

AUGUST 1990 \$1.95

Popular Mechanics

JEEP CHEROKEE TAKES ON
8 NEW 4-DOOR SPORT/UTILITIES

100 MPH JET SHIPS

'Red October' Supermagnet
Motors With No Moving
Parts Are Now For Real



Superconducting magnets propel
a jet-thrust submarine freighter
under the polar ice cap.

HOME&SHOP JOURNAL

- Workshop-Testing
9 Top Circular Saws
- Gas Grill Tuneup For
Better Barbecues
- Mood Lighting For
Your Backyard And Patio



SPECIAL REPORT

ALASKA PIPELINE TIMEBOMB

Repairs Are Already
Needed To Prevent
The Worst Environmental
Disaster In History



There's never been a car like Thunderbird. And there's never been a Thunderbird like this.

Quality by design.

The idea is simple: commitment to the excellence of each vehicle component can result in improved vehicle quality overall. An example: over 400 of Thunderbird's mechanical, operational, and comfort features were compared to features on cars like Mercedes 190E, Toyota Supra L, and BMW 633CSi. By employing this kind of detailed analysis, Ford strives to make each new vehicle superior to what we've offered before. It's all part of insuring that Quality is Job 1.

Structural integrity.

Thunderbird was designed with increased structural adhesives at joints and two-part expanding foam throughout.

Buckle up—together we can save lives.

This not only results in reduced noise and vibration in the passenger compartment, but allows for a longer, wider wheelbase that gives the vehicle a more substantial feel over the road.

Ride and handling.

Thunderbird features a four wheel independent suspension with rear control arms and a front tension strut that are "double isolated." All of which helps to insure less harshness in ride and in handling.

"Speed sensitive" rack and pinion steering also adds to the Thunderbird's "feel." It adjusts the amount of power assist from light effort steering at lower speeds to a firmer feel at faster speeds.



Power.

Thunderbird's 3.8 liter V-6 features "low friction" roller tappets and sequential electronic fuel injection. Also, lightweight components like magnesium rocker covers assist in providing a better power-to-weight ratio.

Aerodynamics and ergonomics.

This is the most aerodynamic Thunderbird ever designed. Which translates into less wind resistance, improved handling, and reduced interior noise. Ergonomically, there's more head, shoulder, hip, and leg room than the Thunderbird of just a couple of years past.

Fully equipped.

Thunderbird LX features air condition-

ing, power windows, electronic AM/FM stereo with cassette player, speed control, fuel/distance computer, and full electronic instrumentation. All standard.

Best-built American cars.

The best-built American cars are built by Ford. This is based on an average of consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1."

Ford Thunderbird

Have you driven a Ford...lately?



65C7-LX7-G73U

Материал из официального сайта Ford

For better performance, fill up with premium.



If you're looking for a way to improve your vehicle's performance, install a set of Bosch Platinum spark plugs. And step on it.

The minute you do, you'll get smoother acceleration, improved fuel efficiency, and, of course, quicker starts. As you can see in the cut-away, Bosch Platinum has a 99.9% pure platinum center

electrode engineered into a revolutionary extended insulator design. It's the only plug in the world with this feature.

Next time you change your plugs, try a set of Bosch Platinum, the premium spark plug. You'll be better off in the long run.

To locate the Bosch dealer nearest you, call 1-800-882-8101.



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Popular[®] Mechanics

AUGUST 1990
VOLUME 167
NO. 8



60 COVER STORY

A practical electromagnetic drive may one day make propellers, and other moving parts, obsolete and push submarines underwater at 100 mph.

—PM cover illustration by Jeff Mangiat

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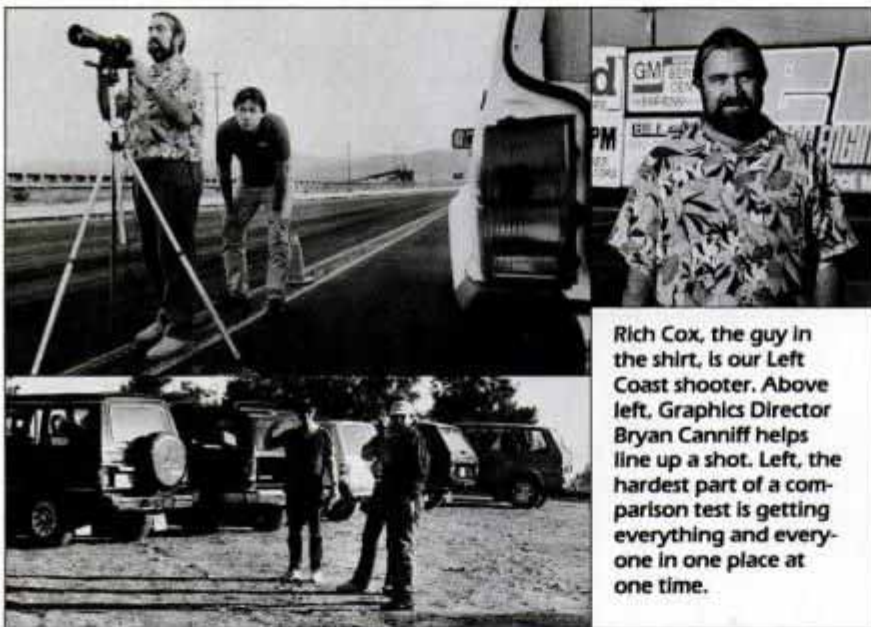
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EDITOR'S NOTES

HOW DOES ONE go about comparing the performance of the new group of 4-door sport/utility vehicles? Well, first you make about a million phone calls to nine different motor vehicle manufacturers. Eventually, you end up with nine sport/utes in roughly the same vicinity—in our case, for this month's comparison test, Los Angeles. Then you rent Los Angeles County Raceway and Willow Springs road racing circuit, so that you have places to conduct the battery of instrumented tests you'll need. At some point in time, four editors, one art director and three assistants get on a plane in New York City and fly out to L.A. with suitcases and trunks loaded with test gear. Once they land, everyone fans out, collects all the vehicles and drives them to a hotel parking lot. Now, at last, the actual testing can begin. This is about how it went with this month's sport/ute shootout (and with all our comparison tests). The actual testing took another several days.



Rich Cox, the guy in the shirt, is our Left Coast shooter. Above left, Graphics Director Bryan Canniff helps line up a shot. Left, the hardest part of a comparison test is getting everything and everyone in one place at one time.

Then the raw data had to be tabulated and compiled, the story written and laid out and, *viola!*—you have what you see on pages 55-59 of this issue. The one missing ingredient is the photos you see that accompany the story. For this story, we called on Rich Cox. We consider Cox to be the Top Gun of West Coast shooters, even if he does charge an arm and a leg and shows up with his own entourage of assistants, adding mightily to the controlled chaos at any auto test site. But Cox always gets the shot and much of his work borders on art. Look for his photo credit and work in this and other issues of PM. . . . I was probably the only person in the world who didn't read *The Hunt For Red October* by Tom Clancy, the master creator of techno-thrillers. So when I saw the movie recently, and Alec Baldwin and Sean Connery started talking about propulsion systems with no moving parts, capable of hurtling a submarine through the depths at unprecedented speeds, I said, hey, that's our August cover story. And so it is. It's real. Working models of such propulsion systems already exist. And you can read all about it beginning on page 60. Till next time.


Joe Oldham

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Paul Flinn, Construction Superintendent, Weatherford, Texas.
Over the past 40 years, he's never worked without his favorite hat. Or his Skilsaw.

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We made it first. We make it last.



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O N L Y O N



The World Championship-winning Mercedes-Benz team now uses only one make of tires: Goodyear Eagles.



A Goodyear Eagle "contact patch." Where an Eagle demonstrates its superiority.

Mercedes-Benz is known throughout the world for quality, technical innovation and engineering brilliance.

Nowhere are all of those qualities more apparent than in the highly exotic and very sophisticated Championship-winning Mercedes-Benz race cars.

These are the cars that, in 1989, won seven of the eight endurance races that constitute the FIA

All of GM going all out for you.



**"You told us you'd consider
buying a GM car or truck
if we changed more than
just the looks.**

Well, take a look inside!"

"WE'D LIKE TO TAKE YOU INS BECAUSE THAT'S WHERE THE RE

The changes are real, not just cosmetic. They reflect a change in General Motors itself. In the way we work, and in the way we work together.

We've listened to what you said about quality. We've heard your demands for reliable, durable cars and trucks. And we've responded with new vehicles, with new technology, with new production methods in new and refurbished plants.

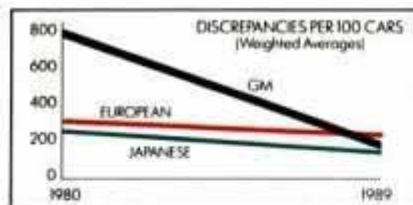
THE HEART OF GM QUALITY

We've introduced 77 new models since 1985. Almost all the cars and half the trucks we make. All re-designed and engineered to dramatically improve quality.

The looks are new. But that's not all. The big improvements are in the engines, transmissions, and electrical systems—the heart of any car or truck. And we're continuing to improve.

MEASURABLY BETTER

GM builds cars you can count on for the long term. No U.S. carmaker has done that job better in the last five years. In fact one measure of dependability, the J. D. Power dependability study of 1985 models, ranks GM highest in vehicle dependability among all American manufacturers.¹



Since we built those cars, independent measures have confirmed that our quality has improved substantially. The differences today between GM and the best imports are very small indeed.

According to one quality study by Harbour & Associates, we're better than the average European make, and the difference between GM and the average Japanese import is less than one-half of one discrepancy per car. Our own tracking confirms GM's significant improvement.

GREATER DURABILITY



According to R. L. Polk Registrations, a higher percentage of 10-year-old GM cars are still on the road than '79s from Ford, Chrysler, Mazda, Nissan, Toyota, or Honda.

RELIABLE ENGINES

GM's engines are more dependable than those of all other domestic carmakers. Our 3800 V-6 is at the top in engine quality among engines from all makers, foreign or domestic. That's the finding of the most comprehensive customer-based survey in the auto industry.



In the latest evaluation of 1989 engine quality, the 2.3-liter Quad 4 was as problem-free as 2-liter engines from Toyota or Honda after three months' ownership. In the latest survey of a full year of ownership (for 1988 models), Cadillac owners reported fewer engine problems than Toyota or Mercedes-Benz owners—a tribute to the 4.5-liter V-8 engine. In 1990, we're striving to deliver the quality you demand.

BETTER-BUILT AIR CONDITIONING

The reliability of major mechanical systems is important to our customers. GM's new cars have better-built air

conditioning systems than cars from Honda, Nissan, or Mazda.

PROBLEM-FREE TRANSMISSIONS

Any car or truck is only as reliable as its transmission. And our automatic transmissions are more problem-free than those of any domestic competitor—and most imports.²

This year GM is introducing an electronically controlled transmission that is linked with the engine's control system. An electronically integrated powertrain raises fuel efficiency, lowers emissions, and improves response.



TECHNOLOGY THAT LASTS

GM is the only domestic manufacturer to design and build multivalve engines. And we build them to last. Our 16-valve Quad 4 has already run the equivalent of 100,000 miles at 100 mph without stopping under test conditions.

On the endurance track, a full-size Chevrolet sport truck equipped with GM's



IDE OUR CARS AND TRUCKS. AL CHANGES IN QUALITY ARE"

350 cu. in. V-8 captured the Hulman Trophy for sustaining 100 mph for 24 hours at Indianapolis.

MOST TROUBLE-FREE U.S. CARS

For the second year in a row, Buick LeSabre is the most trouble-free American car. That's the finding of the new 1990 J. D. Power and Associates Initial Quality Survey.¹ Initial quality like this helped Buick repeat for 1990 as the highest-ranking U.S. nameplate.

Chevrolet's Lumina Coupe was ranked as the top midsize specialty car in the new study—based on owner-reported problems in the first 90 days of ownership.



CORROSION PROTECTION

We offer the highest level of exterior-galvanized corrosion protection in the world. In fact, we're the only high-volume carmaker extensively using two-sided galvanized materials to protect against rust.



That's how we can stretch our limited warranty's corrosion coverage to six years or 100,000 miles minimum.³

99.9% CERTAIN STARTS

Virtually every engine in every GM car or light truck features electronic fuel injection. Electronic sensors measure temperature and



engine conditions.

Re-designed injectors and engine control computers meter the right amount of fuel for sure starts.

These GM cars start the first time, hot or cold, in any weather, regardless of where you live in the United States.

HIGHLY SATISFIED CUSTOMERS

GM's Cadillac division has been the highest-ranked domestic nameplate in customer satisfaction for the past three years.⁴

The customers of every other GM division are highly satisfied as well. After six months of ownership, at least 95% of all Chevrolet, Pontiac, Oldsmobile, Buick, Cadillac, or GMC Truck owners would recommend a vehicle from that GM division to a friend.

ENDURING VALUE

Over the last 10 years, cars built by General Motors have kept more of their original value, on the average, than cars made by any other U.S. manufacturer. Chevy and GMC trucks retain more of their original value than trucks sold in the U.S. by any other manufacturer in the world—foreign or domestic.⁵



WE COVER EVERY PART

We back our vehicles the way we build them. Our Bumper-to-Bumper Plus limited warranty covers every part of every GM car or light truck. For three years or 50,000 miles.⁶



WE CARE ABOUT YOU

We care what you think about GM quality. People throughout General Motors—the GM Quality Network—have taken a long, hard look at the cars and trucks we build. And the way we build them.

Today there is a new pride at GM. A new commitment to quality. A clear focus on our customers and on their needs. A dedication to continually improving our vehicles. Year after year. Until every model is as good as the best in the world.

We've accomplished much already. We invite you to take a good, close look at the results: our new GM cars and trucks, and the new level of General Motors quality.

1: J. D. Power and Associates Vehicle Dependability Index Study.SM In a ranking of the three domestic manufacturers, based on things gone wrong to 4-to-5-year-old 1985 model vehicles in the past 12 months.

2: GM owner-satisfaction survey for first quarter of 1990.

3: See your GM dealer for details of this limited warranty covering corrosion.

4: J. D. Power and Associates 1987-1989 Car Customer Satisfaction with Product Quality and Dealer ServiceSM studies. After one year of ownership.

5: GM corporate study of 3-to-5-year-old used vehicles resold between 1979 and 1989.

6: Tires on GM cars are warranted by their manufacturers. Cadillac's Gold Key Bumper-to-Bumper limited warranty offers coverage for 4 years/50,000 miles, and Cadillac's Allante is backed for 7 years/100,000 miles. See your GM dealer for details of the limited warranty. A deductible applies.

PUTTING QUALITY ON THE ROAD



MARK OF EXCELLENCE

Chevrolet Pontiac Oldsmobile
Buick Cadillac GMC Truck

"SOME OF THE 77 ALL-NEW MODELS WE'VE INTRODUCED SINCE 1985, ALL RE-DESIGNED AND ENGINEERED TO DRAMATICALLY IMPROVE QUALITY."



CHEVROLET CAPRICE CLASSIC



CHEVROLET LUMINA APV



CHEVROLET CORVETTE ZR1



CHEVROLET LUMINA EURO SEDAN



CHEVROLET 4-DOOR S-10 BLAZER 4X4



CHEVROLET FULL SIZE PICKUP



PONTIAC



PONTIAC TRANS SPORT SE



PONTIAC GRAND AM SE COUPE



PONTIAC GRAND PRIX SE



Oldsmobile



OLDSMOBILE CUTLASS SUPREME



OLDSMOBILE SILHOUETTE



OLDSMOBILE CUTLASS CIERA SL



BUICK



BUICK REATA CONVERTIBLE



BUICK 4-DOOR REGAL



BUICK LESABRE



Cadillac



CADILLAC FLEETWOOD 60 SPECIAL



CADILLAC ELDORADO



CADILLAC SEVILLE STS



GMC TRUCK



GMC TRUCK SAFARI GT



GMC TRUCK S-15 JIMMY (4-DOOR)



GMC TRUCK SIERRA WIDESIDE

PUTTING QUALITY ON THE ROAD



MARK OF EXCELLENCE

LETTERS

Missing Horses

AFTER reading your story, "Heavy Metal Haulers" (page 53, May '90), I wonder why a 1990 "high-tech" 454 Chevy engine in your test truck produces only 230 horsepower when, in the same issue on page 100 (Car Care Guide, "A Gallery Of Great Cars"), a 20-year-old 1970 Chevy Chevelle with a 454 produces 450 horsepower? I thought things were supposed to get better in 20 years, not worse. Keep up the good work.

ANDREW MARFINK
WARREN, PA

Close Shave

If the Gillette "Sensor" razor cost \$200 million to research and develop (Tech Update, "Cutting Edge Redefined," page 18, May '90), then it's no wonder that the United States is losing its position in the world as a manufacturing leader. While it's good to know that Gillette has a new product, I'd like to see a blind shaving blade comparison test as a real-world evaluation.

LAWRENCE A. BECKSTED
SAN RAFAEL, CA

Re-Volting Situation

The electric car ("Batteries Are Included," page 134, April '90) is nothing more than slick public relations on the part of all auto companies. In 1963, the Pennsylvania Power Co. assembled an electric car using a VW bug chassis and a rear seat full of lead-acid batteries which performed as well as the GM Impact car. I drove it, and it could burn rubber on hard acceleration.

The electric utilities realized, even at that early date, that electric-powered vehi-



Engine power: They don't make them like they used to.

cles could not be the answer to energy and air-pollution problems because the capacity of America's powerplants cannot supply the recharging needs for millions of autos. Atmospheric pollution would be switched from petroleum hydrocarbons to that derived from coal combustion, which doesn't really ease the problem.

DOUGLAS A. KOHL
OSSEO, MN

Thrust Buster

I read with interest the item in Tech Update ("Biggest Jetliner Engine," page 16, May '90) on General Electric's plans to build a high-bypass turbofan engine that will eventually produce up to 95,000 pounds of thrust. I wonder if G.E.'s decision to borrow the inadequate thrust reverser systems from earlier engines includes a willingness to accept the responsibility of a performance record that includes numerous accidents due to inadequate stopping ability.

I think air travelers deserve a change that's long overdue.

BERT KENNETH BRANDT
RENTON, WA

Cutting Remark

I have been a long-time reader of POPULAR MECHANICS

and found it to be an excellent magazine. But I was somewhat appalled at the statement made in the Home Finance column (page 38, April '90): "It's the same kind of bargain as you'll get from a surgeon who, if you can't afford the operation, will offer to touch up the X-rays for much less."

As a physician and surgeon, I find this statement to be offensive. Maybe I interpreted the statement incorrectly, but my interpretation is: "If you can't afford the operation, I will do it for less, or do second-class surgery."

MILTON R. TIGNOR JR., M.D.
WEST PALM BEACH, FL

Cable Vision

Your article on the Hawaiian deep water cable project in your May issue (Tech Update, "Cable Laid At Record Depth," page 20) accurately portrayed the challenges and success of the program. However, should the commercial aspect of the project come about, the deep-sea electrical connection you wrote about would be between the geothermal fields on the islands of Hawaii (not Maui) and Oahu.

Hawaii is the most oil-dependent state in the union with more than 90 percent of the oil coming from foreign sources. We are currently negotiating with a consortium for the possible purchase of up to 500 megawatts of geothermal energy and shipment of that power from Hawaii to Oahu.

PM's shop project improved upon by reader Kirchman.

If we can negotiate a price that is reasonable to our customers and be assured of an adequate resource, the development of up to 500 megawatts of renewable geothermal energy would be a huge environmental plus in our fight against global warming. It would also move the state of Hawaii many steps forward in its quest for energy self-sufficiency, and decrease the potential for a disastrous oil spill by reducing our oil imports by 387 million gallons a year.

SCOTT SHIRAI
COMM. SUPERVISOR
HAWAIIAN ELECTRIC CO.
HONOLULU, HI

Desk Project

I am enclosing some snapshots of the secretary desk I built from the article you ran in your November '89 issue (Woodworking Guide, page 71). I enjoyed making this desk. The prints were clear, accurate and very well presented.

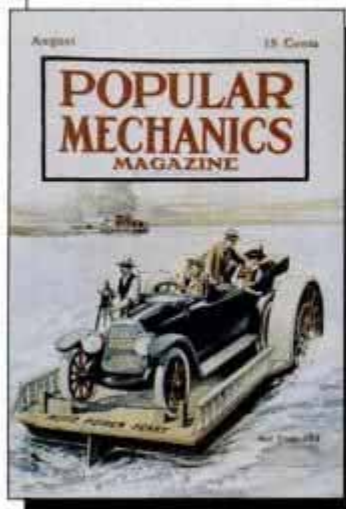
I made a slight change in designing the front drop drawer. I used a brass inlay on the cover.

HARVEY KIRCHMAN
NO ADDRESS GIVEN



TIME MACHINE

75 YEARS AGO: AUGUST 1915



Car-Powered Ferry

The entrepreneurs of the Model-T era were always looking for new ways to harness the power of the automotive engine. Take the 1-car ferry we put on our cover three quarters of a century ago. You put your car on a small barge, jacked up the rear end, and clamped the spokes of your rear wheels to the axles of the boat's twin paddle wheels. With your foot on the gas pedal, you powered your way across the bay. Total cost of the ferry in 1915-dollars: \$100.

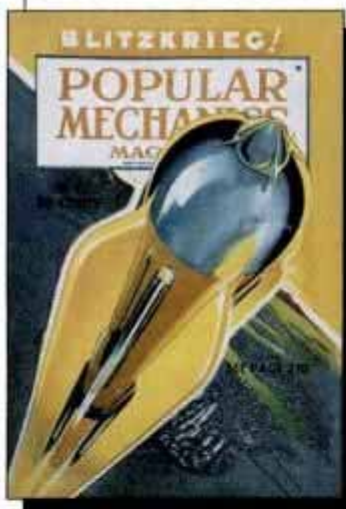
Sign Of The Times

The billboard below, mounted along every highway entering the county, says a lot about the early years of the 20th century. We reported that the system worked very

well, and that for a while a grassroots movement strove to extend the honor system to all counties between Los Angeles and San Francisco. We can only wonder, wistfully, what became of it.



50 YEARS AGO: AUGUST 1940



Final Frontier

The Space Age was decades away, but pioneers at Cal Tech were laying the groundwork. Crouched behind sandbag walls, they detonated rocket motors and gauged the effects of 5000° F temperatures on nozzles and firing chambers. The test motors, fixed to torsion balances, vented their exhaust at 3600 mph, charring and twisting the steel nozzles. The researchers' aim: to loft a 3-stage rocket to 500,000 ft., 5-times higher than any man-made object had ventured.

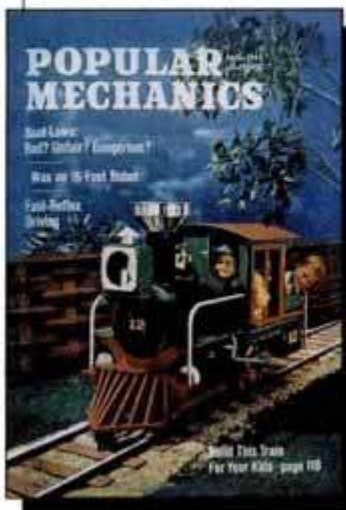


Sky Eyes

Radar was still largely a military tool, but civil aviators were hoping to reap some benefit. The airspace above Chicago and New York was becoming thick with DC-3s, and pilots had no air-to-air communications, only air-to-

ground capability. Aeronautical engineers, therefore, proposed arming all airliners with interplane phones and collision-avoidance radar systems. The "radio headlights" would probe 60 miles ahead, setting off a warning light if collision threatened.

25 YEARS AGO: AUGUST 1965

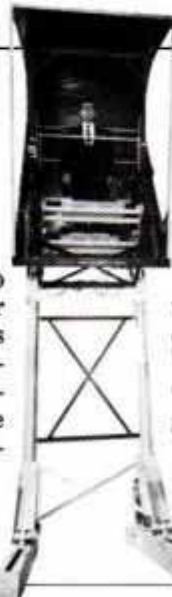


Backyard Railroad

For the home craftsman with an indulgent streak, we placed on our cover the latest in a series of extravagant homebuilt toys, sure to draw gasps from the most jaded tyke. The Backyard & Bird-bath R.R. chugged along at 5 mph on 2 x 4 rails. Steam streaming from the stack belied the fact that power really came from a pair of jumbo solenoids attached to the connecting rods. For safety, a simple handbrake would halt the train in a half turn of the wheels.

Low-Tech Cyborg

Given the primitive state of mid-'60s computer technology, the only way to get a robot to work was to let a human do the thinking. Our writer offered his brain to science, taking a spin in an automaton called the Pedipulator at General Electric's Advanced Technology Laboratories in Schenectady,



New York. Designed to demonstrate a human's ability to balance a 2-legged cyborg, it was one of an emerging class of research vehicles called cybernetic anthropomorphic machines (CAMs). The builders envisioned CAMs one day humping girders around shipyards and other heavy manufacturing sites, and charging over rough terrain as Army vehicles. **PM**

The Best Radar Detector Ever Made Is Now Even Better. What Does That Mean to You? PLENTY.



How Can The Best Get Better?

The answer to that question is simple: The new ESCORT picks up radar signals from farther away than ever was possible before...in its new, smaller, streamlined case.

**Advanced Computer Technology:
What's New Under the Handsome Case**
The all-new ESCORT literally uses space-age technology—Digital Signal Processing (DSP), the same advanced system NASA uses to "sharpen" radar images.

If you like technical talk, here's what DSP does: It samples incoming radar signals 50,000 times a second. Information is digitized and analyzed by a signal-recognition computer.



The heart of ESCORT's DSP circuitry is a custom version of the Motorola DSP 56000. This 20 MHz 24 bit parallel HCMOS processor is capable of 10.25 million instructions per second, and is also used in Steve Jobs' new \$10,000 NeXT computer.

Result? Greater distance than any detector ever had before. Greater separation of garbage-signals. Incredibly fast reaction to instant-on traps. Better protection than any driver could have had before.

And oh, yes: The case itself is aluminum, finished in non-glare black...not cheap plastic.

A New High Level of Safety and Protection

The new ESCORT brings you up to a level of protection no radar detector could provide before. You no longer will wander into a sudden "beep-explosion," too late to slow down. Even distant "instant-on" radar doesn't faze this mighty detector.

Early warning is well beyond the capability of early detectors without ESCORT's power and sensitivity. You know the value of radar warning. You should know, too — Only one detector is most powerful: ESCORT.

Here's What the Experts Say

"If you are a fan of the old Escort, you are really going to love the new Escort...The unit is the first to utilize Digital Signal Processing (DSP) to sniff out weak radar signals."

—Sport Truck

"A new automobile radar detector picks up weaker signals than was previously possible, thanks to Digital Signal Processing (DSP)."

—Machine Design

"The new Escort uses Digital Signal Processing, something not used before in other than military applications."

—Stock Car Racing

"The new Escort packs ultimate sensitivity into a small package. Nothing else even comes close, and no wonder...No analog device can hope to match this performance."

—BMW Roundel

- Just 7/8" high, 3 1/4" wide
- Visor clip and adjustable windshield mount
- Alert lamp glows on radar contact
- Variable-pulse warning
- Hewlett-Packard LED bar graph shows radar proximity
- Photocell adjusts display to car's light level (dark mode for discreet operation)
- Adjustable volume and mute switch (including "automute" to turn down volume after first alert)

Thieves Know:

They Can't Use a Stolen ESCORT!
ESCORT has a tiny "Digital Key." Use it to unlock your ESCORT when you first get it, then every couple of months. Without the key, ESCORT won't work.

Thieves know this. When they spot an ESCORT, smart crooks move on to the next car.

It Costs No More to Have The Best
ESCORT costs \$295. That's actually less than some radar detectors with a fraction of ESCORT's ability. We've built more than two million PASSPORT and ESCORT radar detectors, and we stand behind every one of them.

But—
You don't risk one cent to find out for yourself just how much protection ESCORT gives you. Use it for one full month. If for any reason you think you can get along without it, send it back and we'll send you a complete refund, even including your return shipping costs. What could be fairer than that?

Use ESCORT for One Month at Our Risk
Order by Toll-Free Phone 24 Hours a Day, Seven Days a Week.

Call toll-free 1-800-543-1608



ESCORT

RADAR WARNING RECEIVER

\$295 Ohio residents add \$16.23 tax. Higher in Canada.

A product of Cincinnati Microwave, maker of PASSPORT and ESCORT.

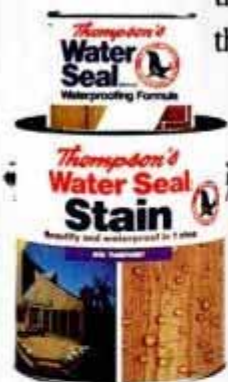
Cincinnati Microwave
► Department 006880
One Microwave Plaza
Cincinnati, Ohio 45249

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Thompson's® proves that oil and water not only mix, but make a better stain.

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that gives you the advantages of both without the disadvantages:



Thompson's® Water Seal® Stain.

Our unique formula gives your home beauty that's more than skin deep.

Thompson's Stain has a formula so unique it's been granted a patent by the U.S. Patent Office. It provides the deep penetrating color of an oil-base

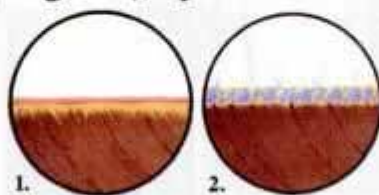


it bonds to the surface fortifying it and protecting against chalking and fading. All the while Thompson's® Water Seal® works to protect against the ravages of water and weather.

stain with the durable surface protection of an acrylic stain. Then we add the waterproofing power of Thompson's® Water Seal®. The result is a stain that gives your home beautiful, long-lasting color and protection.

**Long lasting beauty.
Long lasting protection.**

As you apply Thompson's Stain (Diagram 1), it penetrates



to anchor the color throughout the wood and protect against chipping and flaking. At the same time (Diagram 2)

Tests prove Thompson's is an extraordinary exterior stain.

To prove how well Thompson's



Fading and cracking without Thompsons!

works, we had an independent lab conduct extensive tests.

The results: outstanding overall protection against fading, chalking, cracking; and superior waterproofing.

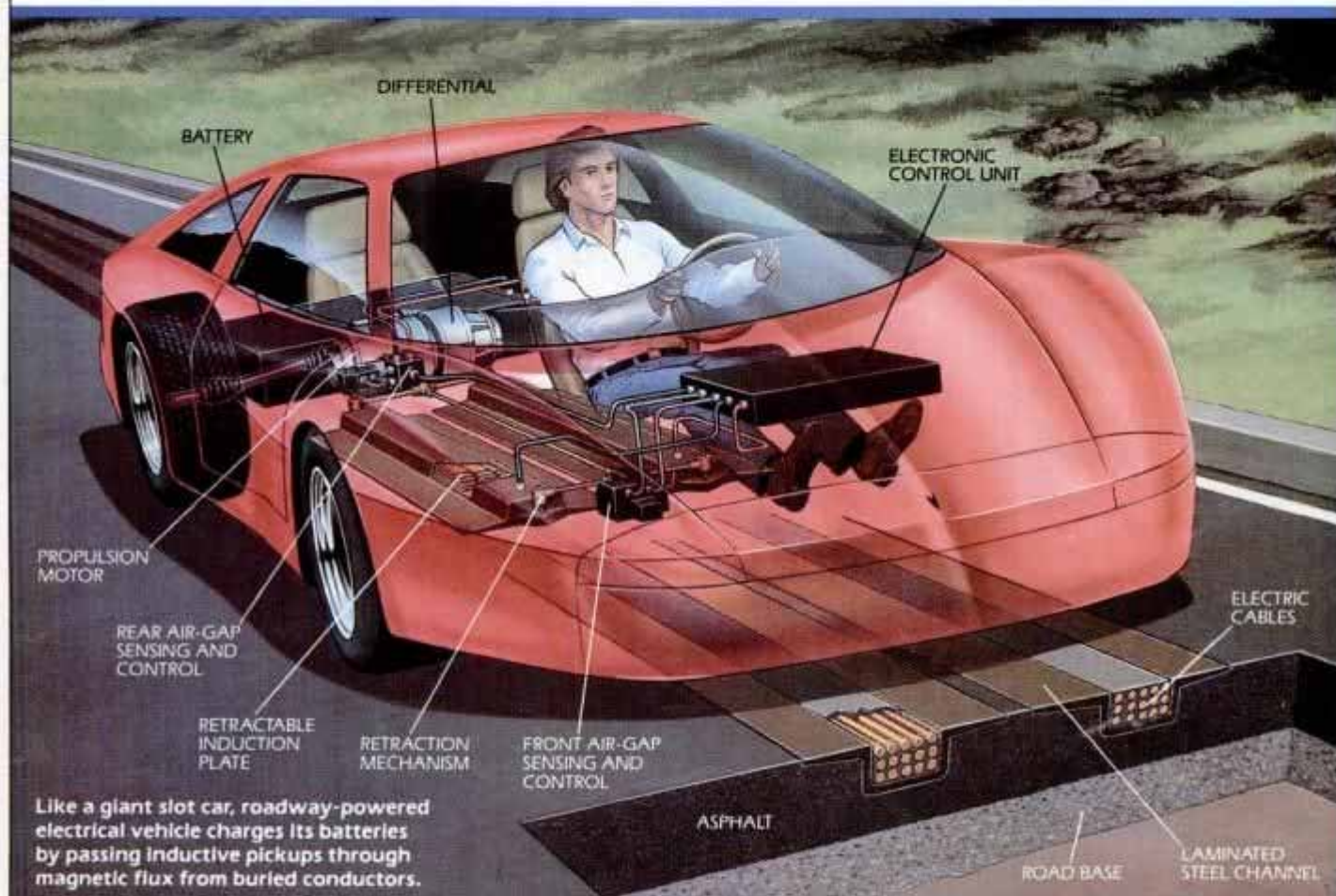
To get more information, call 1-800-367-6297. And to give your home a freshly stained look that lasts, get Thompson's® Water Seal® Stain.



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TECH UPDATE

News Of Tomorrow's Technology Today



Like a giant slot car, roadway-powered electrical vehicle charges its batteries by passing inductive pickups through magnetic flux from buried conductors.

PM ILLUSTRATION BY MARK MCCANDLISH

Juiced-Up Roads To Power Electric Cars

LOS ANGELES, CA—Instead of keeping your electric car couped up in the garage every night for recharging, why not let an electrified highway keep the batteries alive? Two California utilities are testing the idea on a 1000-ft. strip of road in an L.A. housing development.

The system operates on the principle of magnetic induction. Current passes through electric cables buried in the roadway, creating a magnetic field. Induction sets up a second electric current in a metal plate moving through the magnetic field. Testers are reporting 90-percent efficiency in energy transfer.

The plate deploys from the

bottom of a vehicle and feeds electric power to a propulsion motor and to a charging system for on-board storage batteries. Once off the electrified roadstrip, the plate retracts and the battery powers the motor.

California officials hope to electrify a network of freeway lanes to give roadway-powered electric vehicles (RPEVs) unlimited range. Costs would run between \$1 million and \$1.5 million per mile. But whether the idea will work outside Southern California's benign climate is a big question mark. Induction requires a smooth 2- to 3-

Editor: Abe Dane
Assistant Editor: Gregory T. Pope
Contributor: Mike Fillon

in. air gap between pickup plate and road surface, and pothole-riddled East Coast roads may not cooperate.

Forward-looking, obstacle-detection equipment may be able to solve that problem, however.

Highlights This Month

■ **Airplane 1995**—Boeing's high-flying 777 will vie with MD-11 and Airbus jets.

■ **Hey! You Take The Wheel**—Toyota engineers give "concept car" a bizarre new definition.

■ **Revenge Of The Diesel**—Exhaust-recycling system gives new life—and stealth—to the venerable diesel submarine.

■ **Seven-Ton Skydiver**—Records shatter as heavy-payload parafoils glide to the ground.

■ **Venus Unwrapped**—Magellan begins mapping the mysterious planet.



BOEING ILLUSTRATION

Long-Range Twin-Jet

SEATTLE, WA—Stung by competition from Airbus and the incipient threat of McDonnell-Douglas's MD-11, Boeing is trying to lure customers with an all-new plane to be called the 777.

The transcontinental twin-jet will carry 350 passengers, and a 280-seat version for the West Coast-to-Europe flights is also in the works. A 197-ft. wingspan gives the 777 high-altitude fuel efficiency, and folding wingtips would enable it to negotiate airport gates. If it sells, first flight should be in 1995.

Like a DC-10 with 747 wings, the Boeing 777 could fly over crowded 30,000- to 35,000-ft. airspace.

Six Wheels To Mars

PASADENA, CA—While walking Mars rovers have captured attention, Jet Propulsion Laboratory researchers say wheels are more reliable. A 6-wheeled, articulated-chassis vehicle is now roaming a canyon here, testing autonomous-navigation software.

