

MAY 1989 \$1.95

Popular Mechanics

**SPECIAL
DOUBLE
ISSUE**

**THE
AMERICAN
ADVENTURE**

RESTORING THE GREAT STEAM TRAINS

- How They're Rebuilding The Legendary Locomotives Of The Past
- Places Where You Can Still Ride The Oldtime Railroads

**DISCOVERING
THE GREATNESS
OF OUR NATION**

- | | |
|--|---|
| JOHN UPDIKE
Our Monuments | RICK MEARS
Our Highways |
| MICHAEL CRICHTON
Our Spaceports | TED WILLIAMS
Our Fishing Spots |
| GEORGE PLIMPTON
Our Thrill Rides | CURT GOWDY
Our Great Outdoors |
| DAVID HALBERSTAM
Our Automobiles | BOB VILA
How We're Restoring Our Heritage |
| WILLIAM HOFFER
Our Craftsmanship | AND A SPECIAL MESSAGE FROM
PRESIDENT GEORGE BUSH |

INDY 500 RACERS

What It Takes To Make A Winner

TABLE SAW TECHNIQUES

Ripping, Crosscutting, Mitering, Beveling And Other Tricky Angle Cuts





**LAST YEAR, AMERICANS BOUGHT
MORE FORD TRUCKS THAN ANY
OTHER TRUCK... EVER!**

**AND FORD
HAS THE MOST
REPEAT BUYERS,
TOO!**



The final 1988 truck sales reports are in—and Ford breaks the all-time record for light truck sales by division in a single year with 1,442,395 trucks sold, according to 1988 calendar year manufacturers' reported retail deliveries. More than Chevy, more than Dodge, more than any other truck line. The highest truck line sales in history! Ford is America's first choice for a tough truck line—for rugged full-size pickups,

newly designed Rangers and Bronco IIs, distinctive Aerostar mini-vans, roomy Econoline vans, Club Wagons and big Bronco utility 4-wheelers.

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*Based on 1988 New Car and Truck Buyer Study.



FORD TRUCKS

BUILT FORD TOUGH

This One



3S82-95G-70UQ

PHOTOGRAPHY: © RICHARD W. HARRIS; © RICHARD W. HARRIS

Too bad there's no such thing as "scratch and taste" advertising.

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Merit Ultra Lights

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Kings: 5 mg "tar," 0.5 mg nicotine av. per cigarette by FTC method.

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117 COVER STORY

Locomotive No. 40 of the Georgetown, Breckenridge & Leadville Railway (cover) starts the Georgetown Loop, between Georgetown and Silver Plume, just west of Denver. It's one of the places where steam still rides the rails.

—PM photo by Arthur Bilster/Stock Imagery



120 Coupes de grâce



140 Shaker boxes



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EDITOR'S NOTES



Crichton



Gowdy



Halberstam



Hoffer



Mears



Plimpton



Updike



Vila



Williams

IF YOU'RE a baseball manager, you dream about permanently managing an all-star team, the kind that plays only once a year, in July, in the All-Star Game. If you're a movie director, you dream about having Stallone, Douglas, Cruise, Streep, Weaver and Cher all in the same movie.

Magazine editors have dreams, too. We dream about having the top writers all working with us at the same time in the same issue of our magazine.

I've been lucky. I've already lived out my dream once—in our July 1986 "Building Of America" special issue. And now, I've gotten to do it again.

There is a special section in this issue of *POPULAR MECHANICS* that is truly an editor's dream. "The American Adventure," beginning on page 17, is a celebration of all the things you can see, do and appreciate in this great land. It's also probably the greatest gathering of literary talent you're likely to encounter in 1989. Here's our lineup:

Science fiction writer **Michael Crichton's** best-known work is *The Andromeda Strain*. He also wrote *The Great Train Robbery*, both of which became popular movies. His latest novel for Knopf is *Sphere*. In *PM*, Crichton takes you on a tour of America's spaceports and tells you about the people and places that are getting us back into space.

As host of ABC's "American Sportsman," **Curt Gowdy** has traveled to many national parks. But his favorites are the smaller, less visited spots still

unspoiled by the crowds. Here, Gowdy lets you in on his secret places.

David Halberstam, Pulitzer Prize winner, former correspondent for *The New York Times*, and author of the best-selling book, *The Reckoning*, has worked in such exotic places as the Congo and Vietnam. But one thing he shares with those of us who lead more mundane lives is his enduring love affair with the car. Here is his true confession.

William Hoffer, author of *Midnight Express*, is a regular contributor to *PM*. In fact, this issue's steam train cover story, "Born Again," (page 117) carries the Hoffer byline. His latest book, *Free-fall* (the story of the Air Canada 767 that made a deadstick landing at an abandoned airfield) is based on his article that originally appeared in *PM*. In this issue, Hoffer shows you places where old-world craftsmanship and pride of workmanship are still alive and well.

Rick Mears lives in the fast lane. Literally. Winner of the Indy 500 three times and numerous other races, Mears takes you on a personal tour of his favorite driving roads.

George Plimpton's forte is hands-on journalism—amply demonstrated by his books about quarterbacking the Detroit Lions and making a movie with John Wayne, and his exploits for us in the cockpit of a U.S. Navy F/A-18 ("Life Begins At Mach 2," page 75, April '86). For this special issue, Plimpton went on another ride for us—on the five hottest roller coasters in America.

And lived to tell you about it.

Pulitzer Prize winner **John Updike** has had so many books on the best-seller list that it would take virtually this entire column to list them. For "The American Adventure," this member of the National Academy of Arts and Letters visited America's sacred places—our most popular monuments—and explored the incredible engineering that went into their construction.

Bob Vila, best known as a *POPULAR MECHANICS* Contributing Editor (his column, Old House Restoration, runs in every issue) also finds a little time to do a television show for WGBH in Boston called "This Old House." We called on Bob's expertise to take us on a tour of some of this country's greatest restoration sites.

Baseball Hall of Famer **Ted Williams**, the last man to hit .400 in the majors, ended his baseball career with every accolade possible, then turned around and started a second career as one of the world's greatest fishermen. And he tells you all about his favorite fishing holes in this issue.

So? Is that an all-star lineup or what? 'Til next time.

Joe Oldham

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LETTERS

Eyes On The Skies

CONGRATULATIONS on a great magazine and the fine article on the Boeing 747-400 in March '89 ("Big Bird," page 74). A fellow student and I are very interested in the field of commercial aircraft and we'll be mounting the 747-400 poster on the wall in our dormitory. We always expect the best from PM and we get it!

THOMAS A. GRIFFIN
FAULKNER UNIVERSITY
MONTGOMERY, AL

Your cover story contains an error. You say that "while 747s have been lost to human error and human intervention of more hostile sorts, no 747 has ever crashed due to a mechanical failure." A 747 has, in fact, crashed due to mechanical failure. A 747 crashed into a mountain in Japan when the aft pressure bulkhead failed, disabling the rear control surfaces.

MARK STEPHENS,
U.S. NAVAL STATION
SUBIC BAY,
PHILIPPINE ISLANDS

You're correct that a failure in the pressure bulkhead of the JAL 747 caused the crash. But investigators from Boeing, the National Transportation Safety Board, and Japanese authorities determined that the bulkhead crack was caused by a human maintenance error, not an inherent structural flaw. Whether or not the Boeing 747's perfect record still stands awaits the investigation of United Flight 811, which suffered an explosive decompression over the Pacific on Feb. 24.

Not A New Angle

Your article "Year Of The Sterndrive," (page 98, Feb. '89), with its reference to the "breakthrough L-Drive," is about 32 years late.

In 1956-57, I installed a marine L-Drive unit marketed by Fagil Coach Co., which consisted of a Crosley 4-cylinder auto engine, marinized and mounted in the vertical position, with a universal-type connection into the 160° turnable hull-mounted drive section. It had dual carbs and good speed, but

could not pull skiers like the 30-hp Johnson it replaced. As you know, it did not last long on the market.

R. A. DISESA
MADERIA BEACH, FL

Work Or Play?

I was extremely disillusioned with your latest "Compact Commandos" truck test (page 51, Feb. '89). Your testing criteria were more suited for evaluating sports cars than trucks. A better comparison would be hauling a full load of rock and bricks to the dumps. You did not load 20 sheets of ½-in. drywall in the cargo bed during the pickup performance tests.

ROGER PLACZEK
SAN DIEGO, CA



March '89: On sale at time of intense scrutiny of the 747.

Many owners are using compact trucks as substitute sports cars. We structured our test with this in mind, while not ignoring the payload information.

Healthy Advice

As a loyal POPULAR MECHANICS reader and a Victorian house lover, I was intrigued to see Bob Vila's article on restoration of iron fences ("Old Home Restoration," page 32, April '89).

I did some research before beginning my iron fence restoration and there is one important fact that came to my attention: Sandblasting can be hazardous to your health. According to the Lead Poison Control Unit in my county, anything that was painted prior to 1940 (like an antique house or iron fence) was most definitely painted with lead paint.

The process of sandblasting sends a cloud of grit and lead paint particles into the air. This cloud *cannot* be contained, thus posing a health hazard to the user, children, pets, plants and neighbors. So please don't sandblast or power sand old paint.

Use a heat gun to remove most of the paint, and follow that with a semipaste chemical stripper. Use goggles, gloves and face mask for your safety. And I'm sure your neighbors will thank you for not sandblasting.

TOM FLAGG
JERSEY CITY, NJ

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TIME MACHINE

75 YEARS AGO: MAY 1914



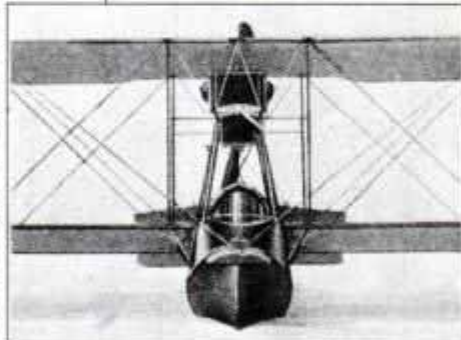
Flameout

Fire was the enemy, technology the defense, three-quarters of a century ago when this innovative fireproof suit adorned PM's cover. The "Salamander" was made of two layers of specially prepared canvas. Water delivered by a ½-in. connection to the firehose coursed between layers. The suit featured an enveloping shower of water that plummeted from a nozzle in the fireman's hat, and a constantly replenished air supply that allowed penetration to the fire source.

Aero Evolution

Noted writers have always found a home in PM's pages. Back in the second decade of the tumultuous 20th century, it was Rudyard Kipling's turn to enlighten our readers. Kipling discussed man's continuing conquest of time and space with advancements in the "aeroplane." "The time is near when the word 'inaccessible' will cease to have any meaning."

The airplane's latest advancement: Glenn Curtiss's enclosed-cockpit flying boat undergoing tests on Lake Keuka, New York.



50 YEARS AGO: MAY 1939



Fold-A-Plane

Isolationist America nonetheless foresaw the need for improved military airlift 50 years ago. And the result was the swing-tail "flying box car." Our cover illustration depicted this unique freight carrier in a peacetime role, but moving light tanks to the battlefield was also envisioned. Designer Benny Howard, a noted airplane racer of the period, planned a 7 x 22-ft. cargo hold in a twin-engine aircraft capable of lifting 4 tons.

Home On The Range

Early signs of America's passion for life on the road materialized in this office/house trailer designed by a New

York executive. The tractor-hauled trailer boasted not only living accommodations, but typewriter, dictaphone and filing cabinets for roadside office work.



25 YEARS AGO: MAY 1964



Acrobatic Sub

By 1964, Nautilus had transited the Pole and Triton had girdled the globe. Navy planners were looking for new underwater worlds to conquer, and they thought they may have found it in the "windmill sub," a fascinating contrivance that dispensed with conventional stern-mounted propellers. Hull-width propulsors revolved around the sub's girth. The variable-pitch blades allowed the sub to stand on its tail, spin 360°, even fire missiles from a special bow tube.

Indytech, Then

A year previously, young Jimmy Clark had come within a whisker of defeating the beefy front-engine Offenhauser roadsters that had dominated the Indy 500. Our report on the '64 Indy anticipated the return of Clark's rear-engine Lotus—400 pounds leaner, stretching fuel and tires to new effi-

ciencies—and the death-knell of the front-engined behemoths that marked Indy's early years. **PM**



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Mr. Goodwrench



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TECH UPDATE

News Of Tomorrow's Technology Today



Astronaut on early 21st century Mars mission rappels after samples while another sets up a weather station.

NASA ILLUSTRATION

NASA Declares A Bold Agenda For 21st Century

WASHINGTON, DC—Targeting Mars, Phobos and the Moon, NASA's Office of Exploration has unveiled its vision for the first round of manned interplanetary missions. The mission to Phobos, proposed for the opening years of the next century, is a totally new concept. Its goal is to develop the Martian satellite as a science and staging area, paving the way for future exploration of Mars.

Under the proposed split/sprint mission profile, a transport craft carrying exploration equipment and return fuel would be launched on a minimum-energy trajectory. Then a manned craft would catch up on a high-energy sprint trajectory, rendezvousing with the cargo ship in Mars orbit after a flight of about nine months.

Two of the crew would be dispatched to explore the surface of Phobos in a lander carried aboard the cargo

ship. The others would remain in orbit, performing the various experiments through teleoperated surface rovers.

The same technologies and basic mission profile could be used for a manned Mars mission, now slated for 2004. Both Mars trips would also require the development of a low-Earth-orbit transportation depot to assemble and fuel outbound spacecraft, and recover them on return.

Closer to home, an observatory on the dark side of the Moon would push back horizons of astronomy another giant step. The lunar site is ideal because it combines clear-sky viewing conditions with a stable platform for the kind of large instruments that cannot be used in orbit.

Two manned and two un-

manned cargo missions scheduled for 2005 would be required to set up the apparatus. Rather than building a permanent habitat, astro-

nauts would live in landers for the full length of each 20-day mission, and commute to experiment stations in unpressurized rovers.

Highlights This Month

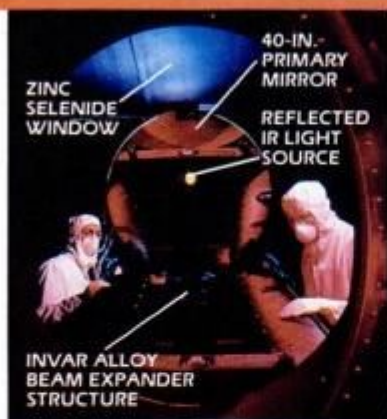
- **Sensor Wars**—The fight to improve infrared target spotters heats up.
- **Coaster Mania**—The *Pipeline* may soon be America's hottest thrill ride.
- **Special Effects**—The technology of illusion takes on new sophistication.
- **Muscle Building**—The reason electrostimulation may replace pumping iron.
- **Sun Power**—Refinements in construction and lower costs rekindle our interest in solar energy.
- **Tanker Topics**—Upgrades enhance the workhorse KC-10 refueler for tactical missions.
- **Atom Probes**—New techniques for observing one of the smallest constituents of matter.

Editor: Tim Cole
Assistant Editor: Abe Dane
Contributors: Mike Fallon,
Paul Ruben

Check For IR Sensors

SEATTLE, WA—A \$44 million facility completed by Boeing will permit real-world calibration of the infrared (IR) sensors used in the growing number of SDI and smart weapons.

Simulations of moving and stationary targets can be produced with an IR beam passing through a series of three hyperbolic and parabolic mirrors, the largest of which is 40 in. across. The mirrors expand the beam to 36 in. across. It then passes from the high vacuum, liquid-nitrogen-cooled optics chamber through a 31-in. zinc



Engineers in optics chamber, seen from IR sensor.

selenide window—the world's largest—to enter the sensor chamber. There, the sensor, mounted on an adjustable bench, is tested at temperatures and pressures simulating orbital environments.

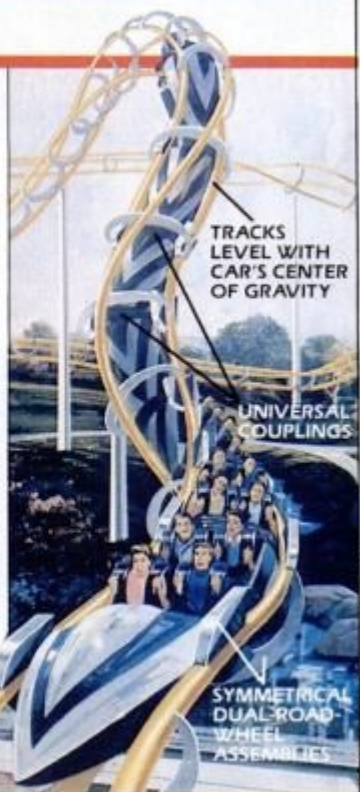
New Twist In Coasters

CLEARFIELD, UT—A unique design will enable the latest roller coaster from Arrow Dynamics to perform airplane-like snap rolls.

Scheduled to be in working-prototype form within the year, the *Pipeline* concept will work by placing the car's center of gravity right between the rails.

Also, unlike present coasters, pipeline wheel assemblies have identical pairs of road wheels top and bottom, so cars operate as comfortably upside down as right-side up.

Spiraling and plunging, the *Pipeline* raises thrill rides to new heights.



ARROW DYNAMICS ILLUSTRATION

Filmmakers Press Limits Of Special-Effects Tech

NEW YORK, NY—The science of cinematic illusion continues to advance the state of the arts.

In one upcoming movie, the containment vessel of an abandoned nuclear reactor has been sealed and filled with 7½ million gallons of water. The rig provides the backdrop for "The Abyss," an

adventure movie set 2000 ft. beneath the Caribbean.

By far the largest freshwater, filtered filming tank ever constructed, the reactor vessel is 209 ft. across and 55 ft. deep. It houses a full-size model of a submersible habitat called *Deepcore*.

Smaller in scale, a new generation of electronic

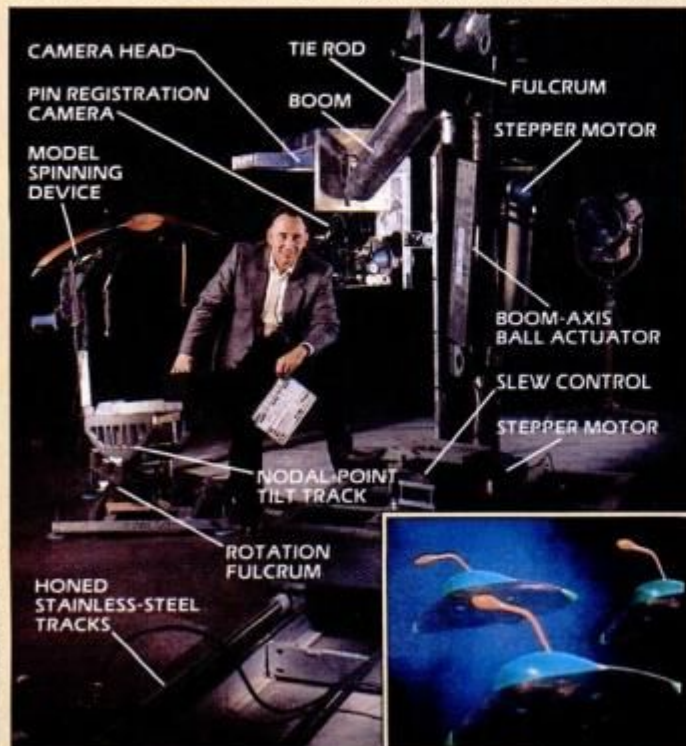
equipment is allowing TV studios to create convincing special effects affordably.

Paramount Pictures' "War of the Worlds" remake provides a good example. An advanced motion control camera, which is computer-driven along 12 axes, films sequences of camera and model movements controllable to within 1/100,000th of an inch. The sequences can be superimposed to realistically combine elements filmed in

miniature with live action.

Amplex ADO digital-effects equipment was used to fine-tune alignment of motion control shots, and to paste images, such as ray-gun blasts pulled from other sources, into appropriate positions on the videotape.

Using these techniques, shots that would have taken more than a month to film were videotaped in a week.



Light & Motion of Toronto's motion control camera (left) filmed "War of the Worlds" spaceships (below left). Sets were anchored in reactor vessel (right) to produce "The Abyss" scene (below).

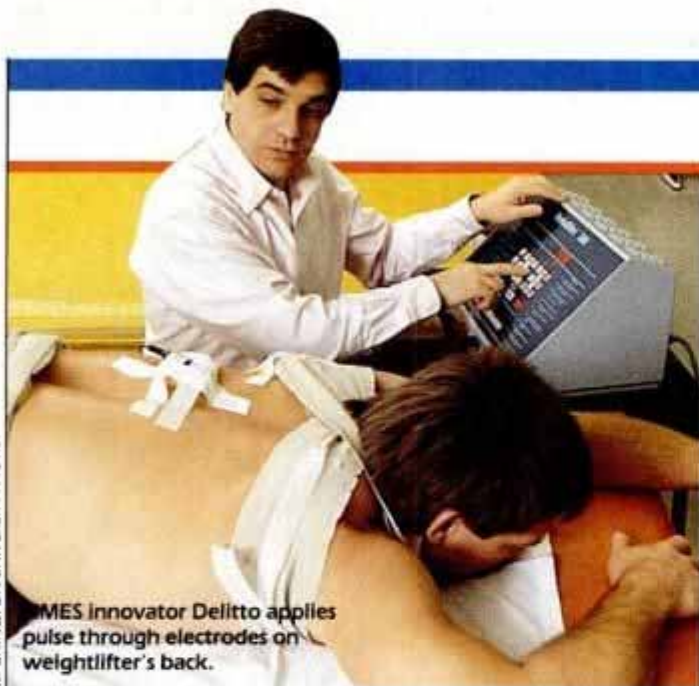


PM PHOTO BY JOHN STEPHENS

ROBERTO SCHMIDTKE FOR LIGHT & MOTION

GIP PHOTO

GIP PHOTO



NEMS innovator Delitto applies pulse through electrodes on weightlifter's back.

Soviet Electromuscle Building

ST. LOUIS, MO—A way has been found to increase muscle strength with jolts of high-intensity electricity.

Although the technique, called neuromuscular electrical stimulation (NMES), has long been used by Soviet Bloc athletic teams, it has baffled Western researchers because pulses strong enough to be effective always caused unbearable pain.

Now physical therapist Anthony Delitto of Washington University has discov-

ered that sensory response can be blocked by using very-high-frequency current interrupted about 50 times per second.

"The high frequency blocks sensory nerve response and allows the subject to endure high levels of current," Delitto says. Pulses from a generator he developed in conjunction with Electro-Med Health Industries can be 20-times stronger than those from earlier machines.

Solar Power: Boosting Efficiency, Cutting Costs

NEW YORK, NY—Solar power research has made major strides toward the twin goals of cheap, endlessly renewable power for Earth use, and lightweight, reliable power for spacecraft.

Dedicated this winter, NASA's new Power System Facility, at Lewis Research Center in Cleveland, has begun work on a solar power module that will supply 75 Kw of continuous electricity to Space Station *Freedom*.

The main test area of the \$6.2 million facility is an 8300-sq.-ft. clean room, where 90 percent of airborne particles can be filtered. There, a system of cables and counterweights will suspend a 60-ft.-dia. solar concentrator for testing in simulated zero-G conditions.

When its 19 graphite-epoxy panels are assembled in space, the concentrator will be part of the Station's solar dynamic power module (SDPM).

Using focused sunlight to heat the working fluid for a turbogenerator, solar dynamic power gets more power from a given surface area than photovoltaic cells. Also, surplus SDPM energy can be stored more efficiently than electricity from photovoltaic arrays.

Back on Earth, a radically improved photovoltaic cell developed at Sandia National Labs has brought closer the

prospect of cost-effective solar power.

Whereas conventional cells are only about 18- to 20-percent efficient, the new cell converts 31 percent of solar energy to electricity.

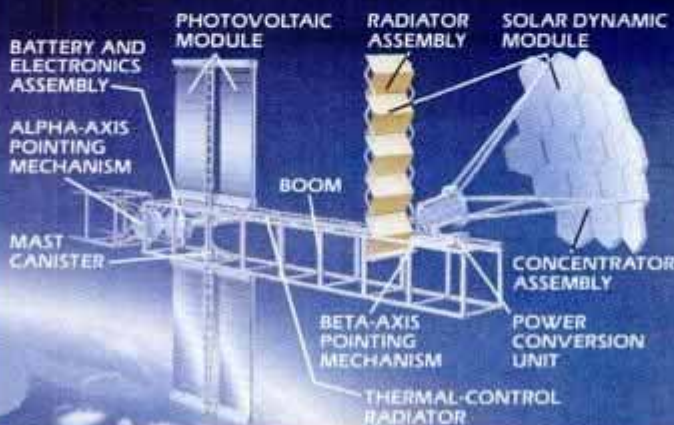
By stacking a gallium arsenide cell on top of a silicon cell, it captures energy from a broader spectrum than a single element could.

A Fresnell lens concentra-

tor intensifies the light before it hits the cells. The new technology brings the cost per watt for photovoltaic power down to \$4 to \$6, compared to \$100 per watt in the mid 1970s.



SPACE STATION SOLAR POWER MODULE



Newly dedicated Power System Facility (above) will develop subsystems to be integrated into Space Station power supply (left), comprising solar dynamic and photovoltaic modules. Fresnell lens concentrators (below) focus sun on Sandia's photovoltaic cells.



MCDONNELL DOUGLAS PHOTO



McDonnell Douglas KC-10 with all fueling hoses deployed.

tanker in the world. The aircraft is designed to replenish all manner of Air Force hardware, but its primary role is in refueling the tactical air command's fleet of F-111s, F-15s and F-16s. A fleet of KC-10 "mother tankers" was used in the 1986 raid on Libya.

From his position in the belly of the craft, the refueling operator can direct the fueling of NATO or U.S.

Navy planes from three drogues. Air Force planes are fueled with a 58-ft. telescoping boom that maneuvers with its own control surfaces. The operator "flies" the boom, monitors refueling operations through periscopes and a video camera, and guides refueling planes with belly-mounted signal lights.

Air Force plans call for the retrofiting of removable versions of the wingtip pods to additional KC-10s.

Drogues Enhance Tanker

LONG BEACH, CA—The last of 60 Air Force KC-10 aerial refueling tankers came off the McDonnell Douglas assembly line with new wing-

tip refueling pods.

Holding retractable hoses to fuel two additional planes, the pods make the KC-10 the most versatile air-to-air

New Probes Reveal Atomic Structures

NEW YORK, NY—Keener tools are coming to the aid of materials science, the modern alchemy that seeks to understand how building blocks of matter combine to produce substances with specific properties.

The latest instruments will speed the development of superconductors and other key industrial materials.

The position sensing atom probe (POSAP), developed at Oxford University, uses a nanosecond pulse of high-voltage electricity to blast a thin layer of ionized atoms off the tip of a needle-like sample. The ions fly toward positively charged detectors.

On earlier probes of similar design, the detectors simply timed the flight, allowing operators to determine the mass and thence, the identity of individual ions.

The POSAP, however, uses a wide-angle detector

which produces information on both time of flight and trajectory. A computer interprets the data, and produces a picture showing the identity of each ion and where it came from in the sample.

In the U.S., an expand-

ing array of neutron-beam-based probes will be made available to industry to foster continued competitiveness.

The National Institute of Standards and Technology (NIST) has completed this country's first cold neutron re-

search facility in Gaithersburg, Maryland.

The NIST facility consists of a 20,000-sq.-ft. hall, into which seven cold neutron beams are directed from an adjacent nuclear reactor.

Chilled in a -415° F chamber within the reactor, the neutrons have very low kinetic energy. They can probe deep within materials, detect both light and heavy elements, and make subtle distinctions between isotopes of the same element.

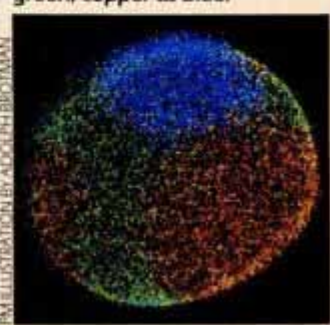
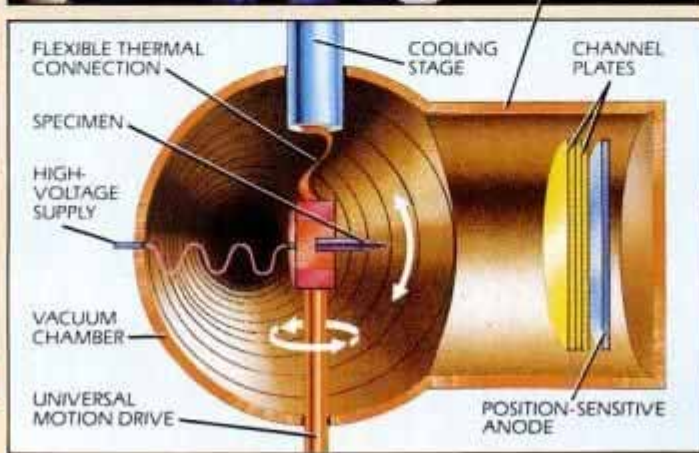
The Argonne National Laboratory Intense Pulsed Neutron Source (IPNS) has been fitted with a new uranium target, making it the most powerful neutron beam available.

When the neutrons pass through a sample, slight deflections caused by collisions with atomic nuclei are detected by instruments and interpreted to reveal atomic structure.

POSAP (above left) uses wide-angle sensor (below left) intensifying channel plates to show arrangement of individual atoms. Detail shows iron atoms as red, aluminum as green, copper as blue.



IPNS facility staff prepare to lower sample into instrument.



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THE AMERICAN ADVENTURE



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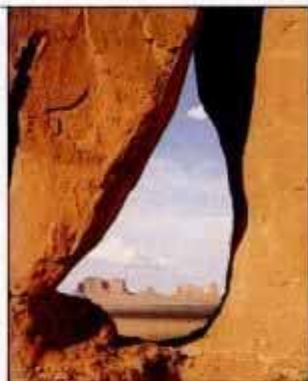


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THE AMERICAN ADVENTURE

Our national spirit comes from knowing that we'll never be truly finished with the task of making this country great.

BY GEORGE BUSH

THE AMERICAN Adventure. Some call it the Invention of America—the process by which we have evolved as a nation. It is a story of human progress from the first pilgrims who reached our shores to the astronauts who are reaching for the stars. It is an unfinished story, because there is a New America in the making every day. Our job is to manage the change. It happens in steps, sometimes so small it's invisible to the naked eye, other times so big the whole world can see it. And though change cannot be avoided, it can be for the better. We are the ones—each of us—who must ensure that a changing America is a better America.

In October, I watched the Space Shuttle land at Edwards Air Force Base. We had been waiting out in the sun for about an hour—and suddenly, just barely through some scattered clouds, you could see it. There were two quick booms as it slowed from supersonic to subsonic speed.

When it landed, you could see the dust it sent up from the lake bed. Everyone around me erupted in applause. When the astronauts came out, they greeted me, holding in their hands the American flag. They said they felt a bit wobbly, but you wouldn't have known it.

The return of the Shuttle—the return

of America to space—has been enormously moving for all of us. I was overwhelmed on the day of liftoff by the cheers and tears, by the excited schoolchildren jumping up and down.

President Reagan said we must lead in space if we are to continue to lead on Earth. Space is where great scientific and commercial breakthroughs of the future will be made. Space is where we can achieve progress in making our country safer from ballistic missile attack. Space is also where medicines of the future will be made, and where some of our children may make their living.

It was on that day in October when I realized America will always be an unfinished nation, reaching toward the future and toward the stars. The potential is always there, drawing from the talent and manpower the American people provide. This is what constitutes the American edge.

But how do we keep the edge and stay competitive in the world? We keep it by keeping the economy rolling and keeping the job-creation machine in high gear—by keeping taxes down, encouraging capital investment and research and development, keeping big government off the backs of small business—and by making economic opportunity a reality for all Americans.

True participation in the American

Dream requires a full commitment to individual initiative and, especially, to entrepreneurship. The health of the nation's economy relies on the competitiveness of our businesses, large and small, and on the entrepreneurs who have built American business from the ground up. Our policies and priorities must support them, so that the nation remains competitive.

But, when you get to the bottom line, after looking at the myriad of policies, regulations and studies, you'll find the best competitiveness policy we've got is improving education. The next generation's education is, in many ways, the key to this nation's success in the world marketplace.

As I have said, I want to be the education president. I have proposed a series of education initiatives as a strategy for investing in people. This is a key part of our building a better America.

We cannot tolerate mediocrity. We've got to cut the dropout rate, and make America a more literate nation. Initiatives such as rewarding merit schools and excellent teachers, providing greater choice through the use of magnet schools, and instituting "alternative certification" are good ones. Creativity and a can-do approach will make all the difference in the world.

Children often imitate what they see



in us. If we don't make education a top priority, how can it be one of theirs?

Our students should be encouraged to study science and math, because their achievement in these fields is vital to their personal future and to the growth of many of the nation's future industries. Among today's strong science and math students are tomorrow's talented entrepreneurs. The establishment of a National Science Scholars Program can foster a greater commitment to science and mathematics education. We've proposed scholarships and opportunities for hands-on experience in federal research laboratories for top high school students across the country. It's good for the students, and in the long run, it's even better for America.

We'll build a better nation by working hard every step of the way. Before one can build, however, one has to envision the structure, imagine the framework and dream the dream. "For a dreamer lives forever, and a toiler dies in a day."

Our nation was founded because a small band of visionaries dared to dream of democracy. We opened the West because courageous pioneers risked everything for the dream of a new home in a new land.

Thousands of lives have been saved because American scientists have dreamed of a world free from disease, and we have crossed the frontiers of space because Americans have always dreamt big dreams.

The American Adventure goes to

"the inner light in which freedom lives," to that inherent self-respect each of us finds when we work with our hands and minds, building a life for ourselves and our families. It's the power to do what we want with our lives and our futures. It's the power to be free.

The Invention of America is a rare formula. It is one part hard work, one part fortitude, one part courage and one part compassion. But most important, it is a vision and belief that each new day, each new tomorrow, can be better than the last.

The Invention of America is a formula with no copyright. It is a vision we can share with the world. It is the American Adventure in which we can take pride.

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SACRED PLACES

America's monuments have chronicled our growing engineering skills while reflecting important shifts in the mood of a nation.

BY JOHN UPDIKE

THIS DEMOCRACY'S sacred places have evolved through processes that in retrospect seem random and chancy, out of seeds of inspiration in one or two determined individuals, under clouds of debate and delay and budget shortfall, into an impalpable rapport with the masses. In 1987, the seven most visited national sites were, in order—according to the statistics of the U.S. Park Service—the Lincoln Memorial, the Vietnam Veterans Memorial, the Statue of Liberty, the St. Louis Arch, the Jefferson Memorial in Washington, Mount Rushmore and the Washington Monument. The poor showing of the last-named seems surprising; but you have to stand in a 3-hour line, on a summer day, to ride to the top of the monument, whereas the Lincoln Memorial is an easy walk-through at the end of the Reflecting Pool.

The nearby Vietnam Veterans Memorial is undoubtedly the nation's most emotional spot now, its eloquent starkness of engraved black panels crowded with the written and floral tributes of wives and parents and sweethearts and fellow-soldiers for whom the war and its wounds are still fresh memories. But such warm-blooded immediacy is rare in major monuments. Washington was dead for 77 years, Lincoln for 57, and Jefferson for well over a century when their monuments were at last dedicated. At the time of his death in 1885, Ulysses Grant was, we are assured, "undoubtedly the most popular man in America." A crowd of over one million attended his funeral and, 12 years later, the dedication, in New York City, of the Grant Monument, popularly known as "Grant's Tomb"—a classical mausoleum comparable in sheer size and costliness only, in 19th-century America, to the Washington Monument and the Statue

of Liberty. But over the years the crowds who came to this vast shrine thinned, the last veteran of the Grand Army of the Republic passed away, and Grant's heroic generalship became diluted, in our shifting historical memory, by our awareness of his drinking and the sad corruption of his Presidential administrations. Warmth has ebbed from Grant's memorial, though its park is still gratefully used. The eventual fate of all monuments is to become, like the Sphinx, a riddle.

The word "monument" derives from the Latin *monere*, "to advise or remind." To achieve its monitory, mnemonic objective, the monument should be striking in some way, usually in its great size, from which comes the secondary meaning of "monumental." The Washington Monument was and still is the world's largest masonry structure, the Statue of Liberty its largest free-standing statue, the faces of Mount Rushmore its largest examples of sculpture, the St. Louis Arch—properly, the Jefferson National Expansion Memorial—its highest arch by far, containing more stainless steel than any other human project. To erect these symbolic marvels, engineers must cope with unprecedented challenges and create inventive solutions.

For instance, the Bunker Hill Monument, a granite obelisk 221 ft. high in the Charlestown section of Boston, occasioned, in 1826, the building of the first railway in the United States. The monument, which, in the words of a fund-raising flyer, "Will commemorate the *Greatest Event* in the history of civil liberty [the battle of June 17, 1775], should be, and *shall be*, the grandest monument in the world," required large blocks of gray granite from a quarry in Quincy that thenceforth was named Bunker Hill Ledge. A 3-mile rail line from the quarry to the shore was constructed, with granite sleepers, wooden rails topped by iron



STOCK IMAGERY PHOTO

Author John Updike visits the Washington Monument (opposite), a grand yet simple obelisk of stone. The Vietnam Veterans Memorial (above) evokes emotions from a painful chapter in our nation's history. Both monuments possess distinctive designs and unique construction that reveals much about the life and times of a changing America.

SACRED PLACES

ARTEAGA PHOTO



A simple geometric form and innovative construction mark the St. Louis Arch, a suitable example of modern monument-making.



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plates, and a continuous chain that enabled the loaded cars, traveling downhill, to pull up the empty ones. Yet the loading and unloading at the Quincy and Charlestown wharves proved troublesome, and the Granite Railway Co., not justifying its disproportionate expense, was replaced by the time-honored method of ox teams, which pulled the blocks the 12 overland miles to Bunker Hill.

The original design called for courses of stone 18 in. high. The final architect, Solomon Willard, asked for blocks 2½ ft. wide and 12 ft. long. The extraction and handling of such massive stones prompted the invention of a number of ingenious hoisting jacks, with worm gears and lifting wedges. Most importantly, a steam-driven crane was designed by the Boston seaman Almorán Holmes. Its boom had a range of 50 ft. and could be rotated through 360°. The latter stages of construction were greatly eased and speeded by this improvement over ox-powered hoisting. Willard wrote admiringly, "This hoisting apparatus is remarkable for its compass, and for the ease and grace with which it performs its work." Also, marvels of stone carving were achieved to fit a center core inside the obelisk, in exactly twice as many courses as the exterior, with a curved stair and a conical air space.

AN OBELISK MANAGES to combine, in its form, aggressiveness and eternity, peace and a spear. Obelisks in ancient Egypt, appearing first as grave markers, came to be used to celebrate Pharaonic jubilees and, their pyramidal summits plated with shiny electrum, as symbols of Sun worship. Despite their immense weight, a number were taken to Europe, and one such "Cleopatra's needle" adorns New York City's Central Park. The obelisk became a popular 19th-century motif of tombstones and a monumental rival to the triumphal column, a Roman form found in the Place Vendôme,

in Trafalgar Square (Nelson's column), and in Baltimore, as a monument to George Washington.

The idea of a monument to Washington is as old as the Continental Congress, which in 1783 passed a resolution in favor of an equestrian statue of the toga-clad general. Washington himself objected to the expense and the matter was dropped. No sooner was he dead, however, in 1799, than the matter revived. The jurist John Marshall proposed a marble mausoleum in the form of a pyramid 100 ft. sq. at the base. Three decades later, Henry Clay cried in Congress, "As a monument, rear it. Spend on it what you will. Make it as durable as the Pyramids, eternal as the mountains!" In 1836 a competition was held, and the contending entries included Italian campaniles, English Gothic towers, and most grotesquely, a structure, proposed by a California architect, showing "affinity with some of the better Hindu pagodas" and featuring a giant statue of Washington "attended by ladies gracefully leaning on their elbows." Even the winning entry, by Robert Mills, called for gigantic stars on the obelisk, at its 600-ft.-high tip a statue of Washington in a Roman chariot driving four horses, and around the base a colonnaded Greek temple 100 ft. high with 30 columns 12 ft. across. All these elaborate features were dropped during the actual construction, one of the most prolonged and tortuous labors in the history of American sacred places.

In the three decades after Washington's death, Congress had proved readier to come up with florid praise of the first President than with funds and legislation enacting a monument. In 1833, private citizens formed the Washington National Monument Society, which held a competition for the design and attempted to raise money by way of the 1840 census, awarding lithographs to contributors. By 1847, \$70,000 had been collected, enough to finance the commencement of construction. On July 4, 1848, with impressive Masonic rites, a cornerstone was laid, though no one now knows which stone it was. By 1845, \$300,000 had been raised, and the shaft had been raised to the height of 150 ft.

There it stopped for more than 20 years. The approaching War Between the States and its aftermath extended the interruption, but the affair of "The Pope's Stone" was the immediate cause. As anyone knows who has walked up the steps inside the Washington Monument, the interior walls hold about 200 memorial stones donated by states, cities, organizations, Indian tribes and foreign states. Pope Pius IX sent a block

from the Temple of Concord in Rome, and the Know Nothings, a xenophobic secret society especially antagonistic to Roman Catholicism, attacked the watchman on the night of March 5, 1854, and stole the "Pope's Stone," and presumably dumped it in the Potomac. The next year, on the eve of a substantial Congressional appropriation for completion of the great shaft, the Know Nothings broke into the office of the society, stole all the books and records, and claimed to be in possession of the monument, which they promised to complete as "an American institution, supported by all Americans."

But the easily observed change of color about a third of the way up the obelisk does not relate, as is sometimes thought, to a change from imported Italian to native marble. Up to 1854, the monument was faced with marble from a quarry at Texas, Maryland, just north of Baltimore. Upon resumption in 1879, four courses were laid with marble from Lee, Massachusetts. But this proved too expensive, and the remainder of its 555-ft. height was finished with marble from Cockeysville, in the Piedmont section of Maryland. In late December of 1884, 36 years after its disappearing cornerstone had been laid, the monument was capped with a stone weighing a ton and a half and topped by a 100-pound pyramid of pure aluminum. The giant obelisk was at this time the tallest structure in the world, and it remains, by civic decree, the tallest building in the nation's Capitol.

Before the era of skyscrapers and airplane travel, such vertical monuments

and mountaintops were the only way men could view their world from above. Now that aerial views are commercially commonplace, sacred places tend to hug the earth. Indeed, the Vietnam Veterans Memorial descends into it, to the depth of 10.1 ft. The most recent heroically high American monument is the Jefferson National Expansion Monument, designed by Eero Saarinen and erected to symbolize the city of St. Louis's historical role as gateway to the West. It would arch over the Washington Monument with more than 60 ft. of clearance. The construction of this great parabola of stainless steel, from 1962 to 1965, with the MacDonald Construction Co. as general contractor, involved prodigies of improvisatory engineering.

THE ARCH WAS ASSEMBLED of 142 noninterchangeable segments, equilaterally triangular in cross section. Prefabricated in Pittsburgh, they consisted of an outer skin of 1/4-in. stainless steel and an inner skin of carbon steel. The gap between the skins, 3 ft. at the bottom of the arch and less than 8 in. at the top, was filled with reinforced concrete up to the 300-ft. mark and then left hollow but for interconnecting braces. The first six sections, to a height of 72 ft., were stacked by crawler cranes on the ground. For the rest, a kind of twin railroad into the sky was devised. Eighty-ton work platforms climbed the two legs of the arch on tracks of 30-in. steel beams spaced 24 ft. apart. Telescoping supports kept the work platforms, with their own heated shacks, tool sheds and sanitary facilities, level as they climbed the arch. When a height of 530 ft. was reached, the original plan to use guy cables for stability was scrapped in favor of that of a 60-ton steel stabilizing truss nearly as long as a football field. Yet amid all these dimensions and tonnages, an almost microscopic precision had to be maintained: An error of as little as 1/64 of an inch would cause trouble at the top, when the two met. The steel walls were cambered 1 1/2 in. every 35 ft. to allow for welding deformation, and geometry control readings were taken at night, to eliminate uneven expansion in the sun's heat. The last segment fit perfectly.

Heat expansion also figured in the construction of the Statue of Liberty nearly a century before. The outside of the 151-ft.-high statue consists of copper sheets 3.32 of an inch thick—a hair thicker than a penny—beaten into shape over wooden forms. Its interior structure was designed by the great French engineer Gustave Eiffel. Eiffel concocted a gridwork of iron bars shaped to follow the convolutions of Frederic Bartholdi's statue. The armature bars were not directly attached to the copper skin but were fitted loosely into U-shaped saddles riveted to it, thus enabling the great sheets of shaped copper to expand and contract in the weather. In preparation for the renovation of the Statue in the 1980s, a team discovered that all 1705 of these bars



NATIONAL PARK SERVICE PHOTO

In contrast, The Bunker Hill Monument—America's first monumental monument—also introduced innovative construction techniques for the period. One of America's early railways was constructed to move stone from quarry to building site, and a steam-powered derrick—capable of 360° movement—gently laid the massive blocks in place.



SACRED PLACES

were frozen into place by corrosion. The replacement of 1699 of them was one of the most painstaking and crucial, though unspectacular, aspects of the renovation, whose most prominent improvement was the de-electrification of the torch and a return to Bartholdi's original concept of a gilded, reflective flame. The entire renovation, in passing, generated another monumental "most": The scaffolding at no point touched the Statue; it was the largest free-standing scaffolding ever built.

News stories about the heavily publicized restoration spoke of the pride and *esprit de corps* among the workmen. The quixotic actualization of these enormous symbols does seem to inspire the work crews. Monuments tend to have good safety records: The construction of the St. Louis arch, calculated to cost the lives of 13 workmen, in fact proved fatality-free, and the Mount Rushmore sculptures, though carved at a perilous height amid a number of mishaps, caused injuries but no death in their 14 years of creation, from 1927 to 1941. Not the least accomplishment of Gutzon Borglum, the headstrong creator of the gigantic sculptures, was his welding of a crew of mostly local South Dakota mine workers and roughnecks into an artistic instrument that, with dynamite and jack hammers, sensitively translated his vision to a granite mountaintop. One of the crew, Red Anderson, said shortly before his death 36 years after work stopped, "I think now that Rushmore has been 90 percent of my life." Borglum himself devised the sling-seats that held the men secure as they drilled at the cliff-face. And Borglum, who had previously worked on Stone Mountain near Atlanta and there used a photo-projector for his aborted bas-relief, invented for Mount Rushmore a boom-and-plumb-bob arrangement whereby points could be transferred, at the enlargement of an inch to a foot, from his 3-dimensional models to the rugged volumes of the mountain.

A HAPPY PROVIDENCE, it may be, has watched over our foremost national monuments, stopping them short at a grand simplicity. The Vietnam Veterans Memorial, we are surprised to read, was first designed by Maya Lin with a row of toppling stone dominoes in front of the wall of names—an obstructing pun her Yale classmates persuaded her to eliminate. In arriving at a sacred place, we are moved, often, by effects that can scarcely have been planned—the sheer loneliness, for example, of the Washington Monument on its bare knoll and, at a new sacred place in Washington, the slight tilt of

the round plaza of the United States Navy Memorial on Pennsylvania Avenue, a tilt that makes us feel we are on the deck of a ship with the statue, slightly more than life-size, of the Lone Sailor and his duffel bag. This plaza, a map of the world carried out in two tones of granite, embodies a new breakthrough in stone cutting, a method of cutting an irregular line with a high-powered, computer-directed jet of water and silica slurry. Without this technique, which can slice 2-in. granite at 1/2-in. per minute, the tightly fitting coastlines could not have been carved.

Advanced stoneworking techniques contributed as well to the emotional impact of the black granite tablets—imported from India, since all American granite was gray-streaked—that make up the Vietnam Veterans Memorial. The mirroring polish was imparted, in the final stage, by a felt buffer covered with tin oxide, which is finer than talc. The beauty and legibility of the lettering were finely calibrated. They are precisely .038 in. deep, with a central valley that minimizes shadow.

THE NEWEST MAJOR American monument, the planned Astronauts Memorial in Florida, also employs highly polished granite—a mirror-finished sheet, 50 ft. wide and 40 ft. high, which will reflect the sky while angled mirrors behind it shine sunlight through the dead astronauts' names, which are perforated in the stone and filled with glass or a light-diffusing epoxy. The names—12 men and two women have thus far died in the space program—will thus appear to float in a reflected sky. The slab is mounted and motorized to track the Sun through the day, and at night electric light will shine through the names. The emotional effect of this apparatus must wait upon its construction. In its depictions, the memorial seems possibly too glitzy and tricky. Its designers claim that a technological venture warrants a technological memorial, but technology can outrace our aesthetic sense and render matter trivial. We expect our monuments to be simple and still—emblems of permanence to which we bring the living flowers and passions of freedom.

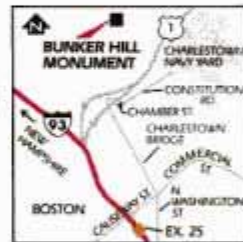
We expect monuments, too, to be low maintenance and relatively immune to the erosions of time. In fact, nothing material is totally immune. Even the giant faces of Mount Rushmore are constantly inspected for fissures and repaired. Rust and corrosion attack metal, frost and spalling attack stone, and vandalism and acid rain are on the rise. And there is a danger, even in our spacious and ceremonial Capi-

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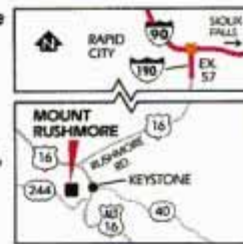
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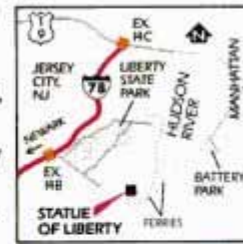
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tol. of too many monuments. The long delay in building the Franklin Delano Roosevelt Memorial, though its funds have been already voted by Congress, shows a traditional reluctance to rush into creating sacred places. A monument needs space around it, and time as well. A clutter and proliferation of sacred symbols and spots is a sign of decadence in religion, including the secular religion of patriotism. A monument should be singular. Fate and happenstance have endowed this democracy with a constellation of remarkably varied and aesthetically impressive representations of our national adventure, and this endowment should be enlarged with care.

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BY MICHAEL CRICHTON

GO NEGATIVE Y, negative Y," says the voice, and I push the joystick left. "That's better, watch your speed now." I'm starting to sweat, standing here at the console in the Shuttle. I look up, and see the arm swing the giant white payload cylinder over my head, toward the hab module.

I am surrounded by multicolored control screens, flickering video images and windows. Out windows to my left and right extend gridwork wings of the Space Station, silver against the black of space. Directly ahead, the curved habitation module roof, and the blue Earth beyond. All the other windows are black. I lower the payload cylinder tensely. It weighs 20 tons.

"Down on Z axis—no, the other way—Z axis, looking good—now your correct yaw—no, the yaw—uh oh! Soft alarm!"

A yellow button flashes. My console screens shift color.

"Your robot arm is too tight against the payload." Looking at the monitors, I see that this is true. "Go to your menu. Switch to single-joint mode."

Standing beside me in the simulator at NASA's Johnson Space Center in Houston, Blaine Brown talks me through the payload docking. I am practicing something that no human being will do in real life for at least five years, but procedures for 1995 must be tested now. The simulator evaluates docking procedures and console instrumentation for the Station yet to be built, and it's realistic enough to make me a little nervous.

In fact, one of the pleasures of the Johnson Space Center, outside Houston, is that visitors can get a real sense of what it's like to live in space, both now and in the future. Manned spaceflight is the special province of JSC because the astronauts are trained here on Shuttle simulators. You can also see

the mockup of the new Space Station scheduled for construction in 1995, and WETS, the huge tank where astronauts practice their extravehicular activities, or EVAs.

Our future in space is constantly surprising. Nothing is quite the way you think it will be. It's ironic that astronauts should practice EVAs in a giant water tank, because it turns out that EVAs are dangerous not for the traditional science fiction reasons of floating away or being punctured by meteorites, but because spacesuits are maintained at less than one atmosphere pressure and decompression problems are possible.

Something better will be needed for the Space Station, where astronauts are expected to assemble the Mars ships in orbit.

Robotics teams at Johnson are making an automated buddy, called the EVA Retriever. Lucky visitors occasionally glimpse the Retriever being tested. If a tool is lost, the Retriever can immediately go pick it up. Its video- and laser-imaging eyes distinguish among visual targets. Its programs can inspect the tool and decide where to grab it. In addition, the Retriever will also serve as a perfect dumb assistant for astronauts, following simple verbal commands such as "hand me the wrench" or "hold this for me."

Hands are a traditional robotics problem. Cliff Hess of JSC talks about making "smart hands" for robots—hands that sense when something is within their grasp, hands that can feel how tightly they are squeezing, hands that can manipulate an object between their fingers, as we can turn a fork or a screwdriver. In fact, robotic technology has advanced remarkably in the past few years.

In one lab, I tossed a baseball to a smart robot hand, which caught it perfectly every time—except when it got too quick, and caught the ball between its fingertips. I shook hands with this Utah/MIT hand, and its grip was gentle and precise, although its



NASA PHOTO

For now, our space quests must begin on Earth. Author Michael Crichton (opposite) visits Kennedy Space Center, America's principal space facility, prior to last fall's Discovery launch. The model of the Shuttle-deployable Starlab remote-sensing platform represents one avenue to future exploration of the Cosmos. Kennedy's Vehicle Assembly Building (above) is framed by a rather mundane yet vital element in America's space infrastructure—the huge crawler tractor that transports assembled orbiters to one of Kennedy's two launch complexes.

SPACEPORT AMERICA



NASA PHOTO

Johnson Space Center's Mission Control, the heart of NASA during an actual space launch.



NASA PHOTO

New spacesuits are developed in large water tanks at Marshall Space Flight Center.



SPACE CAMP PHOTO

America's future astronauts convene at Space Camp in Huntsville, Alabama.

infrared sensors gave it a slight quiver, as if hinting that there was still more to come.

WHAT'S AMERICA'S future in space?" Rick Chappell pauses, looks out the window at the beautiful rolling hills of the Marshall Space Flight Center in Huntsville, Alabama. This is Von Braun territory, the place where NASA's propulsion systems are designed, a place of pragmatic, hard-nosed men. Visitors see signs of that tough legacy everywhere, from the tiny primitive bunkers where we tested our first rocket motors (now a historical preservation site) to the giant concrete superstructures used to check modifications in the Shuttle engines after *Challenger*.

Chappell is tough-minded too, and his message has its grim side. "Every commission that has looked at what we ought to do in space—the Payne Commission, the Ride Report, the National Commission on Space, the National Academy of Sciences—has recommended the same thing," he says. "A vigorous program in both space science and in manned flight. We should have a program to study our Earth from a variety of orbiting platforms. We should have a robotic exploration of the solar system. We should go back to the Moon, reach out to Mars, and ultimately colonize both places, as a part of man's eventual release from the bonds of this planet."

Chappell points out that the American public agrees: Polls show that 67 percent of Americans want a vigorous space program, and 72 percent favor a joint U.S.-Soviet mission to Mars.

Will we do it?

"I hope so," Chappell says. "The future could be just incredible." But then he frowns. He doesn't say what we are both thinking.

Present trends are not so encouraging.

The Soviet Union, the first nation to put a satellite in space, the first nation to put a man into orbit, is now the preeminent spacefaring nation on Earth, far surpassing the United States. Last year, the U.S.S.R. accounted for almost 90 percent of the

world's orbital launches. We launched seven rockets into orbit. The Soviets launched 110—and much of that supporting a manned program. The Soviets have now put eight Space Stations into orbit, and have logged three times as many man-years in space as we have, although 15 years ago, we were in the lead.

"I don't want to sound negative," Rick Chappell says, but the statistics are disturbing. American education is faltering, especially in science and engineering. Ten years ago, Americans made 75 percent of the world's new discoveries. Now we make 50 percent. If present trends continue, in 10 years we will make only 30 percent. America has always competed with advanced technology, but we are slipping fast.

What about the cost of the space program, at a time of budget deficits? What about our priorities, our pressing problems on planet Earth?

In a competitive, technological world, we can't afford *not* to go. And Chappell points out that out of a total national budget of \$1 trillion, an annual expenditure of \$20 billion on space is not burdensome. The Defense Department spends 30 times what NASA does and a small part of that could easily be diverted to civilian space.

IF CONGRESS CAN'T grasp that space is vital to America's future, youngsters sense it instinctively. Outside Marshall is the Alabama Space and Rocket Center, where visitors can crawl inside an *Apollo* capsule, walk through *Sky-lab*, and take rides that give them a sense of weightlessness and high-G acceleration. Space Camp is also located here, and last year 19,000 youngsters, a third of them girls, came to Huntsville to attend. The number of kids has been increasing steadily every year since the camp opened.

One 10-year-old was interviewed on TV after his week at camp. Asked about the future, he spoke of colonies on the Moon and trips to Mars. The reporter said, "How are you going to get the Congress to pay for it?"

"Maybe your Congress won't," the 10-year-old said. "But mine will."

At the National Air and Space Museum in Washington, D.C., visitors are reminded that the history of manned flight is a peculiarly American undertaking—something we have dominated from the days of Kitty Hawk. Two blocks from the museum, in NASA's newly formed Office of Exploration, Alan Ladwig considers where we'll go next.

Mars is the next great emotional objective, the next target to fire the imagination, but Mars is far, both in distance and in time. "The Moon isn't very far away," Ladwig says. "You can go and come back in a few days. But the shortest scenario for a round trip to Mars is 15 months, and some scenarios run almost three years."

What's the best way to go? The Ride Report recommended the "split sprint," in

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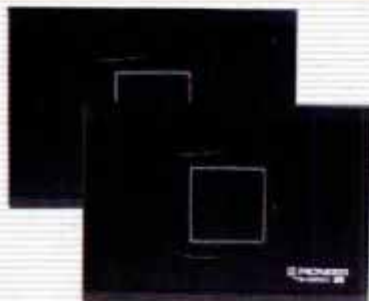


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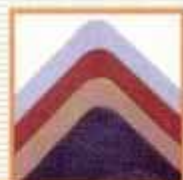
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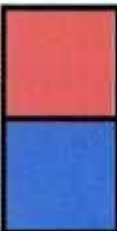
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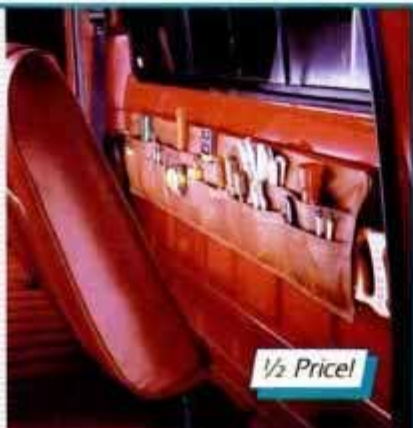
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NASA PHOTO

Visitors to Kennedy Space Center learn of America's space heritage at Spaceport USA.



NASA PHOTO

The controlled ecological life support system experiment at Kennedy will show Mars mission planners how to grow food on long-duration flights.

which an unmanned cargo vessel is put in orbit around Mars, followed by a manned flight that would take 15 months—440 days, including 30 days in orbit around the planet. Astronaut Michael Collins argues for the "Venus Flyby," which would take 22 months—660 days, with two months at Mars. Other possibilities include orbiting the red planet with a manned landing on the Martian Moon Phobos, which is much easier, but which lacks the excitement of Martian landing. Ladwig's office won't even make a recommendation about the best way to go until 1992. And there won't be an actual flight to Mars until 2004 or so. For Ladwig, even the quickest journeys will require demonstrated technology that does not, at the moment, exist.

"To take a single example," he says, "we talk about assembling the Mars ships in low Earth orbit, using personnel from the Space Station. But at Cape Kennedy they need hundreds of people to assemble the Shuttle. We won't have all those people up there. It's not clear to me that anyone has taken a hard look at whether we can really do assembly in orbit."

"I'm certain we can work all this out," Ladwig says. "But right now, as we sit here, the studies haven't been done."

IN THE FAR CORNER of the Kennedy Space Center in Florida, miles from the excitement of the launch complexes that draws so many visitors each year, across the causeway near the manatee preserve, is Building L, where Bill Knott runs CELSS: Controlled Ecological Life Support System. At its center is a hyperbaric chamber once used to test *Mercury* capsules. Surrounding the chamber are two stories of giant air handlers, filters and pumps, miles of tubing, thousands of wires. All for a simple purpose.

Bill Knott is trying to grow food for one man in space.

People have talked glibly about growing food for years, but Knott is, in his words, "actually trying to do it." It's not so easy. He has massive technical problems growing wheat, potatoes and soy in a closed environ-

mental loop. And he's also worried about the psychological problems of food for the crew.

Knott asked a university nutrition department for recipes using the six foods he knew he could grow. "They gave us about 200 recipes, of which maybe 35 were doable." It's not enough. "They told us they needed tomatoes, and we hadn't planned to grow tomatoes. And you need a source of oil for cooking. The astronauts have flour, but bread is hard to make if you don't have eggs and milk."

Will future astronauts be vegetarians? "Not necessarily," Knott says. "We're trying to get some meat in there." One system he is studying involves growing Tilapia, a trash fish. In one laboratory, spinach grows on hydroponic stems, nourished by the waste of swimming fish in an adjacent tank. But will this system work energetically? It's too soon to tell.

THE EARLY DAYS of spaceflight were short on amenities. It's said that when ground crews opened the 3-man *Apollo* capsules back from the Moon, the stench was breathtaking. The Shuttle is roomier and more pleasant, but its toilet is notorious: smelly, noisy, despised by crews. This is tolerable for 4- to 7-day flights in space. But what will long-duration life in space be like?

Moving down the Space Station mockup at Johnson, we come to the crew quarters. Inside, the station is square. Crewmen live on each of the four walls (including floor and ceiling, since in orbit there's no up and down.) Each personal space is roughly the size of a small walk-in closet, containing a computer, TV screen, VCR, lockers and a porthole. They'll sleep in wall-mounted sleeping bags, and will call home to their families every night. "The Soviets found that was the key to long periods in space," I am told. "They've got to be able to call home every night."

Further down the hab module is the toilet (extensively revised) and a vacuum shower (slow, but it works), then the medical station and the galley. Where's the exercise equipment? They point up. It's directly above me, mounted on the ceiling. The galley is pleasant, white and clean. Racks of food pull down from the ceiling, each meal individually wrapped. I try to imagine what it will be like to sit here with my feet hooked into foot restraints and eat a meal while someone else sits upside down in front of me on a rowing machine.

Listening to the explanations, it becomes clear that LEO—Low Earth Orbit—is still very much a part of Earth. The Space Station is not separate from the Earth, but rather a remote outpost, like Antarctica. Its environmental loops are not truly closed. It is not truly independent. True independence for man in space lies in the future.

This is how we got to the Moon: Werner Von Braun of Huntsville strapped nine proven



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SPACEPORT AMERICA

rockets together to make the *Saturn I*—and then he strapped together five of those to make the mighty *Saturn 5*. In essence, we rode to the Moon on 45 previously proven rockets coupled with an absolute minimum of new technology.

Another Huntsville project in the Von Braun tradition is the unmanned Shuttle-C, intended for startup in 1991. Utilizing existing boosters, rockets and launch facilities, it gives NASA a heavy-lift capability at minimal cost.

Although the Shuttle can lift 240,000 pounds into orbit, the orbiter itself weighs 200,000 pounds. This means the payload is only about 40,000 pounds, which is not enough for the 1990s. But the unmanned Shuttle-C can lift 170,000 pounds, with greater launch schedule reliability, at half the cost.

Woven into the schedule of manned flights, Shuttle-C would enable the Space Station to be built in 19 months, instead of 38 months. And Shuttle-C can lift, for example, a Mars Rover probe and its Centaur Rocket into orbit. (In fact, it can lift two into orbit at one time.) For scientific teams like the Jet Propulsion Lab, which have been fighting probe weight with expensive miniaturization, Shuttle-C offers attractive possibilities. And NASA desperately needs an alternative to the manned orbiter.

If Shuttle-C represents the sensible near future, what's farther ahead? One place to look is the Ames Research Center outside San Francisco. Here, amid a startling, unworldly landscape of giant pipes and enormous braced tubes—the wind tunnels that have made Ames world-renowned—some of NASA's most advanced work is being done. It hints at a bizarre and startling future to come.

For example, the National Aerospace Plane, the "Orient Express" intended to fly at Mach 22 from New York to Tokyo in an hour, is now being studied with the most powerful supercomputers in the world. But it isn't just a matter of airflows and wing structure—the computers at Ames are also doing molecular chemistry.

PROJECT SPOKESMAN James Arnold points out that "the Aero-Space plane will be literally flying in an inferno—at temperatures of 3000° F, where most metals liquefy and run." At such extremes, the hot metal surfaces react chemically with molecules of air flowing over them, affecting performance. And hydrogen ions in its exhaust flow into the metal of the plane, changing the aircraft in what is called "hydrogen embrittlement"—flexible metal may now shatter like glass.

