue 4.0-liter straight Six—190 hp, 225 ft.-lb. of torque—the vote would have been much closer. But even without the V8, the Grand Cherokee's combination of good looks, on-road ride quality and off-road athleticism is very compelling. Adding good old V8 torque to the package makes it irresistible.

As a station wagon, the Grand Cherokee gives something away to the segment-leading Ford Explorer, even though it sports a driver's



CHEVROLET S-10 BLAZER TAHOE



SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE TYPE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	TRANS- MISSION TYPE	WHEELBASE/ LENGTH (in.)	TRACK FRONT/REAR (in.)	WIDTH/ HEIGHT (in.)	HEAD-, LEG-, HIPROOM F/R (in.)	CURB WEIGHT (lb.) HP/WEIGHT RATIO (lb./hp)
Chevrolet S-10 Blazer Tahoe	\$16,258/ \$23,851	OHV V6 262/4300	200 @ 4500 rpm 260 @ 3600 rpm	4-speed automatic	107.0/ 176.8	54.1/ 54.1	65.4/ 64.3	F: 39.1/42.5/50.5 R: 36.8/36.5/52.6	3748/ 16.74
Ford Explorer Eddie Bauer	\$24,066/ \$27,158	OHV V6 244/4000	160 @ 4200 rpm 225 @ 2400 rpm	4-speed automatic	111.9/ 184.3	58.3/ 58.3	70.2/ 67.5	F: 39.9/42.4/NA R: 39.3/37.7/NA	3997/ 24.98
Isuzu Trooper LS	\$26,150/ \$27,769	DOHC V6 195/3200	190 @ 5600 rpm 195 @ 3800 rpm	4-speed automatic	108.7/ 183.5	57.3/ 57.5	68.7/ 72.8	F: 39.8/40.8/53.7 R: 39.8/39.1/53.5	4210/ 22.16
Jeep Grand Cherokee Laredo	\$20,884/ \$27,304	OHV V8 318/5200	220 @ 4800 rpm 285 @ 3600 rpm	4-speed automatic	105.9/ 176.7	58.0/ 58.0	69.2/ 64.9	F: 38.9/40.9/56.9 R: 39.0/35.7/49.3	3901/ 17.73
Land Rover Range Rover County LWB	\$49,825/ \$49,825	OHV V8 261/4278	200 @ 4850 rpm 251 @ 3250 rpm	4-speed automatic	108.0/ 183.0	58.5/ 58.5	71.4/ 72.2	F: 38.4/41.0/58.3 R: 37.3/39.7/59.0	4574/ 22.87
Mitsubishi Montero SR	\$25,300/ \$29,975	SOHC V6 183/3000	151 @ 5000 rpm 174 @ 4000 rpm	4-speed automatic	107.3/ 186.6	57.7/ 58.3	70.3/ 74.0	F: 40.9/40.3/53.5 R: 40.0/37.6/52.4	4225/ 27.98
Nissan Pathfinder SE V6	\$23,440/ \$25,730	SOHC V6 181/2960	153 @ 4800 rpm 180 @ 4000 rpm	5-speed manual	104.3/ 171.9	57.3/ 56.7	66.5/ 65.7	F: 39.3/42.6/52.2 R: 36.8/33.1/55.1	3890/ 25.42
Suzuki Sidekick JLX	\$13,899/ \$15,099	SOHC I4 97/1590	95 @ 5600 rpm 98 @ 4000 rpm	4-speed automatic	97.6/ 158.7	54.9/ 55.1	64.4/ 66.5	F: 40.6/42.1/NA R: 40.0/32.7/NA	2773/ 29.19
Toyota 4Runner SR5 V6	\$22,258/ \$27,988	SOHC V6 183/3000	150 @ 4800 rpm 180 @ 3400 rpm	4-speed automatic	103.3/ 176.0	56.3/ 56.0	66.5/ 66.1	F: 37.9/41.5/49.6 R: 36.6/31.6/51.0	4145/ 27.83

1. Times from a steady state 40 to 70 mph. 2. Best speed achieved while weaving through 8 cones placed in line, 100 ft. apart. Speeds provide index of transient response.

airbag. There's just not as much space inside, something that's severely aggravated by the inside spare-tire storage.

But as a dust buster, the Grand Cherokee stands out. Its optional Quadra-Trac full-time 4-wheel-drive system—one of three 4wd systems available for the line—makes child's play of virtually any traction situation. The only off-road setup that's more versatile costs some \$20,000 more. For all-around go-anywhere driving complete with luxury, this Jeep is tough to beat.

Chevrolet S-10 Blazer Tahoe

It's interesting to see that Chevy's compact SUV is making a strong sales comeback right near the end of its life span. But it's not hard to see why. Even in semi-luxo Tahoe trim, our tester sported the second-lowest sticker price in the group—lowest, if you regard the Suzuki Sidekick as anomalous. Either way, we think you get a lot for your money here.

Particularly under the hood.

Although the Blazer (and its GMC twin, the Jimmy) doesn't have as much torque as the Jeep V8, its Enhanced 4.3-liter V6 holds its own.

Choosing the Enhanced V6 means you also get a pushbutton 4wd selector, with shift-on-the-fly capability.

It's as easy as on-demand gets.

One other Blazer strong suit is rear-seat legroom. Adding a second set of doors stretched the wheelbase 7 in., virtually all of which found its way into the rear seating area.

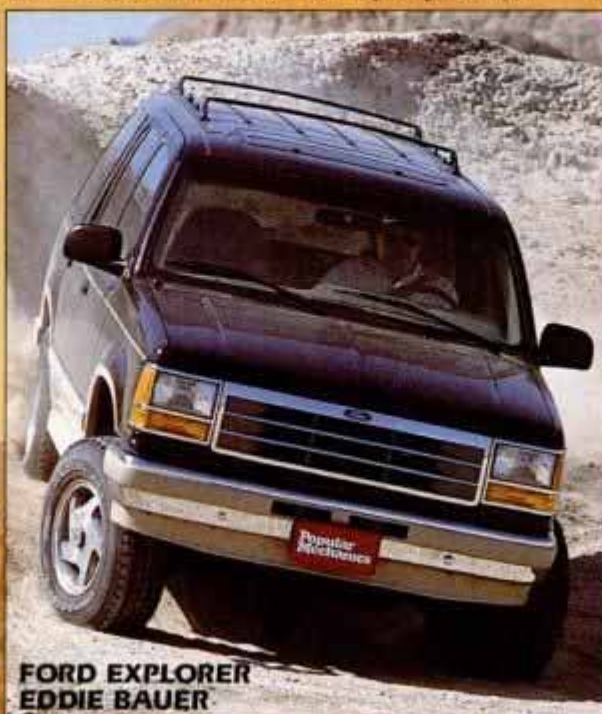
Some of the other rigs look newer than the Blazer. Some are more luxurious. Some are more sophisticated. But for dollar value, this setup is tough to top—particularly if you're planning to do any heavy-duty towing.

Ford Explorer Eddie Bauer

Don't be too alarmed by this Explorer's as-tested price. Up until a couple of months ago—when the Explorer Limited came along—this was as much money as you could pay for an Explorer. But you can get a 4-door Explorer complete with Ford's Touch Drive electric-shift 4wd for considerably less.

The qualities that sent the Explorer to the top of this class are its good looks, its long wheelbase (for a carlike ride) and its rear-seat space.

However, some of these vir-



Left to right: Chevrolet S-10 Blazer Tahoe, Nissan Pathfinder SE V6, Range Rover County LWB, Ford Explorer Eddie Bauer, Jeep Grand Cherokee Laredo, Mitsubishi Montero SR, Isuzu Trooper LS, Toyota 4Runner SR5 V6, Suzuki Sidekick JLX.

				TEST RESULTS					
CARGO VOLUME (cu. ft.) SEATBACK UP/FOLDED	MIN. GROUND CLEARANCE (in.)	TOWING BASE/AS TESTED (lb.)	TURNING CIRCLE/STEERING LOCK-TO-LOCK	FUEL ECONOMY (MPG EPA city/hwy.) PM test	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING ACCELERATION 40-70 MPH (sec.)	BRAKING 80-0 MPH (ft.)	700-FT. SLALOM MPH	PM SERVICEABILITY INDEX
35.2/74.3	7.8	5250/5500	37.1/NA	16/21 20.7	8.8 17.87 @ 75.78	9.5	123	63.2	10
42.6/81.6	6.3	NA/5200	38.5/4.0	15/20 19.4	11.8 19.69 @ 71.36	11.5	119	59.6	6
47.3/90.2	8.5	5000/5000	38.1/3.6	15/18 19.1	10.8 19.08 @ 71.18	9.8	123	58.9	9
40.1/79.6	8.7	5000/6500	35.9/NA	14/18 15.5	8.7 17.88 @ 76.92	8.9	117	60.4	10
36.2/76.3	8.0	7700/7700	39.4/3.38	12/15 16.3	9.5 18.58 @ 73.35	8.7	115	56.1	9
44.8/99.6	8.9	4000/4000	38.7/3.28	15/18 19.2	12.8 20.13 @ 67.61	11.54	122	57.9	8
31.4/80.2	9.25	3500/3500	42.0/NA	15/18 20.0	20.0 19.69 @ 67.51	10.3	115	59.9	9
NA/45.0	7.9	1500/1500	35.4/NA	22/26 26.1	12.3 20.86 @ 64.96	14.4	116	59.6	8
43.5/78.3	10.2	3500/3500	37.4/3.9	14/16 17.9	12.7 20.15 @ 66.22	13.3	156	62.2	9

3. Based on 12 basic maintenance functions.

DUST BUSTERS

tues hamper the Explorer off-road. The 4-door's spring rates and shock damping are tuned for pavement driving, and ground clearance is marginal.

The Explorer's 4.0-liter V6 doesn't have as much low-end poke as the Jeep's V8 or the Chevy's V6, but it still delivers a favorable power-to-weight ratio. And its torque peak comes on at a low, low 2400 rpm, a plus for either mud-slogging or towing.

But if off-road use is important, the better choice from the Explorer lineup is the 2-door—or perhaps its 2-door Mazda clone, the Navajo. It's not that the 4-door Explorer can't handle off-road duty. It's just that some of the others handle it better.

Isuzu Trooper LS

If this were just a beauty contest, the Trooper would be our queen of the



ISUZU TROOPER LS

tero is the tallest vehicle in this fleet—a little too tall, in fact, for some of our testers, who liked the squatter track-to-height aspect ratio of the Grand Cherokee for aggressive maneuvers in the dirt.

All hands agreed, though, that in SR trim the Montero has few equals on the comfort/convenience scale. We were impressed with the comfort of the leather-clad seats, and liked the unique auxiliary instrumentation with its inclinometer and altimeter. And the Active Trac (shift-on-the-fly up to 62 mph) 4wd system measured up with the best on-demand systems available.

However, while the Montero's comfort, quality and all-around utility drew high marks, its engine performance drew a stifled yawn. The 3.0-liter sohc V6 is smooth, but hitched to the second-highest curb weight in the group, it just doesn't have enough snort to get the old adrenal pumps going.

Nissan Pathfinder SE V6

Although there are newer shapes around, the Pathfinder continues to be very popular with younger buyers. It's regarded as cool, which tells you something about the importance of styling in this segment.

The Pathfinder SE V6 has contemporary off-road virtues—plenty of ground clearance, a good on-demand 4wd system, excellent steering, limited-slip differential, rear-wheel ABS, real off-road tires—plus luxury equipment like power windows, power mirrors, central locking, an exterior spare-tire mount, a sunroof and, of course, a premium sound system.

The Pathfinder also feels very stable thrashing around at a lot of odd angles, well above the group median in this regard.

Where the Pathfinder loses a bit of ground to many of its competitors is in rear-seat legroom and in the power department. The SE's 3.0-liter sohc V6 puts out a little more torque than its Mitsubishi rival and has a little less weight to propel, but it adds up to a level of performance that's only so-so stacked up against the Grand Cherokee.



MITSUBISHI MONTERO SR

outback. But don't get the idea that this is just another pretty face. On pavement, the Trooper is smooth, quiet, roomy and posh, particularly in LS trim, which includes a long list of luxury features. It's come a long way from the boxiness of the original.

In the dirt, the Trooper clambers around with the best. There's plenty of ground clearance, the on-demand 4wd gets power out smoothly to all four corners and the sophisticated suspension system does a very good job of optimizing power delivery.

However, we wish the Trooper had just a little more power to deliver. The 3.2-liter dohc 24-valve V6 engine is smooth and impressively torquey for a multivalve. But with 2 tons of vehicle to move, it isn't what you'd call lively.

Still, if sheer off-road muscle isn't a priority, the Trooper is very seductive with lots of lux for the bucks.

Mitsubishi Montero SR

If you wanna sit tall in the saddle—and eat high on the hog—this here's the ride for you, podnuh. The Mon-



NISSAN PATHFINDER SE V6

Range Rover County LWB

Considered as an off-road vehicle, the Range Rover has two big strikes against it. The first is obvious—its window sticker. The second is that most U.S. Range Rovers never get any closer to real off-roading than the overflow parking at a Long Island horse show. Thanks to their unique styling and traditional British luxury touches—walnut trim, aromatic leather and quirky controls—Range Rovers are immensely popular with old-money Easterners who employ them as weekend cars for their country places.

Too bad, because when it comes to dirty driving the Range Rover offers the most supple, sophisticated full-time 4-wheel-drive system in the business. The best.



But before you dismiss the Sidekick JLX, check the price tag. For about \$7000 less than anything else in this group, the Sidekick gives you a modern on-demand 4wd system,



The latest refinement to these superb underpinnings is an Electronic Air Suspension system, with automatic load-leveling and driver-select ride-height features. LWB stands for long wheelbase—8 in. longer than the standard Range Rover—which in turn equals improved ride quality and lots more legroom behind the front seats.

The Range Rover also offers the only other V8 in this class. Its powerband is well suited to low-speed off-road grunt work, but it's hard to forget the hefty curb weight. We're also inclined to be skeptical of the 7700-pound tow rating. Not that it won't tow this much—but how long do we have to get there?

So it's pricey and it's portly. But if we had to pick one vehicle from this fleet—money-no-object—for a week in a realm of no roads, this is it.

Suzuki Sidekick JLX

Okay, it's not in the same size and power class. There's hardly any cargo space behind the rear seats, and it won't tow much at all.

rear-wheel antilock braking and adequate ground clearance. It would do even better off-road with a more aggressive set of tires, but that's why there's an aftermarket.

On the street side of the ledger, the Sidekick affords very good front-seat legroom and adequate rear-seat space for adult-size people. Ride quality is good—something that can also be said for the seating, overall assembly and general fit and finish.

We don't think the Sidekick is the answer for regular excursions into the wilds. But for 4wd street chic that's cheap to buy and cheap to own, the Sidekick is tops in this group. It's also an excellent choice for younger drivers in the household.

Toyota 4Runner SR5 V6

The distinctions between the 4Runner and Nissan's Pathfinder are subtle indeed, particularly when the pavement ends. Their 4-wheel-drive systems are very similar, and both performed without a hitch. The 4Runner offers excellent ground clearance—the best in the group—but the Pathfinder has less front and rear overhang, which adds up to slightly better handling.

Like the Pathfinder, the 4Runner is mildly anemic in the torque department, a condition that's aggravated by its slightly higher curb weight. On the other hand, the 4Runner's 3.0-liter sohc V6 hits peak torque 600 rpm sooner, which is useful in slow going.

One big minus for the 4Runner is its cramped rear-seat area. When Toyota added a 4-door to the lineup, it was created on the existing wheelbase with the same overall length. That's why its rear-seat legroom is the most limited in the group.

Elsewhere, the 4Runner reflected Toyota's usual attention to quality. It was quiet, nicely appointed, well finished and good looking. **FM**



GREAT TRAINS, GREAT RIDES

Fifteen fabulous trains you can still ride, from steam locomotives to Amtrak's finest.

BY ABE DANE, Science/Technology Editor



● Evans knocked and entered with hot coffee and a copy of the *Sunday Blade*, a newspaper we'd apparently taken aboard last night while fueling up in Toledo. I asked him not to fold my bed just yet. The Capitol Limited would be arriving in Chicago late, so there was little to do but lie under the thick wool blanket and watch the snow-dusted Illinois countryside roll past at 80 mph. Seldom have I found a travel delay less exasperating.

This trip was to be the source of many such revelations. Like most people born since the 1950s, all I knew of long-distance rail travel had come through the wistful recollections of parents and grandparents: heavy silverware and crystal tinkling on crisp dining-car linens, porters shining your shoes while you slept and magnificently powerful machinery hauling it all from city to city.

Hoping to discover what, if anything, remained of these memories, I packed my bags and hit the rails for 11 days last winter. My course, plotted with the help of ex-

perts at the National Association of Railroad Passengers, would follow a great loop across the U.S., then back through Canada.

At 11:24 am, 4 minutes behind schedule, the quiet but persuasive tug of a 7000-horsepower AEM-7 electric locomotive coaxes the 6-car Amtrak Congressional out of New York's Penn Station. It's a snowy December Saturday, and I'm relieved to escape the pre-Christmas frenzy of Manhattan.

We blaze out from beneath the Hudson River onto the fastest, smoothest set of rails in the country. This is where the New York-Washington Metroliners run at 125 mph, racing with the airlines to lure time-conscious customers. On weekdays, lawyers and lobbyists fill the slender-bodied Amfleet I cars, pounding on their laptops. Today, we loaf over these silken rails at no more than 110 mph, but still arrive early in Washington's Union Station. Now beautifully renovated, this soaring beaux-arts mas-



terpiece is again the country's grandest temple of transportation, and a fitting spot from which to launch westward across America.

Six-thousand horsepower from two GM Electromotive F-40PHs set the Capitol Limited's 13 cars in motion 9 minutes after the appointed time. Along with coaches, baggage cars and a diner, the train includes two sleepers like my own. Built by Pullman Standard in the 1940s, these are marvels of miniaturization. My roomette, for example, measures a closet-like 7½ ft. × 3½ ft., yet it contains an upholstered seat wide enough for a sumo wrestler, a fold-out sink, a toilet, a small closet, a shoe locker, an overhead luggage rack and a variety of knobs and switches for precise control over climate and lighting. At night, the porter folds down a freshly made-up bed.

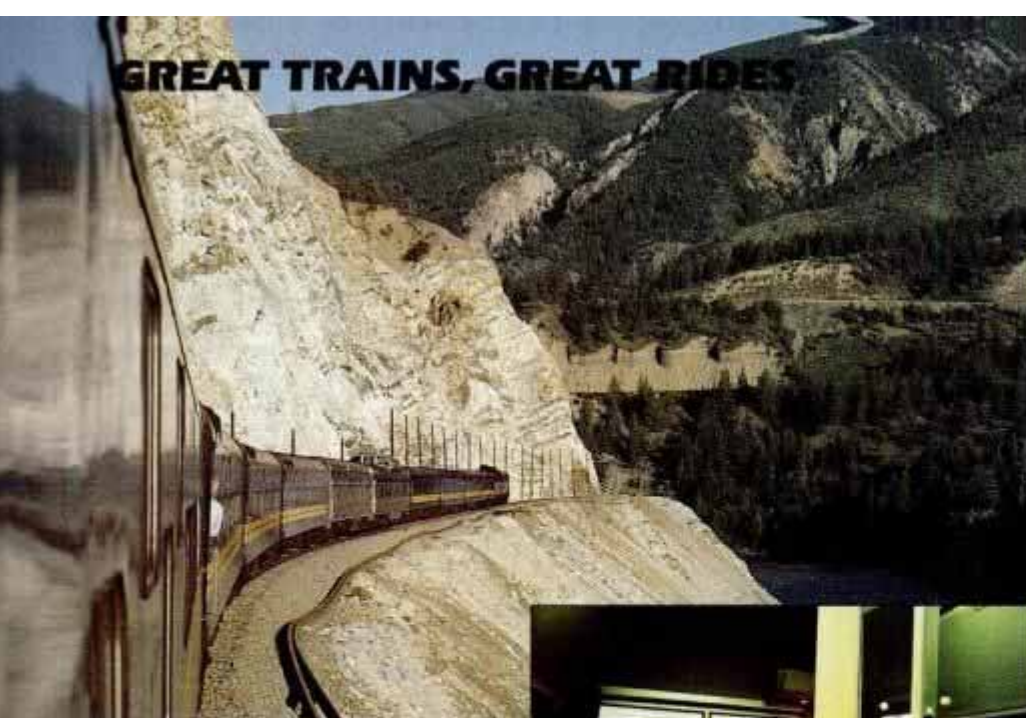
Our late arrival in Chicago illustrates a phenomenon none too rare on Amtrak. Ironically, this is in part due to the railroad's success. Ridership is up, and at the same

time, Amtrak has worked steadily to reduce its dependence on government subsidies by avoiding investment in new equipment. Now, when a breakdown occurs, there isn't much slack in the system to deal with it.

But train travel offers much to distract and soothe all but the most fanatically punctual. My deluxe bedroom aboard one of the Southwest Chief's double-deck Superliner sleepers is one example. Equipped with a bathroom, shower, sink and two bunks, it seemed spacious and comfortable enough to live in indefinitely. The dining car and observation lounge a few steps away allow life to go on pretty much as always, except that you have to reset your watch occasionally to keep up with the time zones.

What is magical is that you are carried effortlessly amid all this luxury through country there's no other way to see without snowshoes. Climbing through the ruggedly beautiful Raton Pass entering New Mexico, I sat down to lunch with a delightful couple, a retired GM executive and

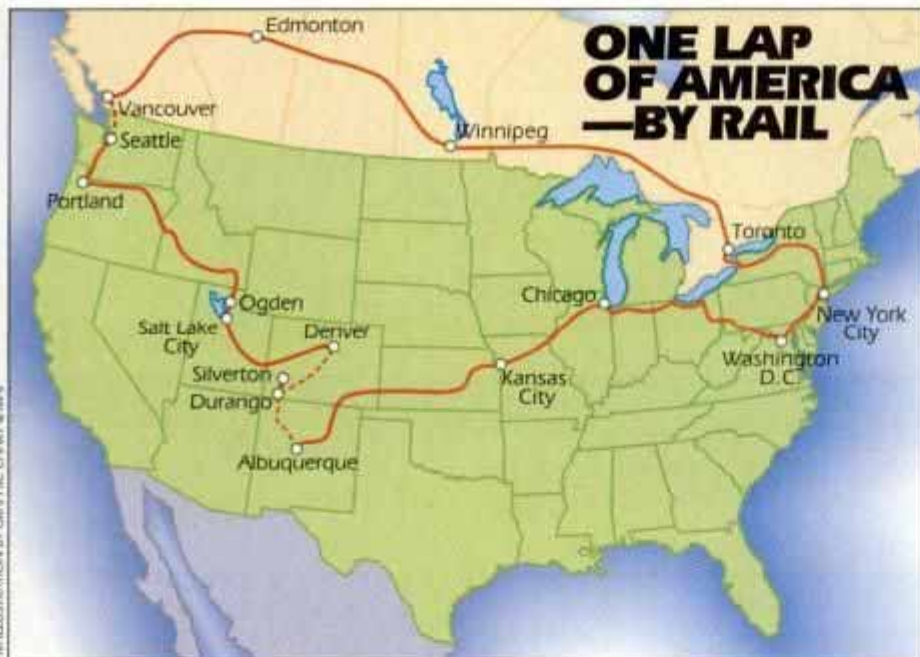
GREAT TRAINS, GREAT RIDES



Canadian (above) represents refinement amid ruggedness. Amtrak's best accommodation is the deluxe bedroom (right), which can be joined with an adjacent room to form a suite. Map shows our route (dotted lines are car or airplane), calculated to show the full spectrum of intercity rail.



AMTRAK PHOTO



FM ILLUSTRATION BY GRAPHIC CHART & MAP

his wife. The conversation was animated, rambling from cars to engineering to travel while we enjoyed a well-prepared meal and watched for elk on the sun dappled snow.

Disembarking in Albuquerque, I drove north into the Rocky Mountain town of Durango for a look at rail transport in a more basic form. With 112 years behind it, the Durango & Silverton is the oldest continuously running narrow-gauge line in the United States. And although it is no longer meant as a serious means of transport, things are still run very much as they were when the line was part of the old Rio Grande. The D&S maintains a fully operating, 18-place

roundhouse where locomotives are stored and maintained. An extensive machine shop and track repair facilities make the railroad nearly self-sufficient.

The point of it all is of course the tortuous, dizzying and beautiful climb to the former mining town of Silverton. (In winter, they turn around partway up at Cascade Canyon.) Two 470-series steam engines built in the 1920s are assigned to the winter work. With relatively small 42-in. driving wheels arranged in a 2-8-2 layout, they produce 27,500 pounds of tractive effort. "This thing was built for power. It wasn't built for speed," our engineer told me.

After the D&S's lurching, squeaking run through steep ravines and jagged precipices, I flew to Denver in the trip's only concession to the aviation age. From there, another Superliner-equipped train, the California Zephyr, was to take me to Oakland. Then I planned to take Coast Starlight, a route renowned for its Pacific views, up to Seattle, but it didn't work out that way. After a magnificent trek over the Rockies, a split rail held the Zephyr up in Salt Lake City.

For a while, it looked like I would miss my connection with the Starlight, and thus eventually with the Canadian, which was to take me back East. But quick thinking by the Zephyr's chief of onboard services rerouted me via the Pioneer, which turned out to be a spectacular trip in its own way. Taking a more direct path toward Seattle, it crosses the Blue Mountains and joins up with the Columbia River. In a matter of an hour or so, the air's wintry, arid snap softens, and the landscape takes on the green and gentle grandeur of the Pacific Northwest.

A drive from Seattle to Vancouver set me up for the 3-night journey back to Toronto aboard Via Rail's Canadian. This train is a destination in itself. Where Amtrak's Superliners are comfortable in a casual kind of way, Via Rail has impeccably restored the art deco interiors of its 1950s Budd rolling stock to create a strong evocation of rail's past. There is a stylish solidity and precision to these cars that is unlike anything built today.

It is an extraordinary thing to ride beneath the glass of what one crewmember called the "scenographic dome bullet lounge" at the rear of the train and watch this snow-smothered wilderness sweep by. When the other passengers had gone to bed, I would sit there under the stars with an after-dinner drink. The track would bend, and I could see the warm chain of lights from the train's windows snaking ahead, casting white beams over the undulating snow like the legs of a luminescent centipede. This was train travel as I'd envisioned it.

The journey ends on Amtrak's Maple Leaf from Toronto to New York City. With the familiar landscape of the populous Northeast crowding in, I brace for reentry, and think back on the people I've met and the things I've seen.

One fact stands out: Although the circulation's slowed a bit, America's lifeblood still pumps along these ribbons of steel. Check the following pages for places where you can put your finger on the pulse.



PHOTO BY MIKE SCHAEFER

Northwest Rail Museum Inc.

P.O. Box 19342

Portland, OR 97280

Equipment: GS4 class 484 Northern steam locomotive, built 1941, currently owned by the City of Portland. Entire train is restored to 1940s-'50s appearance, when the train operated as the Southern Pacific "Daylight" between Los Angeles and San Francisco.

Operation: Irregular operation with special long trips. Next scheduled trip is February 1994, with a 2-day, 750-mile round trip from Portland to Klamath Falls, Oregon. Fare is \$180 for coach, \$240 for first class.

Special Features: Train climbs almost 4000 ft. over the Cascade Mountains in the snow. Route travels through 23 tunnels and snow sheds. Baggage car allows passengers to lean out and take photos.



PHOTO BY STEVE SHALUTA JR.

Cass Scenic Railroad State Park

P.O. Box 107

Cass, WV 24927

(304) 456-4300; (800) CALL-WVA

Equipment: Four Shay steam locomotives and one Heisler locomotive, all 1905-1923 vintage. Coaches are converted logging cars.

Operation: Memorial Day to Labor Day, with Tuesday through Sunday service to Bald Knob and daily service to Whittaker. Weekend-only service after Labor Day through October. Mount Cass to top of Bald Knob (elevation 4842 ft.), 4½-hour, 22-mile round trip: adults \$12, children \$6. Mount Cass to Whittaker Station, 1½-hour, 8-mile round trip: adults \$9, children \$5. Dinner train: adults \$25, children \$15.

Special Features: Steep mountain grades (up to 11%) and switchbacks (trains climb going forward and in reverse). Steam-locomotive shops are open for self-guided tours.

Durango & Silverton Narrow Gauge Railroad

479 Main Ave.

Durango, CO 81301

(303) 247-2733

Equipment: Three 1923 Alco and three 1925 Baldwin steam locomotives with 1880-vintage wooden coaches. Open gondola cars are also available.

Operation: April through October, November 24 to January 1. Daily schedule varies. Durango to Silverton, 9-hour, 90-mile round trip: adults \$37.15, children \$18.65. Parlor car: \$63.85. A 52-mile trip from Durango to Cascade Canyon is also available. Return bus service from Silverton to Durango cuts trip time by 3 hours.



Special Features: Great Rocky Mountain scenery as the train runs through wild territory otherwise only accessible by foot or horseback. Route travels 400 ft. above the Animas River along a shelf of the San Juan Mountains. Stops are scheduled at Needleton and Elk Park to allow hikers and fishermen on and off.

Georgetown Loop Railroad

c/o Old Georgetown Station

P.O. Box 217

1106 Rose St.

Georgetown, CO 80444

(303) 670-1686;

(303) 569-2403

Equipment: Five 1920s-vintage Baldwin steam engines, plus two 1920s-vintage Shay locomotives with open-style excursion cars and a caboose.

Operation: Memorial Day to end of October. Georgetown to Silver Plume, 70-minute, 6½-mile round trip: adults \$10.50, children \$6 (children 3 years and younger ride free). Charters available year-round, and group rates are available.

Special Features: Tours of Lebanon



PHOTO BY MIKE DANNEBMAN

Silver Mine available. Passengers are dropped off at the halfway point on the run for a 1-hour, 20-minute mine tour (adults \$3, children \$1.50). Train crosses Clear Creek four times and then crosses over its own tracks as it circles and climbs. Santa Express, first two weekends in December.

Gettysburg Railroad

106 N. Washington St.

Gettysburg, PA 17325

(717) 334-6932

Equipment: Two steam locomotives—a 1920 Baldwin 2-8-0 from the former Mississippi Railway and a 1948 4-6-2 built by the former Canadian Pacific Railroad. Vintage 1920s and '30s coaches plus open-air cars, converted from double-decker auto carriers.

Operation: April through October, daily in July and August. Gettysburg to Biglerville, 1¼-hour, 16-mile round trip: adults \$7 (senior rate \$6.50), children \$3.50.

Special Features: Runs through historic Adams County and Civil War



battlefields. During first week in August, a Lincoln impersonator performs on the train. October fall-foliage special, 50-mile round trip to Mount Holly Springs. Civil War train raids July 3, 4 and September 18, 19. Dinner trains once a month from May to September (the train ride is to dinner, not in-car dining).

GREAT TRAINS, GREAT RIDES



Grand Canyon Railway

518 E. Bill Williams Ave.
Williams, AZ 86046
(800) 843-8724

Equipment: Five steam locomotives, including 1906 and 1910 2-8-0 Consolidation types and a 1923 2-8-2 Mikado type, with 1920s Harriman coach cars.
Operation: Year-round service, schedule varies month to month. Williams depot to Grand Canyon depot, 8 hours (including 3½-hour layover at Grand Canyon's south rim), 65-mile round trip: adults \$47, children \$14.50 coach

fares (add \$10 for Club Class, \$30 for Chief Class). Special package deals, including overnight accommodations and meals at the Canyon, are available.

Special Features: The trip covers classic Old West territory, including wide-open plains, minor canyons and portions of the world's largest stand of Ponderosa pine. Williams depot dates from 1908. Formerly the Fray Marcos Hotel, run by legendary concessioner Fred Harvey, it's the largest poured-concrete building in Arizona. Grand Canyon depot, built of Ponderosa pine logs, dates from 1910.



Mount Washington Railway Company

Mount Washington, NH 03589
(603) 846-5404;
(800) 922-8825 (for advance ticket purchases)

Equipment: Eight steam 0-2-2-0 cogwheel locomotives, six of which were built by the Manchester Locomotive Works between 1870-1908. Open- and closed-platform coaches.

Operation: Runs weekends from first week in May through Memorial Day weekend, then daily through October. Base camp to the summit of Mount Washington (6288-ft. elevation, the Northeast's highest peak), 3700-ft. climb and descent, 3-hour round trip: \$32 with special group rates and family and senior citizen discounts available.

Special Features: The world's first cogwheel locomotive, "Old Peppercorn," is on display at the base station. Track's average grade runs 25%, steepest grade is 37.41% over a trestle known as "Jacob's Ladder."

My Old Kentucky Dinner Train

602 N. Third St.
Bardstown, KY 40004
(502) 348-7300

Equipment: Two early-1950s FP-7A streamline diesels, 1940s Budd steel-skirted coach cars. Includes dining and sleeper cars.

Operation: April through October, daily (except Monday) excursions. November through March, Friday through Sunday. Bardstown to Limestone Springs, 2 hours, 35-mile round trip: adults \$44.95-\$57.95 (including full 4-course meal). Charter, group and children's rates available.

Special Features: Bardstown depot was built in 1860 and is refurbished in correct vintage character. Only railroad station in Kentucky listed in the National Register. Excursion also passes two other original depots and crosses a historic wooden trestle.



Napa Valley Wine Train

1275 McKinstry St.
Napa, CA 94559
(707) 253-2111;
(800) 522-4142 (for reservations)

Equipment: Four late 1950s Alco FP-A4 streamline diesels, 1915 Pullman coaches, two parlor cars, two dining cars and a kitchen car.

Operation: Year-round, daily schedule. Napa to St. Helena, 3 hours, 36-mile round trip: \$29, plus \$22 brunch or lunch, \$45 dinner (train fare discounted 50% when two or more dinners are ordered).

Special Features: Homemade gourmet meals, including Angus beef, poached salmon, mixed grill, seafood pasta and vegetarian dishes. Parlor cars are used for hors d'oeuvres, cocktails and special wine tasting. Train runs at about 15 mph along an old Southern Pacific branch in Napa Valley wine country.



Norfolk Southern Railroad

Carl Jensen, Mgr. Steam Operations
110 Franklin Rd. S.E.
Roanoke, VA 24042-0002

Equipment: 1950 Roanoke Shops Class J 4-8-4 (bullet-nose Northern). Class A 2-6-6-4 articulated steam locomotive (front engine goes one way, rear engine goes the other way). Air-conditioned and open-window coaches, commissary cars, tape-recording car. Some trains include 1940-'50 vintage deluxe, first-class cars and/or dome coaches.

Operation: Runs at least 50 trips a year, with weekly operation April 1 to mid-November. Various origins and destinations, 10 to 12 hours, 200- to 250-mile round trips: \$60-\$80.

Special Features: Unique engines.



Roaring Camp & Big Trees Narrow Gauge Railroad

P.O. Box G-1
Felton, CA 95018
(408) 335-4484

Equipment: Narrow-gauge track (36 in. between rails versus standard 4-ft., 8.5-in. gauge). Two 1912 Shay steam locomotives, two 1899 Heisler steam locomotives, open excursion-type gondola cars, side-door caboose and observation car.

Operation: Year-round service, schedule varies. Roaring Camp (Felton) to Bear Mountain, 1¼-hour, 6-mile round trip: adults \$11.50, children \$8.50.

Special Features: Runs up and down an 8.5% grade and includes a double switchback at Spring Canyon. Train passes steam sawmill, 1880 general store, covered bridge, red caboose saloon. Other activities include chuckwagon barbecue, annual Civil War reenactment, 1830s mountain-man rendezvous, handcar races and Fourth of July Frog Jump.