The rover scans ahead with four stereo cameras, then plots a course through the scanned terrain and follows the course. Once faster

vision processors are grafted on, the rover will be able to cover ground at an average speed of 1 in. per second. If sensors detect sudden dips or rises, the vehicle halts for safety. Meanwhile, data from sensors will add detail to a low-resolution satellite-derived Martian map stored in the rover's memory.

Self-steering rover houses stereo TV cameras and processors in central chassis. Front axle holds robotic arm.



NASA JPL PHOTO

Toyota's Wacky World

NEW YORK, NY—Challenged by a company contest for the most impractical vehicles possible, Toyota's engineers channeled their imaginations into six tongue-

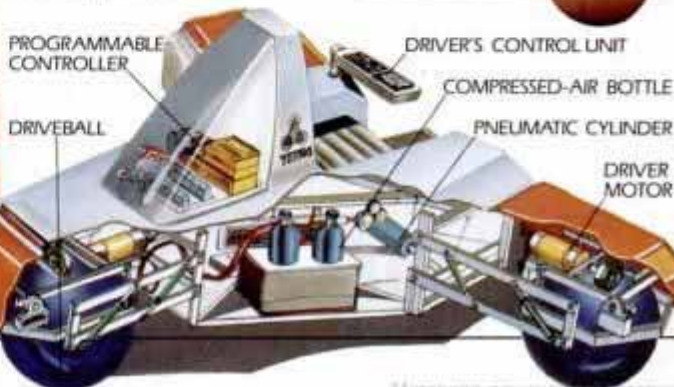
in-cheek cars that stole the Auto Show here in April. Tetra runs on three independently powered plastic spheres, with rotations that are computer-choreo-

graphed into omnidirectional movement. Similar spheres propel the telescopic Daddy Long Legs. Also at the show: the New Walker, with eight wheels mounted on four legs, the voice-activated VCV ("Turn left!" "Stop!"), voice-powered Screamer (the louder you scream, the faster it goes), and "Hey! You take the wheel," with basic controls built into a free-floating steering wheel.

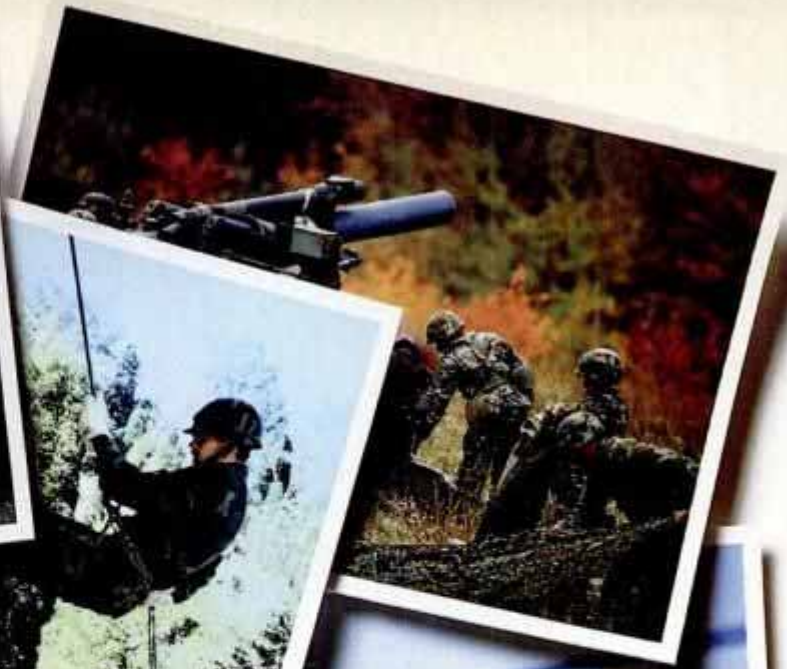


TOYOTA PHOTOS

Omnidirectional spheres carry Tetra (above) and Daddy Long Legs (far right). Each of Tetra's spheres has its own motor.



TOYOTA ILLUSTRATION



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Branch _____

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Americans At Their Best.

Spacecraft To Explore Van Allen Belts

NEW YORK, NY—NASA and the Air Force are pooling their resources to build a 4000-pound satellite that will report on the effects of the Van Allen radiation belts, which have mysteriously disabled spacecraft in the past.

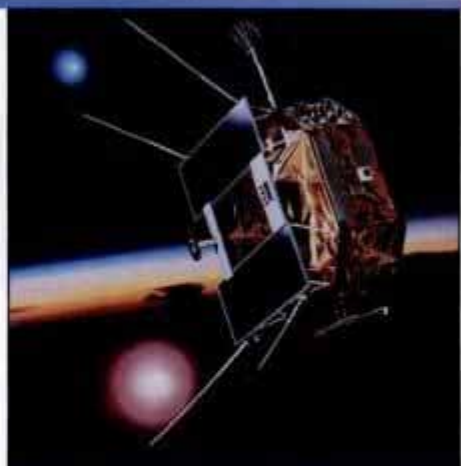
The 8-sided aluminum honeycomb craft, known as Combined Release and Radiation Effects Satellite (CRRES), will be launched aboard an Atlas Centaur Booster this summer. Following a highly elliptical or-

bit, ranging from 22,231 miles to 215 miles above the Earth, CRRES will pass through the belts twice on every circuit.

To determine the properties of the radiation belts, the spacecraft contains 24 canisters charged with lithium, barium, calcium or strontium. Observed from the ground, the brightly colored clouds of



CRRES satellite undergoes checkout (above), before being launched into elliptical orbit gauged for maximum exposure to Van Allen radiation (right).



NASA PHOTO; NASA ILLUSTRATION

charged particles that result from release of these chemicals will provide clues as to the belts' composition. To investigate their ef-

fects on electronics, the Air Force has placed test circuits aboard, which it will monitor remotely.



Power-Payload Parafoils

EDWARDS AFB, CA—NASA is testing vast parafoils designed to recover jettisoned launch-system components such as rocket engines. The aim is to recycle costly parts.

One 3600-sq.-ft. foil, designed by Pioneer Aerospace, recently carried 14,000 pounds to the ground. The parafoil, called the High

Glide Recovery System, set new records for foil area and payload.

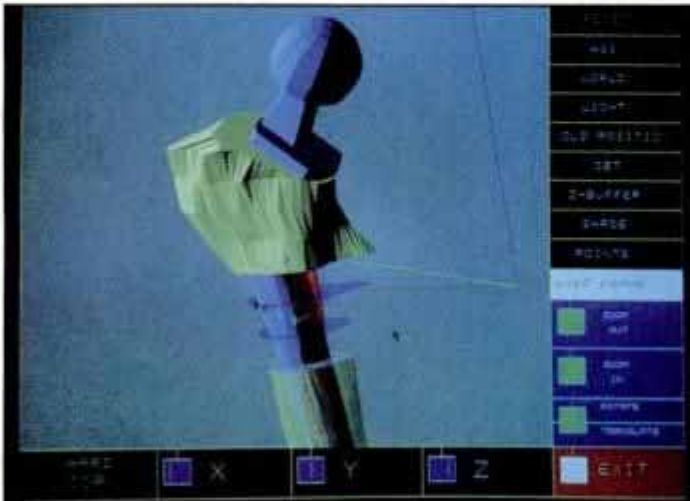
Testers unloaded the payload pallet from an Air Force C-130 flying at altitudes of 12,000 ft. and 14,000 ft. As the main parafoil unfurled, ground-based controllers guided the drop-test vehicle remotely. Commands that are radioed to an on-pallet

Drogue chute first guides payload into vertical plunge, then releases itself as main 105-ft. parafoil deploys.

electronics pod actuate deflection of the foil's trailing edge, turning the drop-test vehicle left or right.

By year's end, Pioneer plans to demonstrate a 10-ton-payload foil, aiming ultimately for 30-ton capability.

PIONEER AEROSPACE PHOTOS



Supercomputer image of artificial hip. Image data can be fed directly to numerically controlled machine tool.

Supercomputer Bone Models

ITHACA, NY—Physicians and mechanical engineers are turning to the supercomputer to predict the performance of artificial joints. The goal is to extend the lifetime of implants such as prosthetic hips.

The reason for bringing in high-powered number crunchers, such as Cornell University's IBM 3090, is the difficulty in designing an implant with a surface geometry that reflects the complexity of bone surfaces.

In addition, as it models the bone-implant interface, a

supercomputer can factor in the unequal strengths of different regions of bone, information that a CAT scan can provide.

The resulting information may be used to develop rules of thumb that will help in the design of a whole family of longer-lived implants.

Researchers involved in designing these artificial joints liken the process to the supercomputer-performed aerodynamics computations that now routinely precede wind-tunnel testing of cars and aircraft.

Tune up your dashboard at the Kmart Auto Sound Sale.

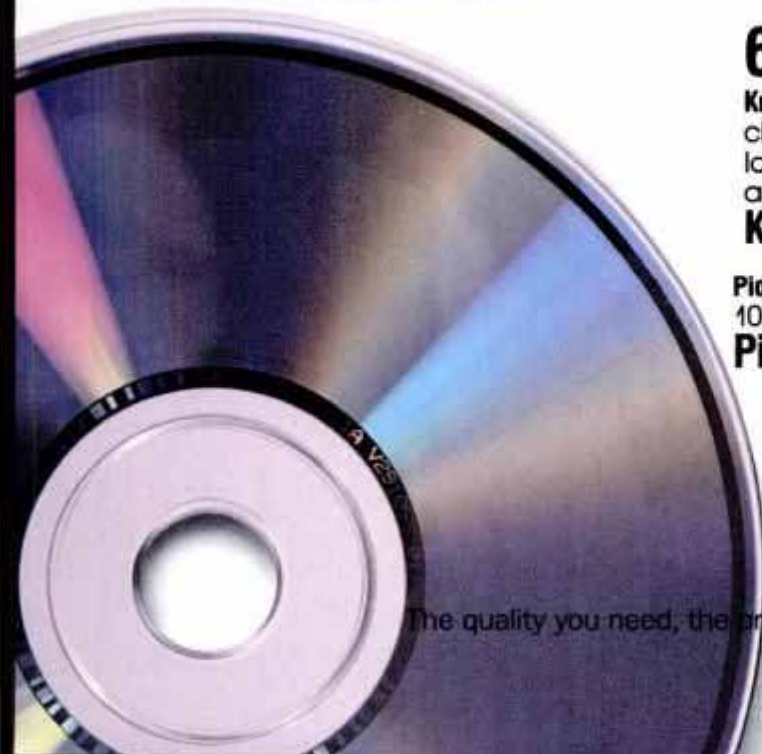


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Sparkomatic SR600 AM/FM Compact Disc Player with Synthesizer Tuner. 3-beam laser pickup, 12 FM and 6 AM presets, scan and standby controls, and 25-watt output.
Sparkomatic



69.00 Your Choice.
Kraco KPA100 100-Watt Amplifier. 50 watts per channel, 3-way input compatible for high level, low level and high power. Automatic remote activation.
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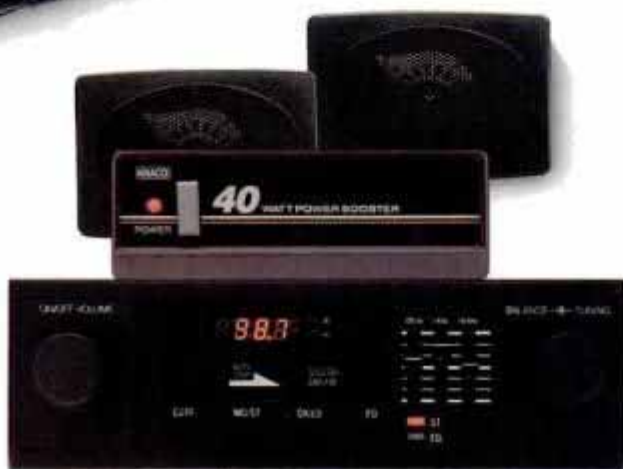
Pioneer TS6933 2-Way Speakers. 6" x 9" Maxxial® 100 watts maximum.
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79.00 SAVE 20.97 Our Reg. 99.97 **Kraco KMP600 AM/FM Stereo Cassette with Speakers.** Digital display, 3-band graphic equalizer and 40-watt power booster. Includes one pair 6" x 9" coaxial speakers.
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AudioVox



64.00 SAVE 15.97 Our Reg. 79.97 **Sparkomatic 9440 3-Way Surface-Mount Speakers** with dome mid-range tweeters and 3/4" woofers for accurate bass response.
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99.00 SAVE 15.97
New! Our Reg. 114.97 AudioVox AV952 AM/FM Stereo Cassette. Electronically tuned stereo with station memory, seek tuning, and locking fast forward.
AudioVox



159.00 SAVE 30.97
Our Reg. 189.97 Pioneer KE2022 In-Dash Deluxe ETR AM/FM Stereo Cassette with auto-reverse, 15-station preset, locking fast forward and rewind, and liquid crystal display.
Pioneer



149.00 SAVE 20.97
Our Reg. 169.97 Sony ESR11 AM/FM Auto-Reverse Cassette Stereo with seek and preset quartz tuning.
Sony



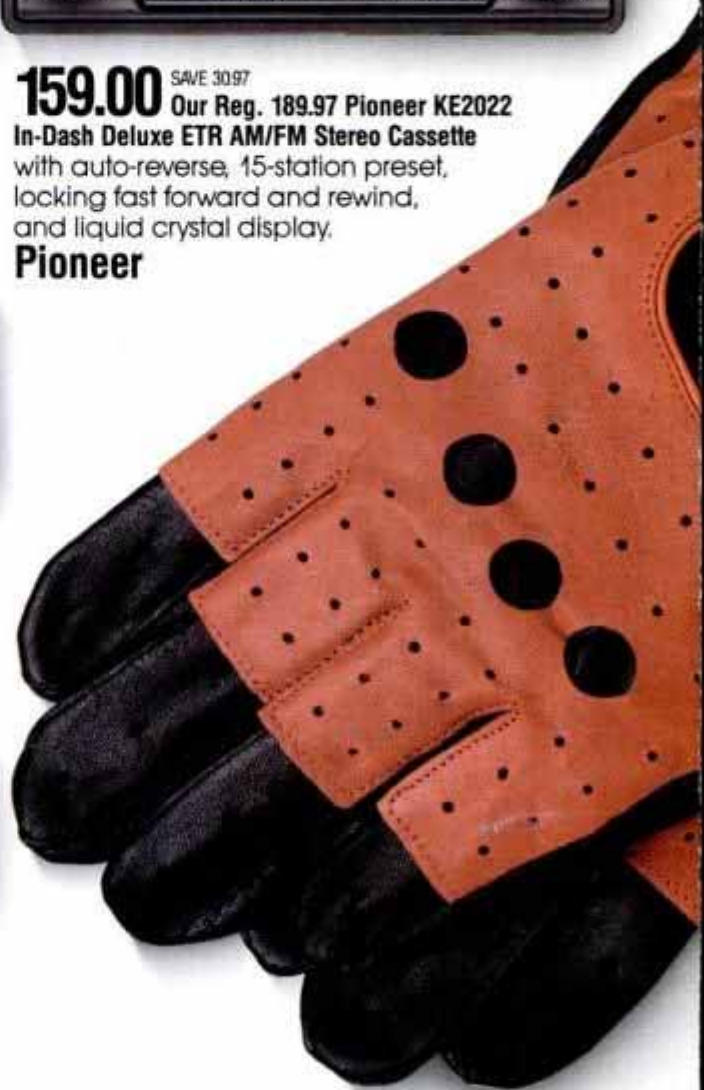
129.00 SAVE 20.97
Our Reg. 149.97 Jensen CS4500 AM/FM Cassette Stereo with auto-reverse, seek, fader, 12 FM and 6 AM presets, and automatic program control.
Jensen



69.00 SAVE 20.97
Our Reg. 89.97 Sparkomatic SR338 Electronically Tuned AM/FM Cassette Stereo with programmable station memory and seek function.
Sparkomatic



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Our Reg. 64.97 AudioVox AMP785 50-Watt Graphic Equalizer/Amplifier with dual power meters, built-in fader and seven frequency controls.
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Deluxe Radar Detector.**
Compact full-feature
detector with high-
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switch, pulse protec-
tion, 5-segment LED
array and advanced
selectivity system.
Whistler

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***59.00** SAVE 20.00
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**79.00 Whistler WH225
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3-segment LED array,
monitors both K and
X bands, highway/
city mode switch,
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Whistler

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24.00 Your Choice.

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6" x 9" Speakers. Not shown: Kraco THP3 3 1/2" Speakers
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Sparkomatic / AudioVox / Kraco



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Concept Yacht

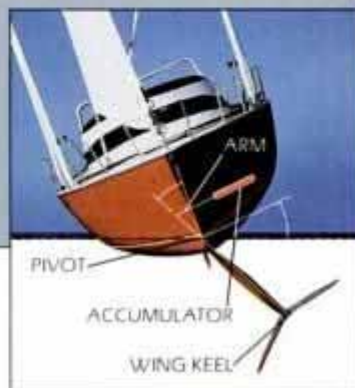
KEY LARGO, FL—Ideas for swifter, smoother sailing are coming together in a sloop now under construction at Catalina Yachts' facility here. The most radical feature on the 65-ft. cruising yacht, dubbed *Amoco Procyon*, is a canting wing keel, operated with a hydraulic accumulator. Pivoting automatically to the windward when the boat comes about, it reduces heeling in strong winds, while the wing design prevents sideslipping.

Above decks, a unique bipod mast improves sail performance, and the two carbon-fiber poles can be lowered while under way, enabling the boat to duck under 20-ft. bridges. The main-sail furls like a jib, on to a central stay, and its battens are flexible enough to be rolled up during furling. The jib itself features a self-tack-



ing mechanism for quicker turns. Overall, the high-technology craft adds 10 to 20 percent to sailing speeds, says designer Britt Chance.

Amoco Procyon, conceived by Olaf Harken, combines unusual rigging with canting wing keel to make sailing faster and less labor-intensive.



AMOCO ILLUSTRATIONS

Underwater Diesel

High and low pressure alternate in transfer cylinders, circulating fresh water into absorber and dirty water overboard. Switch-over valves reverse flow between cylinders.

KETTERING, ENGLAND—A new type of diesel engine developed by Indycar enginemaker Cosworth Engineering now threatens the nuclear sub's monopoly on long-range diving ability.

Normal diesels don't work underwater because expelling exhaust gases at pressurized depths drains too much power. Cosworth solves the problem with an ingenious exhaust recycling system.

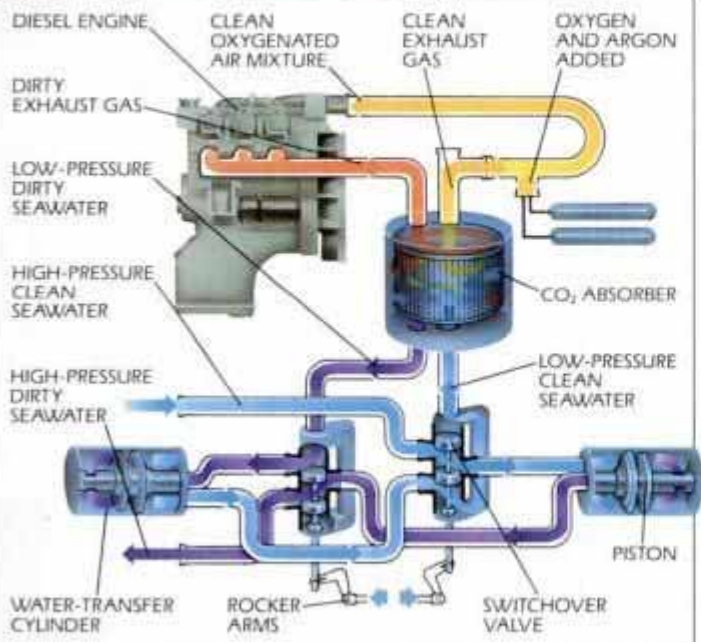
The apparatus centers on a carbon-dioxide absorber that dissolves exhaust products in seawater. Two reciprocating pistons shunt clean and contaminated water in and out of the absorber.

A pump along the clean-water intake pipe adds enough pressure to keep the flow moving, yet the total engine drain is only between 10 and 15 percent.

The system could enable Third World countries to develop low-cost submarine fleets that needn't surface continually.



COSWORTH DEEP-SEA SYSTEMS PHOTO



PMA ILLUSTRATION BY GEORGE BETSECK

Hubble Awakens

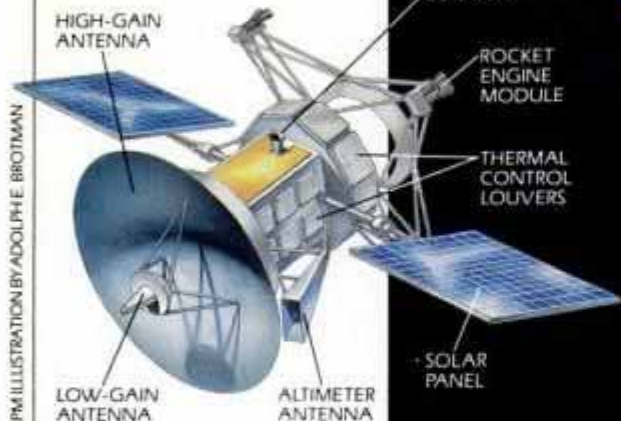
HOUSTON, TX—With the Hubble Space Telescope safely in orbit, controllers have begun the lengthy process of calibration required before it can go to work. After hauling the scope into a 370-mile-high orbit, the Space Shuttle *Discovery* stood by while ground controllers grappled with a balky antenna and solar panel. NASA hopes the scope will go to work within two months of its arrival in orbit.



Discovery photo shows Hubble unfolding solar arrays.

NASA PHOTO

Magellan On Course



PM ILLUSTRATION BY ADOLPHE BROTMANN

During part of each orbit, *Magellan's* high-gain antenna works as a radar mapper, then it transmits data back to Earth.

PASADENA, CA—At this writing, all systems aboard the *Magellan* radar mapping probe are functioning well, as it hurtles toward Venus at 69,000 mph. Now hibernating in cruise mode, the craft

recently tested its maneuvering systems, and the radar it will use to map the planet's cloud-encased surface. Both have survived

their 104-million-mile journey intact. Earlier glitches in the craft's software, star tracker and thrusters have been solved.

Launched from the shuttle *Atlantis* on May 4, 1989, the probe is now 15 million miles short of Venus, and should enter orbit on August 10.



NASA ILLUSTRATION

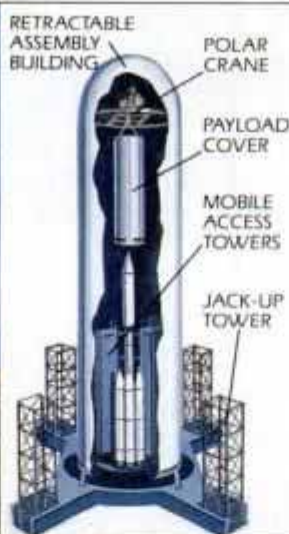
Low-Cost Launch System

HOUSTON, TX—The giant engineering and construction firm Brown & Root has announced plans it says could lower operation and building costs for rocket launch facilities by 50 percent.

The proposal includes a cylindrical, 460-ft.-tall vehicle assembly building that moves on rails so that spacecraft components can be assembled right on the pad. Before launch, the building rolls clear, and a computerized rack-and-pinion system raises the pad into position atop four jack-up towers.

Much of the cost advantage comes from using off-site fabrication techniques developed for offshore oil exploration.

These permit completed components to be delivered to the launch site in barges, reducing the need for large construction crews and extensive excavation. Brown & Root is now preparing to present its plans to NASA and the Air Force.



PM ILLUSTRATIONS BY ED VALIGURSKY

Spacecraft components are trucked to pad and assembled with polar crane (inset). Assembly building rolls back, and pad rises for launch.



One gram of Livermore's smoke-like aerogel supports 100 grams.

Aerogels Get Airier

LIVERMORE, CA—Lawrence Livermore Labs has developed a way to make silica aerogel—one of the lightest solids known—about 10 times lighter. Consisting of about 99 percent air intermingled with a wispy lattice of silicon, it is created by diluting a concentrated silica solution into a thin gel, then drying it at a high temperature so that the silica doesn't collapse with the loss of the supporting liquid. Uses may include extremely efficient insulation and sensitive scientific instruments. **TU**

LAWRENCE LIVERMORE PHOTO

Before You Buy Your Next Classic Sports Car, Check Under The Hood.



Open the hinged hood, doors and trunk and see all the special features — from fully operable steering and wheels to wire mesh stoneguards over the headlights! Shown approximately actual size of 6 7/8" long.

CHEVROLET

Chevrolet Motor Division presents an extraordinary die-cast replica of the 1953 Corvette.

Spectacular — right down to the incredible detail of the "Blue Flame Special" engine.



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Please mail by August 31, 1990.

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Franklin Center, Pennsylvania 19091

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*Plus my state sales tax and a total of \$3 for shipping and handling.

SIGNATURE _____

MR./MRS./MISS _____

ADDRESS _____

CITY _____

STATE/ZIP _____

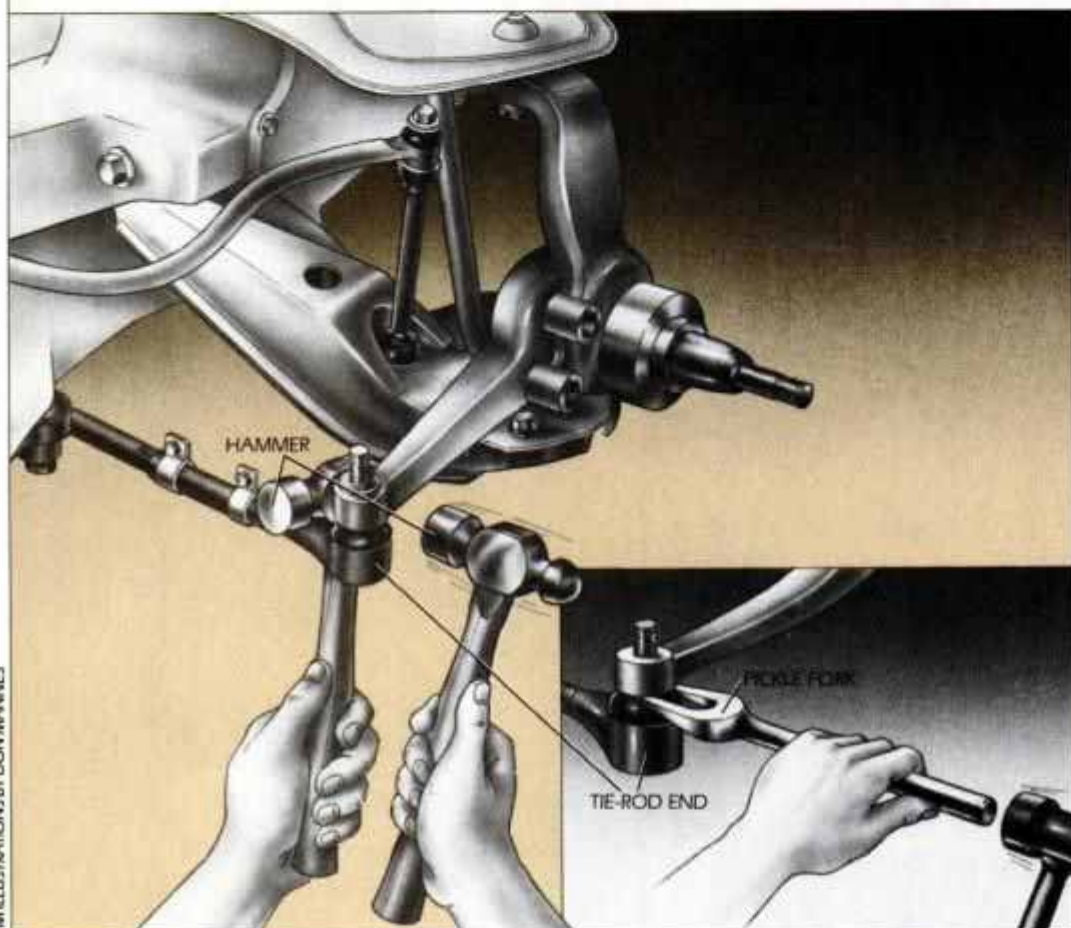
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Franklin Mint Precision Models. Simply Miles Ahead.

Материал: защитный авторский тираж

CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



Foreign Intrigue

I WAS GOING to replace the tie-rod ends of my beloved foreign car myself, something I've always done on my domestics. But the dealership mechanics say that I'll need a special tool to remove the rod end from the steering arm—and the special tool has to be ordered from Germany, and costs over \$100. Is this for real?

DAN LEONARD
CHICAGO, IL

Yes, there is a special tool, specified by the manufacturer, and it's not cheap.

But there are also a number of aftermarket tools, available at your neighborhood auto parts store, that will accomplish the same task—removing the rod end

without damaging either the rod end or the steering arm. You'll have to examine the specific tool to see if it's suitable for your particular car.

If you're sure that the rod end is history, the cheap way out is with the "pickle fork" type of tool illustrated here. Beware—this simple gadget may tear the rod end's dust boot, so don't try it unless you're prepared to install a new rod end.

However, here's my favorite way of removing rod ends. This will work about 95 percent of the time, unless it's really stuck. Remove the nut holding the tie-rod end in place. Hold a big weight or a large hammer against the back side of the steering arm. Whack the front of the arm

smartly with a ball-peen hammer, and the rod end should drop out. If a couple of pops don't do the job, try hitting both sides of the arm simultaneously with hammers. This might be difficult, as it's tough to get much room to swing the one coming from the inside.

Never hit anything except a nail with a claw hammer—use ball-peen hammers for this. And wear eye protection.

Incidentally, before you install the new rod ends, you might think about adding grease fittings, which are probably absent.

Oil Crisis

I have a 1989 F-150 pickup with the 5.0L engine. This truck has about 9000 miles on it, and uses 1 quart of oil every 700 miles. Several Ford

dealers tell me this is normal consumption for this particular engine until break-in, and that eventually I will see oil consumption more like 1000 to 2000 miles/quart. Does this sound reasonable to you?

I have changed the oil every 2500 miles, and drive it less than 10 miles per day.

DUANE STANTON
KIMBERTON, PA

Oil consumption in modern vehicles should be substantially less than a generation ago. Many Car Clinic readers report that their engines won't use any measurable amount of oil between normal oil change intervals. Tighter clearances, better gaskets and improved seals keep oil where it belongs.

But even an extremely minor internal or external leak can push oil consumption to the 700 miles per quart that you are seeing. I agree with your dealership—oil consumption won't stabilize until the engine sees as many as 10,000 miles. Especially if the driving cycle is as short as 10 miles per day—this engine isn't really getting a chance to warm up.

Consider the economics of the situation. Adding a quart of oil every 750 miles (round numbers) for 100,000 miles, (counting the 2500- or 3000-mile oil changes that won't make adding a quart necessary) will cost approximately \$150 for additional oil, compared to the operating cost of an engine that doesn't use any oil at all. If oil consumption is a more expected 1500 miles/quart, and the oil is changed every 3000 miles, you'll need to spend about 50 bucks over the life of the truck.

The difference is about a \$100. An engine rebuild is more on the order of \$1000.

(Please turn to page 26)



1958 Thunderbird

With Motorcraft Quality Parts, it could be 1958 forever.

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If the truck is running well, has a good leakdown rate on all eight cylinders, doesn't leave a puddle on the driveway or a blue cloud behind it, count your blessings. And treat this truck to a trip of more than 5 miles from the house every week or two. You'll have less sludge buildup, longer engine life and, maybe, an improvement in oil consumption.

Recovery Room

My 1986 Olds Cutlass Ciera with 2.5L engine uses coolant very quickly—I have to refill the recovery tank every three or four weeks. It runs fine, there's no evidence of water in the oil, white smoke in the exhaust or leakage of any sort. Yet, even though the recovery tank may be practically empty, the underside of the radiator cap and its seal are always wet. What's wrong with the cooling system?

CHRIS SCARBA
TRESCKOW, PA

There's nothing wrong with your cooling system. The problem is in your recovery system. The radiator cap has two seals to the filler neck. The inner one is the pressure seal, maintaining the 12- to 14-psi difference between the radiator and the atmosphere. The outer one, the one you describe as wet, is designed to route excess expanded coolant to the overflow bottle, and to maintain a vacuum as the radiator cools, sucking coolant into it. If it's wet, it's doing its job.

Look for a leaky connection on the hose between the tank and radiator, or a crack or pinhole in the tank.

Wheels Of Misfortune

The anodized aluminum alloy wheels on my truck have started to develop a lot of chips from rocks and salt. The guys at the local body shop say there is nothing that can be done, there's only one place that anodizes aluminum, and it will cost a lot to ship them to California.

Aside from replacing them, what can I do?

JOHN BARTHMANN
PRAIRIE FARMS, WI

There must be hundreds of shops that can anodize aluminum wheels—look in the Yellow Pages under Plating.

That's only if you're sure your wheels are anodized—a lot of alloy wheels are actually painted with aluminum-colored paint. If the aluminum has a satin finish, just have them glass-beaded at a machine shop, and painted with either clear or silver metallic urethane auto enamel. Don't sandblast wheels, or any other aluminum alloy parts. It will seriously weaken them.

Ground Potential

When doing electrical work, both you and GM recommend disconnecting the battery's negative (ground) terminal. I

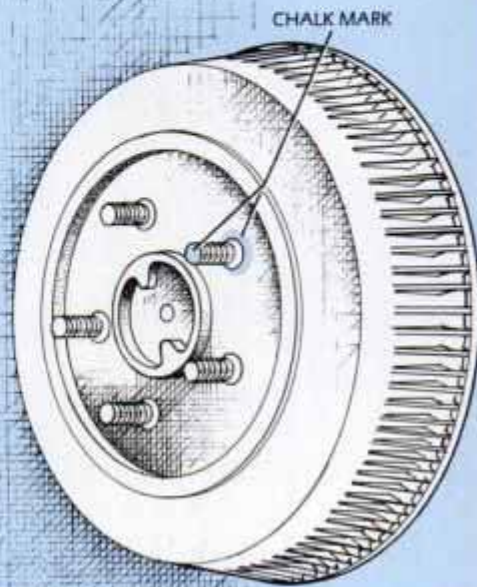
The Other Wheel Alignment

There are still plenty of old cars that use brake drums on all four wheels. There are also a great many new cars that use a combination of disc brakes at the front of the car, where the heaviest braking loads are generated, and drum brakes at the rear.

Drum brakes are still as easy to work on as they always were. If corrosion hasn't set in, it's simple enough to yank the drum loose with your hands. Once the drum is off, simple hand tools are all you need to replace the shoes or cylinder.

But—remember that it's best to reinstall the drum in its original index to the axle, to minimize runout or out-of-balance.

So don't forget to use a chalk mark, felt pen, paint mark or whatever other method is handy to mark one of the studs and its accompanying hole before you remove the drum.



PM ILLUSTRATION BY ADOLPHE BROTMAN

always thought that if the positive terminal were still connected, it would be possible to have a direct short if you happened to touch a hot connection and accidentally touched the body or frame at the same time with a wrench or screwdriver. So why disconnect the negative and not the positive terminal?

CLARENCE STAUGH
NORTH HUNTINGTON, PA

If either battery connection is removed, there's no such thing as a hot connection anymore. The only thing "hot" would be the naked post on the battery.

GM and I suggest removing the ground post to obviate the possibility of striking a short circuit with the wrench while loosening the clamp bolt. If you remove the positive connection first, the entire car is hot with respect to the post—and your wrench. But the negative post is really hot only with respect to the positive post, which is covered. If you accidentally bump the tie-downs or the body of the car while removing the negative clamp first, there won't be any current flow. Do that while removing the positive clamp, and there will be a big spark, and your wrench will get too hot to hold in about a second.

PM

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

■ If your GM car with cast-aluminum wheels shows discoloration around the wheelweights, try switching to the new nylon-coated weights mentioned in TSB 89-65-3E.

■ Most Ford products produced since the 1984 model year have Throttle Position Sensors attached to the throttle body with Pozidrive fasteners, which look like a Phillips-head. Be sure to use a No. 2 Pozidrive screwdriver on these vehicles. TSB 89-14-7

■ 1985-88 GM vehicles with 4.3L, 5.0L or 5.7L engines and automatic transmissions may occasionally clash the starter motor gears, as if the engine were still running. Starter motor No. 10456422 uses a stiffer spring to prevent this problem. When servicing this problem, be sure to inspect the teeth on the ring gear. If three or more consecutive teeth show damage, the flexplate assembly should be replaced as well.

■ Pre-1989 SAAB 900s with leaky automatic transmissions may benefit from a revised transmission oil pan kit, which includes modified front and rear pans, improved gaskets, reinforcing frames for each pan and longer screws with integral washers. The new transmission pans no longer need to be retorqued after 100 miles.