Then, when the airplane enters space and cools, the supersaturated hydrogen ions may leave the aircraft so rapidly, like soda fizzing over in a bottle, that they literally explode the airplane. It is as if the whole airplane is subject to the bends.

Faced with these exotic problems, Arnold says it will take three years of intensive study to decide whether the NASP is buildable at all in the foreseeable future. But as Arnold says, "that's what turns us on—the challenges."

COMPUTER SIMULATIONS of a different sort can be found in the Life Sciences building, where Steve Bryson and Rick Jacoby demonstrate the Virtual Interactive Environment, known locally as "the helmet." It's almost unbelievable: a system out of 21st century science fiction.

You wear a special glove, and a headset which contains an LCD screen on which is projected a computer image of a different room. As you walk and turn your head, the projected view before your eyes changes. The illusion is uncanny.

You can push objects around in this other room, bounce balls off the walls, manipulate robot arms. You can make Macintosh-like menus that hang in space, and you can grab the menus in your hand and move them out of the way if they're blocking your view. You can ride up and down escalators.

Yet none of this is "there," in the real world. Flip up your helmet, and you're standing in an ordinary room at Ames. Flip down the helmet, and you are back in some other, very exotic world.

What good is the system? Operators can control distant robots with precision, taking them over. Already the Mars Rover's eyes have been linked up to the helmet. Earthbound scientists can walk through graphic displays of their data, inspecting them from all sides. Astronauts can use menus and diagrams inside their helmets on EVA.

In fact, the Virtual Interactive Environment is so revolutionary it seems a little like the first computers—it'll be a few years before people figure out all the things it can be used for.

Back in the real world—Launch Complex 39 at Cape Kennedy—one day before the launch of STS-26, *Discovery*. It's the first launch in two and a half years since *Challenger*. It's one day before the 30th anniversary of NASA. Roughly 30 years after *Sputnik*, roughly 20 years after the landing on the Moon. And one day before the signing of the international agreement on the Space Station in Washington.

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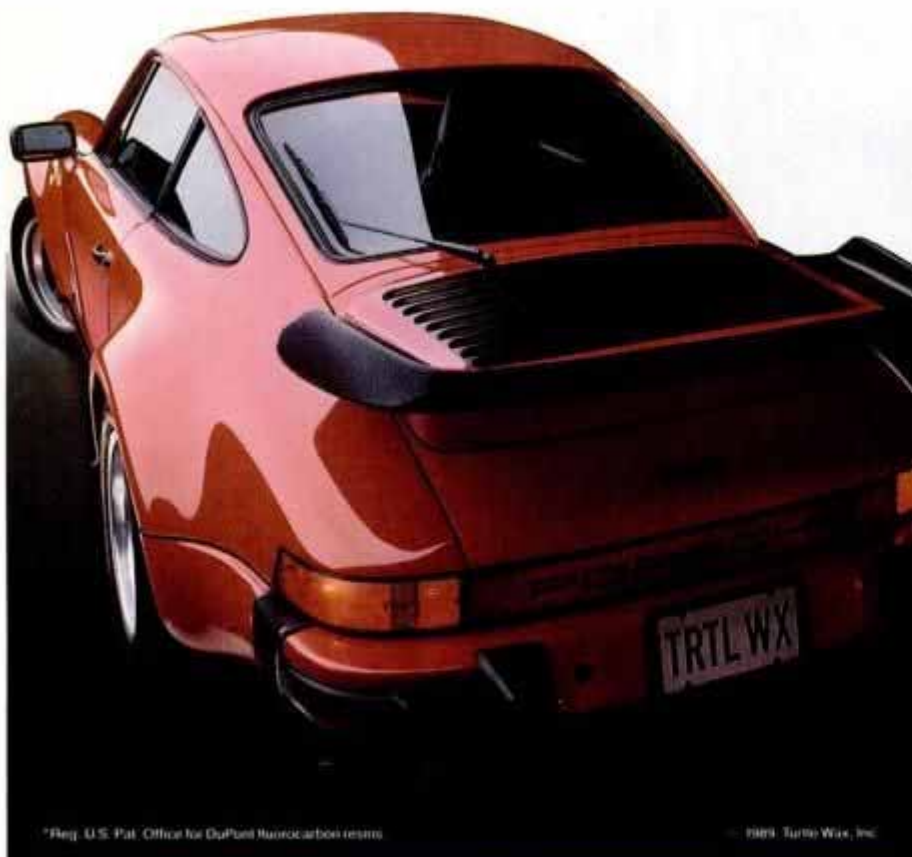
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SPACEPORT

are here at Kennedy. NASA's overloaded. The weather's sticky. The press is irritable and complaining until sundown, when everybody goes out in buses to Launch Complex 39B.

Then all the complaining stops. Everyone falls silent, standing before the most expensive and dangerous departure lounge in the world. In the darkness, the Shuttle is brilliantly illuminated by searchlights which streak far into the night sky. *Discovery* shines like a jewel.

As hundreds of press photographers swat mosquitoes and snap their photos, the Shuttle appears like a cathedral, a great edifice reaching toward the heavens, brightly illuminated.

Emotions come unbidden, the realization that the exploration of space is the great human adventure of our century. It is a profoundly romantic undertaking, and it is unquestionably expensive and dangerous, as exploration throughout human history has always been. But this is the next step, and it is ours to take. **PM**

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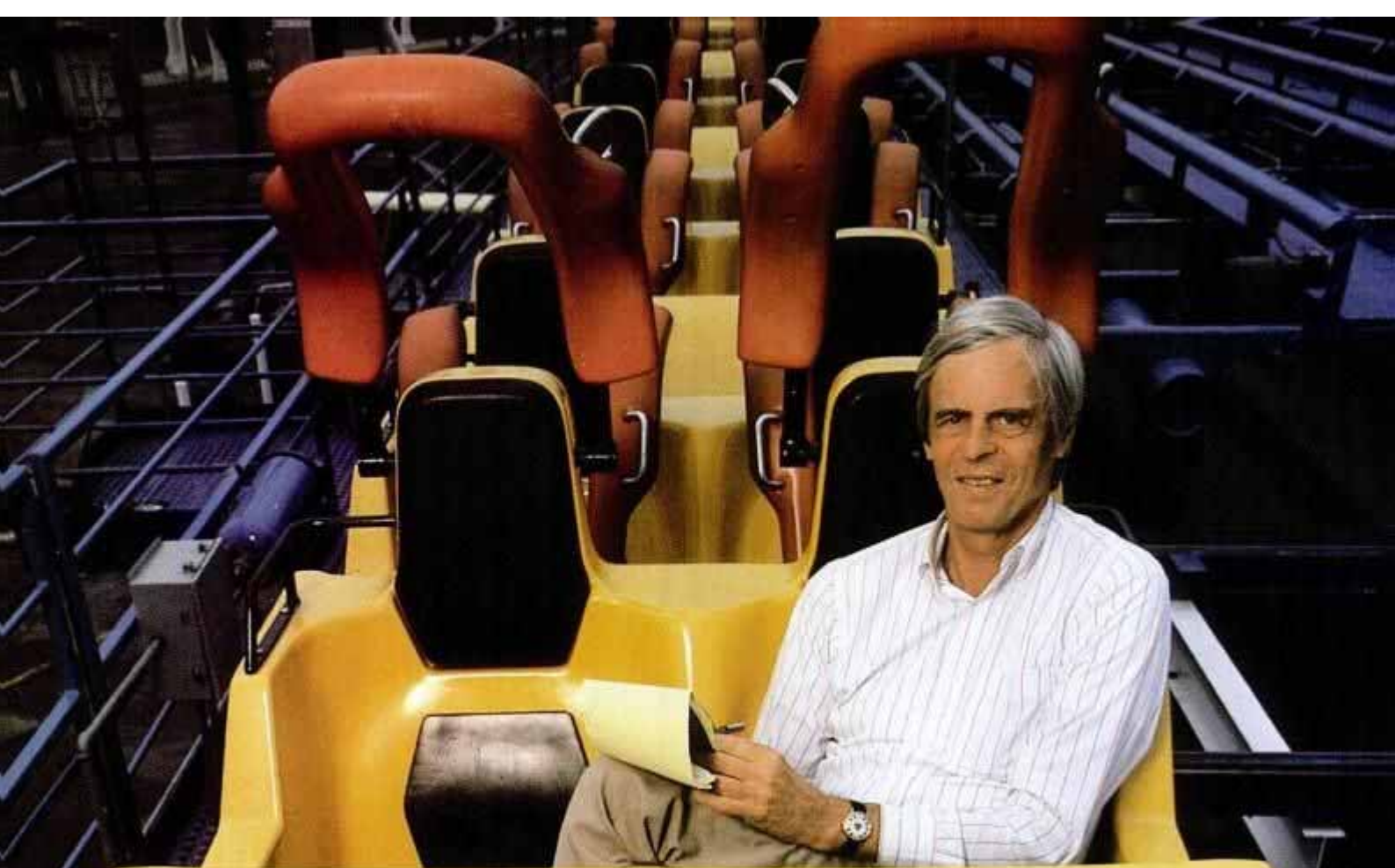
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SHOCK WAVE

AMERICAN THRILLS

From oldie-but-goodie woodies, to high-looping steel, PM takes a coast-to-coast tour of the nation's hottest roller coasters.

BY GEORGE PLIMPTON

O for a life of Sensations rather than of Thoughts!
 —Keats

LAST AUTUMN I TOOK the last ride of the season on the Coney Island *Cyclone* before it closed for the winter. I drove to the Brooklyn seashore—a mistake, perhaps. I had been told that the best way to prepare for the *Cyclone* was to take the subway—its jostling, sudden stops, lurching, swerves, swaying and noise being the perfect conditioning exercise. I had not been on a roller coaster for more than 20 years, but as I drove along Surf Avenue and saw the bulk of the *Cyclone* against the evening sky the same feelings came back—the vague discomfort, the slight quickening of the pulse, the same self-questioning: Why on earth am I doing this? In fact, I had a perfectly legitimate reason—to report about experiencing rides on five of the nation's great roller coasters.

The *Cyclone*, Coney Island, Brooklyn, New York

Coney Island was the obvious choice to begin with. Opened in 1927 and remodeled in 1967, its *Cyclone* is the most celebrated of roller coasters. Charles Lindberg once said that the thrill of the *Cyclone* beat the thrill of flying. After all, such an experience is perhaps the keenest-felt, certainly of adolescence—with a near tactile memory of the event itself: the climate of the evening, one's pals on the trip, the first sight of the vast edifice, the faint shrieks of those already committed to its embrace, the slow inexorable progress of the waiting line, the wonder that one did not duck under the restraining ropes to forget the whole thing and enjoy a lemonade at the concession stand before a visit to the less-taxing Fun House.

But no, one shuffled slowly toward the

loading station, cackling hysterically at the feeble jokes of gallows humor until the final lowering into the cracked leather seat of the car itself, the clamp of the iron bar across the lap—and then as one stared gloomily up the incline of the lift-hill, the pleasant carnival sounds of the fairgrounds fading away, one heard only the harsh clacking of the ratchets underneath as the coaster headed up through the cool of the evening toward the last hump, which had nothing beyond it but the dark sky.

All of this came instantly back to mind on the *Cyclone*. The true terror set in on the first drop. After poising at the top of the lift-hill the train picks up speed down a sharp incline and then abruptly—almost as if the tracks had come to the edge of a cliff—the slope falls away at an even greater angle, nearly straight down, so that I was stricken by two stages of terror, one following on the other almost instantaneously. I do not remember yelling outright during the ride, but I recall a number of strangled cries and a few breathless exclamations of “Lordy!”—an expression I tend to use at moments of extreme stress. I decided that this would be an interesting method of rating the five roller coaster rides I had planned. I jotted down in my notebook that the *Cyclone* had produced 10 “Lordy!”s, including one in relief as we glided back to the station.

I rode twice that evening, sitting in the rearmost car for the last ride of the season. In the seat in front of me I noticed a passenger wearing a jacket covered with pins, buttons and patches denoting various roller coasters around the country. On the station platform I introduced myself. His name was Steve Urbanowicz, and he had been riding the *Cyclone* since it had started up that morning. He announced himself as a roller coaster buff and a long-standing member of A.C.E., which stands for American Coaster Enthusiasts, a club of about 2000 mem-



Action journalism: Author George Plimpton recollects emotion in tranquility (opposite) after his front-seat ride on Six Flags' Shock Wave (above).

AMERICAN THRILLS



PHOTO BY PAULL RUBEN

Riverside's Cyclone, in Agawam, Massachusetts, compensates for small size with very steep drops.

bers. He referred to his jacket as his roller coaster tuxedo. "I wear it for rides on the opening and closing days of the season."

I explained my project and asked Urbanowicz how he rated the *Cyclone* among the hundreds of coasters he had ridden. He hardly paused.

"The Coney Island *Cyclone* is at the top," he said. "It has that fantastic first drop." I nodded in firm agreement. "It had good turns and a big finish—it doesn't peter out. Just as you think you're getting to the safety zone at the end, it gets faster."

"But I've never been bored on any roller coaster," Urbanowicz went on to say. "For my 29th birthday I picked the *Hurricane* to ride for every year of my life. I wondered if that wouldn't be a test of my enthusiasm." The *Hurricane*, he explained, is located at Boardwalk And Baseball, an amusement complex near Haines City, Florida. "I ar-

rived at 9 in the morning. It was raining slightly, which is good because you get a faster ride. I reached 29 rides and I had no thought of stopping except for a lunch break. I rode the *Hurricane* until it closed—79 times. That's 24 more than my record up until then, which was 55 times on the *Loch Ness Monster* in Busch Gardens, near Williamsburg, Virginia."

I whistled in awe and asked if he still yelled at points during the rides. "Perhaps not a yell," he said. "A shout from time to time is certainly a part of it."

We went across the street to an open air bar. The tracery of lights along the length of the *Cyclone* winked off, its strange convoluted shape dark against the sky. "It'll be a long winter," Urbanowicz said wistfully.

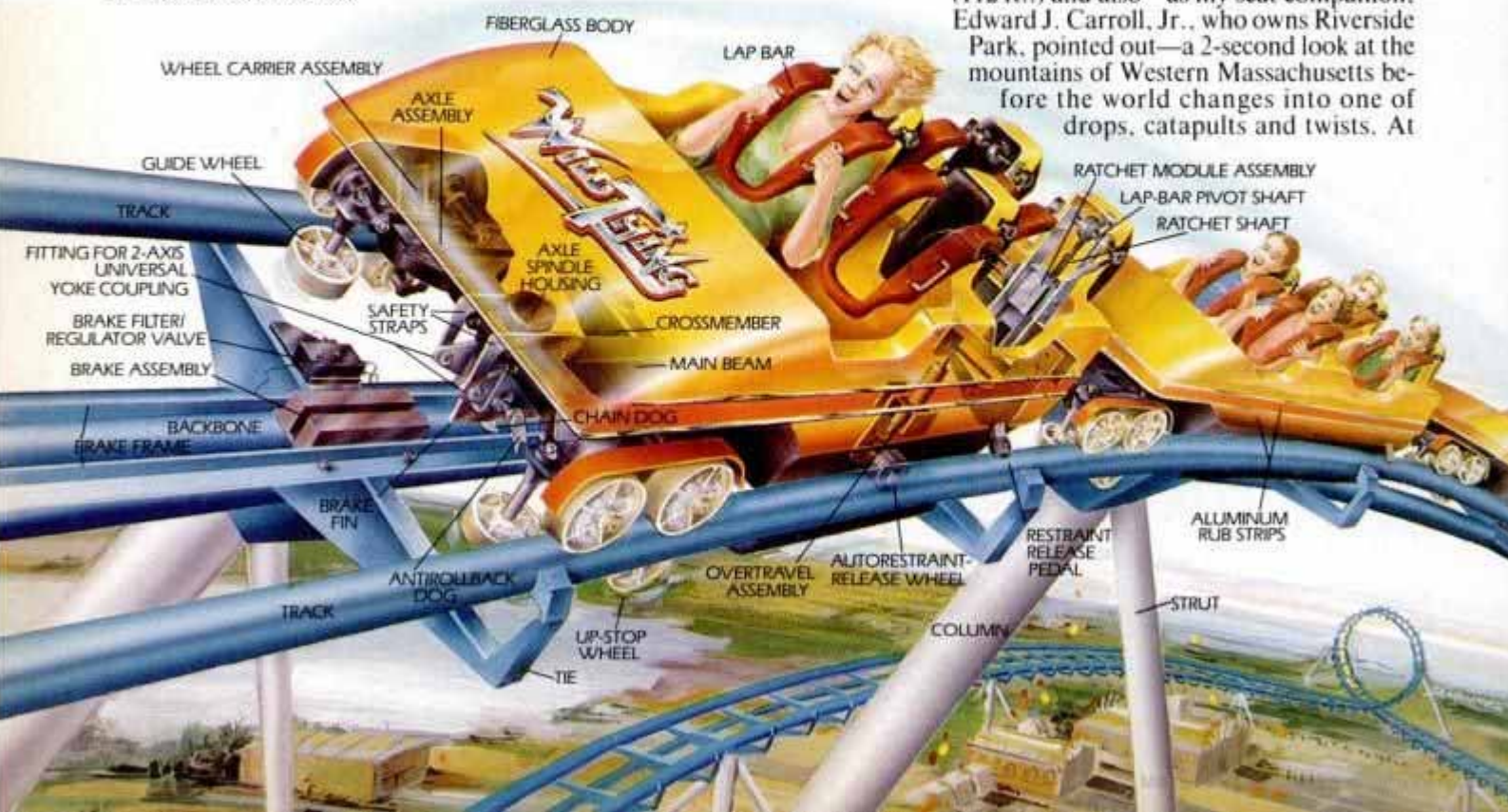
The Cyclone, Riverside Park, Agawam, Massachusetts

The Riverside *Cyclone* is aesthetically wonderful to see—a vast pure white structure set in the hills at Agawam, 4 miles across the Connecticut River from Springfield, Massachusetts. Physically, the *Cyclone* is a terror—perhaps the wildest ride of all the major roller coasters. One of the reasons for its kinetic violence is that it is built in a small area, requiring extraordinarily steep drops and quick turns to fit everything in. It was designed by Bill Cobb, who has gone through open-heart surgery and is advised not to ride his awesome creations.

The lift-hill is extremely steep, a 28° slope, so that I found myself tilted back hard against my seat as the train clacked up toward the summit. Here there is a mild turn to the right onto a kind of platform. This ingenious design gives the passenger a sideview glimpse of the horrifying first drop (112 ft.!) and also—as my seat companion, Edward J. Carroll, Jr., who owns Riverside Park, pointed out—a 2-second look at the mountains of Western Massachusetts before the world changes into one of drops, catapults and twists. At

Anatomy Of The Modern Steel Roller Coaster

PH ILLUSTRATION BY DON MANNES



the bottom of the first drop, the train moves at 60 mph into a high-speed banked turn, so that if it were not for the restraining bar, a rider would be tossed over Route 159 into a grove of trees. Enthusiasts consider this wrenching, 45° banked turn to be the country's prime first-drop experience—in my case, producing three "Lordy!"s in a row.

I asked Carroll why Riverside had not picked a more original name than *Cyclone*. He smiled and said his people had had a number of naming sessions. But they decided they couldn't go wrong naming their roller coaster after the granddaddy of them all—Coney Island's *Cyclone*. I nodded in agreement: The number of "Lordy!"s was about the same.

The Shock Wave, Six Flags, Great America, Gurney, Illinois

I did not much like the looks of the *Shock Wave* at first glance. Staring up at the great tubes of the complex I was reminded of the conduits and pipes of an oil refinery. *Shock Wave* provided not only the first steel roller coaster ride of my life, but also my first experience with loop-the-loops. There are seven in the ride during which the passenger is literally upside down. Because people waiting in line can see the loops and the trains sweeping through them upside down, there is a fair amount of anticipatory yelping and near-weeping from the high school crowd. One young girl started to approach her car, glanced over at the loops, then just kept on walking toward the exit sign.

My guide on the *Shock Wave* was Paul Ruben, a member of A.C.E and the editor of *RollerCoaster!*, the organization's magazine. He carries Dramamine pills so his pleasure on the rides is not compromised by feeling queasy. He offered me one.

"You get clammy after four or five times."

I said one ride might be enough.

I accepted his offer.

As we inched forward in the line for the train, Ruben said that the back car was the desirable place to ride the loopers: One sees the front of the train upside down, which gives a vivid premonition of what is to come. He also suggested that I turn my head to either side in the loop and watch the horizon rotate—thereby intensifying the feeling of being upside down.

Such advice is very much like the suggestion that the best way to ride a roller coaster is to resist the urge to grip the restraining bar with desperate strength—"white knuckling it" as it is called—but to relax instead, so that the ride can be experienced, not fought against. Another way to "feel" a ride is to lift one's feet off the floor of the car. A better-known method is to hold one's arms aloft. This is not only a macho gesture ("Look Ma, no hands!"—suggesting emancipation from the bonds of



PHOTO BY RICHARD ROBERTSON

adolescence), but since one is held in place only by the restraining bar, there is a greater sense of flirting with danger. That is a familiar sight from the Midway—a trainload of upstretched arms on the upper slopes of the coaster, as if the passengers were victims of a stickup by a gunman in the rearmost car. It is, however, not a common sight on *Shock Wave*.

At the time I rode *Shock Wave*, it was the tallest (170 ft.) and fastest (65 mph) steel, looping coaster in existence. The length of the first vertical drop is 155 ft.—the equivalent to an urbanite like myself to peering over the edge of a 12-story building.

I did not lift my feet off the floor. I white-knuckled it. I do not remember following Paul Ruben's advice on the loops. I suspect my eyes were closed.

I cannot truthfully say what it was like to be in the loops except that I wondered vaguely if Ruben's Dramamine pill would be effective. As for the "Lordy!"s, they were too many to count.

The Thunderbolt, Kennywood Park, West Mifflin, Pennsylvania

Most roller coasters move out of the station and begin climbing a lift-hill almost immediately. First-time riders on the *Thunderbolt* are puzzled, even lulled into complacency, because looking along the track from the loading platform they can see no sign of a lift-hill: The track leads off at a slight decline into a leafy forest of oak trees. Stranger still, there is no sound. Missing is the familiar clatter of the ratchets, which prevent the cars from slipping backward if the chain lift breaks. Absent too are the yells of passengers on a downward plunge. Only the operator in his little booth at the end of the platform, impishly rolling his eyes heavenward and crossing himself, suggests that what lies ahead is not going to be like taking a horse-drawn carriage-ride through a forest parkland.

Sure enough, a short distance into the trees the coaster drops into a ravine and plunges down toward the Monongahela

Four minutes on Kings Island's The Beast includes terrifying tunnels and a spiraling descent.



PHOTO BY PAUL L. RUBEN

Here's a vertigo-inducing view of the first drop on Coney Island's Cyclone.



PHOTO BY PAUL L. RUBEN

Gut-wrenching surprise drops characterize Kennywood Park's deceptive Thunderbolt.

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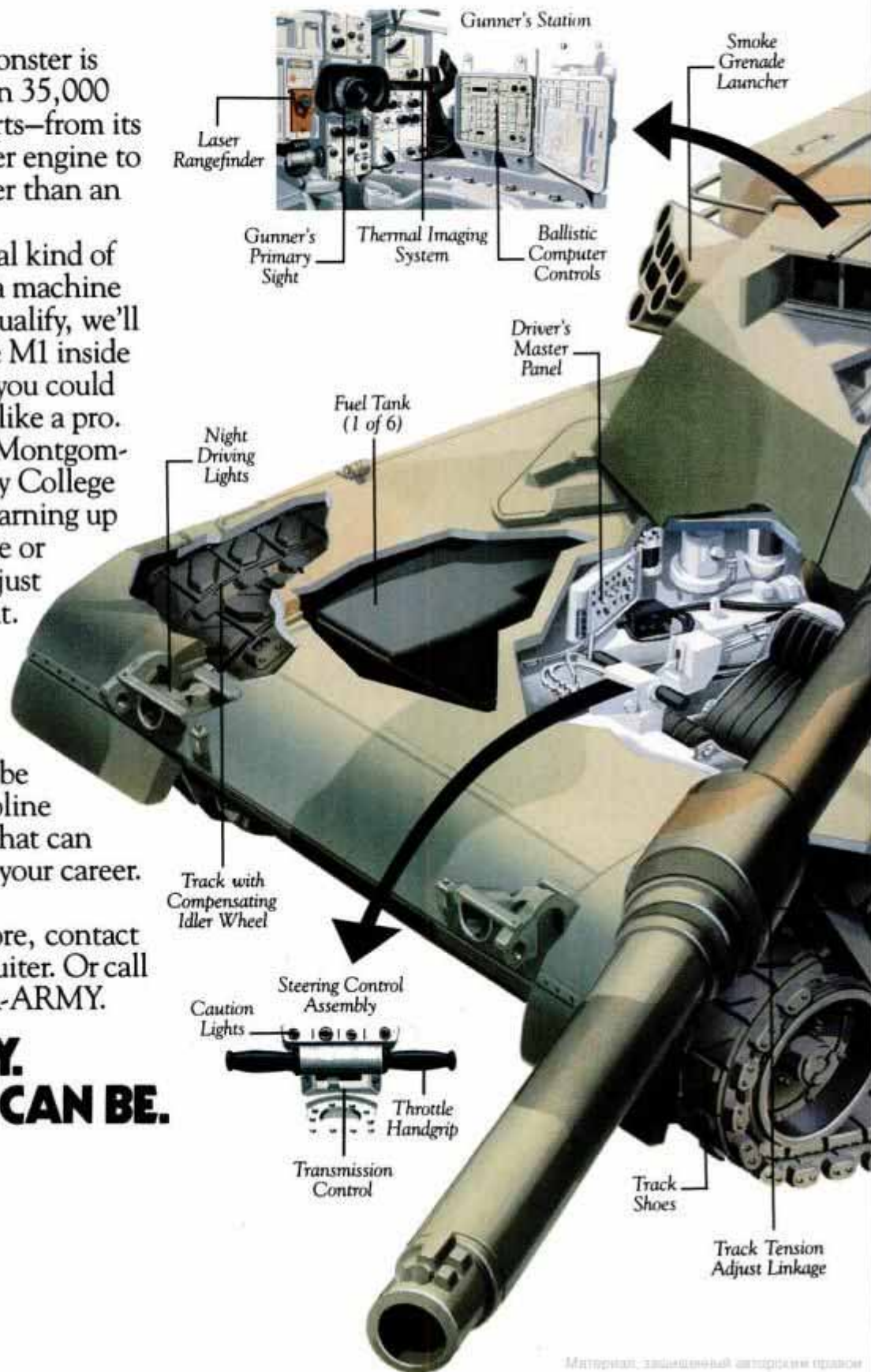
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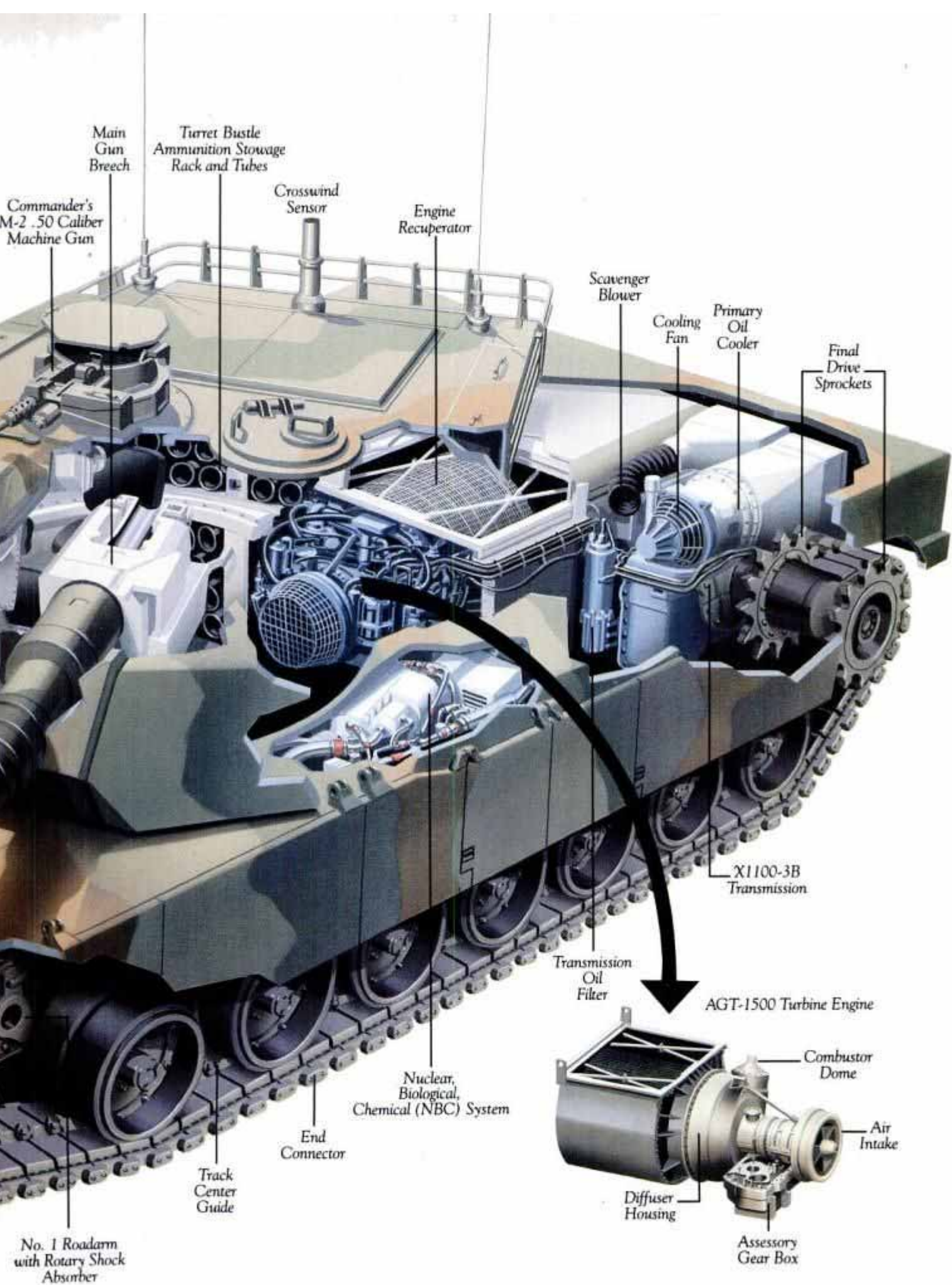
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AMERICAN THRILLS

River. The unique feature of the *Thunderbolt* is that the lift-hill occurs halfway through the course. The train races around a curve and glides to a halt part way up a long slope, where the ratchets catch and the link belt begins to pull the cars up toward the distant summit.

With no lift-hill at its start, *Thunderbolt* seems to have been built backward. Indeed, one of its most abrupt drops is right at the end. Just at the point where one expects a smooth glide into the station, and begins exulting with a sigh of relief that one has survived, once again the bottom seems to fall out of the forest and the train hurtles down a 90-ft. drop. Passengers returning to the station have a unique look—a kind of glazed, uncertain, nervous stare as if perhaps the station itself might suddenly revolve on its axis and subject them to still one more fright.

Originally built in 1926 and known as *The Pippin*, the coaster was extended structurally in 1968 and rechristened *Thunderbolt*. Paul Ruben told me that its designer, Andrew S. Vettel, rarely rode his roller coasters because he had a "nervous stomach."

That first drop into the ravine through the forest certainly unsettled mine. For the surprise of its start and the fury of its finish, *Thunderbolt* finishes very high on the "Lordy!" list. In fact, I even let loose with an exclamation or two long after the ride was over and I was simply thinking back on the experience.

The Beast, Kings Island, Kings Island, Ohio

At every park I had visited, someone had mentioned *The Beast*. "You haven't done *The Beast* yet?" someone would ask with a shake of the head.

This wonderfully named coaster on the outskirts of Cincinnati was, at the time I rode it, the longest (7400 ft.), highest (141 ft.) and fastest (66 mph) wooden coaster in the world. By the entrance, quaint signs in Gothic lettering set the tone for what is to come. One reads, "The Beast Is Always Lurking In Ambush," and another, "Beware: You May Lose Your Eyeglasses To The Beast." Ruben pointed out a shelter-like area just off the loading platform where, on a red-cushioned settee, overwrought riders could sit for a while and recover. While we watched, a frightened young boy was half-supported from the train to the settee. His mother hovered over him, patting his forehead. She turned and complained to his older brother. "I told you, Charlie, he's big enough but he's not old enough for *The Beast*."

The Beast has several distinctive features. Like the *Thunderbolt* it winds

through a forest. Its great length affords two lift-hills, giving a passenger almost 4 minutes of its tortures rather than the usual minute or two. At the bottom of both lift-hills is a tunnel, its entrance pitch black and so small at first sight that coming over the summit and tearing down the slope, it seems doubtful the train can squeeze through. The black holes of the tunnels seem to suck the trains into them.

Once inside, the sounds—especially the shrieks—are magnified along with the sensation of speed, so that one sighs with relief when the cars burst back out into the dappled sunlight of the forest.

The slope off the first lift-hill is perhaps the most frightening aspect of *The Beast*. Not precipitous, it is long, very long, so that the train picks up speed and reaches the tunnel entrance like a runaway truck, brakes gone, at that 66-mph figure. The tunnel is the first of five along the ride, which climaxes in a 540° spiraling descent through the darkness, the track twisting back on itself like a snake.

When it was over, I would have headed for the red settee myself if Charlie's kid brother were not still there.

As we walked to the parking lot, Ruben said that a famous 1920's roller coaster, the *Cyclone* at Crystal Beach, in Ontario, Canada, provided such a violent ride that a nurse, quickly identifiable in her white outfit, was on hand to meet the incoming trains. She carried smelling salts to stick under the noses of those unable to extricate themselves from their seats. He said the *Cyclone* was finally taken down because the Crystal Beach management realized that more people were standing down below watching the passengers going through their travails than were taking the ride.

I smiled and said I thought the nurse was a nice touch. It is something the management of *The Beast* should well consider.

Back To Earth: Thoughts On Tittilation And Terror

The principle behind all great roller coaster rides is that there should be a succession of starting surprises—a series of benevolent muggings.

Coaster designers, especially working with steel, today can make their huge structures steeper, longer, and therefore build in greater kinetic forces: There is talk of hoisting riders 20 stories high before gravity takes over. Moreover, the experience of the rides can be heightened with any number of extra sensations. Designers can be devilish. Years ago a European designer set huge steel mirrors above the tracks of a roller coaster in Gothenberg, Sweden,

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(413) 786-9300
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(312) 249-1776
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Fee: Ages 4-59, \$18.50; Age 60 and older, \$10; Age 3 and under, free.



Kennywood Park
4800 Kennywood Blvd., West Mifflin, PA 15122
(412) 461-0500
Open: 4/16-9/4
Fee: Weekdays, \$12; Weekends, \$14. Children under 3 pay only for rides.



Kings Island Theme Park
Kings Island, OH 45034
(513) 241-5600
Open: 4/8-10/1
Fee: Age 7 and older, \$18.95; Ages 4-6, \$9.45; Age 3 and under, free; Senior Citizens, \$10.95.



so that riders hurtling down a steep hill would look up to see another coaster coming straight at them full blast! After a while the mirrors were removed: The traumatic effect on riders was simply too much.

But such ingenuity is at once the charm of the roller coaster as well as its force of intimidation. The effect can be profound. In the summer of 1949, a man named Emilio Franco stepped aboard the Coney Island *Cyclone*. For six years he had been mute because of a nervous disorder. On the second drop of the ride he suddenly began to shriek along with everyone else. By the time he stepped off the *Cyclone* his condition had been cured. His first words after six years of silence were: "I feel sick." **PM**

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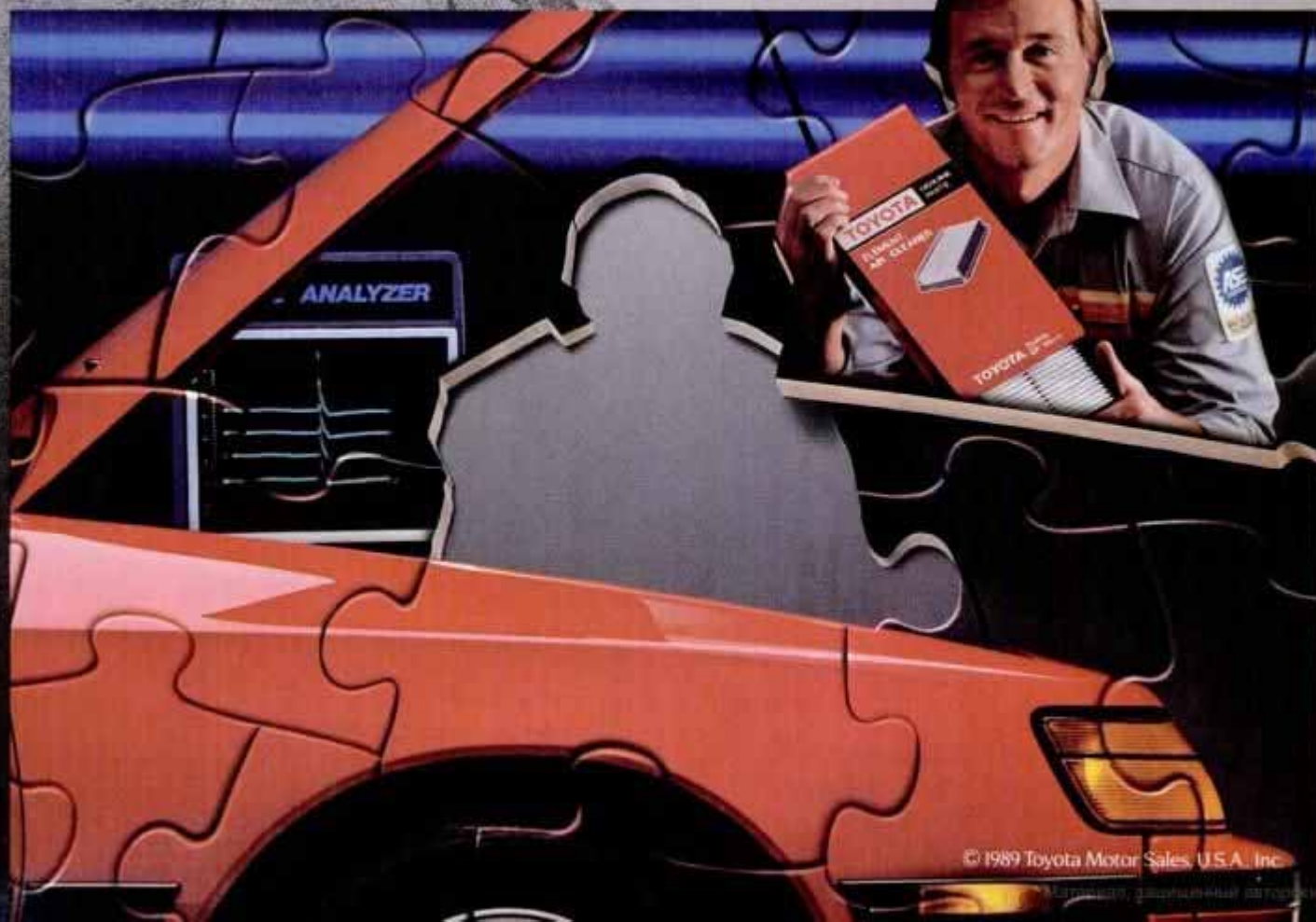
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AN AMERICAN ROMANCE

More than anywhere else on Earth, the automobile has helped give definition to America and Americans.

BY DAVID HALBERSTAM

THE FIRST MAJOR TRIP came in the spring of 1942. I was 8 years old that fall and my brother was 10. Earlier that year my father, a doctor, had gone back into the Army. He was by then stationed at Biggs Field in El Paso and the rest of us, having moved first from New York to Winsted, Connecticut, were about to join him in the new and mysterious subcontinent of Texas. The trip, the first of many such in my boyhood, was some 2100 miles. On the Richter scale of contemporary travel, it isn't very much. Today my family makes trips like that all the time. We rush to airports, board an endless series of crowded 727s, rub shoulders and elbows with equally irritable fellow passengers, eat our semi-plastic food, and are disgorged some 3 hours later at a similar airport, hoping that we will be reunited with our baggage. As I rush to a rental car office, I sometimes look at my 6-year-old daughter and ponder if there is very much sense of travel left for her, any sense of the size of the country, and the infinite varieties of America contained within, and any sense of wonder. She is a marvelous traveler. At the age of 2½, she flew the 14 hours to Tokyo without a whimper. She is equally immune to the jostling from fellow passengers and the turbulence of occasionally unfriendly skies. Yet, sometimes I suspect that travel itself is, for her, experience without experience.

Forty five years ago, a transcontinental trip was very different. That trip to El Paso, if I remember correctly, lasted some nine days and it was, in retrospect, not just an immense adventure but a celebration—of our car, of America as an endless and expansive and always changing nation, and, unconsciously, of us as a family. We had planned the trip carefully. My mother, a school teacher, had given us a list of possi-

ble places that we might want to visit and we were, by democratic means, allowed to choose the ones we most wanted. We selected (with some prompting, of course) Mount Vernon, Monticello, Lookout Mountain, the Hermitage and the Carlsbad Caverns. My mother thereupon sent our itinerary to Conoco and they duly sent back a map of the United States, our own personalized journey marked with a thick red crayon, linking Winsted to El Paso by way of the tourist attractions we selected. We dutifully, of course, purchased Conoco gas on the entire trip.

The Depression had merged with World War II and we as a family were just beginning to work our way up from the least expensive cars available to somewhat fancier ones. That year, we owned a light green 1940 Chrysler which was to last us through the war. It was solid, steadfast, comfortable, and it never seemed to break down. I can still remember, with the odd garbage collector's quality of my memory, the license plate: Connecticut LK 614. My mother did all the driving. Despite all the radio jokes then prevalent about women drivers, she drove carefully and well. She was a good athlete with good reflexes and, unlike most women of her generation, had learned to drive while she was young. She was both comfortable and confident behind the wheel. In truth, she was a better driver than my father (though this was never acknowledged as we grew up), who drove impatiently, and roughly, quick to his accelerator, quick to his brakes and quick to his horn. If in contemporary life I have had less of a political problem with the coming of the woman's movement than some of my contemporaries, I suspect it is that in much of my childhood, many things in our lives, such as this trip, which were normally the province of the father, became, because of the war, the responsibility of the mother.



Although New York-based author David Halberstam (opposite) is no longer a mainstream American motorist, his early experiences with automobiles parallel those of an entire generation. A best-selling observer of the U.S. auto industry, Halberstam sees the role of the automobile in U.S. society, as well as in his own life, as uniquely central. And even though some of the names have changed, he believes the romance is far from over.



"We grew up imagining much of what was new and exciting through the prism of the car."

She was, of course, more than a driver on those trips. She was our guide, group leader and inventor of games. We played not just Twenty Questions and Animal, Vegetable, Mineral, but our own games, including License Plates in which we competed for the better license-plate collection. We each got alternate cars, and the winner was the one who could assemble the greatest variety of states in a given period.

She was also arbiter of all disputes (no more than 10 a day) and she did this while hiding what must have been her own immense fear of taking a young family to a new, temporary home she had never seen, in a city where she knew no one, to join a husband who in those fretful days would rarely be home and would soon be shipped overseas. Travel was comparatively primitive in those days and all the more exciting for that.

There were no superhighways, just old-fashioned roads, good ones to be sure, compared to the America of the '20s. Billboard advertising was relatively new, and for any young child, the Burma Shave signs ("Don't Try Passing/On a Slope/Unless You Have/A Periscope/Burma Shave") were among the most memorable sights of a trip, and we forced our mother to slow down every time we came to one. We, my brother and I, hated staying in the many rooming houses which marked our itinerary, converted old homes which seemed to us dark and gloomy, houses in which, I remember, too many shades had been pulled down for far too long. We vastly preferred the small downtown hotels, themselves soon to be an offering to a new and modern highway system with its bypasses of downtown areas. Above all, we loved the motels which were just beginning to spring up. Tourist cabins, they were still more often than not called. We loved the sense of privacy of being once in a place which was ours, as if after traveling all day we had found a place which was our home.

THERE WERE ALMOST no franchised food restaurants in those days, except perhaps the Howard Johnson chain. A journey of that size, for any child is, I think, part excitement and part terror as well. My brother and I expressed our terror with the wariness with which we ordered food on the road. We did not lightly experiment. We ate more often than not at diners, which were still in those days converted railroad cars—our experience in Winsted had taught us that these were places in which we were comfortable—and we ordered what we knew best,

food that was safe. So we went through that trip alternately ordering the roast beef sandwich, the beef stew or the chicken special at an endless selection of diners marked along the roadside. My mother believed in the old axiom that truckers knew where the good food was and we faithfully looked for large numbers of trucks parked outside those diners, Ma's or Woody's or Hap's (25 years later I heard the great axiom of Nelson Algren, "Never eat at a restaurant called Ma's, never play poker with a man called Doc, and never sleep with a woman who has more problems than you do.")

THE POINT OF THIS was that the car was at the center of travel for my generation, as much a symbol of freedom and adventure as it was of function. What we were experiencing was something new in the modern world—the civilization of the road, a love of the highway and a belief that it would break down barriers of isolation and take us to some exciting place and result in something wonderful which we had never done before. My brother and I learned then how big the country was, that we could adapt to different places, that there was little to fear and much to enjoy by traveling through our native land. So it was that nearly 50 years ago we grew up by imagining much of what was new and different and exciting through the prism of the car and its uses.

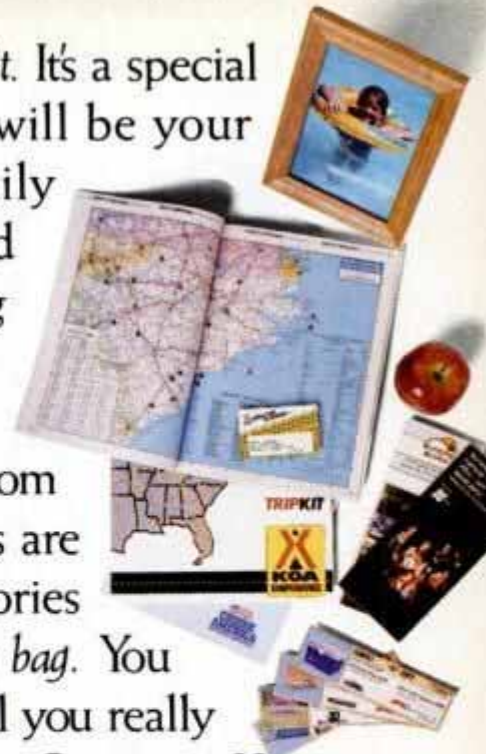
When I was young, the car took us to our dreams. That is, I think, a relatively typical generational story.

Certainly that connection between travel and adventure is a critical part of the American love affair with the car. That, and the freedom which, from the very start, the car offered to the average American. For America, in this regard, is different. Its affinity for cars is, I think, unique, in part a reflection not just of its size, but every bit as much a reflection of the independence of its people, their desire for mobility, not just physically but socially, and their constant need, generation upon generation, for a fresh start. It sets this nation apart from others. There is no doubt that the very size of America made the car more important here than in Europe. There was more need for it, and more land to explore. But certainly as well, it fit the nature of the people—restless, independent, less rooted than other people, more often than not already cut off from the land—and attitudes and customs of their fathers. Americans were from the start more willing, indeed anxious, to try new things and go new places. In addition, particularly with the coming of the first Henry Ford, America became the first industrialized society with a mass culture, and no particular item marked the entrance of an ordinary citizen into full membership







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"The car meant that my grandfather was not limited to staying where he was doing poorly—he could move on, and try his luck again."



in the mass society, than the purchase of an automobile.

Fifty and 60 years ago, ordinary Americans were buying cars in the way that much of the rest of the developed world is just beginning to do today.

By contrast, up until very recently in Europe, it was an elite thing, the property of the rich. A European did not drive a car as a necessity, he drove it as a high sport. A European bought a car as he might buy a fine horse, a blood thing. He always thought the car should fit his specifications, not those of the mass. In Japan, for example, it's different again. There, it's not so much mass or elite, as it is fantasy. The Japanese owner wants a beautiful car to admire and have his neighbors admire in turn, for he is not unaware of the status involved. So he goes out and buys something, often something he can barely afford, and then he takes excessively good care of it, polishing it relentlessly, and he dreams of driving it without the pressure of heavy Tokyo traffic. But that's hard to do in Japan. So he goes back to polishing it and dreaming about it and he ends up loving it just as much in his own way.

BUT IN THE United States, it is much more down to earth, and in a way a less romantic love affair. It has been a mass vehicle almost from the start here and with the coming of the Ford V8 in 1931, power was available to the average person. He could buy a car that was not very expensive and blow past a luxury car on the road. It changed the way we think of our lives. Here, because of the car, we have grown up with the instinct for mobility and with a sense of being less class dominated for the past 75 years.

So it was in my own family. My grandfather, who was an immigrant from Eastern Europe, was the first member of the family to drive. Like many men of his generation who learned later rather than earlier of cars, he at once loved his car and feared it, and drove as if in conflict with the machinery at hand. His impatience suitably annoyed his wife, Sarah Halberstam, after one early ride with him wherein she watched him shift back and forth and finally said to him, "Harry Halberstam, if you don't leave that stick in one place and stop moving it around, I'll never drive with you again."

But the car meant that he was not limited to staying in a part of the country where he was doing poorly, and he could move on, to another small town, and try his luck again. With that early mobility, he tried with varying degrees of success and failure a number of small towns before settling in Torrington, Connecticut. My father once told me when I was very young (and clearly overwhelmed by my grandfather's driving ability) that I should understand that the car, of which my grandfather was so proud, had not merely transported him to different

places, it had made him feel more *American*, more a citizen of this land than a refugee from the old one. It was in some way akin, my father was saying, to citizenship papers for a man of my grandfather's generation. By contrast, my father, born in this country and on the eve of this century (he was 17 when Henry Ford invented the Model T), was much more at ease with cars. Before he and my mother had children, he was something of a dandy, and spent far more than his budget nominally permitted on the various snappy models of that era. As his family responsibilities increased, he inevitably turned to more sedate models.

I GOT MY FIRST license in 1951. My own cars were at first functional. They came to me off the used-car lots in Waterbury where my Uncle Moe worked, and they were deals, more or less. There was a series of them and they cost, if memory serves, about \$150 each and if I was lucky, patched and repatched, they would last a year or two. They were just short of being wrecks and not quite old enough to be classics. I loved the funkiness of them.

When I graduated from college in 1955, I bought, for my trip to Mississippi and the beginning of my professional career, a 1946



Chevy. It was a wonderful car, unadorned and straightforward, already getting on in years, but an honest car

which pretended to be nothing but what it was. It lasted me three good years during which I ran it extremely hard. It was everything a car was supposed to be and when I finally turned it in, I did so with a certain sadness. That was in 1958, and I had become quite grand, or at least as grand as a young reporter making \$95 a week can be. For the first time in my life, I was doing what millions of Americans had done before and would do after me. I was defining myself in terms of what I drove. For in that period, I was working as a reporter in Nashville, Tennessee, which, with its endless winding country roads, was a wonderful place to drive. It was also a time when Detroit was obsessed with physical opulence. Bigger was always better. I wanted more than that, or perhaps more accurately, less than that. The American cars of that era gave me power which I could not use, and denied me performance and handling I badly wanted.

Besides, there was my statement. I was not ordinary. I was not conventional. And I did not want to be predictable. I was not truly eccentric, mind you, but my job was different, my hours were different, my career was not about money and traditional reward. So it was that one day, somewhat to my own surprise I walked into the showroom of a sports-car dealer, and bought my first sports car—a 1952 MG TD. It was a beautiful car, classic in its lines from the day it was born, designed as if to be a collector's

HANG TOUGH.

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AMERICAN ROMANCE

item. If short on pure power, it was nonetheless a pleasure to drive. I was not by any means the true sports-car buff. I did not drive in rallies or anything like that. But I loved being in the car, loved the feel of it on a twisting road, loved surprising the bigger, heavier cars which could not handle those roads, and passing them with little open room. I loved the way it handled, and I liked the secret pleasure of it all, the way it made me feel about myself.

In time, as a good American, I grad-

uated upward. In late 1959, a friend let me handle his TR3 and I was immediately dumbstruck. Here was the performance of the MG with far more additional power. I immediately went out and traded the MG for a used Triumph. That was step two in the cumulative self-definition. I was now somewhat more openly advertising myself. I was not someone who blindly saluted Detroit or accepted what Madison Avenue wanted. I made my own choices, I did not have them made for me. If there were better things out there

in life, even if they were made in distant places, I wanted to sample them. I loved that car. I drove it everywhere I went. In 1960 I covered Estes Kefauver's last race for the Senate in Tennessee and he went to every small hamlet in Tennessee and I drove along right behind. Sometimes, it seemed to me, my car attracted more attention than the candidate. If the TD was to me more of an idea, a pleasant fantasy of self-definition, then the TR3 was more clearly a piece of machinery. The power was always there, waiting to be summoned. Recently, another magazine asked me to think of my favorite year in the past 30, and I did. It was 1960, my last year as a reporter in Tennessee. There was a rare symbiosis between my job and my leisure time, and when I think of that year, I think if not first, then at least often, of that red TR3. By 1961 I had joined the *Times*, gone to the Congo, the Triumph was sold, and when I returned I lived in New York. The days in which cars gave me pleasure were over.

I DID, TO BE truthful, own one car during the ensuing years, which was in Nantucket where I have a summer house. It was an aged Jeep. The floor and roof were rotting, and the ignition system rarely worked on damp and foggy days—weather in which Nantucket abounds. The Jeep had been something of a family joke for years, purchased inexpensively, and maintained expensively for years. In the summer of 1983, my wife insisted that it was time to get rid of it (which I did for \$200 to a semiway college student, who told me on the day of the sale that he had dreamed the night before that I had raised the price to \$2000).

S O IT WAS that we chose a replacement: a small car, preferably inexpensive, to be driven a limited number of months, and a limited number of miles a year. We wanted good dependable transportation at a reasonable price. We decided to buy a used 1979 Ford Fiesta from a friend for \$3500. Between the time of the agreement and the delivery of the car, our friend hit a deer. The price came down to \$3000 for a deer-dented Fiesta. It is a car I immediately fell in love with. Handling it was, for me, more like handling the TR3. Last summer, our family needed even more automotive space and we bought a second car, a brand-new Jeep Cherokee. Again, I am surprised by how much I like it. It handles well, drives easily, is exceptionally comfortable on the beach, gets surprisingly good mileage on the highway. Even more, I like its looks. I have, as I did some 30 years ago, a sense of a car that has simply

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How one air conditioner handled the heat in the toughest challenge of all

by
General Chuck Yeager, USAF Ret.
Test Pilot



General Yeager is our nation's most respected test pilot.



Introducing our newest air conditioner, the 1989 Bryant Reliant.



To ensure our air conditioners can withstand the elements, we expose experimental models to corrosive salt air.

The folks at Bryant say they've got a pretty fine air conditioner in their new Reliant. But I don't believe we should take their word for it.

Sure, they built it from top-quality materials, constructed the compressor valves out of hardened steel, the exterior valves from brass, the cabinet from galvanized steel. Then they checked it out and rechecked it out in one of the most sophisticated air conditioner research facilities on the planet.

Mother Nature's Lab

Next, they torture-tested the Reliant, set it out on the beach and just left it there. That may seem strange but, you see, they figured if it could stand all that salt air, it could stand the conditions in your backyard.

One More Test

But no matter how much they did in the lab, Bryant's engineers couldn't be really sure the Reliant air conditioner would do the job till it faced a real live challenge.

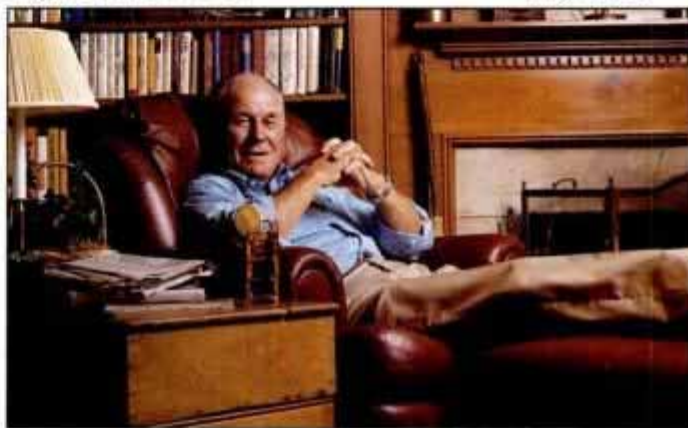
It had to pass the toughest challenge of all: the Yeager test.

Nothing too fancy, just me, a comfortable recliner and a scorching hot day. See, I don't much care how it did in the

lab if it can't take the sweat off my brow.

Let me tell you, I've tested jets for the Air Force for quite some time and I know high technology and good engineering when I see it.

The Reliant undergoing the grueling Yeager test.



And I'm gratified to report that all of the quality of the Reliant air conditioner shows in its operation.

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The right stuff
to last.

1-800-HOT-SALE

AMERICAN ROMANCE

wonderful lines, and that someday people will look back and call a classic.

I am like other customers now, shrewder, and better educated about the market, with more options, in an age when class lines and tastes have been crossed, recrossed and merged. Young blue collar workers drive Saabs, a car which should be the preserve of the yuppie.

DON FREY, a friend of mine who was one of the key men behind the original Mustang back in 1965, and now works in Chicago, has seen a comparable crossover: suburban upper-middle-class Evanston housewives driving 4-wheel-drive Cherokees, machines which were built to ford muddy streams in Wyoming, and which will get far less mud on them in suburban Chicago, but which in some way make the driver feel better about herself or himself.

"You figure it out. These really are respectable housewives—the incomes in the homes are over \$100,000—and by the charts these ladies are supposed to be driving BMWs or Volvos," he says.

As much as anybody I met during the five years I worked on my book about

Detroit and Tokyo, Don Frey, who is now the head of Bell & Howell, is a man who loves machinery. He is a survivor of what now seems to be a dying breed in America—the automotive tinkerer, the sons of farmers who, in a poorer age, fashioned their own replacement parts in makeshift workshops set up in barns or garages. At Ford, he was legendary for his obsession with the machinery of cars. Recently, we had a drink together and I asked him if he had any regrets about any cars he might have bought during his lifetime and then failed to buy.

"Oh yes," he said, "most assuredly. When I was at Ford, I drove a GT-40 for about a year. It was the road version of the Ford car which won at LeMans in 1966. It was a beautiful piece of machinery—for someone like me, the perfect advertisement for yourself. It told the world how much I loved machines—it was the ultimate engineer's statement. When I drove it I was saying that I knew what fine machinery was and I could afford it. I think I could have bought it from the company for about \$5000. It would be worth minimally \$100,000 today—and I shake my head at the thought of the pleasure I would have had from it. I mean, I could

have just put it in Cosmoline and waited. I didn't do it. The funny thing is that I knew I was making a mistake at the time, knew the moment I passed up the deal that I was doing the wrong thing. It fitted who I was and who I wanted to be just perfectly."

I THOUGHT for a moment about cars I'd seen, and wanted in that way. I let my secret self take over, the secret self which had once propelled me into a showroom to buy an MG and a Triumph. If I were living somewhere other than New York City where a car mattered, where you could drive it daily with true pleasure, I thought, setting the ground rules first. Visions of the great showrooms of the world flashed in front of me. A Jaguar, I thought. I lectured out in California recently and I was driven around in one. God, I loved it. I felt I had graduated and gone to a higher level of life. It's funny, I used to hate them. Back when I owned the TD and the TR3, I thought they were heavy and that you virtually needed a brother-in-law as a mechanic to keep them running.

But it's different now, and it seemed as I paused, owner of an 8-year-old deer-dented Fiesta and a 1-year-old Jeep, so right for me. **PM**

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JOHN MADDEN



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“The Sailfish 255 knifed through rollers like a Mercedes of the water.”

—POPULAR MECHANICS, June 1988

“It’s easy to see why Grady-Whites are limited production boats,” POPULAR MECHANICS editors said, “(the) combination of careful design and outstanding performance make it the boat our test team would most like to take offshore for trophy billfish.”

Rated first in POPULAR MECHANICS’ recent comparison with four other popular offshore boats, Grady-White’s Sailfish 255 drew more raves. “Exceptionally soft re-entry,” “superb attention to detail,” and “its chines threw salt spray well away from the cockpit” were other comments from the editors.

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MADE IN THE U.S.A.

Shaping wood, blowing glass or bending metal, Americans are leading the world in important areas of old-world craftsmanship.

BY WILLIAM HOFFER

SOME SAY THAT craftsmanship died in 1913, when Henry Ford introduced the concept of the assembly line, when quantity replaced quality as the goal of the production team. But, in truth, craftsmanship never died—it merely went underground. Today, it is difficult to find and view examples of vintage-style craftsmanship, but the rewards of the quest are satisfying. When you have the opportunity to witness modern American craftsmen plying their intricate trades, you gain a new appreciation for that portion of the human soul that cries out for excellence.

Look at a craftsman as he labors over his wood, metal, glass or other material and, at first glance, your attention will be drawn to the hands. But you have to look deeper. The work of the hands is merely the outward manifestation. True craftsmanship is a journey of the spirit.

Consider these views:

"We don't make them like they used to," argues William J. Morgan, owner of Morgan Marine in Silver Bay, New York, producer of Hacker Craft pleasure boats. "We make them *better*."

"The one word that's most important is *pride*," contends Billy Thompson, president of White Post Restorations in White Post, Virginia, arguably the nation's premier restorer of antique and classic automobiles.

James Krenov, who both practices his craft of woodworking and instructs others at his school at The College of the Redwoods in Fort Bragg, California, declares: "I think the thing that personifies the work that people like myself do is that we are, indeed, amateurs. In other words, we work the way we want to work, trying to express something personal."

If you wend your way to the village of Lake George in upstate New York and head

north on Route 9N for 20 miles or so, just past Sabbath Day Point, you will happen upon the unassuming sign of Morgan Marine. Bill Morgan would like you to call for an appointment first, but then he would be happy to show you how a handful of modern-day technicians are fashioning mahogany dreamboats out of a special combination of nostalgic style and modern materials.

John L. Hacker, who once worked alongside Henry Ford in a machine shop, took a divergent route from the originator of mass production. Hacker became a premier naval architect who designed a number of Gold Cup winners, but was best known for his handcrafted runabouts. A long sweeping bow, impeccable brightwork and an abundant use of chrome were the trademarks of Hacker Craft, known in its day as "the Steinway of Boats."

By the time Bill Morgan was growing up in Cleveland, Hacker's creations were already champions. He experienced spasms of ecstasy when his father bought a 26-ft. Hacker direct from the factory. A boat nut from the beginning, Morgan enjoyed success as a racer (in his final year of competition he won 34 out of 36 heats) before he bought his boatyard 30 years ago, and his fascination led him into the task of restoring and/or copying some of the old champions. He is the proud owner of 36 Best of Show awards for his antique craft, and the ones that seemed to capture the most attention were the Hackers. Morgan decided, "Why not create updated versions for those who would still yearn to own one?" He obtained the rights to the Hacker Craft name and set to work.

The trick is to combine the best of the past with the best of the present and mold them via the craftsman's hand into a thing of both beauty and utility. Morgan has improved upon Hacker's original design by adding 25 percent more frame and twice as many floor



CORNING GLASS WORKS PHOTO

Author William Hoffer (opposite) and the craftsmen of Morgan Marine, where reproduction runabouts of the 1920s are painstakingly assembled. Modern materials and updated powerplants have improved upon, but not completely surpassed, yesterday's boatbuilding techniques. Crafting glass objects (above) is still faithful to ancient methods at Steuben Glass.



FM PHOTO BY HUMPHREY SUTTON

Careful research and meticulous workmanship bring a 1910 Babcock back to life at White Post Restorations.



FM PHOTO BY HUMPHREY SUTTON

Form meets function in the lines of a Hacker Craft under construction at Morgan Marine.



FM PHOTO BY HUMPHREY SUTTON

Guided by a patient hand, a crystal vase takes shape during final polishing at Steuben Glass.

timbers. This allows for the use of a modern powerplant, larger than the original could tolerate. Other modern amenities include a more maneuverable steering system.

A Hacker begins as a twinkle in Bill Morgan's eye, and as a 2x4 white oak keel laid out upside down on a jig. On top of the keel, workers interlace a skeleton of 1x3 sawn white oak ribs. The inverted construction position allows one to view the deep-V of the forward part of the hull, which softens gradually to a 9° deadrise at the transom.