St. Louis & Chain Of Rocks Railroad

4351 Holly Hills Blvd.
St. Louis, MO 63116-2255
(314) 752-3148

Equipment: Early-1950s GM Electromotive FP-7A streamline diesels, 1920s coaches, caboose and open car.

Operation: From second Sunday in April through the second Sunday in October. Baden to Dam 27 along Riverview Drive in northern St. Louis, 1-hour, 6-mile round trip: free in coach and open car, \$3 for private car.

Special Features: Runs along scenic Mississippi River. November hay rides, December Santa Claus trains, once-a-year full-moon evening run.

Strasburg Railroad

P.O. Box 96
Strasburg, PA 17579
(717) 687-7522;
(717) 687-6486 (for dinner train reservations)

Equipment: 1908 Baldwin 0-6-0 (former Canadian National), 1910 Canadian National 2-6-0, 1924 Baldwin "Decapod" 2-10-0 (former Great Western), 1906 Baldwin 4-8-0 (former Northern & Western) steam locomotives. Dinner train uses 1920s-vintage dining coaches.

Operation: Year-round, seven days a week between April and October. The number of day trips varies from 4 to 14, depending on season. Strasburg to Paradise, 45-minute, 9-mile round trip: adults \$6, children \$3 (\$8.50, \$5



for parlor car). Group rates available. **Special Features:** America's oldest shortline, operating since 1832. Railroad Museum of Pennsylvania, featuring vintage steam engines, diesels and passenger cars, is located across the street. Dinner train service also is available.

Valley Railroad Company

P.O. Box 452
Essex, CT 06426
(203) 767-0103

Equipment: Two vintage 1920s Alco steam engines, a 1923 2-8-0 Consolidation type (former Birmingham and Southeastern), a 1920 2-8-2 Mikado (former Aberdeen and Rockfish) and two GE diesel locomotives. Open platform combination car, steel coaches, extra-fare "Wallingford" Pullman parlor car.

Operation: May through October and December. Essex to Chester, 2-hour, 12-mile round trip: adults \$8.50, children \$4.25. Passengers can switch to



steamboat that continues up the Connecticut River past Gillette Castle, Goodspeed Opera House and 19th-century homes. Additional \$5.50 (children \$2.75) charge for boat ride. Reduced rates for groups of 25 or more. **Special Features:** North Pole Santa Express, murder-mystery specials.

VIA Rail Canadian

P.O. Box 8116, Station A
Montreal
Quebec H3C 3N3
(800) 561-9181

Equipment: Beautifully restored stainless-steel Budd cars began service as the Canadian in 1955. All trains have dining cars and observation domes. Final car is a bullet-shaped Park Car, containing a lounge and observation dome for first-class passengers.

Operation: Three times a week year-round between Vancouver and Toronto. Depending on season and accommodations, single-passenger fares for a full 3-night trip range from \$228.27



to \$1577.26, meals not included. **Special Features:** This is the closest one can come to reliving railroad travel as it was during the 1950s. Cars are immaculate and authentic, but have comfort improvements such as showers and electric heat. **PM**

Note: Schedules and operation subject to change. A comprehensive listing of tourist railways, museums and exhibits in the U.S. and Canada is available in the 1993 edition of *The Steam Passenger Service Directory*. The cost is \$9.95 plus \$2.50 shipping, from Great Eastern Publishing, P.O. Box 246, Richmond, VT 05477; (800) 356-0246.



CADILLAC TO KEY WEST

Cadillac said the Fleetwood Brougham could tow a 7000-pound load 2000 miles. We were crazy enough to take them up on it.

BY JOE SKORUPA, Boating/Outdoors Editor

• "Think Key West," I tell myself as I use my stiff, stinging fingers to work on the snow-covered Chris-Craft. It's a bitter spring day in Cadillac, Michigan, and I have no hat, gloves, coat or cold-weather gear of any kind. I'm in the process of snapping down the boat's canvas cover when suddenly the ice-covered fiberglass becomes too slick for my feet. I hit the deck, but a last-second grab of the bowrail saves me from a hard and embarrassing fall to the ground.

Witnessing the pratfall from across the parking lot, a passerby shouts, "Get a snowmobile." After carefully

righting myself, I brush wet snow from my pants and my much-too-thin windbreaker. "In four days I'll be in Key West," I yell to the stranger. But he doesn't hear. He's laughing too hard.

It wasn't supposed to happen this way. Yesterday, when Associate Automotive Editor Mike Allen picked me up in the 1993 Cadillac Fleetwood Brougham and 1994 Chris-Craft 262 Crowne, it was warm and sunny. Perfect weather to start a 2000-mile tow test. But on the way to Cadillac (Where else would you begin a road trip driving a Fleetwood Brougham?) in North-



The long haul from Northern Michigan to the southernmost point in the U.S. (see inset map) took the heavily laden Fleetwood Brougham over the Sunshine Skyway Bridge near Tampa.

western Michigan, the weather turned decidedly nasty.

We knew this marathon wasn't going to be easy. Things tend to get tricky when you tow a load that's 66% heavier than the tow vehicle. But after fitting the Caddy with a sturdy weight-distributing hitch, we thought we had the most difficult problem licked.

Before leaving New York, Mike and I speculated that while the Fleetwood may be technically capable of towing a 7000-pound load (which makes it the highest-rated passenger car in the world), it would probably do so with considerable effort. We guessed that the stand-

ard small-block engine would feel underpowered during acceleration and that the plush suspension would noticeably suffer under the strain of 680 pounds of tongue weight—which is 10% of the combined weight of the boat, trailer and gear, or 6800 pounds.

However, the Fleetwood surprised us. During a 2-hour shakedown ride from Lansing to Cadillac, it handled both load and road flawlessly.

Then it began to snow.

After fueling up during one of the darkest dawns on record, I got behind the wheel and began easing the

FROM CADILLAC TO KEY WEST



The official starting point was the snowy Cadillac train station (above). Winter still seemed in full force while driving through the hills of Northern Michigan (left).

Caddy through Michigan's snow-covered hills. My worst fear was a traffic snarl on a downhill slope. Even without snow, this kind of situation would have caused major problems because the trailer is equipped with inertia-activated surge brakes (standard on all boat trailers) instead of electric brakes, which give the driver an increased measure of control.

Fortunately, the bleak weather and early hour kept traffic to a minimum. Even more fortunately, I began to outrun the slow-moving cold front with the passing of each mile.

By the time the intrepid PM tow team reached Bay City, the Caddy's outside thermometer showed a temperature of 52° F, a warming of 20° since our departure in Cadillac. By the time we reached Detroit, it was 62° and the snow a distant memory. Mike and I were finally, and safely, on our way.

If you look at a map, you'll see that the best route from Cadillac to Key West is basically a straight shot down I-75. Best in this instance means quickest and easiest. Picture-postcard scenery isn't high on our list

of priorities during this trip. Things change dramatically when you're hauling a 6800-pound load.

The first thing you notice is that your adrenaline is up. It has to be because other drivers cut you off and crowd you, blithely unaware of your added burden. You find that your attention is firmly riveted to the conditions, surroundings and the task at hand. Vehicle control is precise and smooth. Adjustments are kept to a minimum. Your eyes look far down the road, and your brain maps out driving strategy well in advance.

Getting Properly Hitched

● One generally tows such a large trailer with a truck, Suburban or full-size van—and on the right vehicle, all you have to do is drop the tongue on the ball, hook up the electrics and drive away.

This is how Cadillac engineers set up our Brougham—no extra parts beyond the Reese hitch and the ball. They felt the Caddy's automatic rear ride-height adjustment would compensate for the extra 700 or so pounds of tongue weight 6 in. behind the bumper.

Wrong.

It took me about 2 miles to realize the rig was unacceptable. The trailer started to sway violently at about 50 mph. Worse yet, anytime it was necessary to slow down hard enough to activate the trailer's surge brakes, the hitch would start to skip off the pavement as the rear end sank under the weight. The Caddy's suspension, while well-mannered and comfortable in civilian use, has spring and damping rates simply inadequate for such serious towing.

A very slow, wide-eyed, white-

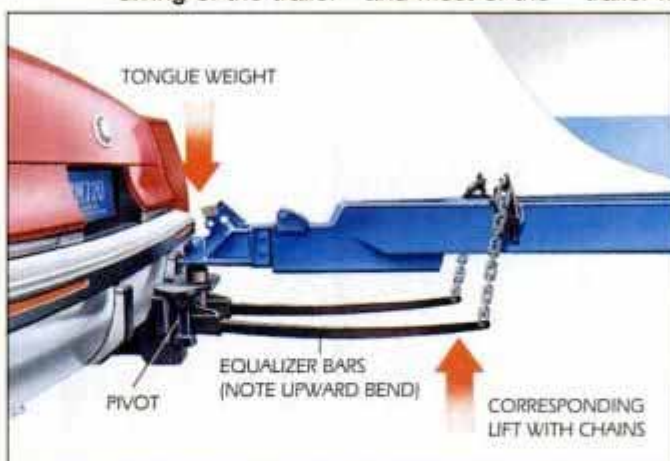
knuckled 2-hour drive ended in the driveway of Complete Hitch in Lansing, Michigan. And \$450 later, I drove out with the equalizing-type hitch you see illustrated. This tamed the nose-diving of the trailer—and most of the

saltwater use electric brakes, which are compatible with sway controls. Surge brakes operate by telescoping the frame of the trailer—as the car tries to retard the trailer's mass, the trailer moves closer to the hitch, activating the brakes.

Equalizing hitches function by transferring the bulk of the tongue weight of the trailer forward. The chain is in tension—enough tension to visibly bend the springy equalizing bars. The effect is to raise the rear bumper of the vehicle back to the correct ride height and bring the front bumper back down. An over-center mechanism on the hook permits you to preload the chains without giving yourself a hernia.

There's one complication because of the Caddy's automatic ride-height adjustment—you have to pull the fuse for the compressor while you set the ride height for the first time. Then you can reinstall the fuse.

Cadillac has recently revised its towing recommendations for trailers over 2000 pounds, partly to reflect the results of PM's testing. —Mike Allen



sway problem. Normally, you could add friction-type sway dampers to trim out the last bit of sway—but they would have made the surge brakes ineffective. And with 7000 pounds pushing you along, properly functioning trailer brakes are absolutely necessary. Most trailers that aren't intended to be constantly dipped in



If these are palm trees, this must be Florida (above). The big Chris-Craft 262 Crownne dwarfs the Fleetwood Brougham, the world's longest regular production car (left).



No matter how well behaved the trailer seems, you never forget it's there. You use a light touch on the brakes. You accelerate slowly but deliberately. And when a crosswind or bump causes the trailer to sway, you hold the wheel steady for a beat, and then make only a fraction of the normal steering-wheel correction. It's vitally important to fight the impulse to compound a temporary swaying problem by introducing driver-induced oscillation.

Despite the heightened intensity of the driving, the Cadillac to Key West expedition wasn't exactly rugged duty. Sure, we put in four 500-mile days in a row and were on the road from seven to seven, but the limo-like luxury of the Fleetwood Brougham tended to balance out the stress.

As befits the longest regular production vehicle (225.1 in.) on the market, interior room in the Fleetwood Brougham is enormous. The plush split-frame seats have triple-element lumbar adjustments and deliver the comfort level of a nicely broken-in sofa.

Interior climate control and new noise-damping acoustical treatments help give the Fleetwood Brougham a

megadose of upscale Cadillac style.

Interestingly, many of the features that make the Fleetwood a luxury sedan also help make it a heavy-duty tow vehicle.

As noted, the standard 185-horse 5.7-liter engine had surprisingly little trouble climbing hills and accelerat-

rectly under the load, and the Fleetwood is one of the few remaining rwd passenger cars on the market. In addition, the automatic transmission and new electronic cruise control proved to be up to the task of delivering precise performance on demand.

Once we left our doubts behind on Michigan's snowy hills, Mike and I settled into the typical long-distance road-trip pattern of fast food, copious coffee, country music and a cruise-control setting of 65 mph. We made three overnight stops in Cincinnati, Atlanta and Tampa, with the longest run being between the latter two cities—550 miles.

Total mileage to the southernmost point in the U.S. was 1923 miles. Fuel consumed was 221.8 gallons. This averages out to 8.7 mpg, which is quite respectable considering the heft of the load.

After arriving in Key West, we made the obligatory visit to Sloppy Joe's and then dropped the big Chris-Craft into Garrison Bight for a well-deserved shakedown cruise. An interesting new wrinkle on the Chris-Craft is its 5.7-liter Volvo Penta Duoprop engine, which signals the beginning of a new era in boating. As far as I know, it is the first OMC boat in the country to be publicly unveiled with a Volvo engine. Sounds like the basis for a good future story.

After spending a week of intense involvement with the Fleetwood Brougham (base price \$33,990, and as tested \$36,867), we came to appreciate its gutsy capabilities. While it's clearly best suited to luxury touring and occasional light towing, it definitely deserves its place as one of the heaviest haulers on the road and helps give Cadillac style an entirely new meaning.

PM



Mission accomplished. Who said we need a snowmobile?

ing under load. Plus, as a small V8, it delivers respectable fuel economy for a large car. Unhitched, the EPA rating is 16 mpg city and 25 mpg highway.

Rear-wheel drive (rwd), as veteran haulers know, is a bonus for towing because it puts the drive wheels di-

THE INSIDE STORY OF U.S. AIRPOWER

● Anyone serious about aviation and the history of U.S. combat aircraft will want to add the POPULAR MECHANICS "America's Fighter Planes—The Inside Story Of U.S. Airpower" video to their library. Volume 2 in PM's "Technology Of War" series, this video puts you in the thick of the aerial action with gripping combat sequences, explosive battle scenes and dramatic kill and crash footage. The only way you can get closer to the action is to strap yourself into the cockpit of an F-14 Tomcat.

Spanning a century of airpower, the video shows vintage footage of our earliest military aircraft in flight—a biplane glider with a 12-hp engine and the 1908 Wright brothers' Model A—all the way to exclusive footage of our next-generation 21st-century F-22.

The essentials of air combat haven't changed since the earliest fighters. Speed, maneuverability, superior weapons systems and the ability to surprise the enemy were just as important then as they are now. The video traces the development of different aircraft components to illustrate how they shaped the overall U.S. airpower picture and the effect these developments had on our combat capability with enemy aircraft.

The video takes you through the development of airframes—from the drawing board to construction to test flights of the earliest spindly biplanes to innovative concepts, such as the F-111 swing-wing fighter, to our newest cutting-edge fighters and multipurpose designs. Powerplant evolution shows the development of propeller engines, the profound transition from propeller to jets and the continuing development of ever-more-powerful jet engines.

Weapons-systems development traces back to the time when observer pilots first threw monkey wrenches at each other. Vintage footage shows the effect of the early over-

the-prop machine guns in aerial combat and illustrates how the dogfight advantage suddenly swung to the planes equipped with the new, revolutionary and deadly through-the-prop guns. Weaponry development unfolds before your eyes to today's rapid-fire cannons and array of deadly air-to-air missiles.



The strategy and science of eluding the enemy by becoming "invisible" is a story in itself. From camouflaging planes by painting their bottoms blue to blend with the sky and mottling their tops to blend with the ground to attacking out of the sun and stealth technology—it's all explained and illustrated in

great detail. The video shows just how and why a stealth plane is invisible to enemy radar and analyzes our frontline stealth fighter—the F-117—a plane used in Desert Storm with a devastating effect.

Fast-paced, "America's Fighter Planes" delivers an enormous amount of information on the development of U.S. airpower, making it a valuable resource and reference tool. The information itself is presented in a logical, easy-to-understand format with detailed illustrations so technical concepts are readily absorbed.

This is not a video that encourages you to sit back and be entertained. Rather, it involves you in its documentation of historic events. The evolution of U.S. airpower, and the testing of our air strength by enemy nations, is a fascinating chapter in the history of our country's defense, as well as a tribute to the men and women who design, build and fly our warplanes.

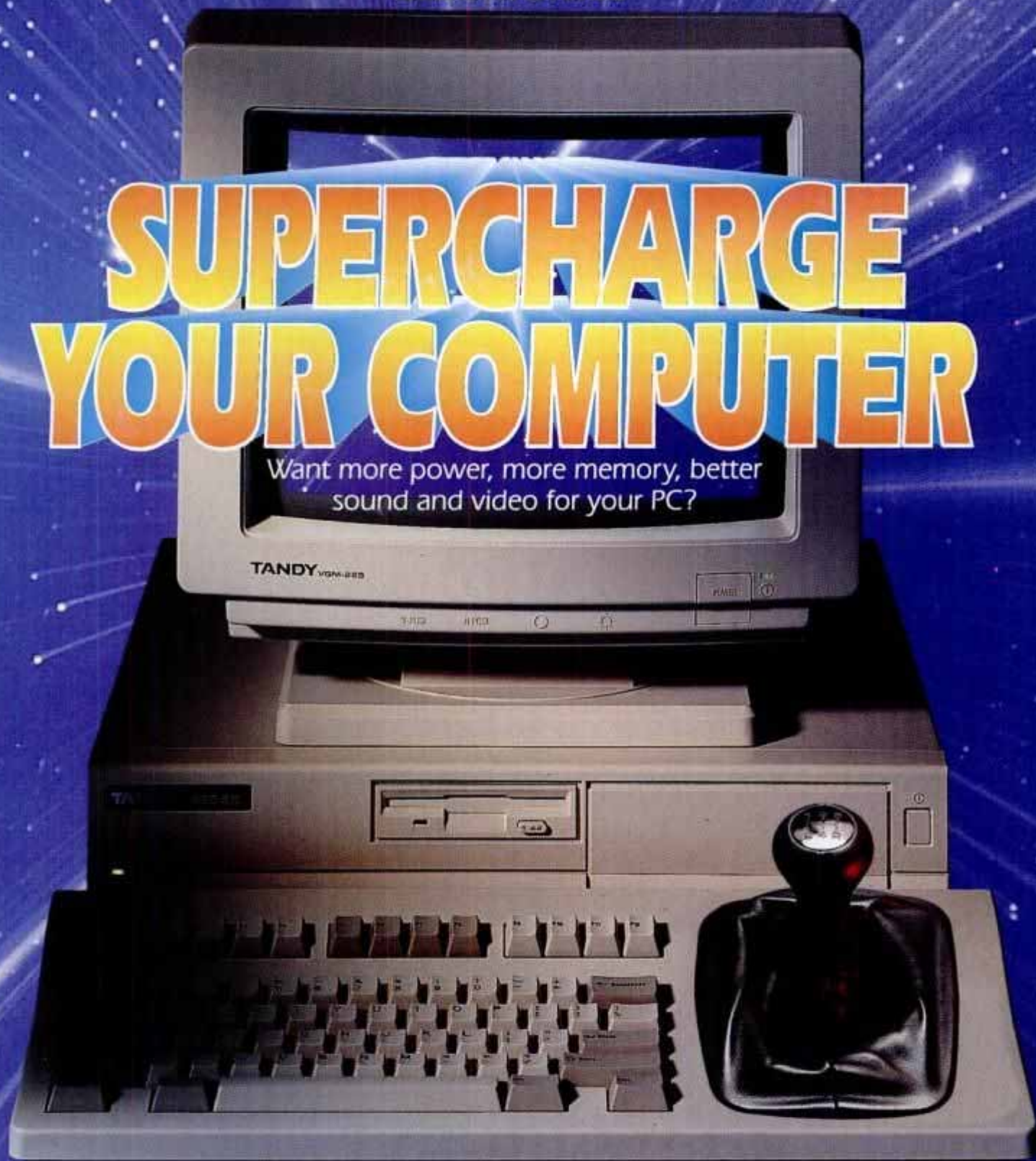
But the most compelling aspect of "America's Fighter Planes" is the life-and-death drama of the dogfight footage, which will keep you on the edge of your seat. Rare historical footage dating back to World War I shows American airpower challenging and being challenged by some of the deadliest fighters of the day. You'll fly World War II P-51s against the planes of the German Luftwaffe and Corsairs against Japanese Zeros. You'll fly F-86s against Russian-built MIG 15s in Korea. And you'll enter the unreal world of today's warplanes, dogfighting at speeds of Mach 2. Candid pilot interviews give you an

added dimension to air combat available nowhere else. The perspective from the pilot's seat is unforgettable as you push the throttle, bank to get the enemy aircraft in your sights and fire for the kill. —Cliff Gromer

"America's Fighter Planes" is available from POPULAR MECHANICS for \$9.95, plus \$4.50 shipping and handling (per order). To order, call toll-free (800) 888-4078.

SUPERCHARGE YOUR COMPUTER

Want more power, more memory, better sound and video for your PC?



• It didn't happen overnight, but you're finally able to call yourself computer literate. You've divined the secrets of the C prompt, learned the difference between a suffix and a path, even memorized the shortcuts in your favorite programs. In fact, you may even be ready to move on to the next level of computing power.

If so, keep in mind that buying a new machine isn't the only route to greater performance. New hardware can be expensive, but making your current rig run better than new isn't. In the new PC world, old computers don't have to die, they simply get upgraded.

BY RON GOLDBERG

A strategic hardware upgrade can give you exactly the kind of power you need. You can tweak your machine one component at a time, or replace a few boards and end up with a whole new computer. There are also ways of optimizing your set-up with nothing more than some new software. Whichever way you do it, the advantages are unlimited. You get more speed, better graphics and sound and, in general, a more efficient way to work and play. Here are a few suggestions on how to turbocharge your setup.

The first and probably the most important upgrade you can make is to increase your computer's random-

SUPERCHARGE YOUR COMPUTER

access memory (RAM). Back in the old days (as in just a few years ago), application programs were limited in size to 640 kilobytes of memory. Today, you'll find programs for both PCs and the Macintosh platform that are triple that size. Throw in all the other jobs that your machine does while these programs are running—not to mention your actual work files—and it's easy to see how you can run out of memory fast.

More memory

How much memory should you install? Let's put it this way—there's no such thing as too much RAM. If you like to work while running *Microsoft Windows*, for example, you're eating almost a megabyte (1000 kilobytes) of extra memory or more before you even open an application. If you're a Mac user running *System 7*, your machine is gobbling more than a meg just for startup. Programs that work with graphics, sounds or digitized pictures usually require plentiful memory. If you want to keep more than one program open at a time, think of allocating at least 1 meg of RAM for each. Suddenly, the 4 megabytes of RAM you thought were more than you'd ever need when you bought the computer just don't cut it.

Memory upgrades are easy and relatively cheap—about \$40 per megabyte is typical. The most popular method is to use what is called a SIMM (single inline memory module) chip, which plugs right into the motherboard. Different computers, however, accept different kinds of SIMMs. Depending on the type of machine you have and the amount of RAM you want to upgrade to, you'll have to install specific SIMMs in pairs, or sometimes in groups of four. If you know your hardware and don't mind opening the computer, you can install a RAM upgrade in minutes. More RAM is an intelligent and inexpensive first upgrade step.

Add-on cards like this Video Blaster from Creative Labs slide into PC expansion slots.

If, like many PC users, you're used to working with *Windows*, you're probably also used to how it can slow things down. That's because the on-screen information under *Windows* is saved as tiny graphic pictures called bitmaps. These must be redrawn by the CPU (central processing unit) every time you scroll down the screen. Likewise, the Macintosh uses a graphics method called QuickDraw to build the on-screen interface. You can speed up these chores substantially with a graphics accelerator.

In the PC world, these upgrade cards are inexpensive, and will make your *Windows* applications run much faster without an upgrade of your entire CPU. Rather than overhaul your computer's engine, they simply share the workload when it comes to redrawing the bitmapped *Windows* screens. Cards like the Paradise Accelerator Card by Western Digital (\$199) can wash your *Windows* up to 15 times faster than a standard VGA graphics card. The SuperX Accelerator VGA by Boca (\$299) features similar performance, with the added attraction of high-resolution monitor support. A standard VGA monitor is set up for resolutions of 640 horizontal pixels by 480 vertical. The newer VGA boards up the ante to 1024 by 768 or better, giving you crisper images for graphics-intensive multimedia programs and

the like. Of course, you'll need a Super VGA monitor capable of this finer resolution, as well as programs that can take advantage of it. But Super VGA capability is no longer news, and many low- to midpriced PC clones already have this capability. If yours does, and you're not getting the speed that you think you should be getting, check out a graphics accelerator that can support this protocol. Everything will look sharper and run faster.

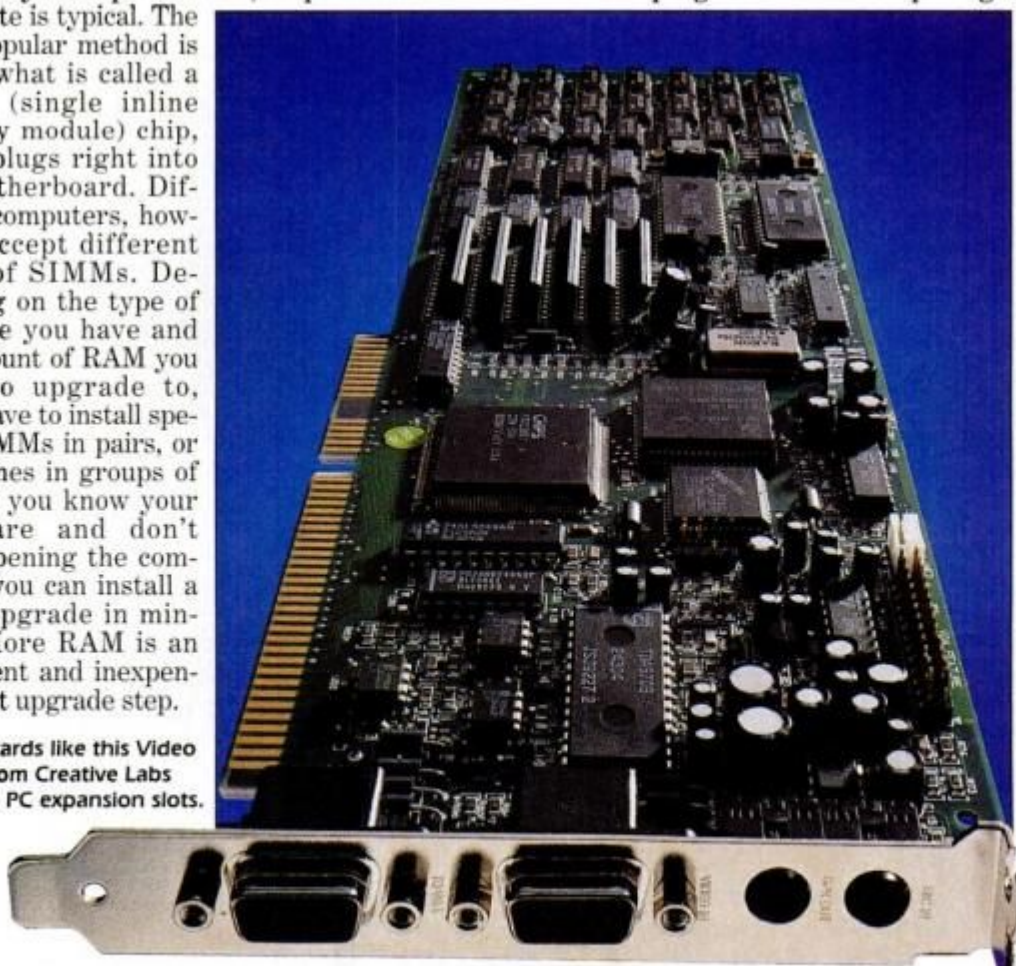
Discs, not disks

The biggest news in PCs these days is definitely CD-ROM. Introduced years ago as an inexpensive way to store massive amounts of data, a CD-ROM (compact disc, read-only memory) looks like a standard audio CD and can hold the equivalent of hundreds of floppy disks of information. You can't write information to a CD-ROM (hence, the read-only tag), which accounts for the difference in spellings. While there's much confusion over disc versus disk, the following formula seems to hold up: If you can write to it, it's a disk, as in hard disk and floppy disk. If you can't, it's a disc, like a compact disc or an interactive disc.

Adding a CD-ROM drive to your computer immediately puts you in touch with the best that personal computing has to offer. There are

thousands of titles available, ranging from extensive reference works to elaborate multimedia games, with CD-quality sound and high-resolution graphics. Only a CD-ROM would be capable of holding all this information in one place, conveniently and inexpensively.

Inexpensive is the latest news in CD-ROM. Over the past year or so, demand for CD-ROM drives was exceeding manufacturers' supplies, and prices were set accordingly. Now, it seems every computer and consumer electronics company has at least a model or two for sale. If your computer has a bay for it, you can buy an internal CD-ROM drive. If not, there are plentiful choices for an external unit. These drives are more or



Inside The PC

EXPANSION SLOTS

MAIN LOGIC BOARD

486 MICROPROCESSOR

POWER SUPPLY

DRIVE DATA CABLE

CD-ROM PORT

3.5-IN. FLOPPY DISK DRIVE

less plug and play—simply install a software driver or two, connect a card in an empty slot, and you're in business.

The current generation of CD-ROM drives has two new features. One is called double-speed, which spins the disc at twice the normal rotational speed, and as a result, allows the drive to access information in half the time. The other enhancement is Photo-CD capability. With Kodak's new Photo-CD format, you can play back high-resolution photographs through your computer. Get yourself a digital darkroom program like *Adobe Photoshop*, and you can perform the same elaborate image manipulations that the pros do. Want to see what Aunt Millie would look like with a different hairstyle? Or what the house would look like if it was painted blue? Draw it on your computer and see.

Some of the more interesting CD-ROM drives on the market include the Toshiba XM-3401E (\$895), the NEC CDR-74 (\$725), the Apple CD-

300 (\$599) and the Chinon CDX-535 (\$795).

All of these are capable of double-speed performance and can read Photo CDs. One particularly cool solution for adding CD-ROM comes from Creative Labs Inc. in the form of the Multimedia Upgrade Kit (\$799 internal, \$899 external). Packaged as a complete upgrade kit, you get a CD-ROM drive, a MIDI (musical instrument digital interface) for connecting to synthesizer boxes and sound modules, and the company's Sound Blaster Pro audio card, which provides stereo sound for your CD-ROMs. Once you get into the world of CD-ROM, you'll find it's pretty addictive. Fortunately, software is plentiful and often irresistibly cheap.

The sound of music

Since a CD-ROM drive also plays regular audio CDs, as well as CD-quality audio from ROM programs, it makes sense to have some kind of en-

hanced audio capability in your machine. The upper-level Macintosh computers are way ahead of the PC world here, in that they feature internal stereo output capability. However, you can easily add high-quality audio to your PC by installing a sound card (like the aforementioned Sound Blaster, starting at \$149) and a small pair of powered speakers. It's possible to connect the audio outputs from the CD-ROM drive into your stereo setup. However, life will be simpler with a sound system designed specifically for PC setups.

The most popular card on the market for the PC platform is Sound Blaster. Move up to a higher model like the Sound Blaster Pro (\$299) and you can get MIDI capability with synthesized and sampled sounds—great for games and business presentations. A related product, the Video Blaster (\$500), lets you edit video as well. The ViVa Maestro 16VR moves you up to full 16-bit CD-quality sound, and includes a nifty voice-recognition feature that lets you operate your PC

SUPERCHARGE YOUR COMPUTER



A CD-ROM drive and powered speakers offer new education and entertainment options.

via voice commands. Point the mouse where you want the action to happen, tell your computer to cut, copy, save or any other command that you've loaded and the computer does everything except say, "Yes sir/madam."

The aforementioned products are what are called audio output cards. That is, they are designed to play back sound already embedded in your software. But desktop technologies have come so far that it's now possi-

ble to perform professional-quality digital recording at home. The key here is an audio input card or device that takes analog audio signals from a musical instrument, tape deck, microphone or mixing console and digitizes the sound. Once the sound is stored on your hard drive, you can do the same nonlinear, cut-and-paste editing you're used to with your word processor. Both Mac and PC platforms are ably covered by a company called Digidesign, which offers a variety of pro-quality sound boards for desktop audio production.

Powered speakers are an easy way to enhance the work environment. There are numerous models on the market, ranging from simple cubes that attach to the sides of the computer screen,

all the way up to 3-piece subwoofer/satellite systems. Some of the more popular models include the Roland MA-12C (\$290), the AR Powered Partners (\$475), the Sony SRS-D2K (\$199) and the Altec-Lansing ACS-200 (\$300), which is available with an optional subwoofer as the ACS-300 (\$400).

On the soft side

Like RAM, hard-drive space is always at a premium. What if you could

double the size of your hard drive without buying a new one? That's the concept behind *Stacker* (\$129), a software utility that effectively gives you twice the capacity from your hard drive. *Stacker* uses compression technology to squeeze your data into less space than it would normally use. While compression programs like this have been around for a while, *Stacker* has become the most popular. It works fast, it's transparent to the user (you never have to think about it), and it's relatively reliable.

In the event that something does turn out to be unreliable with your computer, a recovery program is great insurance. The most popular comes from Symantec and is called *Norton Utilities* (\$159). These handy software accessories can recover your data in case of a crash, optimize your hard disk for faster data access and, in general, keep your system running in top form. Even if you only save one crashed hard disk, the software has paid for itself.

Okay, so now you've got more memory, a faster interface, better graphics, 600 megabytes on-line, CD-quality sound and mucho hard-disk space—and all from your existing machine. What more could you want, other than enough time to use everything? **FM**

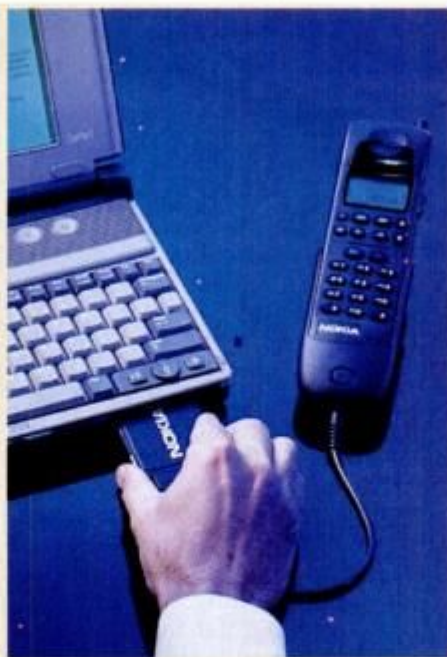
Upgrading Your Laptop

● Laptop owners aren't left out in the cold when it comes to PC upgrades. In fact, laptop and notebook computers may be the most fertile ground for a bit of strategic tweaking.

Portability does you little good if you don't have power. Start upgrading by getting a grip on your battery life, which never seems to be long enough. *Battery Watch Pro* (\$49) from Traveling Systems is a neat software accessory that keeps tabs on how much power you have left before you run out of gas. It supports 50 of the most popular laptop models and keeps track of your work patterns to alert you to save your work before power is gone.

The *VGA Dimmer* (\$35) from Revolution Software is a simple but effective idea—it automatically dims the screen during inactive periods to conserve power. If you use a Macintosh Powerbook, *Norton Essentials For Powerbook* (\$129) finds ways to increase battery life by up to 40%.

Just because you're on the road doesn't mean you're out of touch. If you routinely need portable communications, Nokia and Compaq have a



Nokia's credit-card modem works with PCMCIA-equipped laptops.