STARTING YOUR ENGINE IS A TERRIBLE THING TO DO.



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MOTORSPORTS

BY MIKE ALLEN, Assistant Auto Editor

TEAM UNICORN PHOTO



One Man's Porsche

DAVE FINCH has never driven a Porsche 944 on the street. In spite of this, he's managed to propel his race-prepared Whistler Radar Detector-sponsored 944S to two SCCA national amateur championships.

And along the way, he's managed to collect 22 first-place finishes in 30 starts, including an unbroken string of 17 race wins. In 1988, he was awarded Porsche's Holbert Cup, and in 1989, the SCCA's President's Cup.

He's done this as essentially a part-time venture, paying the bills and underwriting the racing by doing contract engineering for the automotive industry. Partial sponsorship from Whistler Radar Detectors makes up the difference. His company, Raetech Engineering, of Ann Arbor, Michigan, is currently doing development of plastic

intake manifolds for Dupont. He's also worked on drivetrain development for the fwd Revcon motorhome and an all-composite vehicle for Chrysler.

I first met David in the early 1970s, when we were both students, mowing down pylons in parking lot autocrosses with our 914s. David went on to build some ex-

tremely successful racing 914s, but the national championship eluded him. In 1985, he started to construct a 944, but the SCCA changed the rules, mandating a full tube-frame chassis. This obsoleted the partially completed, modified street 944 he was working on. Help from Porsche was welcome, but their main efforts were devoted to endurance racing and the Indy car.

Starting in 1986, Finch took a car that had been driven only a few hundred feet up and down the street in front of his shop (at 2 am the day before the race) to a second-row start and a fourth-place finish. That was when the car used an 8-valve version of the street 944 motor. Ultimately, the 248 hp this motor generated wasn't enough to make it in GT-2, at least at the SCCA's weight limit.

Winter 1986 saw development of the 16-valve head, under contract to Porsche. Pieces, like the manifolds and camshafts, were then made available to other racers through Porsche Motorsports.

Right from the start of the 16-valve program, Finch saw 285 hp at 7600 rpm. Development concentrated on spreading the torque peak around. Ultimately, 200 to 212 ft.-lb. of torque can be had, between 6000 and 6700 rpm. At differ-

(Turn to page 31)



Dave Finch's steel spaceframe chassis has an aluminum front substructure.

G PHOTO

ent tracks, different intake manifolds, exhaust manifolds and camshaft timing are used, to best match the engine to the track. If you'll look closely at the picture of the engine compartment, you'll see a connection between the fuel-injection air intake and the radiator cowling. Actually, there's cold air ducted into the separate shroud for the engine intake, and the ram air effect is good for "some" extra horsepower on the top end. How much, Dave's not really saying. Gearsets inside the 5-speed transaxle are changed as well. First gear is usually good for 70 mph, making all five speeds usable while racing. The idea is to keep the rpm drops between gears smaller than the powerband.

Fuel injection is Bosch mechanical, because the rules prohibit electronic injection. Right now, the rules also mandate a relatively small pair of intake butterflies, limiting horsepower to its present level. Until Finch stops winning, that's not likely to change.

The oiling system is based on a Weaver belt-driven, 3-stage dry sump pump, which uses two stages to scavenge out oil from the engine and into an external tank. From there, oil is pumped by the third stage into the oil galleries. This arrangement both allows oil to deaerate, and avoids horsepower losses caused by the crank whipping around in the viscous oil. This is fairly common race-car practice. Another benefit is a flat oil pan that won't bottom out, allowing the engine to be mounted as low as possible in the frame. And by placing the oil tank far away from the engine, behind the passenger compartment, there's an improvement in front-to-rear weight balance, too.

The transaxle is mounted at the rear of the car, with a torque tube carrying loads between the engine and transmission, and a 1-in. solid drive-shaft running in multiple bearings between the two. A clutch assembly from a 962 (which Finch admits is overkill) is mounted on the flywheel.

Torsional vibrations in the 4-cylinder motor are soaked up by the spring in the drive-shaft, which manages to have a low enough rotational inertia not to overpower the synchronizers in the transmission.

One consideration in mounting the transaxle was to leave enough slop to allow the aluminum torque tube to

expand as it heats up. It's hung from a ¼-in. sheet of aluminum with long ears. The ears are bolted to the car's frame and bend slightly as the transaxle moves back.

The chrome-moly tube-frame chassis is capped at front and rear by deformable aluminum structures. David crashed once—hard. But the damage to the chassis was minimal.



Semitrailing arm rear suspension mimics upper/lower control arms.

"I work a lot for the car industry. As an engineer, I know that controlled crush during an accident just seemed like a principle that I ought to embrace on more than just a superficial level," says Finch. Even the box that the fuel cell sits in is part of the structure, with ½-in.-thick aluminum stressed panels instead of a more commonly used .06-in. material.

The suspension is a heavily modified version of the stock 944. The Firestone racing radials, mounted on 16x10 rims, generate so much force under braking and cornering that the conventional front spindle has been replaced. Instead, the front hub has a large-diameter wheel bearing, with a 1½-in.-thick axle spinning inside it. Stiff.

Stock 944s use a semitrailing arm rear suspension. The Raetech car does also, but it's changed almost beyond recognition, until it acts more like a pair of

upper and lower control arms.

The intent is to control toe-in during suspension travel, resulting in a car that has what amounts to passive rear-wheel steering. The bottom line is a mild understeer at high cornering Gs, making the Raetech car easy to drive at the limit.

Brakes are stolen from the 930 Turbo. With a racing weight of 2000 pounds, plus driver, braking performance is as good as any GT-2 car.

Dave Finch hasn't changed much in the almost 20 years since we met. He's slight of build and soft-spoken. But on the track, it's a different story. He's an aggressive, calculating driver, fully capable of laying a little metal on a competitor when necessary. But unlike some others, he is able to retain some coolness, some strategy under fire. The adrenalin-pumped, so-called Red Mist that makes a great driver make mistakes is absent, much to his credit.

David is that rare combination of talents, a brilliant designer who can also drive well. He also has the drive and tenacity to stick to a long-term project from start to finish.

This season he plans to race the Whistler-Raetech 944S again. But he will be racing in a limited schedule that should qualify him for a return to the SCCA national championships in the fall. However, unless there's some serious sponsorship available, Finch doesn't plan to make this a full-time effort.

In fact, because of the car's unique racing history (having perhaps the highest start/win ratio of any amateur road racing car), Dave is entertaining offers from collectors.

If you want Dave to build you a replica of his winner, negotiations start at around \$150,000. **FM**



Designer/builder/driver Dave Finch and the Raetech 944S, which he plans to race this season.

OUTDOORS

BY JOE SKORUPA, Boating/Outdoors Editor



PM PHOTO BY JERRY HEASLEY

PM's Tri-Flyer Revisited

TO FLY A hovercraft is to experience a full-scale assault on the senses. You crank up the engine, and the fan blades roar at an ear-splitting din. The bottom skirts fill with air. You slide down the beach. It startles you to feel how effortless it is to go from land to water and back again—no traction, no seams, no bumps. You're only 6 in. off the ground, but you're flying.

Now the fun begins. To run straight ahead, you evenly balance your weight. The sensation of speed, as it is with any low-slung, personal-sized sport machine, is immediate and powerful.

To turn, you lean hard in the direction you want to go. But even with perfect technique, you don't really corner, you arc. To tighten the arc, you learn to fly sideways and let the fan do the work. If you oversteer, you'll find yourself in a spinout.

To stop at the end of your flight, you either turn off the engine and gracefully glide to a halt, or you whip the fan around to neutralize forward

progress by using opposite thrust.

If it sounds like hovercraft pilots spend a great deal of time careening around like a hockey puck on ice, they do, and they wouldn't have it any other way.

Air PM

Dreams of flight have long held a powerful grip on our collective imaginations. Perhaps this explains why hovercraft are a hot item among PM readers. Of all the motorized vehicles I cover—boats, ATVs, snowmobiles, personal watercraft and off-road 4x4s—none has a more devoted following than hot-rod hovercraft.

In fact, when PM ran a story several years ago about a top-rated hovercraft called the Tri-Flyer, we received more requests for plans to build it than for any other PM project.

One reader who requested plans was Michael Murry, of El Paso, Texas. Murry, a mechanical engineering student at the University of Texas at El Paso (UTEP) was in-

trigued by the go-anywhere capability of the Tri-Flyer. The craft you see on this page is the result of many hours worth of Murry's skill and tender loving care.

When word reached us that a PM Tri-Flyer was causing a sensation down El Paso way, we sent writer Jerry Heasley to Texas to check it out. Heasley reports that Murry actually incorporated the Tri-Flyer into his engineering course work at UTEP. He used computer programs to determine the effect of altering blade pitch and propeller tilt. Then he carried out controlled tests to compare the predictions with actual results. In this way, Murry was both applying his newfound knowledge and dialing in his hovercraft.

The hardest part of the construction phase, according to Murry, was the fiberglass hull. It needed to be fabricated from scratch, and it required a great deal of grinding, sanding and shaping. The payoff was a profile that looks as sleek as a jet fighter canopy.

For power, Murry chose an 82-horse snowmobile en-

gine, which was the largest 2-stroke mill he could find. A 10-horse engine mounted on the bow inflates the skirts and provides lift.

The result of Murry's hard work and knowhow is an impressive 16-ft. craft that turns heads even when it's sitting still. Many people in the El Paso area have never seen a hovercraft, according to Murry, and interest is intense, especially when he takes it out to scream over the Rio Grande at speeds up to 90 mph.

Hovercraft plans

If you want a complete description of Tri-Flyer, look up "Hot-Rod Hovercraft" (page 92, May '86). Plans for Tri-Flyer, and other projects, are featured in PM's "Plans And Ideas" catalog (\$2 from POPULAR MECHANICS, P.O. Box 1014, Radio City Station, New York, NY 10101). Tri-Flyer plans, supplied by PM, are \$19.55 from the above address.

Hovercraft never actually lose contact with the ground, but they feel like they're flying. And that's the best of both worlds.

PM

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*“There’s no better way
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In addition to an impressive standard payload of 1640 lbs.*, Toyota’s 1990 pickup has a formidable standard towing capacity of 3500 lbs.** Yet with the available 3.0-liter V6 engine in front of you, you’ll hardly notice the load behind. For those who need to haul even more, consider Toyota’s One Ton. It has a standard payload of 2655 lbs. and a towing capacity of 5000 lbs.** So when it comes to work, Toyota’s pickups are all business. And when it comes to play, don’t look back—choose a Toyota.

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FREEWHEELING

BY MICHAEL LAMM, Contributing Editor



Bertone Reinterprets The ZR-1

ALMOST THE only criticism leveled against the new ZR-1 Corvette has had to do with appearance—the supervette, according to some critics, looks too much like the regular L98 coupe.

Enter Nuccio Bertone, the celebrated Italian coachbuilder, with a wild mid-engined ZR-1 variant that suggests a possible next-generation for America's hottest production car. Low, wide and thoroughly exotic, it's an interpretation that would put the ZR-1 in the same class as cars like the Ferrari F40 and Lamborghini Diablo, probably with a price to match.

Although the Bertone ZR-1 is strictly a concept car at this point, it's fully functional. The ZR-1's potent quad-cam 32-valve LT5 V8, transverse-mounted directly behind the seats, is bolted up to a ZF 5-speed gearbox, the same transaxle—DS-252—used in the de Tomaso Pantera and Mangusta. Aside from modifications to exhaust and intake plumbing, required to make everything fit into the cramped engine bay, the aluminum LT5 V8 was left completely

stock, including its catalytic converters.

Unveiled for the Geneva Show last March, the project was headed by Marc Deschamps, Bertone's chief designer. Bertone estimates that the car represents about 30,000 man-hours, and cost his firm somewhere in the neighborhood of \$1.4 to \$1.6 million.

Bertone named the car Nivola, the nickname of Italian racing great Tazio Nuvolari, and the pearlescent yellow paint is in honor of the trademark yellow sweater Nuvo-

lari wore as part of his racing costume.

It's not the first Corvette variant from Carrozzeria Bertone—he produced the somewhat more subdued Ramaro back in 1984—and he's also created a number of noteworthy mid-engined sports cars, including the Lamborghini Countach and Miura, the Ferrari 308 GT4, the Lancia Stratos and the Fiat X-1/9.

ZR-1 hardware

Besides the LT5 engine, the Nivola retains the ZR-1's rack-and-pinion steering, ABS braking system and

some suspension elements. The front lower A-arms were bolted in as is, and the production rear suspension linkage was adapted to the new setup—the trailing arms became lateral links, and the lower lateral links were employed as trailing links. The stock antiroll bar was also used.

The Nivola designers discarded the Corvette's transverse rear leaf spring, and replaced the sophisticated Bilstein shocks with a semiactive pneumatic strut/shock setup from Way Asauto, an ITT subsidiary. Ride height is controlled by sensors and a central micro-processor feeding signals to a system of pumps and rapid-response solenoid valves.

A stock Corvette radiator and air-conditioning compressor ride up front, repositioned to accommodate the swoopy low nose.

That's where mechanical similarity to the ZR-1 ends. The chassis is spaceframe, made of a rugged square section steel tubing, and the hubs and front upper A-arms were fabricated from scratch.

The body is fashioned from traditional sheet steel, rather than the Corvette's resilient plastic compounds, and



Uninhibited interior design keeps pre-'90 Corvette instrumentation.

the design is distinguished by a power-operated hardtop that retracts and stows over the engine bay to make the Nivola into a roadster.

The doors open conventionally, as distinct from the scissor-type doors used on Bertone's Lamborghini designs. However, their extra-thick section houses storage for compact luggage, and the outer skin swings out for access to this storage—not very handy in a crowded parking lot. There are two more briefcase-sized storage compartments hidden in the wide door sills.

Lurid leather

The leather-lined interior, rendered in lurid purple and light green, features electric vibro-massagers built into the seat cushions, to help combat fatigue on long drives, a creature comfort we can probably expect to see on production Chevrolets by the mid-'90s. About the only other visible Corvette reminder inside the car is the dashboard panel, which employs some of the digital instrumentation from the pre-'90 disco dash.



Although almost a foot shorter than ZR-1, Bertone car is 7 in. wider.

Like the Corvette, the Nivola wears massive rubber—245/40ZR-17 front (compared to 275/40 for the production ZR-1) and 315/35ZR-17 rear. Front wheel width is 8 in., compared to 9.5 on the ZR-1, while the rears are

identical at 11 in. Michelin supplies the tires, and the cast-alloy wheels, designed by Bertone, were made by OZ Racing.

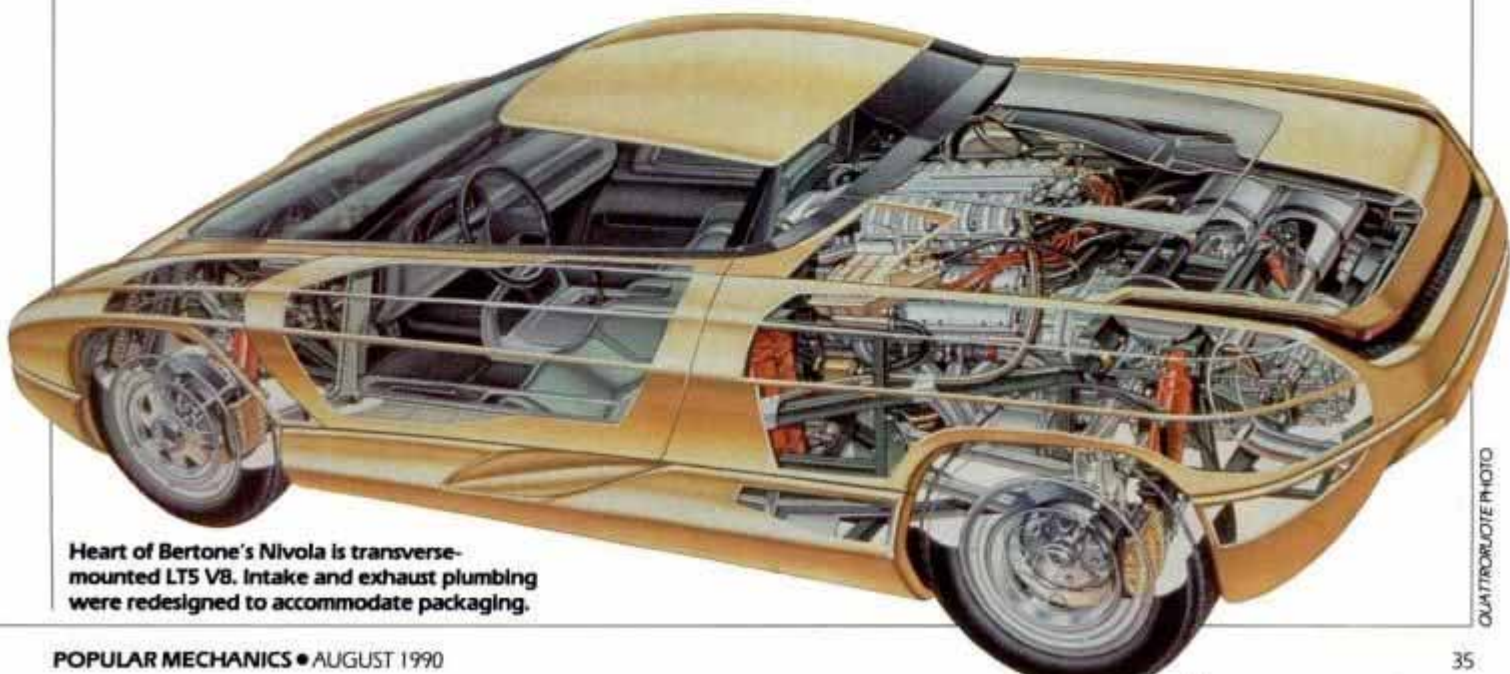
Deschamps' interpretation of Corvette brawniness led to a design that is both

shorter and wider than the current production car. The Nivola rides on a longer wheelbase—100.5 in. compared to 96.5 for the ZR-1—but is almost a foot shorter at 165.7 in. overall, with much less front and rear overhang.

Front/rear track dimensions are 61.0/63.0 in., compared to 59.6/60.4 for the ZR-1, and overall width is 78.0 in., 7 in. more than the Corvette. The show car is also lower—43.3 in., 3.4 in. lower than the ZR-1.

And what's Chevy's connection with all this? Remote, according to insiders in Michigan. It's unlikely that GM Design Staff will farm the next-generation Corvette out to an independent firm. But the engine did come from GM of Europe, and Lotus engine maven Ian James did visit the Bertone facilities to make sure the revised intake and exhaust plumbing didn't emasculate the LT5's output.

But whatever happens with the Nivola concept, one thing's certain: No one will ever confuse this ZR-1 with an ordinary Corvette. **PM**



Heart of Bertone's Nivola is transverse-mounted LT5 V8. Intake and exhaust plumbing were redesigned to accommodate packaging.

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Big Is Back At Buick

SNAPPED during testing at the General Motors Proving Ground at Milford, Michigan, this prototype signals the return of the big car to the Buick lineup, and the revival of the Roadmaster nameplate.

Bigger than Buick's new front-drive Park Avenue Ultra, the 4-door, 6-passenger sedan revives some time-honored American automotive design traditions—front-engine, rear-drive and rugged body-on-frame construction.

Beneath the sheetmetal, the Buick will ride on the same chassis used by Chevy's new Caprice. Due for the 1992 model year, the Roadmaster is expected to fall into the \$20,000 to \$25,000 price range. A 4-door wagon version will be added to the line later.

Buick doesn't expect the new car to erode sales of its Park Avenue line. The Park

Avenue is aimed at younger buyers who want the latest designs, while the Roadmaster is intended for long-time Buick faithful who remember portholes and the days when Buick was "the doctor's car."

Some important technological updates on tradition will be standard antilock brakes, airbags and plastic bumpers.

1992 Suburban

It takes a close look, but a careful squint at this apparent pickup truck will give you a good idea of what the popular GMC Suburban will look like in 1992.

The camper cap hides a rear door and generous side windows set into the rear quarters.

The front end on this test mule is also misleading. Insiders are talking about a more rounded look, and more slope to the hoodline. The styling will be shared with

the full-size Chevy Blazer and GMC Jimmy, which are also due for the 1992 model year.

Look for the Suburban to continue as a favorite with owners who regularly tow heavy loads. Engine options will include Chevy's 350-cu.-in. V8 and a 6.7-liter diesel.

Grand Prix Facelift

Pontiac's popular Grand Prix coupe will get a freshening

market, where diesels are considerably more popular than in the U.S., the vans will probably be hauled by powerplants produced in Europe. Chrysler is negotiating with several diesel producers for the best engine choice—and, of course, the best deal.

Does that mean dieselized minivans for the domestic market? Chrysler insiders say it's not likely as long as gasoline stays under \$2 per gallon.



Pontiac Grand Prix gets a '91 nose job, thanks to small headlights.

this fall. Smaller headlights and auxiliary lights, stretching across most of the front of the car, will help create a lower hoodline.

While the rest of the car will be basically unchanged, there'll also be considerably more punch from a new 3.4-liter V6 engine.

Diesel Minivans

Chrysler is planning to install diesel engines in export versions of its successful minivan series. Intended for the European

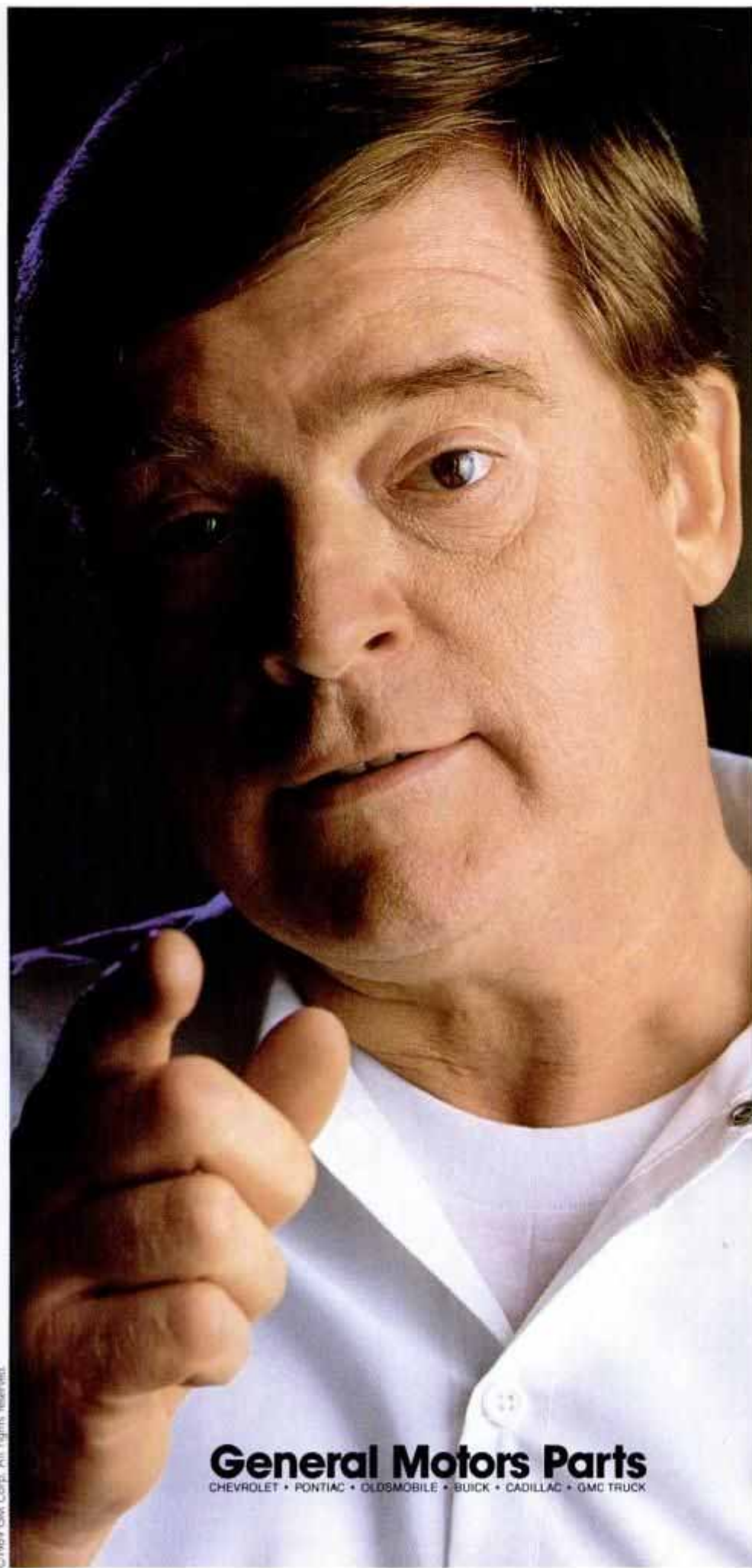
Copycat Countermeasures

General Motors and other automakers have begun copyrighting the designs of replacement parts as part of a campaign for combating the flood of low-priced copies that are coming in from Korea and Taiwan.

The defense goes beyond copyright stamps on parts and packaging—even the design drawings and photos of new parts, such as fenders and wheel covers, carry copyrights. **PM**



Disguised as a camperized pickup, this prototype is the '92 Suburban.



**"We
don't go
for the fakes."**

**And neither
should you!"**

"When an insurance adjuster tells me that his company's policy is to spec 'generic' sheet metal, I tell him my policy. No copycats. Period.

We won't use imitation hoods, doors or fenders. Why? Because it takes too much time to redrill holes so they fit properly. And even then, the knockouts for door handles and side marker lights may not square up right.

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it's your freedom.

IMPORTS

BY RICK TITUS, West Coast Editor



each wheel to give the Q45 the ability to respond automatically to varying road surfaces by actively generating opposite force to cancel out bumps and dips.

Vehicle body roll can also be controlled. Other benefits are reduction of dive during braking and acceleration squat.

As used on the Infiniti Q45, the full-active hydraulic suspension utilizes two systems—hydraulic and micro-processors. The hydraulic system uses four wheel actuators, which resemble conventional strut assemblies.

The hydraulic system also includes a high-pressure variable-volume pump, four pressure control units and 10 accumulators.

The control system has 10 sensors—three vertical G sensors, two lateral G sensors, one fore-and-aft G sensor and four vehicle height sensors. Two 16-bit micro-processors receive information from the sensors as well as signals indicating engine rpm, brake on/off signals, door open/closed signals and vehicle height adjustment switches.

Control with regard to tire contact patch is definitely enhanced in most situations, but the biggest improvement is ride quality. Expected to come to market by early fall, the active suspension option will cost around \$5000. **FM**

Expanding The Infiniti Concept

DESPITE speculation to the contrary, the Infiniti automotive group is pleased with its current market posture.

Determined to stick with the initial business plan, Infiniti will introduce its third model in August, along with an active suspension option for the high-line Q45 sedan.

New G20 sedan

The tag "Sport/Luxury" is admittedly starting to wear a bit thin, but Infiniti's new G20 can lay full claim to the title. Designed in concept for the more practical 1990s buyer, the G20 does an excellent job of balancing both the luxury and sport sides of the scale, while being surprisingly well appointed at \$20,000.

The G20 is powered by an all-new dohc 16-valve 2.0-liter aluminum 4-cylinder engine, producing 140 horsepower and 132 ft.-lb. of torque. A 5-speed manual is standard, with a 4-speed automatic optional.

As with most multivalve engines, it's the open road that really permits the G20 to come to life, which makes steady high-speed cruising routine work.

However, engine performance is just one chapter in the Sport part of the story. The new G20's multilink front and rear suspension systems give it an unusual sense of balance and surefootedness.

As for the Luxury side of the equation, the G20 will stand toe-to-toe in standard features and appointments with anything in its price class. Roominess, comfort and painstaking attention to detail are enhanced by standard features like antilock brakes, air conditioning, power door locks, remote trunk and fuel door releases, alloy wheels, tinted windows and an antitheft system.

We have every reason to believe that the G20 will meet its design objectives. It should, as Infiniti intended, help fill showrooms with

baby boomers looking for more luxury, performance and value at the low end of the high-end segment.

Active Suspension

Active suspension, long the talk of race shops and engineering seminars, is now a market reality. Question is, is the market ready?

Nissan seems to think so, and a number of manufacturers—Chevy in particular—will be watching closely to see if they're right.

As applied to the Q45, it's a system that uses hydraulic pressure with an actuator at

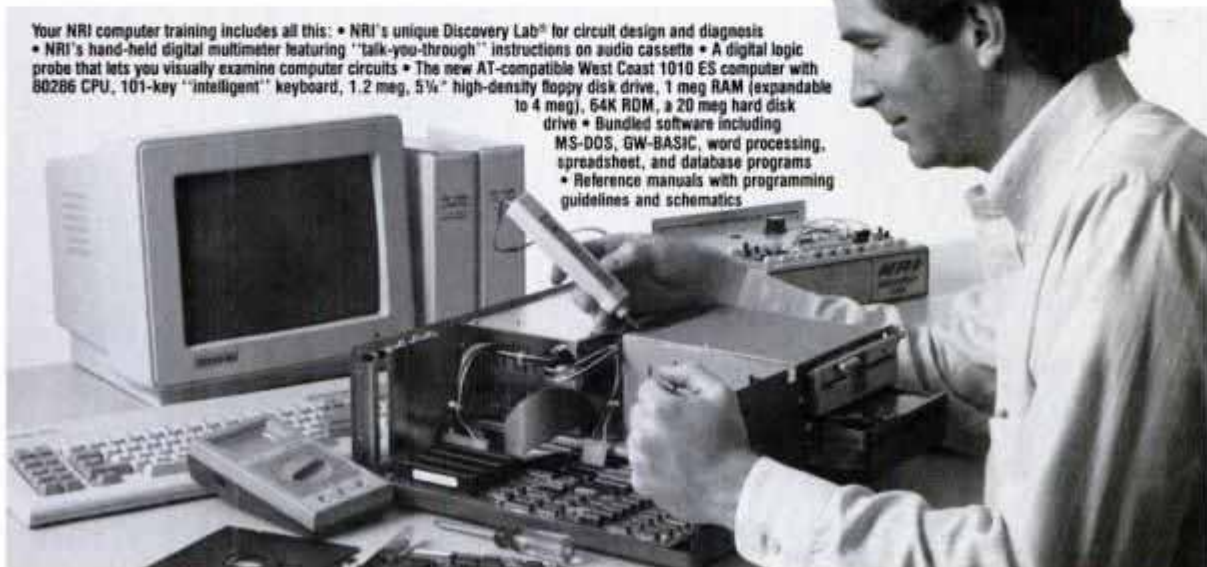


Q45 active suspension option enhances already good handling.

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Jobs for computer service technicians will almost double in the next 10 years according to Department of Labor statistics, making computer service one of the top 10 growth fields in the nation.

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peripheral—now included in your course to dramatically increase the data storage capacity of your computer while giving you lightning-quick data access. Plus you work with exclusive word processing, database, and spreadsheet software, yours to use for your own professional and personal applications.

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SCIENCE

BY ABE DANE, Science/Technology Editor

A Thousand Miles At 1 Mph

THE MAIN thing about Kennedy Space Flight Center's two 6-million-pound Crawler-Transporters is that they're big—in fact, they're the biggest land vehicles ever built. But recently, one of these consummate road hogs distinguished itself in another way.

During April of this year, the odometer on Crawler-Transporter No. 2 clicked over its 1000th mile on the hard-packed crawlerways of Kennedy Space Flight Center, a mark its makers never imagined it would make. Standing beside the super-highway-sized strip of ground river rock leading out from the Vehicle Assembly Building, a small group celebrated as the Crawler paused in its 1-mph trek to the Space Shuttle launch area.

At that rate, it's been a long journey. But for more than 20 years, the behemoth and its twin served as what's known as "stage zero" for every manned spaceflight that the United States has launched since the *Apollo*.

Back in those fevered days, the Crawler began as a problem. The towering *Saturn V* rocket, its launch pad and its support structure had to be assembled miles from where the rocket would lift off. Somehow, the whole 40-story structure would have to be moved. Don Buchanan, the man who designed the Crawler-Transporter, spoke



to me recently about how his solution evolved.

It began as a barge

Buchanan's team set to work in 1961, assuming from the first that they would work out some kind of barge or rail-based system. But as they got down to the details, complications started to propagate at an alarming rate. In the end, barges were

deemed too unstable, and rails too costly and inflexible. By the beginning of 1962, the whole mobile launch concept was in jeopardy.

While all of this was going on, however, the basis for the solution was already in existence, strip mining in the Kentucky coalfields. Built by Bucyrus-Erie, the 3850 B power shovel traveled at only one-fifth the speed NASA needed and relied on external electricity to drive its motors. But the gigantic treaded trucks on which it crawled had the necessary load capacity, and it had a self-leveling system that, although crude, showed a way that the rocket could be held steady on its way to the launch pad.

When NASA finally got wind of the 3850 B, it was

skeptical. But Buchanan and a few others went to see the machine at work, and soon saw it as a way out of their troubles.

Not that the route from the 3850 B to the present Crawler-Transporter was a simple one. NASA's specs for the vehicle went out for competitive bidding, and in 1963, Bucyrus-Erie lost to the Marion Power Shovel Co., another maker of strip-mining equipment. The machine that resulted from their collaboration two years later was a far cry from the one Buchanan had seen in Kentucky.

Four double-tracked trucks containing four electric motors, rated at 187 to 375 horsepower each, provide propulsion. Atop each truck are four 20-in. hydraulic jacks, surrounding a cylindrical guide ring that bears shear loads. Manometers at each corner read hydraulic pressure, and send signals back to the control room, where commands are issued to raise and lower the jacks at each corner, keeping the launch platform level.

Electrical power for the drive system comes from two 2750-hp diesel engines, driving four 1000-kilowatt generators, and venting their exhaust through mufflers the size of Volkswagens. Two 1065-hp motors provide power for the leveling and steering hydraulics, along with on-board electrical systems. Altogether, the Crawler burns 160 gallons of diesel fuel per mile.

Although designed in haste to meet tight *Apollo* deadlines, the Crawler-Transporter has stood the test of time, and after an upgrade in 1977, has continued service as an integral part of the Space Shuttle launch system. **FM**



Crawler-Transporter returns to VAB, minus Space Shuttle cargo.

NASA PHOTOS

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Lumina Sedan. It's designed to steer clear of trouble.

Granted, most of us will never need to understand the science behind near Zero Scrub Radii, drag coefficients, heat dissipation in braking, or, for that matter, modern day algebra. But everyone can understand the benefits of a car designed to help them respond to trouble on the road.

So, we'd like to explain in some detail some very technical reasons why you should choose the Lumina Sedan to be your next family car. Because when you put all those benefits together, they help make the Lumina Sedan one of the most innovative and responsive Chevrolet automobiles ever.

The engineering that went into the engine.

Can you see the safety aspects of an engine? Our engineers can. By taking into account the weight of the car, suspension geometry, tires and brakes, the Lumina's available 3.1 Liter V6 with Multi-Port Fuel Injection becomes one tough, all-around performer. So, not only will you run your family around the city efficiently* you can merge into highway traffic swiftly and have enough reserve power to pass slower moving vehicles.

Our suspension won't keep you in suspense.

You'll appreciate Lumina's suspension most when the road takes a turn for the unexpected. For starters, the Lumina's rear suspension design was inspired by the Corvette. Its leaf

spring is made of fiberglass, not steel. And instead of one steel spring per wheel, as in many cars, one fiberglass rear leaf spring is all that's needed in the Lumina. And with its advanced suspension, your Lumina is designed to help you recover quickly should you have to swerve to avoid something in the road.

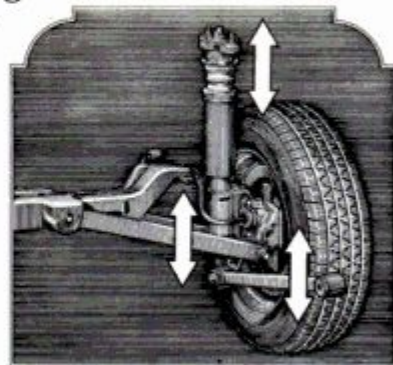
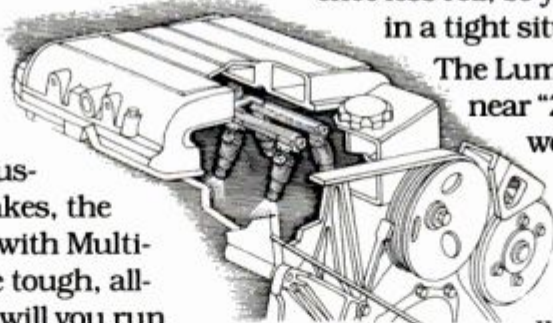
Here's how. In a swerve, when you turn the wheel hard to the left, the right side of your car will push down. Straighten the wheel, and as the right side comes up, the left side will go down. This is called roll. But thanks to the tuning of Lumina's fiberglass rear leaf spring suspension, you'll experience less roll, so your car will respond more quickly in a tight situation.