Once the skeleton is put together, an intricate triple-layer sheathing of 1/2-in. Honduras mahogany skin is set into place. A key and hidden improvement is the use of an epoxy system to encase the entire hull. "The wood isn't going to dry rot," Morgan claims. "Moisture never gets to it."

WORKMEN SUCH AS Pete Fish and his younger brother Wayne labor to lay the triple layers with care, so that they will conform to the necessary sleek design, buff up to a mirror-like polish, and adhere to the specifications of the Morgan Marine guarantee against leakage. The first two layers are set at cross-diagonals to one another, stapled into place so that the epoxy can take hold and bind them like welded metal. The third layer is applied lengthwise, in elongated panels.

Modern Hackers are faithful to the old design configurations, but they boast present-day amenities. The mahogany finish radiates the glow of anywhere from 12 to 17 coats of hand-rubbed varnish, and the deep, red-brown hue blares: I am something special. Butter-soft leather upholstery, dyed to a deep "croupier green," chrome-plated brass fittings, and all other accoutrements are spanking new and shiny.

The 30-ft. Hacker, which can seat 11 people, is powered by a Crusader V8 454-cu.-in. engine that produces 350 hp and kicks up a top speed on the upside of 50 mph. That is faster than the original Hacker, which could accommodate only a 200-hp engine, but just as smooth in its ride, thanks to a modern steering system.

When a Hacker Craft pulls into a marina, old salts turn their gazes upon it immediately, recognizing the undeniable evidence of the craftsman's touch.

FROM LAKE GEORGE, if you head south on I-87 to Albany, then west on I-88 to Binghamton and thence onward past Elmira, you will pull into the town of Corning, New York, to witness the ballet of the "glory hole." Here, at the Steuben Glass Factory, you can view the art of glassmaking, one of the purest forms of craftsmanship, practiced today essentially as it was 3500 years ago. Named after the county in which it is located, Steuben was founded in 1903 by Frederick Carder, and is now owned by Corning Glass Works.

A hundred craftsmen ply their ancient trade at Steuben in full view of the public, and the center of activity is the glory hole, or reheating furnace. There are six in use, and each circular furnace has four inlet doors, allowing as many as 24 teams to work at once.

Underneath the glory holes, in a basement level not on view to visitors, the process begins with a fundamental and characteristic theme. For a craftsman to produce the finest work, he must utilize the finest materials. Pure sand, imported from Africa, is mixed with alkali, lead and cullet (shards of glass from the same formulas, damaged in production or rejected by inspectors). The lead is a critical component of this primordial "soup." Since 1676, crystal, universally regarded as the finest form of glass, has been made with the addition of lead to enhance its brilliance, weight and reflectivity.

The components are heated in a melting furnace and stirred constantly with a platinum spatula, which imparts no impurities. Each hour, 24 times daily, a sample is taken to be examined microscopically. Three times a week, the samples are subjected to much more rigorous scrutiny, such as X-ray spectroscopy.

The glassmaking process begins when a "gaffer" directs a "gatherer" to obtain a supply of molten glass. Watch closely or you will miss the subtleties of a trade learned only through patient apprenticeship.

The gatherer approaches the holding oven, where the molten glass soup has been lifted mechanically to the shop floor. To create the specific piece called for by Steuben designers, the gatherer obtains the precise amount of the "gather" by specifying the pouring time, in seconds. A smooth incandescent, orange-red stream pours into his mold.

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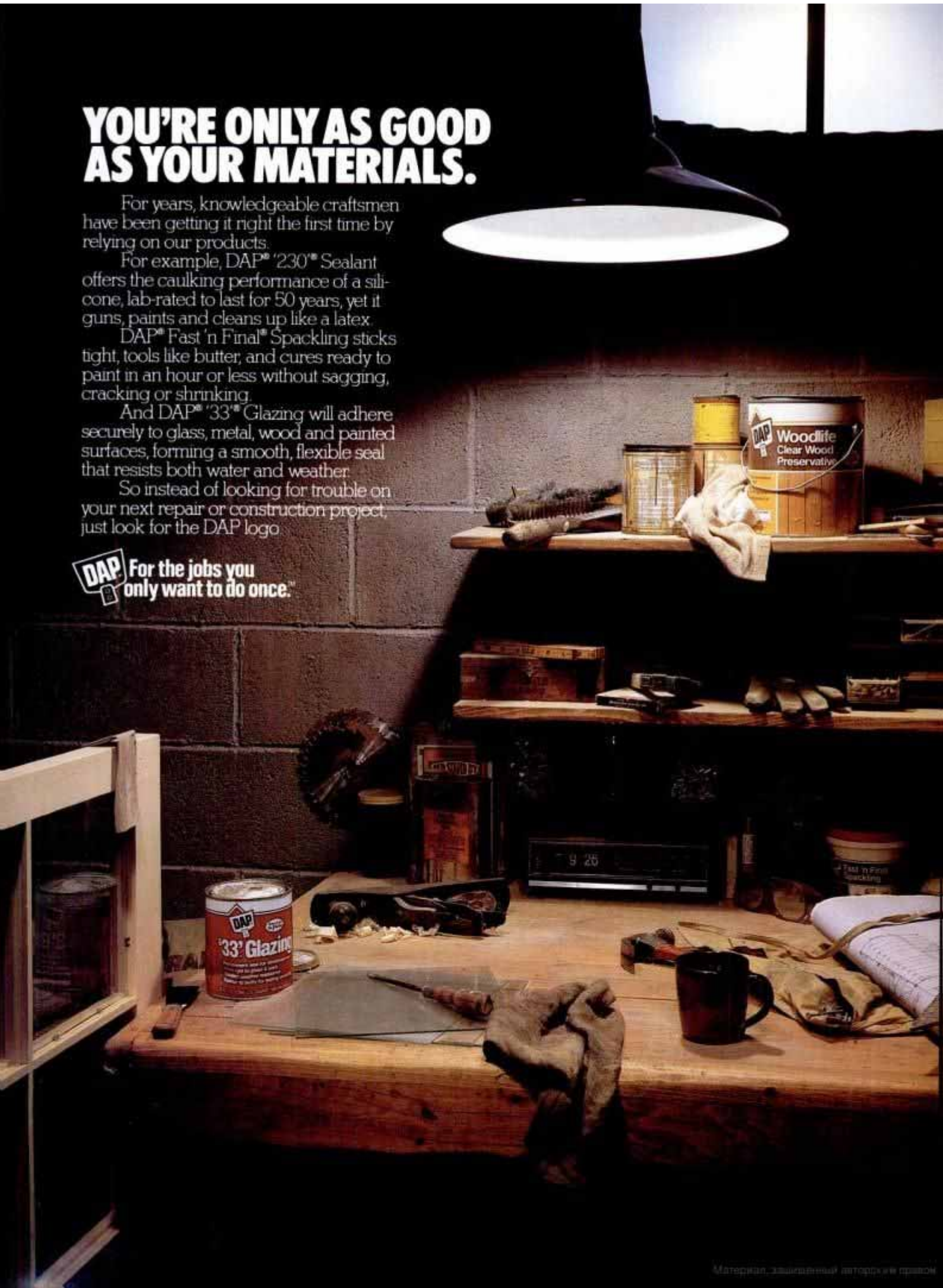
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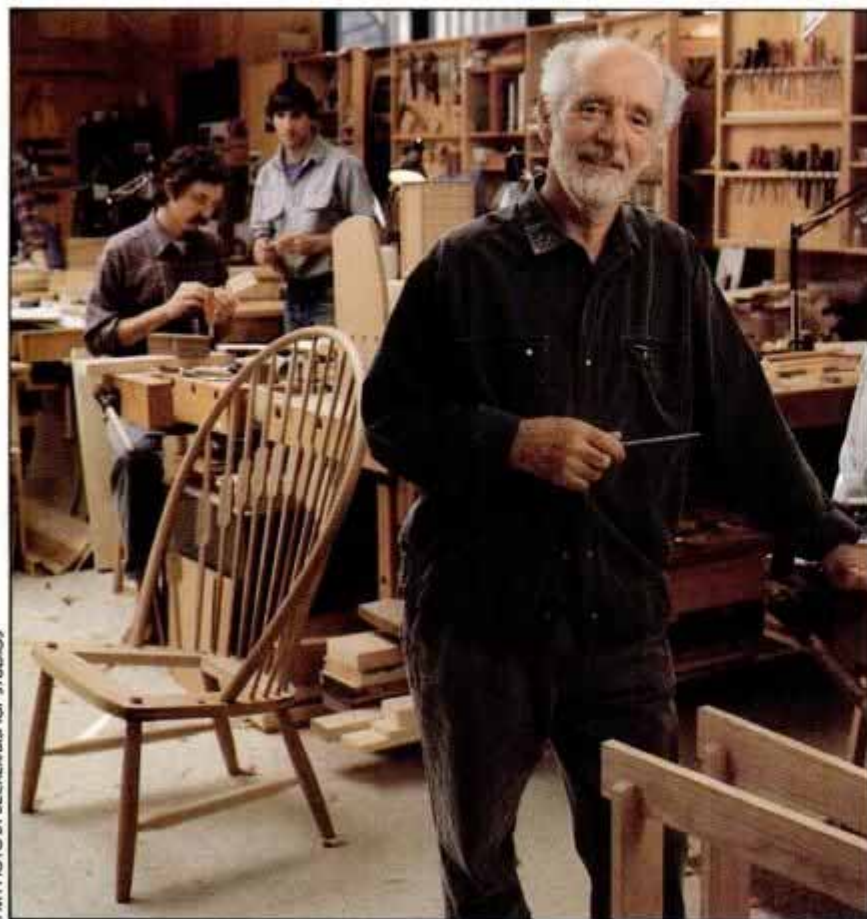
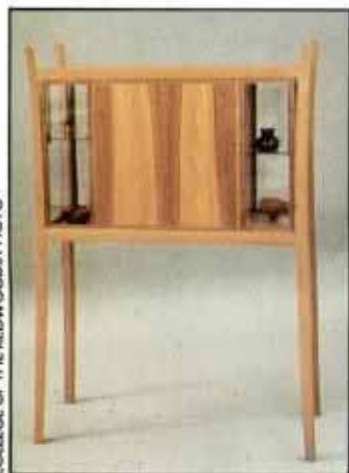


PHOTO BY BECKERBISHOP STUDIOS

James Krenov and his team of artisans redefine the craft of woodworking at The College of the Redwoods.



COLLEGE OF THE REDWOODS PHOTO

One Krenov creation, "Walkaround," combines style, substance and utility in a work of high art.

When the gather arrives at the glory hole, the exotic work begins. Henry Ford notwithstanding, for more than 3½ millennia, man has not determined a method to mechanize the process. Fine glasswork *must* be created by hand.

The gaffer holds the gather on the end of a long steel rod, periodically tripping a dead-man switch to open a door to the glory hole and thrusting the gather inside to maintain a workable malleability. Working from drawings and specifications created by Steuben designers, the gaffer manipulates the rod like a baton, rolling, tossing, bending, to maneuver the hot glass into the desired shape. Preset calipers help assure conformity with the design pattern. The gaffer checks constantly for seeds (air bubbles), stones (specks of contaminant matter) and cords (fault lines).

WOODEN PADDLES and steel tongs (jacks) fashion the piece further. At one side of the room, a gaffer pulls a gather from the glory hole. It is a solid piece, about 12 in. long and 3 in. thick, molded into the cross section of a 5-point star. He eyes it with care, judging the consistency, waiting for the arrival of the precise moment. Suddenly he thrusts the hot mass upward, twists his wrist lightly, and the thick column of glass bends over into a delicate spiral.

Another gaffer places the cool end of a steel rod to his lips. Cheeks puff as he blows a bubble into the center, creating a hollow vase.

A third gaffer calls to a gatherer for a tiny globule of molten glass to be added to her working mass. She indicates the point of contact. The gatherer sets the glass bit into place, the gaffer snips with shears, and suddenly a delicate glass mouse is endowed with a minuscule ear.

The end result is an advertisement for human pride. Unlike any mass-produced product, no two pieces of Steuben glass are ever exactly alike. Each reflects the character and idiosyncrasies of the particular team of men and women who took the time and creative pains to fashion it.

NOW HEAD DOWN U.S. 15 to Harrisburg, Pennsylvania, south on I-81 to Winchester, Virginia, and jog over to U.S. 340 in the direction of the unincorporated town of White Post. When you reach the little crossroads, designated by a replica of the original white post, placed there by a young surveyor named George Washington, drive another 250 ft. south, turn right, and you have reached the spot where a community of about 20 craftsmen band together to produce superb restorations of antique automobiles. Tiny little White Post (approximate population 200) has developed such a reputation as a mecca for craftsmanship that, last October 15, an incredible total of 45,000 visitors jammed their way into town for what has become an annual festival known as White Post Celebrates.

If you don't like crowds, come any other normal working day to take advantage of the free tours, but you might want to call first. This is a renowned, but small operation, and on occasion there is simply no one available as a guide.

The eye of this craftsmanship hurricane is Billy Thompson, who sports a handlebar moustache that is, itself, an antique restoration. Thompson founded the business in 1958 when he took over a 4-bay garage and tractor repair shop from his father. "I knew in order to expand I had to offer the customer something really special," he notes. "And what is really special here is the quality of workmanship and the pride in workmanship."

Often the task begins with what the team refers to as a "basket case," that is, the remnants of an antique auto that may arrive in thousands of pieces. Six to 12 months later, when the job is completed, the White Post team will have disassembled, cleaned, refurbished, retooled or replaced some 50,000 separate components, down to and including every single nut and bolt, enroute to the goal of bringing the auto back to the condition it was in when it left the factory.

Take, for example, the 1910 Babcock, which came to White Post in 1987 and is only now nearing completion. The job was turned over to Greg Cone, who freely admits that his passion is brass era cars and who has achieved the delightful status of meshing work and hobby.

MADE IN THE U.S.A.

With the Babcock, the process of restoration begins with research. The craftsmen at White Post are well-acquainted with the resources of the Library of Congress, two hours away in Washington, D.C.

"I like the small details," he says. A friend in Michigan rolled out copies of the rare and original aluminum for the floor boards and running boards. Nails and rivets must be the same size and material as the original, and installed in the same place. White Post would never use a Phillips-head screw on a 1910 Babcock. Phillips heads did not become available for autos until 1936, and then were only used in limited application.

Cone tore into the Babcock, disassembling it, tagging each part with care, policing his area daily to provide an easy working environment. Each individual part was inspected and, if salvageable, sandblasted or cleaned or reground or polished or reinforced. For the thousands of nonsalvageable components, Cone and his partners in craftsmanship rolled up their sleeves. Cone says with a grin, "Each little piece, you can fuss over."

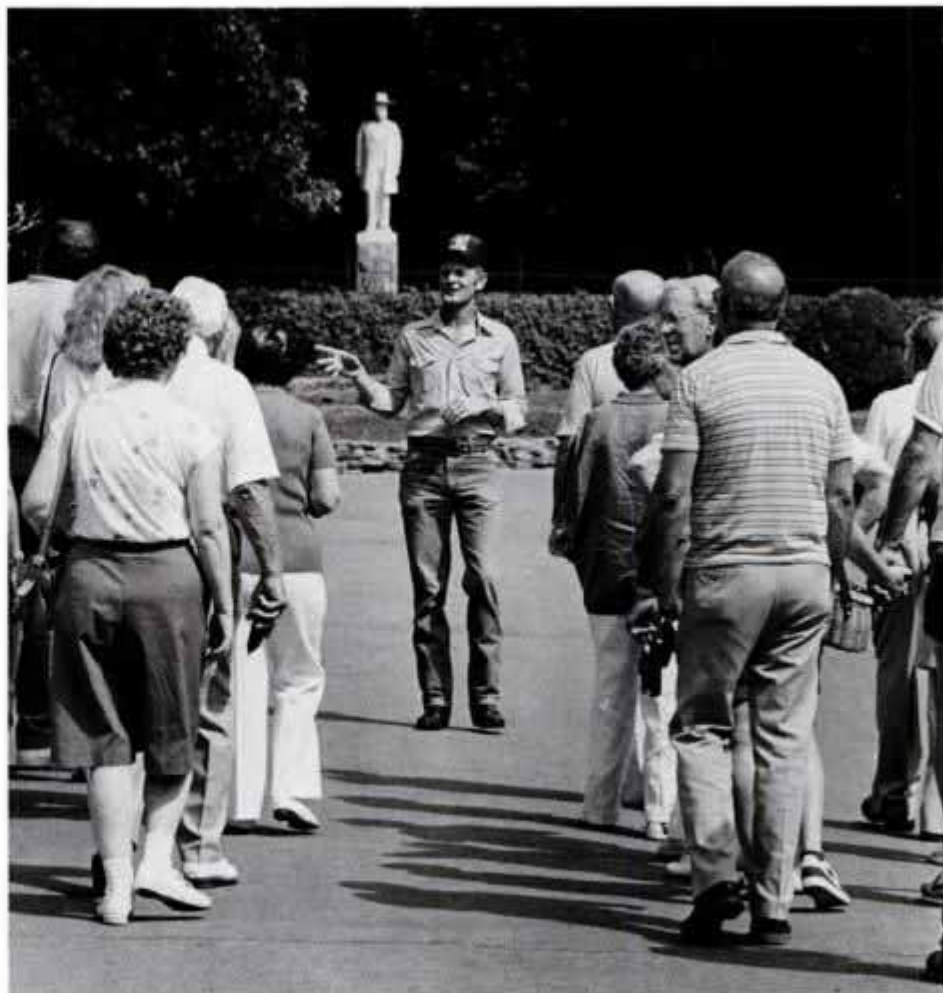
And fuss they do, over the Babcock, as well as a '26 Rolls-Royce, a '29 Model A, a '39 Cadillac limo once owned by President Trujillo of the Dominican Republic, and dozens of other cars in various stages of repair.

Be forewarned: Visit White Post Restorations and you'll never view a mechanical job in the same manner.

RARE, INDEED, IS the craftsman who lends his very name to a style of work. Yet, all over the world, aficionados of fine woodworking know the name James Krenov and apply the term "Krenovian" to describe qualities of line, contour and detail. He both practices his craft and instructs others, a selected few from all over the world, at his school at The College of the Redwoods in Fort Bragg, California, where visitors are always welcome.

Krenov's early years were spent in Washington State and Alaska. "I grew up around wood and tools and the outdoors," he recalls. "I worked as a builder of fine boats in Seattle when I was very young, so wood was very close to me." He describes himself as a traveler, a "loose-footed guy," who journeyed to Europe in 1947 and found himself living in Stockholm, Sweden, for the next 30 years of his life. There, he learned the classic techniques of cabinetmaking as a student, from 1956 to 1958, at the school of renowned Swedish woodworker Carl Malmsten.

Luckily he found himself in a milieu that appreciated a sense of quality.



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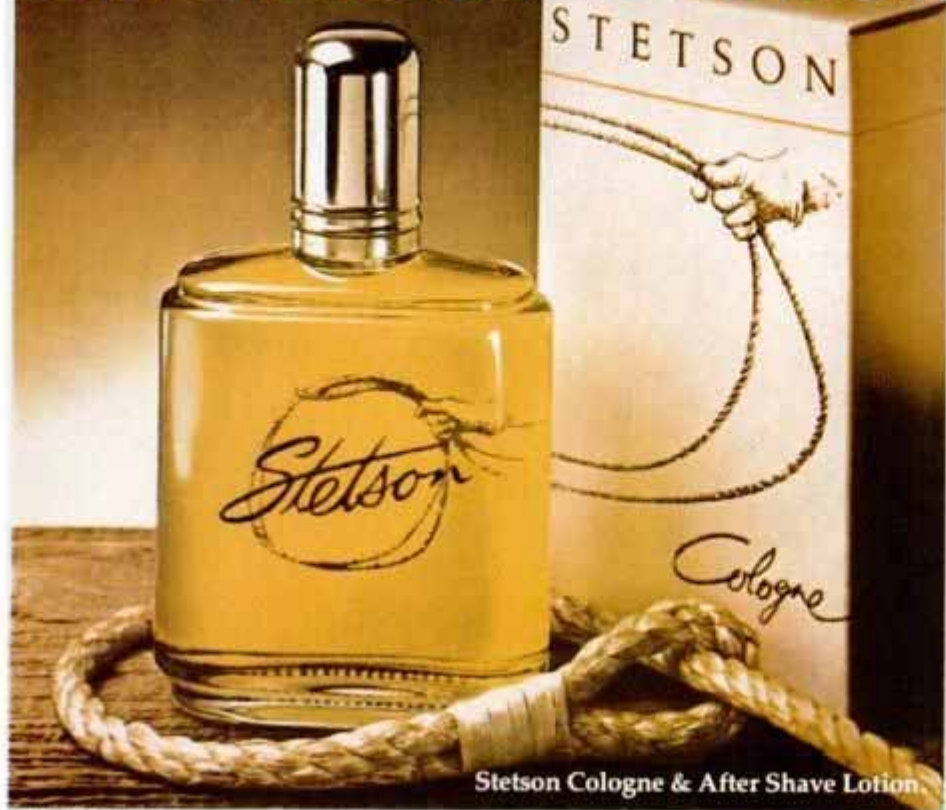
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"That helped me a great deal," he acknowledges, "because I met people who believed that the best was not wasted."

He wrote a book, *Cabinet Maker's Notebook*, "That sort of changed my life," he says, "because suddenly I found that I had struck a chord."

What James Krenov did was to repudiate the "time is money" social movement that threatened to destroy the art of craftsmanship. He worked not for money, but simply for the love of excellence.

AKRENOV WORK is either a fine piece of furniture, or an even finer work of art, depending upon the aesthetic sensitivity of the viewer, and Krenov encourages the artistic view by naming his pieces. A cabinet, titled "Walkaround," invites the observer to do just that, shunting aside the traditional notion of a cabinet as a piece of furniture that must have its back to the wall. There is no back to "Walkaround," nor is there a front.

The cabinet is made from two fitch-cut walnut planks. On one side, a pair of veneered doors present the appearance of a somewhat traditional cabinet. But walk around to the other side and

you find Krenov's surprise, glass doors that allow access to glassed-in outrigger showcase compartments. All of this is suspended upon four slender, gracefully curving legs.

Beautiful as the design is, it would falter under shoddy craftsmanship. In fact, to Krenov, design and craftsmanship work hand in hand. His explanation of the construction of "Walkaround" is as rambling as the process itself: "It started out with just an idea, then I sort of mocked it up. I got some things that represented posts, just pieces of wood, and then I sawed them up.

I think for a while I even worked with different colors of cardboard. I had a sketch or two, just rough sketches, not to scale. As I went through this process of setting it up and looking at it, the whole idea of it all being wood just gradually fell apart and I became intrigued with the fact that those open spaces at the end were interesting. One thing led to another."

The main surfaces of the cabinet are sawn veneer, $\frac{3}{32}$ in. thick, which Krenov cut himself. He book-matched the surfaces in the traditional way, taking a slab of veneer half the width of the surface, slicing it in two, and then opening it up so that the grain formed a mirror image of itself.

Krenov's favorite tool is the hand plane, which he refers to as an instrument, in the sense of musical instrument. He builds his planes himself, both the bodies and the plane irons.

And his favorite wood is pear, for its tranquil color and for the fact that it can be planed to a finish and left unsanded. He obtains the pear wood from Austria and France, and utilizes it along with doussié from Cameroon, French walnut and cherry, and elm, ash, maple, oak, hornbeam, beech and birch from various parts of Europe.

"I don't worship wood," he proclaims. But I care about wood a great deal. I care very much about fine tools and the sensitive things that one can do with them. I don't neglect machines, but I'm never dependent on them for the final expression of whatever I make."

And here, Krenov has once more struck a common chord. It is not the machine that has destroyed the once-prevalent passion for craftsmanship, rather, it is the way in which the worker relates to the machine. It all depends upon the patience of the guiding hand and the pride of the guiding spirit. **PM**

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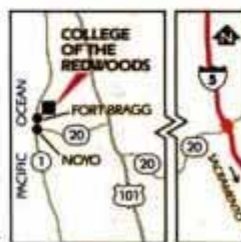
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ALL-AMERICAN HIGHWAYS

A three-time Indianapolis 500 winner reveals his personal gourmet guide to automobile touring in the U.S.A.

BY RICK MEARS

YOU MAY THINK that somebody who makes his living driving racing cars takes a little different view of driving for fun, and I suppose that's true. But not as different as you might think.

Yes, I like roads that give me a little challenge from time to time. That's why I have a problem with our Interstate Highway System. Even when it's running through terrific scenery, it tends to be straight ahead and dull, particularly in places where the 55-mph speed limit is still in force. In most open areas, that speed represents about half the design limit of an interstate highway. It's amazing to me that more people don't die of sheer boredom out there.

On the other hand, this country has a large number of highways that combine beauty with enough curves to keep your driving skills from going dormant. I'm not talking about playing racer on public roads, and I'm not talking about smashing speed records.

What I *am* talking about is roads that allow you to be a driver, instead of just another passenger who happens to be steering.

Although they differ in character and terrain, the roads in this personal collection all include at least a little bit of that kind of driving—plus some of the greatest scenery in America, and a few stops along the way. I hope you can enjoy them.

California: San Joaquin Valley to Carmel

I wanted to start off with old Highway 46 because it's just about the first one I can remember in detail. I started traveling on this road long before I even thought about driving, which is more than a few years ago. We used to drive this route regularly from our home in Bakersfield to visit an uncle of mine

who had a fishing boat near Morro Bay—I got hooked on fishing then and still try to get out when I have a chance, which isn't as often as I'd like.

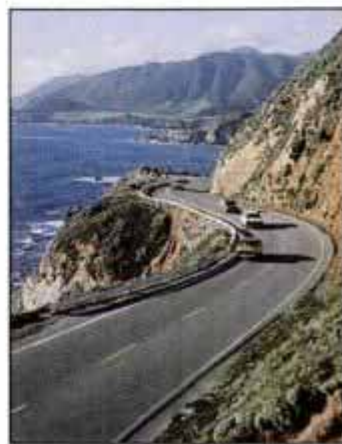
Anyway, when I began driving, and got interested in racing—I don't think there was much of a gap between those two events—I hooked Highway 46 up to California Highway 1, to make the run up to Monterey, which is home for Laguna Seca Raceway.

This isn't the quickest way to get to Laguna, but for my money it's one of the most eye-opening stretches of highway on Earth, let alone America. From San Simeon, a little ways north of Morro Bay, all the way through Big Sur and into Carmel, it's a collection of cliffside switchbacks, blind, decreasing radius turns and ocean views guaranteed to clear your mind.

Although there aren't many man-made attractions along this route, one stop worth making is at the Hearst Castle in San Simeon. This is the mansion built by William Randolph Hearst that's now a California State Historic Park, and it's truly mind-boggling. You'll need to arrange for your tickets in advance.

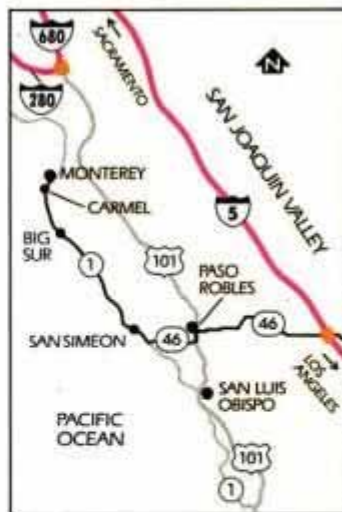
Highway 46, which is a major cut-across from the San Joaquin Valley to the coast, never presents any problems, although I find it at its best at sunrise. There's virtually no traffic at that time, and the dawn light makes the rolling hill country glow.

Highway 1 can be a little trickier. Since a lot of the route between San Simeon and Carmel runs along cliffs, rockslides sometimes block the road in wet weather. Also, if there's fog or low cloud along the coast, there isn't much to see, which means there isn't much point in driving the coast route. And finally, during the summer months there's a lot of camper traffic. Get an early start, and check the weather. The California Highway Patrol is one good information source.



PM PHOTO BY DAVID MLENCH

When Rick Mears (opposite) hits the road, his license plate tips you off that this man really knows how to drive. California Highway 1 (above) parallels the coast.



PM ILLUSTRATION BY MARIO FERRO

CALIFORNIA COAST: California 46, California 1. Not the fastest way to Monterey, but one of the most scenic—and challenging—drives in the Golden State.

ALL-AMERICAN HIGHWAYS

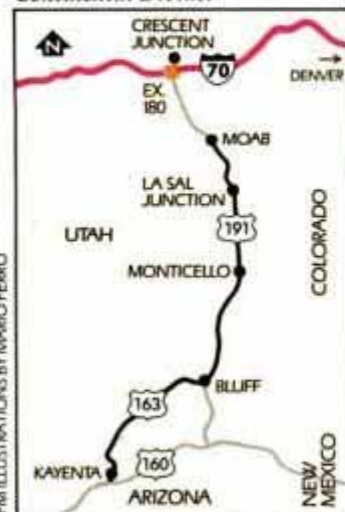


PM PHOTO BY DAVID MUEINCH

The time-worn towers of Monument Valley.



ROCKY MOUNTAIN HIGH: U.S. 285, U.S. 50, U.S. 550. Driving in the sky on the Continental Divide.



RED ROCK COUNTRY: U.S. 191, U.S. 163. Erosion and time conspire to create high drama.

PM ILLUSTRATIONS BY MARIO FERRO

Montana: Kalispell to Boise/ Glacier National Park

Most of western Montana is high, wild and free, and the good news is that the combination of climate and rugged mountain terrain is likely to keep it that way. Which makes it a great place to go for a drive.

From Kalispell, in the northwestern part of the state, U.S. Highway 93 heads almost due south, running along the west shore of Flathead Lake, skirting the western side of the Continental Divide and threading between several National Forests on its way into Idaho. If you stick with it, you could keep rolling all the way into Twin Falls, Idaho, or cut off and head southwest for Boise. Sometimes I like to start out with only a general direction in mind—no real destination—and make it up as I go along. If you're in it for wild mountain scenery, it's hard to pick a wrong road.

This is also a route that offers enough open stretches to allow you to blow the carbon out of your car's system every once in a while, with lots of variety—everything from switchbacks to long straightaways.

A great day trip out of Kalispell is to head northeast on U.S. Highway 2 and visit Glacier National Park. Glacier is mostly trails, for hiking or packing in with mules, but there is one road cutting it in half—the "Going-to-the-Sun Highway"—and it's a stretch of pavement you shouldn't miss if you're in the vicinity.

Besides a number of 9000- and 10,000-ft. peaks, there's a good chance you'll see black bears, deer, Bighorn sheep and maybe even some mountain goats, critters you won't see in any other park. After seeing some of Glacier's high mountain meadows, you may also get the idea that wildflowers were invented here.

Winter comes early and stays late with the combination of altitude and latitude you find up here. Like most areas that have a hard winter, fall can be showy, but spring is my preference in this case.

Utah: Moab to Monument Valley

The thing that always amazes me about the red rock country in southern Utah is that all the scenery was cut *into* the land, instead of sprouting up out of it, like the Rockies. Not only does that include all the canyons, it includes some of the rock spires standing 1000 ft. tall in places like Monument Valley. They're all that's left of an enormous plateau, weathered away by time and water. Tenths of seconds are pretty important to me in my line of work, but they don't seem to mean very much out here.

The rock-carving process has produced an incredible collection of fantastic formations all across the southern half of the state—stone arches, buttes, canyons, towers, with occasional ancient cliff dwellings thrown in for good measure. As an old-timer once remarked of Bryce Canyon, "it's a hell of a place to lose a cow." This jumbled country was one of the last areas in the United States to be mapped, as recently as 1955.

Many of Utah's wildest rock fantasies are under the protection of the National Park Service. Arches and Canyonlands National Parks are handy to our route, which is U.S. Highway 191 south from Moab to Bluff and U.S. 163 southwest from there through Monument Valley. Both parks are well named. There are almost 90 natural rock windows in Arches Park, one of them the longest natural span on Earth—over 290 ft. Canyonlands, where the Green and the Colorado Rivers merge, has some *serious* vertical drops, over 2000 ft.

My favorite part of this drive is Monument Valley, an area that looks to me like it was imported from some other planet. You've probably seen plenty of pictures of all those red rock towers and buttes, but there's nothing like actually being there. It's at its haunting best around sunset, when the twilight and shadows make you think the ancient Indians were right about the spirits that guard the land.

A good side trip before you get to Monument Valley is to circle the Valley of the Gods. Take Utah Highway 95 west south of Blanding, then Utah 261 south again to U.S. 163. Any time of year is good for this drive, including winter, when snow makes the landscape even showier, although getting into the parks can be difficult. Even at the canyon bottoms, this is high country, and up on the plateaus it's 5000 and 6000 ft.

As far as the driving is concerned, it's not the sort of area that makes you want to hurry, although there are plenty of wide-open sections at the southern end of the route. During the summer months, you'll have to contend with a lot of other vacationers, so spring or fall are your best bets.

Colorado: Denver to Durango

Here's *my* idea of a Rocky Mountain high. Not only does this route expose you to some of the wildest mountain country you can drive in the U.S.A., it'll also give you plenty

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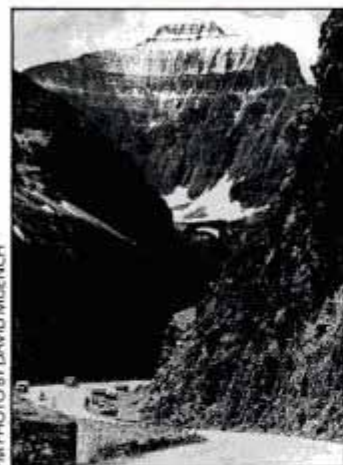


PHOTO BY DAVID MLENCH

Going-to-the-Sun Highway in Montana's Glacier National Park is rated by many as the most spectacular in America.



WILD MONTANA: U.S. 93, Idaho 75, Idaho 21, U.S. 2. Montana-Idaho outback asphalt provides plenty of serious driving.



PH ILLUSTRATIONS BY MARIO FERRO

DEEP SOUTH DIVERSION: U.S. 61. Memphis-to-Natchez Mississippi River run is rich in history as well as Southern hospitality.

of opportunity to work on your cornering techniques. These highways (U.S. 285 southwest out of Denver, U.S. 50 west from Poncha Springs, U.S. 550 south from Montrose to Durango) aren't often overwhelmed with heavy traffic, even in mid-summer, which means you can pick up the pace if you want to, conditions permitting.

Almost everywhere you look along these roads you'll see 10-, 12- and even 14,000-ft. peaks. You'll find yourself driving above the timberline more than a little, and even some of the passes top 11,000 ft.

While you're getting an eyeful, there are a couple of practical considerations to keep in mind. First, altitude is going to take away a lot of your car's performance. Even turbocars suffer, although they do much better at 10,000 ft. than normally aspirated cars. Whatever your car may be, don't expect it to be the same rocket you love at sea level.

Second, be sure to keep an eye on the coolant temperature. The boiling point goes down as the altitude goes up.

Finally, watch out for overheated brakes, particularly if you're hurrying in some sections. The thinner air at 10,000 ft. takes a big bite out of cooling efficiencies.

Almost all of the route from Denver runs through national forest land, which means there are plenty of campsites along the way, if you're so inclined. There are also several ski areas, but that's for another season.

There really isn't much in the way of civilization between point A and point B, which I figure is a big plus if you like to drive. You can catch up on civilization when you get to Durango. Just being in a place with a name like this brings out the cowboy in you.

One local excursion that's worth checking out is a ride on the old Durango and Silverton Railway, a restored narrow-gauge steam train dating back to mining days.

Like the Montana high country, the driving-for-fun season hereabouts is short. The weather is reliable (no blizzards) from mid-May through early October.

Mississippi: Memphis to Natchez

I'll always call California home, but when it comes to feeling at home somewhere else, it's hard to beat the deep South. It's humbling, too. In this part of the world, Indy is just something to help fill up Memorial Day. The *real* racing happens at places like Daytona, or Talladega, or Darlington.

Some folks like to tour Mississippi by driving the Natchez Trace Highway, which cuts across the state from Tupelo, in the northeast, through Jackson, the state capitol, to Natchez, in the southeast. I prefer to drive along the Mississippi River itself, and a good way to do this is to start at Memphis on U.S. Highway 61, cut over to Mississippi Highway 1 at the little town of Rich, then head south down through Greenville.

Eventually Mississippi 1 rejoins U.S. 61, a little way north of Vicksburg, and from there it's another 75 miles or so to Natchez.

You'll find some places to give your suspension a little work here and there along the Mississippi River bluffs, but most of this route is better suited to laid-back cruising.

Just hearing the names of these cities makes me think of steamboats and cotton bales and a military band playing "Dixie." And as you drive along Mississippi 1, you'll see that things haven't changed a whole lot. You can get a bird's-eye view of the river traffic from the 75-ft. tower in Great River Road State Park in Rosedale, north of Greenville—a major shipping and processing point for Mississippi Delta cotton.

If you're at all interested in Civil War history, you'll want to budget a little extra time for Vicksburg. A combined naval and land force under Gen. U.S. Grant captured Vicksburg July 3, 1863, after a 47-day siege. It was the day before Gen. Lee retreated from Gettysburg. With the loss of Vicksburg, the Confederacy's days were numbered.

You can see quite a number of leftovers from the siege at the National Military Park, which is open daily. There's also a 15-minute multimedia production at the Waterfront Theatre that will give you some idea of what the constant bombardment of the siege was like. Another interesting stop is the *USS Cairo*, an ironclad gunboat that was sunk by an electronically detonated Confederate mine. She's been raised and restored and is open to visitors.

Not all of Vicksburg's history is military. For example, there's the Biedenharn Candy Co., which was home for the first Coca-Cola bottling operation back in 1894. Today it's a Coke museum.

Natchez was another big cotton center before the war, and it was lucky enough to escape being flattened, which means a lot of terrific old mansions survived, and have been restored since. If you have the time, it's worth cruising this section of town. Get in touch with the Chamber of Commerce for suggestions. The Memphis-to-Natchez run is one you can make year-round, but the best season is spring, when the dogwoods are blooming.

Virginia: Blue Ridge Parkway

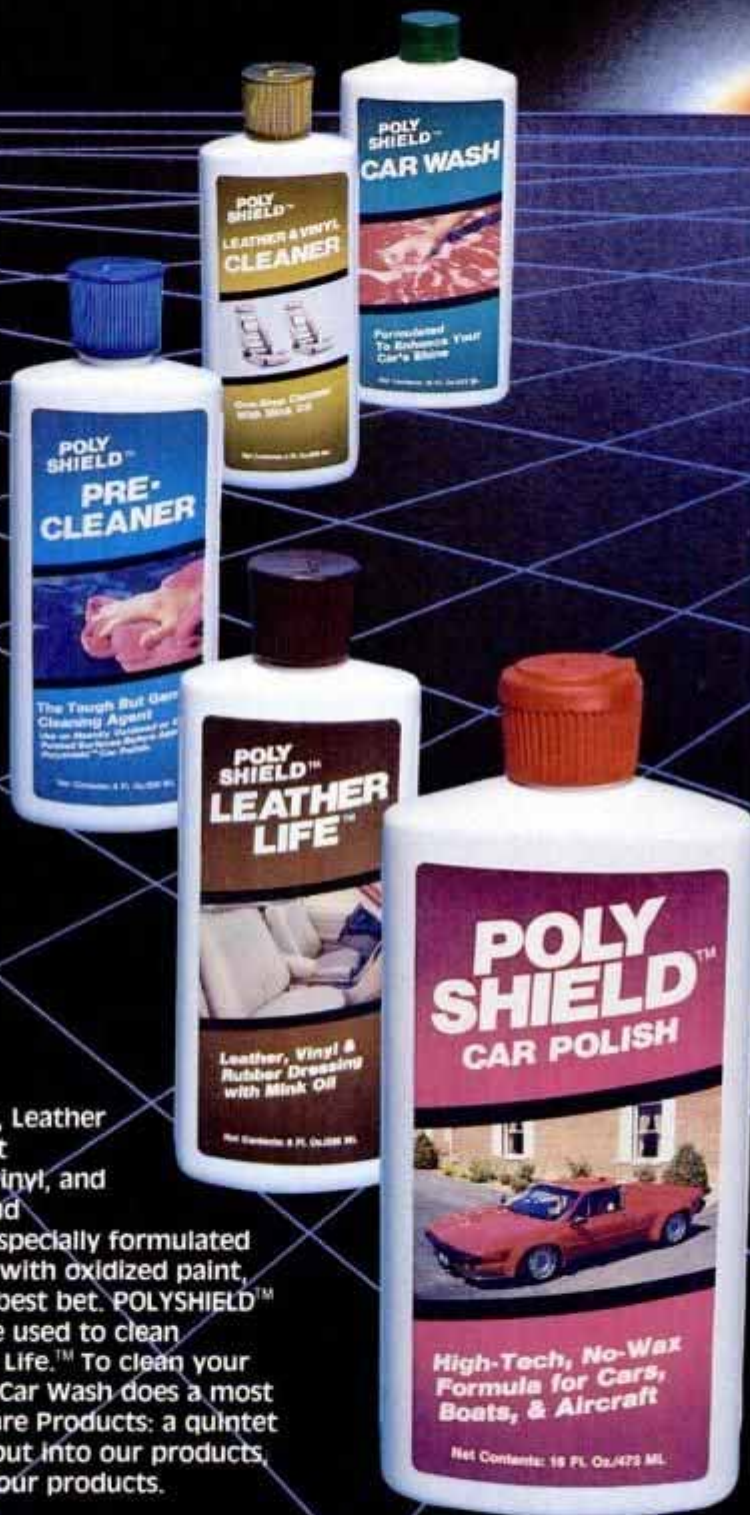
We're back in mountain country again, but it's not nearly as wild as the Rockies. The Blue Ridge Parkway snakes along the broad spine of this section of the Appalachians, running above 5000 ft. for most of its length.

What you get here is 469 miles of nonstop 360° views of Blue Ridge Mountain peaks and valleys, winding up in the Great Smoky Mountains National Park. Spectacular is a word that gets used a lot to describe scenery like this, but it still sounds like the right word to me.

This entire route is maintained by the National Park Service, so there's not much to remind you of life in the big city. No fast food restaurants, no billboards and very

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few gas stations—the rangers advise you to keep your tank at least half full at all times.

The Parkway starts at Waynesboro, Virginia, and continues all the way down into North Carolina. There are lots of pullouts, and plenty of places where you can do a little hiking if you want, plus a number of campgrounds. Get in touch with the National Park Service for information.

If the Blue Ridge Parkway isn't enough for you, or you want to visit another national park during your trip, you can add on the 105-mile Skyline Drive at the northern end of the Parkways. Beginning at Front Royal, Virginia, and connecting with the Parkway at Waynesboro, the Skyline Drive runs right through the middle of Shenandoah National Park and gives you some great views of the Shenandoah Valley. There's excellent trout fishing along the entire route.

One word of caution. This is not a route to take if you're in a hurry. The entire Parkway is posted at 45 mph, and the going is even slower on the Skyline Drive, especially during the peak vacation months. If you want to relive some of the chase scenes from "Thunder Road," try some of the little tributary highways that intersect the Parkway from time to time.

The route can also get weathered in—the altitude is enough to put the whole region in the clouds from time to time—so check the forecast.

The Blue Ridge Parkway is gorgeous from spring until the leaves fall, but it's at its best in late September and early October, when the colors peak.

Maine: Brunswick to Eastport

Although I am rarely the kind of guy who holds up traffic, on this highway it makes sense to take your sweet time. If you don't, you're going to miss something.

U.S. Highway 1 separates itself from Interstate 95 at Brunswick, Maine, and from there all the way to Eastport, the easternmost part of the U.S., it's one long panorama of rugged coastline, pretty little fishing villages, snug harbors, lobster boats and, of course, lots of fresh Maine lobster to hold you for about a year.

They call this the Down East part of Maine, and there's definitely more than a day's worth of things to see and do along the way—a week or two makes more sense, especially if you want to do some ocean fishing from a charter boat. You can book yourself a spot on a party charter boat at practically any of the fishing harbors. There's also good trout fishing in most of the rivers along the eastern half of the route.

Although practically every inch of this route offers some sort of treat for the eyes, the heart of a Down East tour seems to be Bar Harbor and Acadia National Park, which means taking a detour off U.S. 1 and

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heading south on Maine Highway 3 at Ellsworth. Both the park and Bar Harbor are on Mt. Desert Island, and it's easy to spend an entire day driving around here.

Bar Harbor is the commercial center of the island, with lots of shops and good places to eat. It's also a headquarters for deep sea fishing charters—check at the Municipal Pier. Acadia Park covers 22 sq. miles and includes a number of mountains, lots of woody areas, dozens of lakes and plenty of wildlife. It's like Maine in miniature. On the western half of the island, Southwest Harbor is worth a stop. It's a genuine lobster port, and also home for the Mount Desert Oceanarium, which gives you an idea of what's going on under the waves, just offshore.

Not far from Southwest Harbor is Seal Cove, which has an automobile collection, of all things. The museum displays, about 150 in all, run from the turn of the century into the '40s.

There are a few other stops I'd suggest. The first is Bath, back near the beginning of the route, near Brunswick. Bath has a ship-building tradition that goes all the way back to the early 1600s—it's still called the City of Ships—and if you like maritime history, you don't want to miss the Maine Maritime Museum, which is located there.

Not far away is Wiscasset, home for the

Lincoln County Fire Museum and the Wiscasset Musical Wonder House, a collection of wacky musical machinery.

Boothbay and Boothbay Harbor are a little ways south of U.S. 1, on Maine Highway 27. Boothbay has an interesting railroad museum, set up in a restored railroad station complex, and includes a working narrow-gauge steam train.

Boothbay Harbor calls itself "the Boating Capital of New England," and is another great port of embarkation for deep-sea fishing charters.

Another fishing spot is Rockland, which is Maine's largest fishing port, and home for an annual seafood festival in August.

Finally, if you go all the way to Eastport, don't miss seeing the Old Sow whirlpool. This area has some of the highest tides in America, which helps to create conditions that generate the whirlpool, one of the biggest of its kind anywhere.

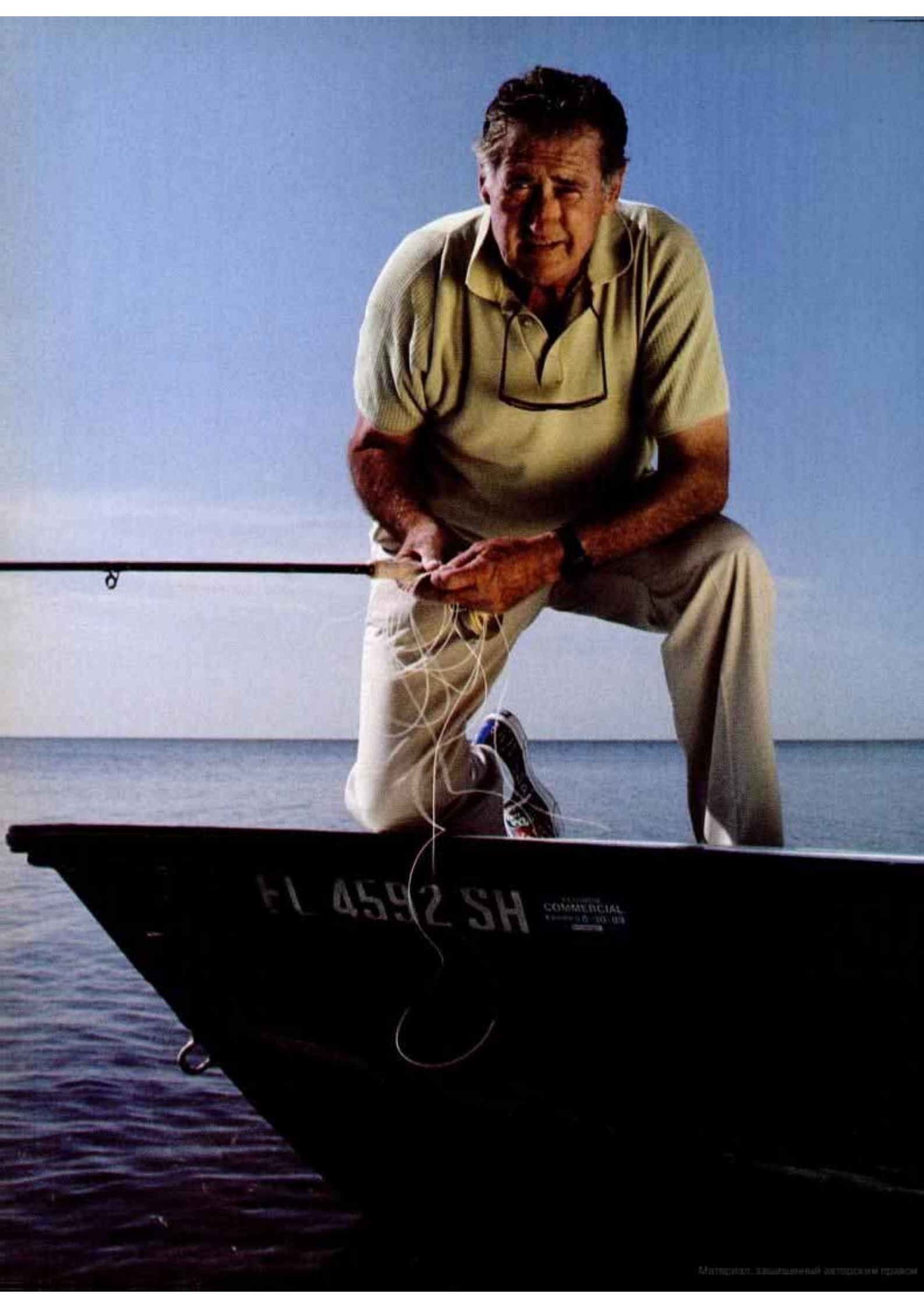
Also, if you want a little diversity on the drive back from Eastport, try Maine Highway 9, which will take you across long, lonely stretches of woods and lakes. It's beautiful country, and also a much quicker return route. This chunk of America is geared for summer—that's when everything's happening—but can also be spectacular after Labor Day, when fall lights up the countryside.

FM



MAP ILLUSTRATION BY MARIO FERRO

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So many fish and so little time. Great rivers, lakes and coastlines form an angler's paradise called America.

BY TED WILLIAMS

I'VE BEEN ASKED a hundred times if I can compare the highlights of my career in baseball to the thrills of fishing. It's a tough question to answer because I've devoted myself to both sports and they're fundamentally different.

Is making a good cast to a fish and fighting it skillfully similar to hitting a home run? I'd be lying if I said yes. There's no feeling in the world comparable to hitting a baseball out of the park in front of a home-town crowd in a big game.

Yet, I firmly believe there's no greater outdoor activity available to human beings than sportfishing. You're never too young or too old to participate, and the excitement, pleasure and challenge are always there. It doesn't matter if the fish you're after is a 2-ounce bluegill or a 200-pound marlin. If the tackle is right for the size of fish, it's always a sporting proposition, and a damn fine one at that.

Some people have called me a "flag waver" for the good ol' U.S. of A., and I've never denied it. They're probably aware I've served as a fighter pilot in World War II and in the Korean Conflict. They're also probably aware that I don't hesitate to speak my mind on subjects regarding the role and status of the U.S. in the world.

Well, to paraphrase a recent president, here I go again: The United States, in my opinion, is the best angling country in the world, because the abundance and variety of fish found here is unmatched anywhere else. I might get an argument from my Canadian friends, who know I've spent a considerable amount of time casting flies at Atlantic salmon in the paradise-like pools of the Miramichi River, in New Brunswick.

But, like many lucky Americans, I've had the good fortune to fish for walleye and muskie in the Midwest, bonefish and tarpon

in Florida's saltwater flats, marlin and tuna in the ocean, salmon and trout in streams from Maine to the Flathead River system in Montana, and bluegill and bass in the Arkansas River, near Little Rock, and throughout the South. I guess you could call me a Will Rogers fisherman: I've never met a fish I didn't like. But my point is that whatever kind of fishing you like to do, we've got plenty of it right here in America.

With 50 years of angling under my belt, and many more ahead, I know I'm not likely to grow tired of the sport. The reason? Whenever I see a young boy fishing with his dad I can't help but notice the magic in his face as he feels a fish pulling on the end of his line. I think I still have some of this kid-at-heart attitude about fishing within me, as I think most fishermen do, regardless of how gray they might be getting around the edges.

Like most fishermen my age, I started fishing with a bamboo pole as a California kid, and progressed from there. I didn't take it up seriously until much later in life. It was tough to break away for a day or so of fishing when I was playing baseball, although I did my best. During spring training in Florida, for example, I always tried to find some time to fish for tarpon off Boca Grande, on the Gulf Coast, marlin off Palm Beach, on the Atlantic Coast, or cast for bonefish in the Keys. Occasionally, I was able to sample the fishing in cities I played ball in, but this was rare. Mostly, I had to wait for the off-season.

As I acquired more experience, comparing techniques with some of the top guys in the field, I began to wonder about the effectiveness of some of the tackle commonly used. Later, when I wasn't hitting baseballs for a living, I served as a consultant for a major line of sports equipment, which included fishing tackle. This gave me a chance to develop equipment and test some of my ideas. I like to think I helped push forward



The keen eyes of baseball's last .400 hitter, Ted Williams (opposite), scan the saltwater flats of Florida's Keys for the glint of a bonefish tail. Spotting one (above), Williams makes a cast with his favorite fly rod.

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FISHING HOLES U.S.A.



PHOTO BY M. TIMOTHY O'KEEFE/BRUCE COLEMAN

An unexpected pleasure for a Florida fisherman is hooking into a rare permit, like this angler.



PHOTO BY GERALD A. ALMY

The mighty tarpon, near Florida's Boca Grande Pass, are among the world's finest fighters.

advancements made in technology and materials for fishing tackle by testing prototype rods, reels, lines and lures.

When I began fishing, more than a half century ago, the tackle wasn't nearly as sophisticated as it is today. In fact, it was pretty crude. Modern reels, for example, are stronger, more reliable and equipped with smoother drags than anything available when I started.

Rods have equally improved. My first rod, as mentioned, was made of split bamboo. This material was replaced by fiberglass, which gave way to graphite, boron and synthetic composites. New rods are lighter, more powerful and much less tiring to use. Monofilament fishing line, of course, is a genuine marvel of science compared to the old silkworm gut leader and braided linen line I started out with.

DESPITE ALL THE technological advances I've witnessed, I've never lost sight of the fact that hard-fighting fish, even big offshore monsters, could always be whipped by using the right tackle. And that tackle didn't have to be heavy duty, either. Keep the pressure on, with just the right touch and skill, and the biggest tarpon or marlin in the world will eventually tire out and give up the fight.

As mentioned earlier, I like to fish for all sorts of fish, but it's no secret that I favor hunting what I call the "big three": bonefish, tarpon and Atlantic salmon. It's also no secret that I'm a dedicated fly fisherman.

For a number of years I've headed for the saltwater flats surrounding Islamorada, in the Florida Keys, for the elusive silvergray bonefish. Many times I've gone out with a guide, who stands on a raised platform and poles the boat into position like a gondolier.

But lately, I've taken to stalking the flats, while wading and casting to fish that I spot sticking their tails up out of the water as they feed. There's nothing like the excitement of seeing the sparkle of sunlight hitting a fish tail, wading in as quietly as possible, and then laying your fly a few feet in front of the bone's nose. If the fish takes the fly, then it's off to the races. Nothing runs line off like a hell-bent-for-leather bonefish. The reel whines and the fish streaks away like a torpedo. All you can do is hold the rod tip high and hope your fly, line and leader all hold together at this breakneck speed.

Then, if the fish stops before your reel empties, it's time to fight back. You reel in some slack line and pow, off it goes again. I release all bonefish I catch because any fish that takes the fly this well, fights this hard and gives me so much excitement deserves to be released. As the name implies, bonefish are too boney to make a convenient meal and too scarce to kill for mounting.

The tarpon is a special fish, too. What makes it so special? The answer is easy: It's a world-class jumper, runs as good as a bonefish, if it has a mind to, and comes in a jumbo-size package.

The average tarpon caught in the waters of Boca Grande Pass, off Florida's Gasparilla Island, is well under 100 pounds, but 100-pounders are far from rare. Tarpon are truly big-league fish, as well as Olympic jumpers.

Remember earlier that I said I prefer to use fly tackle and a tippet that tests 15 pounds or less? I said it and I meant it. Even the mighty tarpon can be landed on this kind of light line and tackle, if you use skill and do it right.

Tarpon are usually caught in relatively shallow water, so the big fish wear themselves out running and jumping, because they can't go deep and pull off your wrists. Keep the pressure on, lower your rod tip when it jumps (to prevent a snap-off or having the fish fall on a taut line) and you'll have the fight of your life, especially with a light fly rod.

THE FLY ROD is a frail-looking instrument to use for hard-fighting fish, when you consider its small diameter and flexible tip. Yet, its special design enables the angler to keep constant pressure on the fish without breaking the delicate leader. Heavier equipment can be used, but the challenge comes in doing the same job with the lighter tackle. Steady pressure, attention to slack line on the reel, avoiding snags and lowering the rod tip when a fish jumps are some of the skills an angler must hone to catch big fish this way. Using heavier tackle will make up for shortcomings, but it lessens the challenge, in my mind.

It may seem harder to fish this way, but there's no doubt that it's more rewarding. And it's fun, otherwise I wouldn't do it. I love fishing with a fly rod, and I've said



PHOTO BY JERRY AMBER

Monsters from the deep, ranging from billfish to tuna, challenge offshore fishermen.



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FISHING HOLES U.S.A.



Fly fishing for trout in Montana is sometimes complicated by large native wildlife.



Largemouth bass in the Arkansas River are great leapers and feisty fish.



Casting flies at trout or salmon in rivers in Maine is like fishing in a little piece of paradise.

many times that I may become tired from casting, but I never get tired of casting.

The final fish of my "big three" is the Atlantic salmon. Of the three, my salmon fishing days outnumber those of the other two by a wide margin. Why? I've asked myself this question many times and the answer is hard to express. The Atlantic salmon, from the Penobscot River, in Maine, to my favorite pools in New Brunswick, Canada, is mysterious in its ways. No matter how much anyone thinks he knows about this magnificent fish, the next day will bring a new surprise.

The Atlantic is a leaper, perhaps not in the class of a frisky tarpon, but a fabulous jumper all the same. (Bonefish, by the way, don't jump at all.) It's easily the match of bones and tarpon in running ability and sheer will to fight.

As the Atlantic salmon leaves the ocean and enters the Penobscot River, for example, it's on a spawning mission that makes it a solid bundle of energy. It will gulp a fly and take off with such a rush that the reel handle becomes a blur. When it leaps, the angler's heart leaps with it—the water explodes and the silver rocket aims for the sky.

I GUESS I COULD say the gods of fishing, whoever they may be, have smiled on me, because I've caught more than a thousand Atlantic salmon. (I've caught about 1000 tarpon and bonefish, too.) I don't keep the big Atlantics anymore, although I did in years past when they were more plentiful. Each year I take a few grilse, the small ones, for the table, but that's about it. Despite the large numbers of fish I've caught, the next one will be just as exciting as the first one, because each is a great adventure in its own way.

It's a funny thing about releasing a fish. The first time you set a big one free feels kind of strange, maybe even a little painful. But the next one is easier and after that, they're

all easy. You don't have to have a dead fish to prove you caught it. You know you did it, and that's all that's important.

AS I MENTIONED, I release all my bonefish, tarpon and all but a fraction of my Atlantic salmon. Why? Because it's clear to me, and to anyone who's been fishing for the last few decades, that size and quantity of gamefish are far below the levels they used to be. Do the fish survive after being caught? Experts disagree on the subject. Obviously, if you manhandle the fish in the process of pulling the hook out, the chances go down. Lately, I've taken to filing the barbs off my hooks, which makes it easy to release a prized fish. Just last fall I caught and released the largest Atlantic salmon of my life, a 30-pound-plus female. And, yes, it was taken on a barbless hook.

When I began angling seriously more than 30 years ago, the fishing was pretty good and I made up my mind to learn everything I could about this fantastic sport. As the years went by, I discovered that not everything I learned was good news.

Oldtimers told me that Atlantic salmon fishing was twice as good when they were younger. I shrugged at this, because I thought it was still pretty good in the mid-1950s. But it wasn't too long before I began to notice a change. Fewer fish appeared each year and they were noticeably smaller. I began to make a journal of my catches to chart the gradual change, but I gave it up before too long. Within a few years, the run of salmon was down to a trickle. You didn't need a written record to note the change, it was like night and day.

Generation after generation of Atlantic salmon were netted wholesale by commercial fishermen looking for an easy catch. They simply set nets up at the mouths of rivers and caught every fish headed toward its instinctive spawning grounds. Many of Maine's most productive salmon streams—and those in the Canadian Provinces, too—were wiped out completely. I don't mean that the fish were so depleted that sportfishermen were less likely to catch them. I mean that no fish made it to the spawning ground for several consecutive years, no eggs were laid, no salmonids hatched and no salmon headed out to the ocean to reach adulthood and someday return. None. Zero.

Bonefish and tarpon suffered during this time as well, and are still suffering. The difference with these fish is that they aren't the primary target of the commercial fishermen. They are an accidental catch. Commercial fishermen are becoming too efficient, using miles of netting and stripping the water of fish wherever they roam. They aren't actively seeking to kill bonefish, kingfish, marlin, swordfish, sailfish and several others, but the result is the same.

Gamefish or sportfish aren't the only species to suffer in recent years. Most fisher-

men are all too aware of species depletion in natural stocks of striped bass, snook, redfish, grouper, several kinds of tuna, sea bass, salmon, steelhead trout on the West Coast and many others. Sportsmen's groups and conservation agencies are working together on this to raise public awareness of the problem, to restore threatened stocks, and to get legislation passed to ensure continuation of current species for future generations. Some of the work done in this area is controversial. Commercial fishermen feel pressured. Even some sportfishermen feel that government regulation goes against the grain of a sport that is among the purest expressions of freedom.

WELL, PILGRIMS, as John Wayne used to say, I'm going to spell out my opinion on the subject as straight as I can. Some people might not like it, but here goes. Firstly, it's time we made saltwater licenses mandatory for all anglers, both commercial and sport. I know that some states already have a saltwater license, but what good does it do if one state is regulated and the neighboring one isn't?

Fishermen with a mind to circumvent the license law just pull into a dock

in an unlicensed state and unload the ill-gotten catch. This type of thing happens every day. Without a federal license and certain nationwide regulations, depletion will continue and hoped for improvement will be impossible.

I'm basically conservative by nature and against government meddling, whenever possible. But I've seen drastic changes in fish population in my lifetime and they haven't been for the better. The problem with licenses, of course, is enforcement. What good are they if no one checks? This is where the fee comes in. It should be written into the legislation that money collected for saltwater licenses goes for hard-nosed law enforcement and restoration work.

My second point (Have I stirred up enough controversy, yet?) concerns sportfish in general. I think a study should be done to determine exactly what a sportfish is and then ban their commercial sale. This is like opening the proverbial can of worms, because not everyone agrees with what a sportfish is. My list would include all the marlin, swordfish, striped bass, bonefish, tarpon, permit, redfish, sailfish and, to be honest, other species in danger of depletion. In addition, I believe

bluefin tuna and Atlantic salmon should be closely watched and, perhaps, commercial fishing near shore temporarily suspended.

LET ME CLARIFY what a sportfish is by explaining what it isn't. It isn't a fish that is essential to commercial fisherman, such as flounder, whiting, haddock, herring, hake, mackerel and so forth. Most common food fish, I believe, shouldn't be considered sportfish.

But, perhaps the most important criterion is whether or not fishermen are willing to spend good money on it. You don't find fishermen renting guides or party boats for carp, suckers, flying fish or mullet.

A fish is a sportfish if fishermen are willing to spend money on airfare, hotels, meals, guides, car rentals and other incidentals to make it more costly per pound than what commercial fishermen get to catch it. Take Atlantic salmon, for instance. Commercial fishermen get about \$3 a pound. I can vouch for the fact that some individual salmon have cost me more than \$200 per pound (counting all the expenses I incurred in the catch). And I paid it willingly. Sportfishing is an important



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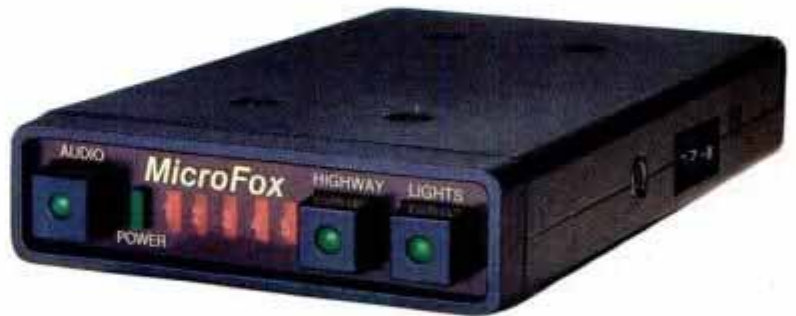
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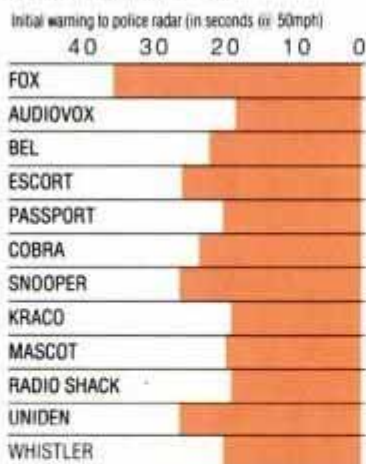
ROAD & TRACK

In its November, 1988 issue, Road & Track said "The advent of instant-on places a premium on K-band sensitivity, because the only defense against this type of radar is to detect it in use on cars ahead of you in the traffic stream."