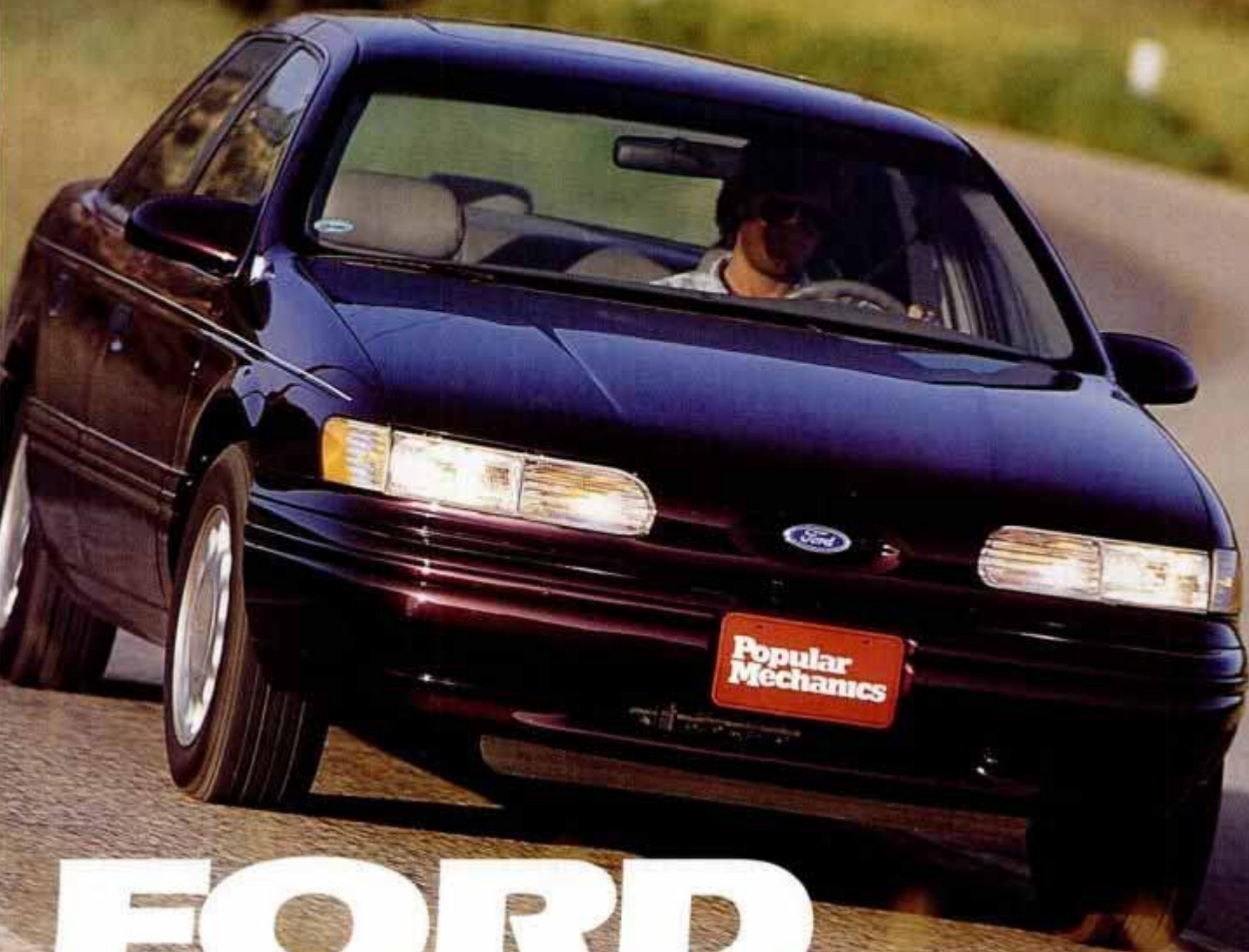
winning combination. Nokia's Cellular Notebook Link (\$89) is a PCMCIA card link for Nokia's Model 121 cellular phone and a Compaq laptop. This

connection lets you transmit data or faxes automatically.

For situations when you can't get an extra phone jack for your modem, or if you're in a country with incompatible phone jacks, there's the *Telecoupler* (\$159) from Computer Products Plus. This handy device connects to your laptop and sends an acoustical modem signal over any telephone line at speeds of up to 9600 baud per second.

If faxing from the road is important, a portable printer would come in handy. The Hewlett-Packard Deskjet Portable (\$599) prints out credible copy from a 4-pound, battery-operated package.

Once you get home, you'll probably want to transfer your work to a desktop machine or load up the laptop's hard drive with new software. Floppies are good, but copying megabytes of information can take forever. Both *Lap Link Pro* (\$169) from Traveling Software and *FastLink 2.0* (\$169) from Rupp Technology will exchange your important data in minutes, saving you enough time to actually get real work done. —R.G.



FORD TAURUS

America's best-selling car is better than ever.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Rich Cox

● When Ford introduced the Taurus in 1986, the company recognized the huge gamble it was taking. Taurus styling was as radical as anything since the Chrysler Airflow, in 1934.

But the public went well beyond merely accepting the Taurus. They absolutely fell in love with it. And dealers at last had a midsize major-league family sedan and wagon to sell—a welcome relief after years of Fairmonts and Fairmont derivatives.

Today's Taurus doesn't look all that different from the original. Ford is understandably reluctant to change so successful a design, especially since the Taurus outsold every other passenger car in America last year and seems to be on its way to doing so again in '93.



As a result, the Taurus doesn't stand out from the crowd the way it once did. But on the other hand, continuous improvement of a good design pays dividends in quality. Seven years ago, 41.2% of the owners we surveyed told us they had to take their cars back to the dealer for adjustments or repairs. In its first year, Taurus quality ranked as no better than average.

So here we are seven years later, same basic Taurus, but with one big difference. This time only 10.9% of our owners said they had to take their new cars back for fixes. It seems the Quality/Job One message is more than mere hype.

Another big change in owner responses, now versus then: Styling ranks a distant third as a purchase motivator, com-

FORD TAURUS



Most called instruments and controls excellent.



Comfort was second best-liked trait.



Taurus power drew high marks.

pared to tops in 1986. The owners in this survey rated past experience (meaning previous ownership) and reputation ahead of looks. Interpretation: People have gotten used to the

aero look. It doesn't stop traffic or turn heads anymore. But it's significant that many of the owners in this survey were satisfied enough the first time around to come back for more.

However, owner loyalty has led to a certain graying of the owner body. The mean age of Taurus owners in 1986 was 53. Today it's 62. When the same people keep buying newer

SUMMARY OF FORD TAURUS OWNERS REPORTS*

Total miles driven	1,299,682	Transmission choices:		Average	1.6	What type of trouble?	
Average miles driven	4206	4-speed automatic	99.7%	Poor	0.0	Transmission	14.7%
Purchase price:		5-speed manual	0.3	Overall performance:		Electrical	11.8
Average	\$17,982	Specific likes:		Excellent	68.5%	Cruise control	8.8
Range	\$14,500-\$23,659	Handling	41.1%	Good	30.3	Antifreeze	8.8
Why did you choose the Ford Taurus?		Comfort	38.7%	Average	1.2	Repair it yourself?	
Previous Ford ownership	37.6%	Styling	34.3%	Poor	0.0	No	100.0%
Ford quality reputation	22.9	Ride quality	29.4	Control layout:		Yes	0.0
Styling	20.3	Ride quality	29.4	Excellent	54.4%	Dealer repairs satisfactory?	
Price/value	19.9	Instrument panel layout	15.7	Good	38.6	Yes	80.8%
Size	8.3	Performance	15.7	Average	5.6	No	19.2
Handling	6.4	Engine power	14.9	Poor	0.4	Dealer service opinion:	
Body style choices:		Specific dislikes:		Instrumentation:		Excellent	53.4%
Sedan	75.4%	No complaints	17.3%	Excellent	54.8%	Good	41.5
Station wagon	24.6	Engine and wind noise	11.2	Good	40.1	Average	3.6
Model choices:		Fuel mileage below expectations	7.6	Average	3.2	Poor	1.6
Taurus GL	72.4%	Auto door-locking function	6.1	Poor	2.0	Dealer sales policy opinion:	
Taurus LX	27.3	Shoulder harness discomfort	5.1	Driver sightlines:		Excellent	64.0%
Taurus SHO	0.3	Suggested changes:		Excellent	51.9%	Good	33.3
Options/Accessories:		No changes	7.7%	Good	39.6	Average	2.4
Air conditioning	99.7%	Reduce noise and rattles	7.7	Average	8.0	Poor	0.3
Preferred Equipment package	80.9	Make dual airbags standard	6.5	Poor	0.8	Number of vehicles owned:	
Antilock brakes	59.2	Make ABS standard	6.5	Workmanship opinion:		This vehicle only	36.3%
Dual airbags	53.4	Improve fuel economy	6.5	Excellent	67.0%	Two vehicles	41.5
Rear-facing rear seat (wagon)	52.0	Improve shoulder harness comfort	5.9	Good	31.7	Three vehicles	14.7
Keyless entry system	29.5	Remote tailgate release (wagon)	5.9	Average	1.3	Four or more	7.6
Heavy-duty suspension system	19.0	Engine power:		Poor	0.0	Principal driver:	
Moonroof	4.5	Excellent	59.1%	Comfort opinion, front seats:		Female	51.9%
Cellular telephone	3.3	Good	39.3	Excellent	65.4%	Male	40.6
Avg. mpg, city/hwy:		Average	1.6	Good	31.5	Equal	7.5
3.0-liter V6	21.3/27.3	Poor	0.0	Average	2.0	Age distribution of owners:	
3.8-liter V6	19.9/26.1	Handling:		Poor	1.0	Under 29	2.9%
Engine choices:		Excellent	72.1%	Comfort opinion, rear seats:		30-49	28.4
3.0-liter V6	60.8%	Good	26.7	Excellent	49.8%	50-plus	38.5
3.8-liter V6	38.2	Average	1.2	Good	45.0	Based on your experiences, would you buy a Ford Taurus if you had it to do over again?	
3.0-liter SHO 24-valve V6	0.7	Poor	0.0	Average	5.2	Yes	75.1%
3.2-liter SHO V6 (auto trans.)	0.3	Braking:		Poor	0.0	No	22.3
		Excellent	70.1%	Mechanical trouble?		Yes	75.1%
		Good	28.3	No	89.1%	Maybe	22.3
				Yes	10.9	No	2.6

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

models of the same car, owner age increases. Ford would prefer to see new buyers coming in, which is why Ford ads are targeting college students and 30-somethings. It's also why Ford introduced the Taurus SHO sport sedan, with its 220-hp Yamaha V6 engine, in 1989.

The years of relatively major changes for the Taurus came in 1990 and '92. In 1990, Ford made the driver's airbag standard equipment, with antilock brakes available as an option (standard on SHO). In '92, all sheetmetal—except the doors—was subtly restyled, and a passenger's airbag became available as an option. Aside from that, changes have been minor: addition of speed-sensitive power steering, electronic controls for the automatic transaxle, express-down power window on the driver's side—things like that. And the 1993 models are virtual carbons of the '92s.

What Taurus owners tell us they really like about their cars is handling, comfort and styling—in that order. Engine power was judged as excellent by nearly 60%, while handling and braking were deemed excellent by more than 70%. Workmanship got an excellent rating from 67% of our respondents, versus 54.5% in '86.

Service scoreboard

Owner opinion of dealer service is up, too: 53.4% excellent, versus 31.6% in 1986. Dealers fixed things right the first time in 80.8% of all cases, instead of 66.9% in '86. So there's no doubt that Dearborn is aiming higher.

However—and it's a very small however—Taurus owners did mention a few tiny problems. Rattles and noises annoyed 11.2%, and 7.6% complained that fuel mileage didn't come up to expectations. A few second-time owners also pointed out that the shoulder harnesses on their cars dug into their necks, a problem they hadn't experienced on earlier models.

Ergonomics and driver sightlines didn't inspire quite the same scores as performance did, but all-around driveability seemed to please most owners.

Dollar value

What it mainly boiled down to, though, was value. As a Florida owner observed, "We also own a new Toyota Camry and consider the Taurus a much finer automobile for considerably less money."

All in all, more than 75% of our owners agreed with this enough to say they'd definitely buy a Taurus if they had it to do all over again. Another 22.3% gave it a definite maybe. Ford can live with percentages like that—for a long time.

PM



Although the exterior was redesigned for '92, styling slipped to third place among Taurus purchase motivators. Previous Ford ownership and high quality swayed most owners.

EDITORS REPORT

Older And Better

● The old line about "you're not getting older, you're getting better" may work for people—after all, the older you get, the more you want to believe it. But it's a tough sell for cars. Regardless of the improvements a manufacturer may make to a particular model, it's hard to have it perceived as new unless it's wrapped in new sheetmetal.

All of which makes the continuing popularity of the Taurus—and the Mercury Sable—that much more impressive. Although these cars did get an extensive redesign for the 1992 model year, the sheetmetal emerged looking very much the same as before. Since the basic shape still looked fresh—particularly the wagon—the designers were able to focus on subtleties like improved control location, better seating, improved instrumentation, switches more readily identifiable to the fingertips and so on. User-friendly is a term that gets far too much exercise these days, but it definitely applies to the changes wrought in the Taurus since its debut.

We've spent time in a number of different Taurus models lately, and all have performed up to expectation—no assembly glitches, no finish flaws and no performance hiccups. Our favorite edition continues to be the SHO, with its superb 220-horsepower 3.0-liter dohc 24-valve aluminum V6 and 5-speed manual transaxle, but we know that mainstream Taurus buyers prefer one of the other V6 engines, mated to an automatic transmission. This isn't surprising, since the SHO is the only Taurus model available with a 5-speed (an automatic SHO became available at midyear).

We think the optional 3.8-liter pushrod V6, with its 215 ft.-lb. of torque, provides better all-around driveability than the standard 3.0-liter. But we did find it to be thirst-

er, particularly in L.A. urban traffic, where we recorded 18.5 mpg, compared with 22.1 for the 3.0-liter. On open-freeway cruise-control runs, the 3.8 did much better at just over 27 mpg, only 0.5 mpg less than a 3.0-liter version. Our conclusion here is that the 3.8's stronger stoplight response tends to make some drivers forget about mpg for a hundred yards or so.

In any case, it seems that most Taurus owners are pleased with their cars' power. But the trait that pleased them most of all, to our surprise, was this car's handling. This isn't to say we think the Taurus has handling deficiencies. Quite the contrary. As an all-around family sedan, this car's handling is as good as any in its class—reasonably responsive, not too roly-poly and predictable as a calendar. What surprises us is the emergence of handling as a best-liked quality in a car such as this. Comfort, which is second on the list, makes more sense, as does ride quality, which our owners ranked fourth. But handling? It tells us Ford has been listening closely to its owners.

In fact, we do have a couple of minor reservations about Taurus handling, but they're limited to the SHOs. We think both SHO editions could use a little more roll stiffness, particularly the automatic. We also think the Taurus shows its age from within via its relatively high cowl height.

So how long can the refinement process go on without a new skin to signal change? It's clear that the continuous development game can be played too long. VW provided the textbook case in point by sticking with the Beetle to the edge of corporate disaster. But it's equally clear that the Taurus/Sable twins—due for redesign in '95—aren't even close to the point of diminishing returns.

The Taurus may not be new anymore—but it's far from old. —Tony Swan

MOTORCYCLE MASTERPIECE

Yamaha's new GTS1000A is arguably the most technologically sophisticated motorcycle ever built.

BY RICH TAYLOR, Contributing Editor



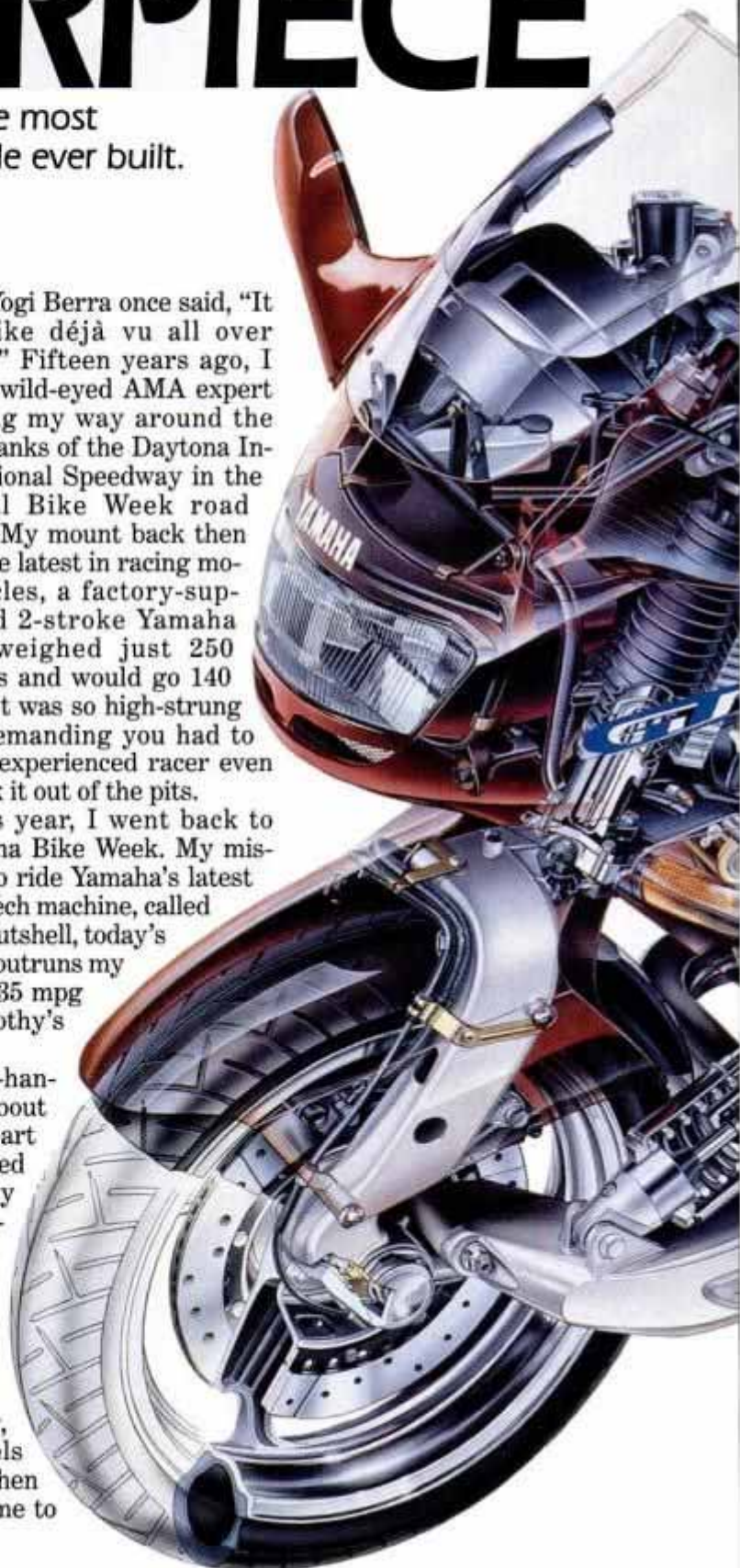
● As Yogi Berra once said, "It was like déjà vu all over again." Fifteen years ago, I was a wild-eyed AMA expert clawing my way around the high banks of the Daytona International Speedway in the annual Bike Week road races. My mount back then was the latest in racing motorcycles, a factory-supported 2-stroke Yamaha that weighed just 250 pounds and would go 140 mph. It was so high-strung and demanding you had to be an experienced racer even to coax it out of the pits.

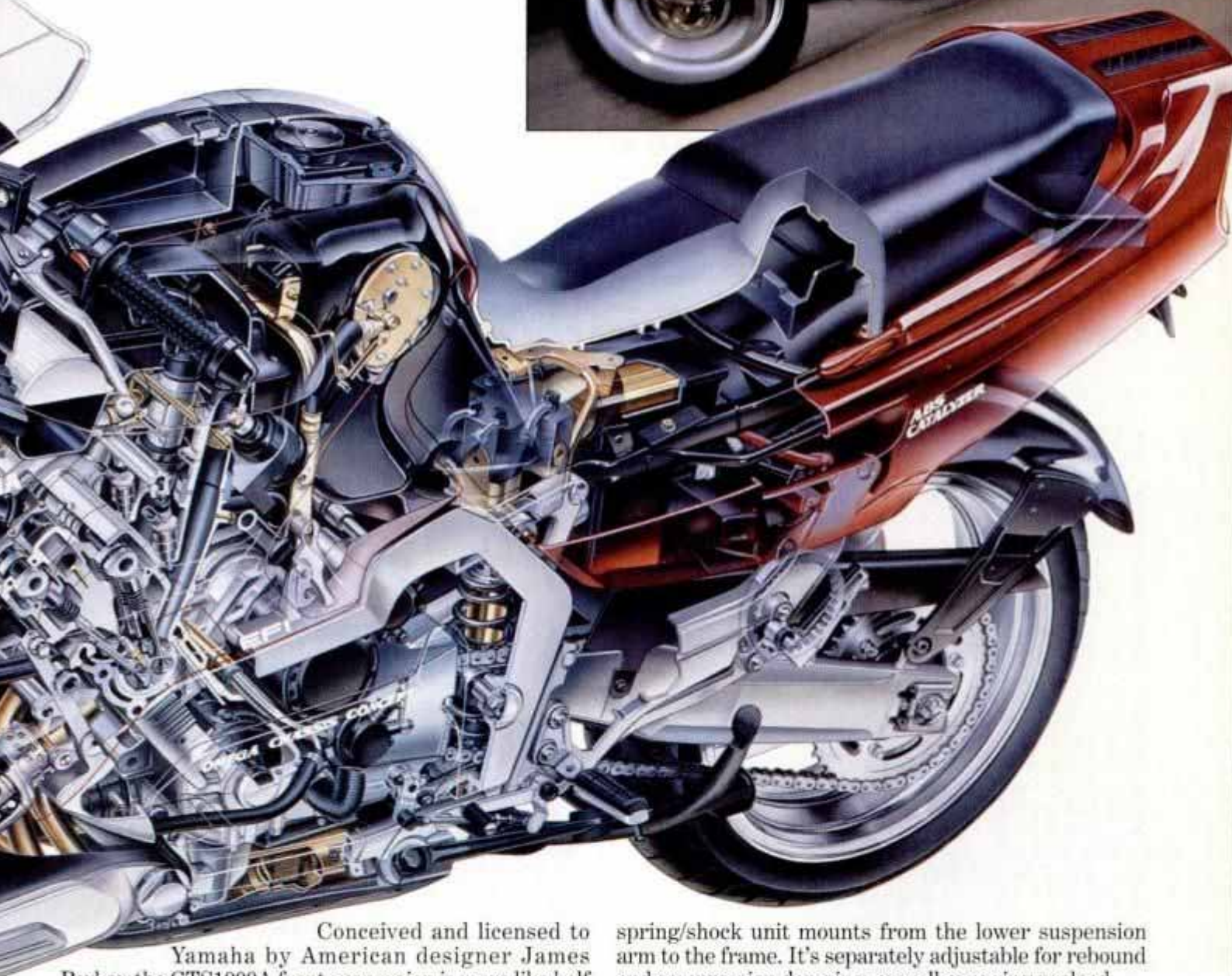
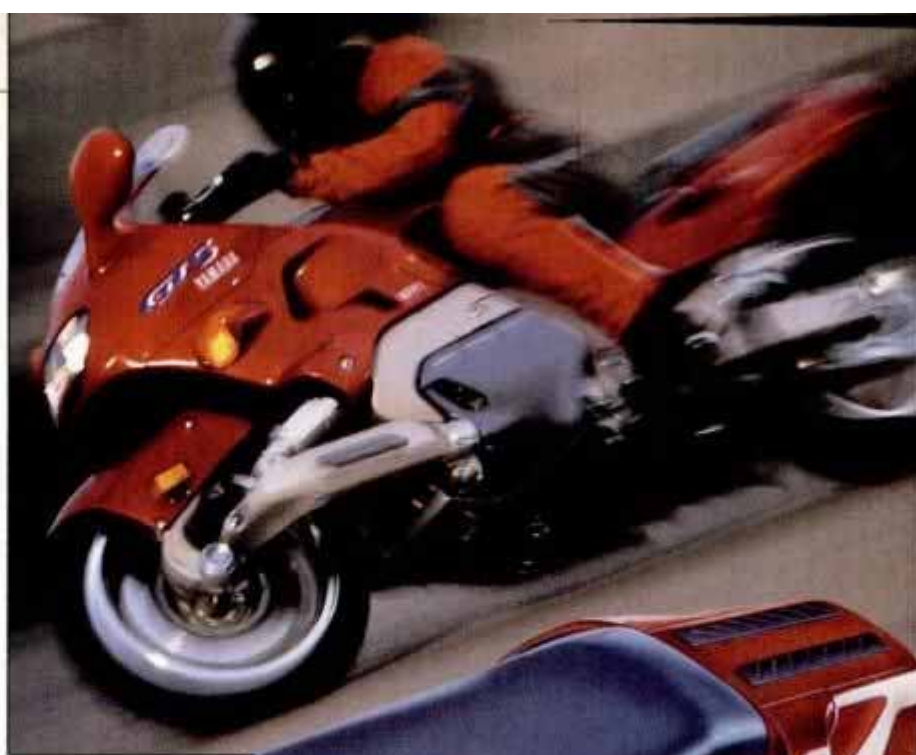
This year, I went back to Daytona Bike Week. My mission: to ride Yamaha's latest high-tech machine, called

the GTS1000A. The difference 15 years makes? In a nutshell, today's 640-pound "sport tourer" outhandles, outbrakes and outruns my old race machine right up to 140 mph, yet delivers 35 mpg and is no more demanding to pilot than Aunt Dorothy's Sedan De Ville. It's a true high-tech tour de force.

This blend of shattering performance and easy-handling comfort is not the only thing that's unique about the GTS1000A. It's also a textbook of state-of-the-art motorcycle engineering, circa 1993. I literally stopped traffic in Daytona—everybody had to examine my Yamaha's front suspension, the first "hub-steer" design to reach production.

Ever since Gottlieb Daimler built the first motorized 2-wheeler in 1885, the front wheel has always been attached to the frame by a pair of fork tubes, one on each side of the wheel. You turn the whole assembly to turn the front wheel. Despite a century of development, the front fork is prone to binding, plus it's flimsy and inefficient. Worse, it channels forces from the front axle up to the steering head then back down to the rear swingarm, requiring the frame to be heavier and more complex than necessary.





Conceived and licensed to Yamaha by American designer James Parker, the GTS1000A front suspension is more like half a car. The front wheel hub is mounted on a spindle supported by a lower A-arm, complete with ball joint. The wheel attaches with four bolts hidden by the first hubcap ever seen on a motorcycle. A fat vertical aluminum upright also acts as the steering arm, braced by a ball-jointed upper A-arm. An automotive-style recirculating-ball steering box transmits steering input from conventional handlebars to the wheel. A single coil-over

spring/shock unit mounts from the lower suspension arm to the frame. It's separately adjustable for rebound and compression damping, as well as spring preload.

What's the advantage? Well, as traditional front forks compress over bumps or during braking, the fork tubes bind in their slides while the wheelbase and caster angle changes. As you might expect, this creates wobbles. The GTS1000A has anti-dive geometry designed into the front suspension—just like your car—plus minimal bump steer. There is nothing to bind, and all the suspension forces are channeled straight back

MOTORCYCLE MASTERPIECE



Stripped of bodywork, GTS1000A clearly shows its compact design with weight low and centered between the wheels for stable handling (above). Hub-ster front suspension incorporates anti-dive geometry and mounts front disc brake on wheel centerline for straightahead stopping (left). Six-piston front brake caliper provides unbelievable stopping power (below).

to the rear swingarm. Compared to even the best conventional motorcycle, the GTS feels more stable under braking, more stable in a bumpy corner and more of a piece, front to rear.

I rode the GTS1000A not only at Daytona Speedway, but for hundreds of high-speed miles on Interstate 95, on bumpy backroads, through flat-out sweepers, over elevated railroad crossings, even repeatedly over a long steel-mesh bridge—a long-time bane of motorcyclists. It never did anything wrong. Ever. The forkless GTS1000A handles impeccably.

The GTS1000A is cutting edge in other ways, too. The rear suspension is a monoshock, and the single spring/shock unit mounts vertically beneath the seat and is operated by a pushrod and rocker from the dual rear trailing arms.

Tires and wheels are economy-car size—the front 130/60ZR17 tire is fitted to a 3.5-in.-wide 3-spoke alloy rim, the rear 170/60ZR17 stretches across a 5.5-in.-wide 3-spoke rim. Brakes are oversize and high-tech, too. The hat-shaped automotive-style front disc is 13 in. in diameter, the rear is 11 in. The rear is ventilated, and the front is both vented and radially drilled and uses a unique caliper with six pistons for incredible bite. It's mounted in the center of the wheel track to eliminate pulling to one side under heavy braking.

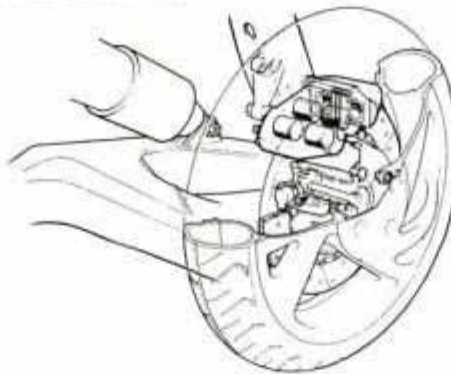
The "A" in the GTS1000A stands

for ABS. Developed by Yamaha, the antilock system has dual micro-computers, self-diagnostics and a hydraulic unit that pumps the brakes 10 times per second. Even more than a car, a motorcycle benefits from ABS—it allows you to steer and keep yourself upright while threshold braking. Like the rest of the GTS1000A, the brakes are both state of the art and flawless in operation.

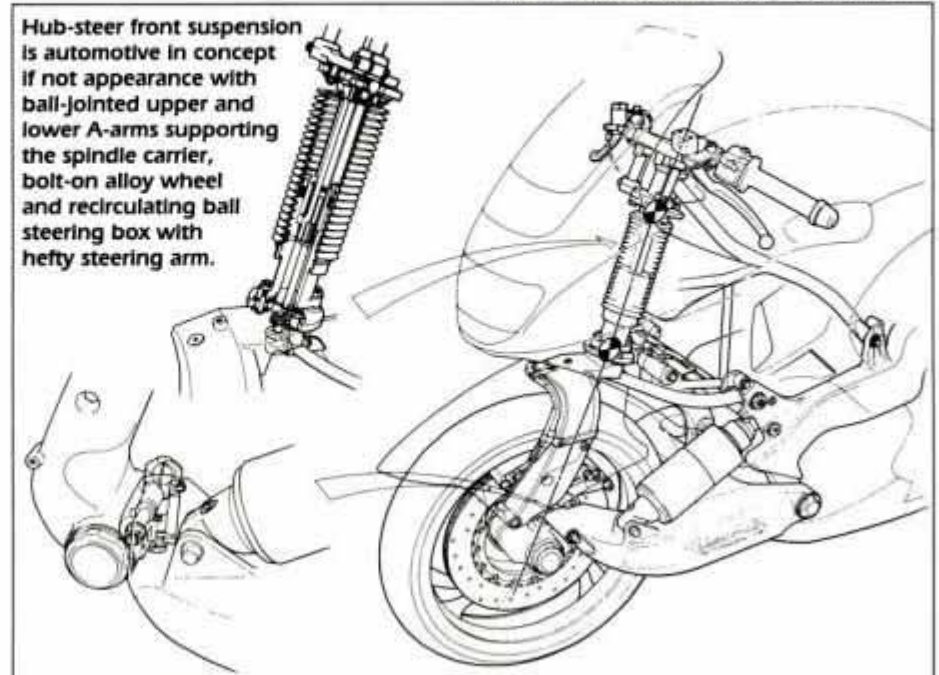
The aluminum front and rear swingarms are connected by a pair of cast-aluminum plates, each the shape of an inverted U. Yamaha calls this the Omega chassis because it resembles the Greek letter. There are lightweight front and rear subframes of steel tubing to support the seat and steering head, and the engine block is used as a stressed member, but the whole load-bearing frame is this tiny aluminum Omega. The Omega ensures a low center of gravity and a low polar moment of inertia. In its unobtrusive way, it's as remarkable a design feature as the hub-ster front end.

Then there's the engine, based on Yamaha's water-cooled 4-stroke 4-cylinder, called Genesis. The Genesis displaces 1002cc and drives through a conventional oil-bath clutch and 5-speed gearbox. The semiracer Yamaha FZR has a 123-hp carbureted version of this engine, with a 12:1 compression ratio. The GTS1000A uses the same double-overhead cam and 5-valves-per-cylinder head, but with a 10.8:1 compression ratio and different cams. It still produces 98 hp at 7500 rpm, with a redline at 10,500.

Where the GTS1000A far surpasses the peaky FZR is in driveability, thanks to the first computerized fuel-injection system on a motorcycle. This automotive-type system in-



Hub-ster front suspension is automotive in concept if not appearance with ball-jointed upper and lower A-arms supporting the spindle carrier, bolt-on alloy wheel and recirculating ball steering box with hefty steering arm.





cludes individual sensors for throttle position, air-intake volume, rpm, water temperature, cylinder mixture and oxygen feedback. The GTS1000A even incorporates a catalytic converter in the exhaust system, a still-rare item among 2-wheelers.

Thanks to EFI, the choke is gone, flat spots are gone, tiresome carburetor synchronization exercises are gone. What's left is a smooth flow of power from 1500 rpm to 10,500, with a satisfying bulge from 5500 to 9000. It does 0-to-60 in 3.5 seconds and the quarter-mile in 11.7 seconds at 115 mph.

By contemporary motorcycle standards, this is a machine of only middlin' potency. On the other hand, the GTS1000A is a lot more fun to ride than any of the quicker but narrow-focus street racers.

The GTS1000A is not perfect. The seat has an unfortunate crown, which causes a numb butt after an hour's riding. The stylish fairing directs a helmet-rattling blast of air right at your face. And despite the uncanny smoothness of the motorcycle as a whole, there is a mysterious tingling in the right handlebar.

Few enthusiasts can afford \$12,999 for a motorcycle—even a high-tech tour de force with hub-steer front end, Omega frame, ABS brakes, fuel-injected 20-valve engine and catalytic converter. Accordingly, Yamaha will only build 500 GTS1000As for the U.S. market each year. High-tech, strikingly styled, expensive and limited-production—a true Japanese exotic. Déjà vu? There's never been anything like it. **PM**



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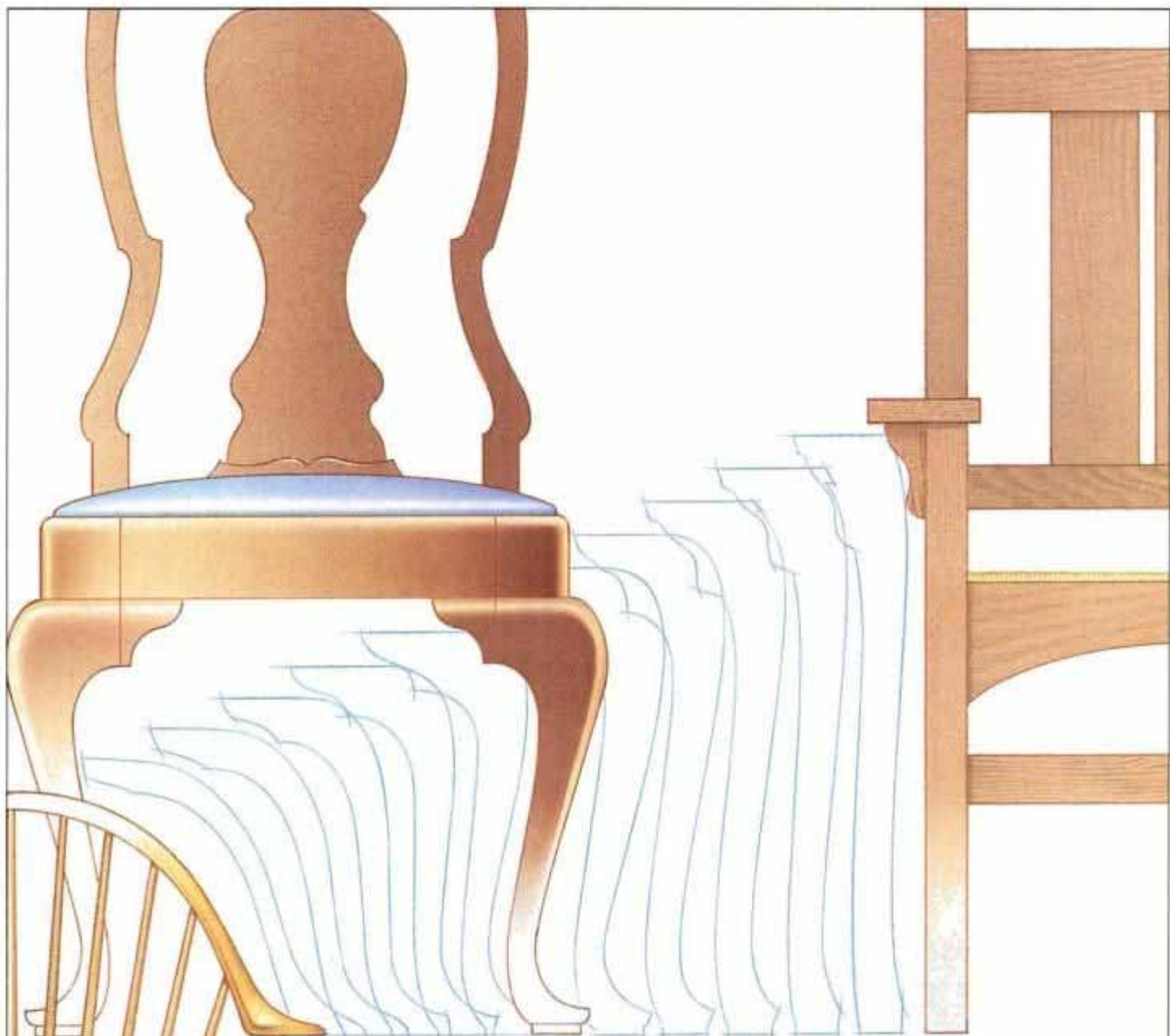
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WOODWORKING

FURNITURE DESIGN

A guide to the evolution of period styles.