The Lumina's front suspension also boasts near "Zero Scrub Radii." Unfortunately, it would take pages to explain it. So suffice it to say that in some cars when you drive through a puddle at 35 miles an hour your car will slow down and your steering wheel will pull. To lessen this,

the Lumina was designed with near Zero Scrub Radii which reduces the sensitivity of your front wheels to changes in the road to help you stay in control without having to over-compensate at the steering wheel. A very helpful feature.

We'd like to clear the air about aerodynamics.

Admittedly, the technical aspects of aerodynamics, such as crosswind stability and drag coefficients, are less than thrilling. We'd much

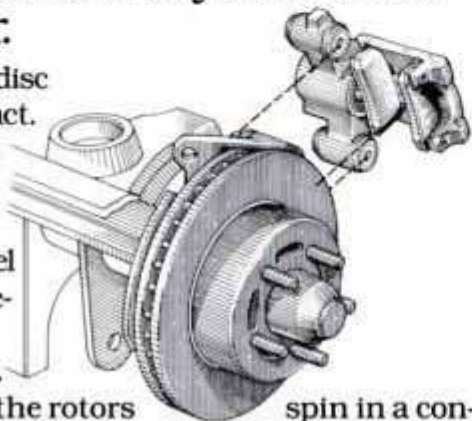


rather describe for you how the Lumina's aerodynamics can contribute to your safety. For instance, Lumina's smooth shape allows for a low drag coefficient of 0.34 which contributes to impressive fuel economy* and acceleration when passing or merging. But those aren't the only rewards of smooth aerodynamics.

Believe it or not, the Lumina is not only aerodynamic when the wind is rushing over the front end, it's aerodynamic when the wind is coming at you from the side. And you'll appreciate that on very windy days or when you get caught in the wake of a passing semi on the interstate.

Here's the brake you've been looking for.

Four-wheel disc brakes, to be exact. They come standard on the Lumina Sedan. Lumina's 4-wheel disc brakes benefit from greater heat dissipation.



That's because the rotors spin in a constant air flow to keep them cool. And the cooler the brakes stay, the more efficiently they work. Now you could buy a Ford Taurus and not get these standard. Or you can buy a Lumina and get standard 4-wheel disc brakes. The choice is yours.

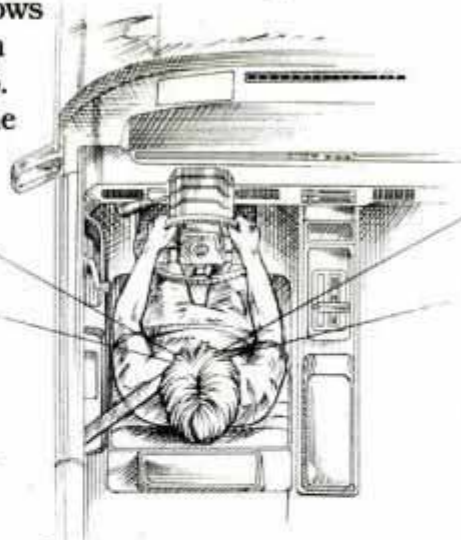
Know what you're getting into.

Innovation isn't limited to exterior features of the Lumina Sedan. Here are just two examples of some thoughtful interior design that may not be evident at first glance.

Notice all the glass. The windows seem deep and wide, don't they? While providing a very comfortable feeling of expansiveness, this also serves

a very practical function: better visibility. And while all that glass helps eliminate blind spots, standard tinted windows all the way around can cut down on glare, too.


Next, look at all the buttons, knobs and controls on the dash. Notice how logical their placement, how easy they are to reach. A simple thing, true, but consider its importance and what can happen in that split second when your eyes leave the road and search for a button.



Now we hope we didn't bore you with all these explanations, but we thought the more you knew about the Lumina Sedan before getting into it, the more you and your family would be able to get out of it.

To find out even more, come in and test drive a Lumina for yourself or, better yet, ask a friend who's driving one. Either way, you're sure to see why Lumina is the fastest-selling 1990 new car name. And why more Americans are winning with The Heartbeat of America.

THE
Heartbeat
OF AMERICA IS WINNING.
TODAY'S CHEVROLET 

*EPA estimated MPG city 19/highway 27. Chevrolet, the Chevrolet emblem, Lumina and Corvette are registered trademarks of the GM Corp. ©1990 GM Corp. All Rights Reserved. Let's get it together... buckle up. 



OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



MID-ATLANTIC CENTER FOR THE ARTS PHOTO

Victorian Restoration Primer

NOT MUCH CAN match the beauty of a properly restored Victorian home. Whether you're lucky enough to own one, or merely dream of buying a Victorian some day, there's lots to learn about these romantic old houses.

Mention the word Victorian and many folks think of Queen Anne- or Italianate-styled structures. Although these are two of the more plentiful Victorian designs, many different styles fall into this sweeping period, a time span that covers the better part of the 19th century. Knowing the hallmarks of some of the major styles, along with tips on conducting a sensitive Victorian restoration, are the first steps in understanding these grand old homes.

Popular in America during the reign of Britain's Queen

Victoria (1837-1901), the idea behind Victorian architecture's romantic, informal designs was that they should fit into the surrounding landscape and be compatible with their natural settings. This was a strong reaction against the earlier Greek Revival and Federal styles which, with their symmetrical, regular shapes, were not considered naturally harmonious.

Keeping in line with this natural emphasis, most Victorian homes were painted colors that resembled organic materials, like stone, bark, granite, slate and sandstone. They are usually considered dark and drab by today's standards. Mixing different siding materials on the same house, like clapboards, shingles and diagonal boards, created a textured look that supported this blending with nature. The irregular, multi-angled shapes of the buildings, with their bay windows

and other projections, also worked toward this end.

The popularity of pattern books in the 19th century was responsible for the spread of Victorian homes from coast to coast. But the span of years that a style was commonly built depends on what part of the country you're talking about. There are no hard and fast rules as far as dates are concerned and some overlap from one style to the next. For example, a style constructed during a certain period of time on the East Coast may not have shown up on the West Coast for some years.

You'll find differences in the design of the same style house depending on where it's located. A Queen Anne built in California, for example, tends to be narrower and taller than one built on the East Coast. An Italianate house built in a suburb may have more porches and be more expansive than one built on a city lot. Sometimes, too, features from more than one style appear on

The Victorian period embraced many different building styles, including this Italianate example with its tall thin windows and massive wraparound porch.

the same house. This can make it difficult to categorize the structure.

Some styles

The earliest Victorian style, the Gothic Revival (1835-1865), was based on the romance of medieval architecture and inspired by English and German cottages. You'll recognize a Gothic Revival house by its sharply pointed gables. Windows are usually tall and thin, sometimes with diamond-shaped, leaded panes. Medieval motifs, like Gothic crosses and trefoils, may be cut into the structure's woodwork.

The Gothic Revival gave way to the Italianate period (1845-1880). Based on the cottages of Italy, houses of this style are characterized by their arched windows and doors, sometimes topped with decorative lintels. The Italianate mansions commonly have flat, wide roofs with large brackets under the overhang. A cupola often crowns the top. These highly symmetrical houses were often built from natural local stone or brick.

The Italianate house has many adapted versions. While they usually maintain the arched windows and doors of the pure models, along with the massive roof brackets, the symmetry is often broken with projecting 1- or 2-story bay windows. These wood- or clapboard-sided houses often have a columned porch with decorative brackets that match those on the roof.

Few smaller houses were constructed in the Second Empire or Mansard style (1860-1885). Usually considered mansions, they are easily

Contributing Editor Bob Vila hosted public television's "This Old House" for 10 years.

recognizable with their distinctive mansard roofs, often tiled in slate, and dormer windows. Carpenter Gothic (1870-1910) houses feature lots of sawn-wood ornamentation, called *gingerbread*, at gable peaks and verge boards. Porches have sawn brackets on posts and cornice.

Perhaps the most popular style, and the one that most folks think of as Victorian, is the Queen Anne (1875-1900). The extremely irregular configurations of these marvelous old homes are a result of what I call *inside-out thinking*. Basically, the Queen Anne style marks the beginning of time when people decided that the interior of the house should be arranged to suit their living preferences. Floor plans became important and resulted in the irregularly placed bay windows and turrets so common to these grand old dames. Gables, dormers and chimneys, often fluted with large caps, adorn many. Their large, often wrapped porches are characterized with surprisingly delicate spindlework.

The Stick style (1875-1900) expresses the building's construction in an *honest* way. Vertical and diagonal boards are used as siding materials, while criss-crossed boards in gables simulate a truss.

One of the final phases of the Victorian era, the Shingle style (1885-1900), is based on the form of the Queen Anne but without its projections and texture. As its

name implies, shingles cover both the exterior walls and gambrel roof. Not popular with the general public, shingle-styled houses were predominantly the domain of the wealthy, and were generally designed by architects.

Sensitive restoration

A rule of thumb when approaching this or any type of restoration is to try to save as much of the original structure as possible. In a Victorian restoration, particular emphasis is placed on preserving the ornate architectural details, along with the original siding materials.

If you're lucky, the original gingerbread or brackets may only need repainting. If not, you'll find they are rotted or damaged beyond repair. If that's the case, you can either have replacements custom made or order new reproductions from the millwork companies who specialize in this type of thing. Obviously, the latter is the most economical decision if several pieces are missing or damaged. When you only need to replace a few, the custom route makes sense.

As far as the siding goes, it can be fairly easy to restore the wood. In most cases, it involves paint removal, sanding, priming and repainting. Damaged pieces are either patched and repaired, or replaced. Don't be tempted to replace wood siding with vinyl or aluminum. You'll lose the

texture (and a great deal of the authenticity) of your Victorian home.

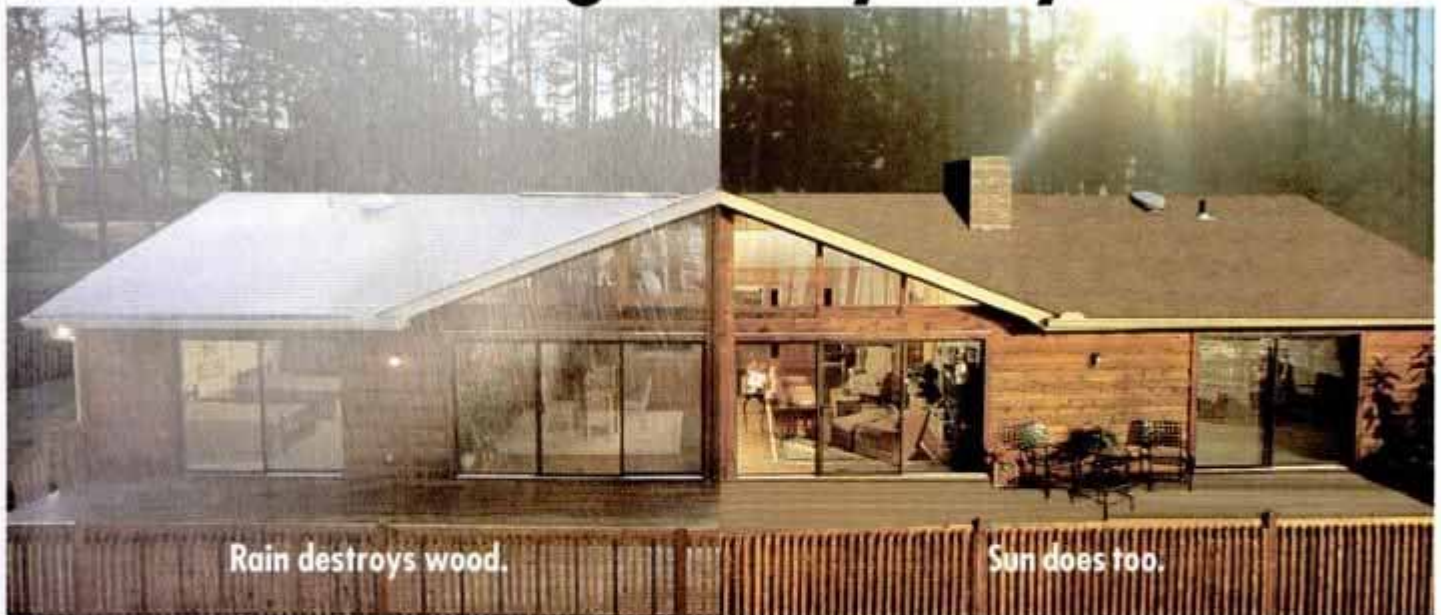
How you deal with roofing materials, too, bears mention here. Most houses built in the 19th century had wood-shingled roofs, usually made of cedar. Slate and tile roofs were also common. In most cases, today's asphalt shingles, which come in a variety of textures and colors, are an acceptable (and less expensive) replacement. Again, it depends on the degree of authenticity you're striving for and, of course, your restoration budget.

Fortunately, I haven't run into too many cases where previous homeowners have removed the large windows the Victorians loved. But if you want to upgrade them and keep the monthly heating and cooling bills reasonable, keep the old window frames but have new sashes made with insulated glass.

Occasionally, too, today's owners find it necessary to add some living space to these old houses. As long as the front and sides of the structure are maintained historically, the back end can usually be altered without losing the charm.

Finally, the colors you choose for a restored Victorian will have a great effect on the image you create. Fortunately, many of the major paint companies offer lines of historical paint colors appropriate for these homes. (See "Exterior Period Painting," page 38, June '89.) **PM**

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ELECTRONICS

BY FRANK VIZARD, Electronics Editor



A New Way To See

SOMETIMES A company develops something so nifty that it takes a while before anyone figures out how to use it effectively. One such case involves Reflection Technology of Waltham, Massachusetts. This company developed a miniature display device two years ago, but products utilizing the display are only coming on the market this year.

The miniature display is called Private Eye. As seen in the picture above, the Private Eye is a 2.5-ounce display that you wear like a headband. The display measures only 1.2 x 1.3 x 3.5 in. in size.

At such close range to the eye, the Private Eye display appears as the equivalent of a 12-in. television screen. Images in the Private Eye are produced using a column of red LEDs, a magnifying lens, a spring-mounted resonating mirror and a counter-moving magnet linked to

advanced electronic circuitry. A full-screen-sized image is developed by turning the LEDs on and off, and by using the mirror to spread the image across the screen. The image appears as vibrant red characters or graphics on a black background with a contrast ratio of 70:1, so it's easy to read. Reflection Technology hopes to have a full-color display in five years.

Private Eye is now being utilized by a number of companies for different applications. A few companies are using the device as the centerpiece for hands-free, portable workstations. Another application is exemplified by a laptop computer being developed by Cyberspace Corp. of Norcross, Georgia. By using the Private Eye, the weight, bulk and ambient light problems associated with traditional displays are eliminated. Information isn't available via over-the-shoulder glances from companions

either. Personal computer kits are available from Reflection Technology for a list price of \$795.

Private Eye is also being used in an electronic book due from Empruve of Knoxville, Tennessee. The Empruve "Scout" uses CD-ROM disks as its database.

Currently available is a paperless fax machine that uses the Private Eye device to view information. Developed by PortaFax Corp. of Woodside, New York, the 2001 model connects directly to a telephone via an RJ-11 jack or acoustic coupler. The 2001 has an internal memory equivalent to 25 pages of text. Users can send or receive faxes, zoom in on a portion of the document for closer examination and even delete text.

The nucleus of the 2001 weighs only 3.5 pounds and measures 1.5 x 4 x 5 in. A series of external ports allows you to connect the 2001 to a video monitor or to a plain-paper computer printer for

hard copies. List price for the 2001 is \$1495. A bar scanner and a 2-in. micro-diskette subsystem for extra memory are optional for list prices of \$900 and \$400, respectively.

Other applications for the Private Eye are probably manifold. Reflection Technologies is interested in any good ideas.

Caller ID Update

One technological innovation often begets another, and the new caller identification feature being offered by some telephone companies is no exception.

Caller ID is a feature available on the Maestro phone made by Northern Telecom and supplied to various telephone companies. The service, which works thus far for only local calls, uses a display on the telephone to show you the number of the incoming call. The Maestro phone lists for \$136 and is available from Bell Atlantic (800-523-0552) and Telcom Phonelab Technologies (800-873-3243) nationally. Caller ID only works if your local telephone operation company offers the service. Caller ID is now available in New Jersey, Maryland, Virginia, West Virginia and on a limited basis in some other states.

The spread of Caller ID is being hampered somewhat by privacy concerns. However, a Beverly Hills, California, company called Private Lines, Inc. is now offering a 900-number that circumvents Caller ID. Only a string of zeros appears on the Maestro display if the call is routed through Private Lines. A battered spouse, for example, could then call home without revealing his or her location. Private Lines charges \$2 per call.

Other states are seeking to
(Please turn to page 51)

introduce Caller ID, but a blocking option may be mandated, as is already the case in California.

Caller ID is not the only new feature available in phones. Logic Solutions, Inc. of Mission, Kansas, sells a device through mail-order catalogs that silently intercepts incoming calls before the phone rings. Callers hear a prerecorded message telling them when to call back. The device lists for \$100.

Sound Wars

Mega-autosound systems are familiar to anyone who's ever driven down a Main Street on a Saturday night. For years, people cursed these drivers as sonic terrorists concerned only with the amount of volume they could generate in a moving vehicle. Fortunately, reason is triumphing over madness.

For those truly interested in exploring the outer frontiers of car audio, the launching pads are the various sound-off contests held around the country each year. While there's still plenty of heart-stopping bass that will test a car's shock absorbers, the emphasis on sound pressure levels is now balanced against sound quality and installation expertise. After a few false organizational starts, sound-off competitions are coalescing under the umbrella of the International Auto Sound Challenge Association (IASCA). Most events are organized by local retailers.

Thanks to IASCA guidelines, massive volume levels are only part of the competition. While some car audio systems can achieve higher levels, IASCA sets the volume ceiling at 130 decibels (dB). For the sake of comparison, a good factory-installed system can achieve 105 dB levels.

As important as volume is the overall sound quality. Here are a few of the areas that are judged:

■ **Frequency response**—how well the system reproduces a signal across the audio bandwidth from a low of 20 Hz to a high of 20,000 Hz (20KHz).

■ **Staging**—the ability of the system to simulate the presence of a stage in front of the listener.

■ **Sound linearity**—the balance between low, middle and high frequencies at low and high volume levels.

More technical tests for sound quality are also used in the judging. Also important

is the neatness of the installation and the cosmetic look of the system. The better a car audio system is integrated into the car, the more points the vehicle is likely to accrue.

Winners of local sound-off contests graduate on to a regional contest. These winners move on to a national contest. All competitions are divided by power classes: 0 to 100 watts, 101 to 250 watts, 251 to 500 watts, 501 to 1000 watts and over 1000 watts. Competitors are divided between amateur and professional classes.

What does it take to win? In the 1000-watt-and-over class, a car like the 1989 Mustang Saleen SSC pictured below would be a good competitor. Packed into the Mustang are eight amplifiers, a cassette receiver, a compact disc changer, a 9-band equalizer and 22 speakers ranging in size from 1-in. tweeters to a pair of 16-in. woofers. System power is 1280 watts per channel.

Membership to the International Auto Sound Challenge Association costs \$30, a fee that gets you a rule book, newsletter and a copy of the test disc or tape used in the judging. IASCA is located at P.O. Box 7493, Riverside, CA 92513-7403.

Longest Videotape

Here's a travel advisory for video fans heading for European vacations. When on the Continent, look to buy the longest blank videotape in the world.

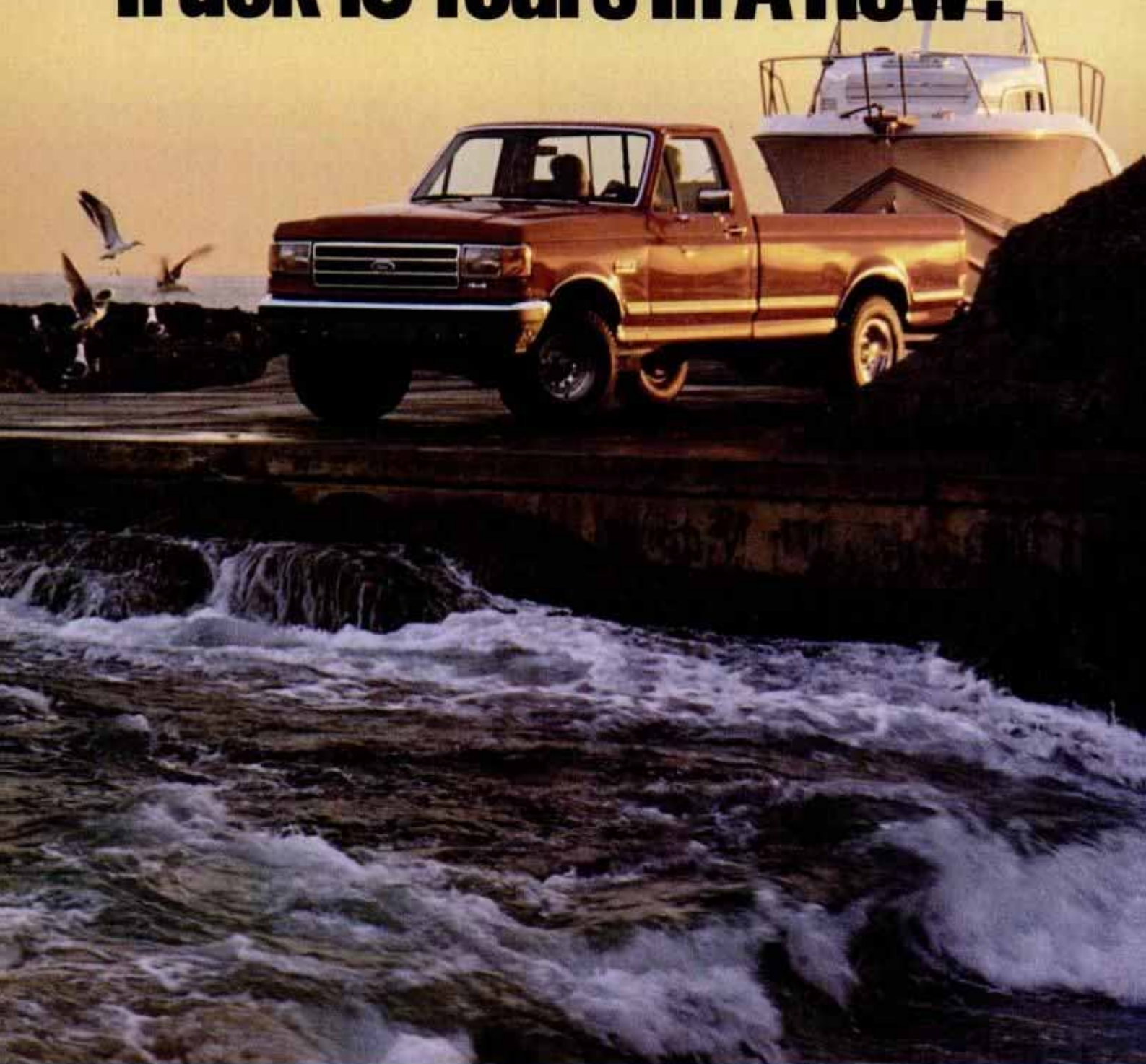
BASF, headquartered in Germany, is selling small quantities of its E300 videotape only in Europe. Due to a difference in television standards, the E300 is the equivalent of a T200 in the United States. This means you can record a little more than 3½ hours in the Standard Play mode and 10 hours in the Extended Play mode. Just think of the television mini-series applications. Officially, BASF says it will not sell this tape in the U.S. any time soon. Videotape by any other name is still videotape so if you see it over there, feel free to bring it here.

Just so you don't feel completely shortchanged, BASF is planning to market a T130-length blank videotape this fall. The extra 10 minutes comes in handy when you're taping those movies that are just a little bit over 2 hours. A T130 will also compensate nicely for those unscheduled solicitations that often accompany Public Broadcasting System (PBS) broadcasts. A T130 also translates into 6½ hours of recording time in the Extended Play mode. **FM**



This '89 Mustang Saleen SSC packs 22 speakers, eight amplifiers for a whopping 1280 watts of power.

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*1989 New Truck Buyer Study.

**Based on an average of consumer-reported problems in a series of surveys of all '81-'89 models designed and built in North America; and total sales by division.



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GENERAL MOTORS CORPORATION

SUBURBAN CHIC

Jeep's Cherokee established a new kind of statusmobile for upwardly mobile America. But can the champ hang on to its title?



**JEEP
CHEROKEE
LIMITED**

BY RICH TAYLOR, Contributing Editor
PM Photos by Ron Hussey

PARK ONE OF these 4-wheel-drive wagons in front of any country club in America, and the crowd will gather round. Unlikely as it may seem, we have AMC to thank for this. In 1984, AMC presented the Jeep Cherokee, a sport/utility vehicle much like its competition, but with four doors instead of two. And that's made all the difference.

The Cherokee 4-door was perceived as a hip replacement for the station wagon by trendy moms who wouldn't be caught dead in a stodgy old Country Squire. Jeep sales soared, and Cherokees popped up in day-

care center parking lots from coast to coast.

Today, this market has blossomed to 750,000 vehicles a year and has attracted competitors from the United States, Japan and Europe. Indeed, the competition has become so intense that the Cherokee is now the oldest design in this group of increasingly sophisticated—and increasingly expensive—wagons.

Which compact 4-door 4x4 is best? We assembled all nine choices in California, ran them through our instrumented track tests, then spent the better part of a week driving them through desert sand, mountain snow and

SUBURBAN CHIC



**FORD EXPLORER
EDDIE BAUER**

baking freeways. We even brought along a 3-year-old to test the car-seat convenience.

Ford Explorer

Unanimously, our test crew preferred the brand-new Ford Explorer

over the others. The 4-door offers an unbeatable combination of looks, performance, features and price—it sets a new standard for this class.

For starters, we see this as the best-looking 4x4 on the market, a subtle combination of trucklike machismo and carlike aerodynamics. The natty Eddie Bauer package provides just

the right upscale touch.

Inside, the spacious Explorer is a quantum leap over the cramped Bronco II it replaces. The Recaro-clone seats are comfortable and infinitely adjustable. Leather is an option. There's plenty of interior room for four or five adults, thanks to scooped-out door panels, low seats and a high roof. There are nice white-on-black analog gauges, and all the controls are logically placed.

Ford's hefty 4.0-liter V6 moves the Explorer acceptably, though none of these 4x4s is exactly a ball of fire. Unlike the old Bronco II, the long-wheelbase Explorer combines comfortable on-road ride with excellent off-road capability. The on-demand 4wd system is engaged with the touch of a pushbutton.

Steering, brakes and shifter function well, though it would be nice to have 4-wheel antilock brakes (ABS), rather than rear wheels only. (Range Rover offers 4-wheel ABS as standard, Jeep and Chevy as an option.)



**MITSUBISHI
MONTERO LS**

**TOYOTA
4RUNNER SR5**

**RANGE ROVER
COUNTY**

**JEEP CHEROKEE
LIMITED**

Best of all, the Explorer is very competitively priced. Not only is it better than any \$20,000 4x4, it's superior to conventional wagons that cost literally twice as much. In our view, this is an excellent buy in a modern, capable, fully-equipped, 4-door 4wd wagon. Nice going, Ford.

Nissan Pathfinder SE

The Pathfinder has been a solid seller since its introduction, and the new 4-door version promises to increase Nissan's presence in this market segment. It's a thoroughly capable vehicle that, in our opinion, edges past its arch-rival from Toyota, the 4Runner.

The edge in this case is attributable to a more comfortable interior. Nissan has done a better job with interior space to match the extra set of doors. The Pathfinder's other strong suit is its engine. The 3.0-liter V6 is basically identical to that in the peppy Maxima. The Pathfinder is much heavier, but the vitality of this smooth-running jewel is still impressive.

Like the Explorer, the Nissan combines a good ride with terrific handling on and off pavement. It clicks into 4wd with the touch of a lever, whether the vehicle is moving or stationary. Its agility in dirt is augmented by optional 31x10.5R-15 tires.

The interior is very straight-



**CHEVROLET
S-10 BLAZER**

forward and functional—though far from spartan—with white-on-black instruments, corduroy upholstery and controls derived from the pickup. There's an acceptable amount of room in the back seat, a reasonable driving position and good visibility.

Overall, we rate the Pathfinder as a very close second to the Explorer, and a thoroughly versatile 4x4.

Toyota 4Runner SR5

The 4-door 4Runner is very similar to the Pathfinder in most respects. Toyota's engineers wanted plentiful ground clearance and a rugged appearance, which accounts for the

31x10.5R-15 tires. However, its roof is lower relative to the frame rails than the Nissan, and there's no real improvement in rear-seat legroom. This adds up to a somewhat cramped interior that's not as comfortable or convenient for driver or passengers.

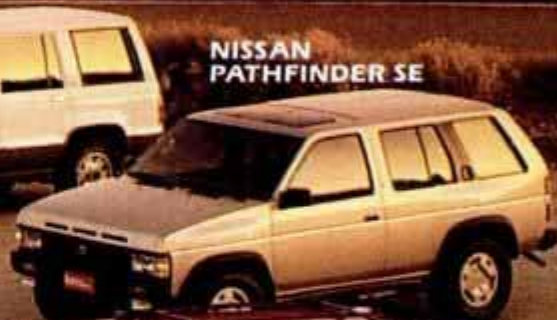
Too bad, because the 4Runner is otherwise identical in most ways to the SR5 V6 pickup that won our most recent compact pickup test. It's strong, smooth, beautifully assembled, nicely finished and handsomely styled. Toyota's shift-on-the-fly 4wd system is thoroughly user-friendly. The 4Runner's performance is good under all conditions, and the handling



LAFORZA



**ISUZU
TROOPER LS**



**NISSAN
PATHFINDER SE**



**FORD EXPLORER
EDDIE BAUER**



**CHEVROLET
S-10 BLAZER**

SUBURBAN CHIC



**ISUZU
TROOPER LS**



**RANGE
ROVER
COUNTY**



**TOYOTA
4RUNNER SR5**

is remarkably sharp.

But the smallish interior, low roof-line and high step-in definitely intrude on usefulness.

Chevrolet S-10 Blazer

Also sold by GMC dealers as the S-15 Jimmy, and by Oldsmobile dealers as the Bravada, the Blazer has two extra doors for 1991. GM wisely lengthened the wheelbase, by 7 in., on the 4-door. The result is a much more useful and comfortable vehicle.

The Blazer's styling still seems attractive, and the big 4.3-liter V6 is torquy. You get ABS brakes on all four wheels, though it functions only in 2-wheel drive. Engaging 4wd on both the Blazer and the Jimmy is a matter of snicking a lever into place, even when the vehicle is in motion, but the system is designed for use in

dirt or gooey going—extended use on pavement is not recommended.

The Blazer falls down in three areas. The engine is noisy and a trifle rough. The suspension doesn't respond as well as some of its competitors in bumpy going. And the interior is limited by marginal bucket seats and glitzy electronic instruments.

The Blazer and Jimmy are competent, roomy 4-door SUVs, with the added appeal of big dealer organizations—you're never far from service. But at \$22,000, we don't consider them the best buys in the class.

Jeep Cherokee Limited

The Cherokee Limited may be the standard of comparison—the 4-door controls 22 percent of the total sport/ute market—but it also costs more than its more modern competitors.

The Jeep's best feature is straight-line performance. Thanks to a smooth 177-hp inline Six, it's the only sport/utility capable of 0-60 in 10 seconds. It's also surprisingly capable both on and off road, despite having a solid front axle, limited suspension travel and comparatively small tires.

It offers two 4wd options: Command-Trac or Cherokee Limited's Selec-Trac system. Command-Trac can be engaged with the vehicle in motion, but has no center differential, and is intended for limited use. Selec-Trac features a center diff and can be used as a full-time system if the owner desires. It also has the option of 4-wheel ABS that functions even when 4wd is engaged.

The Cherokee's weakest feature is its old-fashioned interior with under-size bucket seats, fake woodgrain

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)	CURB WEIGHT (lb.)
Chevrolet S-10 Blazer	\$16,905/ \$22,523	V6 OHV 262/4294	160 @ 4000 rpm/ 230 @ 2600 rpm	front/ part-time 4wd	4-speed auto	107.0	176.8	65.4	54.1/54.1	3938
Ford Explorer	\$14,265/ \$21,760	V6 OHV 244/3996	155 @ 4200 rpm/ 220 @ 2400 rpm	front/ part-time 4wd	4-speed auto	111.9	184.3	70.2	56.9/56.9	4336
Isuzu Trooper LS	\$13,499/ \$19,268	V6 OHV 173/2827	120 @ 4800 rpm/ 150 @ 3600 rpm	front/ part-time 4wd	4-speed auto	104.3	176.0	65.0	54.7/55.1	3848
Jeep Cherokee Limited	\$14,155/ \$26,225	I6 OHV 242/3960	177 @ 4500 rpm/ 224 @ 2500 rpm	front/ part-time 4wd	4-speed auto	101.4	165.3	70.5	57.0/57.0	3652
LaForza	\$43,850/ \$44,500	V8 OHV 302/4950	185 @ 3800 rpm/ 270 @ 2400 rpm	front/ part-time 4wd	4-speed auto	106.0	179.9	78.7	67.8/67.8	5250
Mitsubishi Montero LS	\$18,959/ \$21,854	V6 SOHC 181/2972	143 @ 5000 rpm/ 168 @ 2500 rpm	front/ part-time 4wd	4-speed auto	106.1	181.3	66.6	54.1/55.7	4134
Nissan Pathfinder SE	\$15,720/ \$21,079	V6 SOHC 181/2960	153 @ 4800 rpm/ 180 @ 4000 rpm	front/ part-time 4wd	5-speed manual	104.3	181.9	66.5	56.1/57.3	4209
Range Rover County	\$38,025/ \$38,575	V8 OHV 238/3898	178 @ 4750 rpm/ 220 @ 3250 rpm	front/viscous-coupled full-time 4wd	4-speed auto	100.0	175.0	71.4	58.5/58.5	4389
Toyota 4Runner SR5	\$15,498/ \$24,229	V6 SOHC 181/2958	150 @ 4800 rpm/ 180 @ 3400 rpm	front/ part-time 4wd	4-speed auto	103.3	176.5	68.1	56.3/57.1	4187

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



MITSUBISHI MONTERO LS



LANZA



NISSAN PATHFINDER SE

trim and dated styling. It also suffers from numb, over-assisted power steering and a cramped interior.

We look for some updates on the Cherokee for the 1991 model year, including even more power.

Isuzu Trooper LS

Here's the bargain in this bunch. The Trooper is significantly less expensive than the others, as well as roomier and more convenient. It's tall and boxy, but a box holds more stuff.

It also has lots of neat little touches, like a rear hatch that splits vertically—much easier to use if you actually put stuff in your truck.

The Trooper uses the same smooth, reliable 2.8-liter V6 that's been a mainstay of General Motors cars and trucks for years. All the other controls and mechanical bits are equally

tough and adept. The neatly finished interior is no fashion leader, but it's durable and logical.

Smooth as the V6 is, it's also the thing that holds this SUV back in our ratings: 120 hp just isn't up to toting 3900 pounds, at least not with much verve. And even more than its competitors, the Trooper reveals its pickup truck origins. The ride is stiff, the handling a bit ungainly.

The Isuzu's 4-wheel drive can be engaged from the driver's seat, but is intended for limited use.

Mitsubishi Montero LS

The 4-door Montero is so similar to the Trooper we had a tough time telling them apart. The Mitsubishi is slightly longer, taller, wider, heavier and more expensive. Out on the road, we had to concentrate to remember

which one we were driving—until we tramped on the throttle and the Mitsubishi's smooth V6 came to life. This engine is on a par with those offered by Nissan and Toyota.

Like the Trooper, the Montero seems not only big and boxy, but more agricultural than the competition. It would be right at home hauling hunters across the Alaskan outback. But if you're only heading down to the preschool, you may prefer something more carlike.

On the plus side, the Montero is finished as well as any of its competitors. The on-demand 4wd system can be engaged with the Montero in motion.