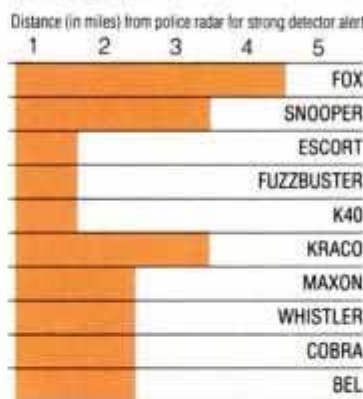
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Road & Track K-Band, Highway Setting



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FISHING HOLES U.S.A.

industry to many statewide and local economies, when you look at the numbers as many analysts have, and it deserves protection.

My final point along these lines concerns pollution. Sure, we've got to do something with our garbage and industrial waste, but pouring it into the nearest body of water isn't the solution. Unrestricted dumping in rivers, lakes and coastal waters harms the habitat and harms the fish. You don't have to be a fisherman to understand this, it's plain to anyone.

Once again, I don't have an easy answer in mind and studies by experts and politicians need to be done. But once those studies are completed, I'd get behind them to make sure we take the steps necessary to create enough clean water to ensure fishing for future generations. Corrective measures this late in the game may prove to be harsh medicine to some special interest groups, but there's no easy solution and not everybody's going to be happy. Is this too strong a stand? I don't think so. In fact, I believe, more fishermen should move to the forefront of the fight against pollution and the cleaning up of the waterways in this country.

DESPITE THE CLOUD that seems to be hanging over some areas of the fishing scene, there are a number of bright spots, too. I have good feelings about the future of the sport, because I think we're finally beginning to turn the corner. In freshwater fishing, trout and bass stocks are actually better in many regions than they were 20 years ago. The Great Lakes have made an amazing comeback and serve as a wonderful example of what can be done when people get serious.

Lake trout, brown trout and Pacific salmon are providing better fishing today than many thought possible a few years ago. Even the Atlantic salmon is on the comeback trail in Maine and a couple of other New England states. Also, striped bass and walleye have recently become increasingly important sport species in freshwater lakes throughout the country.

State conservation agencies and private groups, such as Trout Unlimited, Atlantic Salmon Assn., Federation of Flyfishers, International Gamefish Assn. and the Isaac Walton League, are more active than ever before in conservation efforts. They're fighting the good fight and even winning a few battles. I support their efforts in trying to bring intelligent management to the world of fishing, and I think every fisherman should, too.

People who know me are aware that I have a dream of one day owning a sea-

worthy vessel big enough to carry a couple of skiffs on deck. The plan is to live on the big boat and fish out of the small ones as I cruise from port to port. I've been looking for the perfect boat for about 40 years now, and perhaps it's just a dream that will remain forever out of reach.

But it really doesn't matter, because I've done as much fishing as I could do in this great country of ours and I've enjoyed every minute of it. Fishing has given me a lot in life and the reason I've made such strong statements regarding its future is that I'd like to give something back. We've got the best country in the world for fishing right here in America. Let's do everything we can to keep it that way. **PM**

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Season: peak is May-June, but fish may be caught in summer. State license and salmon tag req.



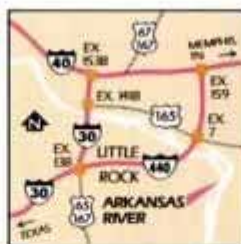
Islamorada Florida Keys, FL

Best Fish: Bonefish in saltwater flats, either wading or on guide boat.
Season: April-October, the hotter the better. No license required.



Arkansas River, AR

Base Town: Little Rock
Best Fish: Largemouth bass on 2-man bass boat.
Season: year-round. State license required.



Flathead River System, MT

Base Town: Kalispell
Best Fish: Trout on fly tackle, wading.
Season: July-September, wait till after snowmelt. State license required.



Boca Grande Gasparilla Island, FL

Best Fish: Tarpon in guided boats offshore near Boca Grande Pass.
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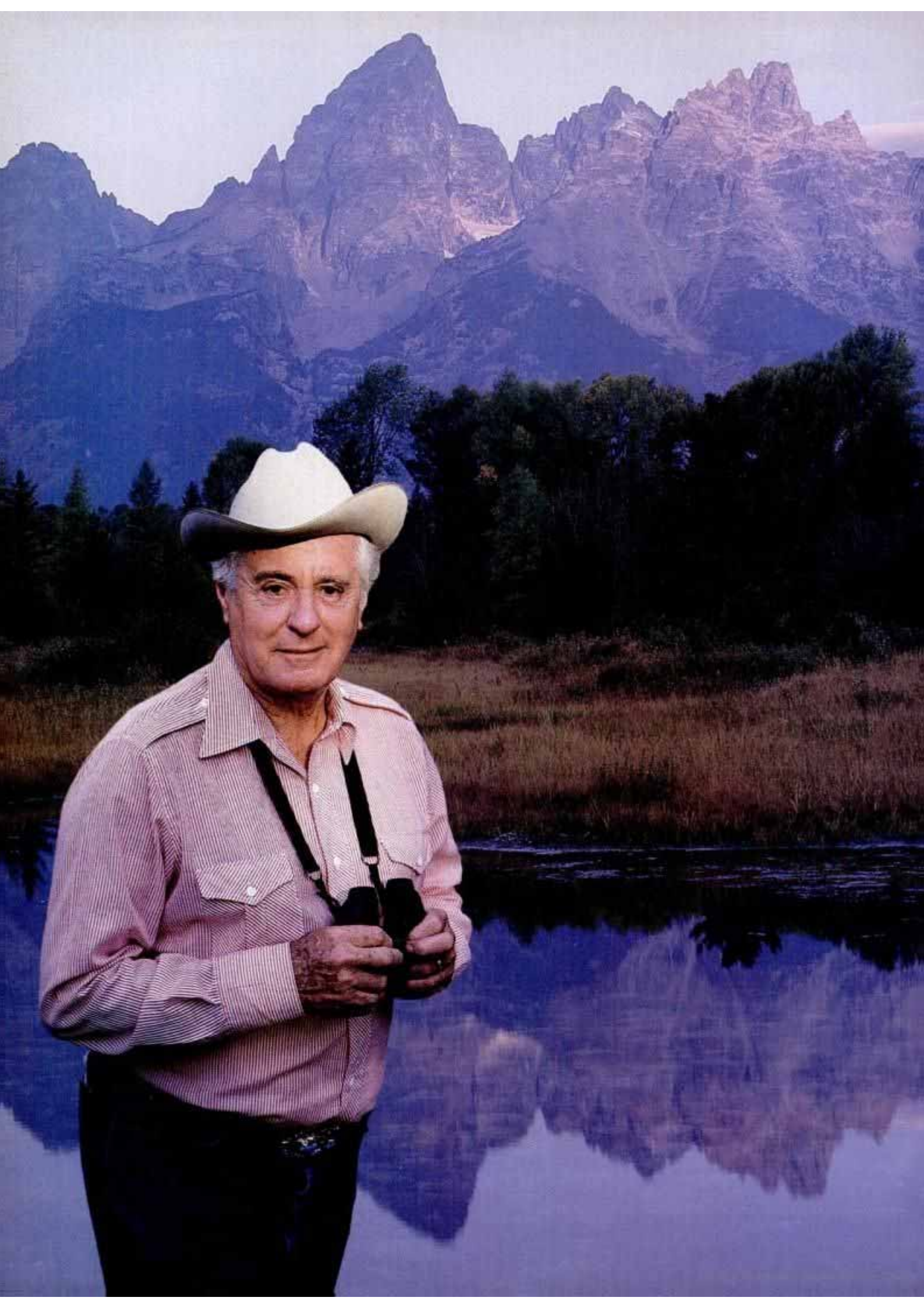
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Let's get it together. Buckle up.



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AMERICAN BEAUTY

From vast geologic wonders to historic little gems, we are enriched by treasures protected by the National Park System.

BY CURT GOWDY

WE HAD JUST finished filming a trout-fishing episode for ABC/TV's show "American Sportsman." The location was the southeast arm of Yellowstone Lake, in Wyoming's Yellowstone National Park. It was a raw, windy day in the nation's first national park, established in 1872. Our guide and host was Jack Anderson, park superintendent at the time. Anderson suggested we take the horses and ride to a naturally sheltered feeder stream he thought would be loaded with trout.

My son, Trevor, a couple of outfitters and I found the crystal-clear stream a couple of miles away and, just as Anderson predicted, it was filled with big cut-throat trout, sweet-tasting fish indigenous to the Yellowstone and Jackson Hole areas. Trevor stayed with the head outfitter, Bud Sailors, near the mouth of the creek, while I walked about half a mile upstream with a member of the crew.

Just as I made my first cast, I heard my partner yell: "Here comes a big grizzly!" Looking up, I saw the huge bear emerge from the nearby brush. With my heart pounding like a piledriver, I turned to ask my buddy what we should do, but he had already bolted, leaving me with a slender fly rod for protection.

The grizzly undoubtedly caught our scent and came out of his day bed to inspect intruders in his territory. I was desperately reeling in line as fast as I could when I happened to look up and glimpse the most memorable sight of my life: magnificent *Ursus Horribilis* standing on his hind legs, sniffing, looking around and displaying his full, powerful form. The sun lit his face just right and I could see the brilliant reflection off the silvery tips of his thick, black fur. It was an awesome and beautiful sight.

At this point, I decided it wasn't a good time to be standing there reeling in line. I raced off dragging my fly rod and loose line through the underbrush, making an Olympic-level dash back to the horses. My son, the crew and Sailors were already mounted when I arrived gasping for breath. "Come on, let's go," Sailors said. "These horses can bolt anytime if they smell that bear, and we'll all be walking home. Also, these grizzlies are smart. They can circle around and come at us from behind."

When we arrived back at camp, I immediately sought out Superintendent Anderson, a renowned expert on grizzlies, and asked him if my natural reactions were the right ones when confronted by a grizzly. "You did everything wrong," Anderson told me. "The grizzly has poor eyesight and a keen sense of smell. When you ran, it probably looked like a blur representing prey. When the bear is upwind and some distance away, it's often better to drop to the ground on your stomach and remain perfectly still."

"What's a grizzly likely to do then?" I asked.

"Anything he wants," Anderson answered. "He's the most powerful animal in North America, and can overtake a horse within 100 yards. If there is one word that describes a grizzly, it's 'unpredictable.' You never know what he's going to do. Charge or calmly walk away. But since you're here without a scratch, you must have done something right."

Over the next week Jack Anderson shared his extensive knowledge with me, not only on grizzlies, but on what it takes to manage what is, in my opinion, our greatest national park.

His areas of concern were ecological balance, preservation of the wild character of the land, control of the limited budget, managing hundreds of employees, and dealing with the growing number of visitors.



PM PHOTO BY DAVID BARNES/STOCK MARKET

The wildlife-rich peaks of Wyoming's Grand Teton National Park tower behind renowned outdoorsman and broadcaster Curt Gowdy (opposite). Cape Hatteras (above) was the first park designated a national seashore. It encompasses beaches, dunes, barrier islands and lighthouses in a 100-mile-long stretch of North Carolina coastline.



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A geologic record of 2 billion years is revealed in the layers of rock of Arizona's Grand Canyon.



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Care of giant sequoia trees is entrusted to the rangers at California's Sequoia Natl. Park.



STOCK IMAGERY PHOTO

Yellowstone's Old Faithful continues its thermal activity despite recent ravaging fires.

Anderson's chief concern, however, was wildlife. Each fall he helicoptered deep into the mountains and hiked his way out, collecting data on animals as he walked. He noted that in some areas large numbers of grizzlies were living too near human dwellings and feeding in garbage sites. This was bad for people, because the animals gradually lost their natural fear of humans, and for the bears, because they were getting sick by ingesting unnatural products, such as aluminum foil. In situations like this, the rangers instituted a program to move some grizzlies in huge slings by helicopter and relocate them to remote wilderness areas that made more sense for the bears.

ANDERSON WAS also the first to notice pressure put on the park's lakes and streams by fishermen. Although it seemed unpopular at the time, he reduced the daily limit of cutthroat trout and closed the well-known Fishing Bridge. Although public outcries were understandable, his gutsy decision was made just in time and saved the species from potential depletion.

Jack Anderson, who recently passed away, was the man who truly inspired my interest in Yellowstone and the National Park System as a whole. My interest turned to deep concern, however, as a result of the well-publicized fires that ravaged Yellowstone last summer.

I traveled to Jackson, Wyoming, last August to address a conservation group, Trout Unlimited, and while there, I stood at the foot of the towering Grand Tetons and watched orange flames climb high into the night sky. Smoke and cinders were everywhere despite the fact that Yellowstone was more than 65 miles away.

Who can forget those vivid images? Television and print media carried them for days. Half of our greatest national park was destroyed. Or was it? Some experts say fires

are an integral part of the natural order and that new growth is already replacing the old. In a few years, these experts say, we won't be able to detect any evidence of the fires of 1988 at all.

But were those fires out of control and dangerous? Should public property, private property and the lives of firefighters be allowed to be threatened by an event that might be better controlled? These are just a few of the tough issues, among many others of equal importance, that face our national parks today. How they're resolved will effect the future shape and character of the entire National Park System.

AS A TELEVISION broadcaster and producer of outdoors programming, I've come to know our national parks as sources of such fascination and beauty that shows filmed in places like Sequoia or Yosemite or Glacier, for example, practically scripted themselves.

I once filmed a show on the Cape Cod National Seashore, located near Provincetown, Massachusetts. This is a unique place of thriving saltmarshes, huge sand dunes and pristine beaches that stretches for 40 miles. Big striped bass roll in the crashing breakers close enough to shore to make it a surfcaster's paradise.

A crew member and I were riding along the beach in a dune buggy equipped with special low-pressure tires, the only kind of vehicle allowed in the park at that time, when he said something that really struck home: "This beautiful stretch of shoreline would be jammed by row after row of commercial development, like the rest of Cape Cod, if it hadn't been designated a national park in 1961."

It took tremendous effort and foresight to create what we now know as the Cape Cod National Seashore, just as it did the other priceless treasures in the vast National Park System.

The first national seashore created by act of Congress was Cape Hatteras, in North Carolina, in 1937. The story of its development illuminates much about how the system works.

Land acquisition takes time and by the end of World War II, eight years after its authorization, the Cape Hatteras project was still far from complete. Finally, a private source, the Melon Foundation, donated sufficient funds—matched by the state of North Carolina—to fully open what is now a gorgeous 100-mile stretch of barrier islands and beaches that provides unparalleled opportunities for surf bathing, fishing, bird watching and nature study.

We now have 10 national seashores in the National Park System, which has expanded over the years to include a wide range of categories. In addition to the 49 national parks, there are 63 historical sites, 25 national memorials, 77 national monuments, 17 recreational areas, four national lake-



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PHOTO BY ROY MURPHY/STOCK IMAGERY

Ancient volcanic activity made 2000-ft.-deep Crater Lake, in Oregon's Cascade Range.



PHOTO BY BRIAN KING

Fort Jefferson, built in 1864, in Florida's Dry Tortugas, is one of the gems of the Park System.

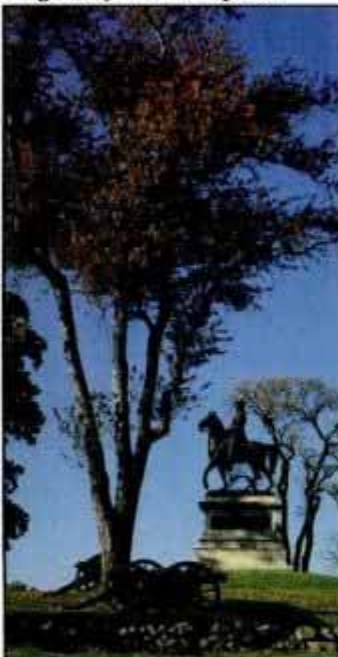


PHOTO BY JAMES BLANKSTOCK IMAGERY

Gettysburg National Military Park is on land President Lincoln called "hallowed ground."

shores, 11 national battlefields, eight national rivers, and let's not forget the White House, where our president lives. In all, there are 341 places included in the National Park System. The two newest additions are the Jimmy Carter National Historic Site, in Plains, Georgia, and El Malpais National Monument, near Grants, New Mexico.

SOME OF THE PARKS are large and renowned throughout the world, such as Yosemite, the Grand Canyon and the Everglades. Some are smaller and lesser known, but fascinating just the same.

One of the most interesting locations I've ever filmed was at Fort Jefferson, in the Dry Tortugas, about 68 miles west of Key West, which was built in 1864 to help control shipping in the Florida straits during the Civil War. It is the largest all-masonry fortification in the Western world. After the Civil War it was temporarily converted into a maximum-security prison.

Its most famous occupant during this time was Dr. Samuel A. Mudd, the man who set the broken leg of President Lincoln's fleeing assassin John Wilkes Booth and was convicted (but later pardoned) as Booth's accomplice. If you remember the old movie "Prisoner of Shark Island," you know that the moat surrounding the forbidding fortress was filled with killer sharks.

Today, Fort Jefferson is preserved as a museum by the Park Service. It's a fascinating place to visit and fishing around the fort is about as varied and exciting as can be found anywhere.

Are you a war buff? The National Park System is the guardian of some of the nation's most important battle scenes. The Custer Battlefield National Monument, in Montana, preserves the site of the most famous encounter in the Indian Wars, the Battle of Little Big Horn. The Minute Man National Historical Park in Concord, Massachusetts, preserves the scene of the first battle of the Revolutionary War. One of the most moving monuments in the system is the Gettysburg National Military Park, in

Pennsylvania, where the pivotal conflict of the Civil War was fought and President Lincoln delivered the Gettysburg Address.

Geologic wonders are also well accounted for in the National Park System. These include the massive monolith of Devil's Tower, in Wyoming, the incredible rock-fault formations of Arches National Park, in Utah, and the stunning volcanic beauty of Crater Lake, in Oregon.

A comprehensive Guide and Map of the Park System, with a list of addresses for regional park offices, is available by writing to the U.S. Department of the Interior, National Park Service, P.O. Box 37127, Washington, D.C. 20013. If further information is desired about a specific location, Official National Park Handbooks exist for most areas in the Park System. These can be requested of one of the regional offices listed in the Guide and Map.

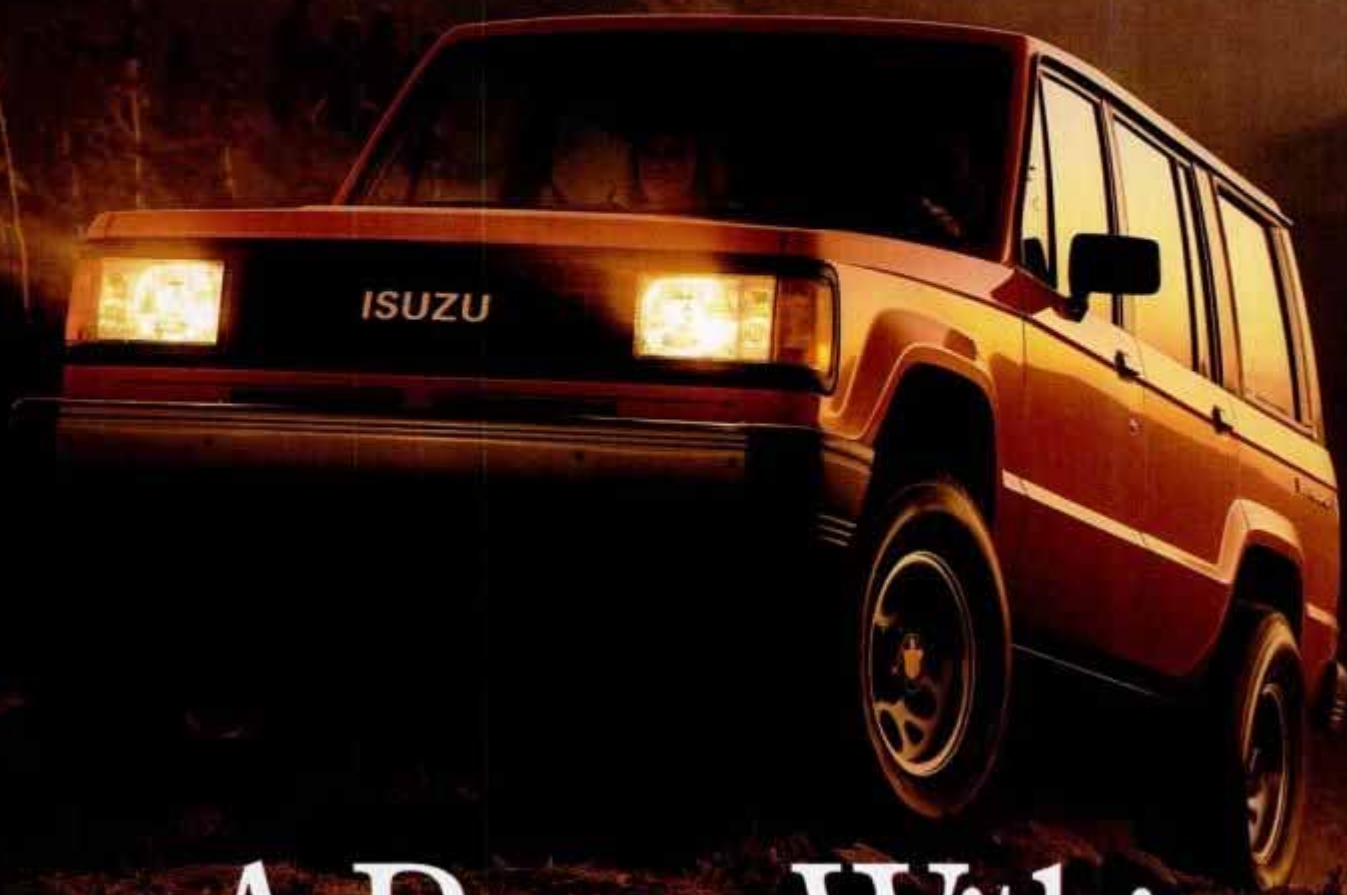
TWICE I HAVE RUN into foreign film crews while I was doing my own filming in national parks. In Yellowstone, I met a crew from Japan and in the Everglades one from England. Both crews said they came to America to film the marvels of our Park System because their countries have nothing comparable to them. They made it clear that in their opinion our system is the envy of the rest of the world.

Yellowstone's successful establishment sparked the authorization of 14 more national parks between 1872 and 1916. Most of them copied the Yellowstone model and their creation was due in large part to contributions by private sources and powerful supporters in Congress. Americans of the time were changing their ideas about nature. They knew our country was a vast and beautiful natural resource, but they also realized how easily it could go the way of the wild buffalo.

I happen to agree with nature writer Roderick Nash, who asserts that America is the inventor and worldwide leader in preservation of huge tracts of land for future generations. Nash says our National Park System is a uniquely American institution that was born out of "our unique experience with nature on the American continent, our democratic ideals, our vast public domain and our affluent society."

The rest of the world may admire how we have successfully preserved more than 79 million acres of land, natural wonders and historic sites for use and enjoyment by the public to the exclusion of limited private interest. But criticism and concern is mounting at home. Many Americans are worried about the future of the Park System, especially in the aftermath of the 1988 Yellowstone fires. Some blame management practices by the Park Service that allow long-term problems to develop unchecked.

Acid rain is a nationwide problem that isn't confined to park boundaries, but it's causing damage to habitat we're trying to



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AMERICAN BEAUTY

preserve, most notably in Tennessee's Great Smoky Mountains National Park. Like it or not, the Park Service must tackle the acid rain issue.

Encroaching development of land abutting our parks has also become a serious threat. For instance, heavy farming near the Florida Everglades has resulted in toxic chemicals fouling the waterways of the wildlife-rich "river of grass." The wading-bird population in the Everglades has dropped 90 percent in the last few decades because of the problem. Many parks, most notably Yellowstone, are now experiencing commercial and residential development right up to their borders.

SHOULD THE Park Service, or some other branch of government, study the potential long-term effects of rapid development of land bordering parks? Many Americans think so, and so do I. Such a study will have to address the difficult issue of preserving national interests while protecting local rights. Nevertheless, I believe such a study is needed, and if it recommends that the Park Service should be allowed to protect its trust without outside interference, I would support it.

I've had many occasions to speak



Lone climber scales the rock in one of the least explored regions of the country in Arches National Park, Utah.

with rangers and other employees of the Park Service. Most of them have a true dedication to the important job they're doing and find their work genuinely rewarding. But many are also worried. While they admit that park lands have expanded during the last decade, they point out the size of the park staffs has remained the same.

Many worry that vital preventative maintenance duties are falling behind schedule and that precious resources are suffering. The explosion in annual visitors, 287 million last year, has

forced stressed park staffs to concentrate their efforts and budgets on such chores as garbage and bathroom patrols to the exclusion of more important functions. And the situation is likely to get worse. By the year 2010, visitors to the Park System could reach 500 million.

Today, we hear many horror stories about land in America ravaged by pollution, and about animal species pushed to the edge of extinction, such as manatees and condors. But there are success stories as well. The wild turkey

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The sun comin' up through
the steam.
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has made a great comeback during the last 20 years, and so has the alligator. There are more whitetail deer today in many states than there were at the time of the American Revolution. Wyoming had about 10,000 prong-horn sheep in 1912, according to old records, but today more than half a million thrive in the state.

How were these dire and seemingly irreversible problems corrected? The answer is through the concerted efforts of well-trained wildlife biologists, effective leaders and a cooperative pub-

lic. With this combination of resources, good things can happen.

But all too often, lately, we've been hearing bad news, especially regarding our air and waterways.

The fouling of our beaches, last summer for example, resulted in a serious nationwide outcry.

Time magazine, in an unusual step, made Earth its Planet of the Year for 1988, instead of naming its annual Man of the Year. Few failed to get the message that the time to act is now, before it's too late.

WITHOUT DOUBT, our National Park System is a bright spot in what many think is a darkening picture. It's a source of tremendous joy and pride and, in fact, it's safe to say that for many Americans, the Park Service has long been their favorite branch of government. The new Administration of President Bush, who is himself an avid outdoorsman, would be well advised, in my nonpolitical opinion, to support the special feeling Americans have for their national parks.

The "best and the brightest" is a term made popular in the Kennedy era of the early 1960s, but it could just as well be applied to the land set aside by the National Park System. This fundamental portion of the fabric of our nation's heritage is in our hands now, for good or ill, and what we do with it will determine how our children, and generations to come, will be able to experience the pleasures, wonders and sense of history preserved in a uniquely American invention—the National Park System—that is a source of envy and inspiration throughout the world. **PM**



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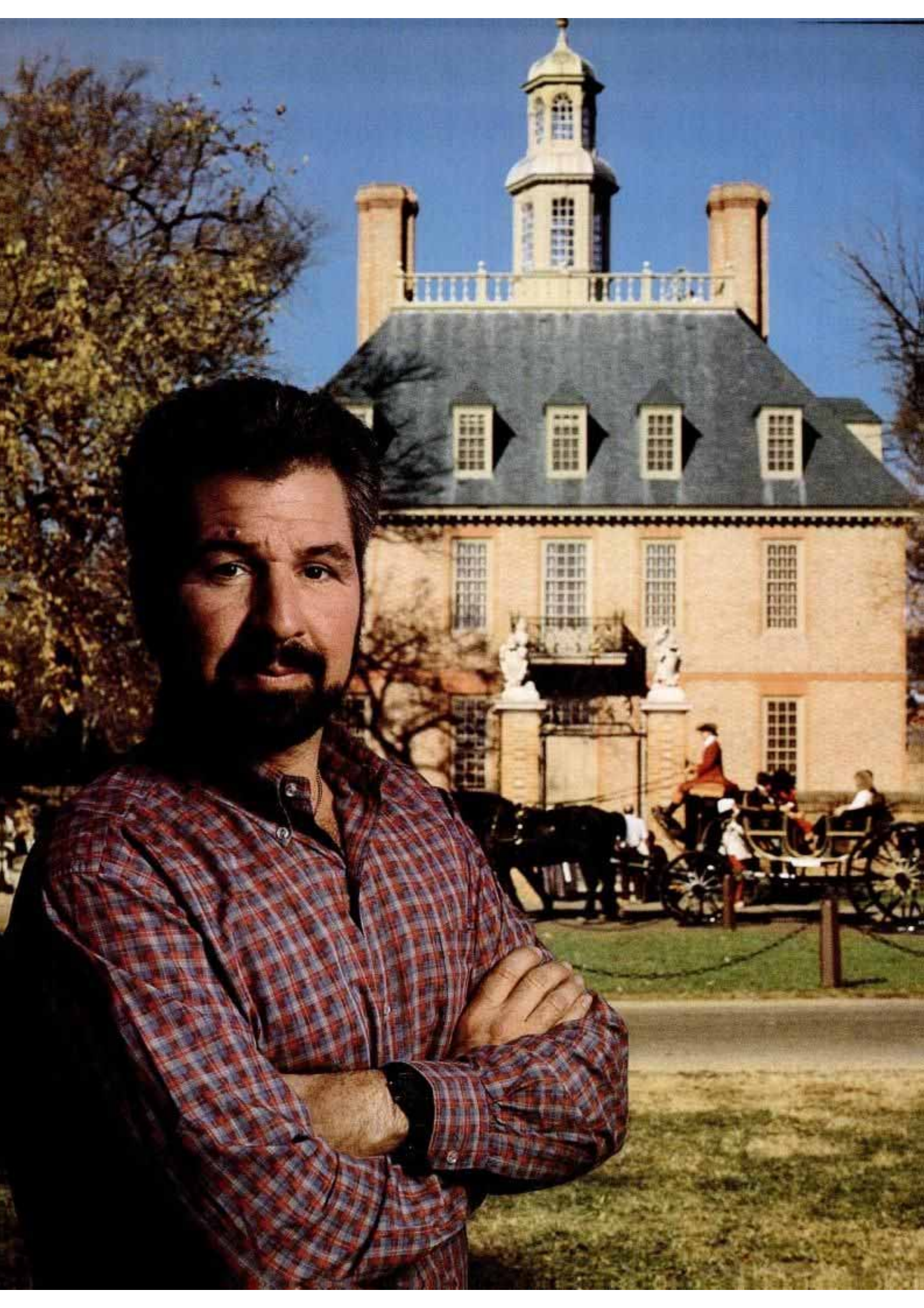
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PM ILLUSTRATIONS BY MARIO FERRO



RESTORING AMERICA

Restoration fever has captured the American imagination and there's no better place to catch it than Colonial Williamsburg.

BY BOB VILA

FOR YEARS NOW, I've had a deep interest in architectural restoration. And, I've had the good fortune to bring part of this interest to bear on my day-to-day work. But as anyone knows who has tried to restore an old house, the dual pressures of time and money force all sorts of compromises. Because of this, when I had the chance to visit Colonial Williamsburg last fall I couldn't pass it up. In many ways Williamsburg is the mecca of restoration in America and I wanted to see just what they had accomplished with their considerable resources.

I went at a time of year when you need a jacket in southern Virginia. The sun was bright and warm but the breeze coming off the neighboring James River was cool and brisk. The trees were nearly half bare and when the sound of leaves swirling around was combined with the occasional smell of burning wood fires, a perfect ambiance for walking the town was created.

On the most superficial level, Williamsburg is like a picture postcard. When you move through the streets there is a real sense that time has stood still and become strangely idealized in the process. The buildings are all painstakingly restored. The tour guides and shopkeepers all wear authentic colonial dress. The roaming character interpreters create vignettes to describe what life was like in colonial times.

At first blush, the overall presentation is endearing, even though it does require a certain good-natured suspension of disbelief. But to think that Colonial Williamsburg is nothing more than a period theme park is to grossly underestimate what goes on there in terms of subtlety, complication and commitment.

Colonial Williamsburg came into being, like most great things, with a good bit of vi-

sion, plenty of hard work, and a strong dose of good fortune. The vision was supplied in the 1920s by two men who have since become local icons. The first was the Reverend W. A. R. Goodwin, rector of Bruton Parish Church which is now one of the restored masterpieces of the village. The second was John D. Rockefeller Jr. who at the time was an occasional resident of Williamsburg.

These two formulated a plan of such scale and complication that it must have dwarfed the imagination of their contemporaries. They decided, at first secretly, to buy up the real estate around the area and then to do nothing less than recreate the world of 18th century Colonial Virginia in the context of small, 20th-century Williamsburg.

The result of their efforts, and the thousands of others who pushed this vision forward, is what Colonial Williamsburg is today. It comprises 173 acres, extending from the College of William and Mary on the west to the reconstructed Colonial Capitol on the east. In this area, 88 predominantly 18th-century buildings have been restored and another 50 major reconstructions were built on their original 18th-century sites. Along the way, scores of 19th- and 20th-century buildings were either moved to new locations, outside the project, or demolished if they were thought to have no particular historical or architectural significance.

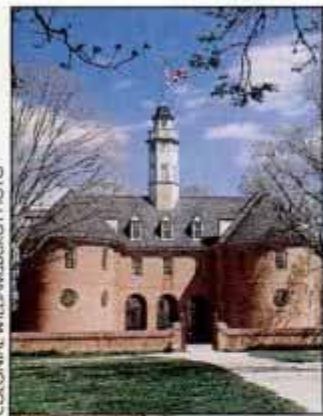
While it was unquestionably good fortune that the Rockefeller family, and their vast financial resources were involved, of equal good fortune was a quirk of fate. In 1780, the Capitol of Virginia was moved from Williamsburg to Richmond. Without the Capitol, Williamsburg turned into a sleepy backwater town where the onslaught of progress largely passed it by. The result was an abnormally high concentration of colonial buildings that had both architectural and historical significance.



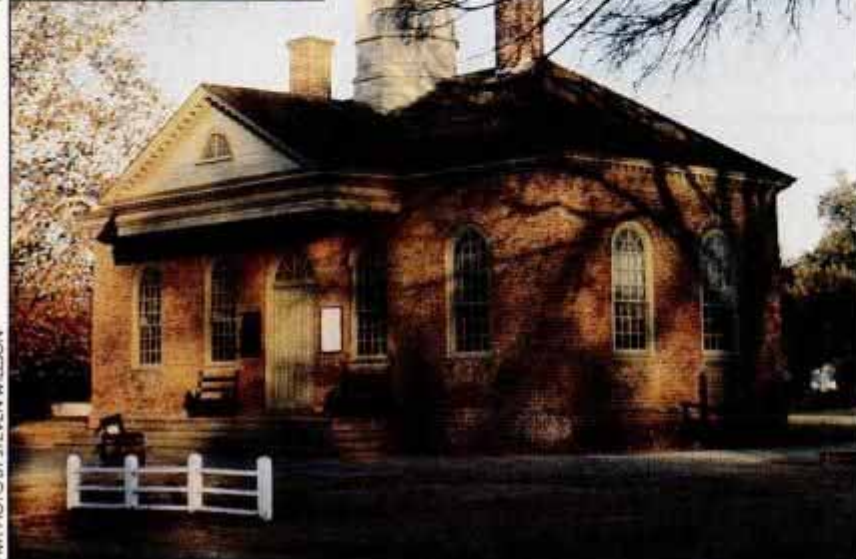
COLONIAL WILLIAMSBURG PHOTO

Bob Vila (opposite) stands in front of the Governor's Palace in Colonial Williamsburg. Williamsburg housewrights (above) are sheathing the Anderson Forge walls and roof with riven oak clapboards.

RESTORING AMERICA



COLONIAL WILLIAMSBURG PHOTO



PM PHOTO BY STEVEN WALLSON

Reconstructed Capitol at Colonial Williamsburg (top) and the Courthouse of 1770 (above), also at Williamsburg, slated for restoration this summer.



PM PHOTO BY ROBERT S. AINOLD

Costumed interpreter working in Towne House garden in Old Sturbridge Village. Center Meeting House is in background.

Williamsburg, after all, was the gathering place for George Washington, Thomas Jefferson and Patrick Henry, to name only a few of our founding fathers. The Capitol was where Henry gave his seminal challenge

to the British throne opposing the Stamp Act. It was also the place where Virginia lawmakers declared their full freedom from the crown, a resolution that became the basis for the Declaration of Independence. But it's not simply the scale or the historical significance of the Williamsburg restoration that is compelling. It's also the fact that, in many ways, Williamsburg represented the first major effort to actually preserve something of the American heritage. And as such, it encouraged many others to pursue restoration. At the same time, it created a yardstick against which these other efforts could be compared.

THIS IS NOT to say that Williamsburg doesn't have its critics, both within the foundation that operates the historic district and from sources outside. A frequent complaint is that Williamsburg was created to match a romantic vision that Goodwin and Rockefeller had of colonial times. And there's some justification for this criticism. Certainly, 18th-century Williamsburg was not simply a merry community of neat, well-painted homes, with charming walkways, picket fences and flowing gardens. It could not have been as homogeneous as the current ambiance implies. Of course there were rich and prominent people, but there were destitute people too, and a tremendous percentage of slaves, fully 52 percent of the population in the 1770s.

"I think there's a lot of validity to such criticism," says Cary Carson, the foundation's Vice President for Research. "Anyone who is at all sophisticated about the practice of history knows that what one discovers is always at least as much a reflection of his or her views of the past as it is a reflection of the past itself. We now look back at the work of our predecessors here and see that they made choices that we would no longer make. We believe our predecessors erred always on the side of high culture rather than recognizing that the high culture that was present here was overlaid with a rigorous vernacular culture.

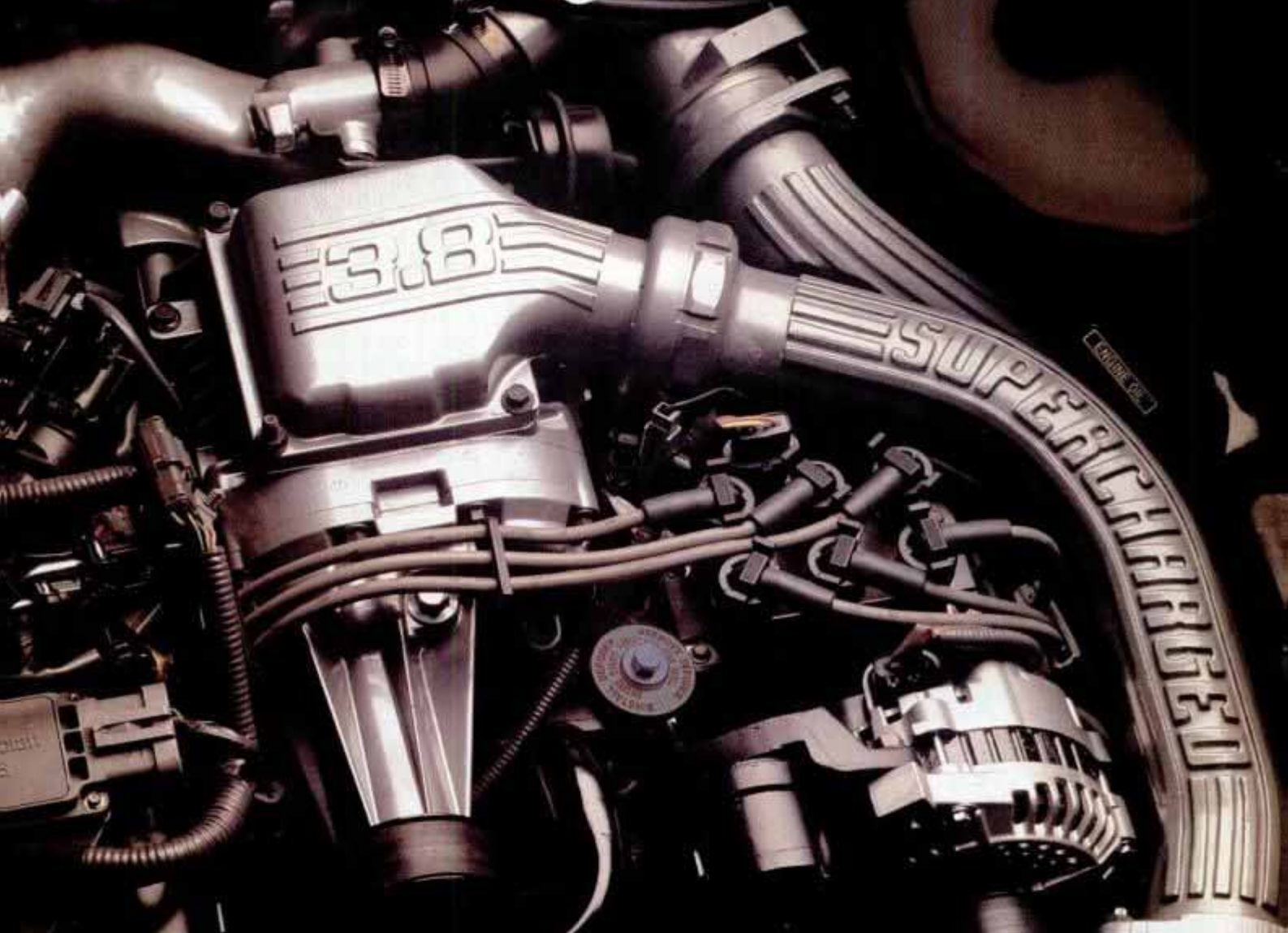
"But ultimately, we are history teachers here. . . . And we take our educational mission very seriously. To a certain extent, we feel that the classroom we have to teach our history sometimes doesn't live up to what we want to do with it. But we can't literally tear down our predecessors' work. We can amend it, make small changes here and there, leave it unpainted. But the really important things that we want our visitors to learn about American life in the 18th century aren't whether the door knockers looked like this or that. We are more interested in the social history lessons we teach."

FOR PEOPLE who think like Carson, the whole milieu of Williamsburg must be something of a puzzle, one that's very difficult to solve. On the one hand, the foundation certainly has the manpower and resources to undertake the most astounding kinds of research and education. Depending on the projects at hand, it employs between 50 and 75 full-time professional researchers in the disciplines of architecture, archeology and social history. As a whole, the foundation has 4000 employees with an endowment of nearly \$160 million. In 1987 their revenues and operating expenses both exceeded \$100 million.

On the other hand, their classroom as Carson puts it, is largely inherited and does have some conceptual problems if their primary mission is education. Such competing influences force a kind of dialectic on Williamsburg that they must struggle to resolve. And this is made all the more difficult by the fact that neither the foundation nor the town itself is a static environment. Both are constantly changing as the result of on-going research.

In many ways, the foundation's commitment to education is most clearly borne by the artisans who ply their crafts in the various exhibition buildings. While shaping barrel staves, a cooper will explain the lifestyle of the colonial worker: the hours, working conditions, pay and so forth. He will also attempt to explain the state of mind shared by colonial workers, what some of their hopes and dreams must have been, what they considered their horizons to be. This is not idle supposition, but rather information based on documentary evidence

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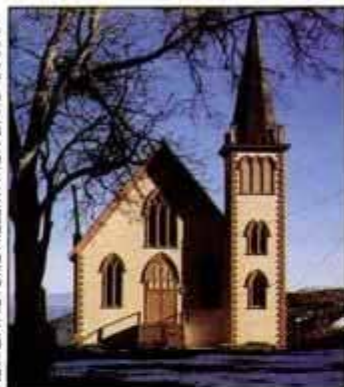
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RESTORING AMERICA

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St. Paul's Episcopal Church in Virginia City Historic District.

such as letters and diaries. What these interchanges basically constitute is the sharing of oral history, which is certainly one of the most accessible kinds of communication.

We have all sat at the feet of our forbears and heard stories of the old days. And it didn't really matter whether they were exciting or mundane. The mere telling of the tale was what counted because it provided a link between our lives and those that came before. When we in turn pass along these stories to our children we are simply extending this link into future generations.

No trip to Williamsburg would be com-

The entire procedure took less than 2 minutes but spoke volumes about the working conditions of colonial tradesmen. As soon as one nail was completed another was begun. Thousands of nails laid in piles on the floor, and it was explained that these would be used for the on-going work in the town. Clearly, a good deal of research was undertaken to establish not only what kind of nails were used in colonial times but also how they were made. But the research for this small detail pales next to the effort that preceded the whole building project.

ACCORDING to Edward Chappell, director of Architectural Research and the man in charge of the Anderson Forge reconstruction, research began in 1980, four years before construction actually began. The building was completed in 1986.

First came the archeological excavation that determined the footprint of the original building and revealed stratigraphic evidence of the sequence in which the building was constructed. Then examination of endless documentary evidence yielded an impression of the methods and materials used to actually build the structure. The research also yielded what sort of activities took place in a forge during colonial times.

The actual building was accomplished with tools, techniques and materials common to the 18th century and was performed by the on-staff housewrights at the foundation. Because of this, it's fair to say that an interpretation of history was built right into the structure. When these efforts are combined with the oral history now being taught by the smiths who work there, the confluence of perspectives and disciplines becomes truly impressive.

"I think the earlier people at Williamsburg really wanted to emphasize the way it was back then," says Chappell. "But I think our generation is most interested in the differences, the relationships, the intersections between people. In fact there isn't any particular way it was back then, anymore than there is today. There was an incredible range of living and working conditions and intellectual perspectives.

"Anderson Forge is simply part of our current effort to paint a broader portrait of what life was like for different kinds of people in the 18th century. For example, the forge was owned by a relatively wealthy person but it was very far from his parlor in social terms. And the kinds of economic choices he made in terms of employing those people and building an environment for them to work in are fascinating.

"What we are trying for is a general perspective of how all of this works together—that these buildings, the town and its landscaping are products of a time when people's mentality was based in another era. And we think the 18th-century mentality was very different than that of the 20th century."

HENRY FORD MUSEUM AND GREENFIELD VILLAGE PHOTO



Thomas Edison's laboratory that was moved in 1928 from Menlo Park, New Jersey, to Greenfield Village outside Detroit, Michigan, by auto magnate Henry Ford.

plete without a tour of the Capitol and Governor's Palace with its breathtaking gardens. These buildings were reconstructed in the 1930s and are not only beautiful architectural monuments, but also astounding examples of mid-20th-century craftsmanship. The effort and cost of these projects must have been awe-inspiring then, to say nothing of today.

But to get to the heart of present-day Williamsburg, to be exposed to the real subtlety of the foundation's current efforts, a trip to the Anderson Forge shouldn't be missed. Situated just off Duke of Gloucester Street, it is a modest, unpretentious building unlike so many others you see in the village. The walls and roof are clad with riven oak clapboards that have weathered nearly black. Inside are housed seven coal-fired forges, and the day I visited, the smiths were making nails. The task was arduous and repetitive. First, a 3-ft. length of red-hot iron bar was pulled from the forge. Then using a small maul, the end of each bar was hammered into a 4-sided tapered shaft. While the iron was still red hot, the bar was cut off on the edge of the anvil. The resulting 4-in. spike was then driven into a sieve, of sorts, so that only 1/4 in. of the spike extended above the opening. This top section was then peened over, to create the nailhead, the spike was tapped from the sieve, and a nail was born.

P&A PHOTO BY TERRY DEBENCK



California Steam Navigation Co. freight depot on Front Street in Old Sacramento, California.

OLD SALEM INC. PHOTO



Old Salem visitors using reconstructed water pump, part of early public water system.



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RESTORING AMERICA

BECAUSE THE foundation is looking to present a synergistic relationship between the physical reality of Colonial Williamsburg (their classroom) and the dynamism of the human activities that took place there, such efforts cannot be regarded simply as the preservation of artifacts. And in my view, this is what's so intellectually stimulating about Williamsburg. The foundation continues to plumb these depths with its latest major project: the Courthouse of 1770.

Reconstruction on the interior of this

18th-century building will begin this summer and will take about a year to 18 months to complete. The research, however, began in 1983. According to Carl Lounsbury, the architectural historian in charge of the job, the research was inhibited not only by the fire inside the building but also by the burning of Richmond during the Civil War where the 18th-century records of the Courthouse had been stored.

Though laborious, the research methods are fairly straightforward. "We search until the next few docu-

ments we discover don't surprise us," says Lounsbury. "If you keep being surprised by what you find then you realize that you haven't covered the corpus of the material. But as soon as you start seeing a pattern to things you can have some confidence that you understand what is going on."

"When we're done, we'll have character interpreters acting out the parts of a lawyer, clerk, magistrate and litigant. And these characters will be based on people that we know existed in the town, all organized to illustrate a point about 18th-century law. For example, we might have a widow come in to turn over her husband's estate because she doesn't own the property. This is a powerful image, especially today with the growth of concern for women's legal rights. And here we would be presenting something that is diametrically opposed to what we are used to today, that is if a man dies intestate, his property goes directly to his spouse. But this is simply not the way colonial society was structured during the 18th century."

"No matter what they do, I don't want visitors to come away thinking that the 18th century was simply a little older and didn't have electricity. I want to stress the differences between the two and how our society, through our legal system, evolved and developed."

OF COURSE, Williamsburg, though large in scale and influence, is but a small corner of the restoration activities occurring in America these days. For purposes of classification, Colonial Williamsburg is considered an outdoor living museum. Other similar institutions can be found at Old Sturbridge Village in Massachusetts and Old Salem in North Carolina.

Sturbridge Village is situated on 200 acres of rolling landscape and depicts the life in rural New England during the 1830s. The village itself boasts a working historical farm and over 40 restored buildings. Artisans also perform their trades and supply crucial observations on the social history of the time.

Old Salem, on the other hand, is part of Winston-Salem, North Carolina. It is situated in the oldest part of town and was originally a Moravian settlement founded in 1766. The restored area is maintained by a nonprofit educational corporation that operates 10 different museums in the area.

A slightly different, though still compelling, approach can be found at the Henry Ford Museum and Greenfield Village in Dearborn, just outside of Detroit. In 1929, Henry Ford founded this enterprise to showcase the tools and products of industrial America, focusing on the period from 1800 to 1950.

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RESTORING AMERICA

Many historic structures were also moved to Greenfield Village, including Thomas Edison's Menlo Park laboratory and the bicycle shop where the Wright brothers built their first airplane.

Furthermore, there isn't an area of the country where there aren't museums dedicated to preserving various artifacts. Federal, state and local historic districts dot the landscape from coast to coast. The old mining town of Virginia City, Nevada and the old river town of Old Sacramento, California,

are but two notable examples. When you add to these the thousands of privately and publicly restored houses, you get a feel for the depth and breadth of this country's interest in restoration.

But all these endeavors must be or have been confronted with the same kinds of difficult decisions that engage Colonial Williamsburg because preserving and interpreting history are such ineffable pursuits. In light of this, I think we should all applaud the efforts that so many are undertaking to make our history more accessible and more

personal. These people and the organizations they represent have set their sights higher than merely providing entertainment. And while the pursuit of edification does not always bring with it impressive financial rewards, that doesn't mean it's less worthwhile. In fact, maybe it's time to think such things are *more* worthwhile. **PM**

WHEN YOU GO...

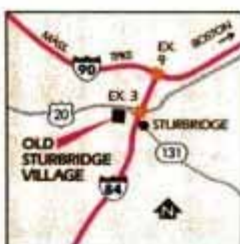
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ILLUSTRATIONS BY MARIO FERRO

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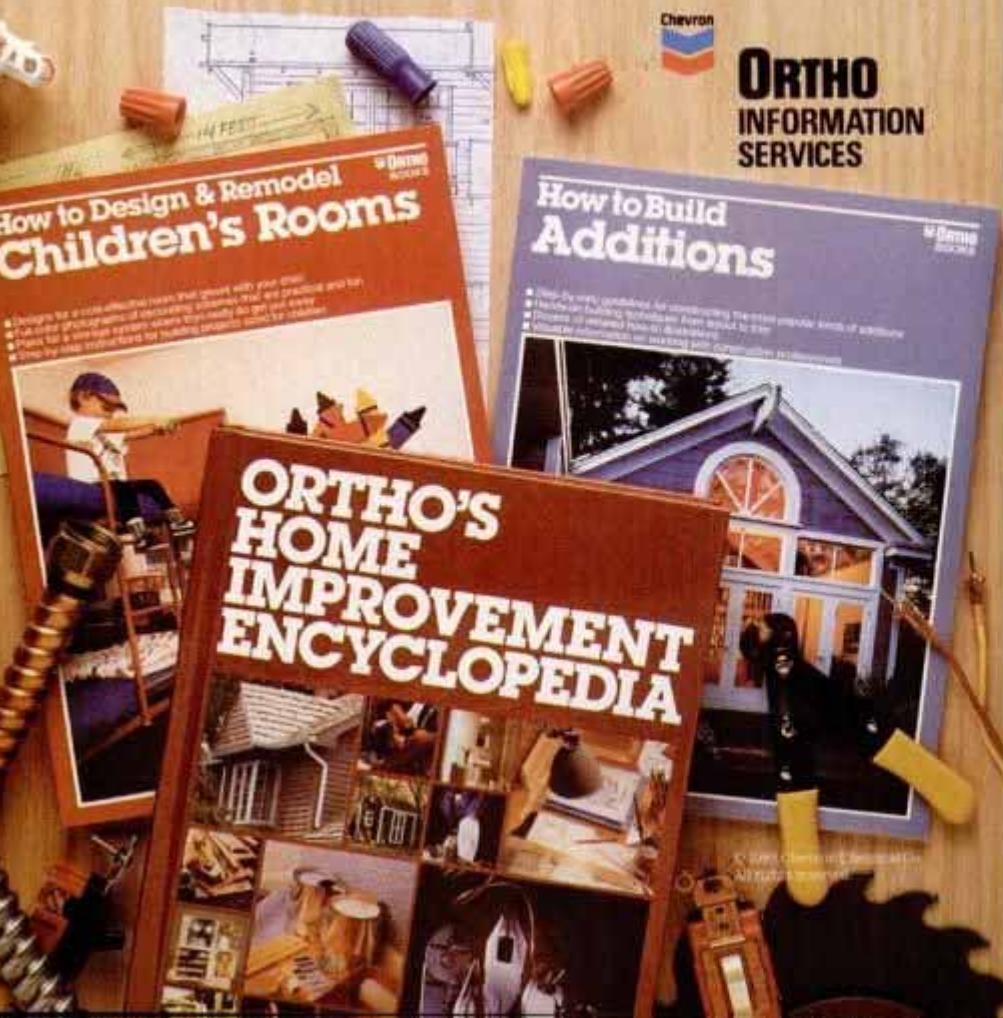
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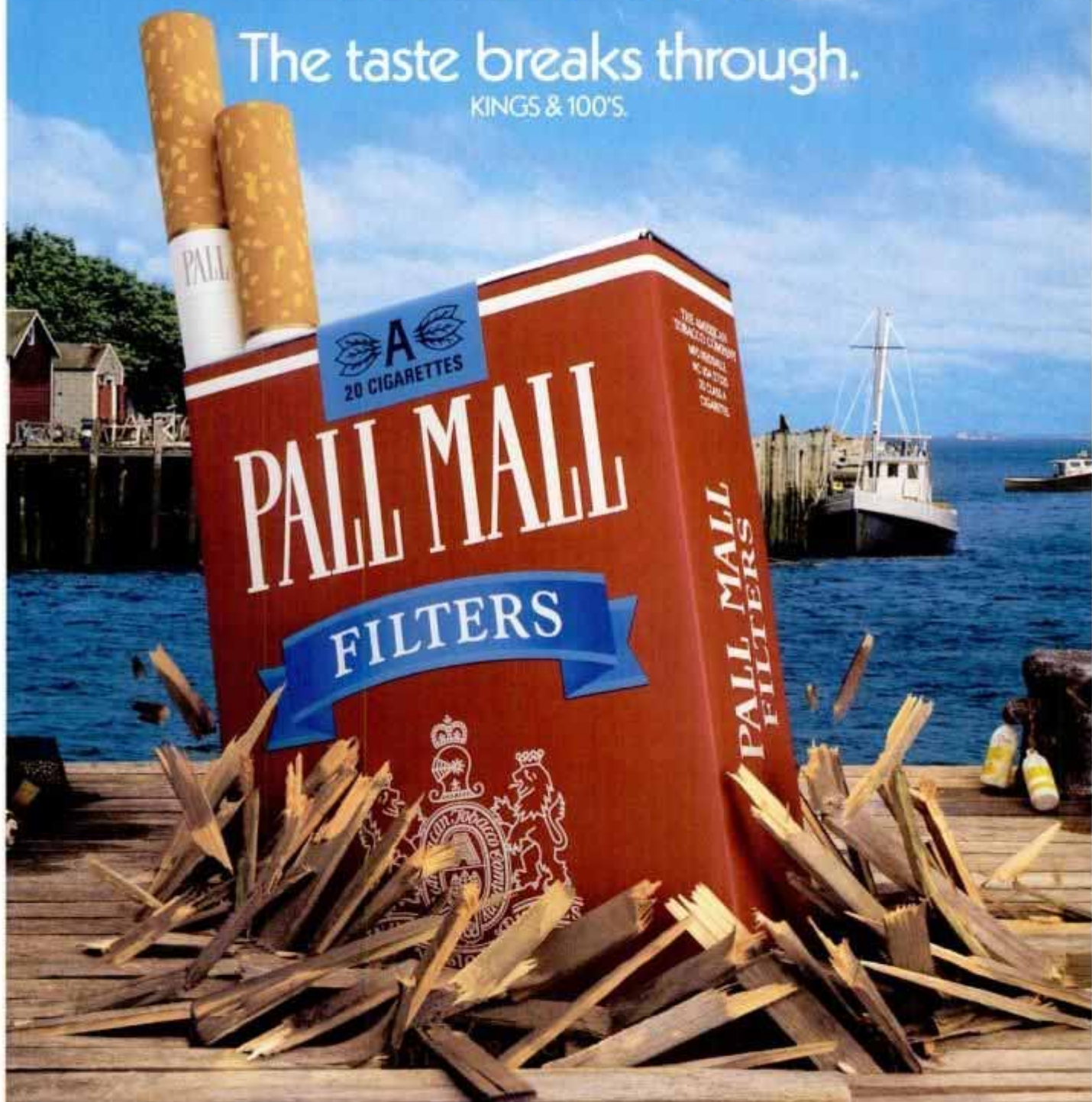
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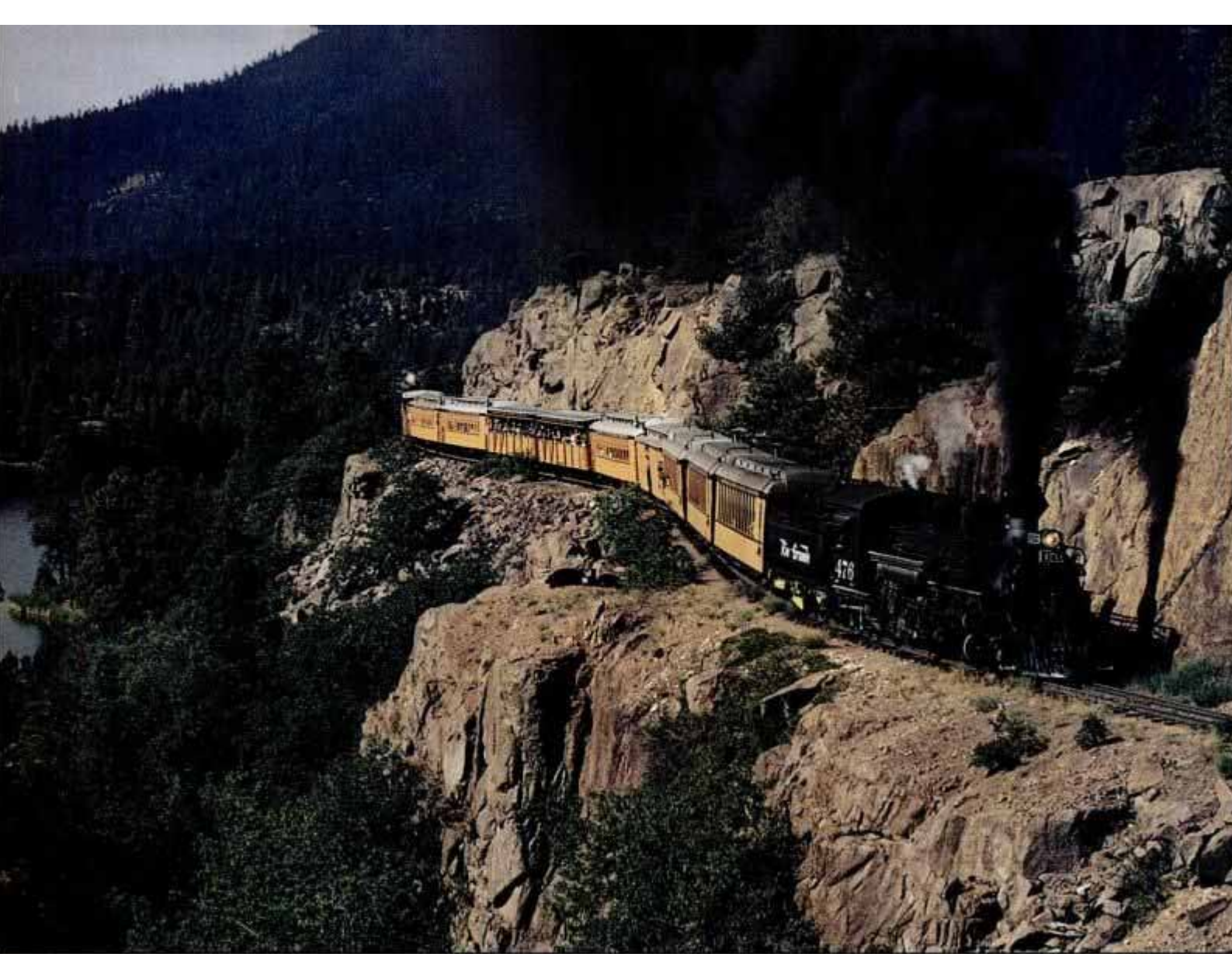
Rehabilitated steam trains are a window on the beginnings of the mechanical age.

BY WILLIAM HOFFER



A working replica of the Central Pacific Jupiter, which took part in the 1869 Golden Spike ceremony that united America, lets off a little steam in Promontory, Utah.

AS THE PASSENGERS board the refurbished, turn-of-the-century railroad coaches, you could swear that the old steam locomotive is alive. She sits on the rails at the head of the procession, breathing, sweating, coughing, seeming to roar, "Hurry up, I want to move!"



"It's just a bunch of simple machinery put together," declares G. Fred Bartels, president of the Strasburg Rail Road located in Strasburg, Pennsylvania.

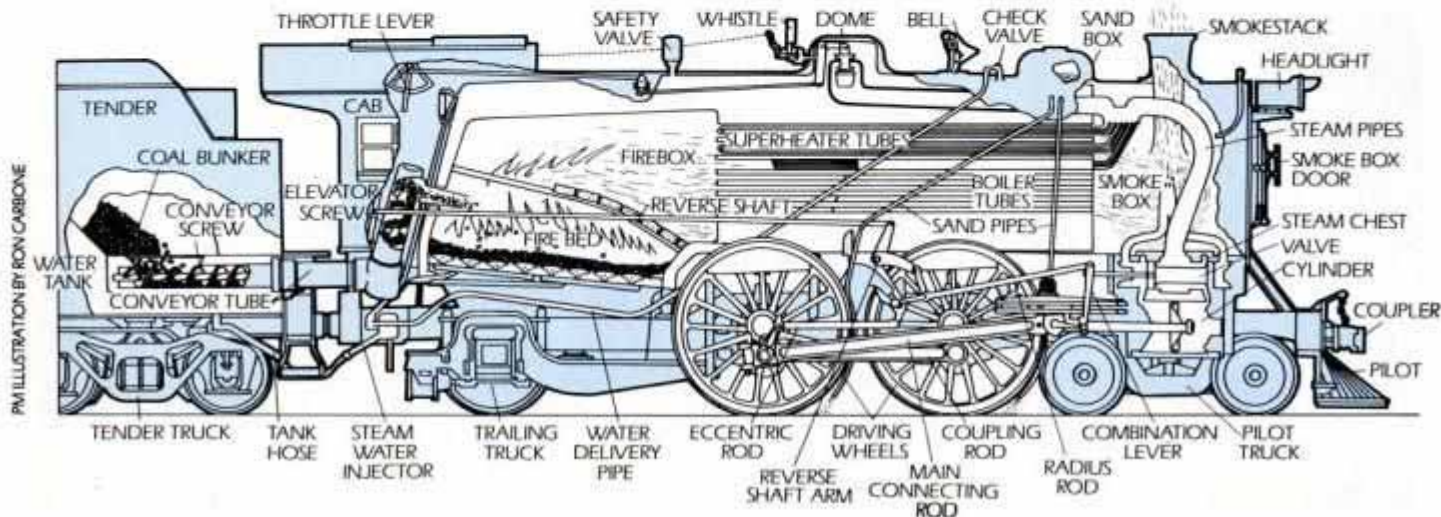
Even as he says it, Bartels knows that he is correct merely in a technical sense. More precisely, the train in question—No. 89—is a 79-year-old firebreathing dragon, a 2-6-0 (two pi-

lot wheels, six driving wheels and no wheels under the firebox) known as a Mogul type, a solid workhorse of a steam locomotive that, in her heyday, hauled both passengers and freight for the Canadian National Railway.