BY THOMAS KLENCK, Associate Home Improvement Editor
PM Illustrations by Eugene Thompson

● Do you want to build a piece of furniture? Here's how to design it. Start with two things—a straight line and a curved line. Combine these lines in three dimensions, adapt the shape to your needs and make the whole thing real with a few pieces of wood and some basic tools.

If that sounds too simple, well, it is. Few builders of furniture work in such a mathe-

tical vacuum, where things spring forth out of a universe of random possibilities. Instead, the urge to create is usually founded on something that exists—someone else's solution for shaping an object on which to sit, store books or eat a meal. Take this process and stretch it out over several hundred years and you end up with a design continuum, an evolution of

form that reflects changes in culture, technology and lifestyle—all based on a few simple elements, materials and techniques.

The path through furniture design history, though, is far from smooth—and to the uninformed, it's also pretty confusing. While one maker may add subtle changes on existing designs, another builder takes a broader approach, pulling details from one period and combining them with forms from another. To recognize the differences between furniture of various periods, you need a tool for classifying design—and that tool is style.

Style Basics

A style is a collection of characteristics and general rules for how they're combined in a finished product. Recognizing things by style is simply a matter of grouping objects by their similarities. In furniture design, styles are defined primarily by shapes, proportions and detailing.

Changes in furniture style come about for many reasons. While the primary motivation is often a personal one that expresses the concerns and tastes of the designer, technology and utility also play a role. In addition, a style can sometimes be defined by a new type of furniture that it brought into being. Writing desks, secretaries and bookcases, for example, are associated with certain tradi-

tional styles because these forms didn't have a reason to exist until changes in lifestyle demanded them.

While style names often refer to a period in history, this is not always the case. They can also refer to a philosophy or an influential designer. For example, the term Federal refers to furniture that was made during the Federal period, while Chippendale refers to work of a certain period that bears a stylistic association with the designs of Thomas Chippendale. Of course, you can no longer build furniture that belongs to a historic period, but you can build pieces in the style of a period. In this way, an understanding of styles provides a starting point as well as an appreciation for traditional forms and their impact on design today.

In this overview, we'll take a brief look at some of the major design directions that have shaped American life up to the 20th century. The illustrations provide a visual timeline and are based on actual pieces from each period. Each style, except for Windsor (a Federal-period chair), is represented by two furniture examples.

American Colonial

The early American colonists didn't start making elegant furniture the moment they stepped off the boat. It took time to develop a socioeconomic structure to support skilled workers.

During this time, it's likely that home-grown woodworking existed on a fairly rough-and-ready level with finer pieces being made in England. It's not surprising, though, that when American workshops became established, they produced work based on the current styles across the Atlantic.

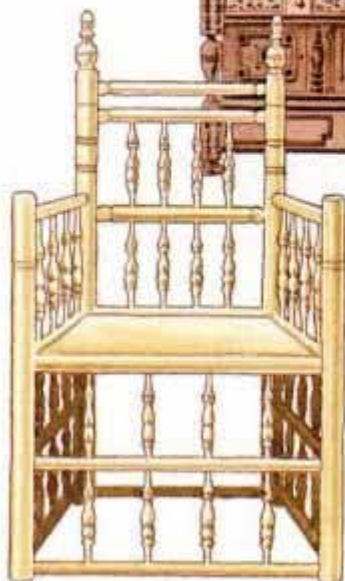
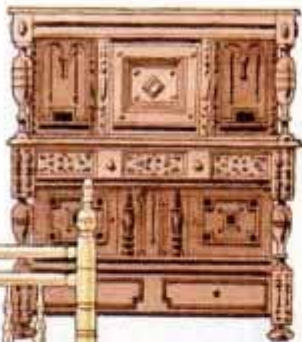
Jacobean

The earliest work, dating from about the middle of the 17th century, is referred to as Jacobean or, more popularly, Pilgrim furniture. It's characterized by heavy turnings used for legs and spindles, or split in half and applied to a surface for decoration. This style also features elaborate relief carving, usually of a geometric or floral motif and often accented with applied moldings that divide areas into geometric shapes. The wood is usually oak and/or pine, and painted ornamentation was popular.

A chest of this period, what we might call a blanket chest today, typically utilized frame-and-panel construction, although the simple pegged, or later nailed, 6-board chest was also evident. As the basic chest with a hinged lid developed, it was enhanced by a shallow bottom drawer. Eventually, the entire chest was filled with drawers and the hinged lid was discarded, creating a chest of drawers. Small, shallow chests, called desk boxes, had sloping or flat

JACOBEAN

COURT
CUPBOARD
(LATE 17TH
CENTURY)



BREWSTER
CHAIR
(1640)

WILLIAM & MARY

HIGHBOY
(1720)



SLAT-BACK
ARMCHAIR
(1720)

QUEEN ANNE

HIGHBOY
(1750)



SIDE
CHAIR
(1750)

hinged lids and were used to hold books and writing materials.

In terms of chair design, the Jacobean style is represented by the Brewster chair and the Carver chair. Both are constructed of heavy, turned spindles—the Brewster chair differs in the rows of vertical spindles spanning the rails both above and below the seat. Another type of chair, called the Wainscot chair, features a back and seat made from flat boards ornamented with carving.

William & Mary

The William & Mary style introduced changes in materials—walnut and maple supplanting oak and pine—and used veneering as a way to create ornamentation through highly figured, naturally decorative wood.

The types of furniture changed as well. Small desk boxes were placed on stands, and the lid was now hinged at the front so it could be opened for writing. The desk box was also united with a chest of drawers and eventually acquired a cupboard top to produce the secretary we're familiar with today.

Although turned legs remain in William & Mary pieces, the profiles are less bulbous and the heavy relief carving of Jacobean designs is replaced by more refined detailing. Drawer openings are frequently accented by thin, half-round strips

called cock beads and frame-and-panel doors acquire the characteristic arched-top panel based on an S-shaped cyma, or ogee, curve.

Perhaps the most notable furniture type introduced in this period is the highboy. This is a chest of drawers placed on a stand. The stand also has drawers and up to six turned legs connected by flat rails sawn to a curved profile. More refined highboys have an arched S-shaped curve motif in the front rail. The stand by itself is called a lowboy and is a precursor of today's dressing table.

The transition from Jacobean to William & Mary produced a variety of chair designs. In addition to a general refining of detail and proportion, chairs with horizontal curved slats and banister-back chairs with vertical profiled slats became popular.

Queen Anne

Roughly 100 years after the settlement at Plymouth, a new design style, called Queen Anne, took the S-shaped curve and made it a more dominant visual component. The most striking example of this is the cabriole leg. Unlike the turnings of previous styles, the bowed, offset cabriole leg created a smooth, graceful curve that grew from the floor to be continued around the entire piece.

Queen Anne chairs, for example, have cabriole legs at the front and

simpler arched legs at the back. The back's central splat is based on a vase shape that further echoes the curves in the legs and back frame.

This cabriole leg design, so indicative of the Queen Anne style, is not exclusive to chairs. It appears on everything from beds to desks to highboys. The highboy, in particular, evolved the S-shaped curve in the form of a sophisticated, broken-scroll pediment at the top of the case.

Queen Anne furniture also features carved shell motifs on the knees of cabriole legs, front panels of highboys and within corner cupboards. Frame-and-panel doors generally feature a half-round arch at the top of each panel. In terms of wood, walnut remained one of the favorites, with maple and cherry also in use. Mahogany was beginning to achieve popularity.

Chippendale

Like earlier styles, Chippendale originated in England, and became part of the American furniture scene around the middle of the 18th century. It's rooted in a combination of French Rococo influences, Chinese design and ornamentation and a revival of English Gothic motifs—all held together in forms based on earlier work. The style was given its name in acknowledgement of Thomas Chippendale's work and his book of

CHIPPENDALE

BREAKFRONT
BOOKCASE
(1770)



FEDERAL

SHERATON-
STYLE DESK
(1800)



WINDSOR

SIDE
CHAIR
(1770)



HEPPLEWHITE-
STYLE SIDE
CHAIR
(1800)



CONTINUOUS-
BACK
ARMCHAIR
(1800)



furniture designs, *The Gentleman And Cabinet-Maker's Director*.

The cabriole leg, broken pediments and arch-top panel doors are a few of the many components carried over from Queen Anne. However, to these were added detail and ornamentation as yet unseen. To chair splats, perforated designs of Chinese or Gothic influence were incorporated. Cabriole legs were carved with highly detailed ball-and-claw feet. Straight legs, a Chinese influence, became common on both chairs and tables.

This period also saw the introduction of the breakfront—a large cabinet with a central section flanked by two shallower and narrower side sections. Chests of drawers saw variation in serpentine designs that transformed the traditional flat front into an undulating symmetrical curve.

The wood of choice was mahogany, although walnut, maple and cherry were also used. Highly figured crotch-grain veneering in geometric patterns was a popular means of decoration.

Federal

The years after the American Revolution saw a new style emerging that was founded on a renewed interest in classical forms. The style, a reaction to the heavily ornamented Chippendale, was, to a large extent, introduced to American woodworkers through the work of George Hepplewhite and Thomas Sheraton.

In addition to being more geomet-

ric, Federal furniture is lighter and more delicate than preceding styles. Details include fine inlay, reeding, cock beads and refined turnings. Both veneering and painting are used as ornament. Chair and table legs are commonly square in section and tapered. Chair backs are either square cornered or curved and often feature elaborate pierced splats.

Of the chair types associated with the Federal period, one of the most popular is the Windsor chair. The Windsor was actually introduced to America well before this time, but it was in this period that it achieved widespread popularity. The design is characterized by spindle construction, splayed legs and a carved slab seat. Individual examples differ in the back design. These range from rod-back versions with straight uprights connected by a horizontal member, to oval-back chairs with a continuous bent-back frame. In chairs with arms, the arms may be integral with the bent-back member, or the back may be a separate assembly joined to a C-shaped armpiece. Seat outlines are either convex or accented with the S-shaped curve.

Duncan Phyfe

Evolving out of Federal traditions and borrowing forms from the English Regency style, Duncan Phyfe, a cabinetmaker based in New York during the early 19th century, generated a distinctive style that can truly

be called American.

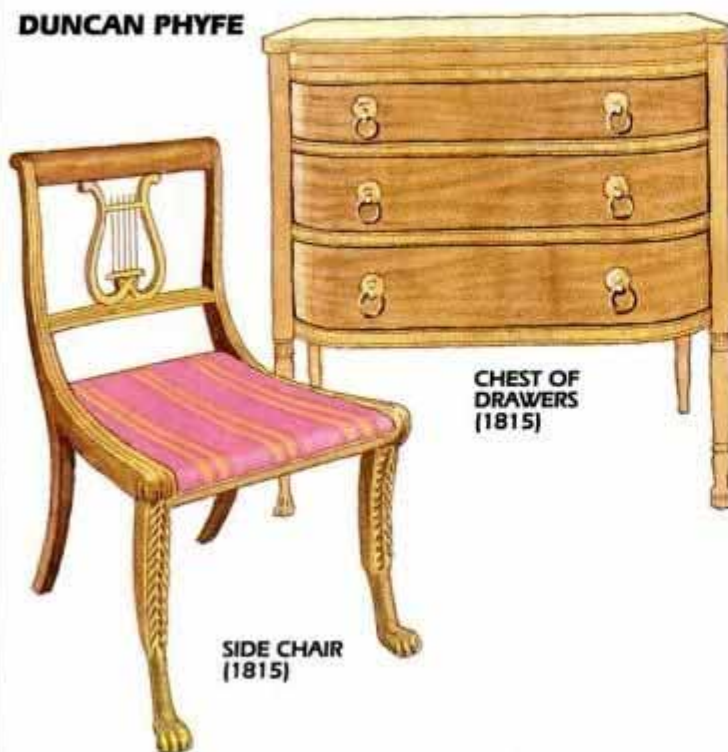
Some of the characteristics of Phyfe's work include vase-shaped pedestal table supports with three or four curved, or sabre, legs, claw feet and cloverleaf-shaped tabletops. The legs were frequently ornamented with reeding or repetitive floral carvings, and multiple beading was a common edge treatment for table- and cabinet-top edges. Broad surfaces such as tabletops and drawer fronts were generally veneered with mahogany, and the pieces were stained dark. Phyfe chairs utilize a lattice back, often with a lyre-shaped splat.

Victorian

Although the term is loosely used today to denote a style, Victorian better refers to a period in which many styles were popular.

At a time when the Industrial Revolution was making its impact felt on both production techniques and the availability of products, users and makers of furniture were thinking of style less as a slow evolution and more as a library of existing possibilities. Victorian designers used style in a manner similar to the way we use it today—as a means to create cohesive settings based on a variety of influences. Makers began to draw from the past, producing furniture inspired by earlier periods, much in the same way we might make a dining suite based on Queen Anne design elements today.

DUNCAN PHYFE



SIDE CHAIR
(1815)

CHEST OF
DRAWERS
(1815)

VICTORIAN



ROMANESQUE-STYLE
BOOKCASE
(1840)

ROCOCO-STYLE
ARMCHAIR
(1860)

Notable movements in Victorian furniture drew inspiration from Gothic, Renaissance, Elizabethan and Rococo styles. The makers relied on the ornamentation of a previous period to imbue their creations with a desired aesthetic effect, and heavy ornamentation is one of the hallmarks of Victorian furniture.

Victorian designers produced several new forms of furniture, most notably the circular ottoman, balloon-back chair and the single-end sofa. The wood used runs the gamut from rosewood to oak.

Shaker

The Shakers, a religious society with communities in various locations ranging from New York to New England and through the Midwest, produced furniture characterized by a desire for utility, economy and efficiency without sacrificing quality. The result is a clean, relatively unadorned style that, as seen alongside others, appears sparse and institutional. In contrast to elaborate highboys, the typical Shaker chest of drawers is an almost featureless assemblage of flat boards, punctuated by simple turned drawer pulls. And, the plain turnings of a classic Shaker chair are about as far as you can get from the carved cabriole legs and heavily ornamented turnings of mainstream styles. However, Shaker furniture is anything but styleless, and the apparent emphasis on utility be-

lies a subtle and restrained sense of detail and ornamentation. Even the most elemental pieces often use simple moldings. Chair turnings are sensitively tapered with carefully shaped finials, and the overall proportioning reflects a concern for balance that's rooted in aesthetic concerns as much as utilitarian requirements. The Shakers made furniture from available domestic hardwoods and pine.

Arts & Crafts

While Victorian woodworkers and designers drew ornament and form from the past and combined them with new industrialized production techniques of the day, another school of design took a more reactionary approach. The Arts & Crafts movement represented a need to return to basics in design and construction, with an emphasis on utility, simplicity and individual craftsmanship.

Rooted in the work of two English designers, John Ruskin and William Morris, the American movement found expression through Charles and Henry Greene and Gustav Stickley. American Arts & Crafts examples are grouped more by common philosophical goals rather than by design detailing. Where some pieces may show Japanese, Renaissance or Gothic influence, others are characteristically unadorned and rely on functional requirements and joinery techniques to give the work identity. The joints themselves are part of the

visual design, supplanting the need for traditional ornamentation. Stickley's furniture, in particular, is typified by straight lines and simple, straightforward joinery. A popular offshoot of the Arts & Crafts movement is the Mission style of furniture. It's characterized by simple rectangular designs, usually built from oak and stained dark.

Art Nouveau

Another group of designers took a different route away from the Victorian mainstream. Art Nouveau based its efforts not on copying natural forms and applying them as ornament, but by using nature as an inspiration for the entire design.

Art Nouveau is characterized by smoothly curving lines and graceful transitions through the form. The end result is an almost sensuous and exotic composition of line. The typical Art Nouveau line begins as a slow S-shaped curve that terminates in a rapid whip-like end. While the intention is natural, the smooth curves and symmetry reflect a synthetic order where the design is a stylistic abstraction of natural form rather than a direct translation.

In America, Art Nouveau furniture never gained the popularity it found in Europe, although the movement was influential in graphic design and architecture. However, pieces were made on a production basis, particularly in the early 20th century. **PM**

SHAKER

CHEST WITH
CUPBOARD
(1840)

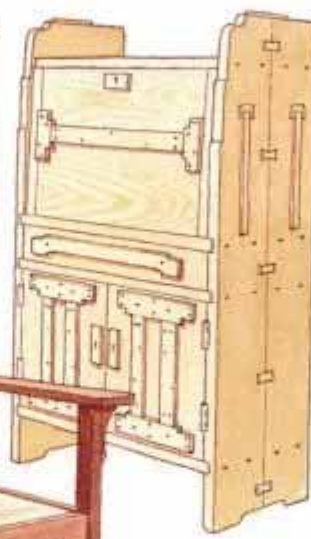


SLAT-BACK
ROCKER
(1830)



ARTS & CRAFTS

GREENE-AND-
GREENE-STYLE
DESK
(1904)



STICKLEY
ARMCHAIR
(EARLY 20TH
CENTURY)

ART NOUVEAU

STAND
(EARLY 20TH
CENTURY)



SIDE CHAIR
(LATE 19TH
CENTURY)

HOW IT WORKS

REFRIGERATOR

BY STEVE TOTH, Contributing Editor; PM Illustrations by George Retseck

● Few folks go to the store just to buy the things they need for one meal—or even one day. It's simply more efficient to make the trip once every week or two and store the food at home. However, unless you eat everything out of a can, it's likely that a good portion of the groceries you buy won't last until your next shopping trip if they're stored in your kitchen cupboard. To keep these perishable foods, you need one basic piece of machinery—a refrigerator.

Early coolers

While it's been known for a long time that keeping food cold or frozen wards off spoilage, having access to a mechanical device to handle the job is a fairly new development. As recently as 70 years ago, the most popular way to keep food cold was with an icebox. This was little more than a wooden cabinet insulated with cork, sawdust or glass wool. Large chunks of ice were placed in the top compartment of the icebox to cool the contents.

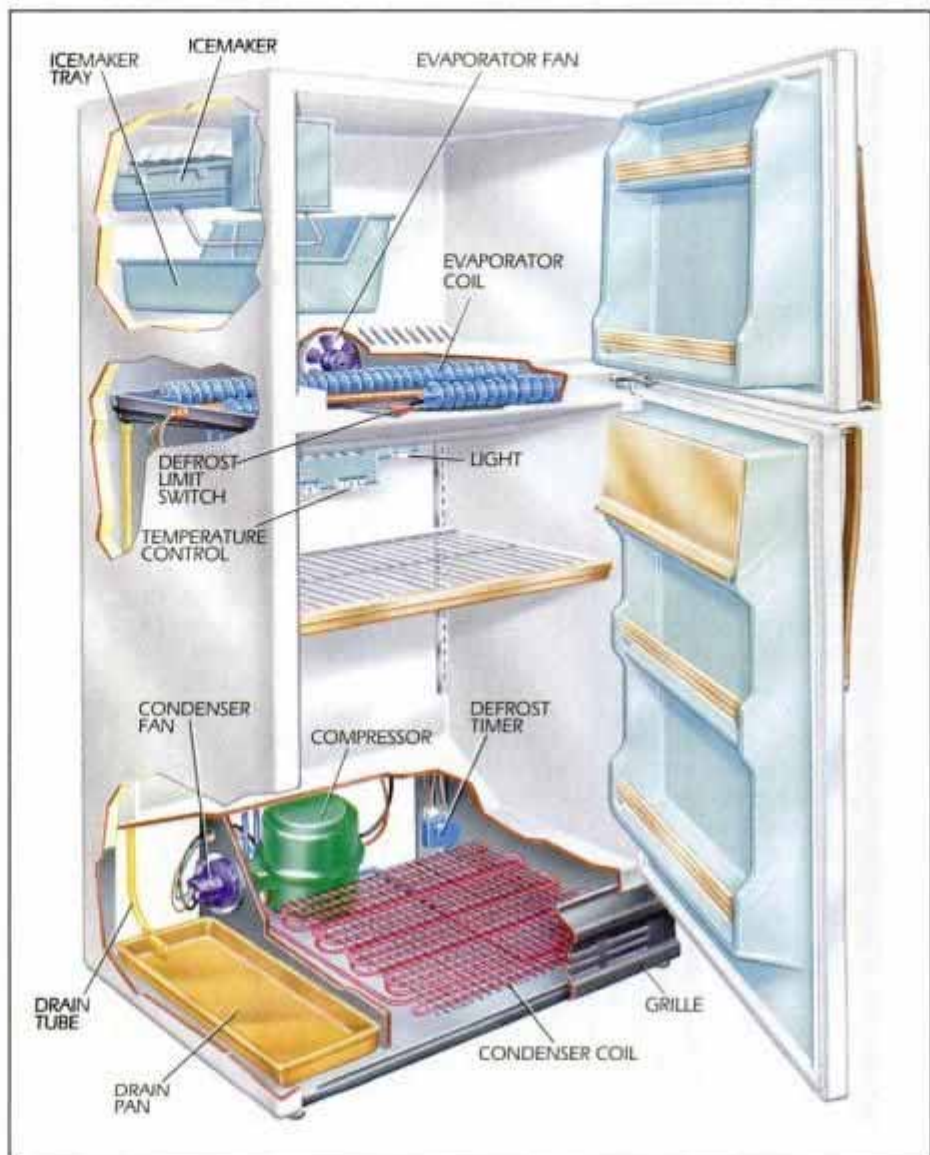
Understanding how the ice cools food in an old icebox is an important step in understanding how a modern refrigerator works. Although both devices differ in terms of mechanical complexity, they both make use of similar principles. In an icebox, the heat energy that's held in the food moves to the cold ice. In doing so, the food cools off because it has lost energy and the ice warms up.

This transfer of heat goes on until everything inside reaches the same temperature. Although the old icebox kept food cold, it was only useful for short-term storage since the average inside temperature was only about 55° F.

Mechanical refrigeration

It has long been known that evaporation and condensation cause changes in heat. For example, evaporation loses heat energy. This is why we sweat—the evaporation on our skin has a cooling effect that lowers body temperature. Conversely, condensing vapors gain heat energy.

In a modern refrigerator, a substance called the refrigerant is con-



A modern refrigerator features a sealed cooling system comprised of compressor, condenser and evaporator. Automatic defrost uses electric heating element when compressor is off to free evaporator of ice. Melted ice drains through tube into drain pan at bottom.

tinually cycled through the evaporation and condensation processes. In the evaporation phase, the refrigerant cools and draws heat from the contents of the refrigerator. The condensation phase releases the heat outside of the cabinet.

In the 1920s, a new refrigerant was discovered called dichlorodifluoromethane—R-12 or Freon, for short—which set the stage for the refrigerator as we know it today. This refrigerant has a boiling point of -22° F. When it's brought to room temperature, it evaporates quickly and soaks up heat from surrounding objects.

What's inside

The modern, sealed refrigeration system consists of a compressor, condenser, dryer, capillary tube, evaporator and refrigerant. The compressor is the heart of the refrigerator. It

pumps evaporated Freon gas through a suction line from the evaporator coil and then compresses it so it returns to a liquid state and gains heat. Here, it's pumped through the condenser—a series of folded tubes that acts as a radiator—where the heat is released outside the cabinet. From the condenser, the refrigerant flows through a filter dryer that traps any foreign particles and absorbs any moisture.

After passing through the filter dryer, the refrigerant enters the capillary tube. This is a small metering device that's carefully calibrated to allow an exact amount of liquid refrigerant to flow through before entering the large tubing of the evaporator. As the refrigerant leaves the small capillary tube, the sudden increase in tube size of the evaporator causes a drop in pressure which al-

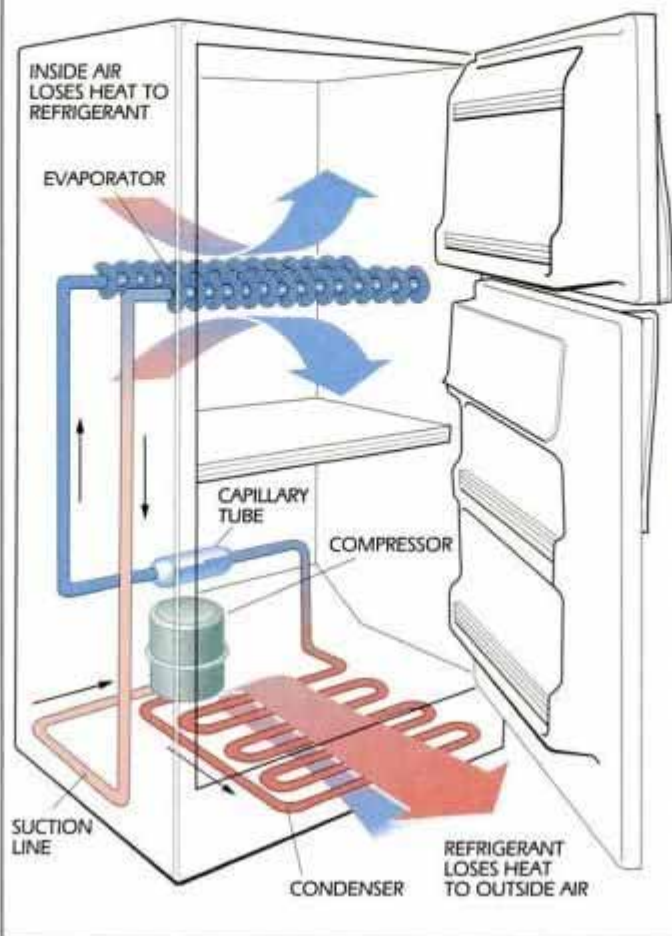
lows the fluid to evaporate and cool down. At this point, it draws heat from the contents of the refrigerator, and is cycled back to the condenser to release the heat outside.

If this cycle—from evaporator to condenser and back—was allowed to continue, everything inside the food compartment would eventually freeze. To control the temperature, a thermostat senses the low temperature at the evaporator and opens a switch that shuts off power to the compressor. As the temperature inside the refrigerator rises, the thermostat turns on the compressor and the cycle starts again. The thermostat can be adjusted to control the desired refrigerator temperature.

Defrosting

As the refrigerator picks up heat from the food and the warm air that enters when you open the door, it also picks up moisture. This collects in the form of frost on the evaporator. Over a period of time, frost accumulation reduces the evaporator's effectiveness, and the refrigerator gets warm. To

HEAT TRANSFER IN A REFRIGERATOR



A refrigerator takes heat from inside and pumps it outside. The evaporator draws heat toward cold vaporized refrigerant. Liquid refrigerant radiates heat away at the condenser.

keep the system operating properly, the refrigerator needs periodic defrosting.

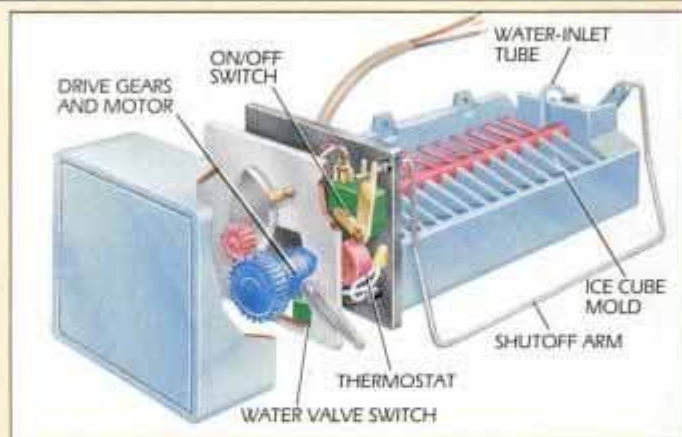
There are three types of defrost systems in use today—manual, cycle and automatic (no frost). In a manual system, you defrost the refrigerator by turning off the temperature control. Then you simply wait until the ice accumulation melts.

A cycle-defrost unit has an electric heater that energizes when the compressor is off to melt any ice. The freezer section of this type of fridge must be manually defrosted when there is a heavy buildup of ice.

An automatic defrost system consists of a low-wattage electric heater to melt the frost, an evaporator thermostat to turn on and off the heater and a timer that controls the defrost cycle. As frost accumulates, the timer advances to the defrost cycle. Then, the compressor shuts off and the heater turns on. When the frost is gone, the thermostat turns off the heater and the timer allows the water to drain to a defrost pan before starting the compressor. **PM**

How An Icemaker Works

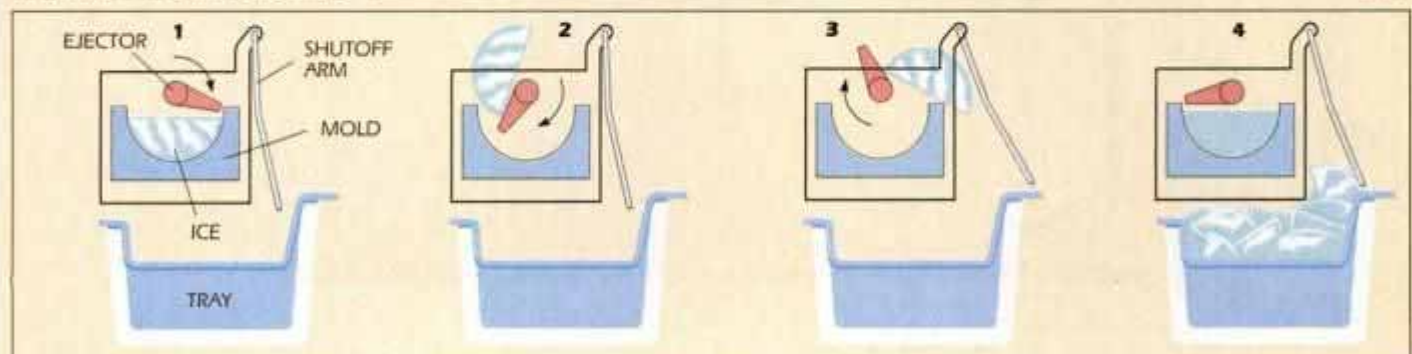
● In a typical icemaker, the water enters the unit when the shutoff arm senses that the ice tray isn't full. An inlet valve meters just enough water to fill the ice mold, and a thermostat senses the temperature of the water. After the water has frozen and the ice is about 18° F, a motor rotates the ejector blades until they hit the ice that's frozen to



the mold (Fig. 1). At this point, a heater warms the mold to free the ice. Then, the ejectors resume turning (Fig. 2) and push the pieces out and into the ice tray (Fig. 3).

With the mold empty, the water-inlet valve opens and the cycle is repeated. The icemaker continues to produce ice and fill the tray until the accumulation of cubes lifts the shutoff arm (Fig. 4). This shuts off power to the unit. When the tray is cleared and the arm falls down, the process starts again.

—S.T.



APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Counter Oven Hinge Broken

I have a Corning counter range, model No. R-30DB, serial No. 2041205188, with a broken oven door hinge. How do I best gain access to the cabinet-housing interior to fix or replace it?

DON BARTON
ENFIELD, CT

Corning discontinued the range portion of its business back in 1976. However, some Corning range parts are still available and can be ordered from Whitewood Limited, P.O. Box 451, Horseheads, NY 14845. A new door hinge and spring assembly for your range is still available as one part. It is part No. 98332, and it costs about \$32, plus shipping. Both the right and left hinge assemblies are the same part number.

To install the door hinge and spring assembly, you first need to remove the oven door. To do this, swing the oven door to the full open

position. Remove the two Phillips screws on the door that hold the hinge to the door. They are located just above where the hinge enters the door.

Next, carefully close the door to the BROIL/STOP position. Grasp the door with both hands, one on each side, then lift the door straight up and off the hinges. To avoid scratching the door or marring a vinyl floor, set the door on a padded surface.

Get a firm grip on the hinge with your hand and slowly pull it out until you see a small hole in the hinge arm near the bottom.

Be careful. There is a lot of spring tension on the hinge. Take a cotter pin or cut a small nail to $\frac{1}{8}$ in. long and insert it into this hole. Then slowly release the tension on the hinge. This pin will lock the hinge in the open position and prevent it from snapping back.

Next, remove the two hinge mounting screws directly above the hinge on the oven front panel. Then remove the second screw directly below the hinge while holding the hinge in position.

Push the hinge up and feed the bottom of the hinge out of the slot in the bottom of the front panel of the oven.

To install the new hinge, you must first pull it open until the small hole in the bottom of the hinge is visible. Then install a pin or a nail in the hole and release the tension on the hinge. Insert the hinge in the slot in the front panel of the oven and screw it in place. Place the oven door back on the hinge posts and screw it in place. Remove the pins from the hinges and the job is done.

1950 Chambers Thermostat

I have been unable to find an oven thermostat for a 1950 vintage Chambers gas range which has a style No. 900 or 90C-610 and a serial No. of 1-25094. Can you help?

HAROLD S. NEIDERHOFFER
MONMOUTH, NJ

I don't think you will have much success finding a new oven thermostat for your vintage Chambers range. Instead, have an appliance servicer remove the old control. Then send the control out to be rebuilt. Package the control and send it to Control Service Co., 1545 Northwestern Ave., Chicago, IL 60622.

Enclose a note stating your name, address and phone number and that you would like the control repaired if possible. Chances are very good that they will be able to repair the old control.

Once the company receives the control, it will check the part then send you a note telling you if it can be repaired. If it cannot be repaired, the company will send it back to you at no cost. To repair the control will cost \$30 to \$100.