Range Rover

An award-winning advertising and public relations blitz has positioned

(Please turn to page 109)

		TEST RESULTS									
STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/ PM test)	ACCELERATION 0-60 MPH (sec.) ¼-MILE (sec. @ mph)	PASSING ¹ ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. ² SLALOM (mph)	200-FT. ³ SKIDPAD (G)	EPA CARGO VOLUME (cu. ft.)	INTERIOR VOLUME (cu. ft.)	MAXIMUM TOW RATING	
Power recirc. ball/ 3.7	F: 10.5-in. vented disc, ABS/ R: 9.5-in. drum, ABS	17/ 14.50	12.3 18.49 @ 71.70	12.90	140	56.63	.70	35	98	6000	
Power recirc. ball/ 3.5	F: 10.3-in. vented disc/ R: 10.0-in. drum, ABS	16/ 16.72	11.3 18.01 @ 74.53	10.53	158	57.11	.72	39	103	7800	
Power recirc. ball/ 3.8	F: 10.1-in. vented disc/ R: 10.4-in. disc	15/ 14.56	14.9 20.06 @ 65.53	14.06	119	55.13	.72	46	94	2000	
Power recirc. ball/ 3.4	F: 11.0-in. vented disc, ABS/ R: 9.0-in. drum, ABS	16/ 14.93	10.2 17.84 @ 74.82	10.21	140	56.11	.75	36	91	5000	
Power rack & pinion/ 3.8	F: 11.7-in. vented disc/ R: 10.0-in. drum	12/ 12.10	15.3 20.21 @ 66.89	14.59	137	54.33	.70	40	115	8000	
Power recirc. ball/ 3.7	F: 10.8-in. vented disc/ R: 10.0-in. drum	16/ 16.54	13.2 19.59 @ 68.91	11.56	133	55.86	.75	43	97	4000	
Power recirc. ball/ 3.0	F: 10.8-in. vented disc/ R: 11.1-in. disc	15/ 16.66	11.6 17.82 @ 74.27	10.90	121	56.02	.73	31	92	3500	
Power worm & roller/ 3.3	F: 11.4-in. vented disc, ABS/ R: 11.4-in. disc, ABS	13/ 12.32	12.1 18.72 @ 73.28	9.68	119	53.06	.66	36	92	7700	
Power recirc. ball/ 3.9	F: 11.3-in. vented disc/ R: 11.6-in. drum, ABS	15/ 14.28	14.8 19.39 @ 70.31	11.09	125	56.01	.70	43	88	3500	

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

JET SHIPS

By replacing propellers with superconducting magnets, jet ships may one day ply the seas at 100 knots.

BY ABE DANE, Science/Technology Editor; PM Illustration by John Berkey



CARGO HOLD

SUPERCONDUCTING MAGNET CLUSTER

AVAST SHAPE darts beneath the polar ice flows, and is gone, as silent as a living creature, but far swifter. Clad in steel, and traveling at over 100 miles per hour, it leaves only a mistlike trail of bubbles in its wake. There are no great screws or turbines churning the water. In fact, there is no sign of any sort of propulsion system at all. Instead, the huge underwater freighter is thrust through the depths by an invisible force generated by water rushing through tubes enclosed in sponsons at the submarine's sides.

Futuristic as it sounds, the force powering this craft is actually so basic it is taught in high school science classes. Called Fleming's Left Hand Rule, this fundamental of electromagnetism states that the confluence of a magnetic field and an electric current passing through a fluid will cause the fluid to be propelled in one direction. It was not until recently, however, that the

technologies existed to harness this phenomenon aboard a seagoing vessel. Now, in laboratories in Japan and the United States, systems known as magnetohydrodynamic (MHD) drive units are putting the Left Hand Rule to work in small models and experimental flow loops. The military is rumored to have been pursuing MHD research for years, to the point where an MHD drive played a key role in "The Hunt For Red October," a movie produced with unprecedented U.S. Navy cooperation and based on Tom Clancy's meticulously researched novel.

Japanese superships

Although the concept was first put forth in a 1961 patent by American scientist W.A. Rice, it is the Japanese who have made the greatest strides toward producing a practical MHD drive in the nonclassified world. A \$40-million program funded by the Japanese Foundation for



Based on a JAFSA concept, a future subsea freighter carries cars from Japan to Europe under the polar ice cap.

NUCLEAR POWERPLANT

Shipbuilding Advancement (JAFSA) has produced a fully operational model 2 meters long. And this summer, they plan to launch a 150-ton, 90-ft.-long seagoing vessel called the *Yamato-1*.

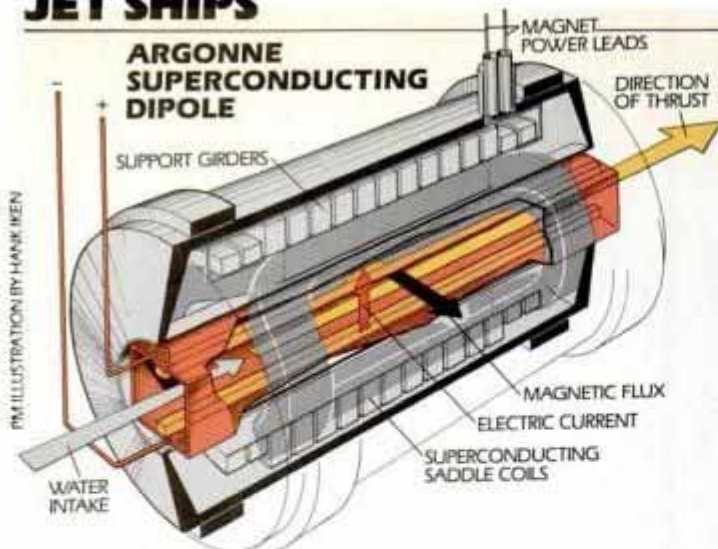
Although this early design is expected to be capable of only 8 knots, and with relatively poor efficiency, MHD has the potential to excel in both these areas. "We don't have to worry about cavitation of propellers with the MHD system. Therefore, there is no limit on speed," says Dr. Michael Petrick, who oversees MHD research at the Argonne National Laboratory in Illinois. The Japanese predict MHD vessels will one day be able to travel from Yokohama to San Francisco in three days. Efficiency is potentially very high as well, increasing in proportion to the square of the intensity of the magnetic field. Thus, the success of MHD depends on the development of extremely powerful magnets light enough to be carried aboard a ship.

Progress in this area has surged ahead, thanks to improvements in superconducting materials that can be formed into the coils of electromagnets. And a quantum leap in affordability is on the horizon, if a way can be found to use new high-temperature yttrium-barium-copper oxide superconducting materials that could be cooled with liquid nitrogen, instead of expensive and difficult-to-handle liquid helium.

Power packages

As more compact, powerful and efficient magnets become available, the challenge shifts toward integrating them into a complete propulsion plant, incorporating cryostats to keep the magnets at superconducting temperatures, and a power supply to feed the magnets and charge the electrodes that pass the current through seawater. The Japanese have tried two basic approaches. The simplest is to install a powerful superconduct-

JET SHIPS



Argonne superconducting dipole (right) crisscrosses lines of magnetic flux and electric current to produce thrust (left).

ing magnet pointed straight down through the ship's bottom. Current from electrodes on the hull interacts with the magnetic field in the open water surrounding it. Although simple and efficient, this arrangement would cause tremendous magnetic disturbances that could interfere with sealife and other shipping.

Thus, JAFSA has embraced a more complex approach. *Yamato-1* will be powered by two jet pods slung along the underside of the vessel. Each pod will contain six cylindrical superconducting dipole magnets arranged in a ring around a central support. Water is drawn in through the front of the pod, and propelled through electrically charged ducts running through the center of each magnet, then jetted out the back. Reversing propulsion direc-

tion is as simple as reversing the current in the ducts.

Big American magnet

"The Japanese are using smaller magnets, but clustering them like the old days of clustered rockets," says Dr. Petrick. By contrast, the Argonne effort is focused on the largest superconducting dipole magnet in the world. Weighing about 200 tons, the magnet, which was originally built for experiments in electric power generation, is far too large for maritime use. The point of the Argonne research, however, is to learn about the effects of extremely powerful magnetic fields with an eye toward the day when such fields will be available from smaller magnets. "Our program provides an opportunity to leapfrog

the Japanese in the scale and magnetic field strength of the MHD experiments," says Dr. Petrick.

Focused as they are on the electromagnetic phenomena at the heart of MHD propulsion, the Argonne team is making no effort to build a complete prototype propulsion system. Instead, they are placing the magnet in a 4-ft.-dia., 60-ft. x 25-ft. water loop—a sort of aquatic dynamometer that will let them scrutinize the magnet's performance in oceanlike conditions, without leaving the lab.

The jet age

If these experiments prove fruitful, Dr. Petrick sees a variety of uses for MHD systems on the horizon. They are already in use as pumping systems for the liquid-metal coolants used in some nuclear reactors. More exciting, of course, is the technology's potential in the area of shipping. Not only is there the advantage of high speed and great efficiency, but the lack of moving parts would also reduce maintenance. What's more, eliminating the need to link the power source with the propulsion system by a shaft or other mechanical means makes radical new hull configurations possible. JAFSA has produced a number of wild-looking concepts, including an airliner-shaped cargo submarine, and small waterplane hull (SWATH) passenger ships that ride on pairs of submerged pods containing MHD drives. Cargo submarines are a particularly intriguing possibility, according to Petrick, "because they would have less drag than surface vessels and could descend to avoid storms. Also, vessels used in marine biological research could benefit from quieter designs that would be less disruptive to sealife."

These and other possibilities continue to spur research that may one day make the propellers as obsolete as they once made the sail.

PM

Tom Clancy's Caterpillar

ENGAGE THE caterpillar," says Sean Connery, playing the grizzled veteran of the Soviet submarine corps, who captains the *Red October*. With that, the top-secret Soviet missile sub vanishes from the sonar monitors of the American attack sub *Dallas*, which has been shadowing her a few ship lengths behind.

The caterpillar is an MHD drive system running up the center of *Red October's* hull, and, like most of the fascinating morsels of technology in the film, it is an idea with at least some basis in reality.

But would an MHD-propelled sub really be undetectable? The short answer is: Probably not.

Capt. James H. Patton Jr., a retired U.S. Navy sub commander who served as a technical consultant during the making of the movie "Red October," says he sees MHD as intriguing, but fraught with problems from a military standpoint. Although an MHD drive system could indeed be very quiet,



Actor Sean Connery as Capt. Marko Ramius at the con of the *Red October*.

et, and, thus, might thwart passive sonar arrays like those aboard American attack subs, the tremendous magnets would produce stray fields that would be relatively easy to pick up. Also, electric current running through the seawater would electrolyze it, producing a traceable trail of gas bubbles, particularly chlorine.

Still, the Navy will follow MHD research with interest. "Any self-respecting naval lab has looked at it," says Patton. "People keep their finger on the pulse." —A.D.

PARAMOUNT PICTURES PHOTO

LEXUS LS 400

High marks for the 'velvet rocket.'

BY MICHAEL LAMM, Contributing Editor
PM Photos by Humphrey Sutton



ALTHOUGH Honda's Acura division is credited with the first Japanese challenge to the luxury car establishment, Toyota's Lexus LS 400 represents a far more serious threat to the old order.

Though successful, Acura's Legend has only nibbled at the fringes of Mercedes-BMW-Jaguar territory. But the LS 400, with its superb V8, sumptuous interior and Mercedes styling, is aimed squarely at the top of the luxury sedan market.



The LS 400 arrived in August 1989, totally new and engineered from the ground up. Lexus engineers and designers had painstakingly dissected and scrutinized the world's leading luxury cars and used the most prestigious as target vehicles, notably the Mercedes 420SEL, BMW 735i and Jaguar XJ6 Vanden Plas, cars whose prices range from \$40,000 to \$62,500.

Building on Toyota's freshly developed 4.0-liter 32-valve quad-cam aluminum V8, the Japanese aimed

LEXUS LS 400



to best their rivals by a comfortable margin, and at a considerably lower price. This they did, not only in terms of power (250 bhp, 260 ft.-lb. of torque) and performance (0-60 mph in under 8 seconds, 150-mph top speed), but in refinements like aerodynamics (Cd 0.29), fuel mileage (18 mpg city, 23 highway, according to the EPA), interior quiet, smoothness and the thoughtful touches that the Japanese are so good at.

For example, dashboard warning symbols are projected onto the gauge glass from tiny projectors up in the panel cover. The ashtray glides out and back on hydraulic struts. Yamaha's piano division supplies the interior walnut paneling. The engine computer retards spark between shifts to remove driveline jolt from the 4-



LS 400 straightline stability is tops, but understeer sets in during hard cornering. Subdued interior is spacious and comfortable. New 4.0-liter V8 offers excellent power, good mpg.

speed automatic transmission.

The driver can also choose from two different sets of shift points (Power and Economy). Suspension is all independent, of course, with load-leveling air springs optional.

In addition to an extensive list of standard equipment—which includes

4-wheel disc brakes with ABS, variable-assist power steering with automatic swingaway column and heated outside electric mirrors—buyers can choose optional traction control along with heated seats, moonroof and a Nakamichi/Lexus premium sound system with remote CD changer.

SUMMARY OF 1990 LEXUS LS 400 OWNERS REPORTS*

Total miles driven	1,300,844	Handling	36.6	Poor	0.0	Good	14.1
Average miles per gallon:		Comfort	36.2	Comfort opinion:		Average	0.8
In town	18.2	Specific dislikes:		Front seats:		Poor	0.4
On the highway	23.1	No complaints	33.3%	Excellent	87.8%	Number of vehicles owned:	
Major options chosen:		Styling too bland	9.6	Good	10.6	This car only	7.6%
Remote entry system	96.8%	Shoulder harness rubs neck	6.1	Average	1.3	Two cars	42.7
Power moonroof	91.3	Lacks sufficient comfort	5.3	Poor	0.3	Three cars	27.7
Luxury group	54.8	Instrument lighting too dim	4.8	Rear seats:		Four or more cars	22.0
Memory seat	43.8	Fuel mileage lower than expected	3.1	Excellent	77.8%	Would you buy a Lexus again next time?	
CD player	37.5	What changes would you like to see?		Good	20.5	Yes	87.6%
Traction control	35.2	No changes	25.3%	Average	1.7	Maybe	11.5
Cellular telephone	31.8	More distinctive styling	8.4	Poor	0.0	No	1.0
Air suspension system	22.4	Add outside temp gauge	7.7	Had any mechanical trouble?		Would you buy a different luxury car next time?	
Why did you choose the Lexus LS 400?		Reposition shoulder harness	5.1	No	89.8%	No	59.8%
Like the styling	31.5%	Greater comfort	4.4	Yes	10.2	Maybe	38.4
Price is right	28.0	Better lumbar support (passenger seat)	4.4	What type of trouble? (Too few data for meaningful analysis.)		Yes	1.8
Quality	24.5	How much did you pay?		Did you repair it yourself?		Principal driver:	
Performance	22.4	Average	\$39,112	No	100.0%	Male	67.6%
Handling	20.6	Range	\$33,000-\$46,000	Yes	0.0	Female	26.4
Reputation	18.9	Workmanship opinion:		Dealer repairs satisfactory?		Equal	6.1
Specific overall likes:		Excellent	97.7%	Yes	82.8%	Age distribution of owners:	
Silence	50.0%	Good	2.3	No	17.2	Under 29 years	1.9%
Riding qualities	43.1	Average	0.0	Dealer service opinion:		30-49	48.6
Power and performance	42.8			Excellent	84.7%	50-plus	49.3
Styling	41.4						

* Percentages might not equal 100 percent due to rounding or an insufficient amount of data.

On paper, and in virtually every published evaluation, the LS 400 grades out very well indeed. But the real testing is performed daily, by the men and women who actually own and/or lease a new car. Which is why we asked a national sample of LS 400 owners to tell us what it's really like to live with this new luxmobile.

And even though we expected enthusiasm, the answers were eye-opening.

According to the owners we surveyed, there's no doubt that the LS 400 excels at transporting driver and passengers in style and comfort. Specific likes, in order of preference, included: interior quiet, riding qualities, power and performance, styling and handling. One owner called the LS 400 his "velvet rocket."

Lexus also seems to excel in building quality and finish into its cars, with a record-breaking 97.7 percent of our respondents rating workmanship as excellent. Never before, in almost 40 years of PM's Owners Reports, have we seen such an unqualified endorsement of an automobile's quality and workmanship.

Reliability also rated high marks. Nearly 90 percent of our owners told us their cars had been entirely trouble-free. Complaints were so minor and scattered that we couldn't tabulate the data—things like wheel alignment, minor radiator leaks and sticky cruise controls. Toyota launched an early voluntary recall to correct the cruise-control defect. A few owners wanted sharper styling (9.6 percent), followed by a complaint that front shoulder harnesses irritated some people's necks.

Front- and rear-seat comfort received mostly marks of excellent again, with the minority opinion running mostly to good, and virtually no one criticized legroom, headroom or lumbar support. Cloth upholstery comes standard, with leather included in the \$4400 Luxury Group, or available separately for \$1400.

Dealer followup and service policies also drew high praise. Several owners mentioned that dealers had topped up their gas tanks after recalls. One woman said she was "flabbergasted" when two Lexus mechanics drove 250 miles round trip to pick up and deliver her car for the voluntary recall and routine service.

The Lexus LS 400 seemed, by all accounts, to sell itself, with no pressure or hardball from salespeople. A number of buyers wrote "best car for the money" on their questionnaires. It's a conviction that's echoed in our bottom-line statistic: If they had it to do over again, nearly 90 percent would still buy an LS 400. **PM**



Although Toyota borrowed heavily from Mercedes in LS 400 design, 41.6 percent of owners cited styling as a best-liked feature. Wind tunnel development yielded excellent 0.29 Cd rating, contributing to exceptional interior quiet.

EDITORS REPORT

The Evolution Of Perfection

TOYOTA'S CREDO for the new Lexus division is "the relentless pursuit of perfection," and as an initial proof of that ethic, the LS 400 sedan is probably the best first offering we've ever seen. It has two of the three requirements for cars in this class—refinement and power.

The third requirement, prestige, takes a little more time, but, judging by the responses of our owner group, this isn't far off. The car is already perceived as a bargain in its class, with most of the capabilities and amenities of the great European cruisers for less money. It's not much of a leap from there to equality in status. Lexus has already leapfrogged Cadillac and Lincoln in this regard.

Our own experiences with the LS 400 largely parallel those of the owners. The Lexus V8 is an outstanding achievement, potent, quiet and economical enough to escape the gas guzzler tax—unlike its competitors.

Fit and finish are similarly remarkable. Inside, outside and even under the hood, this car is a symphony of precision and quality. In the course of several encounters, we have yet to find a mismatched panel or paint blemish, or misaligned seam, or anything that didn't work. Paint quality is of the highest order, and the thoughtful people touches that please the owners get high marks here as well. This is a car that begins providing owner pleasure the moment he or she settles in behind the wheel.

Ride quality is precisely what we'd expect of a great luxury car, and more. The LS 400 irons out Manhattan's craggy thoroughfares better than any car in recent memory, and makes even the lumpiest stretch of interstate almost glass-smooth. With its exceptional noise isolation, excellent seating and world-class ride, it's hard to imagine a car better suited to long-distance travel.

But perfection is an absolute concept, and we have yet to see the perfect car. For example, we disagree with owners who see handling as this car's strongest suit. The LS 400's straightline stability is virtually faultless. But on winding country lanes, the Lexus can be pushed into mulish understeer, and its responses to rapid changes in direction are only ordinary by European standards.

We find that the LS 400's coil spring setup performs better in this regard than the optional air spring suspension, but it still lacks the taut feel and response of, say, a BMW 735i.

But that criticism stems from Toyota's market positioning versus the Europeans. For all its imitation of Mercedes styling, this is not a European car. It's a new interpretation on the luxury sedan theme, one that can stand quite solidly on its own merits.

Perfection will always remain just over the horizon. But for the Lexus LS 400, outstanding makes a pretty good starting point. —Tony Swan

INTRODUCING THE



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SAVING THE ALASKA PIPELINE

The builders said it couldn't happen for 30 years, but with rust already appearing on the Trans Alaska Pipeline, new technology is needed to stop the rot.

BY DAVID W. FREEMAN
PM Illustrations by Jeff Mangiat

BARELY 14 MONTHS after the *Exxon Valdez* supertanker oozed 240,000 barrels of oil into Prince William Sound, Alaska finds itself mired in yet another environmental crisis: The fabled Trans Alaska Pipeline is rusting.

Completed in 1977 at a cost of \$7.7 billion, the 800-mile pipeline was supposed to remain corrosion-free for at least 30 years. But last year, the consortium that maintains the line, Alyeska Pipeline Service Co., unearthed 827 areas of probable corrosion. While much of the trouble is concentrated along a single 8-mile underground stretch near Brooks Range, isolated spots were found virtually the entire length of the pipeline.

A rupture in the pipeline could spill tens of thousands of barrels of oil, not only fouling Alaska's pristine landscape and abundant waterways, but also frustrating America's vast appetite for oil. The Alaska Pipeline now supplies one-fourth of all petroleum consumed in the United States.



Snaking over 800 miles across Alaska, parts of the pipeline are exposed to extremes of both climate and terrain.

Alyeska insists that a spill is not imminent. "These are not the kinds of rust patterns that cause a total rupture," says Bob Howitt, engineering manager for Alyeska. "They're the kind that might cause a pinhole leak." According to Howitt, many of the 827 suspect regions, or anomalies, could turn out to be nothing more than small dents, metallic inclusions or other

nonthreatening defects. Those anomalies confirmed as corrosion have typically been superficial, and no bigger than a quarter.

Howitt maintains that even if the pipe ruptures, a major spill is virtually impossible. One-hundred fifty-one check valves would shut instantly if oil flow stopped or reversed, limiting the total possible spill from any single rupture to 50,000 barrels.

Of more immediate concern is the daunting task of repairing the corrosion. While the 48-in.-dia. pipeline runs aboveground on trestles for about half its length, virtually all of the corroded sections are buried in unstable permafrost. Thus, patching corroded areas necessitates not only welding on new steel jackets, but also excavating and reburying the pipe. The work will take years, and the cost will be staggering. Estimates range from \$600 million to \$1.5 billion. To date, only a fraction of the suspected corrosion spots has been repaired.

Pig improvements

Although Alyeska claimed it had adequate rust detection systems when the pipeline opened, the severity of the corrosion went unrecognized until



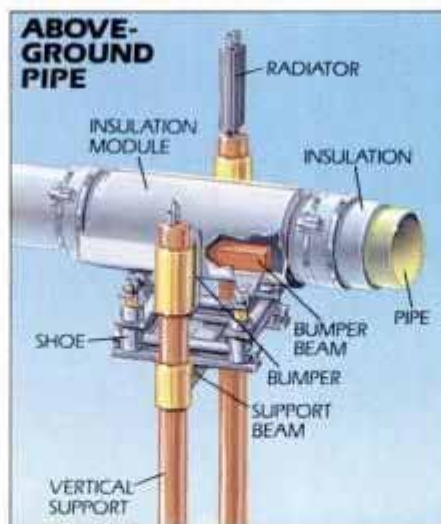
NKK pig travels the length of the Alaska Pipeline once a year, using its ultrasonic transducers to spot rust. Epoxy coatings and tape proved to be inadequate precautions on buried pipe.

last year, when they began surveying the interior of the pipe with a new ultrasonic "pig" manufactured by the Japanese firm NKK. Poking along at 90 percent of the oil speed (roughly 6½ miles an hour), this 11-ft., 6600-pound, titanium-bodied submersible takes 255 soundings for each 15mm of forward travel. That translates into a mind-boggling 27 million readings for each mile of pipeline, all stored on ¾-in. magnetic tape.

This huge volume of soundings gives the ultrasonic pig unprecedented sensitivity. Earlier pigs, which measured pipewall thickness with less sophisticated magnetic flux leakage technology, were blind to pipewall losses of less than 0.25 in.—50 percent of the total pipewall thickness. The NKK pig picks up losses as small as .05 in.

Until the mid-1980s, Alyeska relied on magnetic pigs, built by Ipel (now Pipetronix) of Toronto, Canada. At that point, company officials decided they needed a more precise way to test the pipeline.

Ipel responded by delivering an improved magnetic pig, capable of detecting pipewall loss of as little as 30 percent. On its debut run in 1987, the



Elevated aboveground portions of the pipeline rest on chilled supports that prevent permafrost thawing.

upgraded pig found 14 anomalies, none of which turned out to be actual corrosion. It was run again in 1988, and this time uncovered 241. Finally, in 1989, the ultrasonic pig made its first run. The data it produced were combined with the 1988 Ipel data to come up with 827 anomalies.

So while Alyeska had been relying on pigs since the earliest days of the

pipeline, it wasn't until 1989 that a truly reliable one came into use. Explains Howitt, "We ran what was the best available back in those days. But frankly, it was pretty primitive."

Pressure points

Upon learning of the corrosion problem, Alyeska briefly considered shutting the pipeline. Of special concern were rust spots in regions of high pressure. Pressure varies greatly along the line, depending largely upon terrain. Along mountain passes, pressure is often close to zero, but in valleys, it climbs to almost 1200 psi. Alyeska officials were concerned that rust might cause a rupture at one of these points. But after scrutinizing all the data available, they decided not to shut the line. Instead, engineers took steps to reduce pressure along the 116 riskiest sections until they were inspected and repaired.

The primary means of pressure reduction was to use a long-chain polymer known as drag-reduction additive, an STP-like friction-reducing agent. DRA enabled Alyeska to lower pressure levels significantly, while maintaining the standard flow rate of 2.1 million barrels a day.

SAVING THE ALASKA PIPELINE

Corrosive conditions

Oil pipelines are vulnerable to corrosion even under ideal conditions, but the environment spanned by the Alaska Pipeline is notorious for extremes. From the North Slope oilfields to the Valdez terminal on Prince William Sound, the line traverses barren plains, surmounts three major mountain ranges, fords countless streams and crosses the Denali fault, Alaska's sole active geologic fault. Elevation ranges from sea level at either terminus to 4800 ft., at Atigun Pass in the Brooks Range. Climatic conditions are equally inhospitable. During winter, the mercury often plunges to -70° F, but it can spike to 90° in summer.

The engineering challenge presented by such harsh conditions was further complicated by the temperature disparity between the pipe's contents and the permafrost in which some sections are buried. Oil in the pipe can be as hot as 145° F. (It's hot when it comes out of the ground.) This thaws the surrounding permafrost, releasing moisture, which without adequate protection, causes rust. Thawing can also cause the soil beneath the pipe to



Ultrasonic pig is prepared for launch at one of the pipeline's pumping stations.

subside, which can cause the line to buckle. Such subsidence along the Atigun Pass caused a bad spill in 1979.

Flawed beginnings

Anxious to start construction, Alyeska acquired 800 miles of half-inch steel pipe in 1969 and 1970. But

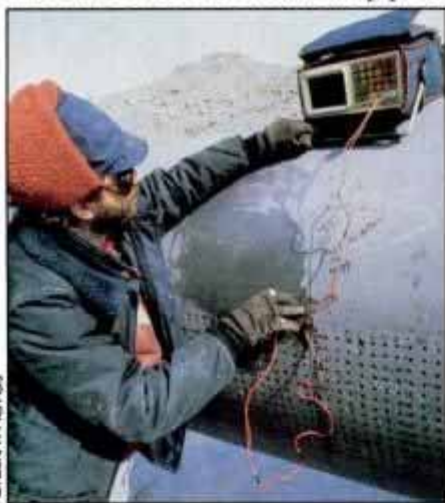
environmentalists' doubts over the company's ability to build an ecologically sound pipeline prompted a spate of lawsuits. These delayed construction until 1974—by which time the pipe had already begun to rust.

Once construction got under way, special precautions were taken. Existing rust was removed, and the pipe was heated to vaporize any remaining moisture. Then the pipe was coated inside and out with epoxy and three kinds of waterproof tape. Zinc rods were buried alongside the pipe. These "sacrificial anodes" were supposed to prevent corrosion by minimizing current flow away from the pipe. In some areas, the pipe was buried in refrigerated trenches designed to keep thawing to an absolute minimum.

Where even these precautions were deemed insufficient, the pipe wasn't buried at all, but suspended above the ground on trestles.

Despite all the precautions, rust spots began to form. Why? Several explanations have been proposed. Alyeska maintains that the epoxy and tape failed to adhere properly. Others have suggested that rushed construction schedules and greedy contractors led to shoddy workmanship. So far, the state of Alaska has tentatively focused blame more squarely on Alyeska, citing imprudent design and construction as culprits.

Whatever the real reason for the fiasco, state and federal officials overseeing the line have expressed concern about Alyeska's ability to effect repairs and prevent future corrosion of the pipeline. So have environmentalists. Says one, who would speak only off the record: "I wouldn't trust Alyeska on this one. They promised they could clean up an oil spill with no difficulty, and look what happened with the *Valdez*." **PM**



Ultrasonic probe (top left) homes in on anomalies. Then, after pipe is sandblasted, coated and taped, steel collars are lifted onto pipe (lower left), and welded (top right). In some areas, slurry is poured into forms (lower right) to guard against sharp rocks.

ALYESKA PHOTOS

BLACK STAR PHOTO

ALYESKA PHOTO

FUJINON
STABISCOPE
10 x40



NEW-LOOK BINOCULARS

Gyrostabilizers, electronic ears and rangefinders expand the focus of the latest multifunction binoculars.

BY BILL McCRAE
PM Photos by Spencer Jones

BINOCULARS used to come in two varieties—clunky and heavy or tiny and light. But, in recent years, advancements in optics have greatly expanded the possibilities. Today's binoculars are not only sleek and lightweight, they're loaded with multifunction options and specialized enhancements.

First, the basics, and then a look at the latest models, which feature gyrostabilization, nitrogen-filled atmospheres, compasses, ranging reticles, microphones and permanent focus.

Binoculars are identified by two numbers. The first represents the power of magnification. The second stands for the diameter of the front objective lens in millimeters. For example, a 7x50 binocular indicates that the model magnifies an image seven times more than normal and that the front objective lens measures 50mm.

JASON 213
PERMA FOCUS
7x50 COMPASS

The larger the front objective lens, the more light it will gather.

High-tech optics

One major problem with binoculars is that they not only magnify images, they magnify every movement of the binocular itself. The problem becomes acute when the instrument is used from a moving platform such as a boat, airplane or helicopter.

Fujinon solved the problem by installing an internal gyrostabilizer in a model called the Stabiscopes. The unique thing about the Stabiscopes is that only the internal optical prisms—not the entire binocular—is stabilized. This enables the external body to move plus or minus 5° without losing the image.

The 10x40 Stabiscopes (\$5400) operates either from its own internal rechargeable battery or an external 12-28 volt DC source.

For boaters, the two biggest concerns are coping with a watery environment and navigating. These areas are successfully dealt with by the Steiner Admiral Compass (\$1350). This binocular comes equipped with a stabilized compass that displays an analog reading across the bottom of the image. It also displays a ranging scale (reticle) that can be used to determine distance from objects. To solve the problem of water intrusion and fogging, it has an internal atmosphere of nitrogen.

Leica, one of the most respected names in camera optics, also has a nitrogen-filled binocular, the compact



TASCO 7-21x40 102 BRZ



PENTAX UCF 12x24



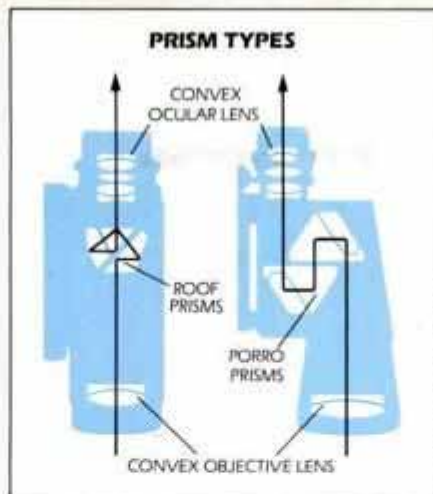
STEINER ADMIRAL COMPASS 7x50

8x42 model (\$1300). It features a 1-piece metal housing with an internal focusing mechanism and is waterproof to 16 ft. After setting lens adjustments for each eye, a single knob controls focusing for both lenses.

Sight and sound

In 1988, Jason Empire introduced its first Perma Focus binocular and started a revolution that's spread throughout the industry. The equivalent of a point-and-shoot camera, the 7x50 Perma Focus 213, with compass and reticle (\$499), is permanently set to focus at about 200 yards. The human eye does the rest, adjusting from as close as 40 ft. out to infinity. Since there are no controls, Perma Focus models are idiot-proof, but there are some caveats. There's no way to adjust for vision differences in a user's eyes. Also, corrected vision is necessary for best results. That is, people who need glasses must wear them. For most users, however, fixed-focus technology is a marvelous advancement. Tasco and Bushnell also make fixed-focus models, and other makers will soon follow.

Bird watchers will appreciate the Jason Discovery Sound Amplifier (\$70) that attaches to most models in the Jason line. The Discovery picks up



Prisms correct image inversion caused by convex ocular and objective lenses.

sound from distances up to 200 ft. It runs on one triple-A battery and comes with a directional microphone and headphones.

Cameralike zoom focusing is the enhanced feature on Tasco's 102 BRZ (\$184), which has a 40mm objective lens and magnification power from 7 to 21. At the lower power setting, it acts like a wide-angle lens. Boaters, for example, can use the binocular at this setting to scan for a marker buoy.

When the buoy is located, switch to a higher setting and zoom in on the identification numbers.

Another binocular designed especially for boaters is the Bushnell Marine 7x50 (\$389). This waterproof model comes with highly visible yellow body armor, which is easy to grip and shields against bumps.

Finally, conventional binoculars have three axis points—the optical axis of each tube and the axis of the hinge. The eye can compensate for only minor misalignment of these axis points. Pentax has attacked the problem of misalignment, usually caused by a worn hinge, by creating a solid-body housing that eliminates the center hinge. In the UCF 12x24 (\$200), when a user adjusts the distance between the eyepieces, the binocular tubes simply rotate in place. An internal gear system synchronizes the movement of the tubes.

In some cases, the latest model binoculars are simply new twists on old ideas. In others, innovative technology is truly transforming handheld magnification optics. But in either case, the multifunction options and specialized enhancements are creating a completely new generation of high-tech instruments. **PM**



LEICA 8x42

BUSHNELL MARINE 7x50



PM'S BOAT OF THE FUTURE

We brainstorm with a top designer to create a next-generation boat for the dawn of the 21st century.

BY JOE SKORUPA, Boating/Outdoors Editor

THE BOAT OF the future will be powered by a 2-cycle stern-drive engine that leaves the water cleaner after running than before. A water scrubber will tie into the cooling system and filter out pollutants to help counterbalance through-hub exhaust. The engine will be torquey enough to power the 23-footer to waterski speeds, yet it will be no larger than a 2-ft. cube. It will be quiet, fuel-efficient and fitted with a telephone jack to send diagnostic data to a service shop through an on-board cellular phone.

In addition to bow and aft transducers for multiple depth readings, the boat will be equipped with forward-

looking sonar. Oncoming objects will appear on a dashboard screen.

Parabolic speakers will be located in overhead half arches creating a stereo cage centered on the aft bench seat. Audio advancements enable the system to transmit frequencies that cancel outside noise.

The contoured windscreen will be hinged and retractable: The down position will be for sporty visibility and the up position for protection. A telescoping rain cover will be hidden in the dash.

Design in the 1990s

In a field where almost anything is possible—modern boats, after all, are

made of molded fiberglass—I've always been baffled by the industry's apparent copycat mentality. I met Peter Granata, a boat designer from Hilton Head, South Carolina, about a year ago, and discovered he felt the same way. After several further meetings, we decided to do something about it. We decided to design the ultimate PM boat for the 1990s.

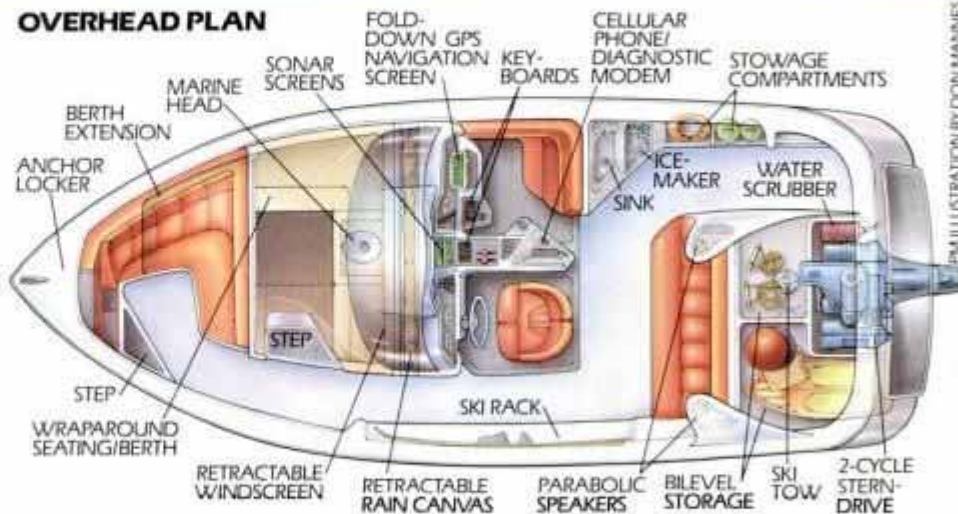
Granata and I proceeded by setting parameters based on current and projected market analysis. We decided our boat will be a trailerable day cruiser. This design is intended to take advantage of two projected demographic trends: 1. Continued migration toward coastal regions, and 2. Maturing of baby-boom families. Other market forces we focused on were: concern for the environment, greater application of microprocessors and increased fascination with instrumentation.