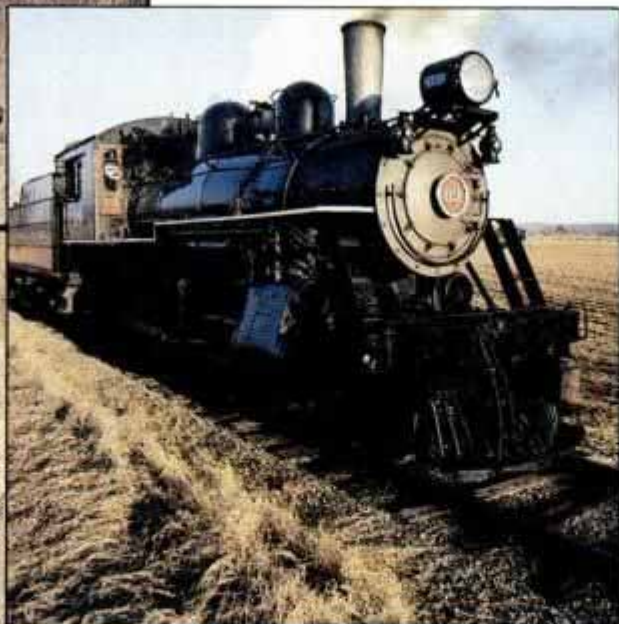
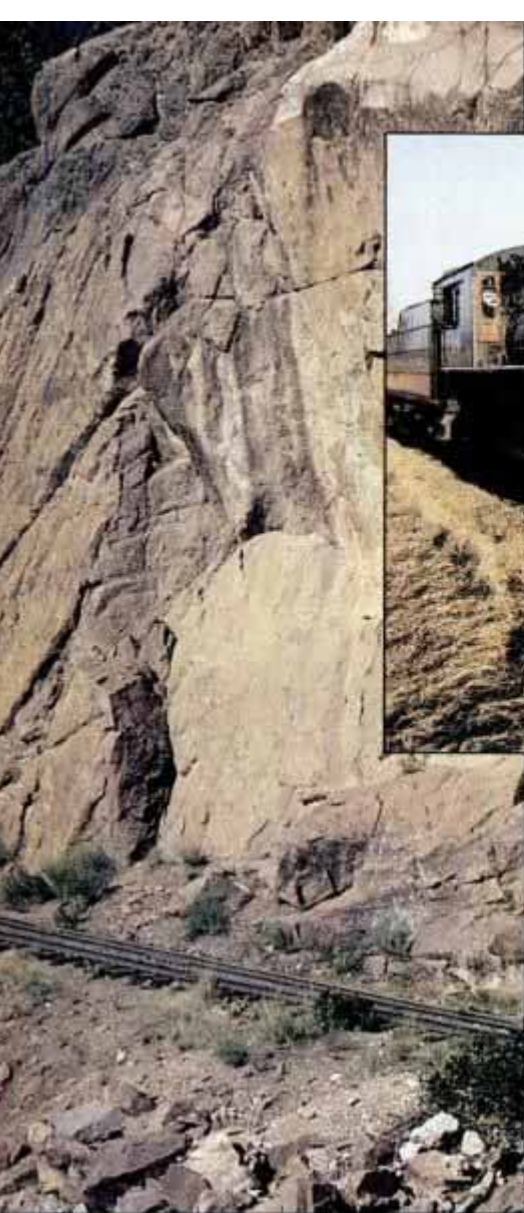
After the Strasburg Rail Road purchased her, technicians stripped her down until she was little more than a set of wheels holding a steel frame.

The firebox was rebuilt, the boiler reconstructed and fitted with scores of staybolts designed to leak small streams of steam if they weaken—providing an early warning of boiler trouble. New brass bearings were machined to interface between the drive rods and the wheels. A 3-in.-thick front boiler template was created, then bored with dozens of holes to

Inside A Steam Locomotive



PM ILLUSTRATION BY RON CARBONE



The Rio Grande takes passengers 'round the bend in the mountains near Durango, Colorado (left). Strasburg Rail Road's restored No. 89 (above) hauls local freight.

No. 89 for a run is a study in oldtime technology, which relied upon muscle as well as savvy. The fireman grabs a shovelful of coal from the tender, turns and plants his foot upon a treadle to open the firebox door. He pitches the coal into the roaring inferno. He checks his gauges.

A steady rush of steam billows from the stack. Hot grease drips off the huge drive rods affixed to the 6-ft. driving wheels. She is a boiler on wheels, and she is incapable of hiding the energy that builds inside.

The engineer releases a small amount of steam through the whistle vent, and her screams can be heard throughout the countryside: "Look out world, No. 89 is on her way."

Now the steam is released to the giant twin cylinders, one on either side,

forcing the pistons that push and pull the driving rods that rotate the wheels. Unlike automobile pistons, these are driven both forward and backward by the steam as valves switch the path into the cylinder. Puffs of steam burst from the stack announcing the onset of heavy labor. Slowly, she inches forward. "Everything is visible," Bartels notes. "That's the difference. Modern equipment is sterile and hidden under a shroud compared to a steam locomotive."

The steam locomotive is the antithesis of today's microchip technology. She is the spiritual shrine of the days when improving technology simply meant to build something bigger and stronger. Use more steel. Shovel in more coal. Make it louder, dirtier.

Today the Strasburg Rail Road boasts what many claim is the nation's best-maintained stable of steam locomotives. In addition to No. 89, the line owns three other working engines, and operates two more under long-term leases with the adjacent Railroad Museum of Pennsylvania. One of these, Atlantic No. 7002, is a speedy 4-4-2 whose sister engine, in 1905, set a world speed record for a reciprocating steam locomotive, hitting a top-end figure of 127½ mph.

The success of the Strasburg Rail Road parallels a general resurgence of interest in steam railroading, a tribute to pockets of private enthusiasts who simply will not let the old era die. Here and there around the country, over the past 30 years, groups of amateurs have banded together to save and restore steam locomotives.

Shop talk

According to Mark Smith, editor/publisher of *Locomotive & Railway Preservation*, some 1875 steam
(Please turn to page 204)

hold the pipes that run lengthwise through the boiler, carrying the coal-fired air that brings the water to a bubbling boil. The massive air compressor was rebuilt, so that it could feed the airbrakes for an entire train.

Coming alive

Watching the engine crew prepare



The "boiler on wheels" (opposite) illustrates the driving principal of a steam locomotive when superheated water expands to move the engine's main cylinders. The operation is controlled by the throttle hand of the engineer (above). Steam locomotives are brought back to life (right) in places like the main shop of the Strasburg Rail Road.

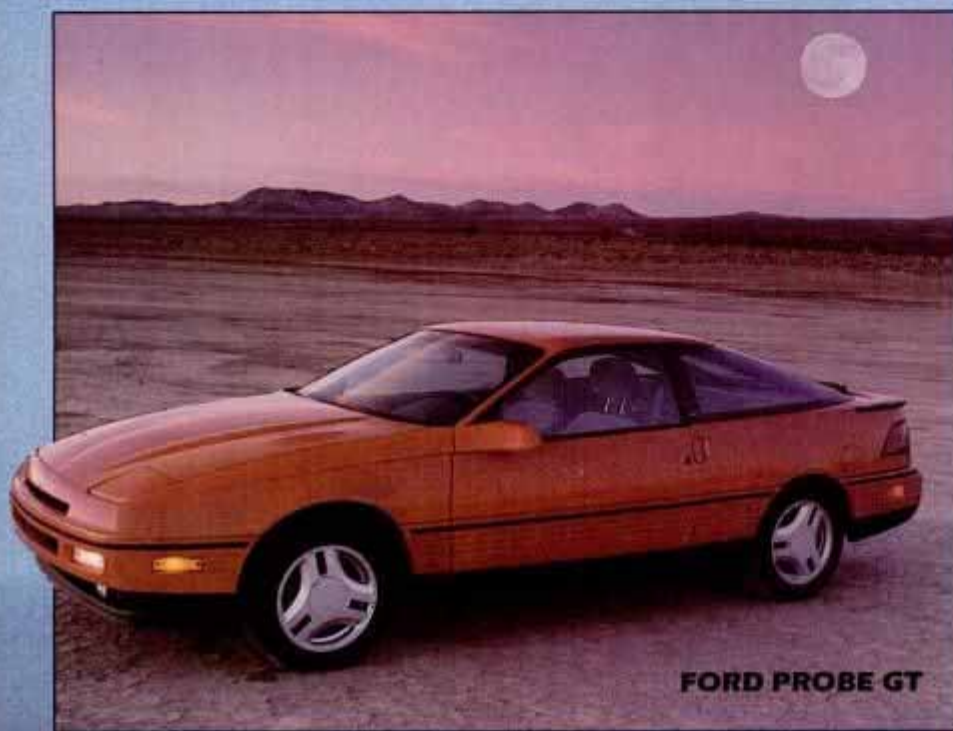


COMPARISON TEST

COUPES DE GRÂCE

The small, the quick and the slick in a high desert shootout.

BY LEN FRANK, West Coast Editor; PM Photos by Ron Hussey



FORD PROBE GT

IN THE BEGINNING, there were sports cars, exciting machines that sacrificed virtually everything for high performance and ego gratification.

Then came the Grand Touring (GT) car, a step closer to the sedan in comfort and utility, without losing the essential sports-car character. But because it was a little heavier, a little roomier, its performance was just a little worse.

Today, the lines between these categories are too blurred to divide clearly. There is a surprising number of roomy 4-door sedans with 4-wheel disc brakes, independent suspension, aerodynamic shapes, double overhead cams, 4 valves per cylinder, turbochargers, 5-speed gearboxes—components that were found only on the most exotic sports/GT cars of the past.

The whole thing probably started with the original 1965 Mustang—which started life as a



MAZDA MX-6 GT

sporty Ford Falcon, an econocar with sex appeal—and within a year had become the firebreathing Shelby American GT-350.

The formula has been refined until we now have air-conditioned GT cars that get gas mileage on the right side of good, and will still outperform those firebreathers that we always thought epitomized performance.

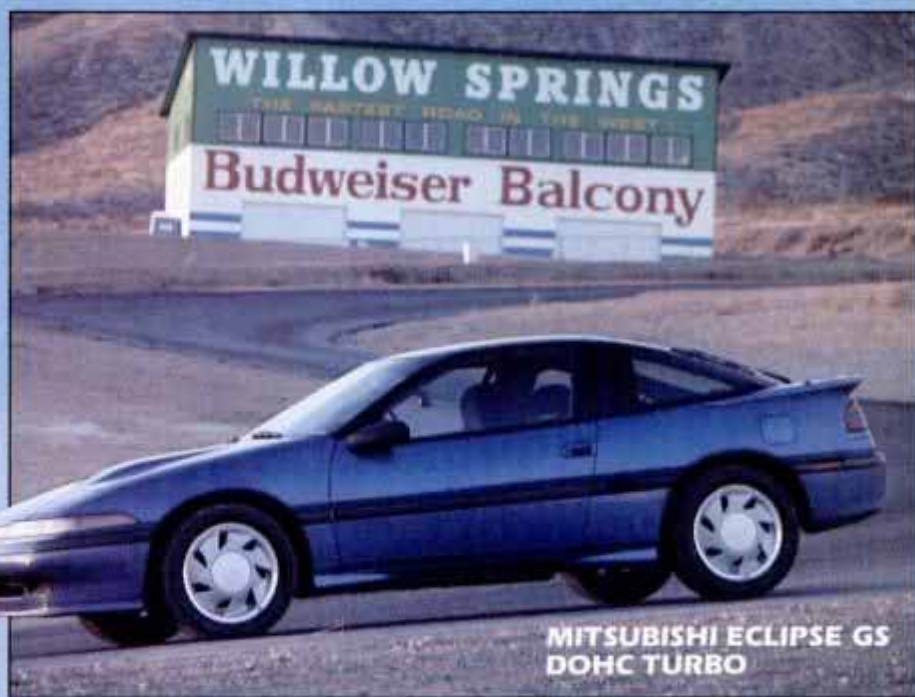
Think again.

Some of the new breed of small Sports/Sporty/GTs are based directly on high-volume sedans, others have been developed on their own. Each of these comes in less expensive and/or lower performance versions that attract buyers interested in personal image, high style, lower purchase price and greater operating economy. Something for almost everyone.

Some of these coupes, without sacrificing too much performance, are pleasant to drive under just about any conditions. Some of them, without giving up too much comfort and utility, have the belt-in-the-back acceleration that used to be the sole province of the big V8. All of them are great for a driver and passenger and provide varying degrees of misery for the usual "+2" others. As a result, there are no clear winners or losers in this test. If you value performance, there are cars at one end of the scale. Comfort, handling, low cost, looks, high-tech—all have their champions.

Chevrolet Beretta GTU

The Beretta coupe and the Corsica sedan are sisters under the skin. The GTU is actually a modification of the GT package on the coupe. The mods



MITSUBISHI ECLIPSE GS DOHC TURBO

back radials (up from 14 in. on the standard coupe, 15 on the GT).

The GTU has the largest engine of this group, and the only one with pushrods. It's fed by a state-of-the-art multipoint fuel-injection system with ram-tuned intake runners. Alloy heads. Getrag-designed transaxle. Strut front suspension, a twist-beam rear axle, coil springs all around.

Handling is very good with understeer tending toward neutral. Brakes fair. Seats are also fair but lacking in lateral support.

Transmission feel and ratios are good for road use, but the overdrive Fifth forced us to make our top-speed runs in Fourth (6200 rpm).

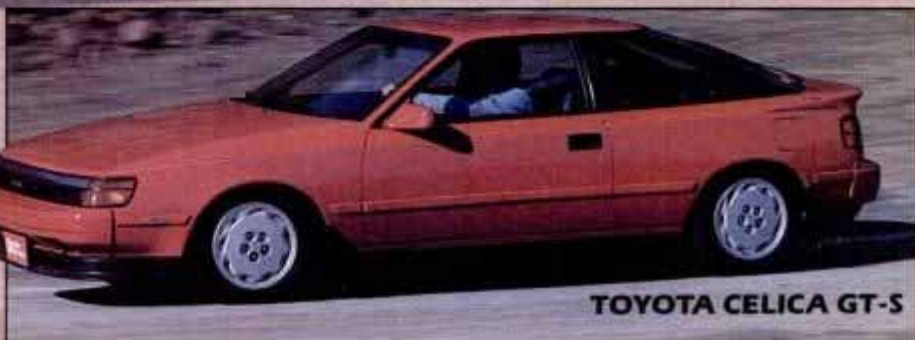
Excellent paint, poor choice of interior materials. Fair ergonomics. The Chevrolet Beretta GTU needs more detail development to be really competitive here.



PLYMOUTH LASER RS TURBO

are by Cars & Concepts, with the cars shipped through from Chevrolet to C&C, then to the dealer.

C&C paints the grille body color (metallic black, white or bright red), adds front and rear spoilers, lower-body aero panels, Porsche-style mirrors, dual exhaust tips and a performance handling package that includes 16-in. styled aluminum wheels with P205/55VR16 Goodyear Gator-



TOYOTA CELICA GT-S

Ford Probe GT

The Probe and the Mazda MX-6 are different versions of the same car. Ford concentrated on the styling and used different suspension tuning—a little firmer, with more roll stiffness. Both cars are built in Mazda's Flat Rock, Michigan, plant and are based on Mazda 626 technology.

The engine has outstanding low- and midrange torque, even without a turbo. With the turbo, front-wheel traction and torque steer can be a problem. Suspension consists of gas struts front and rear with trapezoidal links controlling rear geometry and coil springs all around. Tires are 195/60VR15 Goodyear Eagles on 6-in.-wide wheels.

Bolstered by ABS, the Probe's brakes are excellent, which can also be said for its straight-line stability (above torque steer range).

Although the Probe didn't distinguish itself in our slalom test, and exhibits substantial understeer—a characteristic that's true of most of the cars in this group—it responds well to judicious use of the throttle during cornering.

Throttle response is gratifying at all speeds. Boost builds quickly, and the Probe hustles down the road like the mini-GT it is.

Finish is excellent, inside and out,



CHEVROLET
BERETTA GTU

with good bucket seats offering decent lateral support. The Probe could sell on looks alone, but there's more to this car than just looks—it does what its looks say it should.

Honda Prelude Si

Besides its long development history, the Honda Prelude has the advantage

of a dedicated chassis—it's not based on a sedan.

Suspension is Honda's unique—and effective—double wishbones, front and rear, with gas shocks. The car's variable-boost power steering is too light for best feel, but Honda's 4-wheel steering cancels all understeer. The steering ratio is quicker with 4-



SUBARU XT6



HONDA PRELUDE SI

wheel steering. Handling is absolutely neutral, helping to make the Honda fastest and easiest to drive in the slalom.

Although it is far from being the most potent in this group, the Prelude's 16-valve engine is a pleasure to live with, exceptionally smooth, and the gearbox is light and precise.

Finish is about as good as the Maz-

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE: LIST/ AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (lb.-ft.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in./mm)	LENGTH OVERALL (in./mm)	WIDTH OVERALL (in./mm)	TRACK FRONT/REAR (in./mm)
Chevrolet Beretta GTU	\$14,625/ \$14,707	V6, pushrod OHV 173.1/2837	130 @ 4700 rpm/ 160 @ 3600 rpm	front/ front	5-speed manual	103.4/ 2627	187.2/ 4756	68.2/ 1733	F:57.3/1455 R:57.7/1466
Ford Probe GT	\$14,077/ \$17,406	L4, SOHC Turbo, 12V 133/2184	145 @ 4300 rpm/ 190 @ 3500 rpm	front/ front	5-speed manual	99.0/ 2515	177.0/ 4496	68.5/ 1740	F:57.3/1455 R:57.7/1466
Honda Prelude Si	\$16,965/ \$18,450	L4, DOHC 16V 119/1958	135 @ 6200 rpm/ 127 @ 4500 rpm	front/ front	5-speed manual	101.0/ 2565	175.6/ 4460	67.3/ 1710	F:58.3/1480 R:57.9/1470
Isuzu Impulse Turbo	\$16,329/ \$16,329	L4, SOHC 121/1994	140 @ 5400 rpm/ 166 @ 3000 rpm	front/ rear	5-speed manual	96.1/ 2440	172.6/ 4385	65.7/ 1670	F:53.3/1355 R:54.3/1380
Mazda MX-6 GT	\$16,699/ \$18,499	L4, SOHC Turbo, 12V 133/3218	145 @ 4300 rpm/ 190 @ 3500 rpm	front/ front	5-speed manual	99.0/ 2515	177.0/ 4496	66.5/ 1689	F:57.3/1455 R:57.7/1466
Mitsubishi Eclipse GS DOHC Turbo	\$14,169/ \$15,728	L4, DOHC Turbo, 16V 121/1997	190 @ 6000 rpm/ 203 @ 3000 rpm	front/ front	5-speed manual	97.2/ 2407	170.5/ 4331	66.5/ 1689	F:57.7/1466 R:52.1/1450
Nissan 240SX	\$13,499/ \$14,344	L4, SOHC, 12V 146/2389	140 @ 5600 rpm/ 152 @ 4400 rpm	front/ rear	5-speed manual	97.0/ 2468	178.0/ 4522	66.5/ 1689	F:57.7/1466 R:57.5/1460
Plymouth Laser RS Turbo	\$13,374/ \$15,511	L4, DOHC Turbo, 16V 121/1997	190 @ 6000 rpm/ 203 @ 3000 rpm	front/ front	5-speed manual	97.2/ 2467	170.5/ 4331	66.5/ 1689	F:57.7/1466 R:57.1/1450
Shelby CSX	\$15,000* \$15,000	L4, SOHC Turbo 135/2213	175 @ 5200 rpm/ 205 @ 2400 rpm	front/ front	5-speed manual	97.0/ 2464	171.7/ 4368	67.3/ 1712	F:57.7/1466 R:57.3/1455
Subaru XT6	\$17,951/ \$18,006	Opposed 6, SOHC 165/2700	145 @ 5200 rpm/ 152 @ 4400 rpm	front/ 4wd	5-speed manual	97.4/ 2474	177.6/ 4520	66.5/ 1689	F:56.5/1438 R:56.7/1460
Toyota Celica GT-S	\$15,738/ \$18,828	L4, DOHC, 16V Turbo 122/1998	135 @ 6000 rpm/ 125 @ 4800 rpm	front/ front	5-speed manual	99.4/ 2525	171.9/ 4368	67.3/ 1709	F:57.9/1471 R:56.5/1435

*Estimated

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

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da/Mitsubishi cars—excellent. Everything is usable and well balanced, with Honda's usual painstaking attention to ergonomic detail. The Prelude is always a pleasure to drive, and one of the favorites of the testers.

Isuzu Impulse Turbo

The Impulse is now an old chassis design made better (but not quite good enough) by Lotus tuning. It's commendably stable at speed, but doesn't really deliver the handling advantages one might expect of a rear-drive design. It was also the only car to suffer brake fade during stopping from high-speed runs.

The Impulse's 2.0-liter turbo engine is reasonably powerful, although not a standout in this group, though it's smoother than the normally aspirated 2.3, and geared perfectly for top speed.

Lotus-tuned suspension makes the most of the old double-wishbone front suspension and trailing arm-located solid rear axle. Bridgestone Potenza



ISUZU IMPULSE TURBO

RE-71s were chosen by Lotus to match the bushing, sway bar, shock and spring changes.

Nevertheless, the Impulse is narrow, has poor transient response (slowest in slalom), and is only fair in lateral acceleration. The car turns in well, but the chassis isn't balanced enough to follow through.

Inside, the seats are a big improvement on the original Impulse. The analog instrumentation is good, but the car's small control location is toy-like.

Isuzu's new dohc I-Mark is terrific, proving the company has the right stuff. Now it's time for a new Impulse.

Mazda MX-6 GT

Our MX-6 had 4-wheel steering, and as with the 4-wheel-steering Honda Prelude, this helps mask the basic front-wheel-drive understeer characteristics. It differs from the Ford Probe in this respect.

Like the Probe, though, the MX-6 has too much torque for one pair of front tires to transfer to the ground under anything other than perfect conditions. The tires are 195/60R15 Bridgestone Potenza RE 71s.

The Mazda's notchback styling is far more conservative than the slick-looking hatchback Probe, though it appears to have about the same aerodynamic drag—the two cars both topped out at 133 mph in our top-speed runs, proving once again that looks can be deceiving.

Along with the Probe, the MX-6 can be a handful in wet weather or on slippery surfaces. Boost comes on with a bang, resulting in unwanted wheelspin and torque steer, rather like a modern version of the axle hop and spring wind-up common in the old muscle cars.

On the other hand, strong engine performance is something you'd expect from a car wearing GT badges, and the MX-6 certainly measures up to that expectation.



NISSAN 240SX

TEST RESULTS

CURB WEIGHT (lbs.)	STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (EPA city/PM test)		ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)		BRAKING 60-0 MPH (ft.)	700-FT. ¹ SLALOM (mph)	SKIDPAD ² 200-FT. CIRCLE (G)	EPA ³ INTERIOR VOLUME (cu. ft.)
			21/22.5	9.2	16.2 @ 80.5					
2850*	Power R&P/2.5	F:9.54-in. vented disc/ R:7.87-in. drum	18/20.2	9.2	16.78 @ 80.5	138	58.6	.83	106.7	
2870	Power R&P/2.9	F:10.3-in. vented disc/ R:10.1-in. disc	21/22.5	8.1	16.2 @ 85.9	132	56.5	.83	91.0	
2712	4ws Variable Assist Power R&P/2.66	F:10.24-in. vented disc/ R:9.33-in. disc	23/23.9	9.25	17.03 @ 80.0	149	62.4	.82	87.0	
2970	Power R&P/3.07	F:9.02-in. vented disc/ R:7.09-in. drum	21/20.8	8.1	16.15 @ 83.4	142	54.5	.80	106.0	
2745	Power R&P/3.1	F:10.4-in. vented disc/ R:10.2-in. disc	21/19.7	7.2	15.58 @ 90.4	147	61.0	.83	93.0	
2745	Power R&P/3.1	F:8.6-in. vented disc/ R:8.75-in. disc	22/20.6	8.0	16.44 @ 86.1	131	56.9	.82	80.8	
2684	Power R&P/3.1	F:10.1-in. vented disc/ R:10.2-in. disc	20/24.5	9.5	16.97 @ 80.3	124	60.9	.84	70.8	
2745	Power R&P/2.6	F:8.6-in. vented disc/ R:8.75-in. disc	22/21.2	9.5	16.75 @ 82.9	130	58.5	.84	80.8	
2790	Power R&P/2.5	F:10.1-in. vented disc/ R:10.6-in. disc	NA/18.3	7.8	16.14 @ 86.9	126	60.5	.80	88.7	
2885	Electric/Hydraulic R&P/3.2	F:10.31-in. vented disc/ R:10.8-in. disc	18/20.1	9.0	16.66 @ 80.9	155	56.9	.78	76.0	
2665	Variable Assist R&P/2.78	F:10.2-in. vented disc/ R:10.6-in. disc	22/22.7	8.85	16.75 @ 82.9	128	57.7	.79	79.0	

2. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best cw and ccw.
3. Number indicates maximum volume as determined with rear seatback in normal position.



Mitsubishi Eclipse GS DOHC Turbo/Plymouth Laser RS Turbo

Like the MX-6/Probe, the Eclipse and Laser are twin cars built in the U.S. (Normal, Illinois, by Diamond-Star Motors, a Mitsubishi-Chrysler joint venture) and developed from the Galant sedan platform. Unlike the Mazda/Ford, only the spoiler and paint schemes set the two cars apart.

A 4wd edition (Eagle Talon) will be introduced this fall, and if the weight increase of 4-wheel-drive mechanicals is not too great it should be easily the best performing version of the car.

The Eclipse/Laser is equipped with a wonderful dohc 16-valve turbo engine, and like the Mazda/Ford, it can produce too much torque steer and wheelspin. The torque peak is as high as the Mazda engine, but the boost comes on a little less abruptly.

Horsepower (190 @ 6000 rpm) seems overrated, but it's plentiful nevertheless. This was particularly apparent in our flat-out runs, where the combination of good aerodynam-

ics and plenty of power produced the highest top speed in the basic test group, and by an impressive margin.

Interior layout is generally good but the instrument panel styling draws attention to itself with its odd diagonal placement of part of the layout. Visibility is somewhat limited by the wide B-pillars.

Seating is not the strongest suit for these new cars. Besides the typically cramped rear area, more than a few members of the crew found the front seats distinctly uncomfortable.

In the vehicle dynamics department, we found that the Laser wandered at top speed, while the Eclipse was stable. We attribute the difference to the Mitsubishi's spoilers, as well as its slightly nose-down attitude. Both cars exhibit excessive understeer on tight corners under power, and we found it better to drive through at neutral throttle.

Nissan 240SX

This is Nissan's replacement for the old 200SX, and a thoroughly impressive car. Its rear-drive chassis is not shared with a sedan and is therefore less compromised, which in turn helps to give the 240SX the best subjective handling of the entire group.

Suspension consists of struts in front and a multilink independent rear now shared with the new 300ZX. The car's agility and predictability

won the hearts of the entire test crew, and these qualities were augmented by excellent ride quality.

This new Nissan's limiting factor is a brand-new 12-valve 2.4-liter Four that offers good torque characteristics but is conspicuously short on horsepower. (Both 240SX and Impulse are rated at 140 hp, but there was a 26-hp disparity in our dyno test.) Although the new engine is surprisingly smooth for a big Four, and the 5-speed gearbox is pure pleasure, the car's chassis is faster than its powertrain.

Top speed is limited by a speed-sensitive cutoff (in Fourth and Fifth) to 115. If we had exercised restraint, we could have run through our radar trap at 114, but the cutoff is abrupt, like turning off the key with the car in gear, and 107 mph was the result. Like the tepid horsepower peak, this quirk is a concession to the insurance industry.

The 240SX is roomy, with good seats that look like modern furniture. There are no mistakes in the interior—ergonomics are real and the temptation to add whistles to the bells has been repressed.

Exterior styling is slick, though perilously close to the Eclipse/Laser. Even so, between the 240SX, the new Maxima and even newer 300ZX, Nissan has turned its product picture around in a very short time.

Shelby CSX

The CSX is almost a kit car. It starts life as a Dodge Shadow Turbo, gets new shocks (Monroe Formula GP gas); 3/4-in.-lower, higher-rate springs; larger sway bars; suspension components from other Mopar parts shelves; heavy-duty crossmember; larger disc brakes front; discs at the

(Please turn to page 212)

Toyota Celica All-Trac Turbo

TAKE THE NICE little Celica GT-S, change the rear suspension, add 4wd with a viscous center coupling, optional ABS, new front spoiler, side skirts and an intercooled turbo and it becomes a Serious Car.

Out of curiosity, we got some test numbers on the limited-production, \$20,000-plus All-Trac. It clocked our highest top speed (139), came within one drive-wheel horsepower of the Laser (129 versus 130) and tied for best on the skidpad. Its higher weight and turbo lag were handicaps in the slalom and on the track, and definitely took some getting used to after driving normally aspirated cars with good torque curves (240SX, Beretta, XT6). A skilled driver

would regularly turn the best lap times on a road racing circuit.

The lesson here is that as horsepower advances, fwd becomes more of a liability with excessive weight transfer leading to understeer and wheelspin, and torque steer begins to get ugly. There's

also the problem of tires being required to transmit power and simultaneously steer. As long as the car is based on a front-drive package, 4wd conversion is the only real answer to getting the rear wheels to do more than keeping the rear bumper off of the ground. —L.F.



DESKTOP DUPING



The office photocopier has shed some bulk and moved into the home. The latest desktop models double as fax machines and computer scanners, too.

BY FRANK VIZARD, Contributing Editor; PM Photos by Brian Kosoff

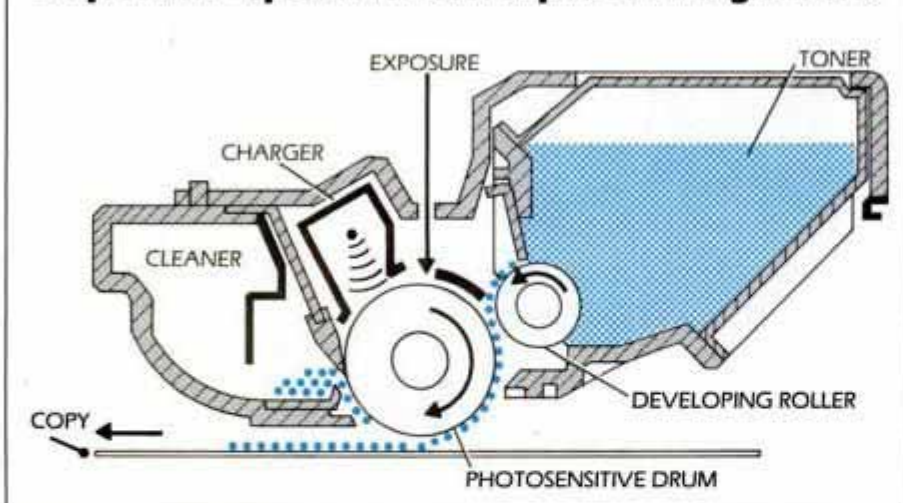
VERY FEW documents these days don't require a copy. Yet despite the necessity for duplicates, it's still a task fraught with inconvenience. In the office, copiers are centrally located for easy access—but it is this accessibility to all that leads to long lines. At home,

making a copy entails a special trip to the library or the neighborhood copy shop. Either way, the need for a copy often contributes to a delay in the work at hand.

Fortunately, delays ascribed to copying chores are quickly becoming a gripe of the past. Desktop copiers

—once an expensive luxury—are now affordable. More important, this new breed of copier is easy to install and maintain. Meanwhile, copiers are not only becoming smaller—they're also becoming more versatile. This year, we'll see the first of a new generation that also can function as a telephone

Disposable Exposures: How Copier Cartridges Work



Single-cartridge copiers such as Canon's PC-7 (diagrammed above and seen in photo on the preceding page) virtually eliminate servicing needs by incorporating toner, photosensitive drum and other moving parts in a disposable module.

facsimile machine and an image scanner for computers.

For the time being, though, the market will be dominated by low-priced personal copiers available from companies such as Canon, Mita, Panasonic, Ricoh, Sanyo, Sharp and Xerox. Personal copiers can be identified by their price tags, ranging from under \$500 to just over \$2000—but often selling for less. The key feature that defines the personal copier, though, is its replaceable cartridge.

How they work

The basic principle of xerography, as plain-paper copying is called, dates from a 1930's process developed by Chester Carlson, commercialized by Xerox in the 1950s.

In xerography, the developed image of an original document is transferred from the reusable photoconductive surface of a rotating

drum to the final copy paper. The photoconductor is an electrical insulating material whose conductivity increases when exposed to a bright light. The disposable drums of personal copiers use an organic photoconductor (OPC) material, while heavy-volume office copiers commonly use some type of selenium alloy for greater durability.

When the COPY button is pressed, the OPC coating on the drum is electrically charged. Imaging occurs when a bright halogen light is reflected from the original through a lens system. The blank areas of the original are viewed as conductive elements, and flow through the OPC without effect. Where no light is reflected—this being the letters or lines of the original—the OPC reacts in a nonconductive manner. The result is a latent electrostatic image of the original document.

The latent electrostatic image attracts the toner particles used in developing. The toner is smoothly applied by a magnetized roller or brush in contact with the OPC drum. The toner recipe varies from manufacturer to manufacturer, and it is available in a variety of colors, typically black, green, red, blue and brown. As the OPC drum revolves and comes into contact with paper, heat and pressure cause the resins in the toner to melt and permanently fuse to the paper. As the copy exits the machine, a cleaning blade or brush removes any residual toner from the OPC drum. Once cleaned, another latent image can be made.

Disposable convenience

Toner and the OPC ultimately need replacing. In large copiers, maintenance and the replacement of parts is the province of service technicians. The beauty of personal copiers is that the toner, OPC and up to 80 percent of all the copier's moving parts are contained in a small, disposable cartridge. Replacing the cartridge is quick and easy, and involves no mess.

Canon is generally credited with popularizing the single-cartridge system, and its use in personal copiers is nearly universal. One alternative, championed by Ricoh, is the dual-cartridge system used in most of the company's machines. One cartridge is a master unit containing the OPC and most of the moving parts. The second cartridge contains the toner. Ricoh argues that the toner usually needs replenishing long before the OPC or any other moving parts need replacing. Ricoh's replacement toner cartridges cost about \$25, as compared to about \$130 for a single Canon-type cartridge. Ricoh master cartridges list for about \$130.

Sharp's Z-30 (\$1000) is a basic copier that uses the disposable cartridge system. Platen (top surface of unit) holds original and slides to scan image.





MC50 thermal copier is the scanning module of Ricoh's Portable Copier/Digitizer System. Other modules (top) enable system to fax documents or feed them to a computer.

range from 70 percent to 122 percent adjustable in 1-percent increments. The PC-7 can make up to 99 copies at eight copies per minute. Warmup time is 13 seconds. The paper tray holds 100 sheets but like any other copier, the tray can be bypassed for manual feeding of other paper sizes.

The PC-7 also utilizes a stationary platen. While most personal copiers are small—the Sharp Z-30 measures 15 × 17 × 5 in.—the platen holding the original document physically moves across the image sensor. This means the space required to operate the machine is greater than the machine itself. In the PC-7, the scanner moves inside the machine, so the platen remains stationary. The PC-7 operates within its own space, an area measuring 20 × 18½ × 10½ in.

The future

Because copiers operate by first scanning a document, their usefulness can

Ricoh's LR-2 (\$1500), for moderate-volume copying, uses separate toner and drum cartridges for economical copying.

be expanded to perform other functions besides merely duplicating an original. On the horizon is the combination copier/facsimile/scanner that can transmit the document as well.

The first of this breed is Ricoh's Portable Copier/Digitizer System, a modular package whose heart is the MC50 copier (\$480).

The MC50 scans the original document and produces a copy the same size as its viewing glass—roughly 4 × 6 in. Printing is done on thermal paper rolls, plain paper or transparent sheets using AC or batteries.

The Ricoh MC50 also can be used in conjunction with two small accessories that expand its versatility. One is the IM-A image controller (\$450). The IM-A allows you to copy halftones, reduce the original image by 80 percent, enlarge the original by 200 percent, produce mirror images or transfer visual images to a computer.

A second module turns the MC50 into a fax machine. The MC50 acts as the scanner for the original material being transmitted or received. Large-size documents received via fax are reduced to a 4 × 6-in. size. Transmitted 4 × 6-in. originals are received by a conventional fax as full-size documents. The IM-F fax module, which transmits at 4800 baud, costs \$480.

Personal copiers, of course, don't have many of the features common to their larger-sized cousins. Double-sided copying most often means running the copy through the machine a second time, upside down. Personal copiers are the solution if you need a quick copy with no delay. They don't have all the bells and whistles of the big office machine but they'll get a small job done quickly. **PM**

The Ricoh system offers an advantage in terms of price per copy, a consideration if you're intent on doing a lot of copying. A single-cartridge system will have to be replaced after 1500 to 3000 copies have been made. Roughly 10 times as many copies can be made before the Ricoh master cartridge has to be replaced. Of course, you'll replace toner in this time.

Choosing a copier

Bare-bones personal copiers priced below \$1000 are designed for low-volume use. A good example of the genre is Sharp's \$1000 Z-30 machine. This letter-size copier can make up to nine copies of an original document at a speed of about five copies per minute. Warmup time for the Z-30 is 20 seconds and the unit's stacker feeder holds up to 50 blank sheets.

The basic dual-cartridge model is exemplified by Ricoh's LR-2 (\$1500). It can make up to 20 copies of a document at eight copies per minute. Warmup time is 15 seconds. An internal paper tray holds 100 sheets.

Features and increased copying capability are available as prices climb. At the top end of the personal copier category is Canon's PC-7 (\$2095). The PC-7 includes most of the features available today, as well as some unique attributes likely to be seen in other personal copiers in the future. One unique feature is a zoom capability, covering a reduction/enlargement



THE INDYTECH

5000

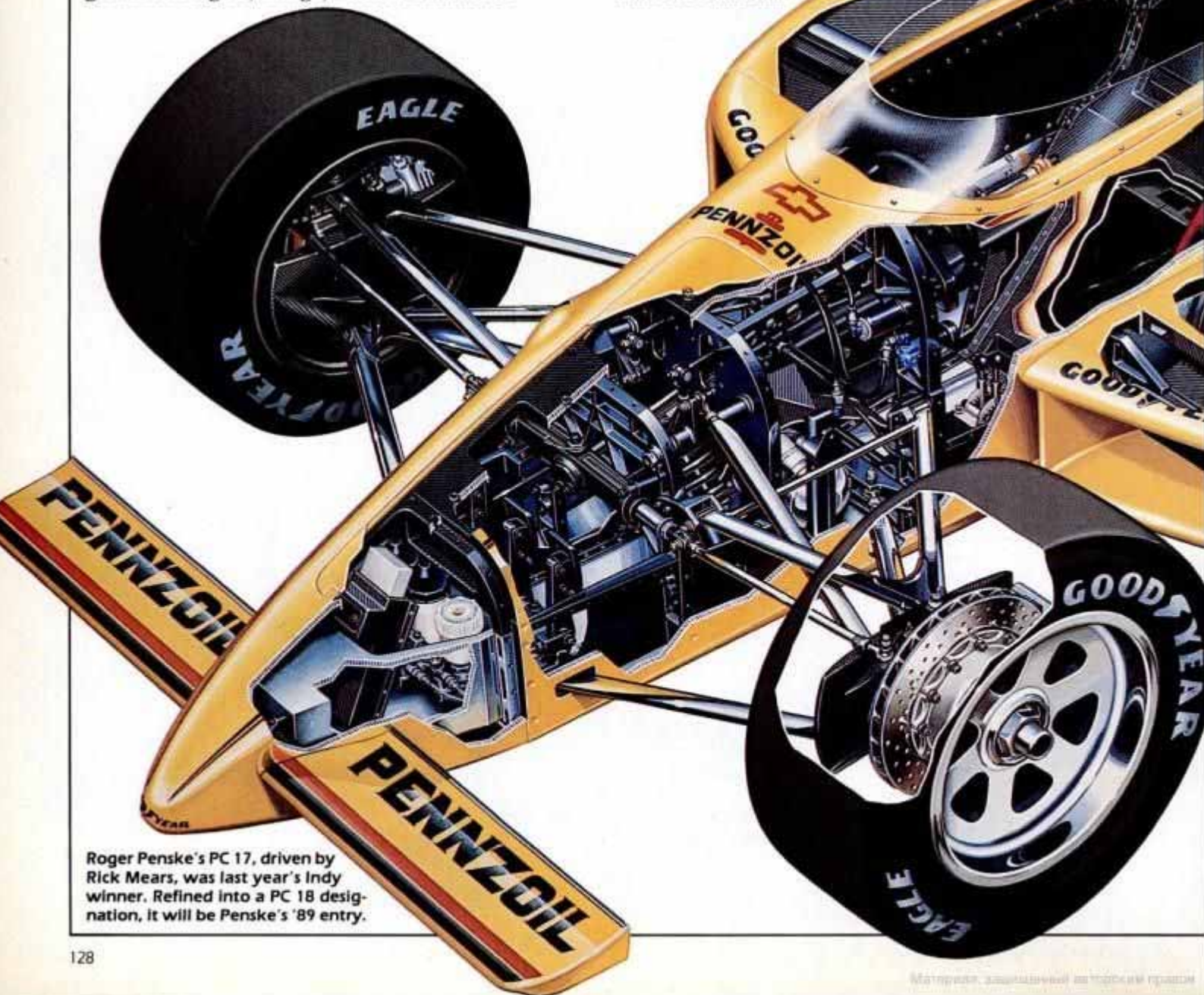
New technology takes the flag at the old Brickyard.

BY PAUL STENQUIST

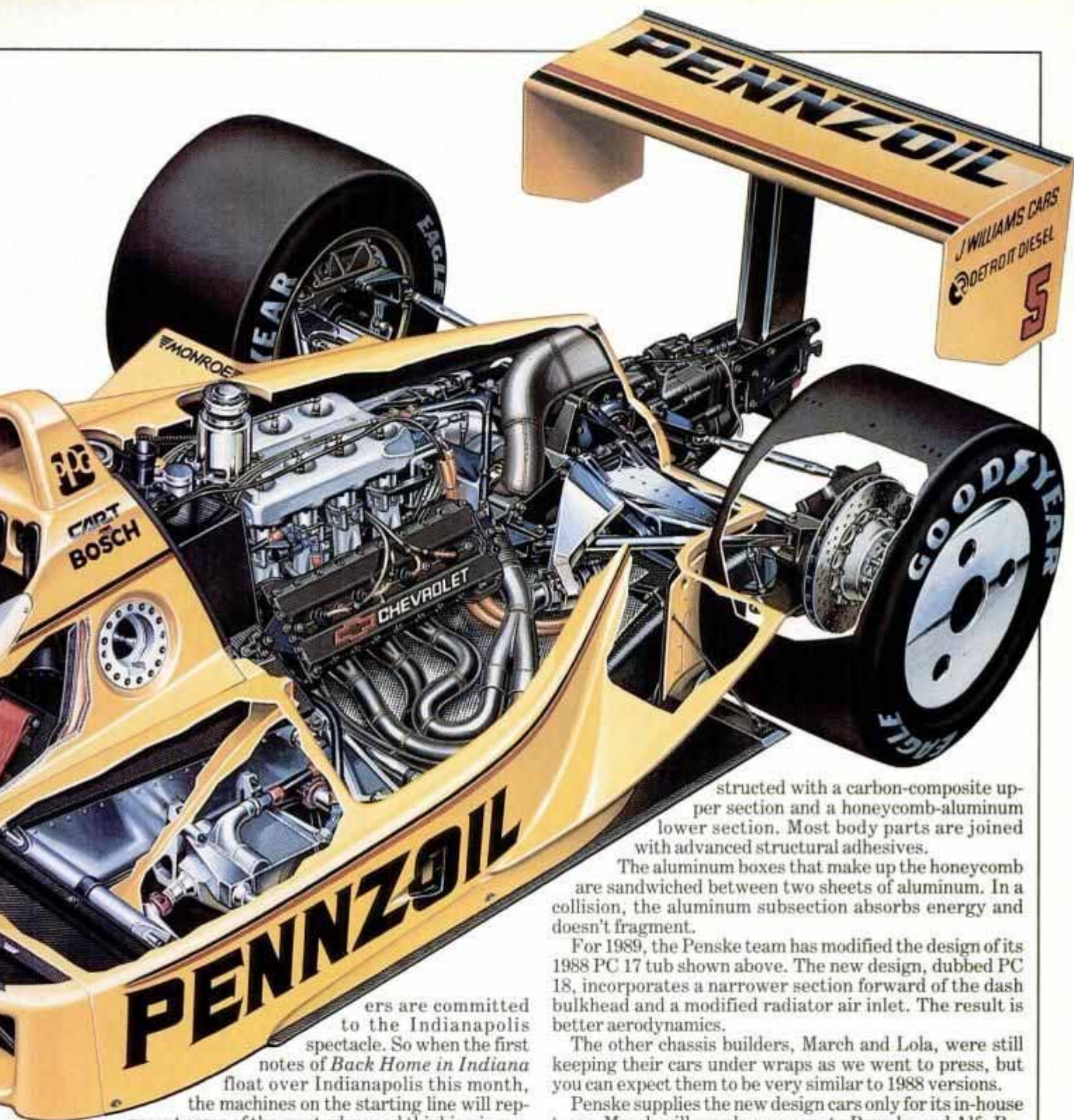
IT WAS AN ASTOUNDING 76 years ago that a 4-valve-per-cylinder, double-overhead-cam Peugeot engine ran away from the Indy 500 field. That powerplant—the grandfather of modern racing engines—serves as a ghostly reminder that Indy was once the technological showcase for the automotive world. An event of international significance, the race was a proving ground to Peugeot, Delage, Mercedes and more.

Over the years both the international flavor of the 500 and the sophistication of its hardware have come and gone. At times the technology was inspirational, at other times it fell short of what could be seen in Grand Prix racing. The difference in mechanical sophistication was usually a matter of cash flow. When the automakers were interested, money poured in and the technology soared.

At the moment, a number of automak-



Roger Penske's PC 17, driven by Rick Mears, was last year's Indy winner. Refined into a PC 18 designation, it will be Penske's '89 entry.



ers are committed to the Indianapolis spectacle. So when the first notes of *Back Home in Indiana* float over Indianapolis this month, the machines on the starting line will represent some of the most advanced thinking in motorsports. And with Porsche, Alfa Romeo and England's Judd every bit as involved as Chevrolet, Ford and Buick, the flavor will be decidedly international.

While there is variety in terms of the engine builders represented and the powerplants used, most 1989 Indianapolis-type race cars are similar. But slight variations and seemingly small ideas can often make a big difference on race day.

The basic Indy car incorporates a monocoque body/chassis unit. There are no frame rails. The bodywork—augmented by the drivetrain components bolted to it—is the structural backbone.

Today's Indy car body units are formed of two materials: carbon-composite plastic and aluminum. Exterior body panels are formed of the carbon composite. The tub, which is both body unit and primary structural member, is con-

structed with a carbon-composite upper section and a honeycomb-aluminum lower section. Most body parts are joined with advanced structural adhesives.

The aluminum boxes that make up the honeycomb are sandwiched between two sheets of aluminum. In a collision, the aluminum subsection absorbs energy and doesn't fragment.

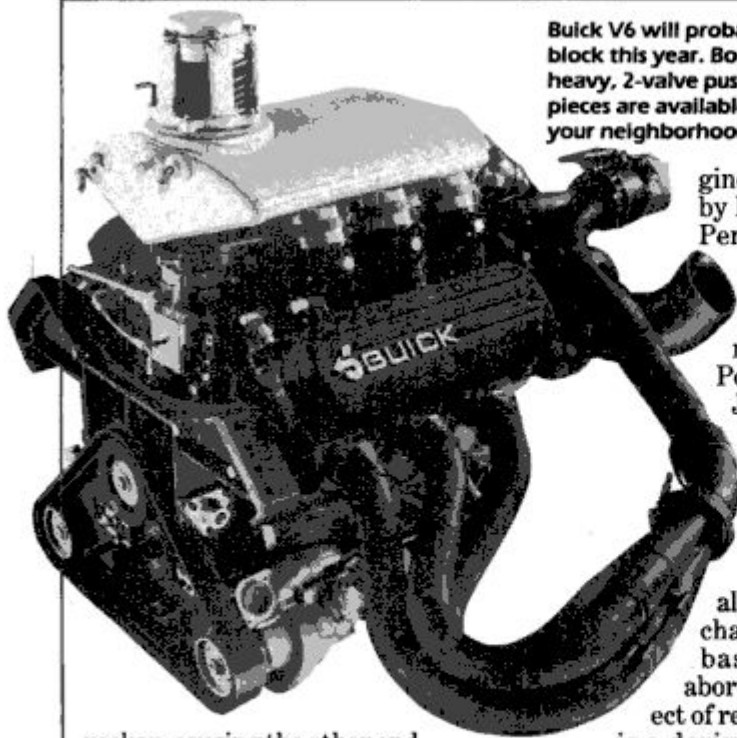
For 1989, the Penske team has modified the design of its 1988 PC 17 tub shown above. The new design, dubbed PC 18, incorporates a narrower section forward of the dash bulkhead and a modified radiator air inlet. The result is better aerodynamics.

The other chassis builders, March and Lola, were still keeping their cars under wraps as we went to press, but you can expect them to be very similar to 1988 versions.

Penske supplies the new design cars only for its in-house team. March will supply new cars to Porsche and Alfa Romeo teams exclusively. Lola will probably produce at least 35 T8900 cars for the other teams.

All cars will be fitted with a pushrod and rocker-type suspension system. This style of suspension has been in use for at least five years now, but every season sees some refinement. In a pushrod and rocker system, the wheel is suspended from the tub by means of two wishbones. Unlike a passenger car, the spring and damper are not mounted on a wishbone. In order to keep these parts out of the airstream, they're mounted inboard and operated by a mechanical linkage system.

The outer end of each lower wishbone is joined to an upright pushrod which is, in turn, connected to one end of a rocker lever. The other end of the rocker lever is attached to the spring and damper unit. Suspension movement pushes up on the pushrod which pushes one end of the



Buick V6 will probably be the only stock-block this year. Boost helps make up for heavy, 2-valve pushrod design. Many pieces are available over the counter at your neighborhood Buick dealer.

gine, jointly developed by Ilmor, Chevrolet and Penske racing, was the most potent of the powerplants. This year it will face serious challenges from Porsche, Alfa, Ferrari, Judd and the venerable Cosworth.

The Porsche engine was not very successful in its initial outings last year but should eventually prove a formidable challenger. The Alfa is based on Ferrari's aborted Indy engine project of recent years. The Judd

is a derivative of a Brabham Honda race engine. The Cosworth, the Indy engine of choice for many years, is a product of the British Cosworth firm and Ford UK that first appeared in Formula One racing more than two decades ago.

All of the ohc Indy V8s are capable of approximately 700 horsepower at about 11,000 rpm. Give or take a few. Of course it's those few that will help put someone in the winner's circle.

Since the Chevy/Ilmor is currently top dog, we'll examine it in some detail. The sand-cast aluminum-alloy crankcase of the compact V8 is mated to an aluminum-alloy tunnel-type sump with integral main bearing caps. In other words, where the block of a typical passenger car engine ends, you'll find a stout subsection engineered to reinforce the block. The purpose of this massive strength is not only crankshaft support but also chassis rigidity: The engine is a structural member of the car.

The crankshaft is a flat 180°-firing design. All V8 passenger cars use 90° crankshafts. The purpose of the 180° design is to allow each bank of the engine to fire at equal intervals. This permits better tuning of the exhaust system. Because the pulses are evenly spaced, scavenging of the cylinders can be maximized and equalized. A secondary benefit of the flat crank is less weight and reduced stress.

To minimize friction, crankshaft bearing diameters are designed to the smallest dimension that will adequately handle the loads generated.

Pistons are forged aluminum. The compression ratio is 11:1, supplemented by the rules-limited maximum turbocharger boost of 7.4 psi

above atmospheric pressure (45 in. Hg). Those pistons, atop machined alloy steel connecting rods, run in steel cylinder liners which are sealed to the heads with bronze compression rings.

The dual-overhead-camshaft cylinder heads incorporate semihemispherical pentroof-shaped combustion chambers with four valves per cylinder surrounding a central sparkplug.

This type of 4-valve head has long been the standard for purpose-built racing engines. The four valves provide better cylinder filling than two valves for a variety of reasons. First, total valve area is increased a bit. Second, valve circumferential area is increased considerably, so at low lift much better cylinder filling is possible. Finally, because the valves are lighter than the larger valves of a 2-valve design, they can be opened faster without inducing valve float.

Valvetrain mass and complexity are minimized by the dual-overhead-camshaft design. Each bank is fitted with both intake and exhaust cams—four in all. The cams open the valves directly, separated from them only by bucket-style cam followers.

The central sparkplug location is a plus because it minimizes the distance the flame must travel to burn the charge. This promotes a more complete burn while limiting heat buildup within the combustion chamber.

Exotic materials are used in abundance on modern Indy cars. Some teams, for example, use titanium connecting rods for qualifying because they're much lighter than the more typical steel rods. Most teams don't use them on race day because the cycle fatigue life of titanium is much less than steel. But Porsche, with lots of titanium-rod experience in other types of racing, uses them all the time.

The Porsche V8 differs from the Chevy/Ilmor in various other ways as well. One significant difference is the use of Nickasil cylinder liners. These sleeves are made of aluminum with a nickel liner and are both lighter than the typical steel sleeve and capable of dissipating heat more rapidly.

The Buick Indy engine is radically different from any of those discussed above in that it is a stock-block V6 pushrod engine. To make the stock-block competitive with all those purpose-built race engines, the United States Auto Club (USAC)—the Indy sanctioning body—grants the engine both an additional 700-cc displacement and 10-in. Hg extra turbo boost. Championship Auto Racing Teams (CART), the organization that sanctions all other Indy car races, gives pushrod engines only a displacement advantage.

rocker, causing the other end of the rocker to compress the spring and damper. Because all these parts must clear the driver's legs in front and the transaxle in back, the assembly is a packaging marvel.

To cope with changing conditions, the driver can stiffen or soften dampers from the cockpit. Reduction of damper stiffness is accomplished by bleeding hydraulic fluid, thereby reducing pressure.

For 1989, car builders have modified their suspension systems to better accommodate the now-standard radial tires. In the past, bias-ply tires were used. Because the circumference of the bias tires varied, tires could be "staggered" to effect changes in handling. Now the suspension has to do all the work.

Rack-and-pinion steering, which provides direct control and optimum feel, is used exclusively by Indy car designers. The steering ratio varies from one racetrack to another, depending on what kind of reaction the driver needs for best control.

Indy car braking systems are 4-wheel disc. Most use a single 4-piston magnesium caliper per wheel with floating pads. On oval tracks where little braking is necessary, pads may be of an organic material that can provide good braking when cold. On road race courses where braking is constant, metallic pads are used. These require some heat to be effective but don't fade as temperatures climb.

Muscle separates the men from the boys. And this year most of the men will be relying on overhead-cam V8 engines that are designed specifically for Indy car racing. All displace 2.65 liters. Last year the Chevy/Ilmor en-

The 3.4-liter Buick is based on factory performance parts, which are available at dealerships. These include aluminum, open-chamber Stage II heads and a staggered even-fire crankshaft forged of 5140 steel. Pistons are aftermarket forged aluminum—connecting rods are aftermarket machined alloy steel.

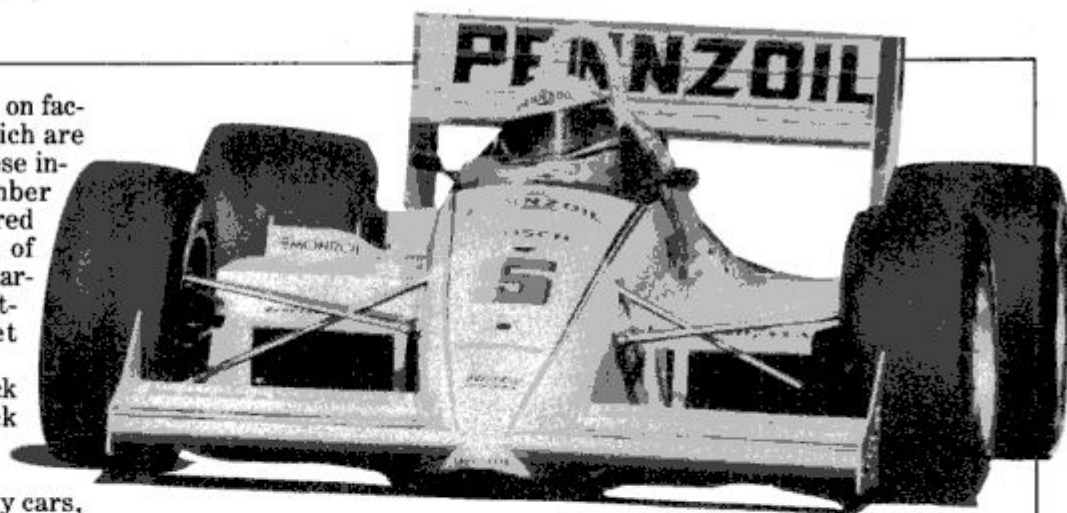
The block used by most Buick teams is the new short-deck 3300 V6 engine. With lower deck height than the engine used in last year's Buick Indy cars, this block offers a lower profile, a lower center of gravity and less weight. The lower center of gravity should help improve handling as it reduces unfriendly cornering forces. The lower profile is the most important asset of the 3300 as it allows better aerodynamics and more airflow to the rear wing.

Typically, the 700 horsepower of an Indy engine is delivered to the rear wheels via a 6-speed transaxle. The sixth speed, however, is used only on road-race courses. At oval tracks like Indy, the transaxle is configured as a 5-speed. The elimination of a ratio provides room in the case for a somewhat stouter top gear—better equipped to take the pounding of 500 long miles.

Most teams employ a fourth gear that is only slightly shorter than top gear. This strategy enables a slight change in engine speed if necessary.

Almost all Indy teams will be rely-

Porsche's V8, developed specifically for Indy, sports titanium connecting rods and on-board telemetry to give crew lap-by-lap updates on engine parameters.



Penske P 17: Note suspension pushrods angling up to top center of front suspension.

ing on electronic fuel injection and spark control this year. Gone are the old lawn-sprinkler-type systems that were used for more than three decades. Here to stay is electronic engine management, with complex spark advance curves and precisely timed sequential fuel injection.

Monitoring a variety of sensors that measure such things as manifold pressure, atmospheric pressure, engine speed, throttle opening, crankshaft position and more, these systems calculate correct fuel mixture and ignition advance and they control both directly. The dividends are enormous: Precise mapping of spark advance, for example, can help eliminate the throttle-up flat spots common to turbocharged engines.

If electronic engine management sounds a lot like passenger-car stuff that's because it is a lot like passenger-car stuff. Electronics is one area where the race car designers have learned a bit from the passenger-car boys. In fact, many of this year's Indy cars will be fitted with digital dash-

boards and warning lights for things like overheating and low oil pressure.

But the Indy teams have taken electronics a step further. When you're trying to tune a car for maximum performance, data acquisition is almost as important as engine control. Enter the black box.

When asked to name the most important advance for 1989, most Indy-car teams choose the black box. What they're referring to is an onboard data acquisition system. Almost every team claims that their system is the most advanced, but each is comparing it to what everyone else had last year. We'd guess that some folks are going to be surprised when they see how much progress the competition has made in this area.

The most advanced systems can record the most minute corner-by-corner, millisecond-by-millisecond details of performance, including comparison of segment times, maps of turbo boost versus distance and time, lateral G forces versus distance and time, exhaust temperature on a cylinder-by-cylinder basis, oil pressure, engine temperature, spark advance maps and a whole range of other valuable numbers.

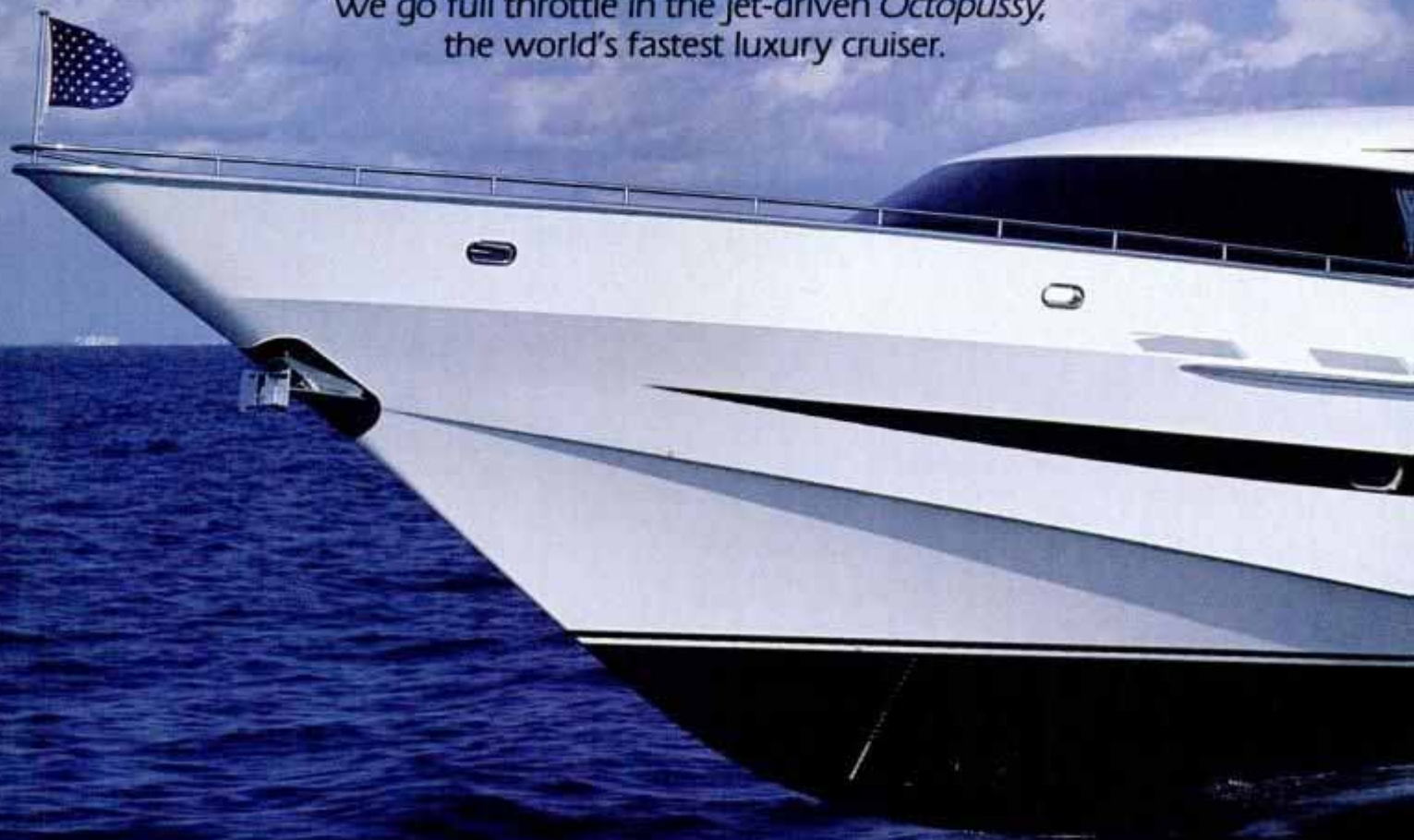
Because the cars are designed to allow adjustment of almost every variable—from caster and camber to spring rates, to shock damping, to fuel and spark curves and more—changes can quickly be made in respect to acquired data and the results compared.

But that's not all. Porsche, for one, can now monitor the data in the pits as the car is lapping the track. This is accomplished via radio devices. The crew chief of one Judd-powered car guesses that some teams will soon be able to change operating parameters from the pits via radio while the car is lapping the track. Others we've talked to suspect that some teams may already be capable of telemetry control. That's pretty high science at the old brickyard.