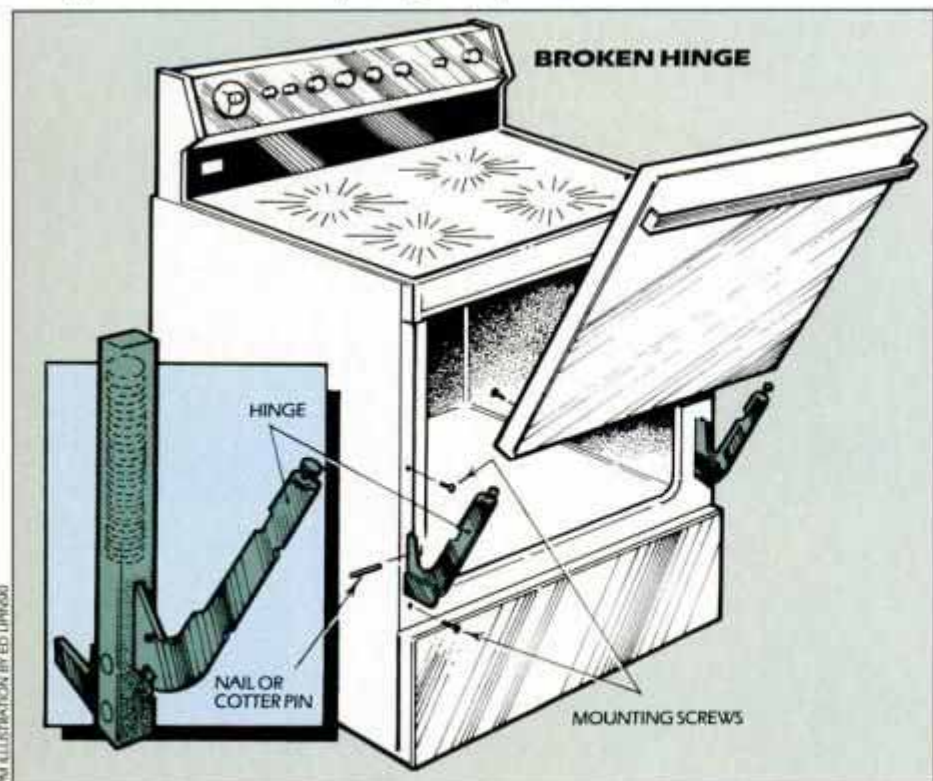
Needs Sealing Ring For Pressure Cooker

We have a 4-qt. Presto Cook Master Cooker, model No. 604. We are trying to locate a 4-qt. sealing ring and an oven pressure plug. We would appreciate your help in locating these parts.

L.E. HICKLIN
CALGARY, ALBERTA
CANADA

To order parts for your Presto pressure cooker, either write National Presto Industries, 3925 N. Hastings, Eau Claire, WI 54703, or call the company's customer service department. The sealing ring and pressure plug cost about \$6 each, plus shipping.

FM



A range's door hinge is under tension so be careful when removing it. With the door held in position, slide it off the hinge posts. Then, you can remove the screws holding the hinge to the range body and install the replacement hinge. Hold the replacement hinge open with a pin, or a cutoff finish nail, when installing it.

NEW PRODUCTS

HOME TEAM

BY ROY BERENDSOHN, Assistant Home Improvement Editor

Soap And Water

This oil paint is different, says its manufacturer, because it cleans up with soap and water. That's right, you don't need mineral spirits or other solvents to clean your brush or roller, just wash them out with warm soap and water. The product serves as a stain-blocking primer, works indoors and out, has low odor and penetrates in the same fashion as traditional oil primers. Its manufacturer says it can be used on virtually any surface, glossy or porous, including wood, masonry, metal and plaster. It costs about \$20 a gallon at paint and hardware stores. For more information, write Wm. Zinsser & Co., 39 Belmont Dr., Dept. PM, Somerset, NJ 08875.



Counter Intelligence

Nuvel is a new plastic laminate with interesting mechanical qualities. To start with, the material is nearly 1/8 in. thick (about 1/32 in.). Unlike standard plastic laminate which has a face color, Nuvel is the same color throughout its thickness. It forms easily using a heat gun, and it can be bent to a 90° angle, its manufacturer says. It's impact resistant, but it works with standard woodworking/plastic laminate tools and is bonded to substrates using laminate contact adhesives. You can remove a burn or gouge from it by sanding or by scrubbing with a Scotch-Brite pad. It's sold in sheets 5 ft. wide by any length, and it costs about \$8.50 per sq. ft. at home centers. For more information, write Formica Corp., 1504 Sadlier Circle South, Indianapolis, IN 46239.



gles. Called Carriage House Shingles, they weigh 350 pounds per square (100 sq. ft. of roofing)—about 120 pounds heavier per square than standard roofing shingles. This is due to their double-thick design, which protects the roof deck with four layers of shingles. The extra weight also helps them resist being torn off by wind. Shingles are available in green, blue, brick red (shown), gray, silver and black. A square costs about \$110 at lumberyards and home centers. For more information about these shingles, write CertainTeed Corp., Roofing Products Group, Carriage House Shingles, P.O. Box 860, Valley Forge, PA 19482.

They Only Look Antique

If you're interested in a modern shingle with an antique look, then you might consider these heavy fiberglass-reinforced asphalt shingles.

Sliding By

With a simple modification, Lee Rowan has made closet wire shelving easier to use. You can slide clothes hangers along the Free Slide Shelving System because there's no mounting hardware or shelf supports to get in the way. The shelving—made from epoxy-coated wire—comes in 8-ft. and 12-ft. lengths and is 12 in. deep. For an exact fit, it can be cut to length. A piece of 8-ft.-long shelving costs about \$24, and a

12-ft.-long piece costs about \$36 at home centers. For more information, write to Lee Rowan, 6333 Etzel Ave., St. Louis, MO 63133.



Muck-Free Gutters

Perma-Flow gutter guards prevent leaves, twigs and debris from entering the gutter, its manufacturer claims. Rainwater flows over the edge of the steps and into the gutter, while leaves and debris fall or are washed over the steps, its manufacturer says. The guards are made from PVC plastic and come in 3-ft.-long pieces. Each piece has a flexible tab that tucks under the shingles. The guards cost about \$4 apiece, and are sold at hardware stores and home centers. For more information, write Crane Plastics, 2141 Fairwood Ave., P.O. Box 1047, Columbus, OH 43216.



Fancy Faucets

Moen's Decorator sink and shower faucets are inspired by older faucet designs while incorporating newer features, such as shapes that are easy to clean and waterflow that is controlled with a quarter-turn of the lever or handle. Both sink and tub faucets are available in chrome, brass or a combination of the two. To widen your design



choices, you can also get handles in porcelain, clear plastic, brass, chrome or porcelain with brass or chrome caps. The brass and chrome set shown costs about \$165, and the all brass model, about \$185. The

Decorator line is sold at plumbing supply stores, hardware stores and home centers. (The faucets are sold to plumbing contractors as the Monticello line.)

To make it comply with increasingly strict plumbing codes, Moen has added a vacuum breaker to its One Touch faucet (above left). A vacuum breaker prevents dirty dishwater from being siphoned through the faucet nozzle. Siphoning can happen if you leave a



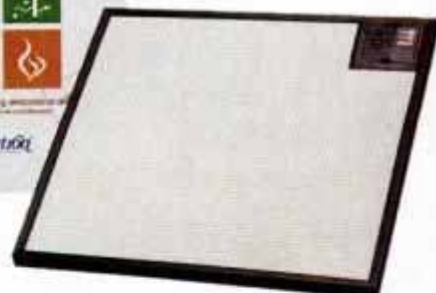
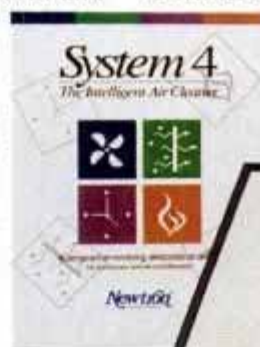
pull-out faucet submerged during a drastic drop in water pressure in your plumbing supply lines or in the water supply to the house. The spray head pulls out to 22 in. long, and the control button on the head adjusts the waterflow from a stream to a spray. The faucet is available in chrome or a matte sand finish, and costs about \$250 at plumbing supply houses and home centers. Write Moen Inc., 377 Woodland Ave., Elyria, OH 44036; or call (800) 553-6636.

Breathe Easier

The System 4 furnace filter cleans the air, but it also serves as a central air-monitoring station, says its manufacturer. It has a smoke alarm and a shutoff switch to turn off the blower motor when smoke is detected continuously for 30 seconds. Also, it has a timer that you set for 30-, 60-, 90- and 120-day intervals to tell you when the filter needs to be cleaned. The device chirps to let you know that the set time has elapsed. The System 4 uses an electrostatic filter media with an anti-

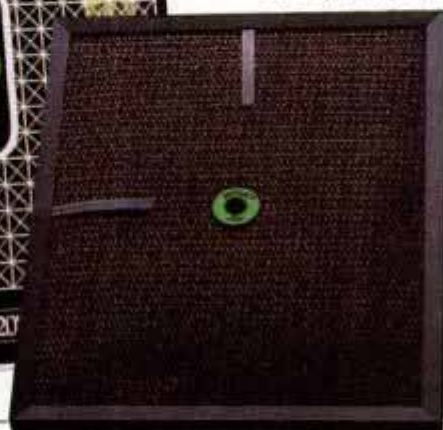
microbial additive to control bacteria, mold and mildew growth on the filter. The filter costs about \$300, and it must be installed by a heating-ventilation contractor. (You clean the filter rather than dispose of it.)

The Whistle Air filter, a do-it-yourself product, whistles when it gets



loaded with trapped particles. The manufacturer says you don't replace it, but instead wash it out and re-install it. It cleans the air using a series of negatively and positively charged filters to trap airborne particles. The filter costs about \$60.

The System 4 filter is sold by heating-and-cooling contractors, while the Whistle Air filter is sold at hardware stores and home centers. For more information, write Newtron Products Co., P.O. Box 27175, Cincinnati, OH 45227; (800) 543-9149.



Laundry Day

Amana has refined its laundry appliances to make them more attractive to homeowners remodeling their laundry rooms. The company made its dryer easier to locate in a laundry room by incorporating a door that can be hinged from the left or right side and swings open a full 180° in either direction. Amana says it's the largest dryer-door opening in the industry. Another nice feature is a dryer rack that you can attach on the inside of the door. Put delicate items on the rack and you can dry them without tumbling. The washer has a 3-cu.-ft. tub so you can wash more laundry per load. Together, the two measure 52½ in. across, or about 1½ in. narrower than the industry standard. The dryer shown costs about \$600 to \$650 and the washer about \$700 to \$750 at Amana dealers. Both appliances have stainless-steel tubs. For more information, write Amana Refrigeration Co., Amana, IA 52204.



Leverage

The Saratoga lever is designed to be easy to use and clean. It gives you the look of a solid brass lever at a fraction of the cost, about \$20 versus \$60 or more for the real thing. The lever is made of brass-plated die-cast zinc. It can be used on interior doors or on the inside of an exterior door when it is paired with a locking knob. It's available in three finishes: bright brass (shown), antique brass or chrome. It's sold at hardware stores and home centers. For more information, write Weiser Lock Marketing Dept., 6660 S. Broadmoor Rd., Tucson, AZ 85746; or call (800) 488-5625.



Squeeze Play

Broan redesigned its already-streamlined Eclipse downdraft ventilator, making it easier to use and to clean. A major departure from its old models is that the new system has done away with the flip-top cover. Now a stationary cover rides with the device. Push a button on the Eclipse top and it rises above or retracts below the counter. The cover is available in brushed aluminum, black or white. The below-the-counter blower has been drastically reduced in size (from about 12 in. deep to 7 in.), and it exhausts cooking fumes from any angle. The old model exhausted cooking fumes only straight down—which posed a problem if the blower was above a floor joist. Now the cook surface and ventilator can be located anywhere in the kitchen. It costs from about \$685 to \$700 at appliance dealers and can be special ordered through home centers. Write Broan Mfg. Co. Inc., P.O. Box 140, Hartford, WI 53027.



Thrifty

Bryant's Plus 90i condensing furnace conserves electricity as well as gas. Its blower motor uses computer circuitry to cut its use of electricity by 20% compared with standard blower motors.



The Plus 90i achieves further fuel savings by using outside air for combustion rather than inside air. Its furnace controls are on a circuit board to make it easier to diagnose problems. The furnace comes in three output capacities: 60,000 BTU, 80,000 BTU and 100,000 BTU, from about \$1800 to \$3500 installed. They are sold through Bryant dealers and heating-and-cooling contractors. Write Bryant, 318 First St., Liverpool, NY 13088.

Take Out The Dirt

This air cleaner mounts on a kitchen counter, desk or wall so you can use it right where you need it. Its manufacturer says it's quiet enough to be unobtrusive. It cleans the air by drawing it through a replaceable multilayered 3M Filtrete filter then through an electrostatic filter, and fi-



Stepping Up

Ceiling tiles take on a new look with this stairstep-edge design in a 1-ft.-sq. size. Called Terrace Square, the tiles have tongue-and-groove edges and a washable painted surface. They can be installed on a metal grid or cemented to a ceiling. They also have a Class A fire rating. A box of 30 tiles costs about \$50 at home centers. For more information, write Armstrong Consumer Response Center, P.O. Box 3001, Lancaster, PA 17604. **PM**

It's A Snap

JiffySnaps are reusable tarp grommets. Position one where you want a grommet and snap it in place. The grommets reduce the wear on the tarp by distributing the stress over a large area. Each grommet has a hook and a ring on the end so you can attach a rope or a bungee cord with a hook. A pack of four costs about \$5 at hardware stores and home centers. For more information, write Buck Work-Man, P.O. Box 1267, El Cajon, CA 92022.



nally through an activated carbon filter to remove unpleasant odors. As the last step in the filtering process, the cleaner sends negatively charged ions into the cleaned air, which attach to airborne particles causing the particles to cling to the floor or other surfaces in the room. Ionized particles are also easier for the appliance to capture. Its manufacturer says it removes 99% of the dust, smoke and pollen in the air. The cleaner is available in two sizes, the AFX-10 and AFX-20, priced at \$110 and \$160, respectively. They are sold at hardware stores and home centers. Write Teledyne Water Pik, 1730 E. Prospect, Fort Collins, CO 80553; or call (800) 525-2774.



HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Slab Jacking

The concrete walk in the corner of our L-shaped house has settled to a slope of 3 or 4 in. The slope causes rainwater to seep into the crawl-space. Can we top this walk with a thin layer of concrete, or will it crumble?

ELEANORE PORADA
 RUBY, MI

You have three choices: replace the slab, top it with a layer of concrete (see the next letter) or lift it up and fill in underneath it. There are two ways a homeowner can lift a slab: If its edge is accessible, you can use a pry bar. If its edge is not accessible, or it's too big to pry up, you can jack it up.

Span across the concrete slab with two 2 x 4s placed on edge. Bore holes through the 2 x 4s and through the concrete slab as shown (rent a hammer drill if need be). Take some threaded rod and put a spring-loaded wing on the end of each. Push the rod through each hole in the 2 x 4s and into the holes in the slab.

Put a washer and a nut on top of each rod and thread down the nut. Drive down the rod, with a hammer if necessary, until the wings open under the slab. Be sure to put the nuts on the threaded rod before

driving down the rod. Driving the rod will mushroom the threads and make it difficult to thread the nuts on the rod.

Tighten the nuts against the 2 x 4s to jack up the slab. Then pour a slurry of cement, sand and water through the open holes in the slab to fill the void underneath. Turn the rod out of the nuts when the filler under the slab has set up a little. Patch the holes, and the job is done.

Concrete Topping

I've been informed that there is a process of applying a thin layer of topping material to a concrete garage floor. I would appreciate any assistance regarding this.

RAY BLOCK
 Le SUEUR, MN

You can top a slab, but you must be careful not to get the topping material too thin. The Portland Cement Association recommends that topping over hardened concrete should not be less than 2 in. thick at any point.

To top a concrete slab, clean the surface with muriatic acid or concrete cleaner (available in paint and hardware stores). To ensure that the topping bonds well, roughen the

surface of any slab that appears shiny and smooth. Use a wire brush and full-strength muriatic acid to do this.

Next, mix a slurry of cement, sand and water and scrub this onto the surface with a throwaway scrub brush. This slurry acts as a primer to ensure that a good bond forms between the slab and the topping. Apply the concrete topping mix on top of the slurry before the slurry starts to dry.

Observe standard concrete work procedures when topping the slab. Keep the topping moist as it cures by covering it with burlap or misting it. Also, don't work the top to a very smooth finish. This prevents the surface from being slippery when it's wet.

Peeling Vinyl Shutters

I have vinyl shutters that are not even 2 years old, and they look horrible. The paint is cracking, chipping and peeling. The man who installed the shutters couldn't find avocado green anywhere, so he just painted them. Do you have any suggestions?

BETTY KREIDER
 WERNERSVILLE, PA

I know someone who had a similar problem and solved it by painting the shutters with Geocel Pro Flex Roof Seal. Paint does not stick well to vinyl shutters, so you need to create a base that paint will stick to. Roof Seal is a brushable, flexible sealant that is paintable, and it has exceptional adhesion properties.

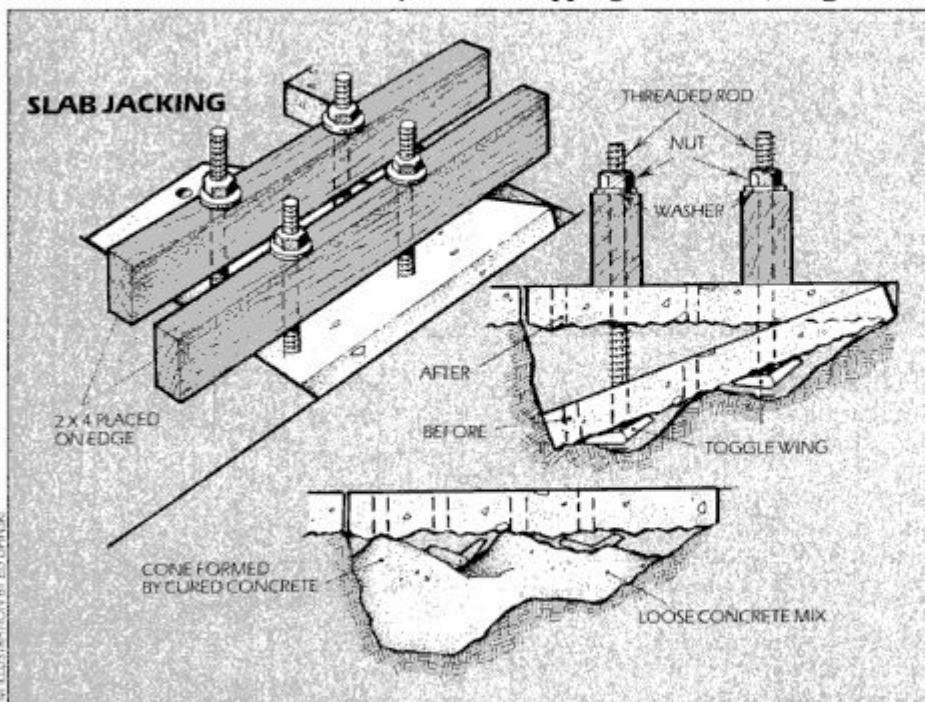
First, use a stiff brush and scrub off as much of the paint as you can. Next, clean the shutters with detergent and water to remove dust and dirt and then hose them off. Let the shutters dry.

Purchase some Roof Seal at a home center or a paint or hardware store. Buy a disposable paint pot, brush and some paint thinner. Pour some Roof Seal into the pot, and thin it out with some paint thinner until it's the consistency of latex paint.

Apply the thinned Roof Seal to the shutters. Wait until it is dry, then paint over it with a good-quality acrylic latex paint.

For more information, call Geocel at (800) 348-7615.

FM



There are two ways a homeowner can lift a piece of concrete: pry it up or jack it up. If you jack up a piece of concrete, fill in underneath it with a portland cement slurry.

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.

HOME IMPROVEMENT

INSTALLING AN ICEMAKER

BY MERLE HENKENIUS
 PM Illustrations by
 George Retseck

● If you have often wanted an icemaker, but somehow missed the opportunity when you bought your refrigerator, you'll be glad to know that you can install one without much trouble. Installing an aftermarket icemaker kit is easy. It takes less than an hour to complete.

Expect to pay around \$120 for the icemaker and an additional \$15 for a saddle-tap valve and the copper tubing that serves as the feed line.

Always choose an icemaker that is the same make as your refrigerator. The Whirlpool icemaker shown (see top illustration on page 68) is installed in a similar manner as other makes, but you should always follow the instructions of the manufacturer that made your icemaker.

Assessing feasibility

While it is possible to install an icemaker in a refrigerator that was not built to accommodate one, it's a complicated retrofit and should be left to professionals. If your refrigerator was built to accept an icemaker, you'll find a rectangular access panel at the back of the appliance, along with two knockout openings identified for icemaker use. Also, the appliance will have a labeled cover plate inside the freezer and several capped



screwholes on the adjacent sidewall.

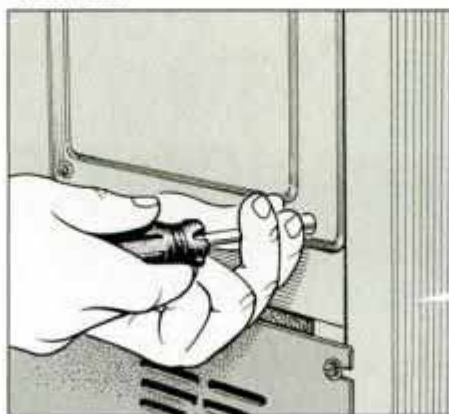
To connect the icemaker, you need access to a cold-water line, either through a sink cabinet or from the basement.

Getting started

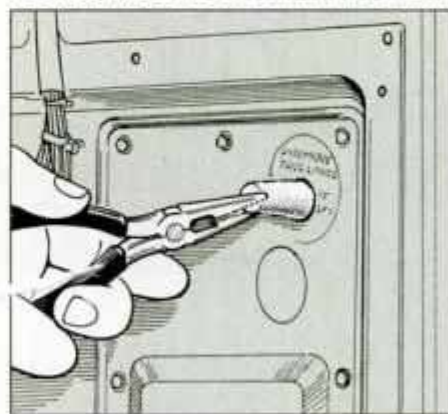
Start by unplugging your refrigerator and pulling it forward. While the icemaker will be mounted in the freezer, most of the work will take



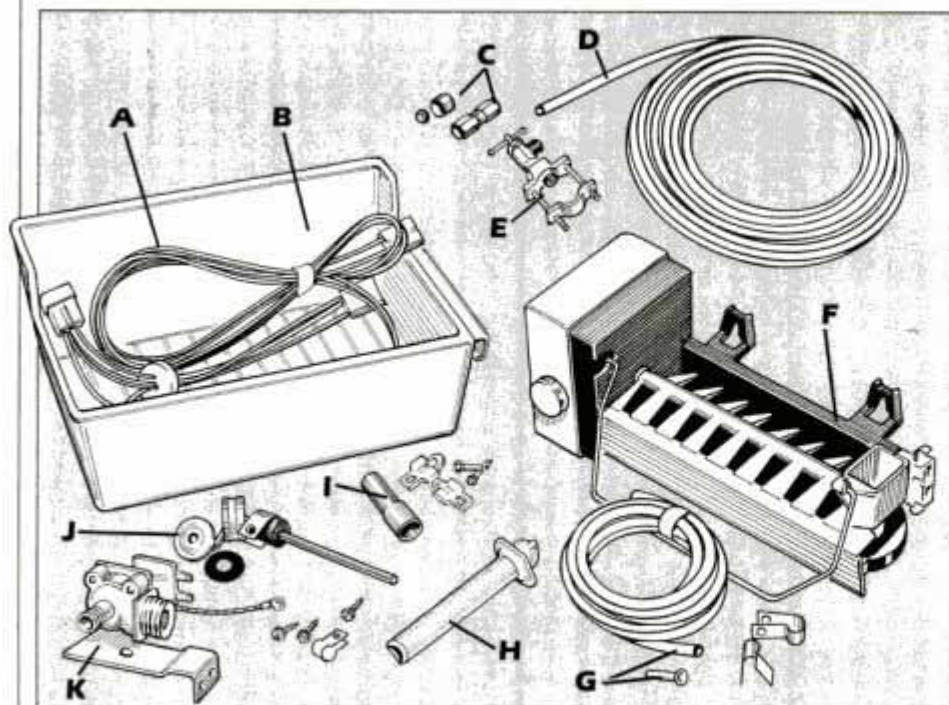
1 Begin by removing the cover plate inside the freezer. Back out the fastening screw, and remove the plate.



2 Remove the access cover at the top of the refrigerator. Use a nut driver to back out the hexhead screws.



3 Peel off the cover on the knockout opening, and use needle-nose pliers to remove the plug of plastic insulation.



The automatic icemaker kit and related hardware: **A**—wiring harness; **B**—ice bin; **C**—coupling; **D**—copper feed line; **E**—saddle-tap valve; **F**—icemaker; **G**—plastic waterline and insert; **H**—water tube; **I**—water-tube extension; **J**—copper inlet tube and **K**—solenoid valve. Unlabeled parts are screws, clips and fittings.

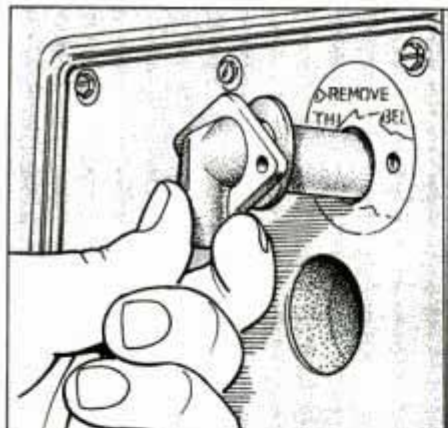
place at the back of the refrigerator.

Next, loosen the screws on the cover plate inside the freezer and drop the plate (Fig. 1).

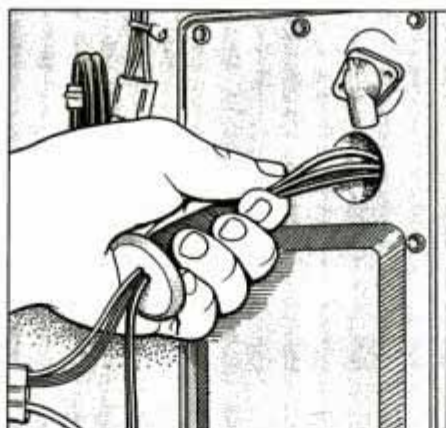
Remove the icemaker access panel on the refrigerator's back and the access panel below it that conceals the compressor (Fig. 2). Behind the icemaker access panel is electrical wiring with a 3-wire electrical slot connector and two knockout openings.

The knockout openings are filled with a precut plastic insulation that is easy to remove. Just peel the paper cover from the opening and pull out the insulation with needle-nose pliers (Fig. 3). Push the water tube through the top opening, and screw the tube's flange to the cabinet (Fig. 4).

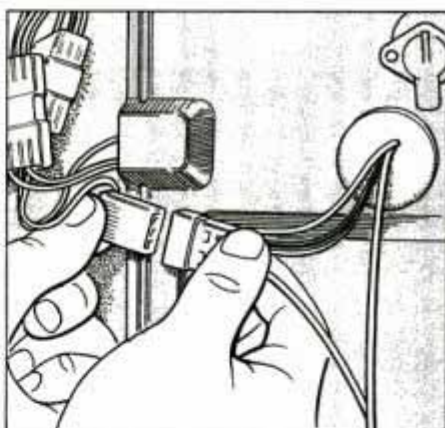
Next, feed the 4-wire end of the wiring harness into the freezer compartment. Push it through the bottom knockout opening, and set its rubber grommet in the opening (Fig. 5). Press the connector on the wiring harness into the equivalent connector that was preinstalled on the refrigerator (Fig. 6). Each slot connector is shaped differently, so there's



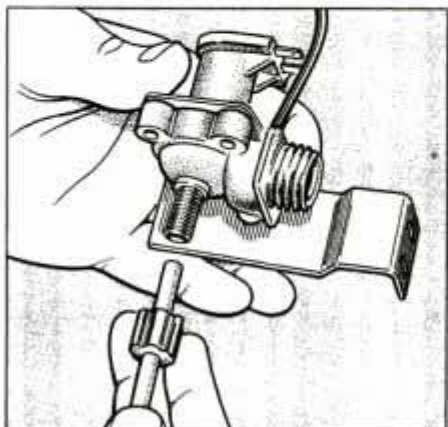
4 Press the water tube through the top knockout opening. Then screw the tube flange to the cabinet.



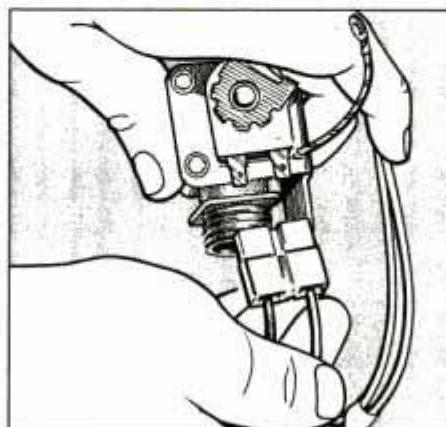
5 Press the 4-wire end of the wiring harness through the bottom knockout. Seat the grommet in the opening.



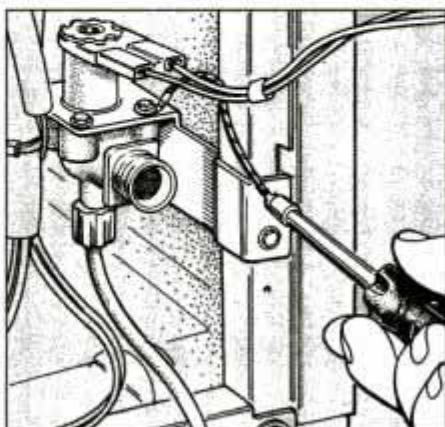
6 Snap the wiring-harness connector to the equivalent connector that was preinstalled on the refrigerator.



7 Place an insert in the plastic waterline, and tighten the line on the solenoid valve with a compression nut.



8 Hold the solenoid valve firmly, and press the wire-harness slot connector onto the brass tabs on the solenoid valve.



9 Screw the solenoid-valve mounting bracket to the cabinet. Fasten the ground wire with one mounting screw.

little chance you'll cross wire the kit.

Next, place a metal insert in one end of the plastic waterline, and push the line into the water-tube inlet port. Hold the line with a band clamp.

Feed the plastic waterline down the refrigerator's back to the compressor compartment. Hold the solenoid valve in place to see how much waterline you need. Put a small loop in the line to prevent it from kinking, and cut the line to length.

Slide a compression nut and ring over one end of the plastic waterline and press a metal insert into the end of the line. The metal insert keeps the line from collapsing as the compression fitting is tightened. Thread the compression nut onto the solenoid valve (Fig. 7). Then, press the remaining wire-harness connector onto the brass solenoid prongs (Fig. 8).

Screw the solenoid valve to the refrigerator cabinet, just inside the compressor compartment. One of these screws will also bind the valve's grounding conductor to the cabinet (Fig. 9).

Next, tuck the plastic waterline

and harness wiring into the panel's recessed channel. Then, install the copper water-inlet tube on the solenoid valve, using slip-jaw pliers to tighten the fitting until it feels snug (Fig. 10). Reinstall the compressor access panel.

Next, connect the copper feed line to the water-inlet tube using a brass compression coupling (Fig. 11). Slide a brass nut and brass ring from the coupling onto the copper inlet tube. Coat the ring with pipe dope or petroleum jelly, and tighten the nut until it feels snug. Repeat the procedure with the second nut and ring on the feed line. Extend the feed line to the nearest cold-water plumbing pipe.

Mount the saddle-tap valve on the cold-water pipe by tightening the two side bolts. Then, trim the feed line to length and connect it to the saddle-tap valve with the remaining compression ring and nut (Fig. 12).

Working inside the freezer

The remaining steps are completed inside the freezer. Begin by sliding the water-tube extension spout onto

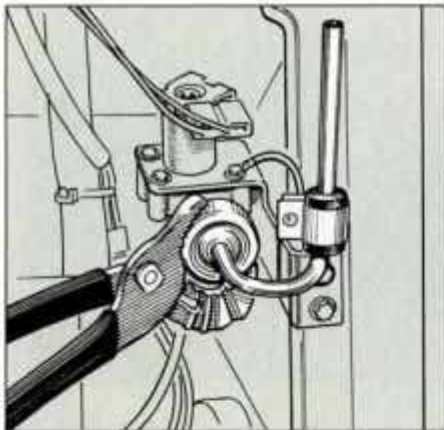
the water tube, so that the spout reaches well into the freezer compartment (Fig. 13). Then, place the icemaker in the compartment and lock the two halves of the electrical connection (Fig. 14).

To mount the icemaker on the freezer wall, pry off the screwhole caps using a putty knife, and screw the icemaker in place (Fig. 15). Then, level the icemaker by adjusting the leveling screw on the underside of the unit. If your kitchen floor slopes noticeably, check the level again after the refrigerator is pushed back.

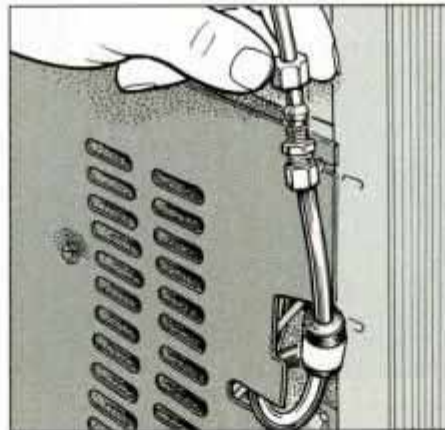
With all the connections made, wash out the ice bin and slide the bin under the icemaker. Replace any shelves you may have removed, and reinstall the remaining access cover.

Next, twist the handle on the saddle-tap valve clockwise, so it pierces the pipe. Open the tap by turning it counterclockwise.

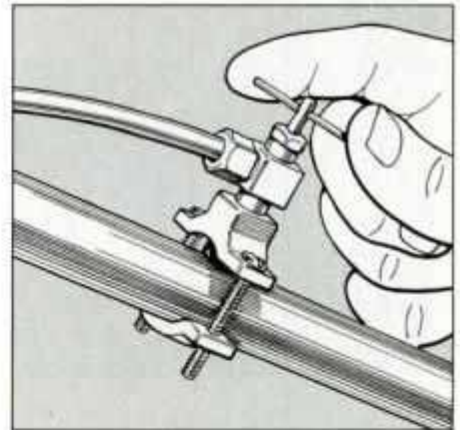
Plug in the refrigerator and slide it back. Set the fill-level knob midway between HIGH and LOW, and allow the icemaker to cycle for 24 hours to purge air from the waterline. **PM**



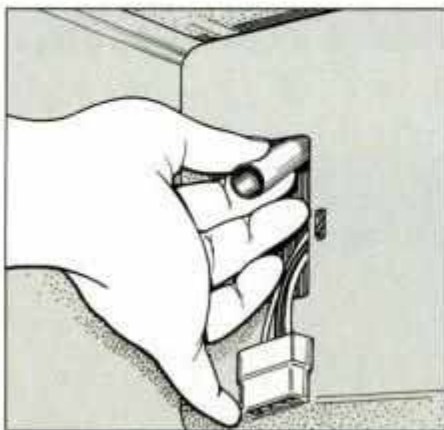
10 Tighten the fitting on the copper water-inlet tube onto the solenoid valve. Screw the tube's clamp to the cabinet.



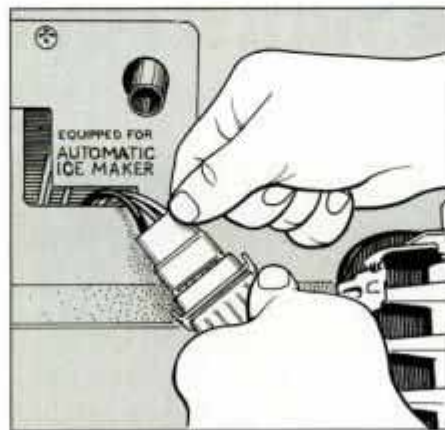
11 Use the brass compression coupling that's included in the kit to join the copper supply line to the copper inlet tube.