What other elements will characterize the PM boat of the future? Its layout will combine the best features of center-console, bowrider and cuddy cabin boats. The driver's position will be located along the centerline and have a nav station to starboard. The double-wide dashboard will provide plenty of room for electronic instruments, such as multiple sonar screens and fold-down computer with loran and GPS (satellite) capabilities.

Projecting forward of the helm will be a simple cuddy cabin. Under the coaming to port will be a ski rack, and to starboard, a convenience center with stowage. Behind the aft bench seat will be a huge bilevel stowage area with a retractable ski tow. The aft sunlounger pads will be made of a quick-drying material and boaters will be able to use them as floating mattresses. And finally, the layers of the hull will be filled with a core made

OVERHEAD PLAN



of scrap fiberglass recycled from old boats. According to Granata, few boats are designed this way. Usually, a builder calls in a designer and says, "Show me what you've got." We ap-

proached it from the other end. We said, let's start by analyzing emerging trends in demographics, lifestyle and engineering. Then we decided to unplug the copy machine. **PM**

PM ILLUSTRATION BY DON MANNES

Open any door and you'll

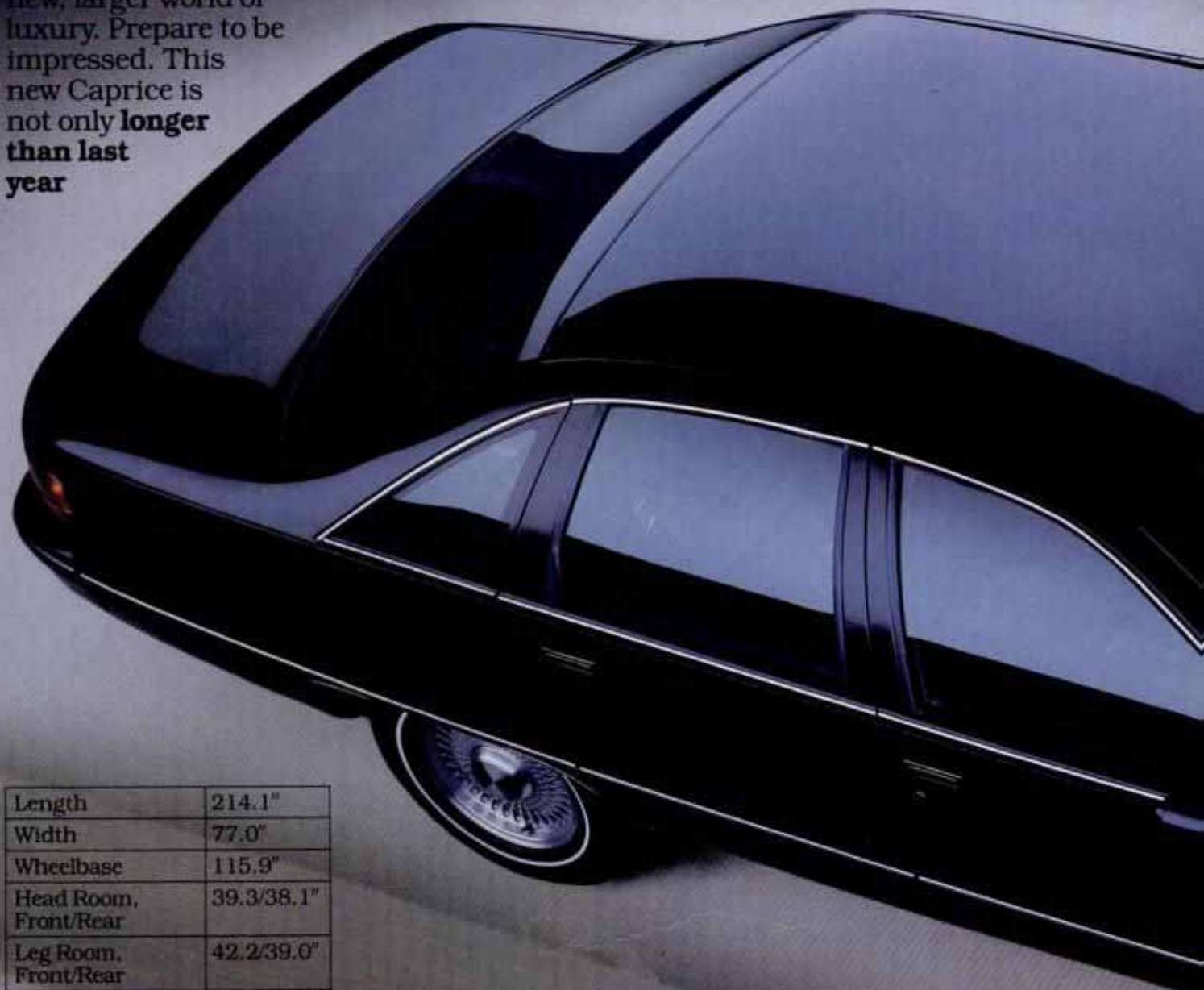
The 1991 Chevrolet Caprice.

You're about to enter a new, larger world of luxury. Prepare to be impressed. This new Caprice is not only **longer than last year**

and roomier than ever before, it's the most spacious Caprice of all time. With more room




for both your passengers and luggage than nearly every luxury sedan sold in America. At any price.



Length	214.1"
Width	77.0"
Wheelbase	115.9"
Head Room, Front/Rear	39.3/38.1"
Leg Room, Front/Rear	42.2/39.0"
Shoulder Room, Front/Rear	63.4/63.4"
Hip Room, Front/Rear	57.0/56.9"
Trunk Space	20.4 cu. ft.

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see more space than ever.

This is the next generation of America's best-selling full-size sedan. The new 1991 Chevrolet Caprice.

Open the driver's door and see what you've been missing. A luxurious environment that **comfortably seats six**. And can include the classic richness of

leather in the seating areas. An option worth the indulgence.

Open the trunk and see how much more you can carry. The **20.4-cu.-ft. trunk holds four golf bags** and enough golf balls to play almost forever.

You expect a car this spacious to come with a long list of features. And it does. Caprice has **more standard features than many higher priced cars**. Standards like anti-lock

brakes, which many only offer as options. Or standard Scotchgard[®] Fabric Protector, which they don't offer at all.

Now that you see how much Caprice has to offer, we invite you to drive it. And discover the biggest pleasure of all.

For more information regarding the 1991 Caprice, please call **1-800-879-1991** or see your Chevrolet dealer.

THE
Heartbeat
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TOP-DOWN

AH, THE THRILL of a convertible. Top down, cruising through the countryside, your hair blowing in the wind. The stereo cranked up.

Suddenly, as Ella Fitzgerald might sing it, the thrill is gone, blown away with your music. So how can you keep Ella or Ellington or the Eurythmics in that convert-

ible without putting the top up? You start with some potent bass—and then plan carefully. Any car stereo installer will tell you a ragtop is a bear, but there are tricks.

Let's assume you want the best sound possible with the top down. Otherwise, why have a ragtop? You'll have to establish more bottom-end punch than you might want in a hardtop, because a lot of bass

energy is lost to the open air. For that punch, you'd normally give up a lot of trunk space to accommodate a couple of big subwoofers and an amplifier or two to drive them.

Compact bass

But you can get your bass. Try the SAS Bazooka series of subwoofers. They get their name from the tubular shape and the low-frequency



TUNES

Ragtops are hot, but they present special problems for the music lover. Here are solutions.

BY LAWRENCE B. JOHNSON

firepower they deliver. The compact Bazooka T52 (\$189 per pair), for example, is a narrow cylinder that will slip neatly into the trunk below the ragtop storage. Another alternative is a servocontrolled bass system like that from Yamaha (\$600). The subwoofer is electronically monitored by a dedicated amplifier.

But that's just half the bass bat-

tle. The other half is getting the sound into the passenger compartment. Because of that inexorable demon ragtop folded into stowage, you can't simply channel bass through the rear seat. It must be piped around or under the seat and vented somewhere. The one good thing is that since very low frequencies tend to be omnidirectional and not a specific function of the stereo

image, the subwoofer can be located wherever it's convenient.

Bass in a box

If you're prepared to go to some expense, an even better bass option might be an isobaric chamber—a custom-designed box fitted to the full space available in your trunk in order to exploit its entire resonating capacity. The isobaric system



TOP-DOWN TUNES

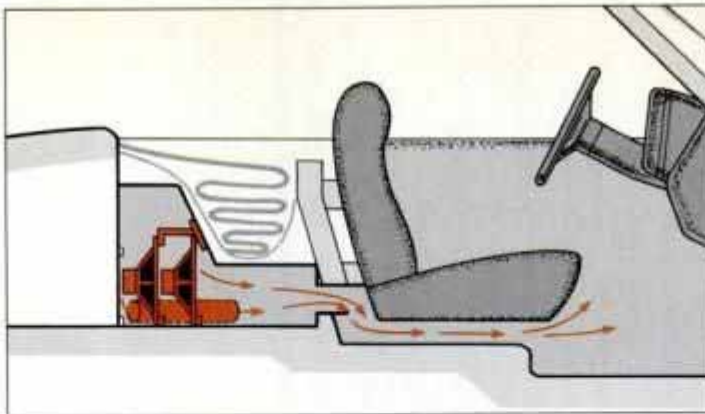
uses two bass drivers working together to generate a formidable and accurate low-frequency sound. Making an isobaric chamber is a precision construction job that's likely to take an expert installer two days to complete. Materials and labor can easily run \$500.

A less radical, and more economical, way to solve the bass problem is to mount one or more subwoofers in the side panels by the rear seat. Here, the speakers (say, 8-in. speakers such as the MB Quart QM 210T, listing for \$319 per pair) need to be enclosed in some type of rugged, tight box made from fiberglass or another strong material. Of course, if the car doesn't have a back seat, you'll have to improvise even more cleverly.

Lift the seats

Finding a good location for the subwoofer amplifier may take a bit of experimenting and even some probing into the car's walls and doors. Don't forget to look under the seats. Some installers like to put the main amplifier for the stereo speakers under one seat and the subwoofer amplifier under another seat. Other experienced voices insist those locations don't provide enough ventilation. But, sometimes you have to make do.

Not only does the extraordinary combination of wind and road noise force you to boost the sound system's bass capacity, all that ambient noise—a good 80 or 90 decibels or more as you fly down the road—also requires solid power for the midrange and high frequencies if you hope to savor Springsteen in a squall. These days some reasonable power is built into receivers (tuner combined with cassette or CD player) that boast 20 to 25 watts per channel. In a hardtop, that much power might deliver the musical



A bass box can be built beneath the ragtop storage compartment. Low bass notes fire forward under the front seat into the passenger compartment. An isobaric system like this one is costly, however.

presence you seek. But it's not enough to blow against the wind.

How much power do you need overall? The amount of power supplied to the subwoofer should be at least five times the amount being supplied to an individual satellite speaker. So if each satellite speaker is receiving 20 watts of power, the subwoofer should be getting at least 100 watts.

Happily, even a hefty car amplifier can be tucked away in the trunk of most convertibles: Usually, all the amplifiers you'd care to use can be bolted onto the subwoofer enclosures, with power cables running the length of the car to the battery. Be warned that most installers caution against overtaxing the car battery and alternator, especially when you're trying to squeeze enough juice to make a convertible system really sing. If you're going to use multiple amplifiers, it might be wise to consider investing in a supergrade alternator. It's definitely advisable to use heavy-duty cables, 7- to 4-gauge, to connect the amps to their power source, the car battery. Hobbyists sometimes even install a second battery to power the stereo system.

While a good subwoofer will anchor a convertible's sound system, creating an effective sense of stereo is still a formidable task. The prime objective

is to mount the midrange and high-frequency drivers as high as possible. That's true of any car installation, but vital here. Positioning the satellite speakers high will help to define a front stage. The rear speakers, generally a 6 × 9-in. coaxial model, will provide ambient fill. There are a few ways to go about it.

The most direct, but typically least effective, approach is to use coaxial-type speakers, typically about 5 1/4 in. in diameter. A coax is a tweeter mounted

directly atop a midrange. These speakers are installed in the front door panels, probably in the same spots where factory-installed speakers are located. These days, however, speaker companies are offering the superior alternative of separately mounted midrange and high-frequency tweeters with a crossover network that may be preset or variable. Component speakers tend to produce better-articulated sound than coaxial speakers.

While both elements of a component package can be mounted in the door, usually with the tweeter a bit higher and farther forward for optimum stereo imaging, there are arguments against this approach. If an upper door location for the tweeter is good, installation in the dashboard is even better. The dashboard location creates a better illusion of musicians performing on stage. The door remains a dandy location for the midrange driver, but every attempt should be made to keep the tweeter and midrange fairly close to each other. If they are too far apart, weird phase relationships result.

Front row, center

While a pair of dash-mounted tweeters can improve the stereo image, a third dash-mounted speaker can nail the image down more solidly. Installation pros are emphasizing that a mono center-channel speaker will strengthen the ear's sense of a front stereo stage. This of course means finding a place to put a front-and-center speaker. Choices usually include the center of the dash, or beneath the radio if there's room.

But not everybody thinks a center channel is worth the bother and expense in a ragtop. It's the same old problem, the one that blew in at the start of this ride. When you're driving under nature's own canopy, the sound is going to disappear into the wind. The only issue is how much you want to hear before it's gone. **PM**



Rear speakers are hidden behind acoustically transparent grilles in this Saab 900 convertible belonging to P.D. Lazarus. Amplifiers and signal processors are installed in trunk under hinged floorboard.

JOURNAL



COMPARISON TEST

CIRCULAR SAWS

We test nine top circular saws for performance and handling.

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

WHETHER you're a homeowner about to build a new deck, or a seasoned pro with a roof full of rafters to cut, a circular saw is one tool that you can't do without. When it comes to cutting lumber, no other saw combines power, speed and accuracy in such a compact, portable package.

Like most power tools, circular saws come in a variety of styles, sizes

and prices, and most manufacturers offer at least one model. The most popular saw size is 7¼ in. The dimension signifies the maximum diameter blade that the saw can handle. This size easily cuts through nominal 2-in. construction lumber—even with the blade set at 45° to the base.

The most common type features a motor axis that is parallel to the axis of rotation of the blade. The motor is

linked to the blade shaft via helical gears that reduce motor speed to about 5800 rpm. (See the drawing on page 83.) Some carpenters prefer a design where the motor axis is at a right angle to blade rotation. These saws are usually worm-gear driven, and are only offered in a professional-level price range. (For specifications on different saw types, see page 84.)

For our comparison test, we col-



SKIL 5750



MAKITA 5007NB



MILWAUKEE 6368



BOSCH 1651

lected top-of-the-line, standard 7¼-in. saws from nine of the major tool manufacturers. Each tool was subjected to a series of trials intended to measure comfort, handling and ease of use. Of course, we can't tell you how long any one tool might last. However, we can tell you which ones, in our opinion, seemed carefully built, ran smoothly and quietly, and were easy to adjust and operate. All of our test tools feature ball and roller bearings.

Although each saw is similar in appearance, depth-adjustment mechanisms fall into one of two categories: pivot-foot models where blade depth is regulated by pivoting the base at a point at the saw front, and drop-foot saws where the base moves up and down in a straight line. Pivot-foot saws force you to hold the tool differently at various blade depths, but are generally lighter, simpler tools. Drop-foot saws have the advantage of constant handle/base relationship regardless of depth of cut. (See the drawing on page 83.) However, the sliding mechanism is prone to jamming. The handle on any drop-foot saw may be designed to favor certain types of work. If it's nearly parallel to the base, the saw is called a top-handle model and is useful when you're directly over the work. However, if you're cutting large panels and likely to be behind the saw pushing it, a push-handle model where the handle is angled back is more comfortable.

Saw bases are either made

of thick aluminum, or thinner stamped steel that's ribbed and bent up at the edges for stiffness. Although the aluminum type looks more substantial, it's doubtful that it provides any great advantage other than offering a better edge for following a cutting guide.

In addition to the saws shown, we also tested the Black & Decker 3047-09 industrial circular saw which is now out of production. Unfortunately, B&D's replacement model was unavailable at the time of our tests. Both the original unit and its updated version share design features including a modified pivot-base depth adjustment, blade brake and convenient depth scale mounted on the upper blade guard. However, the new unit appears to be a somewhat more refined design than the older tool which suffered from a few fit and finish problems.

While all of our test tools are clearly up to the usual cutting chores, most of them display an assortment of inaccuracies that you don't expect to find in tools of this price range. For example, all of our tools, except for the out-of-date Black & Decker industrial model, have no provision for adjusting the base edge parallel to the blade. (The new B&D tool also has this feature.) Not only are the tools nonadjustable, but most show a misalignment as measured from the front and back of the blade to the base edge. Also, blade shaft end play (measured as in-and-

out motion at the blade bolt) ranges as high as .005 in., and in most cases is reflected in clearly detectable side-to-side play at the blade circumference. (See the chart on page 85.) While many of these saws incorporate setscrews as a stop to quickly and accurately set the base for a 90° cut, the setscrews can be loose causing them to vibrate out of position as the saw is used.

What does all this add up to? Perhaps nothing if you're framing a house. However, if you plan to use the best possible, smoothest cutting blade that you can buy, and use your saw with straightedge guides for precision work, many of these tools won't be up to the task.

In terms of cutting speed and power, it's difficult to distinguish one brand from the next—blade condition and type have a far greater effect. However, handling and balance go a long way in determining how any one saw feels like it's performing. The ability of the lower guard to retract smoothly and effortlessly is one of the most important factors here.

AEG PC70-1

The most immediate feature of this saw is its blocky, squared-off design and large base. Power is delivered through a healthy, 13-ft. flexible rubber cord. Not immediately apparent is the AEG's 6400-rpm blade speed—the highest in our test group—and powerful 13.5-amp motor. Both

AEG PC70-1



HITACHI C 75A



SEARS 10925



**PORTER-CABLE
315-1**



RYOBI W-620

of these should indicate effortless cuts. However, the AEG suffered from a fairly stiff lower blade guard. Ordinary crosscuts required unnecessary effort due simply to the raising of the guard.

The high speed does make for a smooth running saw that rates about average in terms of sound level. When following a line, the cut-alignment

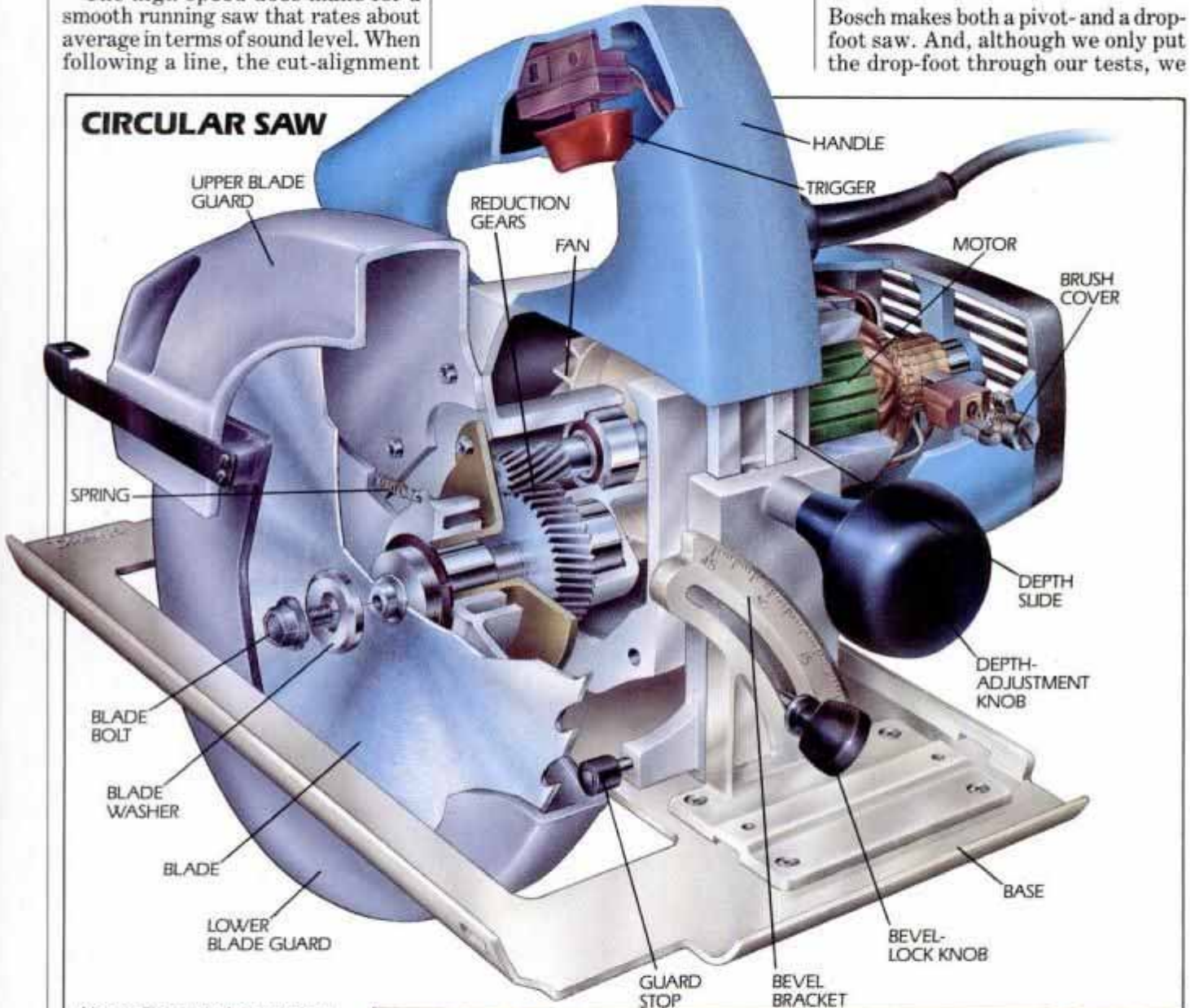
notch split the cutline perfectly for our carbide-tipped blade. Although the base measures a significant .055 in. out of alignment with the blade, the blade shaft has no significant end play, and the 0° stop setscrew is

comfortably tight. The drop-foot mechanism works smoothly and is calibrated in eighths of an inch. The bevel gauge is divided into single degree increments.

Bosch 1651

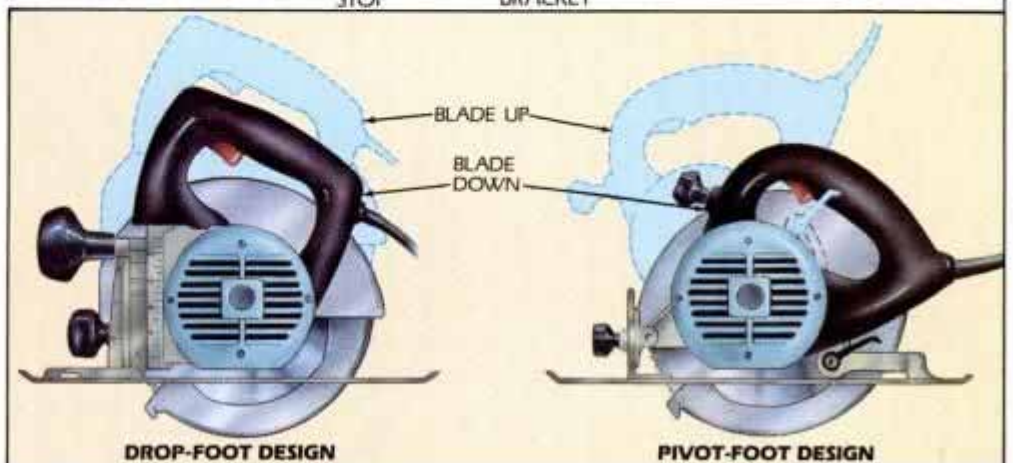
Bosch makes both a pivot- and a drop-foot saw. And, although we only put the drop-foot through our tests, we

CIRCULAR SAW



Above: The typical heavy-duty circular saw features a 10- to 13-amp motor mounted on ball bearings and driving a blade shaft through helical reduction gears. The blade shaft is supported by ball and roller bearings.

Right: Circular saws use either a drop-foot or pivot-foot mechanism for adjusting blade projection below base. The drop-foot's straightline action maintains handle/base relationship at all cutting depths. Pivot-foot saws must be held differently at various cutting depths.





Adjust cut depth on drop-foot saws by loosening knob and sliding base up or down. Graduations on Bosch tool indicate depth of cut in inches or centimeters.



Blade depth on pivot-foot saws is usually controlled by locking lever at rear of saw upper guard. Lifting lever allows saw to pivot freely at front pivot point.



Loosen bevel knob to rotate base to desired cutting angle. This Skil saw is graduated in single degrees. Other tools may be graduated in 5° increments.

did try out the pivot-foot. As expected, the pivot-foot tool is lighter, more compact and is somewhat more comfortable to use, although blade visibility isn't great.

The Bosch drop-foot is a very well-balanced, smooth running, 5500-rpm tool that's powered by a 13-amp motor. Unfortunately, it's also on the noisy side, ranking just under the Sears unit. All of the controls—trigger, depth and bevel—worked exceptionally well. The depth scale is graduated in 1/4-in. or 5-millimeter increments. The bevel scale is in single degrees.

However, we did find that the guard dragged excessively, making the saw harder to use than it should have been. And, the 90° setscrew was loose—not likely to stay in position. The cutline notch on the base indicates the center of the saw kerf.

Hitachi C 7SA

This was the smallest and most compact tool of our test group. And, although the motor is a little smaller than the rest (10 amp versus the usual 13 amp), we had to sink the fully ex-

tended blade into a 4 × 4 to see any real performance difference—and even then the difference wasn't significant.

The saw did have a few unfortunate drawbacks. Most annoying is the rather small, pressed-steel base that doesn't have an adjustable setscrew stop for 0°. To set the base for a square cut, you'll have to rely on the graduations on the bevel gauge—they're only set in 5° increments and are almost impossible to read. The tool did, though, have fairly good cutline visibility.

The blade shaft end play isn't excessive (.002) and the blade to base alignment fell about average among our test tools. However, this tool is eminently comfortable and easy to handle. For simply cutting lumber while holding the tolerances that are usually required in the construction trades, it's well within reason, and no other tool can match it for lightweight comfort.

Makita 5007NB

Although we concentrated on drop-foot saws in this comparison test, the

Makita is clear proof that a well-designed pivot-foot saw can be a match for any drop-foot—with a few advantages of its own.

In terms of effortless cutting, this saw ranks high. The large handle is well designed and comfortable, and the lower blade guard retracts smoothly when starting the cut. Moderate noise level and nearly no vibration add to an overall sense of quality and the tool scores well for fit and finish. Both the bevel and depth adjustment are smooth and easy to operate.

Although the Makita 5007NB is definitely nose heavy, the moderate weight and good handle design make this almost acceptable. The front handle, however, is much too close to the bevel quadrant for comfort. Blade shaft end play is on the high side, but the base is well aligned with the blade. Makita also offers the same basic saw with an electric brake.

Milwaukee 6368

Pick up this tool and there are a few things you'll probably notice right away. First, the tool is compact. Not small, or light, but compact—nothing

CIRCULAR SAW SPECIFICATIONS

MANUFACTURER	MODEL	TYPE ¹	AMPS	RPM	DEPTH OF CUT 90°/45°	WEIGHT (lb.)	BASE ² SIZE	BASE TYPE	SETSCREW ³ STOPS	CORD	SHAFT LOCK	ACCESS. ⁴	PRICE ⁵
AEG	PC70-1	D	13.5	6400	2 1/2" / 1 7/8"	12.1	8 × 12"	alum.	90°	13'	yes	B,W	\$229
Bosch	1651	D	13	5500	2 1/16" / 1 13/16"	12.9	7 1/2 × 12 3/4"	alum.	90°	10'	no	CB,W	\$195
Hitachi	C 7SA	P	10	5500	2 1/2" / 1 1/2"	8.8	5 1/8 × 9 1/2"	steel	none	7.5'	yes	B,W	\$119
Makita	5007NB	P	13	5800	2 3/8" / 1 3/4"	11	6 3/4 × 11 1/2"	alum.	90°	9'	yes	CB,W	\$208
Milwaukee	6368	D	13	5800	2 3/8" / 1 29/32"	11.5	7 × 11 1/4"	alum.	90°	9'	yes	CB,CC,F,W	\$233
Porter-Cable	315-1	D	13	5800	2 1/16" / 1 29/32"	12.5	6 1/2 × 11 3/8"	alum.	90°,45°	10'	no	B,W	\$195
Ryobi	W-620	D	13	5500	2 1/16" / 1 29/32"	11.7	7 3/8 × 12 3/8"	steel	none	6.5'	yes	B,W,F	\$110
Sears	10925	P	12	5000	2 1/2" / 1 3/4"	13	6 1/2 × 11 1/2"	steel	90°	10'	yes	CB,W,F	\$76.98
Skil	5750	D	13	5800	2 7/16" / 1 3/4"	13.6	7 1/2 × 12 3/8"	alum.	90°	8'	yes	B,W	\$228

1. D=drop-foot saw; P=pivot-foot saw. 2. Aluminum bases are flat, about .160 in. thick; steel bases are stamped with ribs and turned edges. 3. Availability of adjustable setscrew to quickly set blade at 90° or 45° to the base. 4. B=steel blade; CB=carbide-tipped blade; W=blade wrench; F=fence; CC=carrying case. 5. Prices are as supplied by manufacturers and are not necessarily an accurate reflection of retail cost.



Most saws have a setscrew stop for setting the base 90° to the blade. P-C (shown) also has a setscrew for 45°. Screw should be stiff or have locknut to keep it in position.

sticks out too far. Next, the tool is well balanced. Although the handle leans more toward the push type (about 45°), the base doesn't hang forward excessively. The handle is hefty, but comfortable.

Depth adjustment is very smooth, and bevel adjustment is controlled by a lever rather than a knob. We measured shaft end play at .001, and the Milwaukee ran very smoothly with no vibration.

On the down side, the blade/base misalignment measured in at a significant .054 (almost 1/16 in.). And, the 90° setscrew on the bevel adjustment isn't long enough to set the base at 90°—we had to adjust the base with a square to be accurate. Milwaukee also offers this saw without a case as model 6366.

Porter-Cable 315-1

This top-handle tool is very well balanced, although a little on the heavy side. (P-C also offers the same basic saw in a push-handle model.) The tool is very nicely put together with a few features that none of the other tools boasted.



Ryobi, Sears and Hitachi have a safety-lock button that must be depressed before trigger can be operated. Side button (as shown) is convenient for righthanded use only.

Most noticeable is the grease cup that allows the user to lubricate the gears without disassembling the machine. The P-C 315-1 is also the only saw with setscrew stops for 90° (hex/slot screw) and 45° (Allen screw).



Porter-Cable is the only saw that has an easy method for lubricating the gears. A simple turn on this grease cup does the job. Other saws must be disassembled.

Both the blade depth slide and the bevel adjustment work very smoothly. The tool is above average in comfort and very well balanced. The blade/base alignment is off by a scant .003 in.

Although the saw runs with little vibration, the motor sounds somewhat rough and blade shaft end play measures .005 in.—the highest in our test group. Our chief complaint with this tool is the excessive blade guard drag. The guard noticeably impedes ease of operation until it's completely up and out of the way.

Ryobi W-620

The Ryobi W-620 has several noteworthy features including the largest overall base size and relatively low noise level. The base is stamped steel and the tool comes with a rip fence. (Ryobi also offers a 7¼-in. saw with an aluminum base.)

Both the depth and bevel adjustments work well, although not as well as the best, and general fit and finish is below average. However, this tool ranked with the best for shaft end play (.001 in.) and measured .006 in. in

CIRCULAR SAW BALANCE

PORTER-CABLE 315-1

BOSCH 1651

MILWAUKEE 6368

HITACHI C 75A

AEG PC70-1

SKIL 5750

RYOBI W-620

MAKITA 5007NB

SEARS 10925



Chart represents, in descending order, the degree to which each saw is balanced from front to back when held normally.

COMPARISON CHART	BLADE SHAFT END PLAY	BLADE/BASE MISALIGNMENT	NOISE LEVEL
	0 .005"	0 .055"	(Icon of saw with noise waves)
AEG PC70-1	██████████	██████████	██████████
BOSCH 1651	██████████	██████████	██████████
HITACHI C 75A	██████████	██████████	██████████
MAKITA 5007NB	██████████	██████████	██████████
MILWAUKEE 6368	██████████	██████████	██████████
PORTER-CABLE 315-1	██████████	██████████	██████████
RYOBI W-620	██████████	██████████	██████████
SEARS 10925	██████████	██████████	██████████
SKIL 5750	██████████	██████████	██████████

Blade shaft end play measured at blade-securing bolt head with dial indicator. Actual side-to-side play at blade circumference may be greater. Blade/base alignment represents difference between distance from one tooth to base edge at base front, and that same tooth to base edge at base rear. Noise level represents relative noise as measured on dbA scale. The test group ranged from 91 to 99 decibels.

blade/base misalignment.

The saw has a definite push-handle design and is balanced toward the nose. It's one of the few tools with a safety button that must be engaged before the trigger can be depressed. The button, however, is almost too easy to press. Most annoying is the short (6½-ft.), kinky power cord. And the bevel adjustment has no setscrew—once you change the blade angle, you'll need a square to reset it accurately.

Sears 10925

The most unusual feature of this push-handle, pivot-foot tool is its balance—it's severely front heavy. It leans so far down when held on one end, that it compares with the long, heavy, worm-drive circular saws that are

preferred by some carpenters.

Like the Hitachi and Ryobi saws, this tool has a safety button that must be depressed before the trigger can be operated. However, the button is mounted on the handle top—so far away from any of your five fingers that its nuisance status completely negates any safety factor. And once the trigger is engaged, you'll know the motor's running. This tool was the loudest and roughest sounding.

The good news is: The Sears 10925 has a very convenient shaft lock, easy to operate depth adjustment, and a 90° setscrew that has its own locknut. The tool also has a wrench holder built into the stamped-steel base. Shaft end play measures about .001 in. and blade/base alignment is better than most. Combine these features with a

carbide-tipped blade, rip fence and a very attractive price, and the saw looks like a competitor.

Skil 5750

Skil doesn't just make circular saws, it makes Skilsaws—a name so well known that the general public has virtually adopted it to signify nearly any portable power tool that cuts wood.

Skil makes a host of circular saw models, including drop-foots, pivot-foots and worm-drives. We selected the model 5750 drop-foot saw for our test. Although this tool is about average in terms of overall and base dimensions, it feels massive and is the heaviest tool in our selection. It's also the quietest and very smooth running. The guard retracts well for square and miter cuts.

An especially novel feature is the depth scale which appears on the base next to the blade. It indicates blade depth by measuring the distance from the front to rear edge of the exposed blade. Both blade/base alignment and shaft end play are on the better side of average. Our only real complaint lies with the weight of this tool. It's hard to understand why anyone would want to lug around extra pounds.

Choosing the best

Each saw has its advantages and disadvantages, and it's worthwhile choosing the one that suits you best. Our choices are not only based on specifications and measurements, but also on how the tool looks, feels and sounds—things that aren't easy to quantify.

For us, the Milwaukee is the best saw in our test group. It's easy to handle, smooth running, compact without being a lightweight, and looks like it's built to last. The Makita 5007NB is next in line. This is a very comfortable tool and except for its nose-heavy balance, would clearly be vying with the Milwaukee for top honors. At the other extreme, we found the Sears to be the most annoying. The others fell somewhere in between with competitive strengths and weaknesses.

However, before you take our advice, or anyone else's for that matter, keep this in mind: All of these saws cut lumber. And, the difference between any one saw and the next is far less than the difference between using a dull blade and a sharp blade. In other words, choosing a make and model is less important than keeping a good blade on hand. Not only will the work go easier and safer, your saw will last longer, too.

PM

Circular Saw Variations

WHILE BOTH users and manufacturers confirm that the standard 7¼-in. saw is the most popular and most useful for the widest range of applications, you certainly aren't limited to this design and size.

Many carpenters prefer the original worm-drive saw first developed by Skil more than 65 years ago. Today, the **Skil 77**, 7¼-in. saw (about \$242) is complemented by 6½-in. and 8¼-in. models. The advantages of a worm-drive saw are all ball-bearing construction (rather than the ball and roller bearings found on standard models), heavy shock-absorbing worm-gear transmission, oil-bath gear lubrication and a heavily constructed motor.

On the down side, these saws are heavy and poorly balanced for level, one-handed work. The worm-drive is actually less efficient in transmitting the motor's torque than standard helical gearing. However, blade speed is geared down to about 4400 rpm, rather than the roughly 5800 rpm of standard saws, to supply the necessary torque to the blade. Also, the motor is on the right side of the cut. Although this makes for good outline visibility, it puts the mass of the saw over what's usually the waste side of the line.