FM

MEGAYACHT

We go full throttle in the jet-driven *Octopussy*, the world's fastest luxury cruiser.



BY JOE SKORUPA,
Boating/Outdoors Editor
PM Photos by Brian King

BIGGER USED TO BE better. Today, the need is for speed. This is especially true in the rarefied world of 100-ft.-plus megayachts. Here, immensity and luxury are taken for granted. Something more is needed to stand out in this crowd.

Something like a 10,500-hp propulsion system that generates the equivalent of a 747 jet engine's thrust—56,000 pounds. Something that powers a 124-ton boat from 0 to 40 mph in 40 seconds. Something that pops a plush, 132-ft. megayacht on plane like a sportboat and sends it racing through rollers at 60-plus mph.

If this sounds like it's right out of a James Bond movie—bold, lavish, high-tech, supercool—it should. The boat is called *Octopussy* and it's currently the fastest megayacht in the world, clocking an incredible 53.17 knots (61.15 mph) while fully outfitted, stocked with ship's



stores, loaded with 2000 gallons of fuel, and carrying 18 passengers.

Even more amazing is that on one brilliant Florida day last fall, I got behind the starship-like helm of the *Octopussy* and drove it for an hour. We were waiting to

The megayacht's starship-like helm has a navigation station to port (left) and five instrument consoles, equipped with video monitors for docking, canted toward a captain's chair that's fitted with shock absorbers.



The James Bond-inspired main salon is both high-tech, with large-screen TV and other state-of-the-art electronics, and high style, with complete bar and plush couch for 15. It leads to a 3-story spiral staircase.

rendezvous with the PM photo helicopter at the mouth of the Worth Inlet, in North Palm Beach, when I asked Capt. Baron K. Rohl if he would mind my sitting in his, well, captain's chair. Baron said, "Be my guest." A few moments later the chopper

arrived and requested that we head north at full speed. Baron turned to me and said, "You know where the throttles are, take her out."

Saltwater Jet

Few megayachts, until recently, were capable of speeds above 30 knots (1 knot, or nautical mile, equals 1.15 statute miles). The technology existed, but not many could afford multiple propulsion systems that cost as much as \$1 million per unit. And, secondly, few wanted to sacrifice the elegance of heavy teak trim and the ocean comfort of a wide, slow-moving displacement hull.

Then in 1983, the 152-ft. megayacht, *Shergar*, was clocked at 45 mph, establishing the record recently broken by *Octopussy*, and a new high-performance megayacht era was born. News of *Shergar's* accomplishment astonished yacht builders not only for its amazing swiftness, but because the speed was achieved using high-tech jet drives.

The principle behind water jets, like many other innovative breakthroughs, is

MEGAYACHT



Jet nozzles, exposed at low tide, beneath Capt. Rohl and stewardess Margaret Kleiser.

relatively simple—draw a large volume of water into a wide inlet duct and force it through a narrow nozzle. This is done by means of an impeller. It is the same operating principle as that of a jet engine for an aircraft.

Power is delivered by three V16 diesel engines made by MTU (Motoren und Turbinen Union) GmbH, of West Germany. Propulsion is generated by three water jet drives made by KaMeWa AB, of Sweden. Altogether, this system weighs 30 tons.

The major advancement on the MTU engines (models 396 TB94) is a system of sequential turbocharging. Each engine is equipped with three turbochargers programmed to operate in combination relative to rpm. With this system, an efficient use of exhaust-gas energy is achieved throughout the rpm range, according to Phil Wasinger, application engineer, MTU of N. America.

The big diesels are connected by the main driveshaft to the KaMeWa water jets. The main driveshaft is connected to a 6-blade impeller that draws water through a 24-in. inlet duct and squeezes it out an 18-in. nozzle. The spinning action of the impeller creates an inefficient swirling flow to the water in the pump, so stationary outlet guide vanes straighten the

flow before it reaches the nozzle.

Steering is accomplished by moving the steering/reversing nozzle plus or minus 30°. This is done by hydraulic servos. Of the three propulsion units, only two are used for steering. The center unit is strictly for thrust.

Reverse thrust is achieved by deflecting the jet of water forward. A clamshell device, called the bucket, opens a port and deflects the jet of water through it. By placing the bucket in a half-open position, net thrust can be set to zero, regardless of how fast water flows through the pump.

The final component in *Octopussy's* formula for speed is the hull, built in Holland by Diaship for multimillionaire car dealer, John Staluppi, of Long Island, New York. The 132-ft.-long, 26-ft.-wide hull is constructed of aluminum with foam coring. To produce a soft ride in rough seas, the bow is brought to a stiletto point that slices through the rollers.

With a hard chine, 12° transom deadrise and planing steps about 7 ft. forward of the jets, *Octopussy's* hull is a planing hull. This design allows the side shell, which adds beam at the waterline, to ride free of water and spray at 40 knots, reducing wetted surface to a minimum.

Stirred, not shaken

It's easy to imagine James Bond sipping a martini aboard *Octopussy*. State-of-the-art gadgets, as if inspired by Bond's gimmick wizard Q, are everywhere. They range from a remote-controlled hydraulic davit, to a retractable barbecue in the outdoor lounge, to Walkman-style walkie-talkies worn by the 7-man crew.

Each of the staterooms has a TV, telephone, intercom and radio. The main stateroom, in addition, has a VCR, CD player, cassette player, sauna and jacuzzi. Large-screen TVs adorn two lounges, pneumatic doors open at the push of a button, and phones (all interphased for satellite communication) are everywhere.

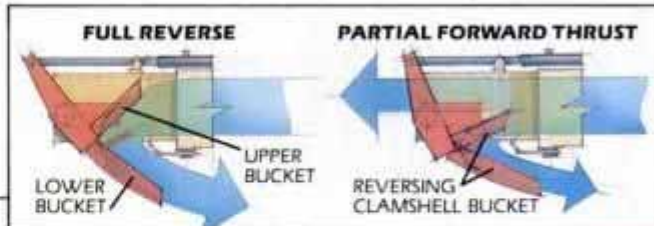
The man who has the most fun aboard *Octopussy*, because he gets to drive her, is Capt. Baron Rohl. Under Capt. Rohl's supervision, I pushed the throttles ahead and felt the megayacht leap forward. The sensation of speed felt more like an aircraft taking off than a yacht moving out to sea.

In about a minute, we reached top-end speed—50.5 knots (58.08 mph) at 2060 rpm. This was achieved with complete ship's stores, 15 passengers and 6500 gallons of fuel. For more than an hour, I ran the boat and, in the process, burned 600 gallons of fuel.

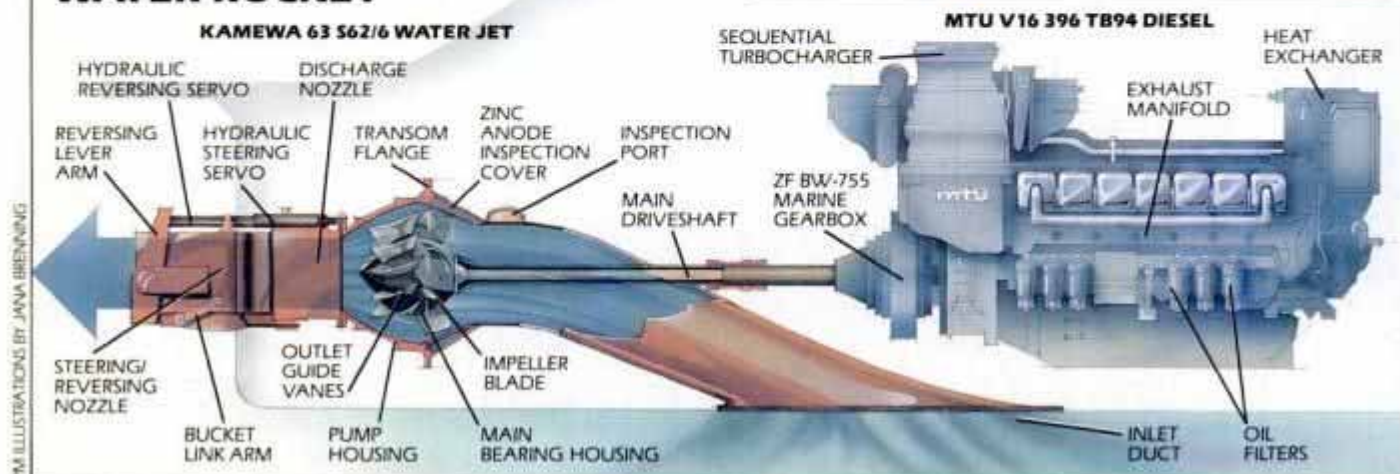
In addition to raw speed, I was impressed by *Octopussy's* quiet and vibration-free ride at full throttle, a hallmark of its innovative jet-drive propulsion system. Secondly, I was amazed by the light touch required for steering and how beautifully it leaned into high-speed turns. In short, it handled like a smooth-running sportboat, and if a 300-ft. rope wasn't required to get beyond the wake, waterskiing didn't seem out of the question.

Someone once said the difference between men and boys is the price of their toys. But, today, I think *speed* is just as important as price, and *Octopussy*, with its \$9 million price tag and 60-mph speed, is the ultimate high-tech toy. **PM**

Jet drive is powered by diesel engine via straight driveline. Deflecting the water flow (right) adjusts forward thrust and gives full reverse.



WATER ROCKET



PM ILLUSTRATIONS BY JAVNA BRENNING

HOME AND SHOP JOURNAL



TOOL TECHNIQUES TACKLING THE TABLE SAW

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO,
Contributing Editor

THE HEART OF any well-equipped woodworking shop is the table saw. And the reason is simple: The table saw is more than just

another tool. It's an extremely versatile and accurate piece of equipment that can handle all the basic woodworking cuts—rip, crosscut, miter, bevel and compound angle cuts—and then some. Its large saw table makes it ideal for cutting both solid-wood boards and plywood panels. It accepts a wide variety of saw blades and special attachments, too, such as a dado blade or molding cutterhead. (For details on using a cutterhead, see "Cutterhead Closeup," page 71, Dec. '86.)

Special abrasive saw blades are available for cutting thin metal on a table saw. They're especially useful for crosscutting thin-wall tubing, such as conduit. Use only reinforced, resin-bonded abrasive blades—non-reinforced blades may shatter.

The table saw is also unsurpassed for cutting joints such as butt, miter, spline, tenon, rabbet, dado, box, tongue-and-groove and lap. The saw's use of a rip fence and miter gauge, and its precise blade adjustments, all contribute to making the tool highly accurate and very exact.

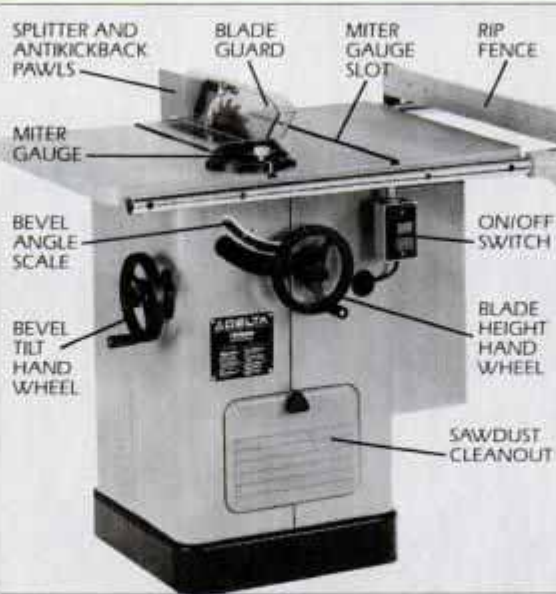
But, don't be scared off by the table saw's workshop sophistication. It's a relatively simple tool to use safely and effectively. Here, we present ways to tackle basic table saw operations. Note that the saw blade guard should be used whenever possible. In some of the photos, the guard has been removed for photo clarity only. Also, wear eye goggles or a face shield. The blade has the tendency to throw dust and chips toward the operator.

Tool Basics

A TYPICAL table saw consists of a motor and arbor assembly which is housed in a base cabinet or stand. The saw blade is mounted to the arbor which is connected to the motor by a belt and pulley. Blade adjustments are controlled by two crank-type handwheels. One handwheel controls the blade's height above the saw table. The other one adjusts the bevel angle of the blade—from 0 to 45°.

The rip fence, which slides on front and rear guide bars, can be locked anywhere along the bars at the desired distance from the blade. Shallow slots, milled into the saw table on either side of the blade, accept an adjustable miter gauge. Use the miter gauge for crosscuts and miters.

Table saws are designated according to the diameter blade used. Models are available in 8-, 9-, 10-, 12- and 14-in. sizes. The 10-in. size, however, is clearly the most popular home



Here's a popular 10-in. table saw—a Delta Unisaw—shown with its major components identified.

toward the operator. The splitter is a thin metal bar mounted directly behind the blade that keeps the kerf open and prevents the work from pinching the blade.

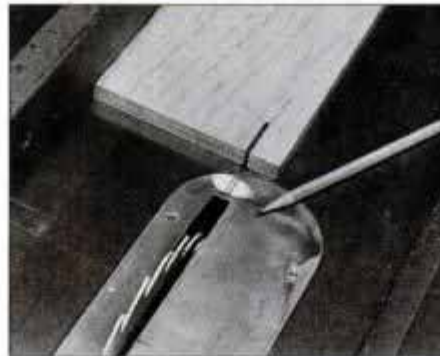
The key to getting a smooth, clean cut is to select the right blade. The basic blades include rip, crosscut, combination, plywood and hollow-ground planer. Rip blades are designed with chisel-like teeth for sawing along the wood's grain (ripping). Crosscut blades, obviously, are used to cut across the wood's grain. A combination blade is a general-purpose blade that can be used for both ripping and crosscuts. A hollow-ground planer blade gives an extremely smooth cut because the teeth are not set. Its body tapers slightly from the teeth down to the hub.

This provides clearance in the kerf and eliminates binding.

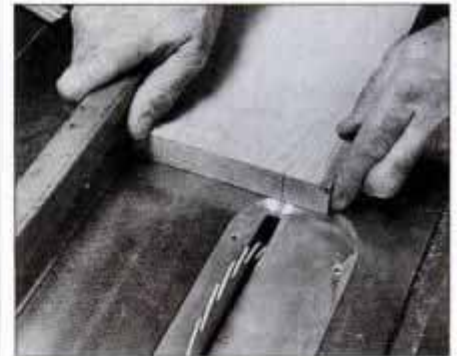
When you're looking for a smooth-cutting blade that will stay sharp longer, use a carbide-tipped blade.



To change blades, first unplug the power cord. Then, use a wood stick to hold blade as you remove the arbor nut with a wrench.



To make blade alignment marks, first make a short cut in a scrap board. Then, mark the kerf on the saw blade insert with a pencil.



Now, to set the fence, align the cutline on the board with pencil mark on blade insert. Remark kerf lines after each blade change.

Rip Cuts

IF A TABLE SAW were used for rip cuts only, it would still be a valuable tool. There's simply no easier or more accurate way to rip a board than on a table saw. The rip fence provides a straight, smooth surface on which to guide the work into and pass the blade. Note that the fence can be positioned on either side of the blade, although the vast majority of rip cuts are made to the right side of the blade.

Be sure that the fence locks securely to the guide bars and parallel to the blade. Most rip fences can be adjusted exactly parallel to the blade.

When cutting on the table saw it's extremely important to keep your fin-

gers away from the blade at all times. Even the best blade guard can't prevent all accidents. This is especially important when making narrow rip cuts. As a general rule, always use a pushstick when ripping a board that's less than 3 in. wide. When ripping wider boards, it's good practice to keep a couple of fingers wrapped over the rip fence as you push the board by the blade. This will help prevent your hand from slipping into the blade.

As you rip long stock, the work must be supported on the outfeed side of the table. One solution is to build an auxiliary worktable that's the same height as the saw table and position it at the outfeed side of the saw.

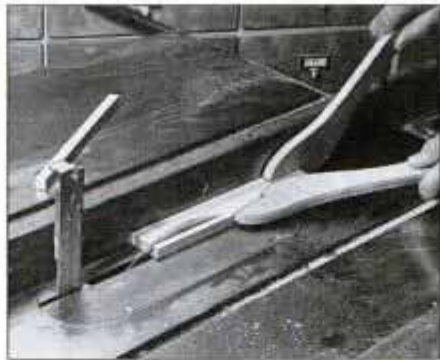
Another solution is to make a simple T-shaped work support fitted with

a wood or steel roller. Clamp the support to a sawhorse, as shown on the following page, so that the roller is at the same height as the saw table.

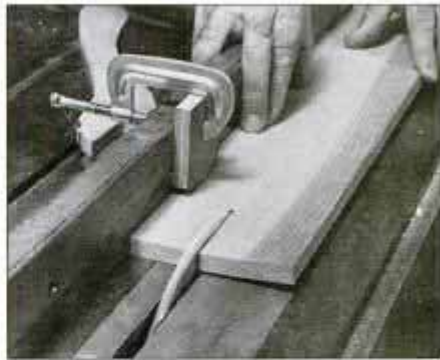
Guiding a board against the rip fence is fine as long as the board's edge is straight. However, how do you make a straight rip cut on a board with two rough, irregular edges? Well, here's how. First, tack nail a narrow rip of plywood to the board so that the plywood overhangs the board's rough edge slightly. Then, guide the board into the blade with the plywood against the rip fence, as shown on the following page. Now remove the plywood guide, turn the board around, and guide its just-cut straight edge against the fence to trim the remaining rough edge.



Long stock must be supported. Make a simple T-shaped frame with roller. Clamp frame to sawhorse so roller is even with saw table.



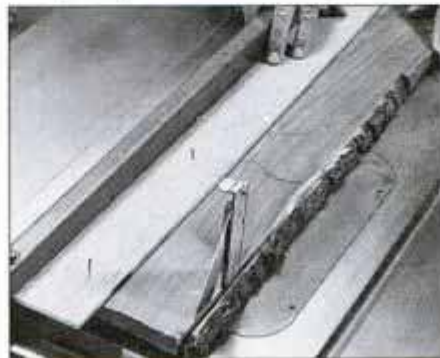
Use pushsticks when ripping narrow pieces. Cut pushsticks from 1/2-in. plywood. For some work, two pushsticks are needed, as shown.



To rip a cupped board, cut it with the concave surface facing up. Clamp a block to the fence to keep the board from rocking.



When ripping thin strips, replace standard table insert with a plywood one. Raise blade through plywood to form the narrow slot.



To rip stock that has two irregular edges, tack nail a plywood strip to board, with its edge overhanging, and rip off rough edge.



Here, a featherboard holds work for resawing—that is, cutting thick boards into thin ones. Cut featherboard on band saw.

Crosscutting

THE TABLE SAW is excellent for crosscutting—especially short, small-dimension pieces.

The miter gauge is used to support the work as you guide it into the blade. The problem with a standard miter gauge, however, is that the work-bearing surface is much too small. Remedy this by screwing an auxiliary wood fence to the miter gauge. Make the wood fence about 3/4 x 3 in. wide x 14 in. long.

The long wood fence also makes it easy to align the cutline on the board

with the saw blade. Here's how it's done: First, raise the blade about 1 in. above the saw table and then make a cut through the wood fence. Now use the cut in the fence as a blade reference mark. Simply align the cutline on the board with the kerf in the fence.

Never use the miter gauge in conjunction with the rip fence. Move the rip fence away during crosscutting to eliminate the chance of the cutoff pieces becoming jammed between the blade and the fence.

To crosscut several pieces to the same exact length, use a stop block. Clamp a wood block to the saw table at the desired distance from the blade.

Then, butt the workpiece against the stop block, as shown, and slide the miter gauge forward to cut the piece. Pull back the miter gauge, slide the work to the stop block again, and repeat. If necessary, use a pushstick to move the cutoff pieces away from the blade. **Caution:** Be sure to position the stop block so that the workpiece is free and clear of the block before it makes contact with the blade.

Crosscutting very small pieces can be dangerous. Therefore, employ a spring clamp to hold the work to the miter gauge fence, as shown. This way you can keep your fingers well clear of the blade.



For crosscutting a wide board, one hand holds the work against the miter gauge fence while the other pushes forward.



A stop block clamped to the saw table allows for identical repetitive cuts. Butt the work against block and advance the miter gauge.



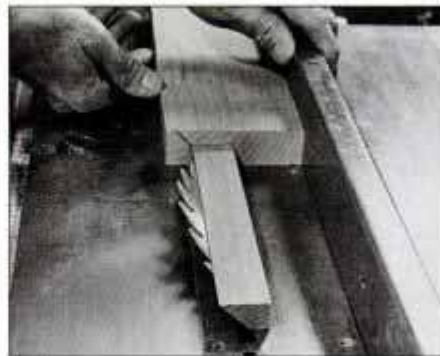
Never take chances when crosscutting small pieces. Use a spring clamp to hold work to miter gauge fence. Keep your fingers away.

Bevel Cuts

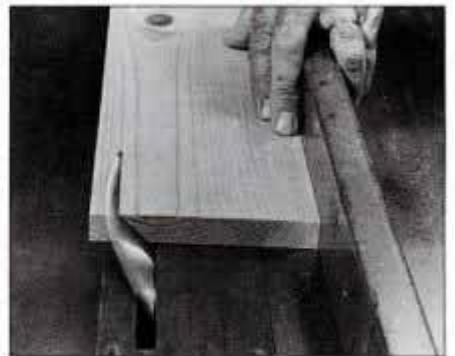
A BEVEL CUT is simply a rip cut or crosscut made with the blade tilted at an angle. Although most bevels are cut at 45°, any angled-blade cut is a bevel cut. Some table saws have blades that tilt to the left, but most tilt right. In either case, when making a bevel rip cut, always position the rip fence so that the blade tilts away from the fence. Otherwise, the workpiece could become jammed between the blade and the fence.

Positioning the rip fence for a bevel rip cut is a little tricky. However, here's a quick, accurate way to position the fence exactly. First, make a bevel rip test-cut in a scrap board that's at least 10 in. long. Next, place the test-cut board against the saw blade. Now align the cutline on the workpiece with the beveled surface of the test board, as shown, and then lock the rip fence in place.

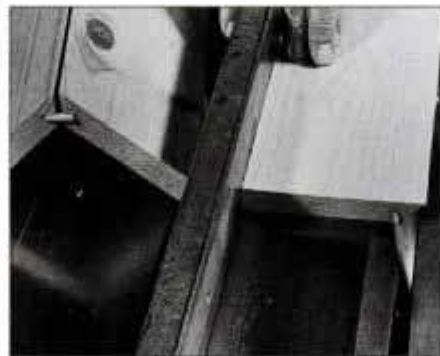
The miter gauge is utilized for making bevel crosscuts. First, make a pass over the angled blade to cut through the miter gauge's auxiliary wood fence. Then, simply align the cutline on the workpiece with the kerf in the fence.



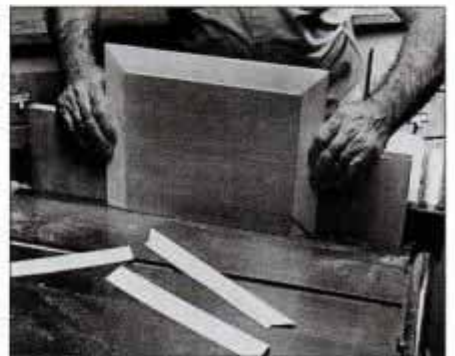
Use a bevel rip test-cut board to position the workpiece and rip fence with the blade. Align the cutline on work with test board.



For a bevel rip cut, set rip fence so blade tilts away from the fence. This way work can't become trapped between blade and fence.



To form a spline-reinforced miter joint, place fence to the right of the blade to cut 1/2-in.-deep spline grooves in the beveled face.



Bevel cutting lets you make raised panels. Install a tall auxiliary fence to the rip fence for support. Make the bevel crosscuts first.

Mitering

A MITER CUT is simply an angled crosscut. And like bevel cuts, most miters are cut at a 45° angle, although any angled crosscut is a miter. As with square crosscuts, the miter gauge is used for mitering, too.

A typical miter gauge adjusts up to 60° for both left- and right-hand miters. Note that the miter gauge can be used in either the closed or open position, as shown. For most jobs, however, the closed position is preferred. First, it places the head of the miter gauge closer to the blade for better

control. Secondly, when mitering a wide board in the open position, all or part of the miter gauge will be off the saw table. In the closed position, however, the miter gauge and board will be supported on the saw table.

Most miter gauges have positive stops at 45° left and right. To test accuracy, first adjust the miter gauge to 45° and lock it in place. Then, make a miter cut and check the angle of the cut with a miter square or combination square. If the cut isn't exactly 45°, readjust the positive stop on the miter gauge.

If you have a job that calls for a lot of mitering, such as when installing

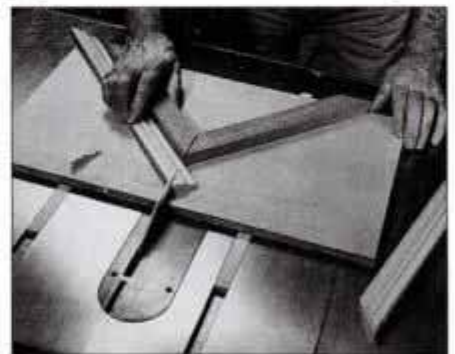
trimwork or making picture frames, make the mitering platform jig shown. The jig provides a quick, accurate way to cut both left- and right-hand 45° miters. The jig consists of a 3/4 × 15-in.-wide × 22-in.-long plywood platform that has attached to its underside two hardwood rails that ride in the miter gauge slots. The work is supported by two 3/4 × 1 1/2-in.-wide hardwood blocks that are glued and screwed to the platform to form an exact 90° angle. The front edges of the blocks are at a 45° angle to the blade. Hold work against the blocks and slide platform forward to cut. Apply wax to rails for smooth sliding.



This shows cutting a 45° miter with miter gauge set in the closed position. Note wood fence attached to miter gauge for support.



Here, miter gauge is in the open position and is set back from blade. When mitering a wide board, the miter gauge will be off saw table.



Shop-built mitering platform jig provides an easy way to cut miters. Hold work against angled block and push platform forward.

Compound Angle Cuts

A COMPOUND angle cut is a combination miter and bevel. The cut is made in a single pass with the blade tilted and the miter gauge locked at the desired angle. Compound angles are used to build boxes and pedestals with tapering sides, and to form splayed legs for chairs and tables. Since two exact angles must be set for the cut to be dead-on accurate, make a couple of test cuts and then check the joint.

Crown and cove moldings also require compound angle cuts because they're installed at an angle where a wall meets a ceiling. However, rather than tilting the blade, leave the blade



Here's the setup for a typical compound angle cut. Tilt the saw blade and angle miter gauge to create both a bevel and miter cut.

angle set at 0° and use the shop-built jig shown. The jig, which mounts to a miter gauge, holds the molding at the proper angle.

The jig consists of a 1/4-in. plywood



Build this simple jig to cut compound angles on crown molding. Wood-strip stop block props up molding, holds it at proper angle.

platform that's screwed to a 1x3 wood fence. Nail a 1/4-in.-thick x 3/4-in.-wide wood strip to the platform to act as a stop block. Nail block so that it props up the molding at the required angle.

Sawing Rabbet Joints

THE POPULAR rabbet joint is a strong, easy-to-make joint that joins two boards at a right angle. A rabbet is simply an L-shaped cutout made in the edge or end of a board.

Generally, the depth of a rabbet equals half the thickness of the stock being rabbeted. The rabbet width must equal the total thickness of the stock being joined to the rabbet. For example, joining two 3/4-in.-thick boards would require a 3/8-in.-deep x 3/4-in.-wide rabbet.

As shown in the photos, there are two ways to cut rabbets on a table saw. You can either use a standard saw blade or a dado blade. Both methods work well, however, the dado blade technique is preferred because the rabbet can be formed in a single pass. When using a standard saw blade, two passes are required to cut a rabbet. Dado blades, either multi-blade/stacking or wobbler type, can be adjusted to various width cuts—

usually from 1/4 in. to 13/16 in. wide.

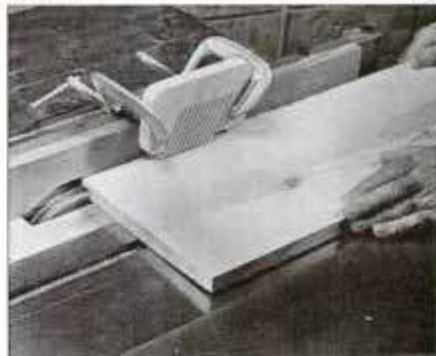
A miter gauge is used to cut rabbets on the ends of short boards, but when working with long boards or plywood panels, utilize the rip fence. Note that an auxiliary wood fence, that conceals part of the blade, is attached to the rip fence when using a dado blade.

Adjust the dado blade elevation and

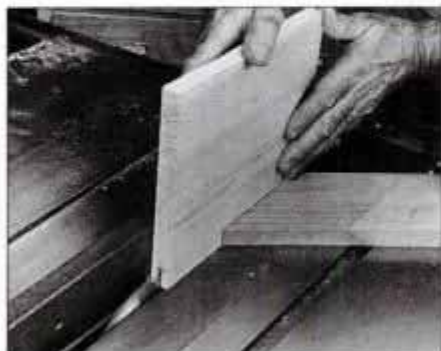


When cutting rabbets with a dado blade, attach an auxiliary wood fence to the rip fence. Note that blade is partially hidden by wood.

fence position for the desired size rabbet. Make a test cut in a scrap board, check the rabbet dimensions and make any additional adjustments. When advancing the workpiece over the blade, keep pressure against the fence and down on the saw table. Even though the blade will be concealed during the cut by the wood fence and workpiece, for safety sake, don't press down directly over the blade. **PM**



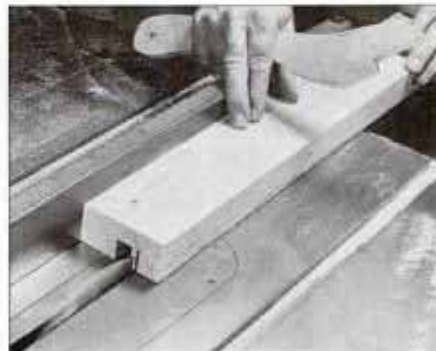
If the board is cupped or very long and hard to control, clamp a featherboard to the fence to apply pressure. Advance board slowly.



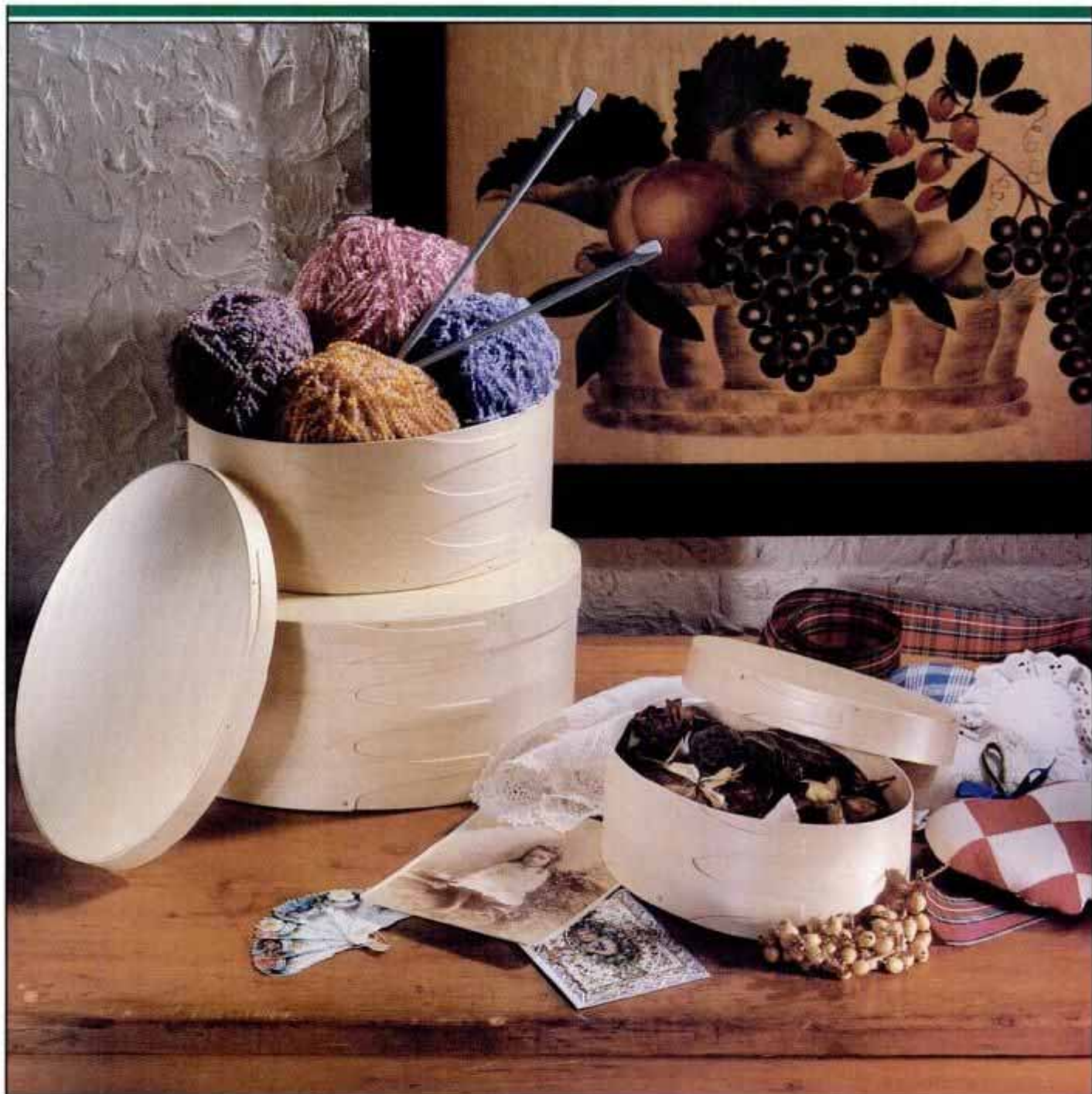
When using a standard saw blade to cut a rabbet, make edge cut first. Clamp a featherboard to press workpiece against the fence.



Readjust blade height and fence position for second cut. Pass work between blade and fence to prevent kickback of cutoff strip.



Standard saw blade can cut large, deep grooves. Shift the rip fence slightly after each pass to get the desired width groove.



HOME AND
SHOP PROJECT

SHAKER BOXES

Capture the Shaker's world:
Build these simple, yet
practical, oval wood boxes.

BY NEAL BARRETT

SHAKER design is famous for its purity of style, simplicity and practicality. Also, for its link to a truly American heritage of superb craftsmanship, faith and passion. Today, nearly 150 years after the height of the Shaker religious colonies in America, Shaker design—furniture, architecture, woolen goods, baskets and art—remains popular.

And one of the most popular designs is bentwood Shaker boxes. Like all the other Shaker designs, the oval boxes are simple, functional and free of superfluous adornments.

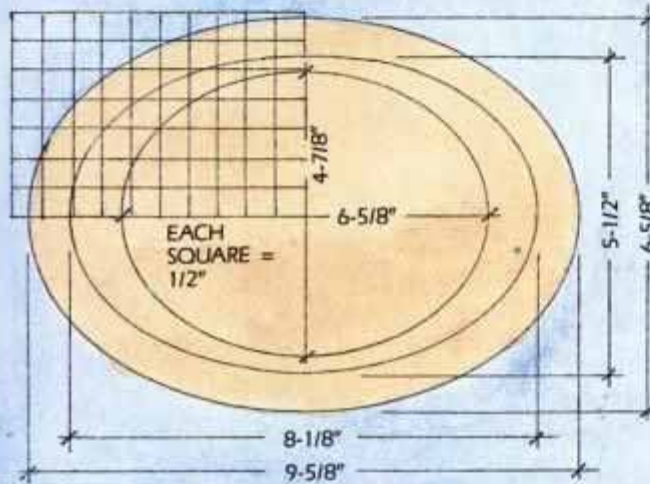
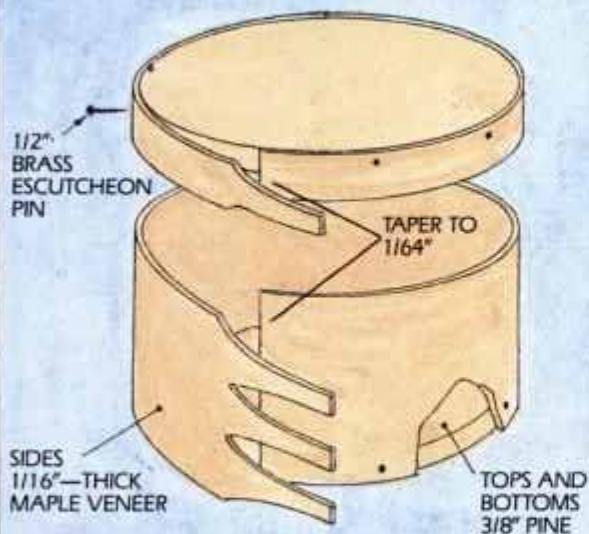
Here, we show a simple, straightforward way to make these thin-

walled boxes without the bother of steam bending wood. The bent sides of the boxes and rims of the lids are made of $\frac{1}{16}$ -in.-thick maple veneer. The veneer is sold through various mail-order woodworking supply firms including Constantine's, 2050 Eastchester Rd., Bronx, NY 10461, and Wood Shed, 1807 Elmwood Ave., Buffalo, NY 14207. The box tops and bottoms are made of $\frac{3}{8}$ -in.-thick pine.

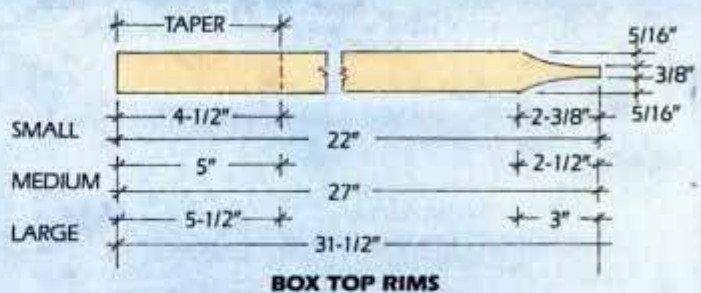
Begin by making a plywood mold
(Please turn to page 146)

Color lead photo: Spencer Jones
How-to photos: Neal Barrett
Technical art: Dyck Fiedderus

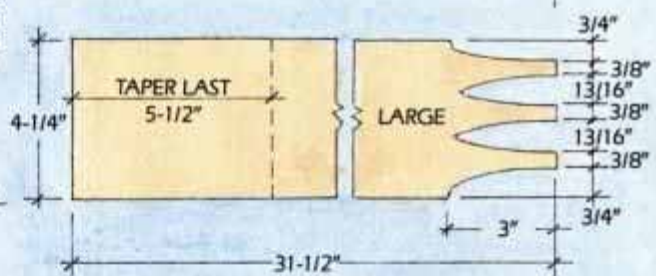
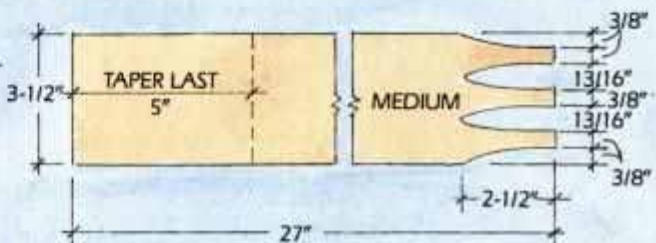
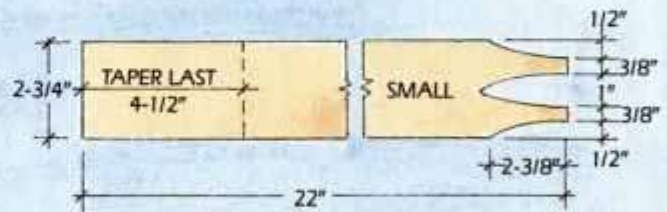
SHAKER BOXES



PLYWOOD MOLD SIZES



BOX TOP RIMS



BOX SIDES



1 After cutting the plywood mold to an oval shape, use a sanding block with 80-grit sandpaper to refine the final shape.



2 Screw a plywood base to the mold bottom to act as a clamping fixture. Cut base 4 in. wider and 8 in. longer than the mold.



3 Clamp box-side veneers between 3/4-in.-thick boards. Allow uneven edge to protrude 3/8 in. Then, plane edges straight.



4 Cut the fingers, or lappers, to rough size on the band saw. Then, file each finger.



5 Use 100-grit sandpaper and a wood block to sand a taper on end of veneer.



6 To soften veneer, place it in a long tray and soak it in boiling water for 4 minutes.

MAIL-ORDER TOOLS

SPECIAL
DELIVERY

Mail-order catalogs bring the world's finest tools and woodworking supplies right to your doorstep.

BY JOSEPH TRUINI,
Shop And Tools Editor
Photos by Rosario Capotosto

Tools On Sale

This may not be the world's most attractive tool catalog—there are no color photographs or fancy illustrations—but page for page, it ranks as one of the best.

This giant, 595-page catalog has a wide variety of tools and accessories, especially portable power tools, all at discounted prices. There's no minimum order and, best of all, no shipping charge. Choose portable power tools from Milwaukee, Skil, Black & Decker, Porter-Cable, Ryobi, Makita, Hitachi, Bosch and AEG. There's a fine selection of Delta, DeWalt and Ryobi stationary tools, too. Choose from such quality products as Plano tool boxes, SK mechanics tools, and various woodworking clamps by Pony, Jorgensen and Bessey.

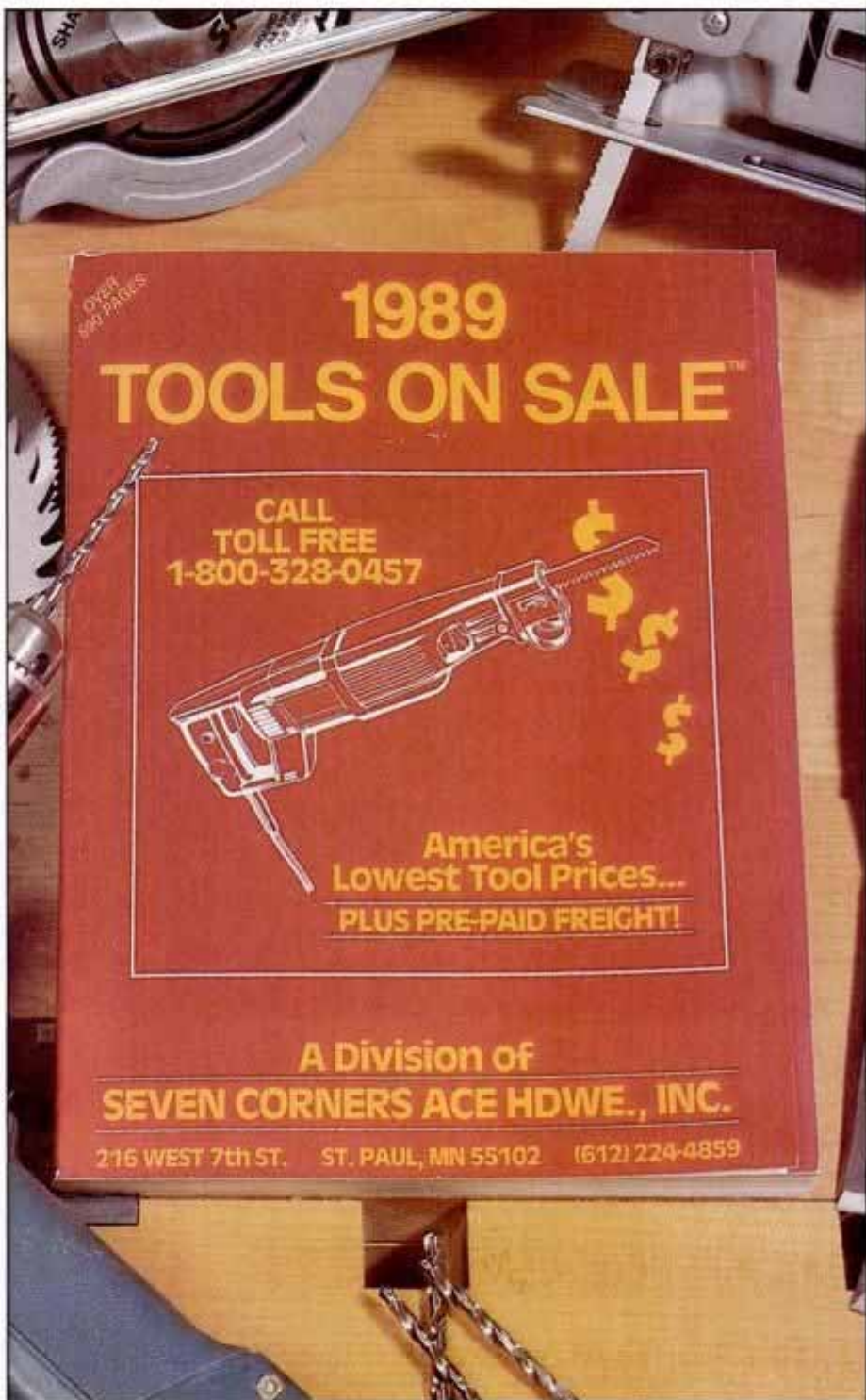
Also offered: Marples chisels, Kennedy tool chests, 3M abrasives and adhesives, Record planes and vises, and 12 pages of Bosch router bits.

For a free catalog, contact Tools On Sale, 216 W. 7th St., St. Paul, MN 55102. Or, call toll-free: (800) 328-0457.

Craftsman Wood



For the past 59 years, Craftsman Wood Service has been catering to cabinetmakers, hobbyists and woodworkers of all ages. This year's 146-page catalog features over 4000 items including



an extensive collection of hardware, hand-finished picture frame moldings, veneers and cabinet-grade hardwoods.

Hobbyists and modelmakers will appreciate the line of compact power tools by Dremel, Foredom and Wen. Also choose from veneer inlays, exotic and domestic hardwood turning blocks in sizes up to 3 x 12 x 12 in., electrical supplies for making lamps, Buck Brothers professional woodcarving tools, and the Craftsman line of clear wood finishes. Select from a

wide array of furniture plans, how-to books and finishing supplies from Minwax, Deft and Watco.

Also worth noting are the real-wood tambour that comes in 2 x 4-ft. sheets, furniture upholstery tools and supplies, wooden ship models and musical movements for use in jewelry boxes and toys. Craftsman Wood Service has a minimum order of \$10. Shipping and handling is extra.

To receive a free catalog, write to Craftsman Wood Service, 1735 W. Cortland Ct., Addison, IL 60101.

Cherry Tree Toys

Everything you need to make wooden toys—plans, parts, kits, tools, books and supplies—is in this 60-page, full-color catalog. The wooden toy kits are packaged to satisfy all skill levels. The kits are available three ways; parts only—no flat lumber provided; uncut kit—all required parts and flat, uncut stock; and pre-cut, ready-to-build kit—just sand, glue and assemble. Also check out the whirligigs, dollhouses and Wild West wagon kits. Send \$1 to Cherry Tree Toys, Box 369, Belmont, OH 43718.



Bridge City Tool Works

This full-color catalog has only 24 pages, but it offers some of the most accurate and attractive layout tools available anywhere. The lineup includes seven different squares, two T-bevels, four precision rules, a scratch awl, marking gauge, 2-ft. straight-edge and an adjustable angle T-square. These top-shelf tools are made of solid rosewood, 360 half-hard tempered brass and Rockwell 54 tool steel. For a free catalog, write to Bridge City Tool Works, 1104 N.E. 28th Ave., Portland, OR 97232.



Trendlines

This no-nonsense catalog offers 72 pages of quality power tools, cabinet hardware and woodworking supplies. Trendlines carries stationary power tools by Delta, Ryobi, Jet and Hitachi. Choose portable power tools from such popular names as Milwaukee, Porter-Cable, Hitachi, Dremel, Makita and AEG. Also offered: shaper cutters, hole-boring tools and made-to-length band-saw blades. For a free catalog, write to Trendlines, 375 Beacham St., Chelsea, MA 02150.



Brookstone

Send for this free 68-page catalog and discover, as we did, that Brookstone carries much more than just hard-to-find tools. This colorful catalog offers a wide variety of items including energy-saving products, automotive accessories, workshop organizers and labor-saving garden tools. Also check out the oriental-rug floor mats for your car, radon-blocking floor drain sealer and the miniature tools for modelmakers. Write to Brookstone, 127 Vose Farm Rd., Peterborough, NH 03458.



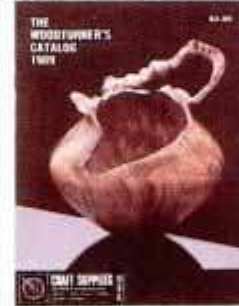
Sporty's Tool Shop

Here are 72 pages filled with leisure-living and convenience products for the home, shop and auto. Select from a wide range of products including an indestructible mailbox, solid-walnut machinist tool chest, numerous workshop storage items and a 12-volt portable refrigerator. Also offered: lawn care, outdoor cooking, camping, and sports and recreation products. For a free catalog, contact Sporty's, Clermont Airport, Batavia, OH 45103. Or, call toll-free: (800) 543-8633.



Craft Supplies

Here's a catalog devoted entirely to woodturners. Its 54 pages contain a wide variety of turning tools, lathe chucks, tool-sharpening devices, wood finishes, and lathes by General, Oliver and Woodfast. Choose from a full line of tools and accessories such as calipers, dividers, various lathe centers, wood moisture meter, abrasive cords and tapes, and PEG green wood sealer. To receive a free catalog, write to Craft Supplies, 1287 E. 1120 So., Provo, UT 84601.



Leichtung

Leichtung's specialty is not specializing in anything in particular. Instead, this compact, colorful 102-page mail-order catalog offers something for everyone. The melange of miscellany includes such useful home and shop items as a microwave oven leak detector, 2-story window washer, motion-detector floodlight, and a 6-ounce, 2500° F butane microtorch. For a free catalog, write to Leichtung, 4944 Commerce Pkwy, Cleveland, OH 44128. Or, call toll-free: (800) 321-6840.



Bob Morgan

Designed for workshop enthusiasts of all skill levels, this 64-page catalog specializes in do-it-yourself woodworking supplies. Choose from an excellent selection of domestic and exotic veneers including flexible veneers in sizes up to 3 x 8 ft. long; pregled, iron-on veneers; and pressure-sensitive veneers with peel-and-stick backing. For a free catalog, contact Bob Morgan Woodworking Supplies, 1123 Bardstown Rd., Louisville, KY 40204.



American Machine & Tool

The free, 32-page AMT catalog provides a way to buy workshop equipment on a tight budget—the tools are sold without motors. This way, you can install your own motor, or buy a new or rebuilt one. AMT sells motors separately, too. The tool line includes table saws, lathes, jointer/planers, shapers, a scroll saw, drill press, band saw and a belt/disc sander. Contact AMT, 4th Ave. and Spring St., Royersford, PA 19468.



NEW PRODUCTS

POWER PLAYERS

Breeze through lawn and garden chores with these eight hot, new pieces of outdoor power equipment.



Leaf Blaster/Catcher

Here's a new addition to the Poulan Pro line of quality lawn and garden power tools. The model 420 is a gas-powered leaf blower that converts to a vacuum with optional accessories.

Driven by a 28-cc, 2-stroke engine, the 11-pound blower produces a velocity of 150 mph, according to Poulan. Use it to blow leaves, litter and grass clippings from walks, driveways and patios. Snap on the

4½-in.-dia. vacuum tube and cloth collection bag (\$30), and clean up around the lawn, garden and curbside.

Optional extension tubes are available for blowing clean rain gutters. The model 420 blower/vac costs about \$150 at outdoor power equipment dealers.

For more information and details, contact Poulan Pro, 5020 Flournoy-Lucas Rd., Shreveport, LA 71129.



Tight-Turning Tractor

If you're looking for an easy-to-operate riding mower, then check out Toro's new HMR (Highly Maneuverable Rider) mowers. An innovative interconnected steering system permits the front wheels to turn 80° for an incredibly small 4-in. turning radius.

A dual 5-speed Peerless transmission drives each rear wheel independently. The 12-hp model with a 38-in. mowing deck costs about \$3200. A 16-hp model (\$3500) is also available with a 44-in. (\$700) or 52-in. (\$800) deck. Contact Toro, 8111 Lyndale Ave. So., Minneapolis, MN 55420.

All-Terrain Mower



If you've got a rough, rugged lawn, try the new Tuff-Cut lawn-mower from Garden Way, 102nd St. and 9th Ave., Troy, NY 12180. The self-propelled mower is powered by an 8-hp Briggs & Stratton engine, and features 20-in.-dia., pneumatic rear wheels. The large wheels greatly improve maneuverability and traction making it easy to mow hilly slopes and uneven terrain. The 24-in.-wide mowing deck makes quick work of large lawns and the cutting height is adjustable from 1½ in. to 3¼ in. The 24-in. Tuff-Cut mower costs \$799. A 5-hp, 22-in. model is available for \$599. Contact Garden Way for more information and details.

No-String Trimmer




RedMax, a relative newcomer to the outdoor power equipment field, offers a revolutionary new weed trimmer, called the Reciprocator, that looks and feels like a string trimmer. However, there's one major difference: The Reciprocator doesn't use a spinning nylon string. Instead, weeds are whacked by two 20-tooth reciprocating blades. This creates a safer, easier-to-use trimmer that doesn't hurl grass and debris or leave whip marks on siding.

And, unlike a string trimmer, the Reciprocator can mow down heavy weeds, brush and small branches. The cutting head can even be submerged under water for mowing down weeds in ponds and rivers. Also, the dual reciprocating blades stop immediately when the engine is shut off.

Powered by a 22.5-cc gasoline engine, the 14-pound trimmer costs about \$500. Other features include a solid-state ignition and automatic centrifugal-type clutch.

For more information and the name of a RedMax dealer nearest to you, contact RedMax, Box 1545, Norcross, GA 30091.

Tall Grass Tamer



This rather odd-looking machine is a sickle bar mower. Made by the West German firm Al-Ko Kober, the Farmer 710 is equipped with a 28-in.-wide, double-cutter mowing bar that plows through the tallest grass and weeds without bogging down. The 126-pound machine is driven by a 3½-hp Tecumseh gasoline engine and runs at 1½ mph. Deep-treaded 3 × 12-in.-dia. tires provide excellent traction for hilly and rough lawns. In fact, when fitted with an optional front-mounted blade, this versatile mower converts to a snow plow. The Farmer 710 mower costs about \$625. Contact Al-Ko Kober, 25784 Borg Rd., Elkhart, IN 46514.



Lawn-Munching Mower

This may look like an ordinary walk-behind lawnmower, but it's the Bolens mulching mower. The mower's deck and blade are specially designed to cut grass and then chop the clippings into fine particles. The clippings and their nutrients return to the soil to promote greener, healthier lawns. And, of course, there are no clippings to rake up. The mower (S475) features a 4-hp Briggs & Stratton engine and self-propelled, front-wheel drive. For more information and details, contact Bolens, 215 S. Park St., Port Washington, WI 53074.



Grime Fighter

Here's a sure-fire way to clean up around the house and yard: Homelite's new gasoline-powered high-pressure washer. Powered by a 3-hp Briggs & Stratton engine, the portable unit sprays water under high pressure to blast dirt, soot and mud from house siding, walks and driveways, brick walls, cars, trucks, boats and motor homes. The compact washer delivers 1200 psi of pressure and 1.7 gallons per minute. The unit is mounted to a 2-wheel dolly and comes with a 2-ft.-long spray wand and 35

ft. of water hose for about \$700. Additional features include soap injection, quick-disconnect couplings and an adjustable spray tip that can be set from low pressure for soap cleaning to high pressure for rinsing with just water.

An electric-powered washer is also available. The electric unit delivers 1000 psi of pressure and 1.8 gallons per minute. It also comes on a 2-wheel dolly.

For additional information and the name of a Homelite dealer nearest to you, contact Homelite, Pressure Washer, 14401 Carowinds Blvd., Charlotte, NC 28217.

Trail-Blazing String Trimmer

Black & Decker has expanded its Lawnforce series of outdoor power equipment with three new, top-of-the-line electric string trimmers. Each trimmer features a clip-to-lock power cord retainer, 2-piece guard that protects the user from flying grass and debris, and a unique, no-hassle string advance mechanism. Simply push the feed bar located on the auxiliary handle to feed out string—there's no need to bounce the unit on the ground. The trimmer shown (model No. ST 1600) features a superwide 16-in. cutting swath and a 5-amp motor for about \$100. And 12-in.-wide, 3.2-amp (\$85) and 14-in.-wide, 4-amp (\$92) trimmers are also available. Contact Black & Decker, 10 N. Park Dr., Hunt Valley, MD 21030. **PM**



Think
Safety
MOTOR WHEEL

Practice wheel & rim safety, and we'll give you this solid bronze belt buckle.

Avoid needless accidents! Ask for the wheel & rim safety training kit provided jointly by The Goodyear Tire & Rubber Company and Motor Wheel Corporation. Post the charts in your garage. Train your service people in proper procedures. And we'll send you a free Think Safety belt buckle.

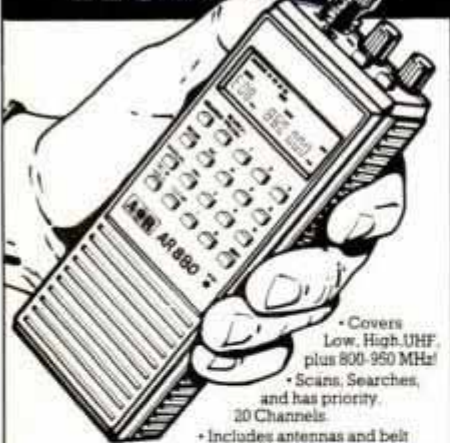
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SHAKER BOXES

(Continued from page 141)

for each size box. The molds are simply glued-up stacks of 3/4-in. plywood that are cut to shape on a band saw. Use 80-grit sandpaper to smooth and refine the oval shapes (Photo 1).

Then, screw a 3/4-in. plywood base to the bottom of each mold (Photo 2). The base provides a means of clamping the mold to the workbench.

Bending the veneer

The 1/16-in.-thick veneer comes in random widths and lengths and usually has wavy, uneven edges. To straighten the edges, clamp the veneer pieces between two 3/4-in.-thick boards and plane the edges straight, as shown in Photo 3. Then, cut the veneer (box sides) to the correct width and length on a table saw.

Using the drawing as reference, trace the fingers, also known as lappers, onto the box sides. Cut out the fingers on a band saw. Then, use a narrow file to smooth and refine the shape of each finger (Photo 4). Next, sand the square end of the box sides to form a slight taper (Photo 5). Sand until the very end of the veneer is only about 1/64 in. thick. This allows the veneer to overlap without creating an obvious bulge.

Place one box-side veneer in a long, narrow tray and pour in boiling water (Photo 6). Allow the veneer to soak for about 4 minutes. While the veneer is soaking, clamp the plywood mold to the workbench. Remove the box side from the water and slowly bend it around the mold. Use a wide web or band clamp to hold the veneer tightly to the mold (Photo 7).

Once the veneer is thoroughly dry, release the clamp. But before lifting off the box side, lightly mark where the fingers overlap the side. Next, slide the box off the mold, spread glue between the overlapping veneer sec-

tion, and then clamp it with a few spring clamps (Photo 8).

Box bottoms and tops

To form the oval-shaped box bottom, trace the outline of the plywood mold onto 3/8-in.-thick pine stock. Cut out the oval bottom on a band saw. Then, file the edges smooth and until the bottom fits snugly in the box side. Apply glue to the edges of the pine bottom and slide it into the box sides. Bore 1/16-in.-dia. pilot holes every 3 or 4 in. around the box and tap in 1/2-in.-long brass escutcheon pins (Photo 9).

The procedure for making the box lid is similar to assembling the box side and bottom. Soak a narrow veneer strip (box rim) in boiling water. Slip the assembled box upside down over the plywood mold. Then, wrap the wet rim around the box, clamp it and let dry overnight. Then, remove the rim, apply glue and clamp it with spring clamps. Next, trace the outline of the box onto 3/8-in.-thick pine for the box top. Cut out the oval top and attach it to the rim with glue and brass escutcheon pins.

Finish-sand all surfaces with 220-grit sandpaper and then apply either two coats of shellac or three coats of tung oil.

PM



7 Secure wet veneer to plywood mold with a web or band clamp. Place scrap veneer over fingers to help prevent splitting.



8 Once the veneer has dried, slip it off the mold, apply glue to overlapping section, and secure it with a few spring clamps.



9 Bore 1/16-in.-dia. pilot holes to prevent splitting the veneer. Then, fasten pine box bottom with 1/2-in. brass escutcheon pins.

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NEW PRODUCT TEST

**SUPERSAFE
PAINT STRIPPER**

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO
Contributing Editor

THANKS to easy-to-apply chemical paint strippers, refinishing furniture is one of the most popular do-it-yourself jobs. Most chemical strippers, though, have serious drawbacks such as being highly flammable, irritating to skin and emitting toxic fumes.

However, I recently tested a new paint and varnish remover that's going to change the way millions of people refinish furniture. Called Safest Stripper, it's manufactured by the folks at 3M and it's nonflammable, it won't burn or irritate skin and it emits no harmful fumes. It's so mild, you don't even need to wear gloves and it cleans up with water. You should, however, wear safety goggles to protect your eyes.

But, the really good news is that, unlike most chemical strippers, Safest Stripper contains no methylene chloride which is highly toxic and has been declared a suspected carcinogen by the Consumer Product Safety Commission.

I know what you're thinking: Okay, the stuff is wonderful, virtually risk-free. But does it work? Well, I'm glad to report that it does, indeed. As a semipaste, it adheres well to both horizontal and vertical surfaces without running. Plus, it can be left on the surfaces for extended periods of time without drying out. I applied

some stripper to the painted chair, shown, and left it overnight. The next day I scraped off the softened paint to reveal bare wood. To remove the stripper and old paint from the turned legs, I used 3M's heavy-duty stripping pad.

Safest Stripper also worked well on varnish, lacquer, and latex, acrylic and oil paints. It's sold at hardware stores and home centers in three sizes: pint (\$3.79), quart (\$6.65) and gallon (\$19.99). For details, write to Ms. Beck, Customer Service, 3M Center, Building 223-4S-01, St. Paul, MN 55101. **PM**



Paint and varnish remover is formulated as a slow-pour, semipaste. This pancake-batter consistency permits the stripper to adhere to vertical surfaces without running. Apply it from a clean metal can.



Apply stripper to work with paint brush. A 2- to 3-in.-wide brush works best. Spread newspaper under piece to protect floor.



Stripper softens paint without blistering. It can be left on for long periods without drying out. Remove paint with a putty knife.



To remove the stripper and softened paint from turned legs and other irregular-shaped surfaces, scrub with a 3M stripping pad.



This section of wall paneling had been painted with latex. Stripper not only removed the paint, but also the factory-applied finish.



One application removed two coats of polyurethane varnish down to bare wood. It also worked well on lacquer and shellac finishes.

How To Install An ELECTRONIC IGNITION

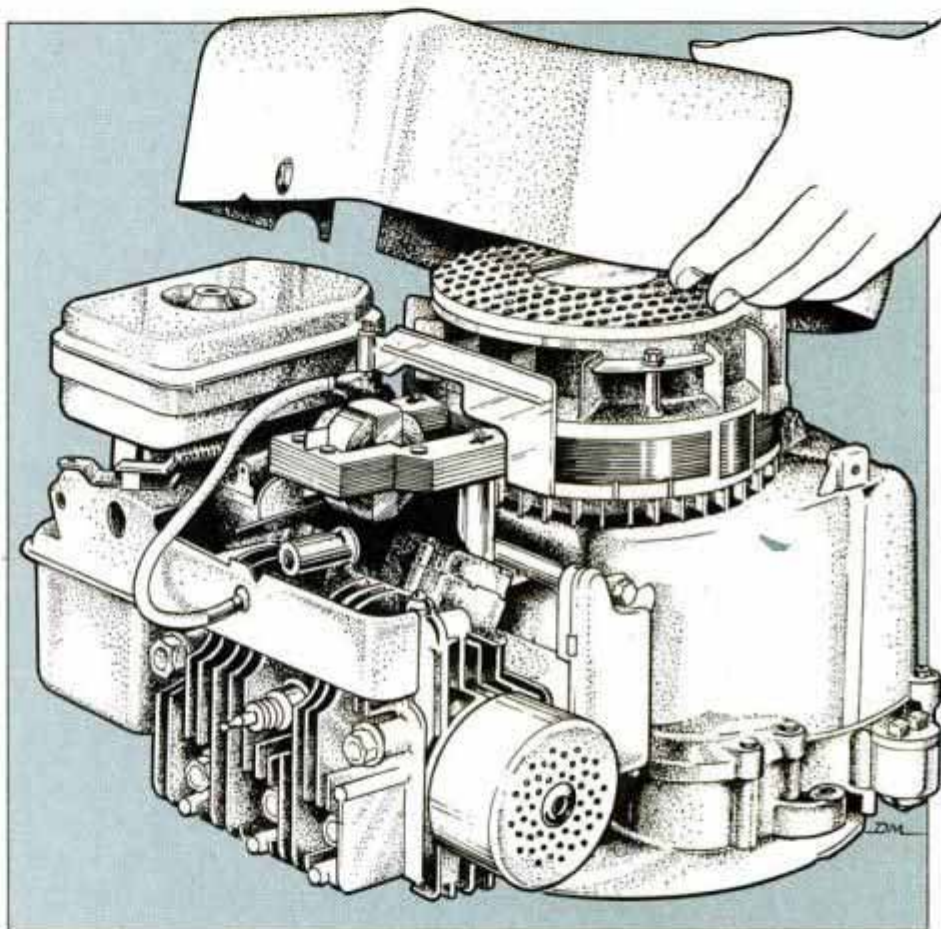
BY MORT SCHULTZ; PM Illustrations by Don Mannes

NOT EVERY self-propelled power lawnmower, riding mower or snowthrower has a Briggs & Stratton engine, but most do—at least the ones made in America. Owners of this equipment ought to be pleased to learn that 99 percent of the engines manufactured since 1963 with conventional breaker points can be retrofitted with a zero-maintenance electronic ignition.