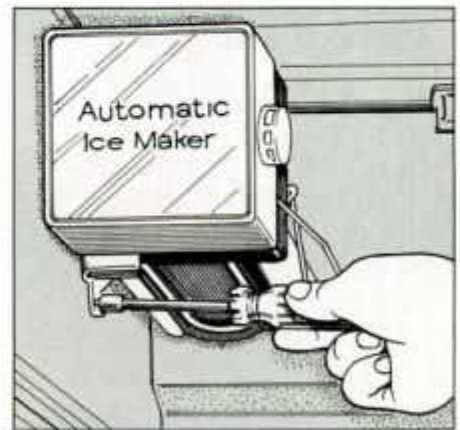
12 Connect the saddle-tap valve to a cold-water pipe, and connect the copper supply line to the valve.



13 Press the water-tube extension spout onto the water tube. The extension should reach well into the freezer.



14 To wire the icemaker, press its slot connector into the connector on the end of the wiring harness.



15 Fasten the icemaker to the wall of the freezer with the three hexhead screws that are provided in the kit.



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CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Dirty Deeds Done Dirt Cheap

I changed the oil and filter in my '89 Cutlass last month myself for the first time. Maybe I never saw it before because I always had this done at the dealer or a quick-lube shop, but I noticed that the oil was already as black as tar in less than 500 miles. So I changed it again, and it's starting to look black again almost immediately. The engine runs fine and still gives me almost 25 mpg in mixed city/country driving.

Should I be concerned? Is there some additive I should be putting in the oil? Is there some particular brand of oil I can use that won't do this?

JOHN ORONON
DUBUQUE, IA

Modern SG- (and now SH-) rated motor oils contain a healthy portion of detergents and dispersants that are intended to keep contaminants suspended in the oil between changes. Particulates that don't stay suspended wind up falling to the bottom of the oil pan as sludge.

Ultimately, these additives are exhausted, or break down chemically as the oil is in service, and are no longer effective. How can you tell if the detergents and dispersants are doing their jobs? One quick test lubrication engineers use is called the blotter spot test. You're supposed to use No. 5 filter paper, but cheap, undyed paper toweling seems to work okay for me.

Drip two or three drops of oil from a warmed-up engine onto the paper. Let the spot dry in the sun or indoors in a warm place for several hours or overnight. The oil will wick out into the paper in a circle from the center.

Fresh, clean oil will leave a spot that has no gradation in coloring. Sludge suspended in the oil will not travel as far as the oil does, leaving a darker spot. The smaller and denser the spot in the center (which



is called the deposit zone), the more sludge the oil is carrying and the closer to the end of its service life the oil is. The color of the oil in the dispersion zone surrounding the sludge should give you some idea of how oxidized the oil is.

For example, an engine that has heavy sludge deposits that gets an oil and filter change would have oil that is not yet heavily oxidized but laden with a lot of particulates from dissolving sludge. This would leave a small, dark deposit zone and a large, almost clear dispersion zone. An engine that had never built up sludge deposits would have a large,

lighter deposit zone. Fresh oil directly from the can would have no deposit zone and a nearly colorless dispersion zone.

How can you tell when the oil is exhausted with this test? You can't. You have to correlate this test with proper oil analysis and establish a baseline. But it will give you a quick idea of what's up.

The Emperor's New Threads

Why does my '83 Caprice have both standard- and metric-size nuts and bolts?

MARTIN LEVINE
BROOKLYN, NY

The auto industry made a wholesale, unannounced changeover to the metric system between 10 and 15 years ago.

Any new vehicles or components since that time are designed to metric dimensions and use metric fasteners. Leftovers, like the venerable small-block V8 engine and much of the structure of your Caprice, still are manufactured to SAE (inch) dimensions and will be until the tooling is replaced.

Assume The Prone Position

The visors on my Chevy ¾ pickup are prone to falling down slowly—right into my line of vision. The dealer says to buy new ones. Other sources are equally as helpful. Any suggestions?

JERRY VILLANE
ALBUQUERQUE, NM

I'll give a generalized answer, which should cover just about anybody's visors, Jerry.

Some visors, particularly those on older vehicles, have a Phillips-head screw right near where the support rod enters the visor. Tighten this screw.

No screw? Feel through the padding or poke carefully into the opening where the rod enters the visor. If the stiffeners in the visor are metal, you can pull the visor off the rod and carefully squeeze with padded pliers to tighten up the fit.

If the interior of the visor is plastic, try working a shim into the gap between the rod and the hole in the visor's internal frame. Careful here—as you might fracture the plastic if you use too thick of a shim.

As a last resort, Velcro the visor to the headliner.

Alcoholic Confusion

In your April '93 issue, you stated that a Flex-Fuel Dodge Spirit gave a higher horsepower rating when burning M85 than it did when burning gasoline, because of the higher octane.

I've always been told that using higher-octane gasoline does not improve horsepower or torque. What's the real story?

D. LITTLETON
DENVER, CO

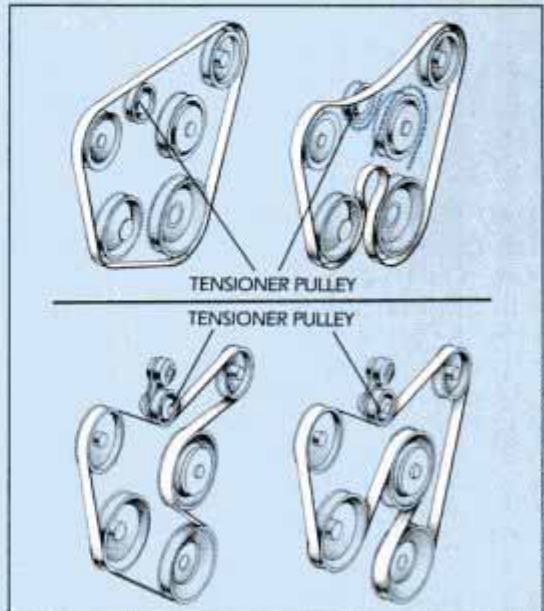
Your classical understanding is essentially correct—once a fuel has a sufficient antiknock rating to prevent detonation, raising the octane

Belts And Suspenders

● We like these newfangled serpentine belts. They're quieter, use less horsepower for better mileage and more power, and will last pretty much the life of the vehicle for most people.

However, life being like it is, sometimes they need to be changed. And of course, this happened to me last week. And, naturally, it was dark and rainy—and the sticker in the engine compartment that illustrates the belt's proper routing was gone.

I got on my way after some head-scratching, and researched the issue the next morning in the comfort of my office. Virtually all of these belts are threaded one of two ways, as you can see in the illustration. Start by draping the belts around the outside of all the pulleys. The belt will fit around the water-pump pulley one of two ways.



rating further will have no positive effect. In fact, the higher the octane, the lower the BTU content of the gasoline, so the effect should be the opposite—but the difference is minor enough in modern gasolines to discount.

There are two phenomena here to explain this. One is that modern cars have knock sensors that will actually delay the ignition timing to prevent detonation. If you feed an engine gas with too low of an octane, the late ignition timing will cost horsepower and efficiency.

In the case of the Flex-Fuel Dodge, however, a different explanation is in order. There's a sensor that tells the engine ECM the proportion of high-octane methanol in the tank. A complex algorithm in the ECM calculates appropriate values for the injector volume and spark timing. These values can be leaner and more advanced than for gasoline because the methanol has a much higher octane rating than even the best gasoline.

When mixtures right near the correct stoichiometric ratio of 14:1 are used, you get more power than if you had to richen up the mixture

slightly to prevent detonation.

Also, alcohol has a very high heat of vaporization—it steals more heat from the intake air as it vaporizes, permitting a cooler, denser mixture for better power.

SERVICE TIPS

● Olds has a new spark plug for 3300 and 3800 of 1992 and later vintage engines that reduces the tendency of the plug boot to permanently bond to the plug's ceramic insulator. Ask for plug No. 41-600 to replace the old R45LT6S.

● Is there a ghostly hand repeatedly locking doors on your '91 or later Chrysler Corp. minivan? There's a revised switch for the sliding door that will also keep the interior lights from flickering and the door chimes from sounding.

● Ford says that overuse of injector cleaning fluids may damage your engine. These potions won't help heavy intake deposits anyway, so they've got a procedure for mechanically removing deposits through the injector port with a science-fiction-sounding gadget called a carbon blaster.

● Some 1990-1991 Geo Storms' headlamps may come on intermittently in the middle of the night. The TSB calls for replacing the turn signal and headlamp switches.

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 West 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.

SATURDAY MECHANIC

TROUBLESHOOTING YOUR ELECTRONIC IGNITION

BY PAUL WEISSLER

● Traffic is backed up six deep behind you at the stop sign, but your car has stalled and simply refuses to start. Twisting the key again only serves one purpose—heating up the already-smoking starter motor even more, which mirrors the steam coming from your ears. Your ignition system has failed.

On many cars, the old no-start diagnosis—check for spark and then

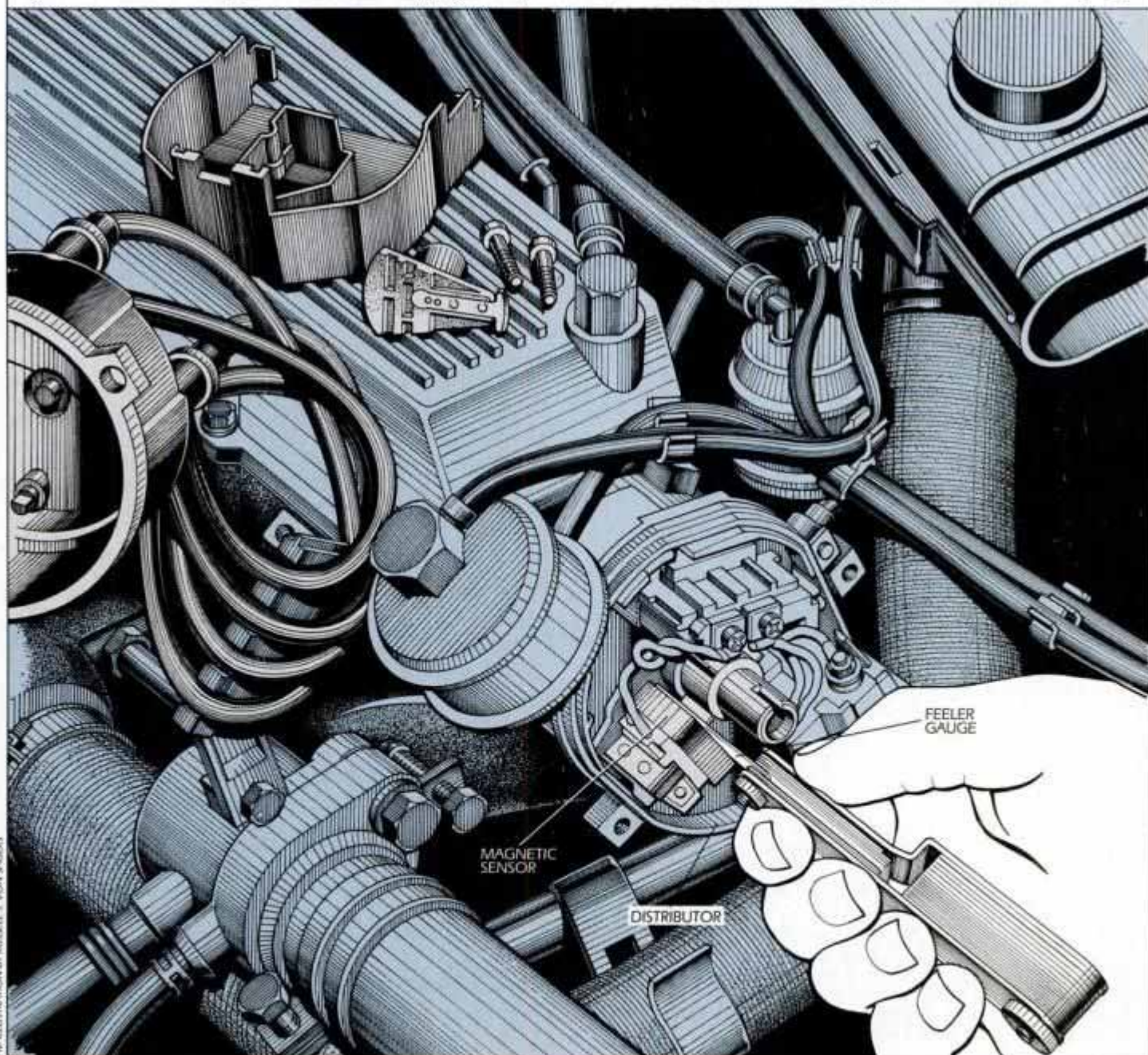
for fuel—may not work. If some computers detect a severe fuel-system problem, they refuse to permit a spark, even if the system is capable of doing so. However, in such cases a trouble code will be set.

So today the opening routine for no-start, hard-start or even misfire and hesitation is always to look for a trouble code (see Saturday Mechanic, page 109, Nov. '92). And because

many computers distinguish between a “hard” (current) failure and one that merely is stored in memory from who knows when, you can see if the code is related to the problem.

When the computer detects a major failure of a sensor, it adopts one of two strategies. If possible, it mere-

Check the gap between the magnetic sensor and trigger wheel using a feeler gauge.



TM ILLUSTRATION BY RUSSELL J. VONHAGEN

ly substitutes an average value for the missing sensor signal and uses other sensors to guide its decisions. The results may be so good, you just think that performance is off a bit.

However, if it can't, or if the failure may significantly increase engine emissions, the computer will go into a "limp-home" mode. The engine keeps running but obviously poorly. The CHECK ENGINE light goes on, and if you shine a timing light on the timing marks, you'll see very little or no change in the number of degrees of ignition advance, even if you rev the engine way up.

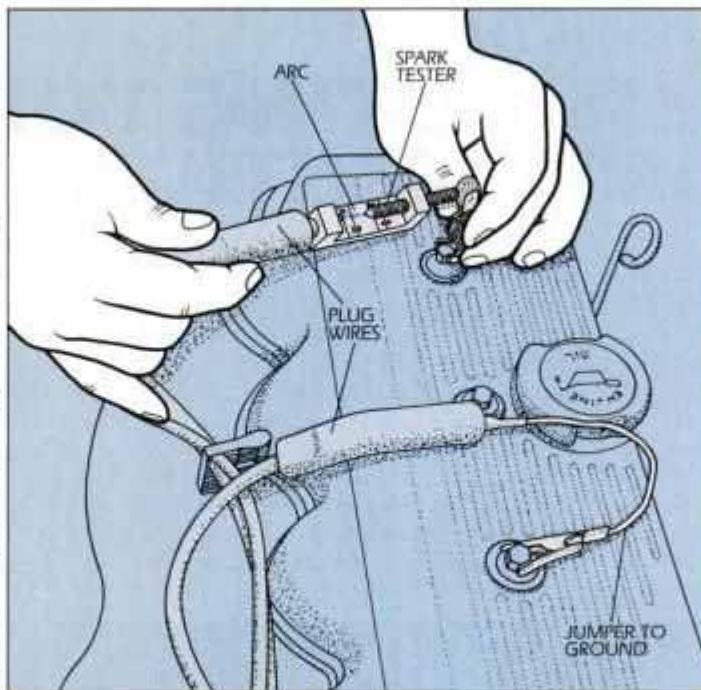
The computer does not monitor the ignition secondary circuit—spark plugs, wires, distributor cap, rotor, etc.—and in fact, can detect only some failures in the ignition primary circuit (the low-voltage part of the system), such as a very badly shorted or opened circuit. The computer also knows if it doesn't receive a signal from an electronic ignition module on engines with a distributor. For problems such as these, the computer can set a trouble code.

If you don't find a code, check for spark. And the best way to do it on today's systems is one spark plug wire at a time with a low-cost spark tester. The best plug testers have adjustable gaps so you can set them for the peak voltage of a particular system.

No spark? Or is there a weak or intermittent spark? The problem has to be in the ignition system itself, beyond the diagnostic capability of the computer.

With a distributor

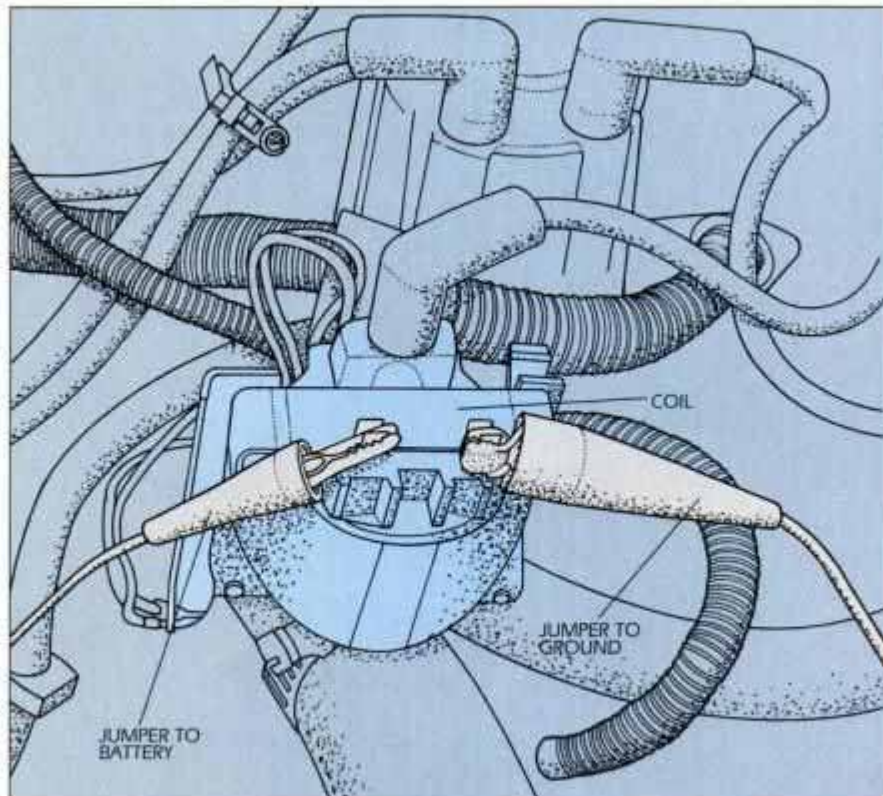
If the engine has a distributor, it also has a single ignition coil, a sensor called a pickup coil in the distributor, a distributor cap and ro-



Most distributorless ignitions require that you ground the other plug lead from the same coil to check for spark.

tor and an electronic module—either on the distributor or elsewhere in the engine compartment.

The first place to check, even for no spark at the plugs, is inside the distributor cap. Electronic ignition produces high voltage, and high voltage arcing around is something like a lightning storm in that tiny area.



Check the coil on distributor-type ignitions by bypassing the electronics completely. See text and the next illustration on page 75.

Look for corroded electrical contacts and any physical deterioration, particularly cracks around any mounting screws and contacts. If you find anything suspicious, replace the part. Don't forget the insides of the spark-plug wire terminals in your search for corrosion and carbon tracks.

Check each plug wire for resistance with an ohmmeter, and replace it if it's over manufacturer's specifications.

Next, test the ignition coil. The simplest way is to unplug the wiring connector from the coil and make a coil tester from jumper wires and a set of breaker points with an integral condenser, which you can get for a few dollars from an auto parts store. Connect one jumper from the bat-

tery's positive terminal to the coil positive, and a second jumper from the coil negative to the terminal on the breaker-points assembly. Ground the plate of the breaker points, and flick open the breaker points with a screwdriver. You should see a spark jump a 1/2-in. gap in the spark tester. If there's no spark, the coil is defective.

If the distributor cap, rotor and wires pass inspection and the ignition coil passes this test, go to the ignition primary circuit to continue diagnosis of a no-spark or intermittent spark problem.

Where the system has a simple electromagnetic pickup, there's generally a resistance test you can make across the pickup's wiring terminals. And if resistance is outside specs, the pickup is defective. This design usually has a trigger wheel with teeth.

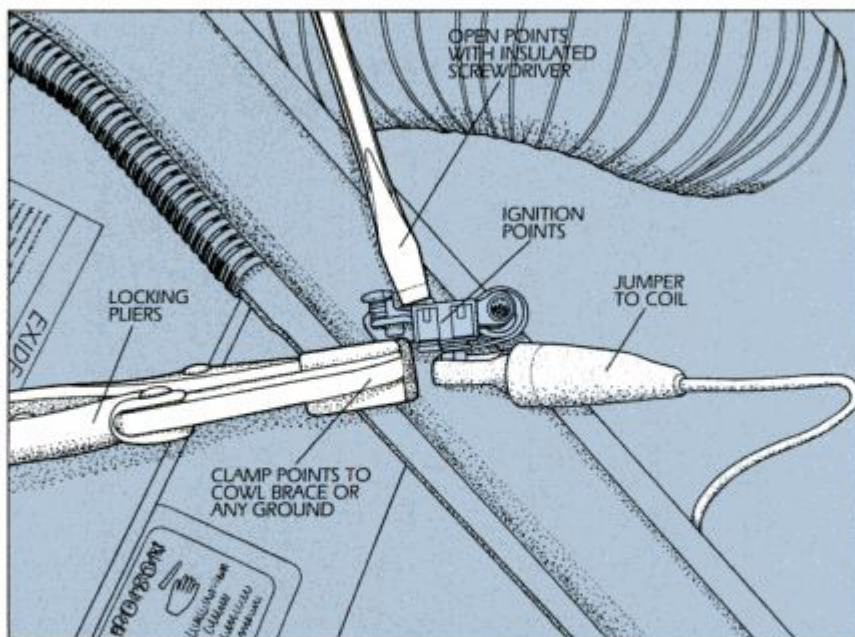
However, more distributors today use a Hall-effect switch, which has a trigger wheel with

shutter blades that pass through a U-shaped part (the Hall switch) and produce a sharp voltage change that signals the electronics.

The typical Hall switch has three wires: one to the ignition coil, one to provide a signal to the engine computer or ignition module and a third to the ground (which also may be to the computer). Check the wiring diagram, unplug the wiring from the Hall switch and hot-wire the switch to the battery (coil terminal to battery positive and ground to battery

negative, a voltmeter positive lead to the signal terminal and the negative lead to ground). If a shutter blade from the trigger wheel is in the Hall-switch gap, the voltmeter should read close to battery voltage. Remove the trigger wheel, and it should drop to 1 volt or less.

A simpler check when there's no spark on Chrysler engines is to connect the ignition-coil wire to the spark tester and ground the tester. Unplug the wiring connector from the Hall switch and, with the ignition on, connect a jumper wire across ter-



Use a spare set of old-style ignition points to switch the ground to the coil while performing tests. Just clamp the points someplace handy that's grounded.

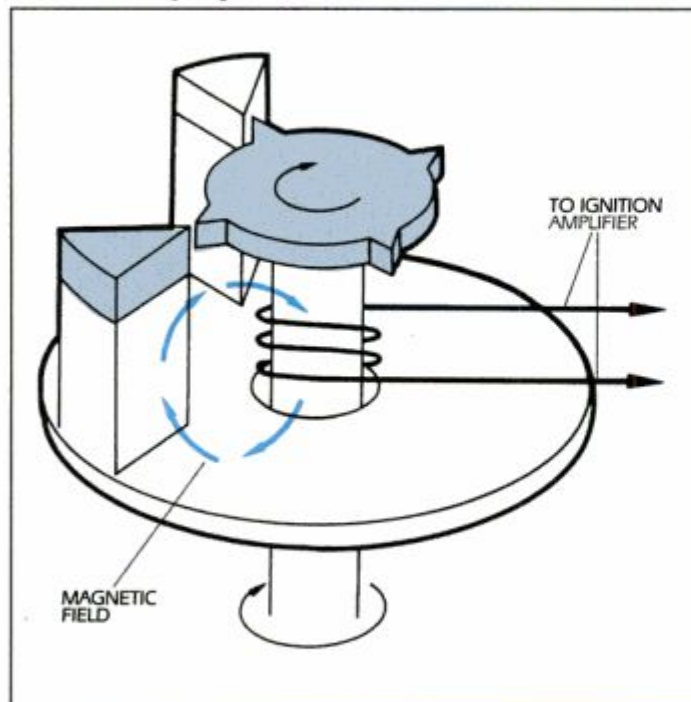
minals 2 and 3 of the harness. If there's now a solid spark, replace the Hall switch.

On Ford products with the Electronic Engine Control IV computer, there's a small ignition module (either on the distributor, or remotely mounted and connected to it). To test the pickup and ignition module, probe the tach terminal of the ignition coil with a grounded test light, crank the engine and the light should flicker brightly. If it doesn't, make a second check with a voltmeter set on AC scale. Connect the voltmeter to

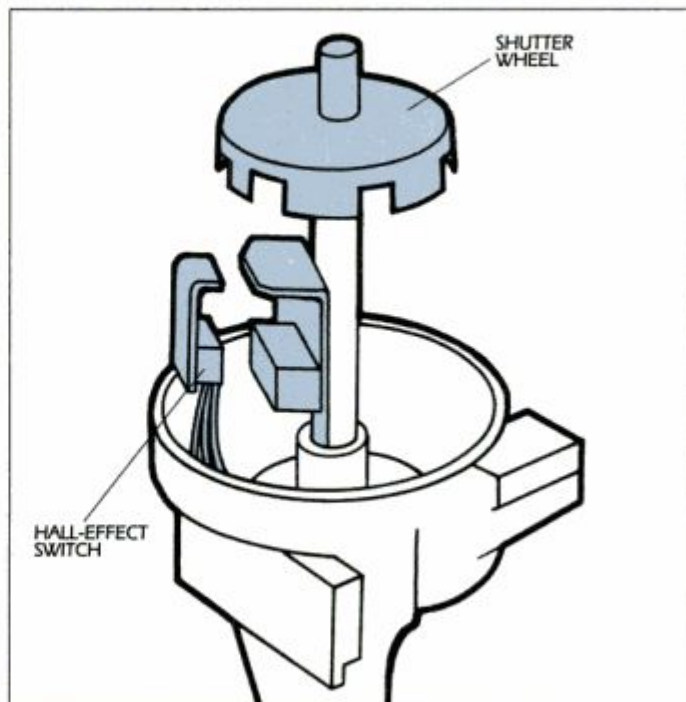
the ignition module's pickup terminal and ground (refer to the circuit diagram). With the engine cranking, it should read between 3.0 and 8.5 volts, if the pickup is good. Normally, when the test light fails to flash, the cause is a bad ignition module, particularly the type mounted on the distributor, but it takes a special tester (more expensive than substituting a module) to be sure. If the Hall pickup looks physically good, try a new module.

Although there are electronic ignition testers that really check out the ignition module, they're professional quality (\$) equipment. You generally can't return electronic parts once you walk out of the store. It's usually still more cost-effective to check the coil, harness wiring and pickup, and if they're good, replace the ignition module if there's no spark or intermittent spark.

Occasionally, you can confirm that a module is the problem if the loss of spark is on a hot restart. Restart the engine when it's cool, then apply heat to the area of the module with a hair



Electromagnetic distributor sensor uses a steel paddle wheel to generate the timing signal for the computer.



Solid-state Hall-effect sensor switches on and off the voltage signal from the engine computer with a metal shutter.

dryer set on high, and if the engine starts misfiring shortly, that's a reasonably solid indication of a defective module.

Whenever you replace an ignition module, whether it's on a domestic or imported car, and the module rests on a flat surface, always apply a thick coat of silicone dielectric grease to the base. It improves heat transfer from the module, so it runs cooler.

Distributorless Ignition

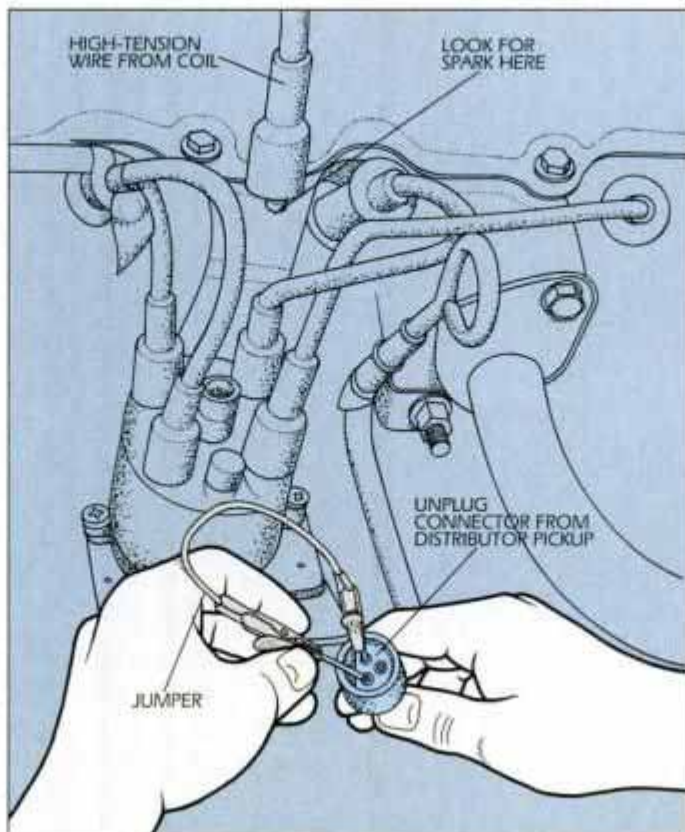
Although there's no distributor cap to inspect, most distributorless ignition systems still have spark plug wires. The wires connect into double-end ignition coils, each lead feeding a separate spark plug—one firing near TDC exhaust and the other near TDC compression. Because the plug to the cylinder on the exhaust stroke should draw virtually no voltage, almost full voltage should go to the one on compression. However, if the plug on exhaust is badly worn, it may draw enough voltage to cause the plug on compression to misfire. So the plug wire that is misfiring in your spark tester may not be in the problem area.

Always begin by unplugging the wires at the coil to inspect for corro-

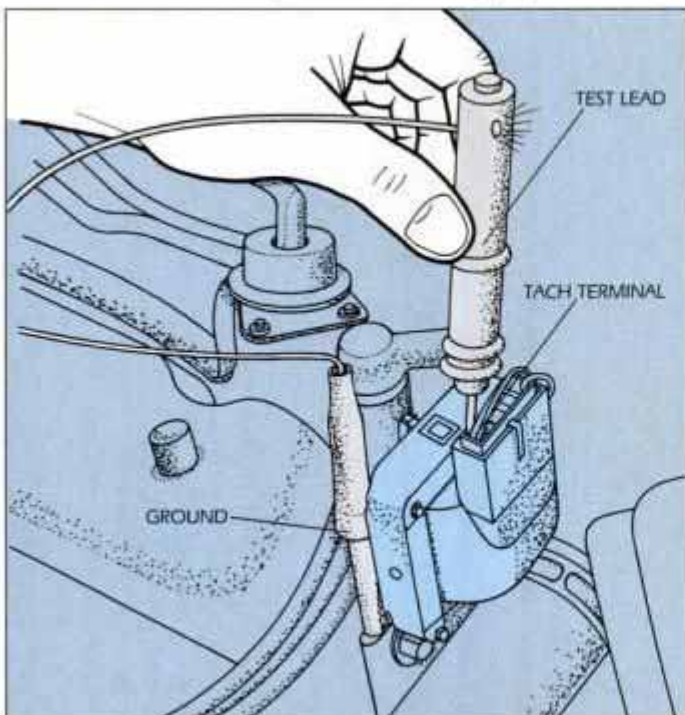
sion, cracks or carbon tracks inside the terminal.

To double-check what seems to be a misfiring plug wire, first ground the wire on the opposite end of the coil with a jumper wire, and if the plug now fires, remove the opposite

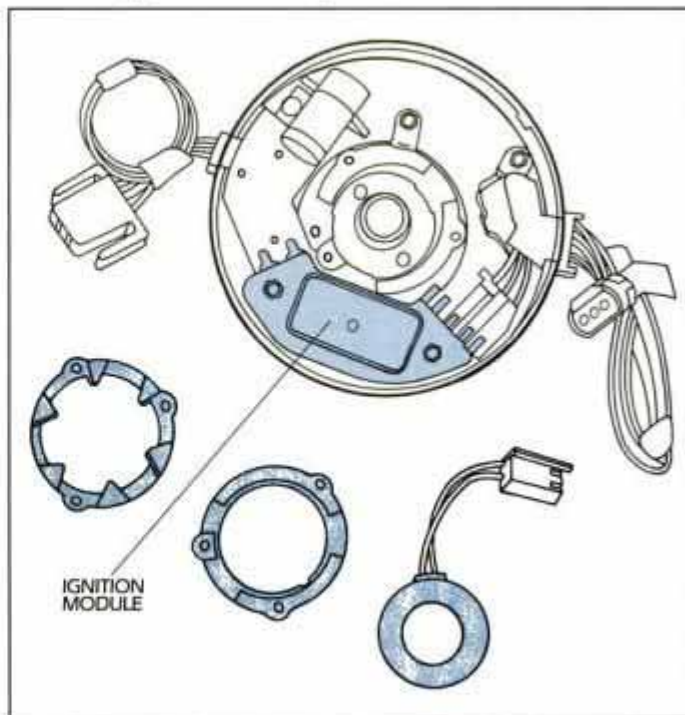
duplicate or eliminate an intermittent misfire, wiggle the wiring connector on the sensor, and if the problem is affected one way or the other, inspect the connector and wiring. If they're good, the sensor apparently is the problem.



Test some ignition systems by shorting across the sensor terminals in the harness and checking for spark at the coil wire.



On Fords, a test light on the tach terminal should flash when cranking over the engine, if the sensor is working.



Use special heat-conductive grease under the replacement ignition module to ensure adequate cooling.

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The second-generation BF Goodrich Comp T/A HR4 is an H-speed-rated (130 mph), all-season radial tire. The new Comp features a unique tread pattern, which the maker credits with the tire's reduced noise level, improved tread life and high-speed traction over the original. The new computer-designed tread pattern features many small grooves placed in the intermediate ribs

of the tread, with one groove bisecting each tread block. Available in 10 sizes, ranging from P185/55R13 up to P225/70R15, prices vary from about \$75 to \$95. Contact BF Goodrich Tires, 600 S. Main St., Akron, OH 44397; (216) 374-3796.



Animal Alert

To help scare wild animals from your path, Winner International has introduced an electronic warning—the Animal Lover. The device emits a warbling, high-pitched sound heard by animals but inaudible to humans. Powered by the vehicle's electrical system, the Animal Lover projects its warning in a 38° cone-shaped pattern up to 250 ft. in front of the vehicle. The unit consists of an ultrasonic transducer, a control unit and wiring. Price is \$59.95. Contact Winner International, 32 W. State St., Sharon, PA 16146; (800) 527-3345 (outside of Pennsylvania).



D-I-Y Exhaust Analyzer

When tuning your engine these days, most of us tend to be more concerned with the level of the various harmful emissions in the exhaust than we are with such things as distributor dwell angle. Therefore, an exhaust-gas analyzer, like this inexpensive unit, the Gastester Professional, would be helpful to many Saturday mechanics. However, unlike the sophisti-

cated and prohibitively expensive 4-gas analyzers used in well-equipped shops, this unit is only able to measure the level of carbon monoxide in the exhaust. The unit's digital display also gives readouts for engine speed (two rpm ranges), volts and, of course, the ever-present dwell. The Gastester Professional costs \$199.95 (plus \$6 shipping), from Auto Expert Products, P.O. Box 811891, Boca Raton, FL 33481; (800) 795-6958.