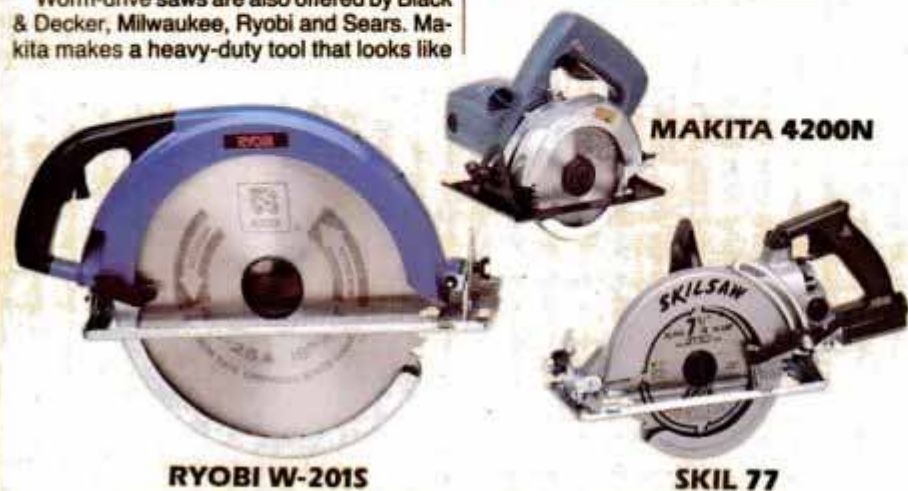
Worm-drive saws are also offered by Black & Decker, Milwaukee, Ryobi and Sears. Makita makes a heavy-duty tool that looks like

the worm-drive models, but uses a right-angle, hypoid gear transmission.

For those of us who only cut light stock such as trim and paneling, there's no need for a 13-amp motor and 2½-in. cutting depth. More in line with these needs is the **Makita 4200N** 4¾-in. saw (about \$225). This tool weighs only 6.2 pounds, has a 7.5-amp motor and comes with a rip fence. With the right blade, it's capable of cutting aluminum, plastic, tile and concrete.

In fact, you don't need a 7¼-in. saw to cut 2 × 4s to length (at a 90° angle). One of the several 5½-in. saws on the market will do the job. And, Porter-Cable's 6-in. Sawboss has the depth capacity to cut through nominal 2-in. stock at 45°.

In some cases though, you'll simply need a bigger saw. An 8¼-in. tool will enable you to cut through a 6 × 6 by working from both sides. Move up to 10¼ in., and you can cut through a 4 × 4 in one pass. However, if you really need cutting depth capacity, then perhaps the **Ryobi W-201S** (about \$325) will do the job. Its 16¼-in.-dia. blade has a maximum 90° capacity of 6⁷/₁₆ in. and will actually cut through a 4 × 4 with the blade set at 45°.



TOOL TEST
**NEW
SHOP VAC**

TEXT AND PHOTOS BY
ROSARIO CAPOTOSTO,
Contributing Editor

SEARS' NEW wet/dry vacuum came along at a most opportune time for an evaluation, because my shop was inundated with debris after completing several major woodworking projects.

Although I don't consider shop cleanup to be fun, I admit experiencing a trace of joy while letting this 2.5-hp machine, with a 2.5-in.-dia. hose, go to work. It easily swallowed nails, wood and metal scraps, shavings and sawdust. With the crevice nozzle attached, it pulled caked sawdust out of my table saw's motor housing.

Dusting off sanded woodwork prior to finishing is an important job for a shop vac. I was disappointed the accessory kit with this vacuum didn't include a dusting brush. I bought one at my local Sears (model No. 9HT 16901, about \$5). The vacuum thoroughly removed surface dust.

The vacuum holds 1.8 bushels of dry debris, and 13 gallons of liquid (its



Sears' powerful wet/dry vacuum comes with accessory nozzles and wands (inset).

16-gallon rating refers to its drum size minus the top). The squeegee nozzle really picked up water, and the automatic shutoff stopped the vacuum when it reached its capacity.

I liked the relatively quiet motor and the accessory storage feature that keeps extension wands and nozzles handy. The accessory drum liner makes it easy to dispose of dry debris. Just lift off the vacuum's top and pull

out the liner (model No. 16940, a bag of five liners costs \$3). You can use the vacuum without the liner, too.

The vacuum, model No. 179780, comes with an accessory kit that includes two extension wands and nozzles for crevices, liquids, floors and car interiors. It costs about \$100 at Sears stores. Write to Sears, Dept. 703 PM, BSC 40-16, Sears Tower, Chicago, IL 60684. **PM**



1 The ports over each caster serve to store accessory items, such as extension wands and nozzles, within easy reach.



2 A good feature is the vacuum's recessed on/off switch, which prevents the vacuum from being accidentally switched on.



3 With powerful suction capacity, the vacuum gets any job done quickly. Here, the floor nozzle picks up planer chips.



4 The durable filter is easily removed for shaking out dust. Impregnated with phenolic resin, the filter is washable.



5 The accessory drum liners are convenient. When full, simply lift them out, and close with a twist tie for dust-free disposal.



6 Unscrew the drain cap to drain the vacuum or flush out the tank with a garden hose. Its liquid capacity is 13 gallons.

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Stairway Design

I am planning to build an addition to my house, and I want to build an interior stairway for access. Are there specific design dimensions that I should follow from a safety point of view?
MITCHELL SACKSON
ARMONK, NY

The two main concerns in stairway design are the treads (the steps) and the risers (the vertical sections that link the steps). It's important that the riser height be the same for all the steps. Otherwise, the dimensional variation interrupts the natural rhythm of ascending and descending the steps, producing a tripping hazard. Also, the treads must not be too narrow, otherwise, a person would need to place his foot diagonally on the treads for safe and comfortable support.

The U.S. Department of Housing and Urban Development (HUD), in its "Design Guide For Home Safety," recommends the following design specifications for interior stairs. The maximum riser height should be 7½ in. Minimum run width should be 10 in., and minimum tread width, 11¼ in. The maximum nosing width should be 1¼ in.

Also note the position of the hand-rail and light switches on the drawing below and the ceiling height requirements. Maintaining adequate ceiling height is important to

avoid low headroom at the bottom of the stairs.

Finally, check with your local building department for further requirements.

Squeaking Floor

I built a stilt house that is 15 ft. off the ground. I put down a ¾-in.-thick tongue-and-groove plywood floor over 2 × 12 floor joists and covered it with carpeting. The floor now squeaks in several places. How can I fix it?
W.V. LITTELL
TAMPA, FL

The type of floor you have is called a single-floor system. It was developed by the plywood industry and can be used in place of the standard floor, which consists of two panels (sub-floor and underlayment).

The squeaking is caused by the floor panels rubbing against one another or against the framing. It's a fairly common condition and usually results from the loosening of some of the nails holding down the subfloor because of shrinkage or warpage of the framing. This generally occurs when smooth shank nails are used to fasten the subfloor rather than ring-shank or spiral-shank nails, which are less likely to pull loose. It's also possible that not enough nails were used to fasten the floor to the joists. In that case, the squeaking should be reduced by re-nailing the loose sections.

According to the American Plywood Association, you should use 6d ring-shank or spiral-thread nails. Also, the nails should be spaced 6 in. on center at the panels' edges (where panels butt each other), and 10 in. on center at intermediate joists.

Gas Leak

Two years ago I purchased a gas-fired furnace, and since then have had re-occurring gas leaks. It was leak-free for nine months after it was installed. But one year later, there was a gas leak and there have been others since then. I've heard of detectors for propane gas leaks, but is there one for natural gas, also?
E. AKEHURST
SOUTH HAVEN, MI

It's very unusual to have reoccurring gas leaks. The condition may be the result of a faulty gas valve or impurities in the gas supply that are reacting with the piping that carries the gas to the furnace, eroding minute holes in the piping. Your local utility should help you solve this problem. If not, your best and safest bet is to replace the entire system.

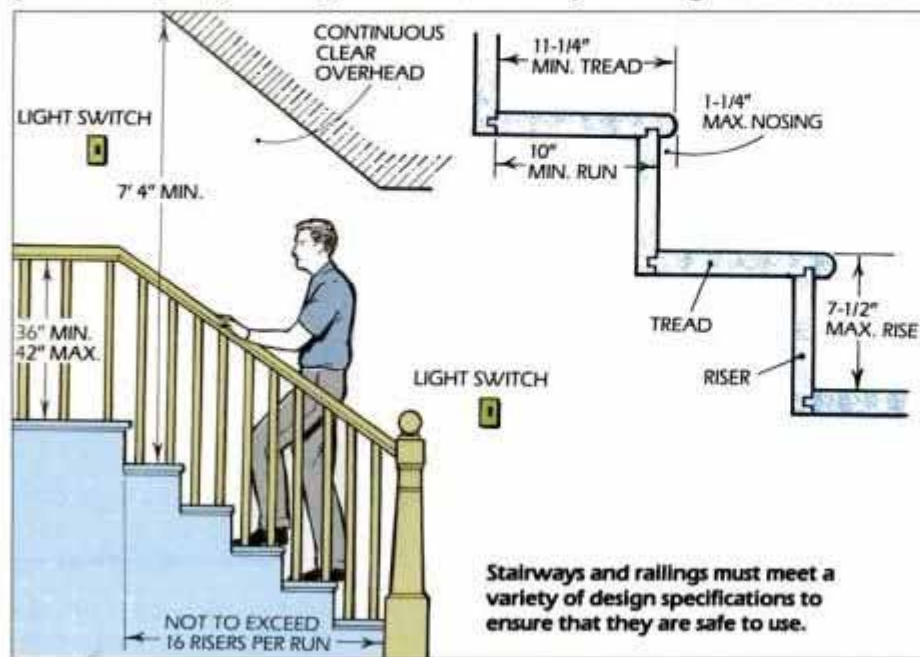
I know of only one company that makes natural gas detectors for residential use. Contact Newtec Industries Ltd., 102-980 W. First St., North Vancouver, B.C. V7P3N4, and ask for detector model No. SG-110, which costs \$65. A commercial grade gas detector is sold by The Specialty Tool Co., Inc., 1450 Grassy Plain St., Bethel, CT 06801. It's item No. 032007, and sells for \$625.

Service Tip

The dilemma that many people face when they need a roof replacement is which roofer to use. The CertainTeed Home Institute, Shelter Materials Group, P.O. Box 860, Valley Forge, PA 19482, has issued a free pamphlet titled, "Choosing A Reputable Roofer." The pamphlet helps you select a good contractor and negotiate a contract. It lists seven questions to ask a roofer and why those questions should be asked. Also, it explains the basic items the contract should cover.

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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



Stairways and railings must meet a variety of design specifications to ensure that they are safe to use.

SHOP PROJECT
**4X5
CAMERA
KIT**

TEXT AND PHOTOS BY
THOMAS KLENCK, Associate
Home and Shop Editor

IF YOU ENJOY photography, but are beginning to find 35mm film lacking when it comes to crisp, clear enlargements, then perhaps you're ready to approach your subject like the pros do—with a large-format, 4 X 5 view camera. Although this type of camera can't compete when it comes to speed and portability, it reigns supreme for still-life, portrait and studio work. View cameras also provide perspective distortion control. This is achieved by mounting the lens and film in separate frames that can be independently adjusted to alter the perspective. A flexible bellows connects the frames.

However, before you spend from \$500 to \$1500 on a professional camera (that's just the camera, no lens), you



1 Begin assembly by using quick-setting epoxy to secure threaded studs in the shift bar ends. Let epoxy set for 8 hours.



2 Focusing slides are assembled with brass screws and washers. Thread plastic knobs on focusing-rod ends and tighten.

might want to examine this do-it-yourself alternative—the Porta-Vu II 4 X 5 View Camera Kit. It's available from Fader Photo Works, 1402 Bardstown, Ann Arbor, MI 48105, and costs \$160 postpaid. The kit comes with everything you'll need to build a wooden (cherry) camera except the lens. It takes about 4 hours to assemble (not counting time for glue to set and for the finish to dry).

A 210mm view-camera lens is an appropriate size for this camera. However, you needn't buy a new one—many camera dealers have used lenses on hand that will do a fine job

for far less money. You'll also need 4 X 5 film holders. Each holder holds two sheets of film. The holders are loaded in total darkness and then inserted in the camera back for exposure. To support the camera, use a medium-weight tripod and have a cable release on hand for operating the shutter.

Building the camera

Construction begins by sanding all of the wooden parts and applying a penetrating-oil finish. Then, assemble the major carriage components, as described in the instructions. The focus slides, used to move the front and rear



3 Install focusing slides on monorail so plastic-sheathed rods bear on abrasive strips. Adjust for smooth operation.

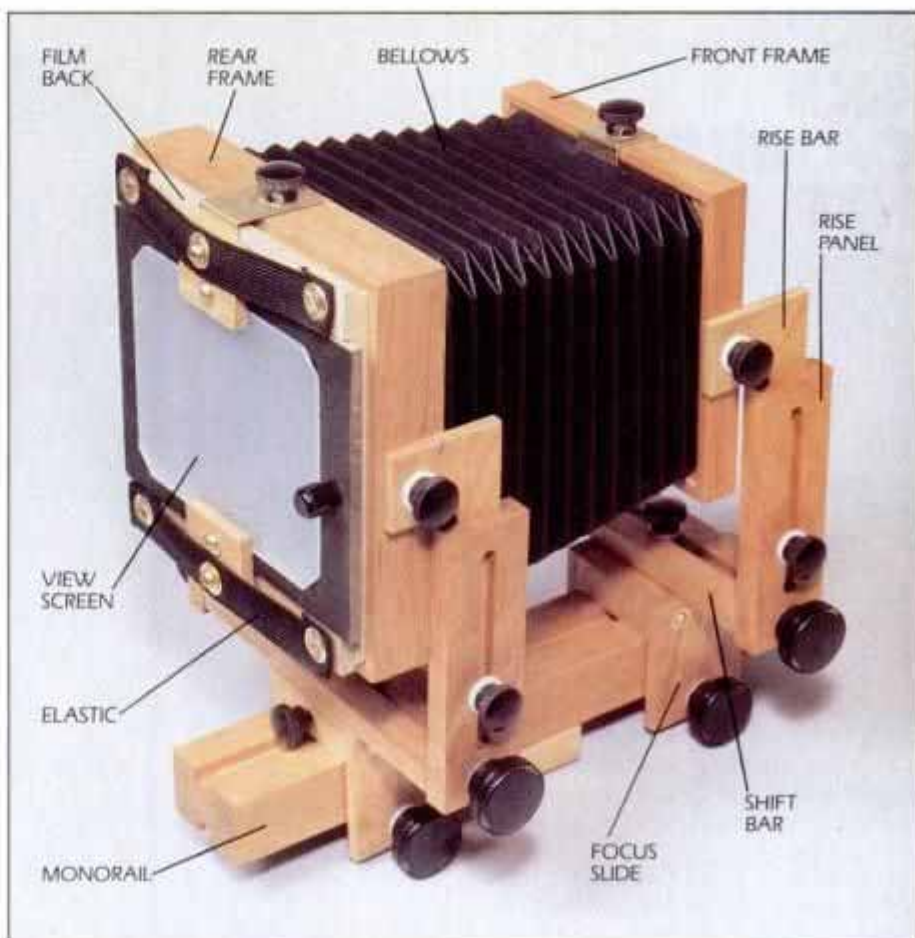


4 Assemble shift bars on focusing slides with appropriate hardware. Use supplied plastic washers under all knobs.

frames for focusing, operate via a friction drive between plastic-sheathed rods and abrasive strips on the monorail (Photos 2 and 3). Fit shift bars to focus slides with provided fittings (Photo 4). The shift bars can both rotate and shift from side to side.

To join the bellows to the frames, apply contact cement to the mating surfaces. When the cement has dried, carefully align the components and press in place (Photo 5). Check that the bellows completely seals at both frames. If there are any openings at the frame corners, install small triangular blocks, or mask the area with matte black tape.

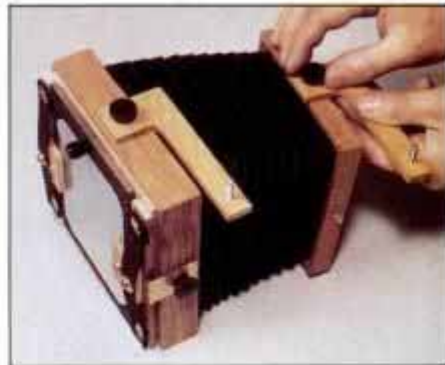
The glass view screen is held in place by two elastic strips. These allow the view screen to be pulled back when inserting the film holder (Photo 6). After securing the film back assembly to the rear frame with brass clips, loosely assemble the rise bars and rise panels to both sides of the front and rear frames (Photo 7). Then, secure the entire assembly to the shift bars and tighten all knobs (Photo 8). Use a holesaw to cut an appropriate hole in the lensboard for your lens. Secure the lens with the lens retaining ring and mount the lensboard in the front frame (Photos 9 and 10). **PM**



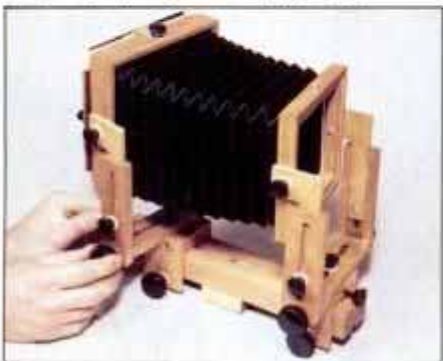
5 Use contact cement to join bellows to front and rear frame. Make sure parts are aligned properly before applying pressure.



6 Screw elastic strips to film back. Lift strips and insert glass view screen. Secure view screen to elastic with brass screws.



7 After installing film back assembly to rear frame with brass brackets, loosely secure rise bars to front and rear frames.



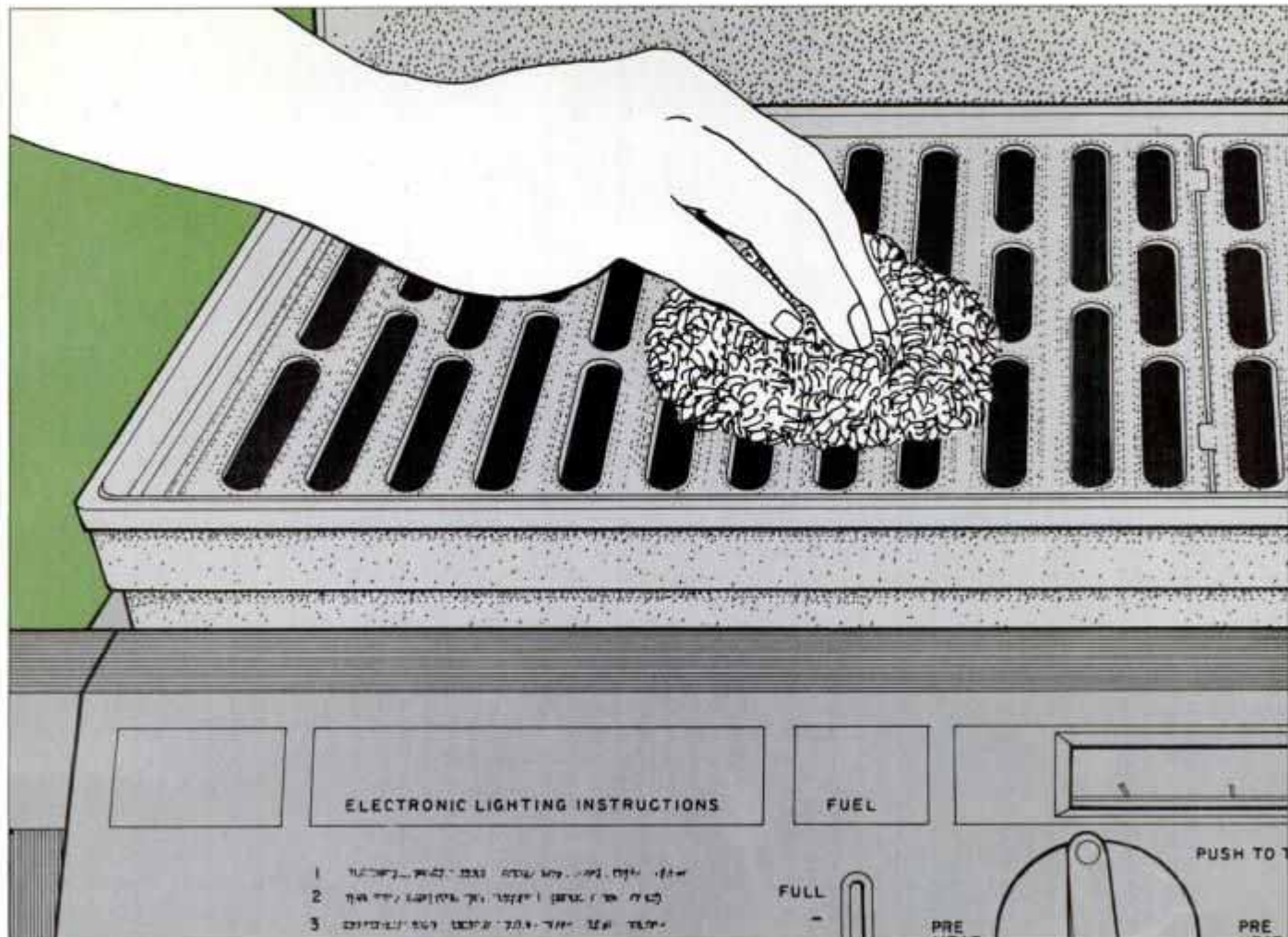
8 Loosely fasten the rise panels to rise bars with knobs and washers. Then, fit the assembly onto shift bars and tighten knobs.



9 Use a holesaw to cut hole for lens in exact center of lensboard. Install lens in hole and secure with lens retaining ring.



10 Brass clips at top and bottom of front frame hold lensboard in place. Secure the clips by tightening plastic knobs.



GAS GRILL TUNEUP

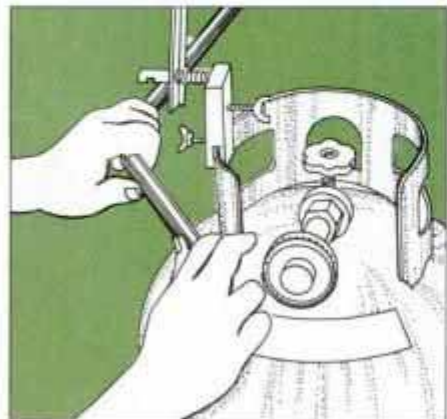
BY STEVE TOTH, Contributing Editor
PM Illustrations by Dyck Fledderus

NOW MAY BE the perfect time to tune up your gas barbecue grill. The barbecue season is well under way, and your grill has probably seen lots of use. Plus, some of the best barbecue days still are ahead, especially

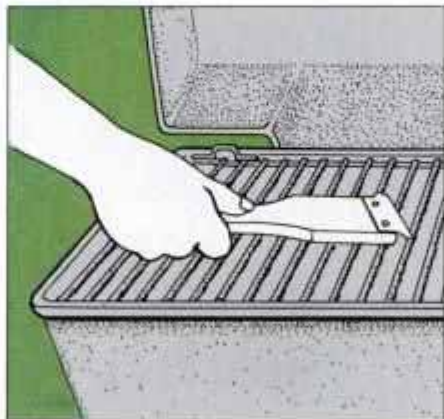
if you're taking a vacation, and with Labor Day weekend coming. If you use your grill year-round, it's easier to tune it up in the summer when you can do the necessary painting and cleaning outside, in nice weather.

Whether you have a natural gas, stationary post model, or an LP (propane gas) model, the procedures you use will be about the same. Also, as a safety precaution, make sure you shut off the gas supply before doing any maintenance or repairs.

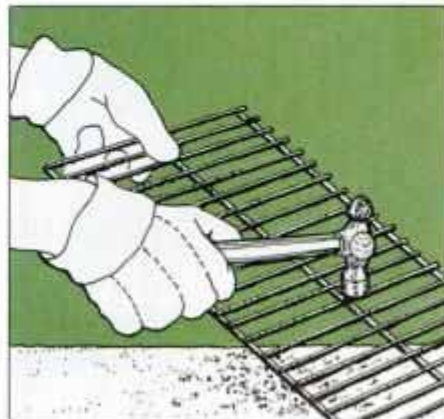
With natural gas-fired grills, you need to pay particularly close attention to the condition of the post. Inspect the post where it goes into the ground and at the top where it attach-



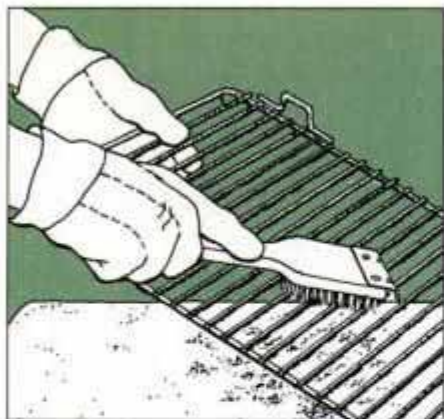
1 Check your grill's flexible supply line for a tight connection. Also, bend it carefully and check it for cracks.



2 Scrape cooking residue and rust off the cooking grate. Then wash grate with warm water and soap, rinse and let dry.



3 Remove fire grate and check whether it is sound by tapping it with a hammer. This also knocks off residue and rust.



4 Finish cleaning the fire grate with a stiff scrub brush. If cleaning reveals weakened areas, replace the grate.

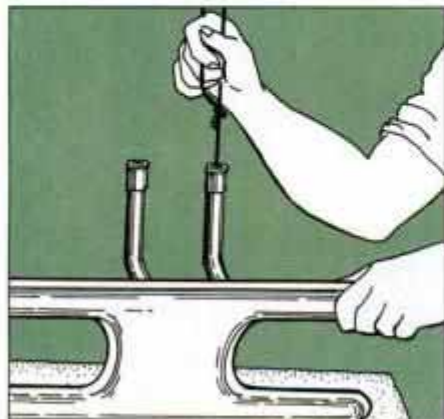
es to the grill. Look for signs of corrosion or holes in the post. If the post appears weak, contact your local plumber and have him replace the post and check the gas supply line to the grill.

If your grill has a flexible gas supply hose, check to be sure it's intact and that the connections are tight. Bend the hose carefully, and look for cracks, cuts or wear (Fig. 1). If you find any, replace the hose.

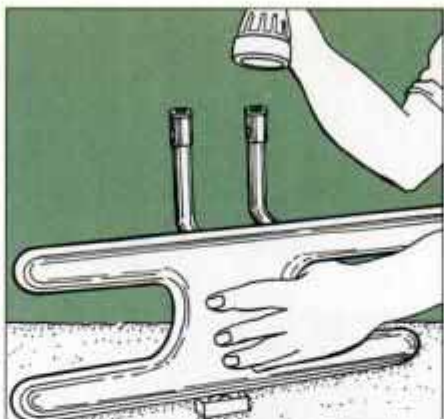
Cleaning the grates

Next, check inside the grill. Open the lid and examine the cooking grate. If you have metal grates, and they are rusted or they have a lot of burned-on cooking residue, scrape them off with a flat knife or paint scraper (Fig. 2). Then, lift the cooking grate out of the grill and wash it with warm, soapy water and rinse it well. Dry it thoroughly and coat the grates with cooking oil or nonstick cooking spray. If the grate shows signs of weakening or a few welds have let go, replace it.

If you have porcelain-on-steel grates, remove them and lay them on a work surface covered with a plastic



7 You can substitute a hanger with a small hook formed on the end to pull obstructions out of the burner venturi.

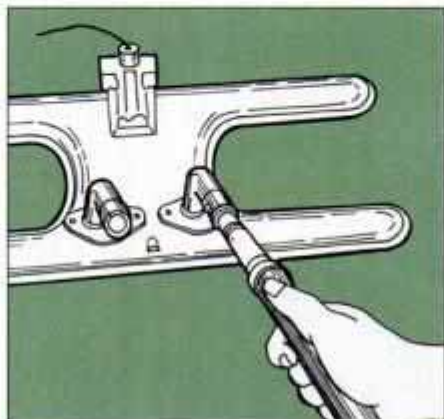


5 Shine flashlight down burner venturi tube to check if insects have built nests in it, obstructing the gas flow through it.

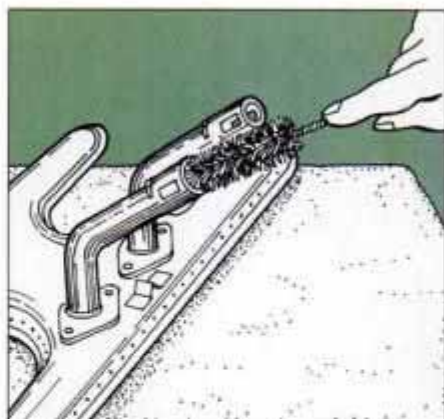
sheet. Clean off residue with a nylon scrubbing pad and a paste of baking soda and water, or use warm, soapy water and a steel wool pad. Rinse off the grate and let it dry.

Next, check the lava rocks and fire grate. Replace the rocks if they crumble in your hand or if they have gotten so small they slip through the fire grate. Sometimes these rocks become coated with cooking residue. Rather than replace the lava rocks, clean them by turning them over and exposing the soiled side to the burner flame. The rocks should be burned clean after 20 or 30 minutes. Another way to clean the rocks is to boil them in a pot of water with a little dish detergent added. Dry the rocks in the sun before putting them back in the grill.

The fire grate may also need attention. This grate can weaken from years of exposure to heat. Check whether the grate is intact by tapping it lightly with a hammer (Fig. 3). This also knocks off scale and rust. Further clean the grate with a combination wire brush and scraper (Fig. 4). If the grate has become very thin or is warped from the weight of the lava



8 Use a garden hose nozzle to flush out burner. Water should flow out the burner ports evenly. If not, check for blockage.



6 Push a narrow bottle brush into venturi tube to remove blockage. Withdraw the brush when it hits the end of the tube.

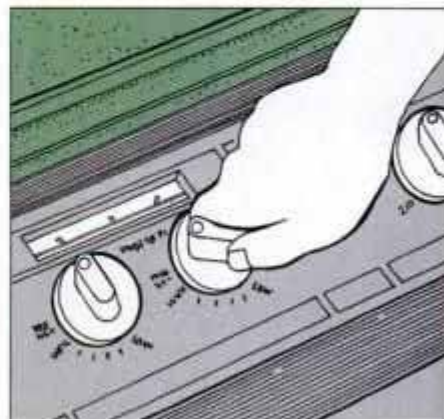
rocks, replace it with a new one. If the grate looks okay, but is just a little warped, turn it over so the curve is facing up.

Burner and valve check

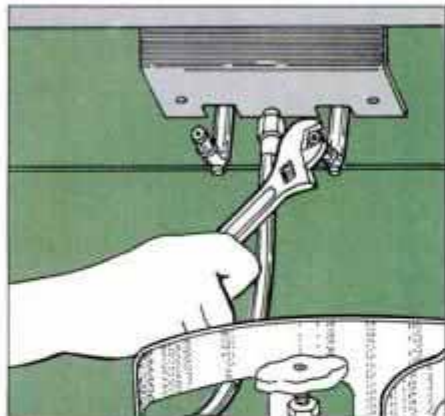
With the grills removed, now's a good time to check the most important area, the burner. Spiders and insects like to build their nests inside the dark recesses of the burner's venturi tube and in the burner's orifice. These nests are so tough they can block the flow of gas to the burner, sometimes causing a fuel mixture to back up and catch fire on the front of the grill at the gas valve knob or orifice opening.

If the grill has not been used for a while, remove the burner and check for blockage. Shine a flashlight down the burner's venturi stem (Fig. 5). If you find blockage, there are several ways to remove it. Scrub the inside of the tube with a long, thin bottle brush (Fig. 6). Another way to remove it is to hook the blockage with a coat hanger—with a small hook bent into one end—and then pull it out of the tube (Fig. 7).

The third way is to flush out the



9 Check the gas valve control knobs for free travel, both up and down and left to right. Replace the valve if knob sticks.

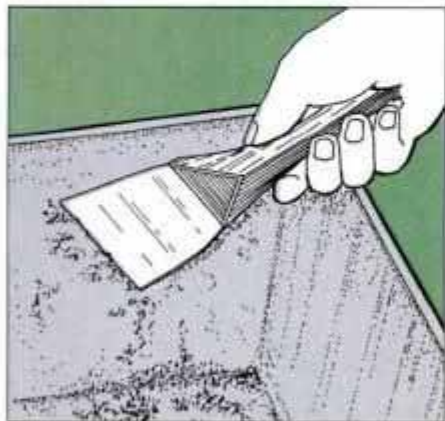


10 Unscrew the gas valve orifice with an adjustable wrench. Clean any dirt off the orifice with an old toothbrush.

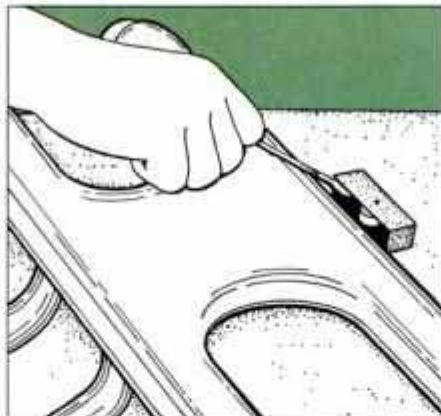
venturi tube with a garden hose at high pressure for 3 to 5 minutes (Fig. 8). This also is an effective way to check whether any of the burner's ports are blocked. The water should come out of the port holes evenly. If it sprinkles out of some holes and none comes out of others, shut off the water and find the blockage. Remove any corrosion you find with a soft, brass wire brush. Open any clogged ports with a fine piece of wire. If, however, you notice cracks have burned through the burner body or even pinholes in the metal, replace the burner.

Check the gas valve to be sure it's operating properly. Push in on the valve knob and release it. The knob should snap back. Next, turn the knob from LOW to HIGH heat then back to OFF (Fig. 9). It should turn smoothly. If it binds or doesn't snap back as it should, replace the valve. If your grill has dual burners, remember to check both valves and burner venturi tubes for blockage.

Sometimes, spiders or small insects can find their way into the small gas valve orifice at the top of the gas valve, or it can be clogged by dirt.



13 Use a flat knife or paint scraper to remove as much residue as possible from the grill's walls before washing it out.



11 Use a cotton swab dipped in alcohol to clean grease off electrode's ceramic insulator. Inspect the electrode for cracks.

Check this opening if the grill has not been used for an extended period, or check it at 6-month intervals if you use the grill year-round. To check the orifice, simply unthread it from the valve body with an adjustable wrench (Fig. 10). Clean away any residue on the orifice with an old toothbrush. Reinstall the orifice after it's cleaned and tighten it with a wrench.

Checking the Ignition

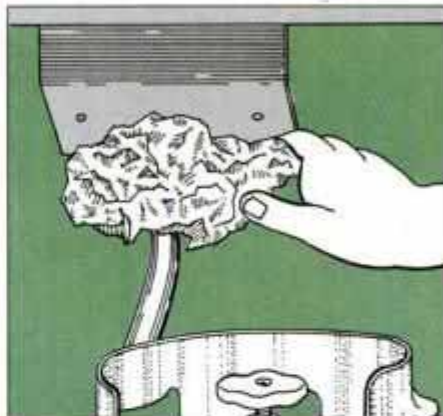
Most gas grills have some type of ignition system to light the burner. Some use a pushbutton ignitor, which creates a spark that jumps between an electrode and the burner.

The ignitor produces a click each time the button is pushed. If you cannot see a spark jump between the burner and electrode, then check the airspace between the two. The gap should be $\frac{1}{4}$ in. to $\frac{5}{32}$ in. wide. Check the manufacturer's instructions for proper gap and adjust the space with a pair of pliers. Also, check the wires going from the pushbutton to the electrode to make sure they are making good contact at all points.

Other gas grills use an electronic ig-



14 Use a rag or a paper towel to wipe up the cooking residue that has been scraped off the grill's walls.

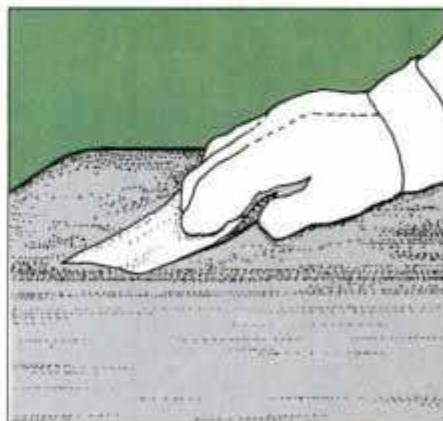


12 Cover the gas valve and orifice with aluminum foil prior to scraping residue and debris out of the grill bottom.

nitor which requires a 9-volt battery. When you push the red button, a spark is produced at the burner, and it will continue to spark until you release the button. Both systems should be checked every two to three months.