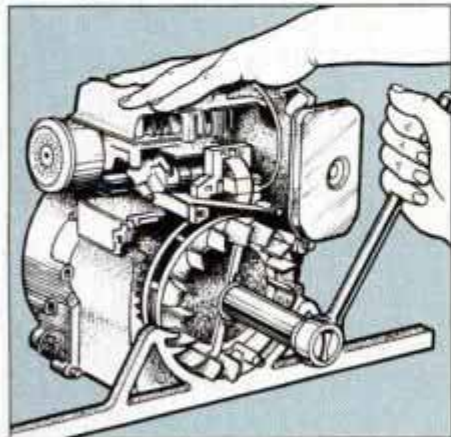
The electronic ignition unit, called Magnetron, is the same one B & S has put on engines at the factory since 1983. As a retrofit, the Magnetron replaces breaker points and condenser. The Magnetron kit (part No. 394970), which fits any horsepower B & S engine, is available from outdoor power equipment dealers for about \$15.

The electronic ignition unit permanently eliminates the need for breaker-point adjustment or replacement, so more reliable starting can be expected. The ignition components are sealed in epoxy to protect them from moisture, oil and dirt. Unlike exposed breaker points, therefore, Magnetron parts are protected from contaminating agents. The unit often outlasts the engine itself.

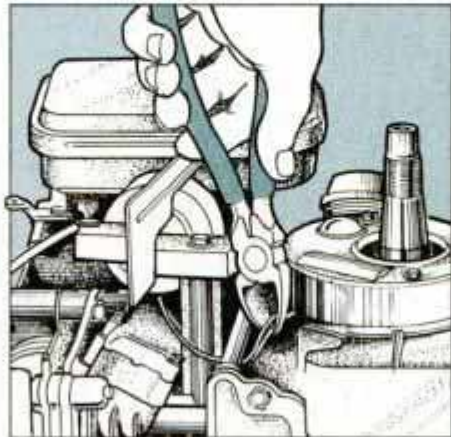
It's not absolutely necessary to remove the flywheel (as shown here) when installing the electronic igni-



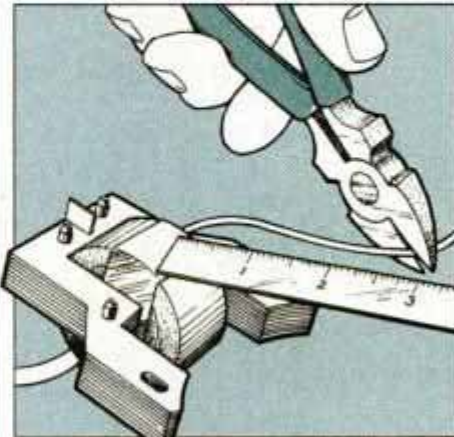
1 Disconnect and ground the sparkplug cable, drain the fuel tank, and unbolt the housing which covers the flywheel. Remove the housing and the filter screen beneath it.



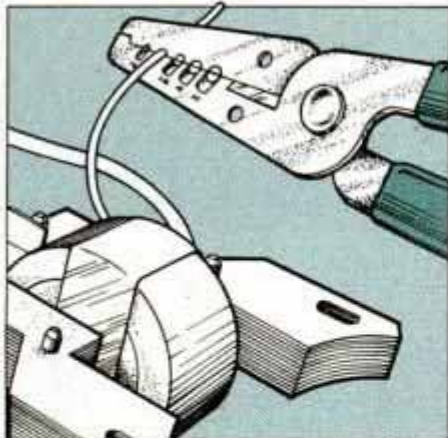
2 Turn the engine on its side and engage the flywheel fins with the holding tool. Unthread the nut from the crankshaft end and use a puller to remove the flywheel.



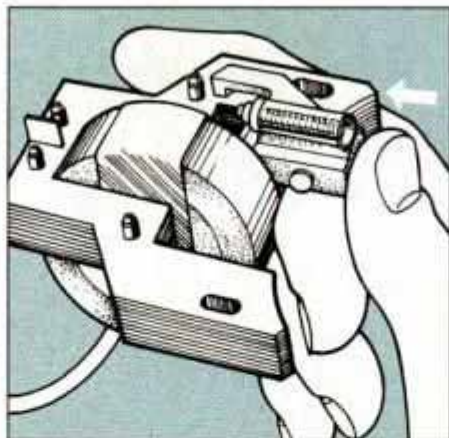
3 Locate the armature primary wire and stop-switch wire coming from the ignition coil. Cut both as close to the breaker points dust cover as possible.



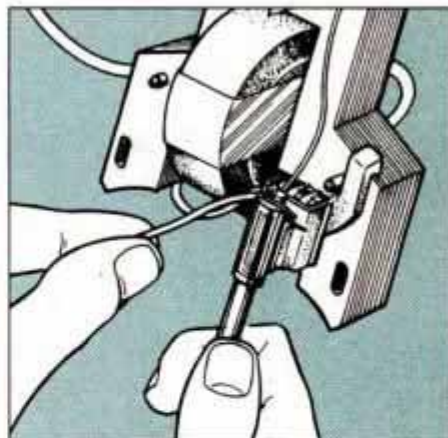
4 Unbolt and remove the coil assembly from the engine. Cut the stop-switch wire flush with the coil. Measure the primary wire out 3 in. from the coil and cut it.



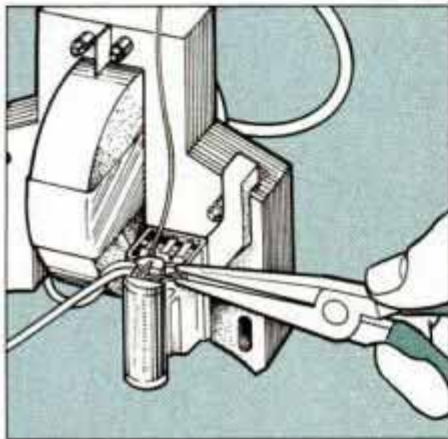
5 Carefully strip the primary wire insulation back $\frac{3}{8}$ in. from the end. Use a knife to scrape the varnish from the wire, taking care not to nick or cut it.



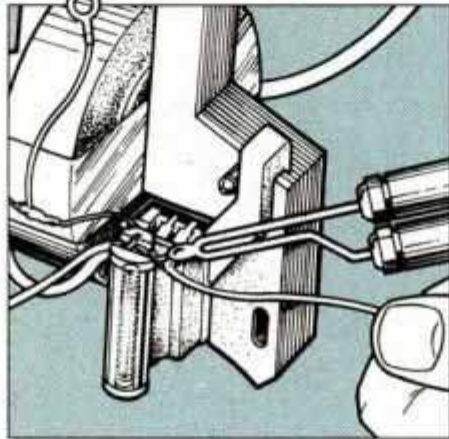
6 Push the Magnetron module into place on the armature leg until the retaining arm engages the angled portion of the leg and locks securely into place.



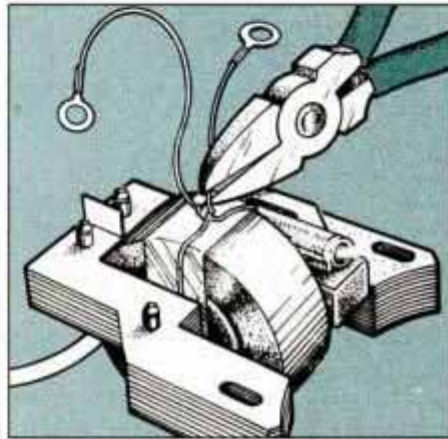
7 Open the module wire connector using a drill bit to compress the spring in the barrel section. Insert the armature primary and two module wires, then release.



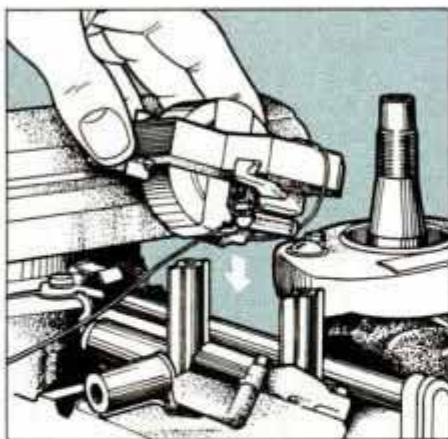
8 Twist the three wires together. Do the same for the armature ground and module ground wires. The module ground is identified by a round terminal at its end.



9 Solder the two ground wires together using a 60/40 rosin core solder. Then solder the three wires at the module connector, taking care not to melt plastic.

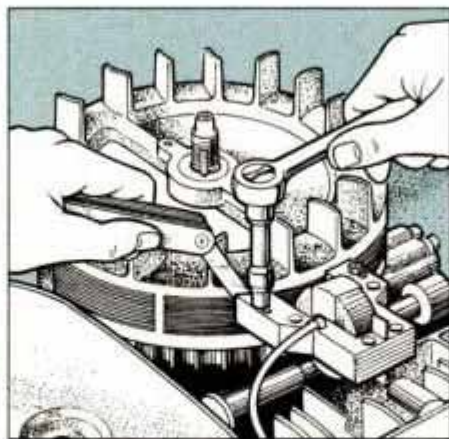


10 Cut the shorter of the two ground wires as close to the soldered connection as possible. Only one of the ground wires will be needed for this installation.



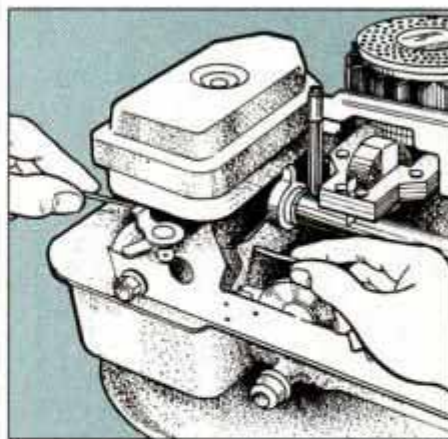
11 Position the coil assembly back on the engine. Slip one of the attaching bolts through the ground wire terminal end before starting the threads.

tion, though it does afford a good opportunity to check on the condition of the flywheel key. If the flywheel is removed, make certain to use the correct holder to prevent cooling fin



12 Replace the flywheel and nut. Set the coil-to-flywheel distance to the manufacturer's spec with a feeler gauge. Tighten the bolts which fasten the coil.

breakage when loosening the crankshaft nut. When the nut is replaced, it should be torqued to the engine maker's spec. Don't attempt to pry the flywheel off either—it will likely be



13 Discard the old stop-switch wire. Route the new wire through the same path and connect it to the switch terminal. Bolt the flywheel housing back in place.

stuck in place and require a flywheel puller. The two tools cost only about \$7 from the power equipment dealer.

To install the Magnetron, just follow the 13 steps shown. **PM**

Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Fresh-Air Vent

There is a large bent pipe coming out of the ground near my house. Is this pipe connected to my drainage system, and if so, can the roof runoff that flows into the gutters and downspouts be directed to this pipe?

ED LIPINSKI
STATEN ISLAND, NY

It can be connected physically, but don't do it. It's usually a violation of the building code and can eventually result in higher taxes. The bent pipe coming out of the ground is the "gooseneck" cover to the house fresh-air inlet pipe that is tied into the sanitary drainage system.

In many communities, the house drain line leading to the sewer must have a house trap (see drawing). Its purpose is to prevent noxious gases from circulating back through the plumbing system.

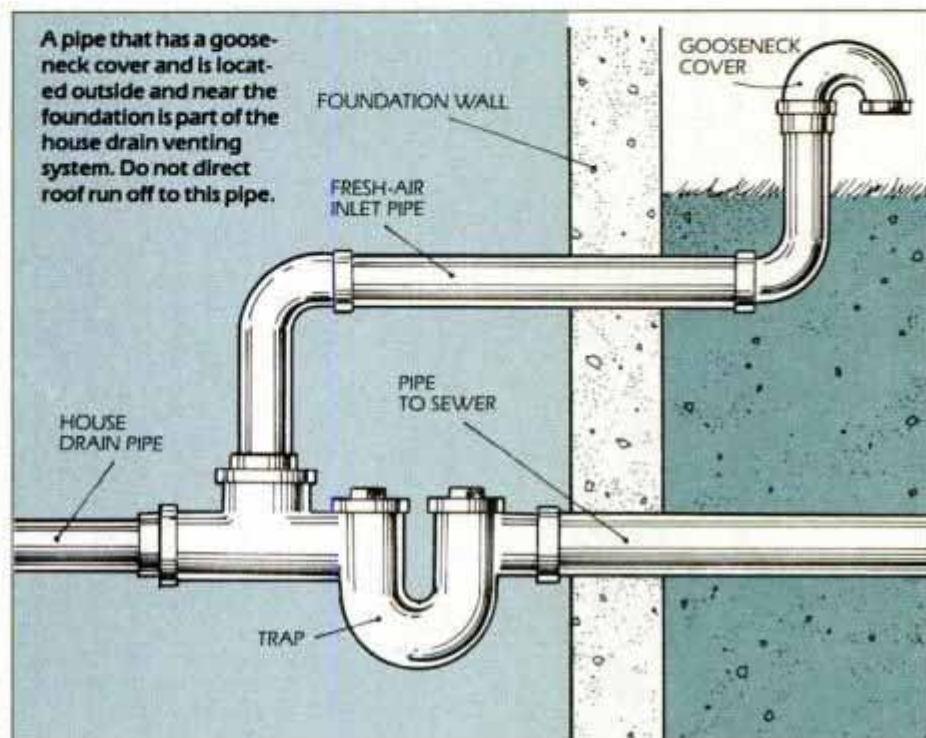
The fresh-air inlet pipe is connected to the house drain on the interior side of the trap. This pipe maintains atmospheric pressure at the trap to ensure complete air movement within the system. The fresh-air inlet pipe can terminate either on the outside surface of the foundation wall where it should be covered with a perforated metal plate, or as a free-standing pipe with a return bend or gooseneck.

By directing roof runoff to the fresh-air vent, you'll be introducing relatively clean water into the sanitary drainage system, and eventually, to the sewage treatment plant.

Each gallon that reaches the treatment plant reduces the plant's capacity to treat sewage. If everyone connected their downspouts to their fresh-air vents, it would result in the need for additional or larger capacity treatment plants which would, in turn, increase taxes. And, where rainwater serves to recharge aquifers for municipal water supplies, your action would be unconscionable.

Cooling Fins

I've been wondering whether spraying a light mist of water on the cooling fins of my air conditioner would have any beneficial effect on the efficiency of the unit. As a source of water, I



could use the condensate obtained from the air conditioner.

FRANK M. O'BRIAN
NORTH HAVEN, CT

The principle of cooling the condenser coil is a good one and is being used in many self-contained room air-conditioning units to achieve a slightly higher efficiency.

The amount of condensate available from the evaporator coil varies with temperature, humidity and house size. There will be times when there is too little, or no condensate available for cooling. Therefore, it's difficult to evaluate any savings.

Do not, however, supplement the cooling water with city or well water. There could be chemicals in the potable water that are corrosive and could cause damage to the condenser fins.

Heat-Shield Ratings

We plan to use fiberglass roof panels to cover our back porch and act as a sun shield. I'd like to know whether the brown panel is more or less effective as a heat shield than the green. Could you tell me the difference?

DIANE MOSS
ELBERTON, GA

The amount of solar energy transmitted through a fiberglass panel will not only vary with the color, but with different shades of the same color. The thickness of the panel (weight per sq. ft.) is also a consideration.

Filon, Division of Standard Oil, offered the following table for nominal 4-ounce-per-sq.-ft. panels:

Color	Visible Light	Solar Energy
Brown	11%	25%
Green	17%	27%
White	69%	46%
Clear	91%	85%

The lower the solar energy figure, the greater the heat shield, and consequently, the cooler it will be. A better heat shield also means less light. Your selection, therefore, should also be based on how much shade you want. In general, colors that transmit less than 38 percent Total Solar Energy are recommended for patio roofs and awnings. Contact Filon at (800) 44-FILON.

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH, Contributing Editor

Deteriorated Seal

Although my 1947 G.E. refrigerator model No. BH-7A, serial No. 46-789-693 is in good working order, the rubber door seal has deteriorated. Can this seal be replaced?

Also, the trigger that turns on the light doesn't work unless it's released manually. Would applying a spray lubricant help?

W.E. MAKE
CLOQUET, MN

You're in luck! A replacement gasket for your refrigerator door is still available from any G.E. appliance parts distributor in your area. The part number for the gasket is WR24X22 and it costs about \$53. To find your nearest G.E. parts distributor, phone G.E. at (800) 626-2000.

To install the gasket, first unplug the refrigerator. The old gasket is held in place around the door by a plastic strip. Loosen all the screws along the perimeter of this strip just enough to ease out the gasket. Then, fit the new gasket around the door, slip it under the plastic strip, and retighten the screws.

You may need to adjust the door latch or hinges to get the new gasket to seal properly. To test for a good seal, place a crisp dollar bill between the cabinet and the gasket, and shut the door. There should be moderate resistance on the bill as you pull it out. Make this check around the door and adjust where necessary.

I don't recommend using a spray lubricant on your light switch. A better idea would be to disconnect the power supply, remove the switch and then take it to the nearest appliance repair and parts center. They may be able to match the switch or provide a similar one that will work.

Oven Won't Light

I have a Magic Chef gas range model No. S64D-3CKXW, serial No. 2X315758829. The baking oven doesn't light. The igniter appears to work and the broiler operates so there isn't a problem with gas supply. Although I have no wiring diagram, I do have a VOM meter. Where should I check?

CHARLES J. POLLOCK
BOYNE CITY, MI



To install door gasket, loosen plastic strip, remove old gasket and slip new one in place. Then, adjust hinges and latch strike.

Your problem could be with either the oven gas valve or the oven igniter. To test these parts, you'll need a clamp-on ammeter. This type of meter measures current flow (amperes) without cutting into the wire.

Clamp the meter around the black wire, or power leg, of the electrical supply line going to the range. Next, turn on the broiler and wait for it to light. You should get a reading of 2.8 to 3.2 amperes on the meter.

Next, turn off the broiler and turn on the oven. The igniter should glow and the meter should read between 2.8 and 3.2 amperes. If it doesn't, then the igniter is probably causing your problem. Even though it may be glowing, it may not be getting hot enough to ignite the gas. Therefore, the gas valve will not open.

If you're getting adequate current to the igniter, then the gas valve is the likely cause of your problem and should be replaced.

Replacement Racks

My 24-year-old KitchenAid dishwasher model No. KDS-14PNF, serial No. 983236 works fine but the racks need to be replaced. I can't find them anywhere. Can you help?

A. REID
SAN DIEGO, CA

After much research, I found that the racks for your dishwasher are no longer available. As a rule, functional parts such as the timer, motor, door seals and racks are stocked by the manufacturer for a period of 10 to 15 years after the appliance has been manufactured.

However, to save your dishwasher from extinction you may be able to repair the racks yourself. If the tines that hold the dishes have broken, they can be replaced by brazing a short length of coat hanger wire to the frame. Then, the new piece should be sanded and cleaned. A dishwasher-safe liquid-vinyl coating can then be brushed on. The coating is available from any KitchenAid parts distributor for about \$11. The part number for the coating is 675506. This product can also be used to touch up any cuts or cracks.

If the tine tips have peeled off, you can get a repair kit from KitchenAid that contains small vinyl caps that fit over the tips. It includes enough tips to repair two racks. The tine tip repair kit is part No. 675576 and costs about \$11.

Product Alert

Owners of Whirlpool under-the-counter dishwashers model Nos. DU7400XS-0, DU7600XS-0, DU7800XS-0, DU9000XR-0 or DU9000XR-1, should contact an authorized service center, or call (800) 541-5746, to arrange to have the selector switch replaced at no charge.

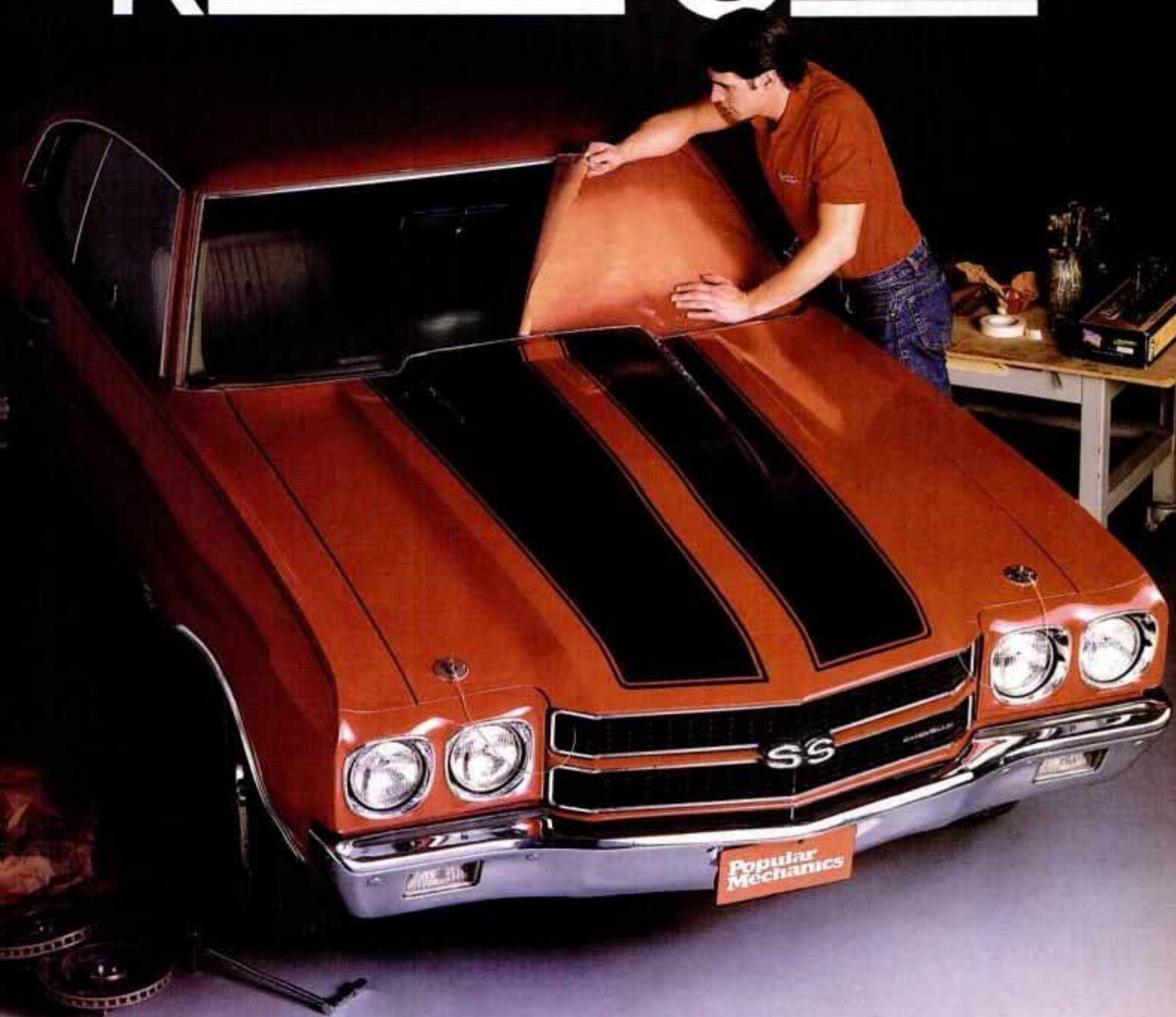
The pushbutton selector switch on these models could, under the right conditions, catch fire. The model number can be found on a plate located along the right front edge of the tub.

Whirlpool suggests that until modified, owners should not use their dishwashers. They should shut off the power to the appliance or leave the door unlatched. **FM**

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

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—Chuck Yeager

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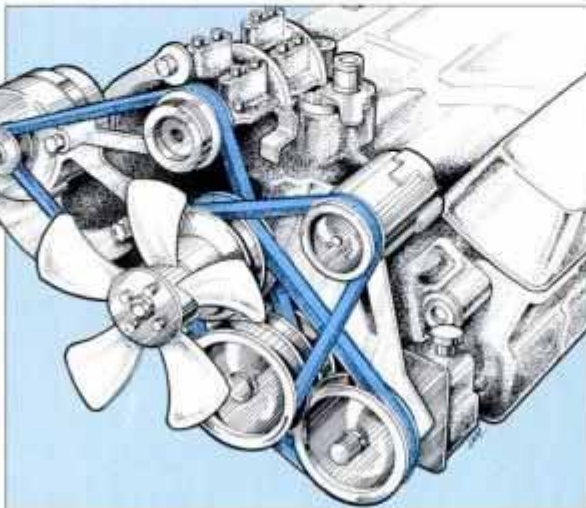
AUTOMOTIVE RENEWAL GUIDE

How To Restore Your Car's Looks, Vitality And Value

LIKE MOVIE stars and racehorses, automobiles are particularly susceptible to the ravages of time. Unlike movie stars and racehorses, however, they are capable of recapturing many elements of their youth—their beauty, for example, or their speed—with a little help from their friends. And that's what the 1989 Renewal Guide is all about. Though it's obviously impossible to roll back the miles or the years, it is possible to restore your car's cosmetic appeal and, more important, its value.

Whether you want to make your old car more attractive to potential buyers or simply more rewarding to own and drive, the pages that follow have something for you—inside, outside, under the hood and at ground level.

Generally speaking, the guide is broken down into three main sections.



Accessory drive belts must be inspected regularly.

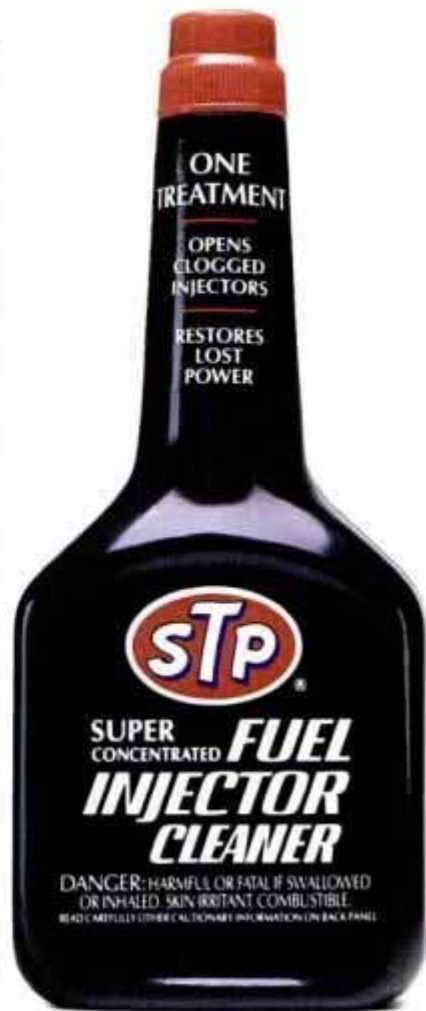
The first deals with the areas of the car that provide pleasure for the eyes and the ears. The second concerns the powertrain, and how to get the most out of it. And finally, there's the chassis—tips designed to make your car handle better and to escape the neglect that seems to be fostered by today's extended service intervals.

Within these three sections, our suggestions fall into two general categories—those intended to upgrade a particular area of your car's performance and/or appearance, and those intended to extend its lifespan.

There's another message here as well. While the guide is aimed primarily at neutralizing the effects of time, many of these chapters apply equally to late-model cars. Even though the industry seems to be conditioning us to believe that most automotive work is now limited almost entirely to professionals with highly specialized equipment, the truth is that the do-it-yourself mechanic, with basic tools, can still care for his car from top to bottom.



Aftermarket seats can enhance your car's interior.



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B FIRST BRANDS

AUTOMOTIVE RENEWAL GUIDE

Aero Updates

CAR designers rarely speak with one voice, and it's a good thing. If they did, we'd all be driving cars that would be virtually indistinguishable from one another.

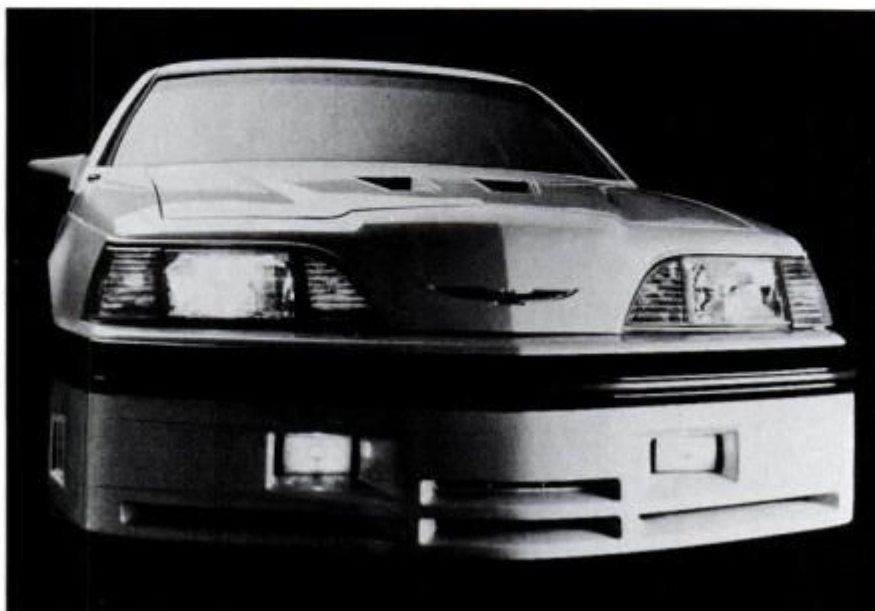
However, if there's one unifying theme in world automotive design today, it's a general preoccupation with aerodynamics. And if there's one uniform effect produced by all this emphasis on aero, it's confusion.

C_d numbers provide an excellent example of this phenomenon. Every manufacturer in the business is working full-time to produce vehicles with low coefficients of drag, an exercise that impacts both fuel economy and, more important, advertising bragging rights.

However, C_d values alone provide only a limited picture of a vehicle's aerodynamic properties. Two cars might share identical C_d values, for example, but have vastly different aero qualities owing to differences in their respective frontal areas.

To get a true index of how slippery a particular car is, C_d has to be multiplied by frontal area ($C_d \times FA$). And even then the picture that emerges is only partial, since it furnishes no information on the relationship between airflow management and handling.

This last part is of particular importance when you're considering the addition of aftermarket body parts to your car. When you add something to the exterior—particularly at the front or rear—you're going to alter how air flows over and under the body. For better or for worse, the car is going to perform differently, though the difference would be difficult to assess outside a wind tunnel—or at the upper limits of a particular car's speed capabilities.



Airdams with fog lights lend aggressive look but are vulnerable to curbs and driveways.

One thing is a 95-percent certainty. Most add-on wings and airdams are going to take a bite out of your car's aero efficiency. The engine will have to work just a little bit harder to push aside the same amount of air, which translates as a negative (though small) impact on fuel economy.

Virtually every add-on available today traces its heritage to racing, where aero concerns have more to do with improving the car's ability to stick to the road than with how well it knives through the air.

Airdams, for example, will generally increase C_d and sometimes even frontal area, but they provide the benefit of limiting airflow beneath the car, thus reducing lift at high speeds. Similarly, a rear deck spoiler, like the ones employed by the good ol' boys of NASCAR, can reduce rear-end lift.

But the real truth is that we want flaps, tabs, spats, rocker panel extensions and spoilers because they lend an aggressive, distinctive appearance to our cars. Whereupon several other purchase considerations come to mind.

Tops on this list is materials. Parts exposed to regular bumps and scrapes, such as front or rear airdams, have to be flexible enough to bounce back from abuse but still retain their shape and finish. Fiber-

glass-reinforced plastic, such as the body panel material used on Fieros and Corvettes, is the best bet here.

However, plain old garden-variety fiberglass can still make sense for use in low-exposure applications where high rigidity is the primary consideration, such as rear deck spoilers.

Paint is another concern. Some materials require only minimal preparation for painting. Others require extensive sanding and priming, and even

then resist certain kinds of paints.

The best bet here is to read the paint guidelines furnished with the pieces, and to get some advice from your friendly local paint shop.

How the aero pieces attach to your car's body is another important factor for you to consider before you make a purchase. Some systems employ small bolts and other fasteners that require a certain amount of drilling. While this method of attachment is secure, it can provide windows for rust to begin working on the body panels.

To avoid this problem, there is a trend in the aftermarket toward systems that rely partially or even entirely on adhesives. The only potential drawback to keep in mind here is that you might want to restore the car to box stock condition some day. Modern adhesives are tenacious, and difficult to remove cleanly.

The question becomes whether you want to fill a few small bolt holes or re-finish entire panels.

Finally, you should also ask yourself whether this is a job you can handle on your own. Our suggestion is that the mechanical aspects of the job—attaching the new panels to your car—are well within the range of most do-it-yourselfers. However, getting a good paint match is tricky, and we'd recommend hiring a professional.



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AUTOMOTIVE RENEWAL GUIDE

Smart Seats

OVER THE LONG run, no single factor contributes more to your satisfaction with the car you drive than a comfortable, supportive seat. Viewed from this perspective, you could think of interior accommodations in the same way you might regard engine performance or suspension tuning—a parameter to be tailored to your individual needs and desires.

Properly designed seats offer far more than simple pampering. They should also provide support which keeps you from dangerously shifting around under the forces of hard cornering. By allowing you to brace yourself against the thigh or torso bolsters, you're better able to maintain control in an emergency—or in any maneuver, for that matter. That's the reason you always read so much about the quality of seating in road test reviews.

Comfort, of course, is an important consideration for any driver, but it's not all just personal gratification, either. A well-engineered, orthopedically designed seat contributes to the active safety features of a car by helping to keep the driver awake and alert at all times. After all, the seat is the last element in a car's suspension system. If it can effectively absorb some of the small bumps and jiggles of the road, the driver will be less fatigued on a long journey. And firm, properly placed supports for the legs and back will help reduce muscle strain.

Automakers have become much more aware of the marketing edge afforded by good seating in the last few years, and many new cars are available with optional sport seating. However, your car may not have come with these amenities. An adjustable lumbar support can make all

the difference in the world on a long drive—particularly if you have lower back trouble—by placing a cushion where your spine needs a little help. Look for this feature in aftermarket seats. Most offer a mechanically operated cushion or an air-adjustable bladder (up to three of them in some top-line seats) that's buried within the backrest.

Fitting a set of aftermarket seats in your car may give you other adjustments, too. Seatback angle and fore-

It could approach as much as \$4000 per seat, so a pair of them might very well run more than the car's initial purchase price.

A more realistic price range for a good set of seats is on the order of \$1000 to \$2000.

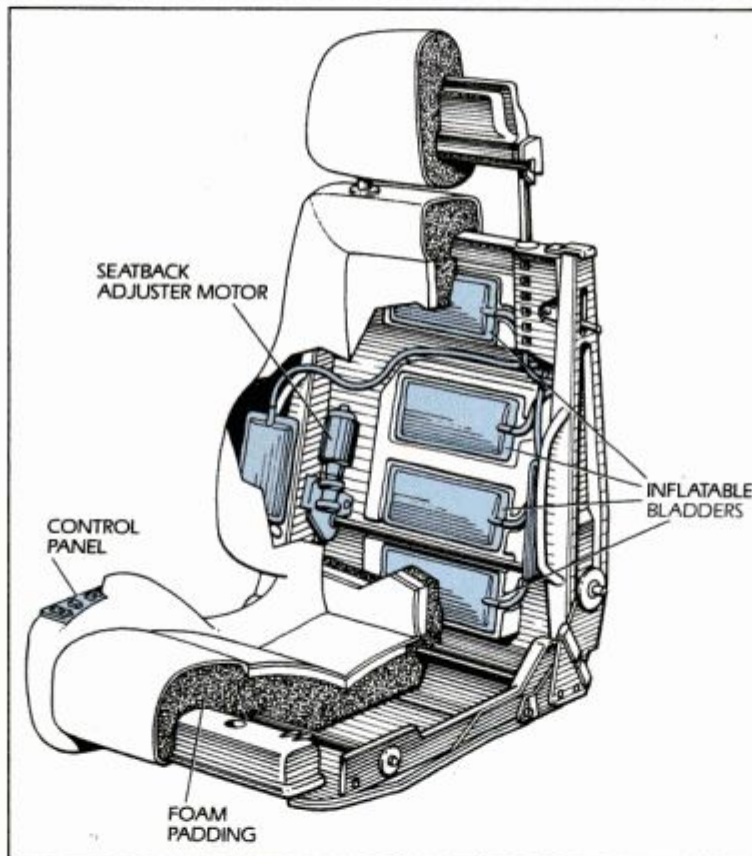
Seat construction technique is another element that merits serious consideration when you're shopping—it's an important index of quality. Look for models with steel framework. Whatever the outer upholstery you

choose, it should be backed by a moisture-absorbent layer which allows adequate air circulation. Most seats use molded foam cushion materials, but if steel springs are used, too, so much the better. Stay away from fiberglass shell racing seats. They may have the look you're after, but they're designed for light weight, not all-day comfort.

By their ergonomic shape alone, a good pair of custom seats will do wonders in dressing up the interior environment of your car. You can take it a step further by specifying leather covering or, in some cases, material that will match the present upholstery.

To embellish the custom look of aftermarket seats you've installed in the front of the car, recover the back seat with the fancy logo-embroidered material offered by some high-end seat builders.

Be certain to order the proper mounting hardware and seat rails necessary to adapt the seat to your car. Tailor-made brackets are often available for popular models, but older or limited-production models may require more involved installations. For obvious safety reasons, make sure that the seat is mounted as securely as—or better than—the original factory seat.



This aftermarket seat has multiple inflatable bladders for adjustability.

aft positioning are the basic necessities, but with careful shopping you could add an extendible seat base, adjustable thigh and side bolsters, as well as multiple height settings for the seat base and headrest.

Heated cushions are available as well, a wonderful way to take the frosty edge off a cold morning while the car's heater is getting up to full steam. Power controls for seat movement are available, too, though they add up to a breathtaking bottom line.



Traffic radar doesn't say which car is being clocked, it merely flashes a number. The radar operator must then try to determine which vehicle produced the reading.

Why radar makes mistakes. How to protect yourself.

Although nine different errors have been documented for traffic radar, the most common source of wrongful tickets is mistaken identity.

It's hard to believe, but traffic radar does not identify which vehicle is responsible for the speed being displayed. It shows only a speed number and nothing else. The radar operator must decide who is to blame.

How radar works

The radar gun is aimed at traffic and it transmits a beam of invisible radar waves. Each moving object within range reflects these invisible waves back to the radar gun. Using the Doppler principle, the radar calculates speed from the reflected waves.

Traffic radar is blind

Traffic radar works differently from military, air-traffic-control, and weather radars. The others use rotating dish antennas in order to track many objects simultaneously.

Traffic radar uses a far smaller, far cheaper, gun-shaped antenna. This simplification requires traffic radar to ignore all reflections but the strongest. The number displayed is speed calculated from the strongest reflection.

The best guess

Remember, these reflections are invisible. Truck reflections can be ten times stronger than car reflections. How can the operator know for sure which vehicle is responsible for the number?

The truth is, he can't be sure in many cases. The result is mistaken identity. You can be ticketed for somebody else's reflection.

Self defense

The only way to defend yourself against these wrongful tickets is to know when radar is operating near you. Others agree with this method. In his verdict upholding a citizen's right to use a radar detector, Judge Joseph Ryan, Superior Court, District of Columbia, wrote:

"If government seeks to use clandestine and furtive methods to monitor citizen actions, it can ill afford to complain should the citizen insist on a method to effect his right to know he is under such surveillance."

We can help

We specialize in radar warning. And Escort and Passport do far more than simply find radar. Upon radar contact, the alert lamp responds and the meter shows radar signal strength. At the same time, you will hear an audio warning—pulsing slowly when the radar is weak, quicker as it strengthens, then constant as you approach close range. When you know exactly how strong the radar waves are, you'll know when the radar unit is near enough to actually have you under surveillance.

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AUTOMOTIVE RENEWAL GUIDE

Sound Installations

PUTTING ON the hits—whether they be those of Mozart, Madonna or Monk—can create an environment as important to driving as a soundtrack is to a movie. Music can make an old familiar car or road seem like a whole new experience.

Unfortunately, a great many of the musical components offered as standard equipment in cars can often contribute more to listener fatigue than listener enjoyment. True, many car companies are now offering premium sound systems, but these systems are not available on all car models.

Elaborate car audio systems are principally the province of car companies installing them at the factory or of retail autosound specialists offering aftermarket equipment. Multispeaker installations involving separate amplifiers and other gear are best done by knowledgeable installers. A detailed knowledge of metalwork, woodworking, upholstery and acoustic principles are often needed to perform the successful high-end installation.

Simpler car audio installations, however, can be done by the do-it-yourselfer, because the car companies have done much of the work for you. If the basic radio and speakers are already installed, then it is simply a matter of replacing the original equipment with better gear. Even if there is no radio or speakers in the car, don't worry.

Somewhere in the dashboard there's a plastic plate concealing the radio opening. Likewise, speaker cutouts are likely to be in the doors and in the rear package shelf.

Assuming that some original sound system is in place, then the quickest

Generally, there are smaller speaker holes in the doors and larger speaker cavities in the rear package shelf. Smaller cars, however, may have the same size speaker holes in the front and the rear.

While fitting the regulation size speaker into the appropriately sized speaker hole is the easiest route to go, you may have other options. Some aftermarket speakers have extremely thin mounting depths. A 6½-in. speaker of this type, for example, can often be mounted in a space designed for a 5¼-in. speaker. The larger the speaker, the better the sound system's bass response is apt to be.

While a larger speaker generally means better sound, you'll soon discover that even smaller aftermarket speakers can offer superior performance. Quality aftermarket speakers generally divide low and high musical frequencies between two drivers. A 5¼-in. coaxial, for instance, divides the musical spectrum between a smaller high-frequency tweeter and a larger low-frequency woofer, both of which are mounted on the same axis. Larger speakers add a midrange to handle middle frequencies. Speaker wiring isn't all that complicated. For door speakers, try to run the wires through existing holes, taking care that the wire is protected from metal edges with rubber grommets.

(Please turn to page 162)



Careful planning, artful surgery and an eye to detail can give you a custom stereo installation that improves on the original factory boom box.

way to sound improvement generally involves upgrading the speakers. The first thing to do is check the dimensions of the existing speaker or cutout. The size of the speaker hole will vary according to the type of car and its location in the car.

Speaker wiring isn't all that complicated. For door speakers, try to run the wires through existing holes, taking care that the wire is protected from metal edges with rubber grommets.



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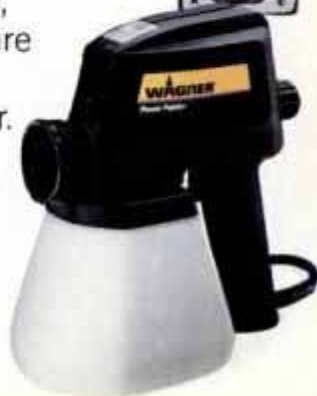
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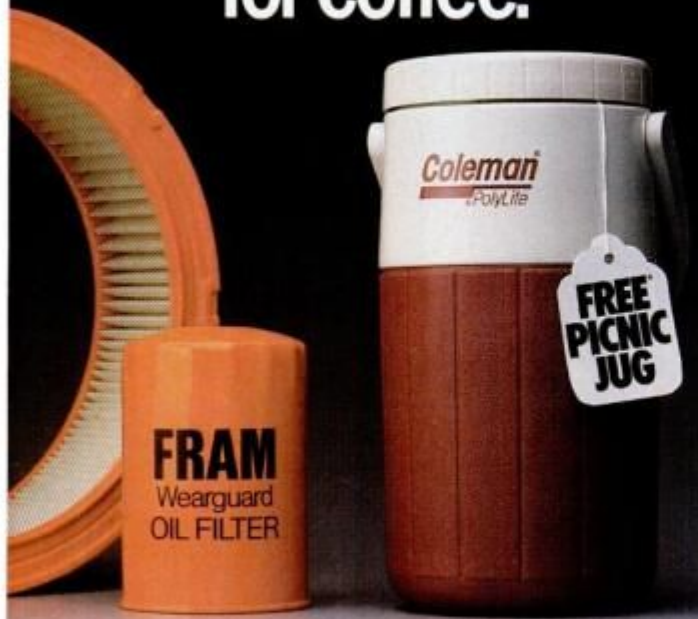
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Sound Installations CD Or Not CD

THE BEST SOURCE of high fidelity music today is the compact disc. Yet while CD players are becoming increasingly affordable for the home, they are still a relatively expensive proposition for the car.

There are basically three ways to put CD sound into your car. Clarion's 5630CD tuner/player illustrates one methodology. The unit, which lists for \$829.95, combines an AM/FM tuner, CD player and 20-watt-per-channel amplifier in a single chassis. Models like the Clarion 5630CD are for the real CD enthusiast who is no longer

Depending on the layout of your dash or console, you can add a CD player to your auto sound system and have it appear as integrated as a factory unit.



SOUND INSTALLATION (Continued from page 162)

Wires running to the rear deck can be concealed beneath door sills and carpeting. In most cases, you'll have to remove the rear seat to do the installation properly.

The two best ways to wire speakers are (a) soldering the wires directly to the terminals or (b) using spade terminals soldered or crimped to the wires and then slid over the speaker terminals.

Signal quality can also be improved by replacing an old radio or cassette receiver. If your music source is only a radio, then a cassette receiver will immediately expand your musical options.

As with speakers, the size of the radio hole has to be measured since this can differ from model to model. Kits are available to make smaller cassette receivers fit into large holes. Fitting a large cassette receiver into a small hole obviously requires some cutting of the dashboard.

Cassette receiver installation is anything but standardized from car model to car model. While all head units are installed either through the back of the dashboard or through the front, there are at least 10 different types of radio openings, each entailing subtle subtypes.

Changing head units can be a chore, but it can represent a substantial upgrade in the performance of an audio system. While audible frequencies range from 20 to 20,000 Hz, many inexpensive cassette receivers typically offer performance between 50 and 10,000 Hz.

More expensive cassette receivers also offer more convenience features, Dolby noise reduction and output jacks that make it easier to add an amplifier to the system at a later date. The added amplification gives the music greater clarity at low-volume levels—or lets everyone know you've arrived when it's cranked up full blast.

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sembly that reads the musical information encoded on the CD floats on four silicon-charged hyperdampers that absorb vibration. When the disc is ejected, however, the optical pickup assembly locks onto the chassis to prevent unnecessary movement. This type of construction is important in models like the CDX-R79 that are designed as pull-out pieces for easy removal from the dashboard for safekeeping.

CD players are the most expensive components that can be included as part of a car audio system. Keep in mind that there is also a hidden cost involved as well, since CD players require the use of a separate amplifier. This is particularly true of player-only and CD changer models as they do not have any built-in power.

Models like Clarion's 5630CD do have some amplification but these models are not designed to power an entire system. The 5630CD is designed to power a front pair of speakers. A separate amplifier would still be needed to power a rear pair of speakers in a typical 4-speaker installation. Prices vary according to power ratings.

Car CD players delineate themselves from the competition with a variety of features. Some models use a higher oversampling rate than others. The higher the oversampling rate the more effective is the removal of spurious noise that might affect the quality of the signal.

OTHER CAR CD models, like the Sony CDX-R77, add unique features such as a tuner timer which enables you to preprogram the unit to turn on the radio at a specific time. The CDX-R77, as well as Sony's CDX-R79, can also play the new 3-in. CD singles without an adapter. Whichever type of CD player you choose, though, you'll be dealing with car audio's high end, both in terms of performance and price.

listening to music on cassette. If you still have an extensive cassette library that you want to listen to, you may want to add an auxiliary CD player like Sansui's CD-6i listing for \$729.95. Models like the CD-6i interface with an existing cassette receiver. In this type of system, you have three signal sources at your command—radio, tape and compact disc.

Some cars, though, don't lend themselves to the addition of an extra component like the CD-6i simply because there isn't enough space in the dashboard. The best option under these circumstances is a CD changer. Offered by companies like Pioneer, Sony, Technics and others, CD changers are roughly the size of a tool box and are meant to be installed in a trunk or other remote location.

Depending on the brand, CD changers store between six and 12 discs. Access to each disc is commonly done via a wired remote control connected to the actual changer. In most instances, the remote control is small enough to get a Velcro mount on the dashboard. The controls on some newer cassette receivers can also be used to operate a CD changer, provided all the equipment is of the same brand. List prices vary from \$650 to \$1000.

CD PLAYERS ARE more sensitive playback devices than are cassette players. While most manufacturers do a superb job of isolating the CD player from vibration, the machines may skip momentarily due to the sudden shock induced by a sharp bump, for example. The music loss will only last a second or two, however, as the optical pickup mechanism inside the CD player quickly returns to the spot on the disc where playback was interrupted and continues playing.

Automotive CD players are also designed to be protected from abuse even when not in use. During playback in Sony's CDX-R79, for instance, the optical pickup as-

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AUTOMOTIVE RENEWAL GUIDE

Steering With Style

EVERY MILE you drive will be spent looking out over your car's directional control input device, so it should be a pleasing view, right? The steering wheel, too often shortchanged in a vehicle's interior design scheme, is also one of the most unchanged features of automobiles through their existence. Even show cars, with their jet fighter control pods, come and go, but the driving public sticks with a basic configuration that needs no revision.

Long ago, the tiller was shelved for today's spoked rim. Similarly, an unattractive factory steering wheel can be easily replaced with a unit of gratifying tactile sensation. You name it—wood rim or leather, fat wheel or thin, blacked out or polished to a gleam.

This isn't all cosmetic indulgence, either. Step up to a "smart" wheel and you'll get infrared controls for the stereo system to easy-to-use switches for the cellular telephone. You can go down in diameter to get a sports-car grip and a little more thigh clearance to boot. Shop around and you can even add a tilt option to the deal.

That's not to say there aren't some catches, though. There are even specialty aftermarket boutiques supplying custom steering wheels to fit airbag-equipped luxury cars, though the price tag approaches the cost of a modest vacation. If that's not exclusive enough for you, add in a matching shift knob for the peak of luxury embellishment.

Experience, helped along by a touch of common sense, says that for all the beauty of highly polished mahogany, it is still a leather covering that offers the most comfortable grip. A thickly padded, oval-shaped wheel rim is more natural to grasp than a

thin round one. Center hubs and spokes are a matter of personal taste, but safety considerations dictate padding and soft edges rather than sharp metal spokes.

There's a reason that racing drivers use fat, padded wheels. The interior of a racing car is usually as cramped as an Irish bar on St. Patrick's day, and the smaller diameter helps. But the smaller wheel reduces the amount of elbow swinging, and also the amount of precious time needed to make steering corrections. The thicker rim helps to improve the "feel" the driver has for the road. And in longer races, a thicker rim is less likely to cause blisters as well.

The disadvantage of a smaller wheel is in the increased effort to turn it, but the most universal use of power steering today obviates that.

Prices range from the \$29.95 discount store chrome-and-metal-flake-vinyl specials to nearly a thousand for semicustom "signature" models, patterned after some famous racing driver's favorite. The better versions will come with a kit to adapt them to your particular vehicle, and purchasing a new kit will permit you to swap the wheel to another vehicle later.

Fasteners of all types are hidden behind the horn pad covering, so you'd better have a look at the factory shop manual before attempting removal of your original steering wheel. From that point on, a steering wheel-puller will be needed to disengage the hub from the steering shaft splines. Observe the factory-recommended torque figures for the center attaching nut, too. This is no place to fool around. Be sure to save the original steering wheel for reinstallation when it comes time to trade for something new.



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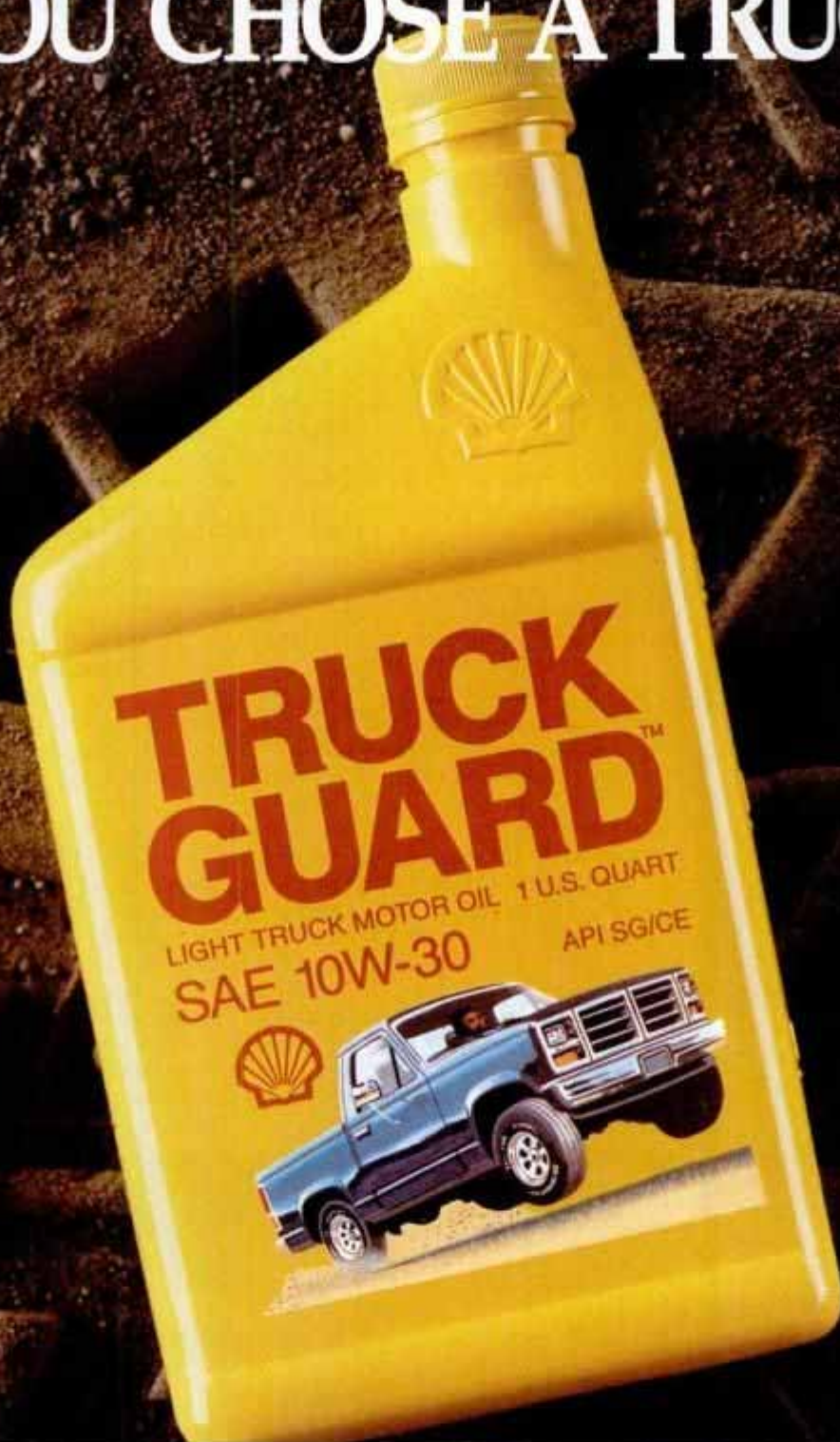
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AUTOMOTIVE RENEWAL GUIDE

Windshield Scratch Removal

SOMETIMES you hunker down in the seat so you can see under it. At other times you stretch your neck so you can see over it. When that becomes too uncomfortable, you cock your head to one side so you can see around it.

That annoying wiper scratch in the windshield. It's more than a cosmetic blemish—it's a potentially dangerous distraction.

If a windshield scratch is deep enough to catch your fingernail, replacement may be the only cure. But minor scratches can be polished out, and you'll save plenty.

We tested a glass polishing kit manufactured by The Eastwood Co. (P.O. Box 296, Malvern, PA 19355), a supplier of automotive tools. The kit consists of a felt polishing wheel and a jar of special fine-grain oxide powder.

After it has been soaked in water for 1 hour, the felt polishing wheel is mounted in a low-speed polisher or a power drill that operates at less than 1500 rpm. We used a drill with $\frac{1}{8}$ -in. chuck, which runs at about 1100 rpm. The polishing compound is mixed 2:1 with water to form a slurry.

Wash the windshield thoroughly before you begin—any residual dirt that mixes with the slurry can cause scratching. Apply the slurry to a section of the windshield with a clean paint brush, spreading it evenly in a

thin coat. We found that dividing the windshield into quarters worked well. But make sure you polish evenly and overlap the previously polished areas.

Apply a substantial amount of polish to the felt wheel and spread it evenly over the flat polishing surface.

Polish the windshield with a circular motion, rather than a straight back and forth pattern. Keep moving. If you concentrate on one area you could wear a groove into the glass. Don't apply pressure, let the weight of the drill or polisher do the work or you could overheat the glass and crack it.

Have a shallow bowl of water handy. When the slurry begins to dry out, dip the wheel into the water and continue. The polisher should run smooth and free. If it's slowed down by the slurry, you're probably running too dry.

When you've polished the entire windshield, check your progress by hosing away the compound. Then, if necessary, reapply slurry and continue polishing until you're satisfied with the results, but remember that you won't be able to polish out deep scratches or stone chips.

Once you're happy with the view from behind the wheel, simply wash any remaining compound with mild soap and water.

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AUTOMOTIVE RENEWAL GUIDE

Rust Abatement

IT'S INEVITABLE—if you use a car on a day-to-day basis, it's going to collect an assortment of stone chips, door dings and scratches. And your car's paint is its first line of defense against rust. Any place where the paint is broken, rust can establish a foothold, and once rust has perforated the metal, you're due for an appointment with a body shop. There you will be subjected to the not-so-tender mercies of someone with a pair of tin snips, a welder and no regard for your bank balance.

The way to avoid this, of course, is to catch the problem before the metal is gone. It's possible to repair most minor chips in an hour or two, in the privacy of your driveway, and you'll be hard pressed to see the repair.

Don't even think of using anything

except automotive primer and paints. Rust-Oleum is terrific for a rusty swing set, but it's not compatible with the solvents in the paint systems used on cars.

surface rust and loose paint, right down to bare metal. Use a sharp awl or knife point, but be careful not to enlarge the chipped area any more than you have to.



Rust can be treated early with 3M's Rust Avenger.

You'll need some primer and touchup paint in those little finger-nail-polish bottles.

Begin by carefully removing flaky

The photo shows a 3M product, available in discount stores and auto parts stores, that will combine chemically with the lingering rust and stabilize the surface of the metal. Follow the label directions. Skipping this step is not recommended if you live anywhere it rains or they use salt on the road.

Using an automotive primer/surfacer and a small brush, carefully prime the metal, again being careful to remain within the confines of the existing chip.

If you do get any paint on the shiny part of the car, wipe it off with paper toweling. It may be necessary when you're finished to use rubbing compound to buff off any residue, but the finish won't suffer any permanent blemish—provided you're gentle with the compound. Don't get any compound on the primer.

Let the primer dry thoroughly. Overnight is best. The primer will shrink considerably as it dries, so another coat may be necessary. What you're trying to do is fill the chip about halfway with primer. Then, using a bottle of touchup color and its built-in brush, cover the primer with a couple of coats, allowing plenty of drying/shrinking time.

Eventually, you'll wind up with an almost invisible repair. If the scratch, chip or ding in question was large, the surface may be irregular, but it'll be the right color, and it won't rust.

You can improve on the appearance even further, by very lightly wet-sanding with 600-grit paper to smooth out the surface. Just build the paint a little higher than the surroundings, and then sand carefully until the paint is smooth.

It's best to wait at least a week in warm weather, longer if it's cold, to allow the lacquer touchup paint to shrink fully before you begin refining your repair.

After sanding, you can restore the gloss with a little compound, taking care, of course, not to compound through the paint surrounding the chip.

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AUTOMOTIVE RENEWAL GUIDE

Paint Prep

BRINGING your car in for a new paint job can be excruciatingly painful. Right where it hurts the most: in the wallet.

But that doesn't mean you have to learn to live with the heartache of fading pigment. By prepping the car yourself and letting a pro spray the paint, you can save big bucks.

The first step toward a new finish is a thorough cleaning with soap and water. But before washing the exterior, try to remove as much dust and dirt from under the car as possible so it won't be blown up onto the new finish when the car is sprayed.

Once the car has been cleaned, you can begin removing trim pieces. It's easier to just mask the surface, but the finished product is not as pleasing.

You'll need a molding removal tool and an upholstery tool—both of which can be purchased at auto parts stores that specialize in body shop supplies. The molding removal tool is used to release the clips that hold the windshield molding in place. The upholstery tool is good for removing interior door trim panels and exterior chrome pieces that are retained with spring clips.

Removal of the interior panels will allow access to door handles and side-view mirrors. You can, of course, mask these parts, but most are secured only by a couple of bolts and are relatively easy to remove. Ditto the lock cylinder, which is usually held in place by a simple retaining clip. You'll probably have to move some of the trunk interior panels to gain access to quarter panel and rear deck badges, as well as the trunk lock cylinder.

You may have to study your service manual to determine how the various exterior molding pieces are attached. You might find that they are adhesive bonded, for example. Other pieces might be attached with threaded fasteners from the interior side of the panel.

When you've removed as many trim pieces as possible, unbolt the front grille, remove the windshield wipers, headlights, taillight lenses and bulbs. Then crawl under the front

and rear of your car and determine how the bumpers are attached. If disassembly is easy—as it is on many older cars—you might want to remove these as well.

Any parts that can't be removed without a lot of difficulty can be

masked off after the body has been sanded.

Before you lay hands on sandpaper, wash down the entire body surface with a wax and grease remover. This solvent is applied with a damp rag and then wiped off with a dry one.

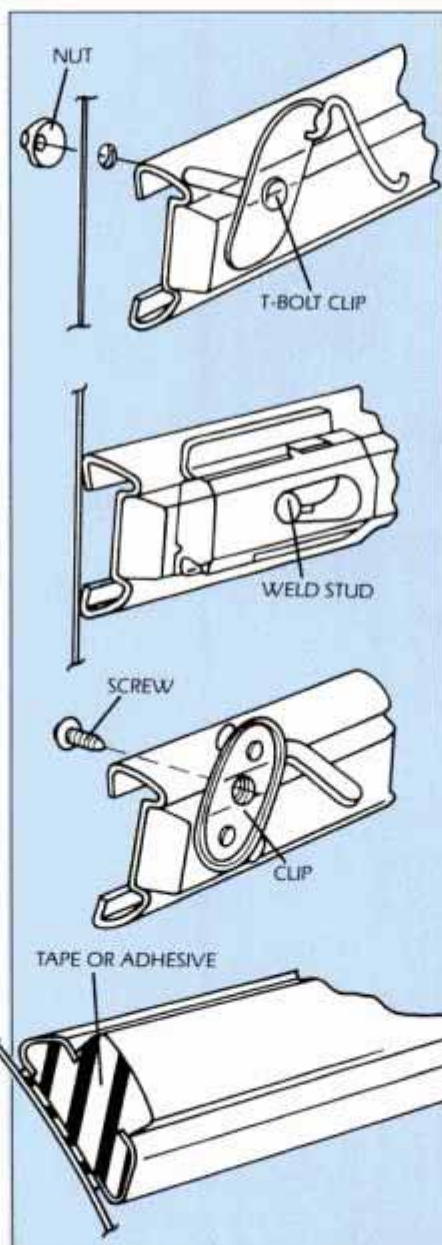
If your car has rust, body damage, stone chips or dings, repair them before proceeding with the paint prep. You can find specific instructions in volumes that are widely available in auto parts stores and book stores.