Tire Iron Leverage

The wrong time to find out that the lug nuts on your car or truck are frozen is when you have a flat tire. To help give you the needed leverage to break those nuts loose, without having to stand or jump up and down dangerously on the lug-nut wrench, you could use an extension on your wrench. The NutPOPPER from Millennial is a 24-in.-long handle which slips over the end of any lug-nut wrench up to 1½-in. in diameter. The NutPOPPER costs \$19.95 (plus \$4 shipping), from Millennial Marketing, Dept. PM, P.O. Box 2123, Lee's Summit, MO 64063. **PM**

Coil Wire Lock

If the secondary ignition wire falls out of the top of the ignition coil, the engine stops. To help keep the wire tightly connected, MSD Ignition has developed a Coil Wire Retainer. The top of the retainer covers the ignition wire, and the bottom portion snaps around the coil itself. A wire tie locks it all into place. A spacer ring is included to accommodate ignition coils with shorter wire towers. The Coil Wire Retainer costs \$16.35, from MSD Ignition, 1490 Henry Brennan Dr., El Paso, TX 79936; (915) 857-5200.



LONG BEACH BLUES

BY JEREMY SHAW



● Looking at the results alone, it's easy to conclude that the Toyota Grand Prix of Long Beach was a near-disaster for Team PM and Dick Simon Racing. Raul Boesel led the way for the 3-car contingent with a 12th-place finish—and one IndyCar World Series championship point—even though his Duracell/Mobil 1/Sadia Lola/Ford-Cosworth XB quit with just over two laps to go.

Scott Brayton's Amway/Northwest Airlines Lola-Ford lasted only 20 laps before the transmission packed up, and Jimmy Vasser came back from a crash during practice only to suffer engine failure in his Kodalux/STP Lola-Chevy/A.

But the bare results, of course, don't tell the full story. When Boesel's electrical system stopped dead, he was running a strong third, with

no challengers on his heels. With just a little luck, he might have headed off for Indianapolis at the top of the IndyCar points standings.

And the subtle lesson that emerged is that Dick Simon Racing is as good as the best when it comes to setting up a car for a particular track. With the wide variety of IndyCar venues—short ovals, long ovals, street circuits, road courses—and the short practice time available at most of them, this is a critical art. The adjustments are myriad—wings, springs, shocks, camber, toe-in, toe-out, chassis rake, even tire pressures—and the changes produced by even the tiniest of adjustments are frequently dramatic.

For Long Beach, Simon's crew was able to draw on information gained during the season opener.

"The setup for Long Beach was very similar to what we ran in the first race in Australia," said Boesel. "Both tracks have very long straights, so you need to be fast on the straights and you have to compromise the car in the corners."

This meant running a relatively low-downforce aerodynamic configuration—reducing straightaway drag—and getting the cars to stick in the corners with chassis adjustments. A new multiaadjustable shock absorber helped this process, eliminating shock-absorber changes from the adjustment process.

Boesel and race engineer Julian Robertson quickly got the Lola in among the leaders during practice at Long Beach, recording the fourth-fastest time in both sessions. Gearbox and electrical problems spoiled Boesel's qualifying run, but his race was smooth and determined—until the car simply stopped running.

"I think I drove one of those perfect races," he said. "I didn't miss a gear, I didn't put a wheel wrong. I couldn't believe it when the thing just quit with two laps to go.

"It turned out all the wiring was completely melted."

Though disappointed, Boesel still kept a positive perspective.

"I was encouraged that we were competitive," he said. "If we had finished third, we would have been going to Indianapolis leading the championship.

"But that's behind us. There's nothing we can do except continue to work hard, do the best job we can. We have a good team right now. I think we can do well this season."

As Indy would show, this was an understatement. **PM**



Transmission problems put Scott Brayton out early at Long Beach. Jimmy Vasser charged hard until his engine let go at mid-race.

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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



1995 S10 Blazer

● This Suburban lookalike is the 1995 Chevy S10 Blazer in full showroom trim. The front end is a duplicate of the 1994 S10 pickup, while the passenger section is a smaller version of Suburban styling. The small Blazer will continue the body-and-frame construction, which permits trailer towing limits of 6000 pounds.

Engines will range up to 4.3-liter V6s, and transmissions will be either 5-speed manuals or 4-speed automatics. Two airbags for front-seat tenants are a must for new vehicles nowadays, and you'll see them in the baby Blazer.

Neon

Plymouth's 1994 Neon will look like this in its showroom attire. Beneath its cab-forward front end will be a 16-valve 2-liter 4-cylinder engine. Neon's sub-2500-pound curb weight will contribute to sub-9-second 0-to-60-mph times, and will result in 30-mpg fuel economy. Neon will be sold by Plymouth and Dodge dealers under the Neon name.

Look for the 4-door Neon to be on

the streets this December, with a 2-door version slated for the 1995 model year. Neons will compete in the subcompact market against the Ford Escort, Chevrolet Corsica and small imports.



Look for Neons to carry both Dodge and Plymouth nameplates, beginning this fall.

Half A Riv

Here's a glimpse of the rear two-thirds of the 1995 Buick Riviera. Spotted in a parking lot, this snatch photo reveals that Buick will offer a completely new design in 1995, with a styling emphasis on sleek, soft body lines. Riviera will use a new "G" body that it will share with the 4-door Olds Aurora. But unlike Olds, Buick will continue to offer a V6 in the



Riviera, with supercharging still as an option. Dimensions will be longer and wider—a 113.8-in. wheelbase (versus 108 today) and an overall length of 205.4 in. (versus 198.3). Track will be widened almost 3 in. to 62.5 in. front, 62.6 in. rear.

Mercedes' U.S. Sport/Ute

Mercedes-Benz has lots of reasons for building its lower-priced sport/utility vehicle in the U.S. instead of in Germany. It will cost less, for one. And, Mercedes can avoid the import taxes that hamper Japanese sport/utility vehicle sales in this country. It plans to sell only about 20,000 a year of the new vehicle at a price in the \$25,000-\$35,000 range. The other 40,000 will be exported—some back to Europe. Mercedes says that the content will be 70% U.S., with the major import being a Mercedes engine.

Balloon Valves

Throw out the doors, hinges, electrical lines and many of the controls used in a/c and heating systems. DuPont and a company called Enterzone Automotive are developing inflatable, balloon-like valves that will open and close air passages. They will replace the doors, hinges and other air-deflecting systems. Simpler, lighter and more reliable, the inflatable valves could be ready within three years.



Disguise fails to hide the sleek lines of the 1995 Buick Riviera.

Other Neons

Lincoln will be among the first to use neon lights. The Mark VIII is set to display its taillights in neon color. Look for this change in the 1995 model when a slight facelift is planned. Neon lights can take on brighter colors, light up more quickly and, best of all, fit the contours of the body surface more easily. Among the imports, the Honda Accord is also ready with neon taillights. Neon lights are expensive, from three to five times more costly to build than today's taillights.

Cheaper Bags

Automotive companies are paying more than \$800 to put two airbags in your car. But new packaging and more precise designs will cut that cost in half. Look for airbag systems to become smaller, especially those in steering wheels. More precise deployment will cut down on wasted materials and reduce the size of the inflator.

Submarine Menace

A major safety problem occurs when passengers submarine under airbags. Passengers lose the cushioning effect and, instead, crunch against the firewall. One solution is to project a kneeboard outward at the same time that the airbag inflates. The kneeboard holds the passenger's legs in place, allowing the upper torso and head to swing forward into the bag. Why not build in a permanent kneeboard? That's being tried. But passengers want more space. They feel cramped when the instrument panel is built too far outward.

Skinny Rears

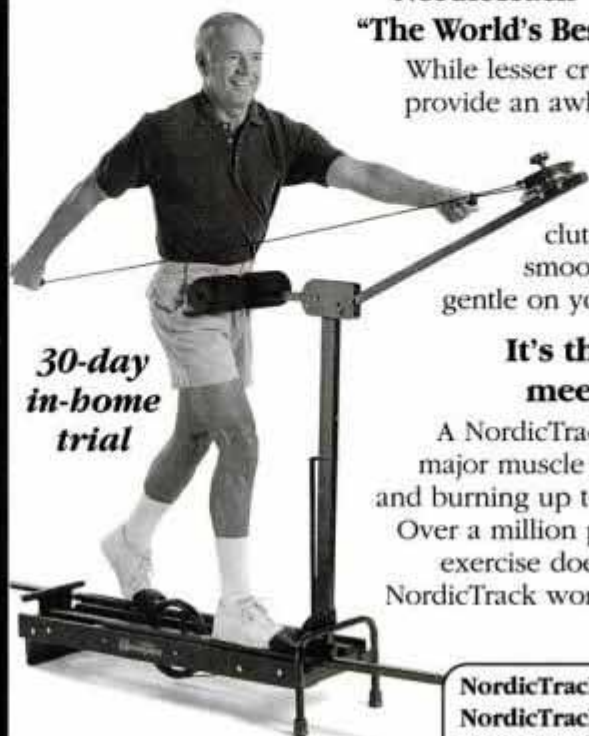
Recent styling trends show a narrowing shape at the rear end of cars. Rear fenders bend inward toward the rear bumper. At the same time, trunklids are set higher. Look at the Oldsmobile Aurora and Buick Riviera rear designs. Olds engineers say they get much better aerodynamic results when the body narrows in this manner. The higher trunklid also aids aero, and together both features improve fuel economy slightly.

Shark Fins

Put this term into your automobile thesaurus. Shark fin is the name for those little metal triangles you see in door windows. They cover up gaps where glass doesn't fit easily. You see them at the front lower corners of front-door glass and at the rear corners of rear doors. GM designers say they also cut down on wind noise, making car interiors quieter. **PM**

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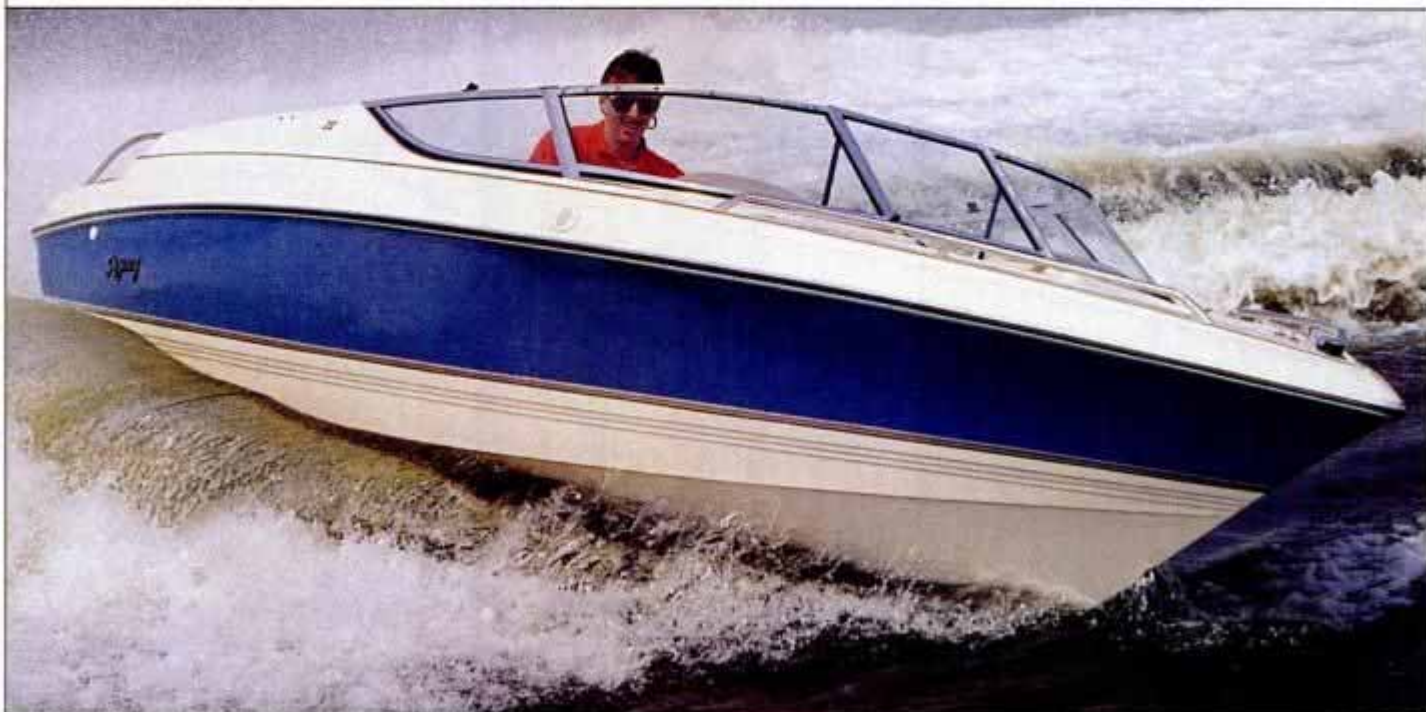
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LONG-TERM BOAT TEST

SUNBIRD REGENCY 210 QR

BY JOE SKORUPA, Boating/Outdoors Editor



● Sometimes I forget that not everyone reads PM. This point was driven home to me recently during a boating expedition off Sandy Hook, New Jersey. I pulled into the Atlantic Highlands Marina for gas, lifted the engine cover to access the fuel fill and was surprised by the number of curious onlookers who'd never before seen an outboard engine mounted inside an enclosed compartment. The boat I was driving was a Sunbird Regency 210 QR (Quiet Rider).

I was surprised about this because PM has covered OMC's innovative Quiet Rider drive system several times since its mid-model-year unveiling in 1991. We even gave it a prestigious Design & Engineering Award in 1992. So why all the fuss?

Well, to be honest, the Quiet Rider is unique in the industry, so much so that only four models use it—the Regency 210 QR and Eurosport 1910 QR both made by Sunbird, the Chris-Craft 194 QR and the Lowe Silhouette 2200 deckboat. Due to the success of these Quiet Rider boats, you can expect to see several others appearing in 1994 model lines.

Despite giving the Quiet Rider several test workouts, I felt it was important to spend some time with it to see if OMC's radical concept truly

held up over the long haul. With that in mind, I arranged to get a Quiet Rider-equipped Sunbird last summer for a long-term test. The Columbia, South Carolina-based boatbuilder provided me with one of the first Regency 210 bowriders to come off the assembly line. I accepted delivery of the boat around the Fourth of July and returned it just after Labor Day. In between, I logged about 50 hours of diverse boat-riding time, which is considered to be the average annual use of a seasonal boat by a typical owner.

For those unfamiliar with the Quiet Rider drive, such as the onlookers I encountered at the fuel dock, the



Non-glare helm has good sightlines for instruments and easy access to controls.

drive system turns outboard powerboating outside in. Instead of hanging off the end of the transom, the Quiet Rider integrates the motor into the structure of the boat and hides it under an engine cover.

To achieve this radical departure from standard outboard technology, OMC helped Sunbird redesign the aft end of the boat without a stress-bearing transom. That's right, QR boats have no transom—not at least in the traditional sense.

To accommodate the Quiet Rider's innovative trim and tilt mechanism, the Regency has a split transom and its motor is mounted on a pair of horizontal aluminum support tubes, which are in turn fixed to a pair of pivoting brackets. The brackets pivot by means of a hydraulic servo, and thereby raise or lower the motor.

As noted, the heart of the Quiet Rider drive is an outboard motor mounted inside an enclosed engine compartment. To get the outboard to work in this compartment and to enable the boat to have a pleasing profile, OMC and Sunbird had to make sure the engine pivoted in its own radius. The innovative tilt/trim system (with its pivoting brackets) makes this happen, as does a modified powerhead cover, which has a spheri-

cal shape. The only other modification made to the stock outboard is the addition of an intake hose to feed air to the engine through a vent on the side of the boat.

The first thing you notice about the sleek outward appearance of the Regency is that everything is gracefully curvilinear. As mentioned, a major goal of the designers was to make sure the boat's profile was pleasing, and they clearly succeeded. Much like a sterndrive boat, the aft end of the Regency flows smoothly from a rear bench seat and finishes with a split swim platform. The engine and drive leg are completely hidden. To access the engine, you simply open two latches while standing in the cockpit and lift the engine cover.

Of course, there's much more to the Regency 210 QR than an interesting engine arrangement. After my initial fascination with the design and structural integration of the Quiet Rider passed, I began to notice the Regency for what it was—a deluxe, comfortable, spacious bowrider that's ideal for cruising, skiing, swimming and doing just about anything on the water.

The well-behaved hull quickly pops up on plane and carves turns crisply with little heel. Top speed with two persons aboard is a brisk 51 mph, which is more than fast enough for skiing and thrills.

Interestingly, the loudest noise you hear at or near top speed isn't the roar of the engine but the wind. There is a reason that the people at OMC named this propulsion system the Quiet Rider, and this is it. The noise damping becomes truly evident when you push down the throttle. At top speed, noise in the cockpit registered a respectable 84 dBA, which is about 20 decibels lower than a typical outboard installation and about 5 decibels lower than a comparable sterndrive.

While much of the sound damping is due to the engine cover, this doesn't tell the whole story, especially since the engine isn't completely sealed. The transom slot is open on the aft end, which enables the ignition and fuel lines to be located outside the boat like a typical outboard. This is important because it eliminates the need for the air-ventilation fan required in sterndrives.

What gives the drive system its characteristic quietness is the fact that



That's right, there's an outboard in the box—a compact but powerful 150-hp unit.

the engine is fastened not to the hull of the boat (as it is in transom-mounted installations), but to the stringers. Veteran boatmen know that a great deal of engine noise heard in the cockpit is actually vibration transmitted and amplified by the hull. Since the Quiet Rider attaches directly to the stringers, these sounds are greatly reduced.

Inside the carpeted cockpit, the Regency features a deep, reassuring freeboard. Seating is copious. In addition to a small bow seating area, there's a large U-shaped bench seat aft and two adjustable, swiveling bucket seats behind the split consoles. The boat accommodates up to seven passengers, something I tested more than once.

Like all Sunbird models, the Re-

Sunbird Regency 210 QR

Overall length	20' 9"
Beam	7' 9"
Draft	2' 2"
Deadrise	18°
Weight	2534 lb.
Fuel capacity	42 gal.
Engine	OMC 150 QR
Block/Displacement	V6/158 cu. in.
Horsepower	150
Prop	14.25" x 21" SS
Price	\$16,900

Sunbird Boat Co., 2348 Shop Rd., Columbia, SC 29201; (803) 799-1125



Eurostyle stern and copious seating characterize the deluxe Regency.

gency 210 comes with a long list of standard features, including full instrumentation, a radio/cassette player, a protective cover, a 5-year hull warranty, a trailer and too many others to list. Suffice it to say that the Regency is loaded. In addition, like all other boats in this company's line, the Regency 210 is a one-price-buys-all package boat. The sticker at test time was \$16,900, which represents sound value for such a sweet-running 20-ft. runabout.

It's easy to see why OMC would want to promote the Quiet Rider drive system. OMC is the world's largest outboard builder, and the Quiet Rider gives the company another outlet for its core product.

But why should boaters welcome this new technology? Is there something wrong with sterndrives? The short answer is, no. Stern drives are perfectly reliable and efficient drive systems. But outboards have certain advantages. The first that comes to mind is power-to-weight ratio. The typical outboard weighs about half as much as a comparable sterndrive, and in a 20-ft. boat, this kind of weight difference can have a big impact. Compactness and ease of maintenance are two other benefits that come to mind.

I did most of my boating last season in the protected waters off the Jersey shore, however, on calm days I went around Sandy Hook and ventured into the Atlantic. The interesting thing about this kind of adventure, especially in the Sea Bright area, is that it takes about a 15-mile run to go around a land mass you can walk across in less than 2 minutes.

While this is unusual duty for a freshwater-oriented boat, the Regency handled the salt spray and moderate ocean swells like an old sea dog. One day the wind picked up unexpectedly and the Regency banged through the chop, but it stayed fairly dry and delivered captain and crew safely ashore with only mild discomfort.

Two years ago, with the appearance of the first Quiet Rider model, I predicted that the conservative boating market would warm up to this new innovation and adopt it as one of its own. Today, there are four hot-selling models on the market. It's an idea that's time has come, and the Regency 210 makes good use of it.

PM

NEW CARS



Acura Renews The Integra Lineup

• If one of the primary objectives of auto styling is to make the current model look dated, the team that penned the new Acura Integra has succeeded better than most. With its rounded front end, projector-beam headlamps and sporty Coke-bottle shape, the '94 Integra has a thoroughly contemporary appearance, inside and out. And sure enough, the '93 Integra looks older in contrast.

It also *feels* older, thanks to the extensive chassis-stiffening efforts that went into the new car. Reduced chassis flex allowed more latitude for tuning the double-wishbone suspension, which led to substantial revisions to the shock absorbers, springs, bushings and control arms, as well as the steering.

Honda chose to reduce the Integra's spring rates, for improved ride quality, with higher shock damping rates and antiroll bars fore and aft to provide better handling precision. Control of rear-wheel toe change is enhanced by a new high-rigidity bearing that resists deflection, and the new steering system varies assist on the basis of engine rpm and the amount of torque generated between the pavement and the tire.

Although the new Integra's legroom is about the same as the current car, interior appearance is improved, with a new instrument panel and front seats that are far more supportive. Dual airbags are standard, and Honda has improved the Integra's side-impact protection



New dashboard, seats and 170-hp 1.8-liter dohc 16-valve VTEC distinguish new Integra GS-R.

by the addition of polypropylene pads integrated into the door panels. Antilock brakes are standard in two of the Integra's three trim levels—LS and GS-R—although even the basic RS editions have 4-wheel discs.

Acura has rationalized the lineup somewhat by having just three trim levels for the two body styles. Aside from heftier front and rear antiroll bars and a slightly more aggressive wheel/tire package, the big difference between a GS-R and the other Integras is in the engine bay. RS and LS models get a modestly refined version of the current base engine—a 1.8-liter dohc 16-valve with 142 hp and 127 ft.-lb. of torque.

The GS-R's new engine is also

1.8 liters with twin cams and 16 valves, but that's where the similarity ends. Thanks to the genius of Honda's Variable Valve Timing and Lift Electronic Control (VTEC), the GS-R's 1.8-liter Four produces 170 hp at 7600 rpm—10 hp more than the previous 1.7-liter version.

Mated to a close-ratio 5-speed gear-box—only the RS and LS have an automatic transmission option—the GS-R engine generates stirring acceleration and impressive top speed. We coaxed the speedometer needle over the 140-mph mark on Honda's Tochigi test track in Japan. Stability at this speed was exemplary.

On Tochigi's handling course, the Integras showed the kind of response



Stiffer chassis and revised suspension give new Integras excellent high-speed stability.



Sleek lines and sporty cockpit reflect the character of the 1995 Oldsmobile Aurora.

we've come to expect of Honda products. They're competent, agile, totally predictable and easy to drive quickly. If there's any criticism, it could be that some drivers might like a little harder edge on the GS-R.

As you'd expect of a luxury brand, the Integras start out well-equipped—power windows, power mirrors, power door locks and an AM/FM/cassette sound system are RS standards—and move up from there. No word on pricing as of yet, but we look for it to be considerably higher than the current Integra, which ranges from about \$13,500 to almost \$19,000. —Tony Swan

Aurora First Drive

Early next year Oldsmobile will move into the luxury market with the Aurora, a high-powered sport sedan. Equipped with a new 250-hp V8, Aurora will compete against pricey imports from Lexus, Infiniti, Acura, Audi and BMW, to name a few.

After our first hands-on experience—a 280-mile test drive in Arizona—it's easy to see why the Olds product planners are aiming so high. In performance, Aurora's new powertrain is clearly world class. The 4.0-liter dohc 32-valve aluminum V8—a derivative of the Cadillac Northstar engine—develops 260 ft.-lb. of torque

at low rpm. The electronically controlled 4-speed automatic—GM's best—is smooth and quick on downshifts, subtle and sure on upshifts.

Body strength is another area where Aurora seems to compare well with the Europeans. What you feel is a steady ride that lets the suspension do the bump-sopping. What you hear



Carrera 4 marks 911's 30th birthday.

is almost nothing. Careful attention to aerodynamics and sealing makes the cabin exceptionally quiet.

Interiors are built around driver control, creating a sport feel with lux-

ury touches. Standard dual airbags protect the two front-seat occupants.

The instrument panel is simple, with four primary gauges and 16 warning lights. Secondary control buttons are hidden, to create a clean appearance.

While there are still hints of GM's traditional luxury-car feel, Aurora comes close to matching the ride and handling of the best European luxury sport sedans. And with a suggested retail price of about \$32,000, Aurora figures to have a huge price advantage against all of its competitors—European and Japanese. —Jim Dunne

The 911 Turns 30

If the Porsche pictured here looks like yet another evolution of the 911 series, then Stuttgart's favorite sports-car company is achieving its objective. Unveiled at this year's New York Auto Show, the 1994 911 Carrera 4 embodies only minor technical changes, but it has the additional responsibility of commemorating 30 years of this famous model.

The progenitor of this species was unveiled at the Frankfurt Auto Show in 1963 and it's been under continuous development ever since. As of early '93, more than 350,000 had been built.

The 4-wheel-drive 911 Carrera 4 was introduced in '89. In this iteration it shares the wide-body look of the 911 Turbo 3.6, including larger wheels (7 × 17 in. front, 9 × 17 in. rear), fatter tires (P205/50ZR17 front, P255/40ZR17 rear) and increased front and rear track.

The price tag: \$78,450.

1994 Continental

With a major revision just over the horizon, Lincoln's Continental will

(Please turn to page 86)



New grillwork and revised bumpers distinguish the '94 Lincoln Continental.



FM PHOTOS BY IAN THURSBY

head into 1994 with only minor styling changes.

Offered in two trim levels—Executive and Signature Series—the '94 Continentals will get new grillwork, bumper coverings, rocker panels, bodyside moldings and taillamps. All Continentals include dual front airbags and 4-wheel disc brakes with

Gullwing doors and spiffy interior touches make Mazda's AZ-1 microcar a hot seller in Japan. Tiny 660cc turbomotor makes 64 hp.

ABS as standard equipment.

Other Continental cosmetic tweaks include 11 new colors. Pricing for the Executive Series starts at \$33,850. Signature Series models start at \$35,750.

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non for ourselves recently in the nifty little midengined AZ-1 coupe. And we do mean little—129.7 in. long on an 88-in. wheelbase, 54.9 in. wide and 45.3 in. tall. It weighs 1587 pounds ready to roll. To lend a little perspective to those numbers, Mazda's splendid Miata sports car—no giant itself—is 25.7 in. longer and 618 pounds heavier.

We hasten to add that tiny doesn't mean tepid. The AZ-1 is powered by a turbocharged 660cc Triple that hammers out 64 hp at 6500 rpm and redlines at 9000 rpm. Peak torque—63 ft.-lb.—comes on at 4000 rpm. It's no great trick to hustle the AZ-1 to 60 mph in about 9 seconds, leaving bewildered sedan drivers wondering where you went.

Beyond the awkward stuff that goes with piloting a righthand-drive car in a lefthand-drive country, there were other drawbacks. Those gullwing doors look pretty nifty, but they don't make climbing in and out particularly easy. Climb is the operative word, too—getting legs and feet under the steering wheel and into the footwells is tricky. Getting them out again is even trickier.

The mailbox-slot windows make getting in and out of automated park-



New Saab 900 will debut at the Frankfurt Auto Show in September.

ing lots quite amusing—to onlookers.

But all of the above doesn't keep the AZ-1 from being a hoot to drive, which undoubtedly has a lot to do with this car's popularity in Japan.

Priced from about \$12,000 at your friendly Autozam dealer (one of Mazda's three Japanese marketing channels), it's a major hit with the 18-to-21 set.

We can imagine the AZ-1 being a hit here in certain circles, too—but not in the circles that generate the safety rules.

—Tony Swan

New Saab 900

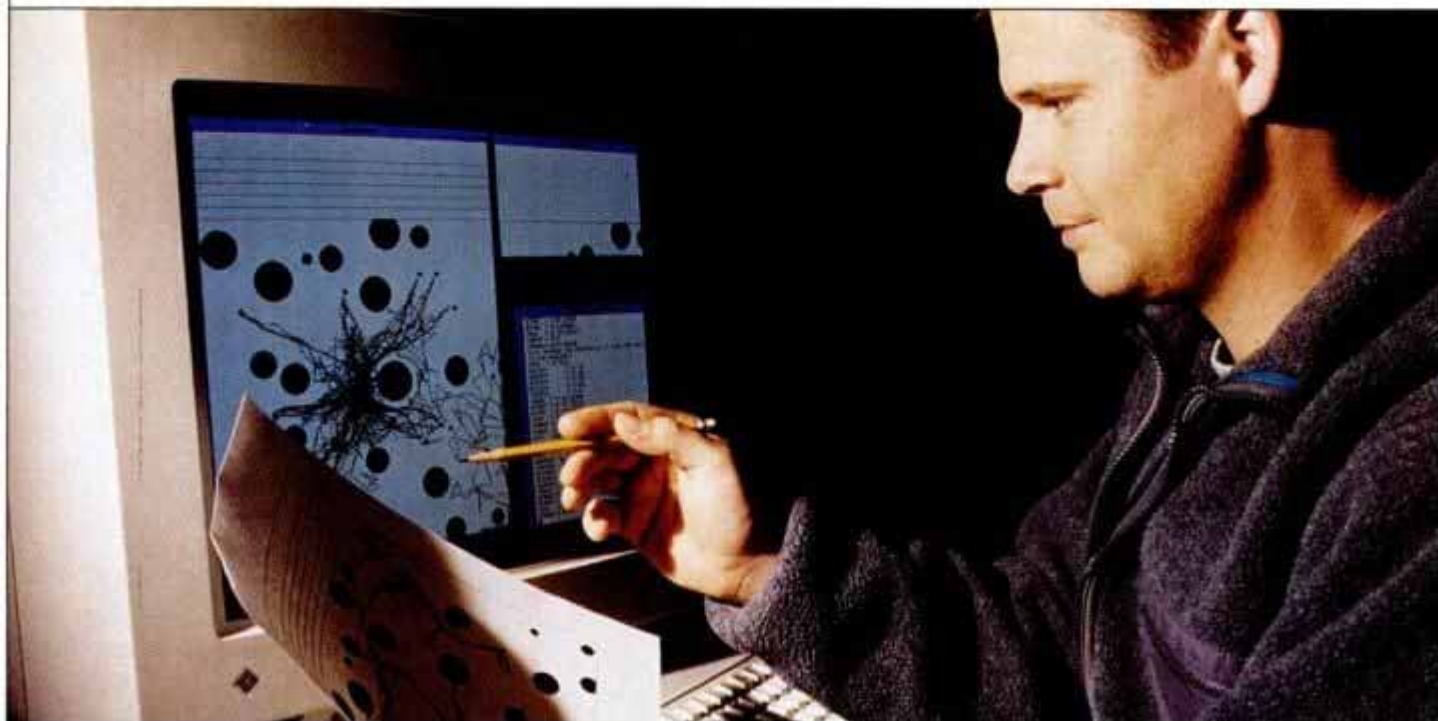
Here's one that a small but fiercely loyal group of enthusiasts has been waiting for for a long time. Due for an official debut at the Frankfurt Auto Show, the next generation of Saab's 900 smooths out the hump-backed lines of its predecessor, but is certainly recognizable as a family member.

Powerplants are expected to include a 190-hp 2.0-liter dohc 16-valve Four and a normally aspirated 24-valve V6 rated at 170 hp.

The new 900s should be in U.S. showrooms in November. **PM**

ROBOTS TEAM UP

BY ABE DANE, Science/Technology Editor



● Imagine yourself as an incredibly dumb animal. You can't see very well, you don't have a memory and you can't think beyond the dictates of a few very simple behavior patterns. You and a group of similarly rudimentary beasts are faced with a task far too complex for any of you to comprehend. How can you possibly succeed? The same way that ants, bees and other dim creatures do: teamwork.

Coaches and managers spend their lives pounding this into people's heads. There's something about pulling together that enables unremarkable beings to accomplish remarkable feats. What's new is that in the past few years, robotics researchers have been finding ways to give machines this same capacity.

In theory, it's already clear that ganging up with swarms of relatively simple robots could be a cheaper and more reliable way of doing things from space exploration to mowing the lawn. But scientists are just beginning to sketch out the best configurations for these multi-agent systems. How many robots of what type would be most cost effective? And how should the robots be organized?

Lacking precedents in the realm of technology, robot researchers have increasingly turned to ethology—the study of animal behavior.

One such investigator is Dr. Ron Arkin, professor of computer science at Georgia Tech. He and his collaborators are developing techniques to

amongst members of a group. Although anyone who's ever screamed "Fumble!" or "I'm open!" in a football game knows that talking is a part of teamwork, Arkin wanted to quantify its importance so that designers could decide whether the added complexity and expense was justified in robotic applications.

In his initial work, Arkin's robots were actually simple assemblages of behaviors concocted on a computer. The computer put these simulated robots through a scenario in which they searched for objects scattered throughout an obstacle-studded area. When they found one of these goals, they were to drag it back to a home base.

The robots' brains were created by weaving together simple rules, or schemas, for reacting to the outside world. One schema, for example, directed the robot to move away from obstacles. Another directed it to move toward goals. And a schema called "noise" added an element of randomness to its behavior.

Depending on the situation, different schemas would be active in varying degrees. For example, when no goals were within a robot's detection



Ph.D. student traces the paths of simulated robots around black circular obstacles (top), while others in Arkin's lab prepare to experiment on real robots (above).

help designers tailor multi-agent systems for particular uses. In the process, they've examined the behavior of animals ranging from fish to whiptail wallabies.

First on their agenda is determining the importance of communication

range, the noise schema would dominate, causing the robot to hunt around randomly. At the same time, other schemas would continue to act, steering the robot around obstacles and repelling it from its teammates so they stayed spread out over a broad search area.

This configuration of schemas, known as the forage state, is one of three such behavioral states that each robot in the simulation is capable of. The other two are the acquire state, which the robot shifts into when a goal is detected, and the retrieve state, which is used to drag the goal home once it has been acquired.

Arkin found that even without communication, robots equipped with this type of intelligence were capable of working together well. Up to a point at least, increasing the number of robots made the work go faster, and simple forms of cooperation occurred spontaneously.

The next step was to see how communication affected team performance. Arkin's approach was for each robot to send out a steady broadcast declaring its behavioral state. This is analogous to animal display behaviors, such as a dog raising its hackles or a peacock spreading its tail. Robots in the forage state would listen for broadcasts from robots in the acquire or retrieve states. They would then home in on the broadcasting robot, and when the goal it was dragging or pursuing came into range, switch over to homing in on that.

Arkin expected that this type of communication would prevent robots from wasting time groping around when they could be helping another robot drag home a goal faster. This turned out to be true. In one case, four robots searching for two goals in a field that was 10% covered with obstacles completed their job 30% faster when communicating than when not.

Arkin has now set up a real robotic system to verify his simulations. After that, he'll be experimenting with more complex social structures, featuring specialized robots optimized for certain tasks like worker and soldier ants are.

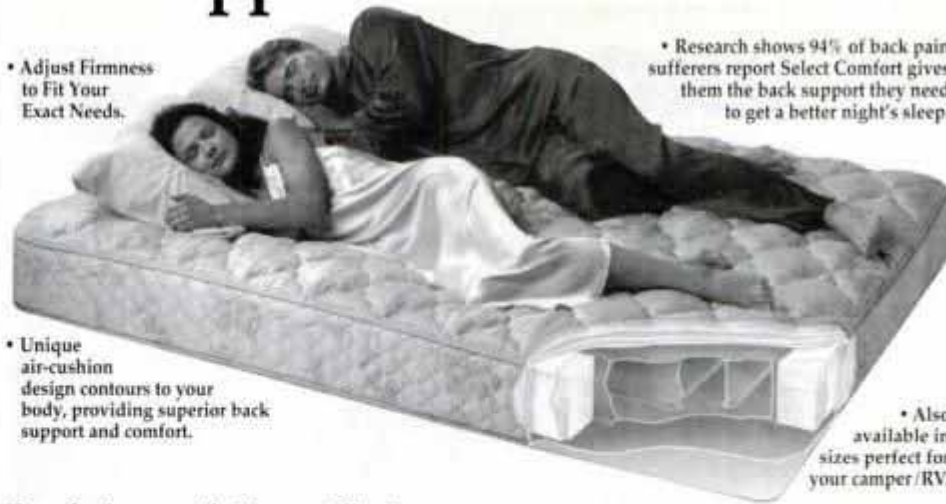
As these robot societies grow more sophisticated, one can only expect that the parallels between them and animals will grow deeper and more complex. Arkin is reluctant to speculate about the implications of his work in arenas outside robotics, but the next time you're faced with an overwhelming task, it looks like many hands may very well make for the lightest work. **PM**

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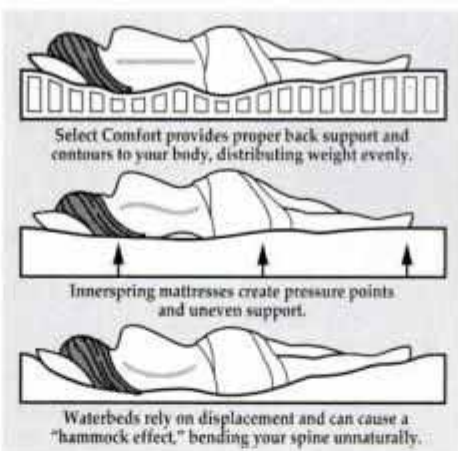
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ELECTRONICS

RADIO TYPECASTING

BY FRANK VIZARD, Electronics Editor

● Nearly every car owner thinks of adding some electronic device to his vehicle. Years ago, the thinking was simple: Upgrade the radio so it will play a cassette. The truly ambitious also may have upgraded the speakers. From there, it was a short jump to a CB or radar-detector purchase.

Today, you might have to give the matter a little more thought. True, many of the accessories of just last year are being integrated into cars. Ford, for example, has hidden a microphone inside its new Mark VIII so you can carry on a hands-free cellular-phone conversation. Simply state the name of the person you wish to call and the connection is made. A little pre-pro-



New car tech: Delco's RDS radio and Cobra's laser detector.

gramming is required, of course.

For every accessory that becomes standard equipment, another option seemingly appears. One of the newest is a radio technology called RDS (radio data system). Simply put, RDS allows FM broadcasters to transmit textual messages that can be received on the radio's display.

PM experimented with a Delco RDS radio installed in a Pontiac Trans Sport during a test drive in the Detroit area. The RDS features are

controlled by buttons along the bottom of the radio. To access the RDS controls, you must first push the RDS button to the left of the cassette door. The most obvious message a radio station would broadcast is its call letters and music format. WLLZ in Detroit, for example, has a rock music format and broadcasts an alternate message—"Detroit Wheels"—when the message button is pushed. The messages are actually broadcast on an FM sub-carrier band, essentially an unused space around the main signal. Up to 64 characters can be transmitted every 2 seconds so interference problems are minimal. If the signal is audi-

ble, then the message is visible.

Given the availability of radio call signs and format information, RDS lets you search through an area's radio offerings by genre. For example, you could sample all the sports programming at the touch of a button.

Touch another button and you are automatically switched to a traffic update. Once the update is over, you are switched back to the original station. And if you're traveling long distances, you can be automatically switched to another station carrying the same program. You could listen to National Public Radio, for instance, on a coast-to-coast drive, even though the NPR frequencies change from location to location.

All this would amount to nothing more than fancy presets, if RDS didn't have some interesting possibilities. Perhaps the most helpful is the ability of RDS technology to be used for car navigation. An RDS radio could triangulate radio-station signals on an electronic map display so you could determine locations exactly.

An RDS radio also could be used in conjunction with a paging service, with messages appearing on the radio's display.

RDS also may replace the existing Emergency Broadcast System. In an emergency, RDS technology would turn on your radio automatically. While this may sound a bit Orwellian,



Sony brings the 2.5-in. optical MiniDisc to the car with the MDX-U1 player.



RDS proponents envision RDS transmitters atop apartment buildings, for instance, which would automatically turn on a firehouse radio and transmit the data needed to respond to a fire.

RDS has been available in Europe for some time, but in this country, the technology will take an American spin. Many are intrigued by the commercial aspects of RDS. Text messages could easily display advertising. A more advanced notion is the use of a "smart" card inserted into the radio that would record the fact that you listened to a specific commercial. You could then take the smart card to a retailer and, like a coupon, redeem it for a discount.

RDS technology is not just something for cars either. Next month, Onkyo will be the first company to

sell a home audio AM/FM tuner with RDS. The T-450RDS will list for \$350. The thinking is that the radio stations will broadcast artist, song title and album textual information related to the music being aired. This means you won't have to wait until the end of a long play list before the disc jockey tells you what you've been listening to. Just push a button and the information will be displayed.

RDS only works on FM since AM signals have no subcarrier. It is expected that manufacturers will add a memory chip containing all AM formats to radios. This data would be updated periodically by an RDS signal.

RDS is not the only new technology slated for dashboard installation. Sony is now offering a car player for its MiniDisc format. The MDX-U1 plays a 2.5-in. optical disc encased in a protective cartridge. The MDX-U1 also has an AM/FM tuner and can be used to control a CD changer. A key feature is a digital memory chip that provides a 10-second buffer of music—so even if the laser pickup is jarred, there is no playback interruption.

List price for the MDX-U1 is \$980. You can expect car players for the other new digital audio format, Digital Compact Cassette (DCC), from companies like Panasonic this fall.

Another common automotive ac-

cessory is the radar detector. Some law-enforcement agencies now use laser (light amplification by stimulated emission of radiation) technology to monitor traffic. In response, companies like Cobra, Beltronics and Cincinnati Microwave are offering laser detectors for about \$100. These laser detectors are piggybacked onto standard radar detectors.

A slight twist to the story is provided by Seymour-Radix Inc. of Irving, Texas. The company's Blackbird LRJ emits an ultrahigh infrared signal, which causes the laser gun to register a blank reading, says the company. List price is \$199.

Smart Cable Box

General Instrument, a leading supplier of cable television converters, is working with chipmaker Intel and computer software giant Microsoft to offer smart cable boxes.

The plan is to integrate Intel's 32-bit microprocessor with General Instrument's compression and graphics circuitry. Microsoft will supply a Windows-type operating system that will appear on the TV screen.

The result will be a new level of interactivity for television. These smart cable boxes will be able to offer electronic program guides, home shopping and other services. **FM**



The Blackbird LRJ jams laser guns.

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YAMAHA'S SECOND DECADE

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY MIRE WALKER

● Lake Hamana may never be the same. Ten American boating writers, myself included, recently descended upon this beautiful Japanese tidal lake and were given the keys to a fleet of high-powered bass boats. Big mistake. Up to this point, we were fairly well behaved, except for several misguided attempts at cracking jokes in the native language and a few unwise turns at the microphone in karaoke bars.

Once on the water, however, the gloves were off. We were finally in our element. Naturally, the first thing we did was race across the lake. The boats were set up with foot throttles so pedals were literally put to the floorboards.

At this pivotal moment, while running at top speed and adjusting trim controls to squeeze every extra mph out of the rigs, the drivers discovered that the throttles didn't bounce back from the floor as expected. Once down, the throttles stayed down. At 60 mph, this caused more than a little consternation, especially among the first group of drivers. Hats were lost, cameras soaked and boats treated like bumper cars during docking. Fortunately, we were all able to adjust to the 1-way throttles before any serious problems occurred. The only real casualty was graceful boating. Basically, it was a typical boat test.

The reason our press group was invited to Japan, aside from provid-

ing unintentional humor, was to help Yamaha celebrate its 10th anniversary of marketing marine products in the United States. We met with the company's top executives, toured a number of manufacturing plants and, as described above, tested two 1994 outboards in our own inimitable fashion.

My biggest impression from the trip, aside from gaining admiration for the people and the country, is that Yamaha is my kind of company. I'm not saying this because Yamaha footed the travel bill. Like all good

journalists, I'm perfectly willing to bite the hand that feeds me.

No, the reason I like Yamaha is that throughout the tour I kept saying to myself, "I'll take one of those and one of those and one of those." To an outdoorsman, the scope of Yamaha's products is breathtaking.

The company's No. 1 product group is motorcycles/ATVs. (This is for the motor division—the musical instrument division is considered a separate company.) The No. 2 group is marine products, which includes outboards, sterndrives, generators,



PHOTO BY JOE SKORUPA

Yamaha's new Saltwater Series outboard (left) features an industry-first fuel-flow computer. Pro V Series (right) delivers peak low-end torque for freshwater fishermen.

PWCs and boats for the world market (excluding the U.S.).

Yamaha, by the way, is the world's largest builder of boats. The great majority are utility fishing boats, but the line includes powerboats of all sizes and types, sailboats, Japan's entry in the last America's Cup Race, solar-powered boats and human-powered hydrofoils.

The list of Yamaha toys doesn't stop here. It also includes snowmobiles, scooters, go-karts and remote-control helicopters, which are intended for crop-dusting. Topping the list is the fastest vehicle in the product line, the Yamaha Super Car, a limited-edition road-legal Formula One race car. At more than \$1 million a copy, it's probably the world's ultimate toy.

Even the products that aren't fun are still interesting, such as the 3.0-liter engine used in the Ford Taurus SHO, two different engines for Toyota cars, industrial robots, ABS for the motorcycle industry and wind turbines. Oh, I almost forgot, Yamaha also makes 15-horse and 40-horse outboards nameplated by Mariner for the world market.

Total revenue generated by the sale of these diverse motor products is about \$4 billion. Another \$4 billion

is generated by Yamaha's musical instrument division. Who said fun doesn't pay?

I've been on a few factory tours in my time, but to appreciate the fine points of the assembly line you have to be far more expert than I. However, to my eye there was a great deal more emphasis on robotics in the Yamaha factories than in the typical marine-engine plants in the U.S.

I asked a company spokesman about this, and he said the reason Yamaha makes maximum use of robotics is to achieve greater accuracy of tolerances. After reading a sign above the assembly line, I can understand the man's reasoning. Translated into English the sign read, "Perfect Quality." Not a bad manufacturing goal for a product I may eventually buy, and a goal probably not reachable without robotics.

While it seems that Japanese automobiles went from being econoboxes to U.S. market leaders overnight, that's not how it happened. It took years of struggle to overcome initial reluctance by the American buying public. This reluctance was so strong, in fact, that Detroit underestimated the threat until it was too late.

That's not what happened in the marine industry. When Yamaha un-

veiled its 1984 model line at the '83 Chicago Boat Show, there was tremendous fanfare. Expectations were sky high, and Yamaha lived up to them.

For starters, Yamaha abandoned the step-by-step approach and became a full-line builder right out of the blocks with 17 engines, ranging from 2 hp to 220 hp. Even more impressive, its top-of-the-line 220-hp V6 Special came equipped with the industry's first microcomputer management system. While Yamaha didn't invent the oil-injected outboard, it made the component a standard feature throughout most of its model line. The industry soon followed.

Since its introduction, Yamaha has continued to fulfill high expectations by carving out a solid share of the U.S. outboard market, despite stiff competition, and by introducing a line of sterndrives in 1991.

While I was visiting in Japan, Yamaha took the opportunity to show us its two big developments for 1994: a new line of outboards called the Saltwater Series and an expansion of the Pro Series.

The Saltwater Series is a new line of 25-in.- and 30-in.-shaft engines that run from 150 hp to 250 hp. The first model to debut was a 225-hp V76X 225.

As you might guess from its name, the Saltwater Series features beefed-up corrosion protection—a stainless-steel steering tube, a triple-latch watertight cowl and a cluster of anti-corrosion elements lumped together under the name Yamaha Ultimate Protection System. Two other features of note are an aggressively cupped and raked stainless-steel prop and the new Yamaha Engine Management System, which includes an industry-first fuel-flow computer.

The Pro V Series of outboards, which is aimed at the freshwater fishing market, expands into the 150-hp and 175-hp class. Both of these 20-in.-shaft outboards use the same powerhead and feature Yamaha's new triple-latch watertight seals and aggressively cupped and raked props, among other advancements.

While I was able to try out these powerful new engines during an informal session in Japan, a full PM test wasn't possible and will have to wait until a future issue. Since my first impression occurred on beautiful Lake Hamana, it will be hard for my second impression to truly stack up. Going back to Japan is probably out of the question. How about the French Riviera? My test gear is packed and ready. **PM**

Biodegradable Oil

● Almost as an aside, a Yamaha executive at our initial presentation mentioned that the company recently developed a biodegradable oil for 2-cycle engines. The environmentally friendly product is called Promar and is currently being test-marketed in Japan. He quickly moved on to another subject, but a couple of astute journalists weren't caught napping, despite the long flight the day before and a massive time-zone shift.

"Could you tell us more about this biodegradable oil?" we immediately asked. The executive appeared a bit flustered by the interruption, and looked around the room at his superiors. Then he answered diplomatically, "I'll get back to you."

True to his word, the executive informed us later that Promar is a mineral-based oil that's 87% biodegradable after 21 days. In other words, after three weeks, the vast majority of Promar oil breaks down into nonpolluting substances. During the same period of time, only 10% of regular oil breaks down into neutral compounds.

As readers of this column know by now, 2-cycle engines are far more polluting than 4-cycle engines. This is so because oil is mixed with gas in 2-strokes, and a portion of the un-

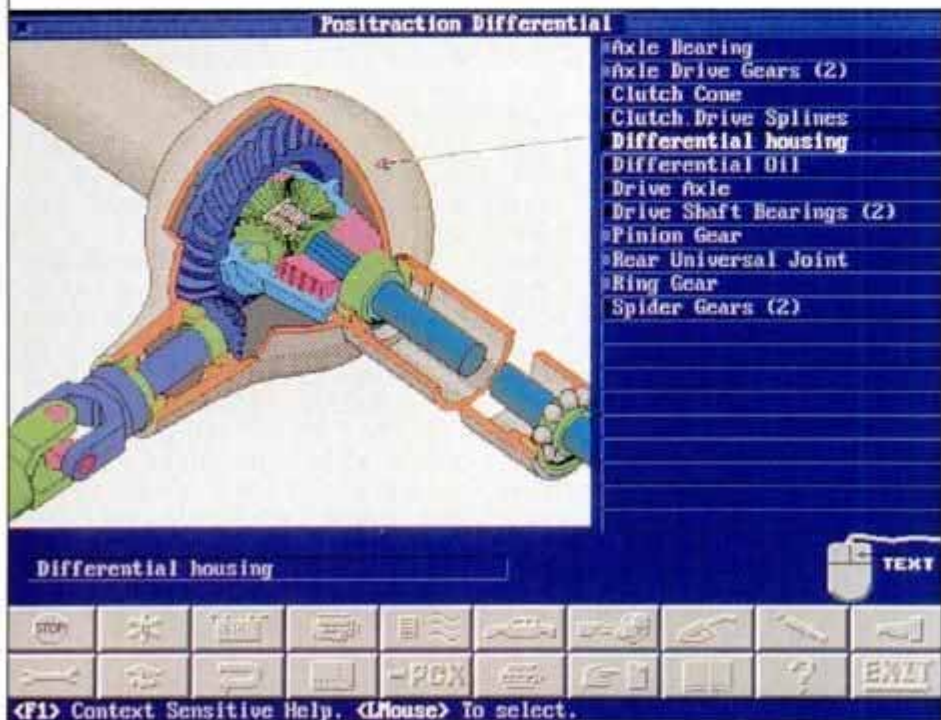


burned charge is ejected directly into the atmosphere. A biodegradable oil would help reduce the polluting effect of 2-strokes tremendously. Come to think of it, it wouldn't be a bad idea for 4-cycle engines, either.

As with so many things in life, there's a catch with Promar. It costs about four times the amount of regular oil. Environmental friendliness has its price, and one of these days we'll probably have to pay it. By then, let's hope that Yamaha's penchant for efficiency will bring the price within easy reach. —J.S.

SOFT SOLUTIONS

BY STEPHEN A. BOOTH, Contributing Editor



ing brakes, cooling, fuel, electrical, transmission, body, steering and suspension. Other topics covered include on-board computers, emissions control, fuel injection versus carburetion, diesel and rotary engines, turbos and supercharging and even electric cars. There's also lots of automotive trivia and even a quiz to test your car smarts.

Auto Insight comes on 3.5-in. double-density and 5.25-in. high-density diskettes. To run the program, you need an IBM or IBM-compatible personal computer with at least a 286 microprocessor running DOS 3.0 or a more recent operating system. You also need 512KB (kilobytes) of RAM memory and a hard drive with 3.5mb (megabytes) of free space. To take full advantage of the program's animated graphics, you need a color monitor with at least EGA- or VGA-level display.

For a different kind of hobbyist, Canada's Ninga Software, (800) 265-5555, offers a program designed to replace the venerable shoebox and notepad. It's called *Sport Card Organizer* (\$50 U.S., \$60 Canadian) and, as the name implies, it's for folks who are serious about organizing their sports-card collections.

According to Ninga, the program contains detailed information on 24,000 cards from four sports: baseball, basketball, football and hockey. This database covers card sets issued by major publishers since 1990. Ninga says databases going back to 1950 are also available. The program lets collectors add, delete or change

● That home computer is beginning to find uses beyond letter writing, grinding out budgets, dealing blackjack or executing John Madden's pass rush. They've been slow in coming, but there are an increasing number of software programs that can help you take apart a car, design an addition to your house or even organize your baseball-card collection. Some of these software titles come on conventional diskettes, while others appear on compact discs (CDs) and require a CD-ROM drive to read them.

Whether you're a Saturday mechanic or just want to know what the service manager means when he says your CV joints died with their boots on, you'll find *Auto Insight* (\$80) a useful and fascinating automotive reference.

The program comes from Phoenix, Arizona-based Informative Graphics, (602) 971-6061, a company that produces animated reference software for industry and the medical profession. The graphics in *Auto Insight* show this professional background.

The internal parts of cars are drawn with the exploded detail of the technical illustrations you find in *POPULAR MECHANICS*. The difference is that the parts actually move

in the animated art of this software package—thereby exploiting one of the computer's main advantages over printed matter. While the high-resolution animation shows how parts interact—you actually see what goes on in an engine's combustion chamber—the ample text explains what's happening. You can print out text and still graphics.

Auto Insight is one of those programs that is elaborately cross-referenced, so you can delve into subjects at greater depth or jump to a related topic instantly. All the various automotive systems are covered, includ-



Handy accessories: The Wrist Trolley (left) alleviates wrist pain, while the Konnex Model 112 (right) circumvents dialing problems. *Auto Insight* (top) is a car diagnostics program.

information about the cards they own, such as purchase price, source, condition and current value.

Sport Card Organizer comes on 3.5-in. and 5.25-in. diskettes. It's designed for IBM-compatible PCs with 512KB of RAM running DOS 2.1 or a later version. A hard drive is recommended, as is a printer.

CDs For PCs

Increasingly, computer software is being published on the same compact discs used for digital music storage. This is especially true for programs that require massive amounts of memory storage space, for example, reference works, or so-called multimedia programs that contain graphics, video and sound.

These program discs are called CD-ROM (read-only memory), and to use them, you need a CD-ROM drive or player connected to your PC. Many computers now include such a drive. Outboard models can be added to older PCs, although most software publishers recommend that the computer has at least a 386-class microprocessor to handle their discs. These add-on drives usually sell for less than \$400, a price that often includes a bundle of discs.

One recent CD-ROM that should appeal to do-it-yourselfers is *Complete House* (\$100) from Portland, Maine-based Deep River Publishing, (207) 871-1684.

The program is designed for people interested in creating plans for building or remodeling—or just interested in home design. Besides acting as a reference encyclopedia on residential architecture, the software's CAD/FP (computer-aided design/floorplan) function enables users to create their own floorplans and print them out to scale.

Although it doesn't require an engineering workstation, a program as complex and ambitious as this requires some heavy horsepower on the hardware side. Fortunately, it's all within the capabilities of a home computer.

To run *Complete House*, the publisher specifies an IBM-compatible with a 386 microprocessor or better, running DOS 3.1 or a later version and operating Microsoft's Windows 3.1. The computer will need at least 2mb of RAM, though 4mb is better. You need a CD-ROM drive and Microsoft's CD-ROM Extensions 2.2 or later. You also need a mouse to run around the house and an SVGA (super-VGA) monitor to display the program. An audio board is required too, as *Complete House* has a soundtrack.

Going Mobile

The ads for a big telecommunications utility claim that we're all connected. Tell that to any portable-computer user who has tried to telecommunicate from a hotel or office with phones that just don't seem to work with a computer's modem.

Usually, it's a hardware mismatch. The hotel or office phone is hardwired to the wall box, making it impossible to tap into the line with the modular RJ11 plug used by the computer. Sometimes, it's the type of phone itself—the jacks and plugs aren't compatible. Other times it's the way the phone system is programmed—for example, the need to get through a central switchboard to access an outside line.

For emergencies like this, there's a neat accessory item from San Diego-based Unlimited Systems, (619) 277-3300. It's called the Konnex Connector Model 112 (\$149), and it lets a mobile-computer user connect a modem to virtually any kind of telephone.

The heart of the system is a battery-powered module that connects between the computer and handset of the phone, and matches the different signal impedance levels of the modem and handset. Like a Swiss Army knife, the Model 112 comes with a variety of attachments—and instructions—to handle different hookup situations. This even includes an adapter for making a connection right at the handset's mouthpiece. It's not an elegant solution, but style doesn't matter when you're in a jam.

Getting Physical

Computers are associated with all sorts of physical ailments—eye strain, neck aches and, among heavy keyboard users, wrist pain. That's why MicroComputer Accessories, a California subsidiary of Rubbermaid, came up with a line of UFO products—as in User-Friendly Office.

MicroComputer, (310) 645-9400, offers a wide selection of easy-to-install accessories to support the keyboard user's hands, thereby taking strain off the wrists. Among the most interesting is the Wrist Trolley (\$100) pictured on the opposite page.

This device attaches in front of the keyboard and supports the user's wrists on two independently gliding height-adjustable pads. Once your hands are on a roll, they require less forearm-muscle effort to get around the keyboard—20% less according to tests cited by MicroComputer. The company brochure contains dozens of products that improve the man/machine interface. **PM**

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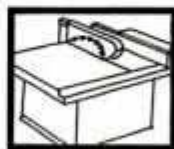


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DESKTOP EDITING

BY STEPHEN A. BOOTH, Contributing Editor

● If home video were an athletic activity, it would come in two flavors: spectator and participatory. You can rent a tape and "veg-out" on the couch with a movie. Or, you can make your own movies with a camcorder. The really serious weekend warriors go that extra yard and perform post-production work on their home movies.

Post-production can entail no more than simple cut-and-paste editing to make a tighter story from raw footage. Or, it can involve adding special effects to jazz up the sight and sound or superimposing titles for a polished, studio look. The great thing about video, compared to film, is that these activities are much more accessible and affordable to the home hobbyist.

There's a wide assortment of desktop editing accessories that work in conjunction with the VCR, camcorder and TV you presumably have. Computers can be found in an increasing number of homes, and lately these too have been enlisted in the cause of video editing. The conventional processors work with analog signals, while computers operate in the digital domain. We'll cover both methods here.

Using the home PC for video is a great way to get more mileage out of your computer, which might otherwise sit idle when you're not writing reports, crunching budget numbers or jockeying an aircraft simulator program. Video editing is a way to

get other family members involved with the computer, too. But the PC can't perform video magic out of the box. You need add-on gear—hardware in the form of cards or boards and software programs that walk you through the production process.

Because computers deal with digital information, live or recorded motion video must be converted into numeric codes for processing. Compared to simply recording analog waveforms on a tape, all this motion and color information consumes a great deal of data storage space and requires fast, powerful processing. That's why IBM-compatible PCs need at least a 386- and preferably a 486-based processor for video editing. Additional-

ly, the computer's operating system must be DOS 3.1 or higher. The advantage, though, is that digital video can be manipulated in ways not possible through analog processing. The buzzword is multimedia—the combining of motion video, computer graphics, test and digital sound.

One new software product that gives you quicker entry into this multimedia world is Microsoft Corp.'s *Video For Windows*. This \$199 program will operate on any Windows-based IBM compatible equipped with Intel's 386 or 486 microprocessor. The software incorporates Intel Corp.'s Indeo technology, also called DVI (Digital Video Interface), which compresses motion-video information digitally in order to process it on a computer.

Compression, broadly speaking, works by breaking down an image into elements that change and don't change—for example, an airplane



New software programs let you use your home computer to edit home-video movies.



Sima's FX Video ED/It 4—no computer literacy needed.

moving across a blue sky. To conserve data space, only the portions of the image that change from frame to frame—say the position of the plane—are updated.

Even with compression, though, full-motion video of 30 frames per second requires vast amounts of computer power. For this reason, the video window occupies only a portion of the computer screen, usually one-third. Anything larger would involve a slower frame rate, such as 10 or 15 fps, or less resolution and sharpness.

In multimedia presentations, the rest of the screen area is usually devoted to graphics and text. For example, a full-motion window of a baseball pitcher's windup might be complemented by scrolling text of his stats, a graphic simulation of the pitch and an audio commentary on why this pitch is hard to hit.

Digital video is capable of very sophisticated, TV-like programming when hardware cards or boards are added to an empty slot in the computer. There are many cards on the market, but one relatively inexpensive package is called *Video Spigot For Windows*. It comes from Creative Labs (Milpitas, California; (800) 998-5227) and sells for \$499, though the price might drop to \$349 by the time you read this. The board will

capture live video from camcorders, VCRs and laserdiscs for display in a variety of window sizes, depending on the frame rate desired. It comes bundled with four software programs, including Microsoft's *Video For Windows*, and includes CD-ROMs with a library of video clips.

If you're not quite ready for digital video or aren't interested in creating multimedia presentations, you can still make your home movies shine with a conventional special-effects editor and a sound mixer. Just add a camcorder and VCR.

One versatile console available today is the FX Video ED/it 4 (\$369) from Skokie, Illinois-based Sima Products. There isn't much you can't do with the ED/it 4. It'll let you insert professional-looking fades or wipes between scenes. You can add music or narration to your movies.

The control panel is easy to learn and use. There are buttons for nine different wipe patterns, including left to right, right to left, top to bottom, diagonal and center vignette. But these can be combined, and also coordinated with fade-in and fade-outs, to create more than 100 patterns in a rainbow of colors. One slider controls the speed of your wipes and fades, and another lets you select from a broad spectrum of colors.

Sliders also let you control the stereo sound mixing from different sources. These include the video's own soundtrack, background music from a CD or other source, as well as narration through the ED/it 4's built-in microphone.

Perhaps the neatest feature of the ED/it 4 is its ability to do cross-fades from two video sources. As a fanciful example, you could mix scenes from a camcorder movie of your local softball team with a VCR tape of "The Three Stooges." The console has inputs for two separate video sources.

This is a lot of versatility and creativity from a product of this price. About the only thing the ED/it 4 doesn't do is character-generation for titles. Fortunately, many camcorders already have a titler or digital superimposer built in. Also, outboard accessory titlers are widely available, from sophisticated to simple. Sima's ScreenWriter (\$320) occupies the middle range and has a nice layout with a typewriter-style keyboard. It produces letters and numbers in four different sizes and stores seven pages (or screen-fulls) of text. You can make your titles zoom in or out, scroll up or down or left to right across the bottom of the screen. You can also adjust the positioning of words on the screen. **FM**

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LITTLE PLANES, BIG IDEAS

BY ABE DANE, Science/Technology Editor



● For four decades, summer has brought to Oshkosh, Wisconsin, a flock of aircraft so vast, so varied and occasionally so peculiar as to demonstrate beyond doubt that man was meant to fly—by whatever means he could find. With acre upon acre of beautifully crafted light planes, plus speed-record attempts, Concorde rides and flying demonstrations by everything from Lockheed Constellations to the Budweiser Blimp, the Experimental Aviation Association's annual Fly-In Convention—scheduled this year for July 29 through August 4—promises once again to be a rich aviation spectacle.

But at heart, Oshkosh is much more than an air show. Despite the unpretentious atmosphere, it is also a meeting place for some of the foremost minds in aviation and beyond. Last year, for example, I attended a meeting at which Buzz Aldrin presented his opinions on the troubles of today's NASA. Then I strolled over and asked Dan Goldin, the head of NASA, what he thought of what Aldrin had to say. Where else would such people be so readily available?

At Oshkosh, the common lineage that binds the humblest and most exalted forms of flight is on display. The little, piston-engined planes that

every aeronaut and astronaut at some point earned his wings in are spread as far as the eye can see, reminding us that the EAA was founded to keep these first stepping stones to the sky within reach of everyone.

With the withering of the factory-built aircraft industry in recent years, this mission has taken on complex new dimensions. Beset by a variety of business problems, the makers of finished planes have fallen off the technological pace, while homebuilders reaped steady performance gains from advanced materials and aerodynamics. Although the EAA's focus has historically been to foster homebuilding, the organization hardly sees this as a victory. Instead, EAAers have now thrown themselves into the battle to rehabilitate the production end of the business.

One of the biggest problems here has been the cumbersome procedure required to get FAA approval for a new aircraft-building venture. The expense of this certification process has stifled the efforts of small companies that otherwise have the technology and initiative to create new airplanes. Of particular concern to the EAA has been the dwindling number of trainers, which could eventually choke off the supply of new pilots.

At last year's Fly-In, EAA President Tom Poberezny announced developments that could cut the red tape for certain types of planes. In collaboration with the FAA, they had worked out ways of interpreting existing rules that should make the certification process less forbidding. Essentially, the new procedures hold manufacturers to the same standards, but give them more flexibility in how they prove their compliance.

As a show of support for the initiative, several kitplane manufacturers presented proposals for aircraft they hoped to put into factory production. No one I spoke to could remember so many certification efforts beginning on a single day. Zenith Aircraft Co. of Mexico, Missouri, appears to have been quickest off the mark, with a low-wing trainer they hope to show at this year's Fly-In.

Similarly compelling evidence of the EAA's impact beyond the homebuilt world will come this year in the form of a first-of-its-kind GPS demonstration. A differential GPS station installed on the field will show how this inexpensive, enhanced-accuracy guidance system can make poor-weather landings possible in locations where they would never be considered today.

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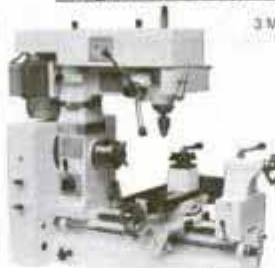
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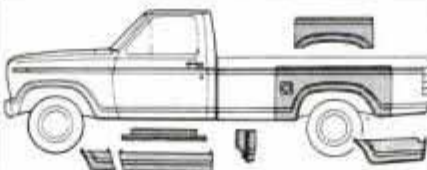
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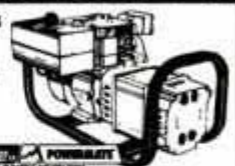
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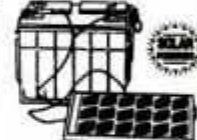
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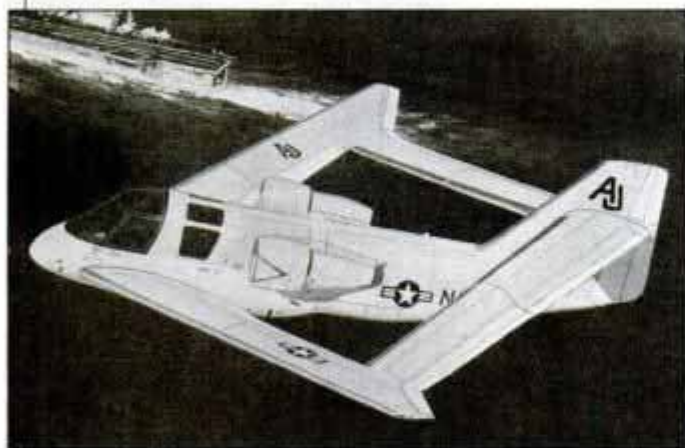
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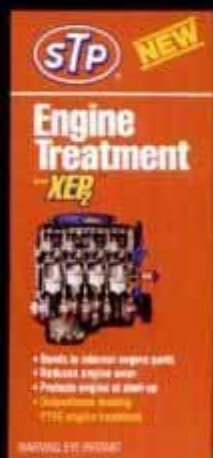
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VIRTUALLY
UNPROTECTED.**



Your poor engine. At start-up, it's only protected by a thin film of oil. It has to wait precious moments for more oil to be pumped up from the pan. The result? Friction and metal-to-metal contact. In fact, most engine wear occurs at start-up. Help stop it by using new STP® Engine Treatment with XEP2™. This breakthrough formula actually bonds to internal engine parts providing protection from the moment you turn the key. Durable protection proven in independent lab tests to stay put, start after start. Don't send your engine out into the world without new STP Engine Treatment. Help stop engine wear before you start.

B FIRST BRANDS



**HELP STOP IT
BEFORE YOU START.**

■ REAR SUSPENSION

Leaf spring suspension in back provides support for heavier loads plus a more comfortable, even ride for passengers.



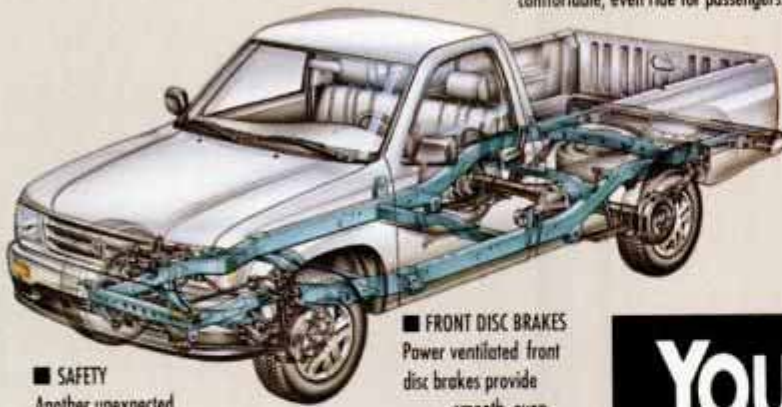
■ RACK-AND-PINION STEERING

Standard power-assisted rack-and-pinion steering on 2WD models provides surprisingly responsive handling.



■ MORE SIZE

The Toyota T100 is a new measure of Toyota Truck. The 4x2 model is 5.9 inches taller, 8.7 inches wider and a very practical 34.5 inches longer than our 4x2 Standard Bed Compact.



■ FRONT DISC BRAKES

Power ventilated front disc brakes provide smooth, even braking. Rotors that are vented to quickly dissipate heat provide stopping power.



■ SAFETY

Another unexpected refinement, the brake pad audible-alert indicator lets you know when it's time to replace brake pads.

YOU HAVE EVERY REASON TO BELIEVE THIS IS YOUR NEXT TRUCK.

■ EVEN BRAKING

Standard rear-wheel Anti-lock Brakes help control rear brake lockup in critical situations.

■ POWER

A V6 overhead cam engine combines the responsiveness of electronically fuel-injected technology with the torque and power you want.



■ STYLE

Aluminum alloy wheels* accent the Toyota T100's rugged stance.

■ PROTECTION

Lower body panels are treated with advanced urethane paint to resist chips and pitting.



■ DOUBLE-WISHBONE FRONT SUSPENSION

Double-wishbone torsion bar front suspension helps keep the ride and handling smooth.

If you're looking for a new measure of performance in a truck this size, you have every reason to read on. The first thing you'll likely notice is that there's more information here than in the typical truck advertisement. The second thing? That the Toyota T100 is anything but typical. In fact, it moved *Motor Trend* magazine to comment, "ride quality, steering response and overall handling are reminiscent of a sporty passenger car." Call 1-800-GO-TOYOTA for a T100 brochure or the location of your nearest dealer. *"I love what you do for me."*

TOYOTA



NOT FOR QUALITY

THE TOYOTA T100

Puts you in a whole new class.

*Available on SR5 models.
Buckle Up! Do it for those who love you.
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