Once all body repairs have been completed, thoroughly sand the old finish with 360-grit wet-sanding paper. Unless your car has been repainted more than once, you won't have to remove all of the old finish. Instead, the purpose of sanding is simply to arrive at a uniform, gloss-free surface texture. Hand sanding is the recommended procedure for the driveway mechanic, as machine sanding can easily ruin the surface. This is a labor-intensive job, but it will help ensure a good final result.

Once you've sanded the entire body surface, clean it with a synthetic scouring material—such as Scotch-brite—and water. Wash windows and any remaining chrome pieces, and dry with a chamois. Avoid applying soap to the car at this point.

For masking, you'll need both masking paper and tape. Overlap paper on the windows and windshield—don't butt the seams. The tape should extend right to the edge of the window channels and must lie flat. Mask headlight openings and taillight holes as well. If you haven't removed the bumpers, mask all exposed areas, including brackets.

Of course, you'll have to have your car towed to the paint shop. But make sure you accompany it so you can do a final inspection and adjust any dislodged masking paper. You might also want to give your car a final wipe-down with a tack rag to remove any dust that has been picked up in transit. If the car is splashed with mud or dirty water, wipe it off with a damp rag and reapply the wax and grease solvent to that area.



Here are four common ways of attaching exterior trim pieces. Once determined how yours are attached, you may have to remove some interior trim to access the fasteners.

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Bookcase Wall—Turn your wall into a great display area for books and other items. Our bookcase goes from floor to ceiling with out-of-sight storage space on the bottom. With these plans, the five cabinets can be adjusted to any width to fit your wall. (PA-1008—\$5.95)



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Roll Top Desk—Nostalgia buffs will especially appreciate the always popular roll top desk for both home and office: it's an antique cherished by many. Make one yourself in fine cherry and take pride in this charming heirloom. You build it as two separate units, a base and a roll top. (PA-1736—\$5.95)



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Colonial Garage/Barn—Park two cars in this 24' x 26' garage and place a workbench along the rear wall. The second-floor loft has an extra 350 sq. ft. of space. A 3' overhang keeps snow or rain away from the garage doors and a 4' side walkway provides space for firewood and garden supplies. (PA-1277—\$30, 1 plan; \$20 each additional plan)



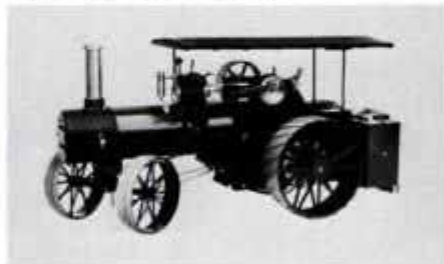
Captain's Bed—Build this space-saver bed/dresser/desk for your kids. The dresser features four drawers and bookshelves, while the desk provides room for writing, doing homework and reading. The bed, which fits securely on top of the dresser and desk, is surrounded by guardrails to protect your sleeping child. (PA-1850—\$6.95)



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AUTOMOTIVE RENEWAL GUIDE

Revitalizing Valvetrains

LISTING the advantages of overhead-cam engine designs is a child's play: fewer parts to break, improved valve timing accuracy and potentially higher engine speeds—which can usually be made to add up to more horsepower. But we've overlooked one of the most important pluses for today's driveway mechanic: Ease of upgrading.

In truth, installation of a performance-type camshaft can improve the response of almost any engine, but the job is really straightforward on modern ohc powerplants. And with the latest computer-generated cam designs, you won't have to tolerate a lumpy idle in order to get significant power gains across the board. The key to a successful swap is in choosing a combination of parts matched to your needs.

Let's quickly review the basics: The camshaft calls the shots for all valvetrain activity, opening and closing the

intake and exhaust valves to control the flow of air/fuel mixture through the engine. If we can stuff more air and fuel into the cylinder, power output will increase, though fuel economy and low-speed tractability might suffer.

Engineers for the carmakers typically optimize their designs for a wide powerband, while race-car builders sacrifice low-end power for the sake of peak output.

New designs from long-time hot-rod suppliers such as Crane Cams offer smart compromises at a reasonable price. To keep the idle smooth and minimize the possibility of engine damage, critical specifications such as cam duration (the amount of time the valve is held open, expressed in degrees of engine rotation) are not increased.

However, the rate at which the valves are opened and closed is improved, so there is effectively more

airflow through the engine. As the engineers put it, the area under the curve—the time that the valves are actually held open—is increased, to promote better filling of the combustion chamber, which means more power per power cycle.

With careful design the cam's characteristics can be tailored to virtually any special needs. How about a boost in the 2500-rpm range for more available cruising power? No problem. Or maybe you need more oomph at 3600 rpm for towing a powerboat over mountain passes? Again, all you have to do is ask for it.

Installing a new camshaft is easiest in a 4-cylinder overhead-cam engine. All the pieces are on top and readily accessible.

The job is more time-consuming on a pushrod V6- or V8-powered car, but not prohibitive so long as the car is rear-wheel drive. Front-drive V-type engines are trickier because there's

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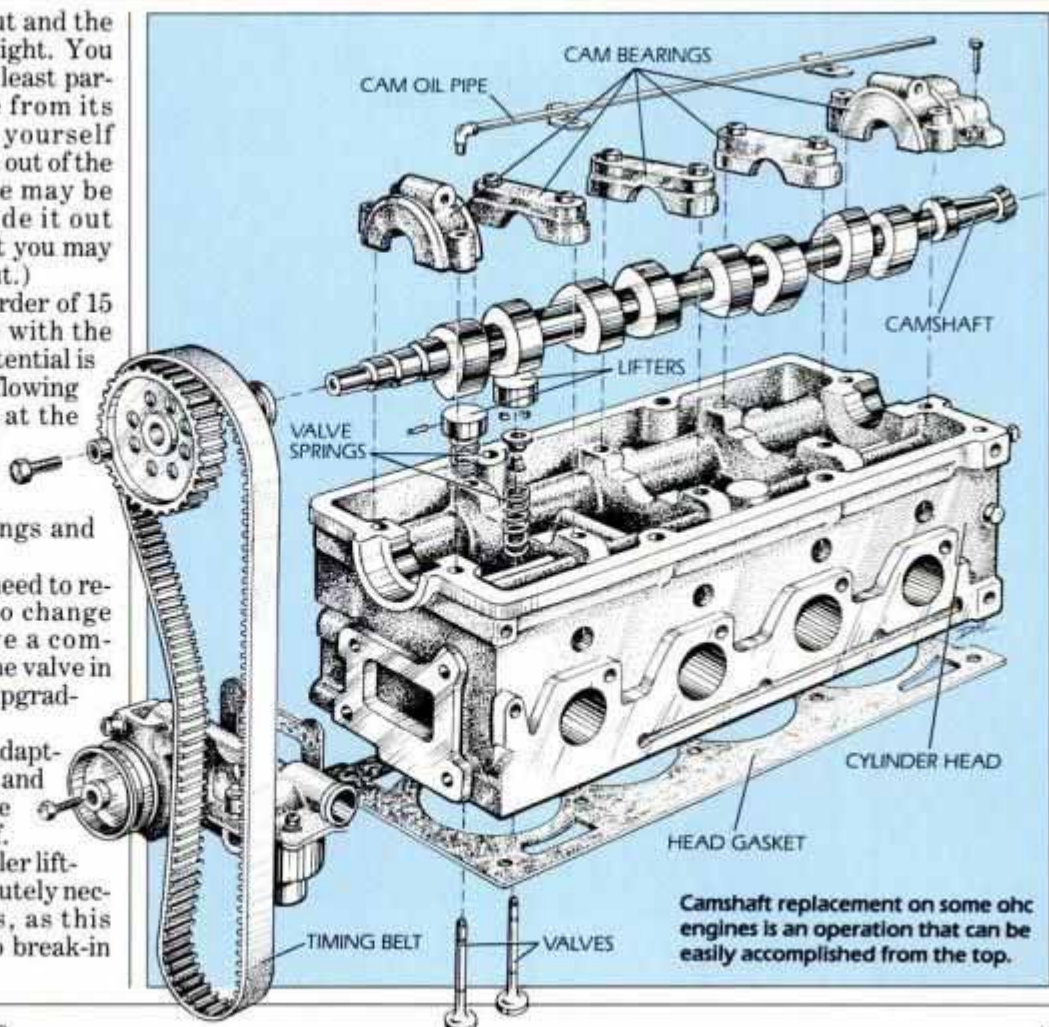


no room to slide the cam out and the accessory packaging is so tight. You may find it necessary to at least partially remove the engine from its mounts in order to give yourself enough room to pull the cam out of the front of the block. (There may be room on some cars to slide it out through the fenderwell, but you may also need to remove the strut.)

Power increases on the order of 15 to 20 percent are possible with the cam swap alone, and the potential is greater if you install a free-flowing intake or exhaust system at the same time. By all means, be sure that you purchase the parts as a matched kit including lifters, valve springs and spring retainers, if needed.

In most cases there's no need to remove the cylinder head to change valve springs if you have a compressed-air supply to hold the valve in place while you install the upgraded springs.

You can make or buy an adapter to fit the sparkplug hole and keep air pressure behind the valve while the spring is off. If you are working with a roller lifter engine it may not be absolutely necessary to buy new lifters, as this design is not as sensitive to break-in and high initial wear.



AUTOMOTIVE RENEWAL GUIDE

Hot Spark Basics

MODERN electronic ignition systems easily outperform the aftermarket hot-rod systems of only a decade ago. High voltage is the key to this remarkable efficiency. But when ignition parts are neglected, it can also become a problem. Given a fouled plug and a pin-pricked cable, 40,000 volts will quickly find their way to a new ground, killing at least one cylinder.

The keys to trouble-free operation are regular maintenance and quality components. Start by running those sparkplugs out to see if they all are firing.

On some engines, you may have to experiment with various socket, extension and universal joint combinations to access hard-to-reach plugs. If any of the plugs are

wet, dark or oily, check engine compression before proceeding.

If the plugs are no more than 15,000 miles old and the electrodes are not

miles. On older cars with contact-breaker ignition, plugs and the contact breaker/condenser assembly should be replaced every 10,000 miles.

On cars with an external ignition coil, continue your maintenance inspection with a check of the coil tower. Look for traces of carbon tracking, arcing or burn-through. If you find damage, replace both the coil and its large high-voltage cable. If the coil looks okay, inspect the cable. Any evidence of cracking, punctured insulation or corrosion is reason for replacement.

Because they're more exposed to road salt and other

corrosives, plug cables are even more susceptible to damage than coil wires. Any damage is grounds for replacement. We replace ours every three years or 30,000 miles regardless of visual condition. Use only premium hypalon-type or silicone rubber-jacketed plug cables.

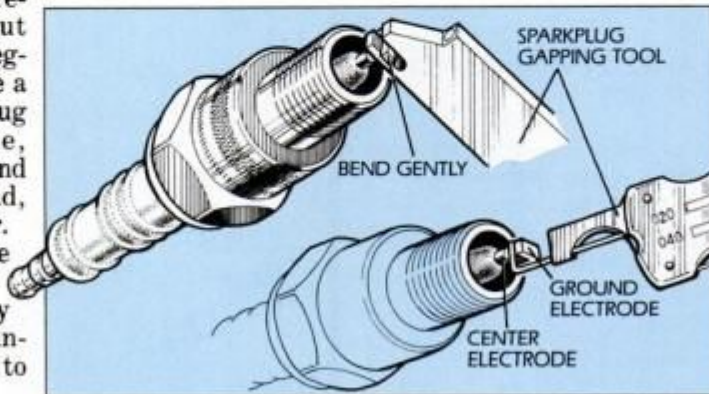
Before installing new sparkplug cables, remove the distributor cap. Most are attached with spring clips or screws. On GM HEI caps with an integral coil, disconnect the wiring connectors from the terminals marked BAT and TACH.

Check the inside of the distributor cap. You may find carbon tracks leading from one terminal to another—evidence of current jump. Look for cracks in the carbon button in the center of the cap or in the cap's plastic housing. Any sign of tracking or damage is grounds for replacement. If the terminals within the cap are corroded, try scraping them with a knife.

Examine the rotor. Look at the plastic shell and the metal contacts. Replace it if there is any evidence of arcing or tracking.

Reassemble the distributor. Then, if it is necessary, install the new sparkplug cables one at a time, matching each to an old cable for length and location.

To seat a conventional cable connector on the coil tower or distributor cap, squeeze the boot to release trapped air. Handle new cables with care, as even a tiny puncture can cause a current leak.



For regapping, use opposite end of gauge to bend electrode.

rounded or worn, you can clean, regap and reinstall them. Platinum-electrode plugs will usually go 30,000

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AUTOMOTIVE RENEWAL GUIDE

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FEW PARTS on today's cars cost less to replace than the air, oil and fuel filters, and yet even fewer are more critical to the long-term well-being of the engine.

While all the engine's filters should be maintained to assure peak running condition, one can stop the car on the spot if neglected too long. The fuel filter can then quickly plug up with an accumulation of rust, dirt or water. If that doesn't actually stall the engine, worse damage can result. Particles the size of a human hair can plug precision port fuel-injection orifices.

Fuel filters come in many forms, from simple transparent in-line canisters to screw-on replaceable element types. The first filtering stage is often right inside the tank itself, particularly on cars

equipped with fuel injection. A woven plastic mesh attached to the electric fuel pump prevents large sediment particles from entering. This filter doesn't require service.

Many fuel filters thread directly into the carburetor body or nestle inside the housing where the fuel line attaches. Filters located at this fuel inlet may be of the pleated paper design or sintered bronze construction. It's always important to install filters in the proper direction of flow, usually marked with an arrow. In the case of bronze elements, the center cone should face the incoming fuel.

Some filters are located in the supply line near the fuel tank. When replacing any fuel filter be sure to inspect connections after starting the car to be certain there are no leaks.

Typically, manufacturers recommend fuel filter replacement every 30,000 miles, though it would be smart to do it more often.

Oil filters are the most important in terms of preventing engine wear. The filter has a full-time job even if you never drive in dusty conditions, because contaminants come from inside the engine itself, formed as a result of

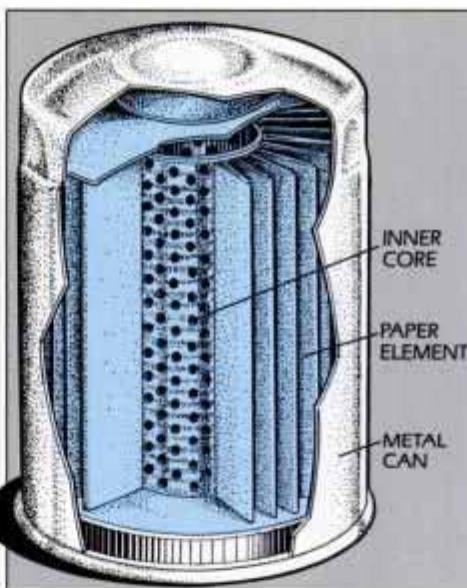
the combustion process. Particles in the 10- to 20-micron size (1 micron equals .00004 in.) can cause accelerated wear on bearings, rings and camshaft lobes.

Back when changing oil filters was a messy task you had some excuse for skipping the job. Ever since Fram invented the spin-on filter some 30 years ago there's been no good excuse not to replace the oil filter with ev-

ery oil change. This is true with today's extended oil change intervals (we recommend 3000 to 5000 miles) and highly stressed powerplants.

Air filters are the easiest to change and may have the most noticeable affect on performance and economy. In normal highway driving conditions you can expect a 30,000-mile lifespan from the filter element, but in severe usage that figure should be cut in half.

Most of the standard service tips still apply. Shine a droplight through the filter from the inside to check for pinholes or tears. Save your engine some wear and tear by replacing the filter entirely, using a filter of 2-ply construction if available. Install a new foam filter for the PCV system and wipe the inside of the filter housing clean before wrapping up the job.



Screw-on canister-type oil filter uses pleated paper to trap and contain abrasive particles.



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AUTOMOTIVE RENEWAL GUIDE

Hoses And Drivebelts

IT USUALLY happens right in the middle of nowhere: Steam billows out from under your hood just as the warning light on the dash turns into a laser beam aimed right at your wallet.

It could be a serious cooling system problem, but it's most likely nothing more than a busted belt or hose—something that could have been avoided with periodic maintenance.

Cooling system belts and hoses should be given at least a quick look every time you check your oil and a thorough examination when you drain, flush and refill your cooling system once a year.

A radiator or heater hose that has begun to get soft and gummy is not long for this world. Look also for signs of cracking, swelling and oil or grease damage. Pay close attention to that part of the hose just behind the clamp. If the clamp has dug its way into the hose, the hose will soon fail at this point. The clamp may have been overtightened when the hose was installed.

If our hoses make it through three full years without a failure, we replace them anyway. They don't last forever, and every year beyond year three is borrowed time.

When purchasing a new hose, take your old one along and match them up. A hose that is not quite the right length or is not properly formed may kink when you install it. Note, though, that to reduce inventory requirements, some aftermarket hoses are designed to be shortened to fit your application, so check to see if shortening is necessary.

When installing a new hose make

sure that it doesn't contact any engine parts or accessory drives. Use new worm-drive clamps and tighten them to the point where the rubber is just beginning to bulge through the holes, and just before the point where they dig into the hose.

Belt life is usually about the same as hose life—three to four years. And you can't accurately gauge the condition of a belt on

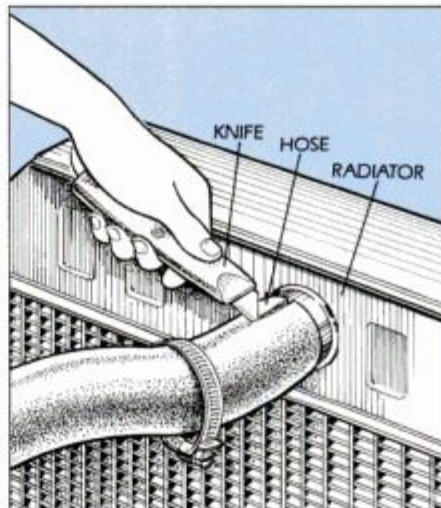
looks alone. Of course, some obvious failure symptoms—such as cracking, shredding or glazing—should not be ignored.

Sometimes premature belt failure is the result of improper tensioning. But it can also be caused by various other unhappy conditions.

Pulley misalignment is another leading cause of premature belt failure. If space

permits, you can detect misalignment by holding a straightedge between the pulleys. If you can't work your way in there, watch the belt while it's running. If it seems to kink or twist, the pulleys are misaligned. Correct the misalignment by filing the mounting areas of brackets or by shimming them. On cars where access space permits, a belt-tension gauge can help you adjust newly installed belts to the manufacturer's recommended tension listed in your service manual.

If you don't have a tension gauge or if a tight engine compartment doesn't leave room for you to use one, check tension by applying moderate pressure to the center point of the longest accessible span. You should be able to deflect a properly tensioned belt approximately 1 in. Once the belts have run in for a few hundred miles, check tension and readjust if necessary.



Remove a stubborn hose with a razor knife. Take care not to gouge radiator neck.

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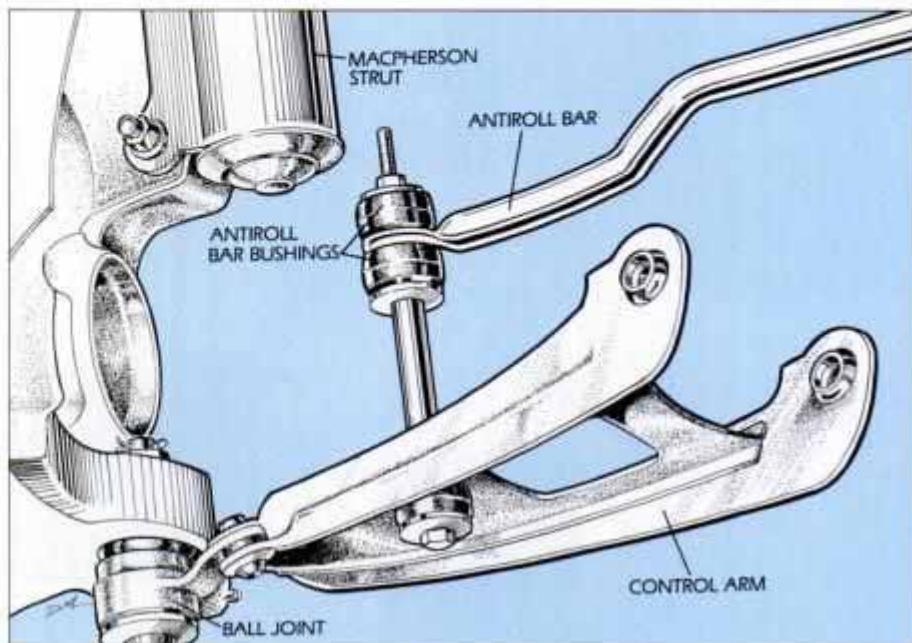
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AUTOMOTIVE RENEWAL GUIDE

Bushing Basics

WHAT WOULD an automobile manufacturer do if it wanted to make an old car ride and handle like a new one? Consider the example of a major European carmaker that offers a special line of used cars through its dealers. These cars are revamped in the conventional way with new shocks, springs, ball joints and steering parts as needed. But there's one part of the renewal procedure that most driveway mechanics might not consider. After considerable study, this automaker determined that all suspension bushings must be replaced to restore that new-car tightness. Suspension bushings are rubber pieces of varying hardness found almost anywhere suspension parts are bolted to the car. Their purpose is to provide a certain amount of *compliance*—just like a spring—while isolating the car from road noise and vibration. When they



Replacing antiroll bar bushings is usually a simple matter once the car is in the air.

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AUTOMOTIVE RENEWAL GUIDE

deteriorate or soften, handling and ride suffer.

You'll find bushings on control arms, antisway bars, at subframe mounting points and at shock absorber mounting points. While replacement of all the bushings is a big job, the returns in improved handling and comfort can be very substantial.

You can purchase original equipment bushings from your dealer. Special, less compliant bushings are available for some cars through high-performance outlets. However, they

will also make the ride considerably harsher.

Replacement of sway bar bushings is quite simple. You'll find donut-shaped bushings on the front sway bar's control arm mounting studs. Bushings that surround the bar are used in the mounting brackets of front and rear sway bars.

Many cars with monocoque body/chassis units mount suspension parts on subframes bolted to the chassis. Bushings between the subframe and body are critical components in the

ride/handling equation. Subframe mount bushings are fairly easy to replace. In many cases, the job is simply a matter of unbolting the entire subframe while it's supported on a floor jack, lowering it a few inches and inserting the new bushings. Consult your shop manual for specifics.

Renewal of front control arm bushings can be a considerable job on both front- and rear-drive cars. You'll need a shop manual to attempt either job, as specific instructions vary. In general, however, extreme caution is necessary as the spring-carrying control arms are heavily loaded. Unless you have a pro-quality spring compressor, this is a job for a pro.

You'll need a special tool to remove the bushings from the control arms. For most cars, it's something like a big C-clamp with special collars that press the bushing from the arm. On some cars, you'll need another tool to flare the new bushings after they've been installed. Even if you decide to remove the control arms yourself, you may want to have your dealer install the new bushings in the arms.

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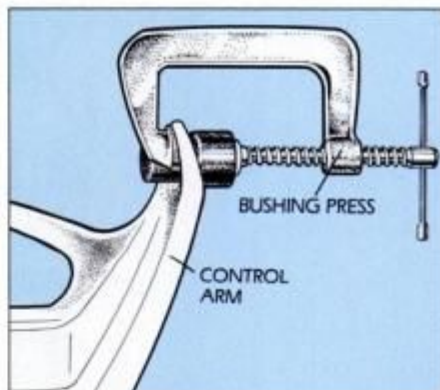
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Control arm bushings will require a bushing press, and perhaps spring compressors.

Rear control arm bushings are usually easier to service than their front suspension counterparts. On most cars, the spring is mounted on the axle housing and the control arms merely serve as locators. Again, specific steps vary from one make to the next, so you'll need a shop manual. But some general instructions apply to most rear-drive cars with typical 4-link suspension.

Raise the car and support it with jackstands located under the axle housing. To unbolt a control arm, remove the rear arm-to-axle housing bracket bolt and the front arm-to-bracket bolts. Remove only one control arm at a time, to prevent the axle from rolling or slipping sideways. On some cars, you'll find bushings mounted in the axle or axle "banjo" rather than in the rear of the control arm.



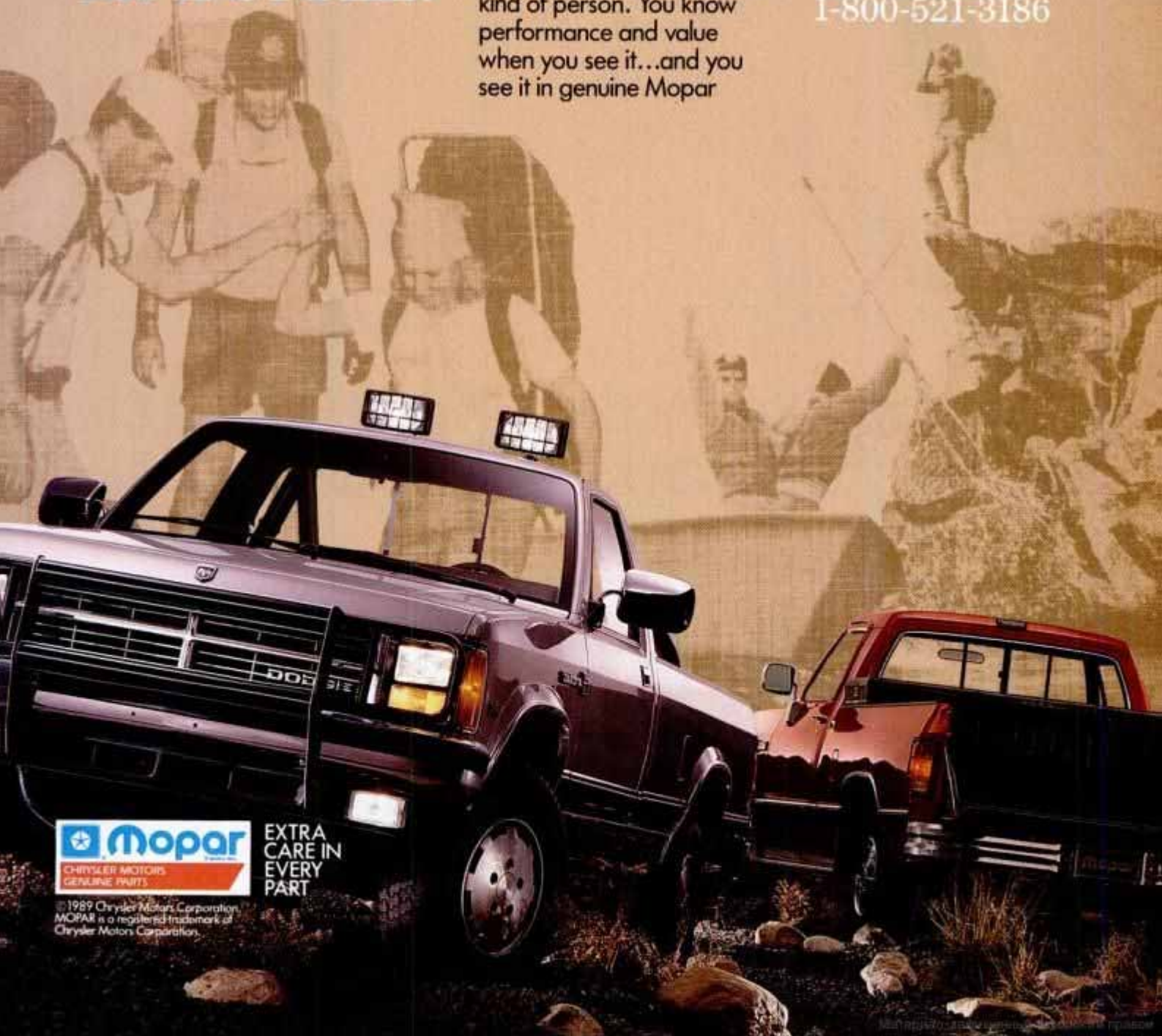
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AUTOMOTIVE RENEWAL GUIDE

Remote Control Ride

UNTIL NOW there's been little reason to take electronically adjustable suspension systems seriously. After all, they have only been available as original equipment on a limited number of new cars and not sold for most of the vehicles already on the road.

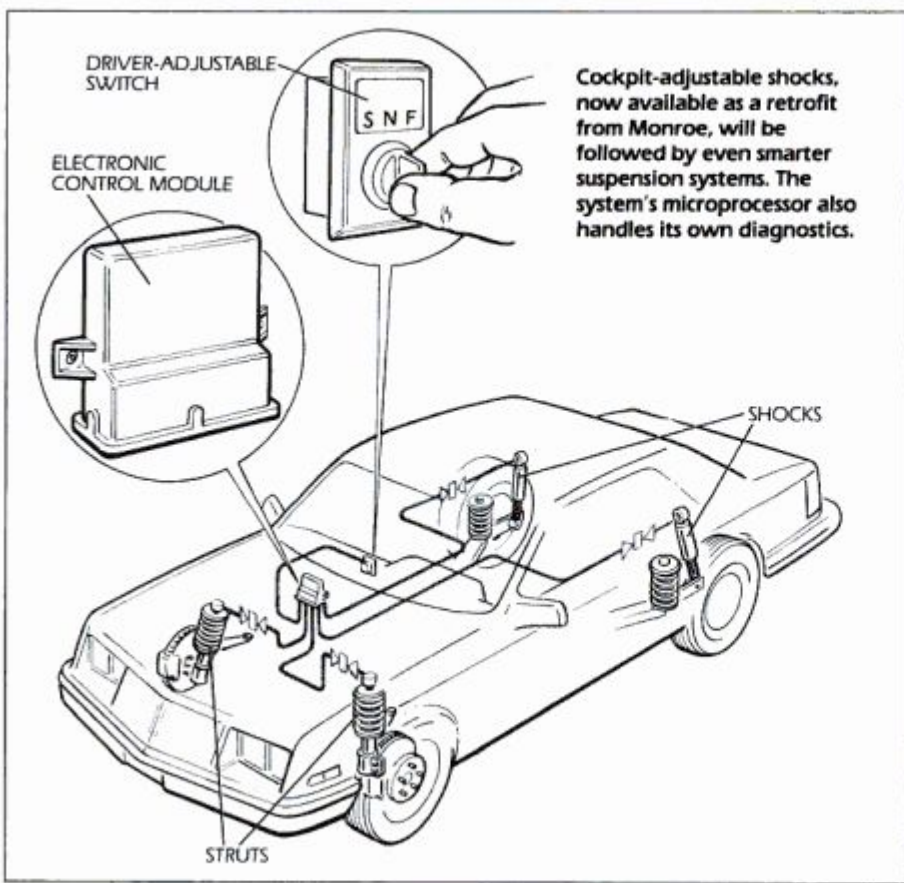
Availability of variable damping rate units from aftermarket sources is changing all of that, raising driver-selectable shock absorber settings from the status of showroom gimmicks to truly useful devices. Improvements in the factory-installed systems are helping, too, by showcasing the possibilities—microprocessor controls with split-second reaction times and real advances in chassis control. The cockpit-adjustable shock applications now range all the way from NASCAR stockers to everyday sports sedans.

One of the first systems available comes from the Ford Motorsports catalog and is an effective way to upgrade late-model Mustangs. The kit

includes front struts, rear shocks, a 3-position dashboard control switch and necessary wiring supplies. The controls regulate an internal rod which selects the orifice through which the shock's fluid passes. It adjusts both compression (jounce) and extension (rebound) damping rates. The kit's price is steep at \$1000, but is a simple plug-in installation once the shock and strut units are in place.

The next step up in bolt-on suspension upgrades is a "smart" reactive setup such as the Monroe Auto Equipment system shown below. Stage one is a manually controlled suspension as shown here, using a microprocessor to relay commands from the cockpit control out to the damping units.

The real promise of the future is auto-setting shocks that use vehicle sensors to read speed, throttle setting, steering and braking. An electronic control module can analyze the readings and choose appropriate damper settings.



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AUTOMOTIVE RENEWAL GUIDE

Chassis Lube

WHATEVER happened to that fine old 2-part basic maintenance tradition, the oil change and grease job?

It used to be that the two were inseparable, the standard maintenance routines that even the most casual car owner knew were necessary to keep his vehicle going down the road. The local garage would put stickers inside the door panels like merit badges for each change-and-lube cycle.

Things are much different today. Recommended oil-change intervals have lengthened dramatically (we still recommend changing between 3000 and 5000 miles, depending on how you drive), and the old-fashioned grease job is all but forgotten. Nevertheless, even though you don't hear so much about chassis lubrication, it's still a vital part of proper car care.

The fact is, regular lubrication of steering and suspension fittings is required not only for older cars, but for new high-tech designs like Chevrolet's Corvette. On that car there are eight fittings, six at the front and two at the rear, each equipped with a standard grease nipple ready to accept pressure-fed lubricant.

Common chassis points requiring periodic greasing on many cars include ball joints, steering tie rod ends, and the idler arm. On older cars it's quite possible that the driveshaft universal joints may have fittings, too.

Driveshafts with a sliding spline section between the front and rear universal joints will require some lubrication at this point. Follow the manufacturer's suggestions for proper lubricants.

Some vehicles are manufactured with flat dish-faced fittings rather than conventional nipples. A special needle-like grease nozzle is used to service these points. Often these joints are not sealed, so grease should be injected slowly until the old grease is forced out.

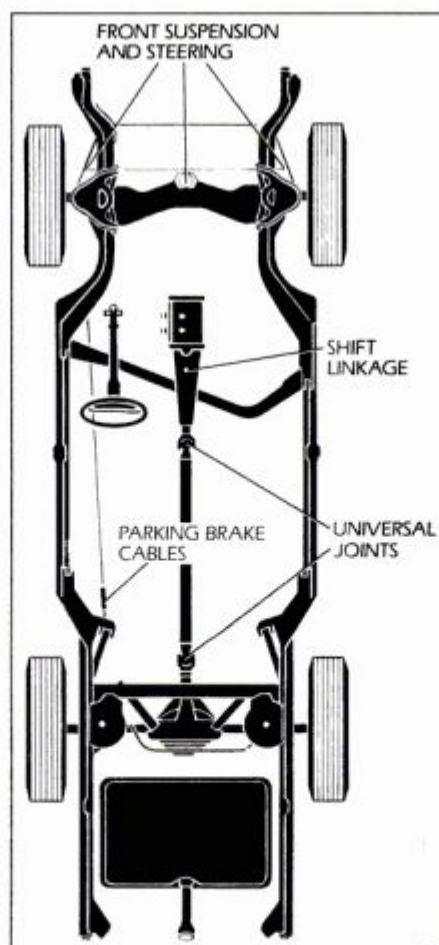
When lubrication intervals are very long—say 10,000 miles or more—the carmaker may install metal or plastic plugs at the grease points. We think it's a very good idea to remove the plug and install a standard nipple fitting in its place. Leave the fitting installed to make the job go quicker next time.

Service intervals vary with manu-

facturer, but Chevrolet is typical in recommending front suspension lubrication every 12 months or 7500 miles (6 months/6000 miles in severe driving conditions). Other brands of cars, such as Porsche or Mercedes-Benz and even Toyota, use sealed suspension components which require no periodic lubrication.

That's not all the attention the chassis requires, though. The same grade of chassis lubricant should be applied in a thin coat to the parking brake cables and guides (but not the cable casing), and the contact areas of the transmission shift linkage.

Every 30,000 miles the clutch cross shaft of manual transmission-equipped cars needs a shot of grease, too. And as long as you've got your hands dirty, apply a bit of white grease to the hood latch mechanism and a slight amount to door and hood hinges.



Many vehicles today still have fittings and other places that require periodic greasing.

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Tire Typing

THE GOOD NEWS about today's tires is that there are more premium quality choices than ever. The bad news is that there is still no one tire that's best for every driver and every road condition.

Buying new tires for your car ought to be a deeply considered decision based on far more than just price or cosmetic considerations. Before you begin a soul-searching analysis of driving style and performance expectations, though, spend some time reviewing the set you've worn out. What is it you would like to change about the way they behave and how much are you willing to trade off? If your budget is big enough you'll be able to find tires which offer the ultimate in handling or best possible ride quality, but not both at the same time.

If your car is of recent vintage, there's a good chance that the original-equipment tires have delivered

remarkable performance. It's no longer a lowest-bidder business among carmakers. Tires have become a critical factor in the performance definition and are more closely matched to the suspension settings and driver's expectations than ever. Assuming the original equipment tires have come close to meeting your needs, you've at least got a good guide to size and the load and speed ratings.

For the most part, every trait you attempt to improve will probably cause a loss in some other quality. One notable exception is adaptability to weather conditions. True high-performance tires with full all-season capabilities are now available in a wide range of sizes. Only at the

very extremes of high-traction road grippers do you have to give up some wet-weather prowess. At the very minimum, try to retain the factory tire height. This dimension not only affects fit inside the wheel well but is also vital to the calculations of ABS braking systems and engine management computers.

The final choice of tires boils down to what characteristics they must have and what you are willing to give up to get them. Tires that deliver optimum cornering traction will give up some tread life and ride comfort, due to the rubber compounding and construction techniques. A tire which offers the security of go-anywhere grip in mud and snow will be noisy on dry highways and vague in cornering, thanks to the deep tread blocks and number of biting edges.

The best expert advice to search out is from drivers with vehicles and



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driving patterns that are similar to your own. Their hands-on experience can help sort out the local road peculiarities and conditions better than any sales pitch. Don't underestimate the knowledgeable tire dealer, though. His background and insights are worthwhile. If he's conscientious he'll ask questions about how and where you drive, as well as look over your vehicle for clues such as a ski rack or tow hitch.

There's a lot of self-education in store before making an informed tire purchase decision and few clear-cut guidelines. Don't try to judge any tire by appearance or price and remember to buy for the 95 percent portion of your driving, not the 5 percent.

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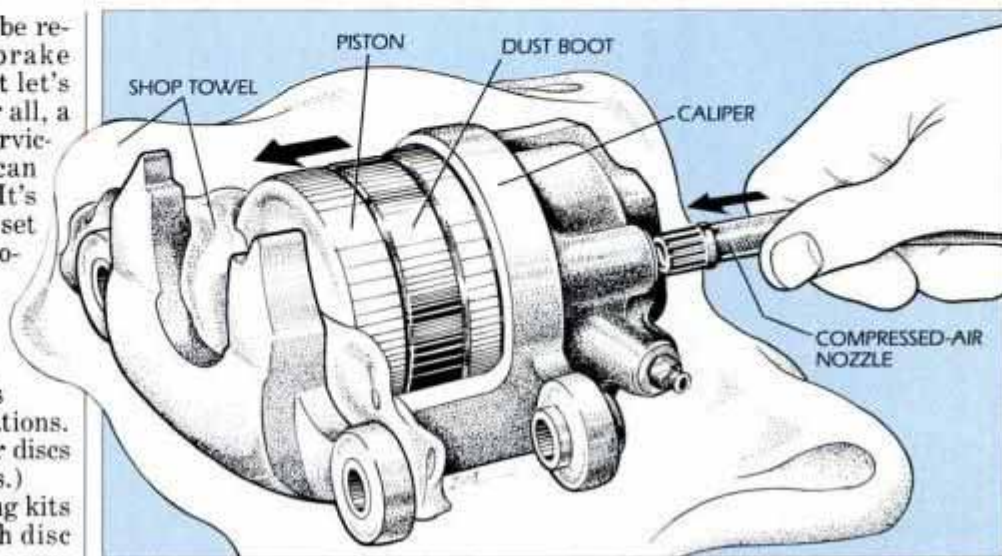
AUTOMOTIVE RENEWAL GUIDE

Reconditioning Brake Calipers

BRAKE calipers should be rebuilt whenever the brake pads are replaced. But let's face it, they rarely are. After all, a complete brake job with full servicing of the hydraulic system can cost several hundred dollars. It's tempting to just throw in a new set of pads and try to forget other potential problems.

The experienced do-it-yourselfer shouldn't have to settle for inferior brake service. Rebuilding your own calipers is relatively easy in most applications. (Exceptions would include rear discs with parking brake mechanisms.)

You'll need caliper rebuilding kits for each wheel equipped with disc brakes, but before you buy make sure the caliper bleed screws can be loos-



Remove the piston by gradually applying air pressure to the caliper inlet fitting.

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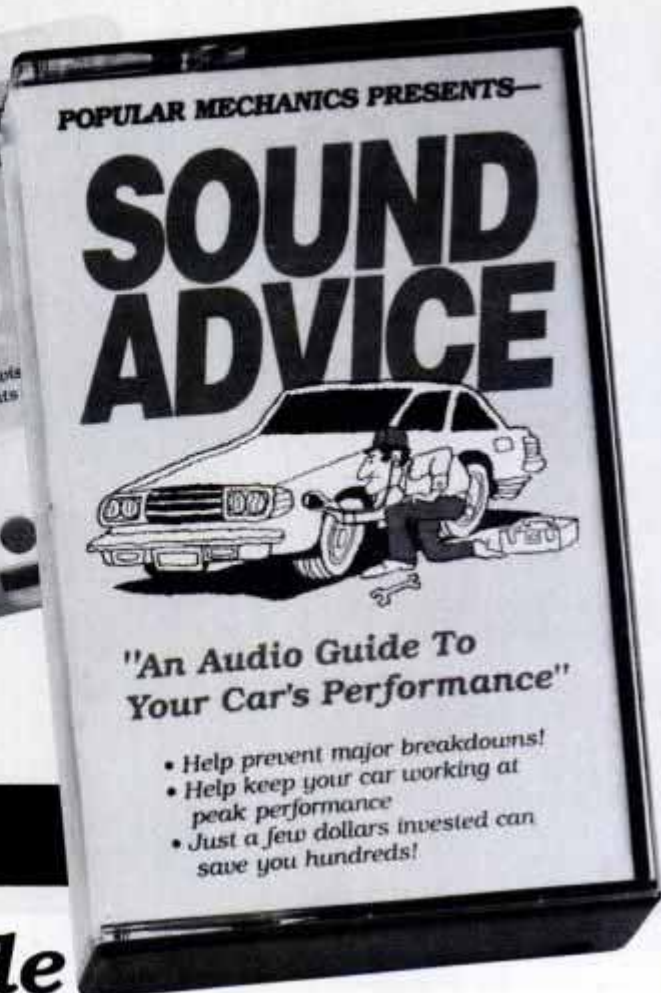
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AUTOMOTIVE RENEWAL GUIDE

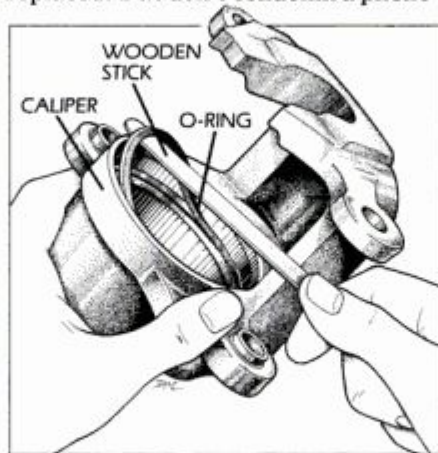
ened for bleeding. If they can't, you'll have to replace the appropriate calipers. If the bleed screws are okay, you should refer to your service manual for any instructions or precautions that are specific to your car.

For most single-piston floating calipers the job goes like this: Once you've unbolted the calipers, remove pads, the pad support spring, the old brake hose and, if applicable, the caliper guide-pin bushings and O-rings. Place several shop rags in each caliper in such a way that they will catch the piston as it is ejected. Then gradually apply air pressure to the caliper inlet to force the piston out of the caliper bore.

Don't try to catch the piston in your hand. If the piston won't come out, tap lightly around its edge with a small brass or plastic hammer and apply air again. If you can't dislodge the piston, you'll have to replace the caliper. Use a dull screwdriver to pry the dust boot out of the caliper, but be careful not to damage the cylinder bore. Use a wooden stick to remove the seal from the groove in the bore.

Clean all metal parts in brake parts cleaner or alcohol. If a piston is not in-

cluded in the rebuilding kit, inspect the old one for scoring, pitting, nicks, corrosion and worn or damaged plating. If the piston is flawed, it *must* be replaced. But don't condemn a pheno-



In removing O-ring seal, be sure to use tool that won't score walls of caliper bore.

lic (plastic) piston on the basis of cosmetic blemishes or small chips between the dust-boot groove and the outer face.

Inspect the cylinder bore. You can remove stains and corrosion with crocus cloth, but nicks, pitting or scoring

are grounds for caliper replacement. Before reassembling the caliper, lube the cylinder and the new piston seal with clean brake fluid. Carefully locate the seal in its groove. Make sure it's flat. Lube the piston with clean brake fluid and slip the dust boot over the end of the piston. Position the piston in its bore and, using hand pressure only, press it to the bottom of the bore.

If your caliper is equipped with a steel-rimmed dust boot, tap it in place with a driver that aligns with the outer edge of the rim. If your dust boot is solid rubber, use the flat side of a screwdriver or other blunt tool to press the boot into the groove, taking care to avoid cuts and tears.

Before reassembling, inspect the old brake hoses and replace them if they're showing any signs of wear or deterioration.

If they're over 3 years old, it's a good idea to replace them anyway. Use new brake hose seal washers whether you replace the hoses or not. Install new caliper guide-pin bushings. After installing new pads, complete the job by bleeding the brake system.

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BORN AGAIN (Continued from page 119)

locomotives still exist in North America. About 110 of those are operable, and each one that is brought back on line represents the culmination of Herculean effort. Last year saw the addition of eight working locomotives to the total, the best report card in years.

Enter a steam locomotive shop and you are Gulliver in the world of the giant Brobdingnagians: The universe has suddenly expanded about you. Here is a 36-in.-long pipe wrench. There is a crescent wrench with a 2½-in. bite. Here is a 2-in. drill bit. There is a ¼-in. threading tap.

A gargantuan hydraulic press stands ready to apply the 400 tons of pressure necessary to pull a wheel on or off its axle. The work is done mainly in steel and brass—steel for the bones and brass for the sinews. Brass is used as much as possible at the points of friction, because it can be replaced more easily.

Time was when each railroad had its service shop and its service manuals, much like an auto repair shop or airline maintenance office today. Basic maintenance and repair procedures were spelled out. The manuals still exist, even if the shops do not, but there is one key difference.

"The railroads used locomotives strictly for production," points out Gary P. Bensman, president of Diversified Rail Services, Fort Wayne, Indiana. "Today we want to restore locomotives and keep them in good running condition."

Those functions can sometimes clash. "The railroads had to operate at maximum capacity. We want our locomotives to last."

Snooping around one day in the back lot of the Illinois Railway Museum, Bensman found what he described as "a bare boiler sitting on wheels, solid rust from front to rear." More particularly, it was the 43-ft.-long hulk of a narrow-gauge 2-6-0 steam locomotive whose 37-in.-dia. wheels once enabled it to make a top speed of about 40 mph. If it could be restored, it would be the perfect artifact to grace the antique mall under construction in Frisco, Colorado, by developer Robert S. Philippe. The builder had enlisted Bensman's aid in finding just such a locomotive.

Research determined that the engine's original identity was *Ferro-Carril de Salaverry A. Trujillo* No. 6. It had been built in Philadelphia in 1875, the fourth production model in its series, and sent to work in Peru. Although No. 6 had never worked in Colorado, it was a twin to the old engines of the Denver South Park and Pacific Rail Road.

Taking pains

A lifetime of patchwork welds had rendered the boiler useless for renovation purposes, and the crew had to rebuild the engine nearly from scratch. Firebox repairs are critical. During a locomotive's lifetime, what is known as "flame erosion" gradually reduces the thickness of the metal plates, and these must be repaired or replaced. The tender required only the replacement of its sheetmetal and the addition of coal boards. On top of the engine the crew built a new cab, basing its appearance on old photographs. Running boards, lagging and jacking were added.

In the junk pile of a Toledo, Ohio, boiler shop, Bensman found a historically accurate whistle. From various collectors he secured gauges and a pop valve. He was amazed when he felt the pop valve attach neatly at the top of the steam dome. The century-old threads still fit perfectly.

After 11 months of labor ending in June 1987, the "boiler on wheels" had metamorphosed into a 28-ton beauty. Rechristened No. 13, the engine now stands in Philippe's Antique Barn, behind a sign that declares: "If you break it, you've bought it—\$85,000."

Ever change a tire on a locomotive? That was the problem faced by J. David Conrad, chief mechanical officer of The Valley Railroad Co., Essex, Connecticut, when he started tearing down an 85-ton steam locomotive, built in 1920. Ultrasound testing discovered two cracked axles on the old machine, one of the cracks stretching a full third of the way through. While attempting to remachine the axles, one of the wheels broke and that, to almost any steam locomotive technician, means a trip to Birmingham, Alabama, and the only quartering machine currently operational in the U.S. It stands in a machine shop run by Norfolk-Southern Railway.

Conrad explains, "Locomotives have double-acting, reciprocating cylinders, the right side 90° ahead of the left. If the crank pins aren't dead on quarter, there will be a lot of wear on the rods."

Kick the tires

Then it was time to change the 3-in.-thick steel tires surrounding the locomotives drive wheels, a common practice back in the workhorse days when the constant pounding of wheel against track fashioned a concave groove. To get a tire on or off of a locomotive wheel, you must heat it to a proper point of expansion. First, you affix a heating collar around the circumference. Then, Conrad details,

(Please turn to page 208)

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The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decrease fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WIVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "Poly" between the parts where it is burnished into the pores of the metal.

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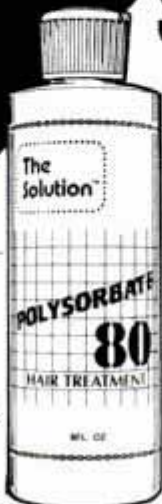
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BORN AGAIN

(Continued from page 204)

"You turn on the propane and wait 30 minutes or so. At approximately 400° the tires have expanded sufficiently to slip them onto the rims. As they cool down, they shrink into place." Shims are sometimes used to compensate for oversize tire bores or under-size wheel centers.

Once set with a new tire, the wheel is placed onto a driving wheel lathe for truing. The diameters of steam locomotive drive wheels must be within $\frac{1}{32}$ in. of each other. It is a job calling for patience. The wheel lathe turns at a speed of only 1 to 4 rpm.

Patience, in fact, is a virtue in all of this work. Take the case of Project 819, an all-volunteer effort to restore a giant 4-8-4 veteran of the St. Louis Southwestern Railway, informally known as the Cotton Belt Railroad. Since the late 1950s, No. 819 had been relegated to idleness as a curiosity on display in Oakland Park in Pine Bluff, Arkansas. Rust and vandalism took their tolls. By 1983 she was merely 367 tons of cold, rotting steel.

She was saved from a slow death by the collective efforts of 400 volunteers, a coalition of enthusiasts and history buffs, supported by groups such as the Pine Bluff Chamber of Commerce, the city of Pine Bluff, the Arkansas Railroad Club, the Little Rock Chapter of the National Railway Historical Society, and the Cotton Belt Railroad itself. A diesel switcher pulled her over temporary track to the old shop of the Cotton Belt line, and work commenced.

Fortunately, much of the lady needed only cosmetic attention, but the primary concern was the boiler itself, corroded by rust, attacked by innumerable seasonal temperature changes. A total of 3000 man-hours were required to remove, refit and replace the 100 superheater units that threaded through the boiler. Refueling was another major task. Volunteer laborers also rebuilt the air compressors, refitted the boiler jacketing, lagged the boiler, refurbished the cab woodwork, rebuilt the cab and brake valves, polished the cylinders and valve chambers, checked the bearings, manufactured and installed innumerable staybolt caps, replaced miles of oil, water and steam lines and, finally, scraped, cleaned, primed and painted the entire assembly. Total cost was \$140,000—almost the cost of the original engine.

Was it worth it? Some three years after the project began, when No. 819 was up and running, many of the volunteers had tears in their eyes. They claimed it was from the smoke. **PM**

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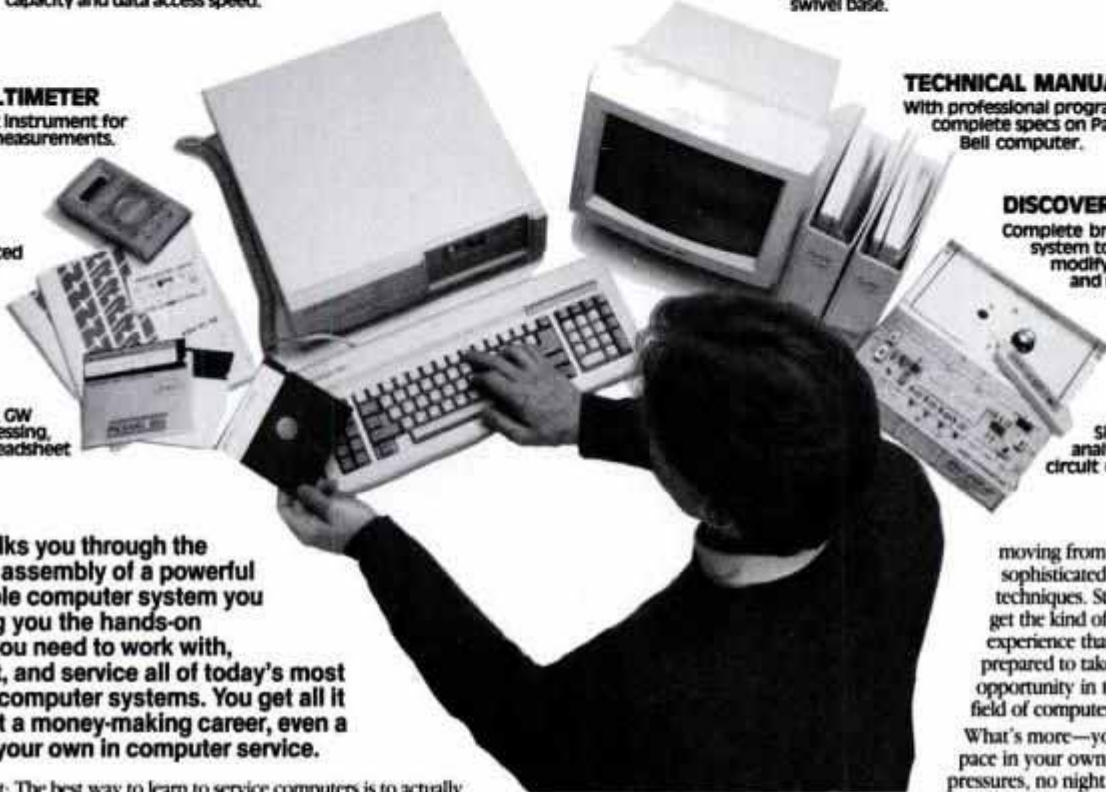
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No doubt about it: The best way to learn to service computers is to actually build a state-of-the-art computer from the keyboard on up. As you put the machine together, performing key tests and demonstrations at each stage of assembly, you see for yourself how each part of it works, what can go wrong, and how you can fix it.

Only NRI—the leader in career-building, at-home electronics training for 75 years—gives you such practical, real-world computer servicing experience. Indeed, no other training—in school, on the job, *anywhere*—shows you how to troubleshoot and service computers like NRI.

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With NRI's exclusive hands-on training, you actually build and keep the powerful new Packard Bell VX88 PC/XT compatible computer, complete with 512K RAM and 20 meg hard disk drive.

You start by assembling and testing the "intelligent" keyboard, move on to test the circuitry on the main logic board, install the power supply and 5 1/4" disk drive, then interface your high-resolution monitor. But that's not all.

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COUPES DE GRÂCE (Continued from page 124)

rear; wider wheels and 225/50VR15 Goodyear Gatorbacks. The 2.5-liter Turbo I engine is replaced by a revised Turbo II 2.2-liter engine with its own computer controls and a new Garrett Variable Nozzle Turbo (to keep gas velocities high and thus improve throttle response), which pushes air through a large intercooler mounted next to the radiator. The power goes through a gearbox with Getrag internals and a revised shift cable.

panel have disappeared. But the package still combines full-time 4wd, self-leveling air suspension, a flat Six sohc engine, and electrohydraulic power steering. New this year are Goodyear Eagle GT+4 tires.

The XT6 isn't as much at home on the track as some of its competitors, although it is reasonably well balanced and predictable, with far less understeer than several of the front-drive cars. In any case, most of us don't do much track driving, and on the road the Subaru combines good ride, excellent traction, low wind noise, great visibility and a wide torque spread to provide an excellent passenger platform.

If raw performance numbers are what you want in a car, the Shelby should be near the top of your list. But if sophistication and finesse, ride quality or noise level are most important, the Shelby probably won't make the cut.

Some of the controls are very well thought out, some are different apparently for the sake of being different (the steering wheel spokes, for example). The innovative steering provides good road feel, but the gearbox is a trifle notchy.

Our car had the optional Recaro seats—among the best in the test. It also had a real usable rear seat—the Beretta was the only other car in the group with room for four.

The 4wd helps under low-traction conditions (what Subaru had in mind), but doesn't make the XT6 a racer. On the other hand, it does contribute to making this a thoroughly companionable everyday car, and the best all-weather sports coupe in the bunch.

The Shelby showed 14 psi of boost at its top speed. Ride at that speed was choppy, but then it's choppy at most speeds. The car exhibited excessive understeer on the skidpad, but was fourth quickest in the slalom—not easy to drive, but pretty quick. The brakes are great.

Toyota Celica GT-S
The Celica has become an old friend. It has undergone very little change since its introduction three years ago, and it didn't need much.

The bottom line: This is a hard-edged car intended for a hard-core audience. If it appeals to you, it'll probably be the only car in this test that does.

The 2.0-liter dohc 16-valve engine is happy up to 7400 rpm, although somewhat buzzy beyond 5000 rpm, and will pull 6300 in Fifth gear, which works out to 124 mph.

Subaru XT6
The-Sports-Coupe-From-Another-Galaxy image has been toned down. The odd exterior striping, op art upholstery and videogame instrument

(Please turn to page 214)

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Since these coupes are designed and marketed as high-performance machines, we added a couple of extra dimensions to our usual battery of objective tests. In the first of these, we determined each car's absolute top-speed capability, measuring the results with the unwinking eye of a radar gun.

Later we measured each car's actual road horsepower on a Clayton portable dynamometer modified and operated by Dave Evans of Evanspeed. Conditions, particularly altitude, favored the turbocars in both tests.

The top-speed runs were conducted legally on a closed, private road at about 2000-ft. elevation, the dyno testing at Willow Springs Raceway, in the California high desert near Edwards Air Force Base, which is about 3000 ft.

—L.F.

Top Speed	Mph
Mitsubishi Eclipse	137
Plymouth Laser RS	137
Ford Probe GT	133
Mazda MX-6 GT	133
Shelby CSX	128
Isuzu Impulse Turbo	126
Toyota Celica GT-S	124
Subaru XT6	122
Honda Prelude Si	117
Chevrolet Beretta GTU	112
Nissan 240SX	107
Drive-Wheel HP	
Plymouth Laser RS	130 @ 6000
Ford Probe GT	125 @ 4500
Mitsubishi Eclipse	123 @ 5500
Shelby CSX	123 @ 5000
Mazda MX-6 GT	122 @ 4500
Isuzu Impulse Turbo	120 @ 5000
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COUPES DE GRÂCE

(Continued from page 212)

Front suspension is a well-developed MacPherson strut variation, rear is independent with dual-transverse links, gas shocks and coil springs all around.

Ride quality is good, handling good up to a point. The Celica seems to have more than its share of roll steer. In the slalom maneuver, the Celica had to be driven in slowly, then accelerated through so that as the yaw increased (with speed), the car would be clear of the course before things got unmanageable. It wags its tail like an old VW Beetle—distinctly odd for a front-drive car.

Seats are better than average, which means very good in this group. Visibility is good, the car is well finished, always a Toyota strength, brakes are excellent, gearbox is smooth and slick with good ratios.

The Celica GT-S is a solidly established sports coupe that has few if any disappointments. But compared with its Mazda and Mitsubishi-based competition, the Toyota performs only about as well as the nonturbo models.

Conclusions

As we noted at the outset, with a group as big and diverse as this, it's impossible to name one car as the star of the entire show. Even the least-loved entries had their merits, and even the favorites had some little aberrations that kept them from taking the consensus title.

Nevertheless, the newer cars tended to draw more praise than the ones that have been on stage for awhile, an indication of how rapidly things are changing in an increasingly high-tech, competitive marketplace.

For all that, the new Nissan 240SX came as close as any of these coupes to winning the outright title, proving, among other things, that rear-wheel drive still delivers an edge in handling. If the Nissan were powered by one of the turbomotors—the Eclipse/Laser 16-valve, for example, or the Probe/MX-6—it would be the undisputed king of this class. Even without muscle, it's a sweetheart to drive.

The Probe and the Prelude were also popular with almost all our testers, the former for its looks and eager throttle response, the latter for its refinement and all-around good manners.

However, in the real world of automobile buying, how we feel about a car's attributes and capabilities is invariably tempered by what we see on the window sticker. And assessed on a what-you-get-for-your-money scale, it's tough to top the Eclipse and the Laser.



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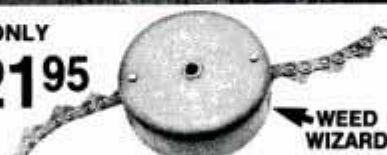
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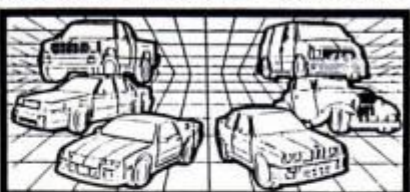
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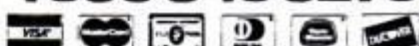
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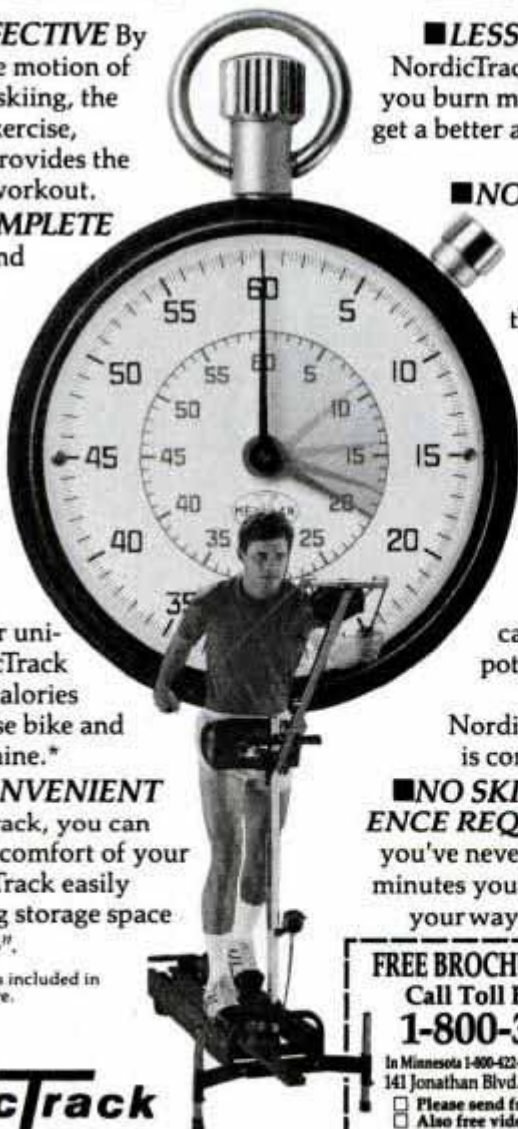
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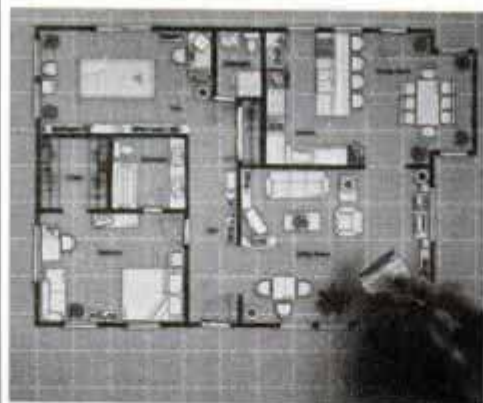
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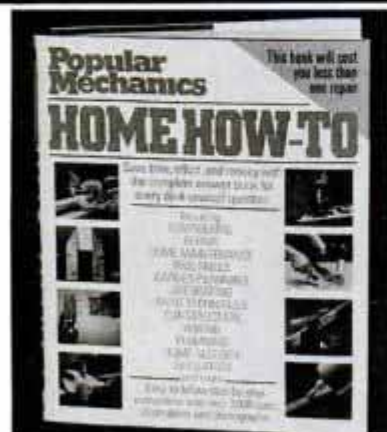
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