If there is no spark, with either system, make sure the electrode inside the collector box near the burner is clean. Sometimes cooking grease or dirt can collect on the electrode's ceramic insulator, preventing it from sparking properly. Clean the insulator with a cotton swab dipped in rubbing alcohol, then wipe it off with a soft cloth (Fig. 11). Check the ceramic insulator for cracks, and replace it if you find any.

If the electrode on your grill goes through the bottom of the aluminum-cast grill body, and comes out next to the burner, check the insulator carefully. Hold the white end of the ceramic insulator with one hand. Reach under the casting and try turning the other end of the ceramic insulator. If the bottom turns and the top stays stationary, the insulator is cracked, and it needs to be replaced.



15 Prepare grill body for painting by brushing off loose paint. Scuff sand outside of grill with a fine-grit sandpaper.



16 Degrease grill body by wiping it with a rag soaked with white vinegar. When the vinegar is dry, the grill is ready to paint.

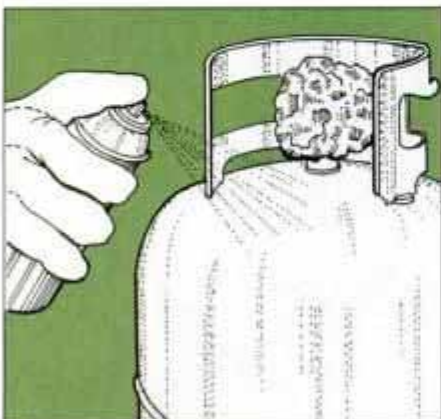
Cleaning and painting

Before reassembling the grill, check whether the lower half of the grill body (the part you cook on) needs to be cleaned. If it does, move the grill to a work area and cover the ground with newspapers. Protect the gas valve and orifice by covering them with aluminum foil (Fig. 12). Also cover the electrode if it's attached to the casting, or remove it.

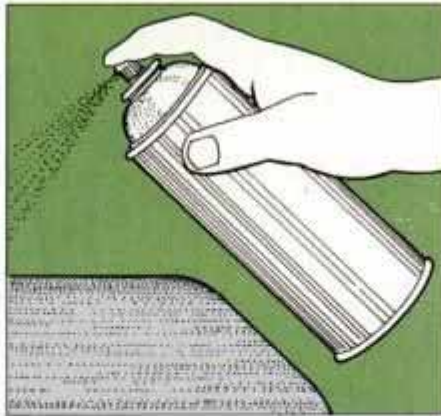
Scrape off cooking residue from inside the grill with either a putty knife or a scraper (Fig. 13). Then, wipe out the residue with a paper towel or rag (Fig. 14). Mix up a solution of strong detergent and warm water or use grill cleaner and wash the inside of the casting with a scrub brush. Rinse it well and air dry. Remove the aluminum foil and replace the electrode and any wiring that was removed.

Inspect the paint on the outside of the grill to determine if the grill should be repainted. If the paint has deteriorated and if white spots show through it, repaint the casting with grill paint or high-temperature automotive paint.

Brush the outside of the casting



19 Wash off paint dust and spray tank with acrylic paint. Spray the primer on bare metal areas before painting them.

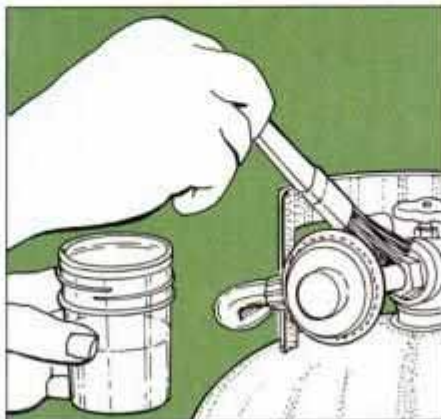


17 Spray paint grill body with automotive or high-temperature paint. Let paint dry completely before igniting grill.

with a wire brush or steel wool to remove loose paint. Sand the grill with a fine-grit sandpaper (Fig. 15). Next, wash the grill with soap and water to remove grease and dust, then let it dry. Clean off any remaining residue or grease by using a lint-free rag that has some white vinegar soaked into it (Fig. 16). Once vinegar is dry, spray paint the grill (Fig. 17). Remove the aluminum foil around the gas valve and orifice.

Repaint the grill's LP tank, if it shows signs of light surface rust or if the paint is worn. Double-check that the gas is shut off, and disconnect the tank's gas regulator and hose. Cover the valve with aluminum foil and wire brush the tank to remove rust or loose paint (Fig. 18). Then, wash the tank with hot, soapy water, rinse it and let it dry. Spray the tank with an acrylic base white paint. If the rusting is severe, prime the spots and let them dry before applying the white finish paint (Fig. 19).

If the tank is more than five years old (the date of manufacture is stamped on the protective metal collar around the tank valve), ask your



20 Check all the gas connections, hose fittings, valves and valve stems for leaks by brushing on a liquid soap solution.



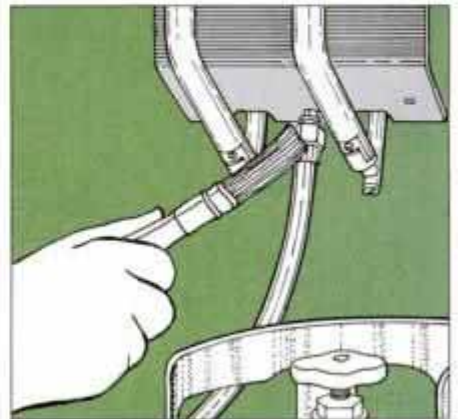
18 Cover gas tank valve with aluminum foil and remove loose paint with a wire brush. Scuff tank with fine-grit sandpaper.

local utility or gas supplier if they can pressure test it for leaks.

Now that the grill is cleaned and painted, reassemble the burner, making sure that the venturi tube slips over the orifice on the gas valve. Connect all wires to the ignition system. Install the fire grate and lava rocks. You should have only one layer of rock covering the grate. Then, put the cooking grate in the grill.

Connect the gas tank to its fittings. Then, leave the grill's lid open and turn on the gas supply without lighting the grill. Check all gas connections, hose fittings, valves and valve stems for leaks by brushing on a solution of half liquid soap and half water (Fig. 20). If you have an LP gas tank, also check tank welds and the pressure relief valve on the back of the tank valve. Leaking gas will cause the solution to bubble up. Tighten leaking fittings, or replace them if tightening fails to stem the leak (Fig. 21).

Turn on the gas valve and light the burner. Close the lid and adjust the gas valve to a medium flame. Operate the grill for 15 to 20 minutes to bake on the paint.



21 Bubbles forming in soap solution indicate there is a gas leak. Tighten the connections, such as at the gas hose.

HOW IT WORKS SEPTIC SYSTEM

BY MERLE HENKENIUS
PM Illustrations
by George Retseck

IN TODAY'S environment-conscious world, we're all beginning to learn that the disposal of ordinary household waste can't be taken for granted. Garbage is routinely separated for recycling, and restrictions as to what we throw away are not uncommon. However, when it comes to the plumbing-system waste, most of us would be just as happy to ignore the issue entirely. Of course, city and town dwellers are served by public sewer systems, and maintain these systems by paying their taxes. Rural homeowners, however, solve the problem in their own backyard—with a residential septic system.

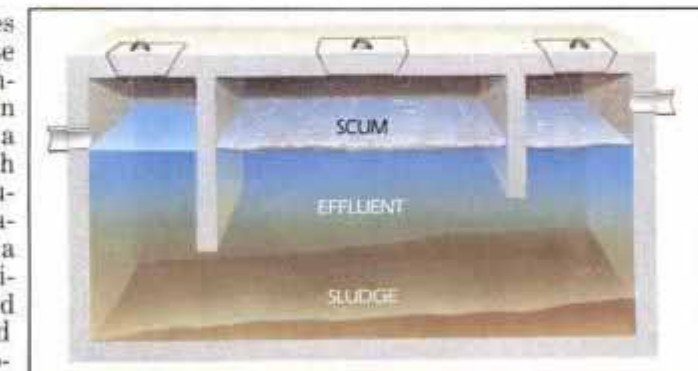
If yours is one of the millions of homes served by a septic system, or if you've contemplated a move to the country, you should arm yourself with as much information on septic systems as possible. Chances are, you'll need to someday make a decision as to which type of replacement or installation best suits your needs. In fact, many property and building loans are contingent upon septic system feasibility. Knowing your options, and knowing how each type of septic system works, may make a big difference in your decision.

There are four basic types of residential systems in use today. By far the most common system consists of an underground septic tank, a distribution box and a leach field. The second most popular is a lagoon system, or stabilization pond. Coming in a distant third is the mechanical tank and leach field. And finally, there are a good many cesspools still in use today. Cesspools are a throw-back to earlier times and represent a serious threat to

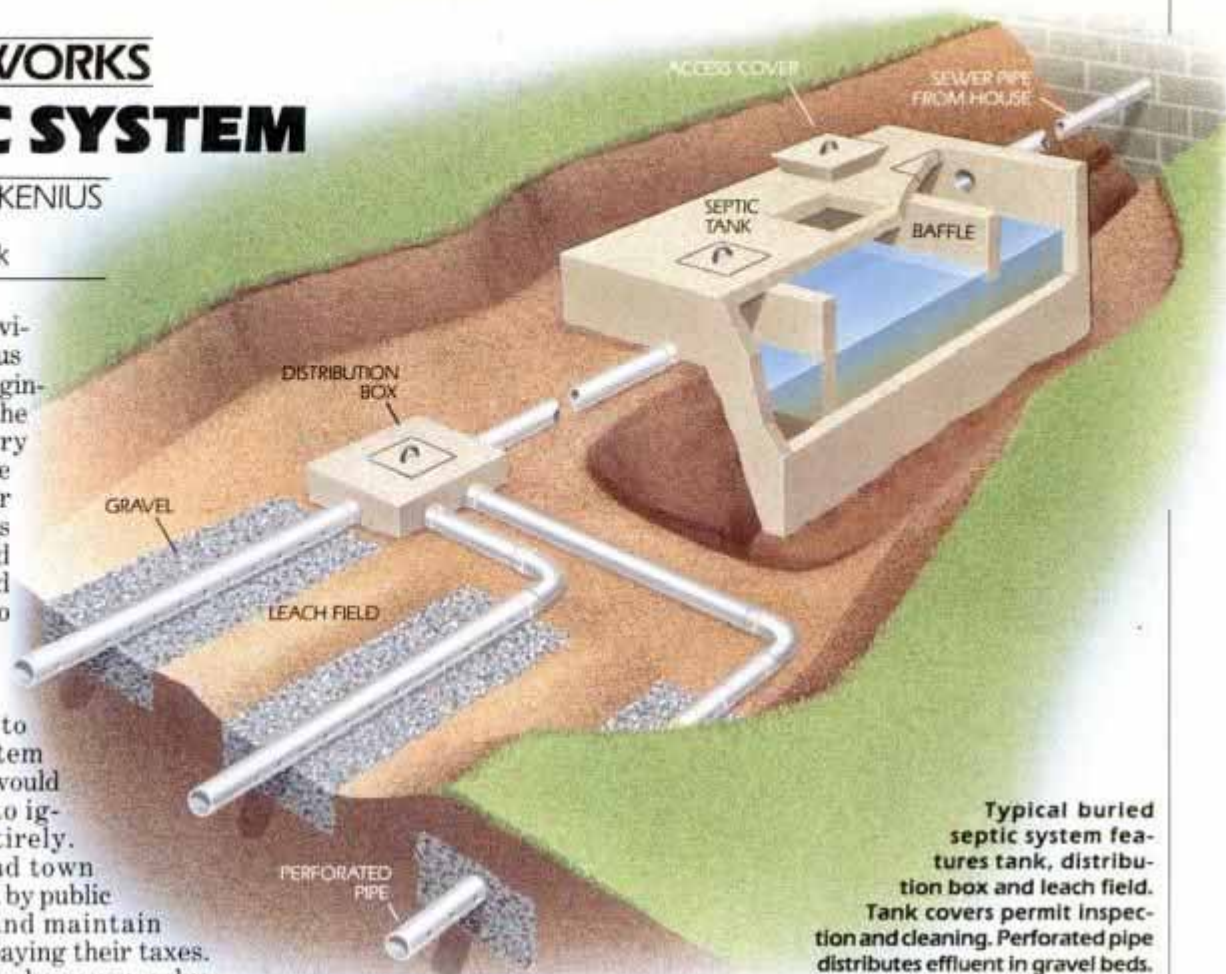
ground-water purity. They are illegal to install and should be replaced as a matter of course.

Anaerobic systems

The standard buried septic system (septic tank, distribution box and leach field) is called an anaerobic system because the bacterial action that processes the waste takes place without free oxygen (air). Waste disposal is a 2-step process that begins with a partial breakdown of solid waste in the tank, followed by the distribution and breakdown of liquid effluent in the leach field.



Bacteria converts entering waste (right side) into liquid effluent and gas. Indigestible particles settle to bottom (sludge), and soap and grease float (scum). Incoming waste pushes effluent out to leach field.



Typical buried septic system features tank, distribution box and leach field. Tank covers permit inspection and cleaning. Perforated pipe distributes effluent in gravel beds.

As sewage enters the tank, it is broken down by anaerobic bacteria naturally present in sewage. In fact, human waste consists of up to 30 percent bacteria—enough so that no enzymatic or bacterial additives are necessary. In the sewage digestion process, waste is separated into three components within the tank: effluent, sludge and surface scum. Undigestible particles settle into sludge at the bottom of the tank. Undigested soap and grease float to the top as surface scum, and the area in between is a constantly churning liquid effluent of organic nitrogen/urea-rich gray water. Because septic tanks do not break down all solid waste, they must be pumped out periodically, usually every three years. It takes roughly six months for a tank to build a fully productive colony of bacteria, and 24 hours for solids to be broken down as far as possible.

As new sewage enters the tank, an equivalent volume of effluent is forced by the exit baffle and floats out into the leach field. Once in the leach field, the effluent is absorbed by the soil. As

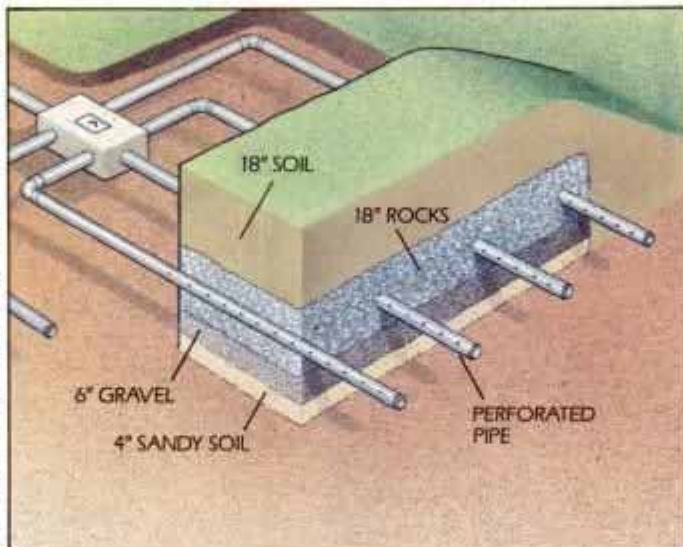
much as 60 percent of the liquid evaporates and the rest is absorbed by plant roots.

The really impressive part of the process, however, concerns the poisonous organic nitrogen and urea components that remain in the leach field. A nitrifying bacteria found only in the top several feet of top soil converts these components into ammonium, nitrites and nitrates. Nitrates, in turn, are tapped by the amino acids in plant roots and become plant food. The entire process requires predominantly septic conditions, however, and too much oxygen in the soil may temporarily reverse the entire cycle.

System design

The design of a buried system is very specific, and the system requires a lot of space. Typically, the buried tank is located 10 ft. or more from the house, and the distribution box is placed 10 ft. beyond the tank. The leach field starts 5 ft. beyond the distribution box and generally consists of several lines of perforated, plastic pipe encased in 3-ft.-wide gravel beds. The gravel is then topped with a foot or more of soil.

None of these lines may be longer than 100 ft. in length, however, or drop more than 6 in. per 100 ft. Leach-field trenches must be less than 5 ft. deep and must be separated by at least 6 ft. of undisturbed soil. They must also be at least 20 ft. from property lines, 50 ft. from a lake or stream and 100 ft. from a water well.



Mound-type leach field aids effluent evaporation and chemical breakdown during winter and in areas with high ground water.

Five or six shorter lines are preferable to one or two 100-ft. lines because distribution tends to be more uniform in shorter lines—320 total lineal feet of leach field is usually the allowed limit. The total required capacity of a leach field is determined by a simple soil percolation test. This is a test that evaluates the rate at which the soil absorbs water. Local health department officials will use the percolation data along with topographical overlays that describe the geological characteristics of the area to determine system capacity or feasibility. If they determine that the soil is not porous enough, or ground-water levels are too near the surface, an alternative system will be ordered.

Tank size is determined by the number of bedrooms within a home, and not by the number of bathrooms, as you might expect. A 3-bedroom

home will usually require a 1000-gallon tank. For every bedroom beyond three, tank size must be increased by 250 gallons. The tank must be placed at least 50 ft. from a water well. These limitations probably sound extreme, but, in practice, are really not that prohibitive. An anaerobic septic system can be made to fit most acreages with acceptable soil and ground-water conditions. Leach-field trenches, for example, can be wrapped around a hill if they don't drop more than 6 in. in 100 ft.

Mound systems

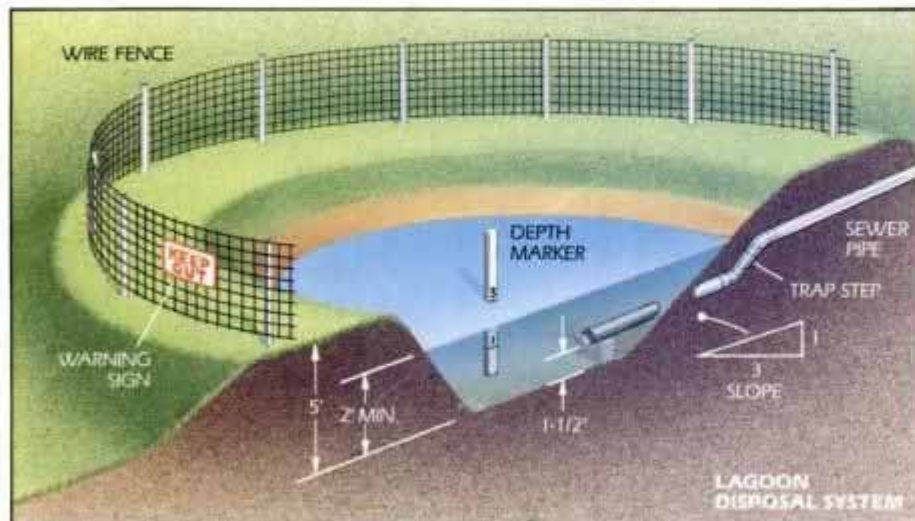
If a septic system fails, it will usually be in late winter or early spring. The reasons are twofold. First, frozen soil releases no water through plant roots and little through evaporation. This means that leach fields in winter are relegated to simple storage troughs, nearly filled with water. In the second instance, spring is often the wettest time of year. These two conditions make for wetter, oxygen-saturated soil around the leach fields, which, in turn, slows or reduces the nitrification of effluent. At some point, the leach fields can hold no more water and the system backs up.

To circumvent this process in colder northern climates, and in areas having naturally high ground water, researchers have developed a leach field that is built aboveground, in the shape of a mound. With sufficient ground-slope between tank and leach field, effluent flows directly into the mound. When the terrain is flat, however, a dose pump may be needed to lift the effluent to mound level.

The mound is constructed of a layered aggregate of rock and sand containing a gridwork of perforated pipe. Because sewage effluent is warm when leaving the tank, the mound does not freeze and evaporation occurs through the top as well as the four sides of the mound, even in winter. Mound systems are still considered experimental in some regions, but most health departments will allow them under close supervision.

Tank and leach-field material choices

Although lighter materials are sometimes allowed, all piping between the house and tank, and the tank and distribution box, should be what is called



Lagoon disposal system digests waste through aerobic bacteria, algae and evaporation. The site must be fenced in completely and clearly marked. This design may suit large plots where typical septic systems are unfeasible.

Schedule 40 plastic. Once in the leach-field trenches, Schedule 20 perforated plastic pipe is standard. In wooded areas, where tree roots are likely to enter and clog perforated pipe, concrete or plastic half rounds, set on concrete blocks, are a better choice. Where possible, perforated pipe should be used, as it distributes effluent more evenly and can be driven over with automobiles and farm machinery.

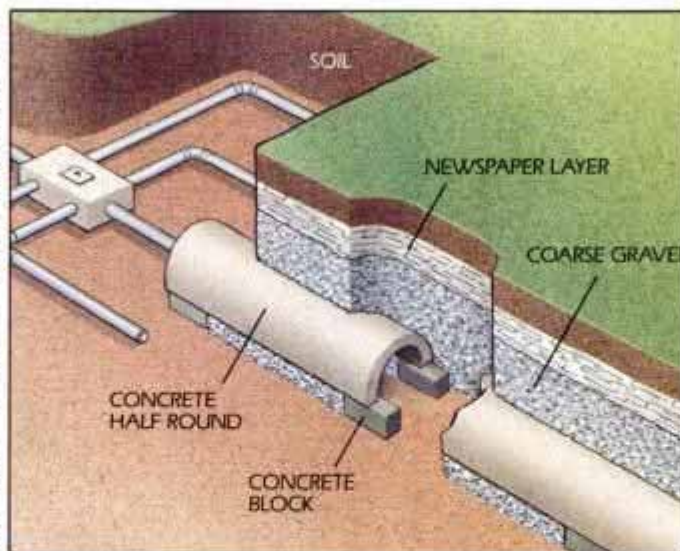
When it comes to septic tanks, you'll have three material choices: concrete, fiberglass and plastic. Of these, concrete is the most problematic. First of all, a concrete tank is heavy and must be set in place with a boom-truck, which may add some expense. Additionally, sewage contains sulfates, which, in the digestion process, may be converted into sulfide gases and sulfuric acid. This caustic soup has been known to eat through concrete. Plastic and fiberglass tanks, on the other hand, are not only lightweight and easily installed, but are more resistant to caustic chemicals.

In all cases, septic tanks must contain outlet baffles. Without this baffle, surface scum will float into a leach field and seal the sides of the trenches. When this happens, the system will be ruined. This is also why a tank must be pumped every three years. If allowed to accumulate in depth, surface scum will make its way past the baffle.

Aerobic lagoon systems

A lagoon system uses aerobic bacteria, algae and evaporation in its process of digestion. Lagoons have a unique design that allows them to work efficiently year-round with little or no maintenance. Specifically, a lagoon is a 5-ft.-deep, conical-shaped hole in the ground with a 1-to-3 sidewall slope. The sides of the lagoon are lined with plastic or sealed with bentonite, a dense non-porous clay product. The sewer pipe enters the lagoon after stepping down to form a natural trap. The pipe then rests on a concrete pad that is 18 in. above the bottom of the lagoon.

How does a lagoon system



Concrete half rounds can be installed in leach field in lieu of perforated pipe to protect against damage from tree roots in wooded areas.

work? Very well indeed. In a lagoon septic system, heavy solids settle to the bottom and are consumed by bacteria. Suspended bacteria break down lighter waste particles, and in the process, release carbon dioxide. In the presence of carbon dioxide, light, nitrogen and phosphate, algae cells multiply. These algae then produce oxygen, which in turn, feeds aerobic bacteria. As aerobic bacteria do not convert sulfates into hydrogen sulfide, there is little of the odor associated with normal sewage disposal.

Lagoons are a miracle of simplicity, but have one serious drawback: They look like what they are. What's more, there is little you can do to disguise them. They must be fenced, of course, and the fence must bear the signs: **No Trespassing and Waste Lagoon**. And because evaporation relies on breezes blowing across the pond, no trees or

tall plants are allowed in the path of prevailing winds.

Beyond these limitations, most health departments prohibit lagoons on plots of less than 3 acres. Even so, a lagoon is a very good alternative when soil conditions prohibit a buried system.

Mechanical tanks

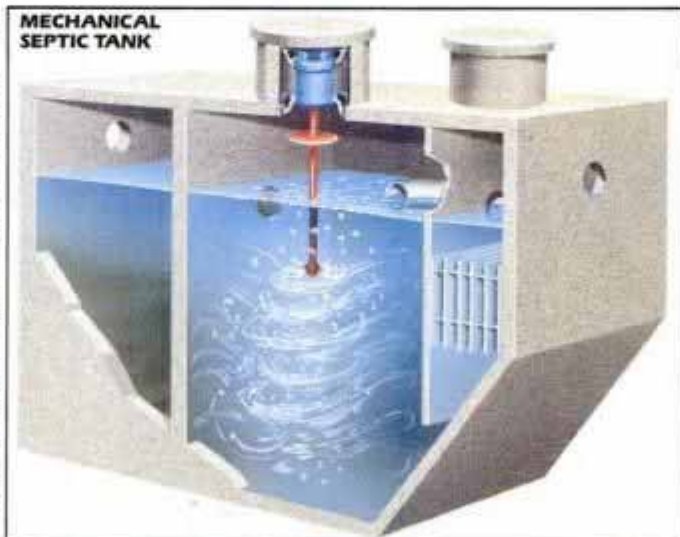
Mechanical tanks are hybrids, in that they use both anaerobic and aerobic bacteria. In that respect, they function more like municipal waste treatment plants. Sewage first flows into a holding compartment in the front of the tank, where anaerobic bacteria act on the solids. A partially treated effluent then flows into a second, aeration compartment, which uses aerobic bacteria to finish the job. Air is introduced into this compartment and the effluent is stirred to accelerate the digestion process. A third compartment allows any undissolved particles to settle out, where they are returned, via gravity, to the aeration chamber.

The result is a less potent, oxygenated effluent produced in a shorter amount of time. While some health department authorities may allow the dumping of this effluent at surface level, most will require some form of leach field. As less nitrogen conversion is required, however, the field is likely to be much smaller than in an ordinary system.

There are several such tanks on the market and most feature a timed aeration sequence keyed to an alarm, should the system ever fail. The timer and alarm are often installed in the basement so that a failure cannot go unnoticed.

While not sold as such, mechanical septic systems are viewed as compromise systems, as problem solvers. If you haven't the soil absorbency, lot size or groundwater depth to accommodate one of the two standard septic systems, then a mechanical septic system can be a lifesaver.

Without any of these problem conditions, however, a properly installed nonmechanical septic system is almost always the better choice to make.



Mechanical tanks utilize anaerobic bacteria in first section. Then, air stimulates aerobic bacteria to prepare effluent for leach field.

NEW PRODUCTS SUMMER VOCATION

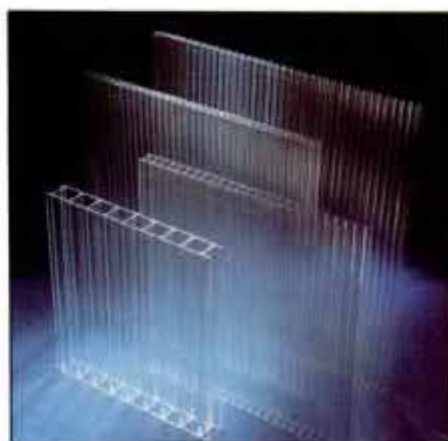
Thirteen new home-improvement products.

BY ROY BERENDSOHN, Assistant Home and Shop Editor



Clean Machine

You can clean anything from your car to your house with this new UL-listed power washer. The manufacturer says its 700-psi nozzle pressure is 18 times more powerful than a garden hose, yet it uses 75-percent less water. The 25-pound washer simply hooks to a garden hose (its hose is 25-ft. long), and its 35-ft.-long cord plugs into an outdoor power outlet. The cord has a built-in ground-fault interrupter with a reset button. It costs about \$250 at hardware stores and home centers. For more information, write to Power-Flo Products Corp., 1661 94th Lane, Minneapolis, MN 55434.



Versatile Plastic

G.E.'s Lexan Thermoclear is a semi-clear, polycarbonate plastic sheet that can be assembled into nearly anything built of sheet material. The UV-resistant sheets can be cut with a variety of saws, drilled, and fastened with screws or adhesives. It comes in 4 x 8-ft. sheets, 6mm and 8mm thick ($\frac{7}{32}$ in. and $\frac{5}{16}$ in., about \$55 and \$65, respectively) at home centers. (Larger and thicker sheets available at industrial distributors.) An 8mm sheet weighs 8 pounds. For information, call (800) 451-3147. To locate a distributor, call (800) 323-3783.



No-Fog Mirror

With a built-in heating element, this bathroom mirror resists fogging. It comes in a variety of sizes and shapes, hard-wired or with an 8-ft.-long extension cord. The element is encased behind the $\frac{1}{4}$ -in.-thick glass by polyester laminate. Each component in the element operates in a parallel circuit, so if one part fails, the rest of the element still works. The 30-in.-dia. model shown costs about \$150 at home centers. Write to Hoyne Industries, 840 Hwy. 155 South, P.O. Box 697, McDonough, GA 30253.



Water Saver

Retrofit a toilet with this flush mechanism and cut domestic water use by 28 percent, the manufacturer says. Made of PVC and fiberglass-reinforced plastic, it's supposed to take less than 10 minutes to install. To flush liquid and paper, flip the short handle, and use the long handle to flush solid waste. It's available in a range of colors and costs about \$25 at hardware stores and home centers. For more information and details, contact Con-Tech Industries, P.O. Box 160, Creswell, OR 97426.

Bathroom Furniture

Based on an 18th-century design, this bathroom vanity is built of solid ash and ash veneers, and is protected with a water-resistant polymeric finish. It measures 37 in. wide x 25½ in. deep x 34 in. high., and accepts an 8-in. faucet set. Its curved-panel doors open to a large drawer, a pair of smaller drawers and a cane pull-out shelf. The vanity comes stained in oak, ash or walnut tones. It costs about \$3500 (excluding sink and faucets) at Kohler dealers. For more information, write Kohler Co., Kohler, WI 53044.



Cold Caulk

The manufacturer of this caulk claims you can apply it below 32° F and on wet surfaces. It retains its flexibility, dries clear and can be finished with oil or latex paint. It's designed to stick to wood, bare concrete, marble and asphalt. A 10-ounce tube costs about \$5 at hardware stores and home centers. Write to Geocel Corp., P.O. Box 398, Elkhart, IN 46515.



Deck Cleaner

Mix 4 ounces of this powder in a gallon of water and brush or spray it on your deck to remove dirt and the effects of weathering. Its manufacturer claims you don't need to scrub, just apply it and rinse after 30 minutes. Let the deck dry, and apply a sealer or preservative. A 6-ounce bucket costs about \$7 and a 30-ounce about \$17 at hardware and paint stores. For more information, write Thompson and Formby, 825 Crossover Lane, Memphis, TN 38117.



Pastel Finish

Rub on a coat of Woodsheen to tint the wood a pastel color while sealing it with a rubbing-oil finish. Subsequent coats enrich the color and, once dry, it can be top coated with a film finish for more wear resistance. The product cleans up with mineral spirits, and a 12-ounce bottle costs about \$6.50 at hardware stores and home centers. It comes in white, gray, slate, teal, pink and peach shades. Write Minwax Co., Inc., 102 Chestnut Ridge Plaza, Montvale, NJ 07645.



Surge Kit

Protect electrical devices throughout your home from damaging electrical surges with this kit. Each device trips in a billionth of a second. Top left, install the Electra Guard on the breaker panel. Plug the EG3C into a 3-prong outlet. Slip the EG11B into a phone jack to protect phones, facsimile or modems (bottom left). Plug the EG6EC into an outlet to protect a TV, VCR and stereo. The kit costs about \$90 at home centers and hardware stores. Write to Intermatic, Intermatic Plaza, Spring Grove, IL 60081-9698.



Luxury Opening

Open one panel of the Nana Glass Wall like a door, open two panels like a French door, or fold open all the panels. Made of Douglas fir and tempered, insulated glass, it can be ordered with single-pane or divided-lite construction. The units are factory prehung, but

are designed to be adjustable for smooth operation. The 11-ft.-wide x 7-ft.-high model shown costs about \$5000 at Nana distributors. A range of sizes is available with the largest size able to span a 12-ft.-wide opening. Write to Nana Windows and Doors, 707 Redwood Hwy., Mill Valley, CA 94941. **PM**

Yesterday's work truck isn't good enough anymore.

TODAY'S NEW CHEVY WORK TRUCK

1 New Duragrille.

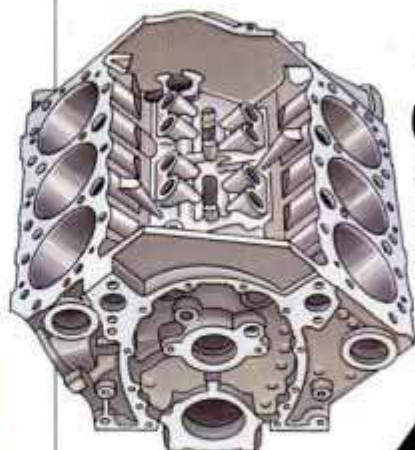
Chevy Work Truck's new grille is built strong to help resist stone damage. Because our new Work Truck has to do more than look pretty. It's built to work.

Yesterday's truck is history. Today's Chevy Work Truck is ready to go to work for you. Today.



2 More total cab room than Ford.

Chevy gives you more leg room. More shoulder room. More total cab room than yesterday's pickup from Ford. And when you add Chevy's excellent ride and visibility, that means a lot of comfort no matter where you work.



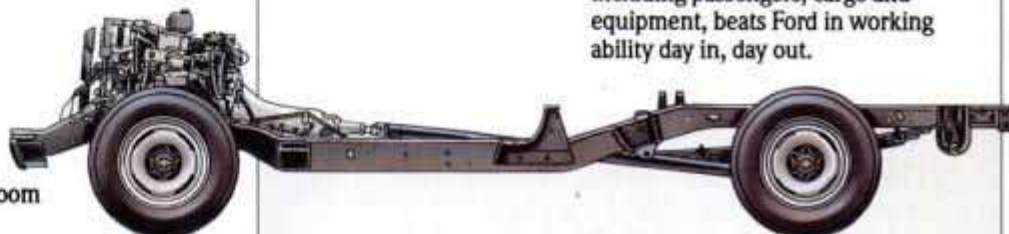
3 More standard 1/2-ton power than Ford.

Chevy Work Truck's standard 4.3L Vortec V6 puts 10% more horsepower to work for you than Ford's standard Six. And it's priced hundreds less than the lowest-priced Ford.*

*Based on Manufacturer's Suggested Retail Price.

4 Heavier Gross Vehicle Weight Rating than Ford.

The 2-wheel-drive Chevy Work Truck's 5600-lb. GVWR, including passengers, cargo and equipment, beats Ford in working ability day in, day out.



5 More two-sided galvanized steel than Ford.

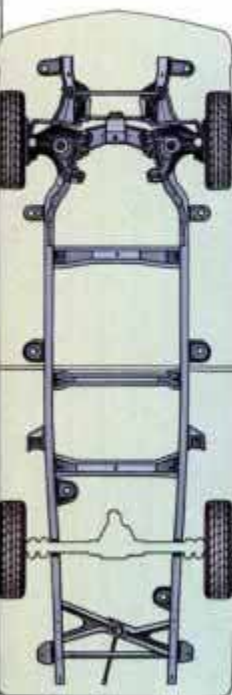
More of Chevy's body panels are made of two-sided galvanized steel, front, sides and rear. Including the cargo bed. So your Chevy will fight corrosion for years. Plus a hot-wax chassis treatment to help seal the frame from road salt and chemicals. You can't get that on a Ford.

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Let's get it together...buckle up.



OUTWORKS FORD 10 WAYS.



6 Bigger, heavier 4x4 frame than Ford.

Chevy's full box-section "Strongbox" frame construction up front is stronger than Ford's "C" section. And Chevy's frame is bigger and heavier overall, too.

7 Two-tier loading Ford doesn't have.

Put 2x6 planks in the pickup wall grooves, and you've got a platform to carry just about anything. While your tools and other materials stay conveniently stowed underneath.



8 More ground clearance than Ford.

On site or off road, you need a pickup that won't leave you high-centered. And Chevy Work Truck's high-stance construction can take you over obstacles Ford's 1/2-ton pickup can't clear.



9 3-year/50,000-mile Bumper to Bumper Plus Warranty.*

It covers hundreds of nonpowertrain parts 2 years longer than Ford's. Electrical parts. Chassis parts. In fact, everything but the tires, which have their own warranty.



*See your Chevrolet dealer for terms of this limited warranty. A deductible applies after 12 months or 12,000 miles.



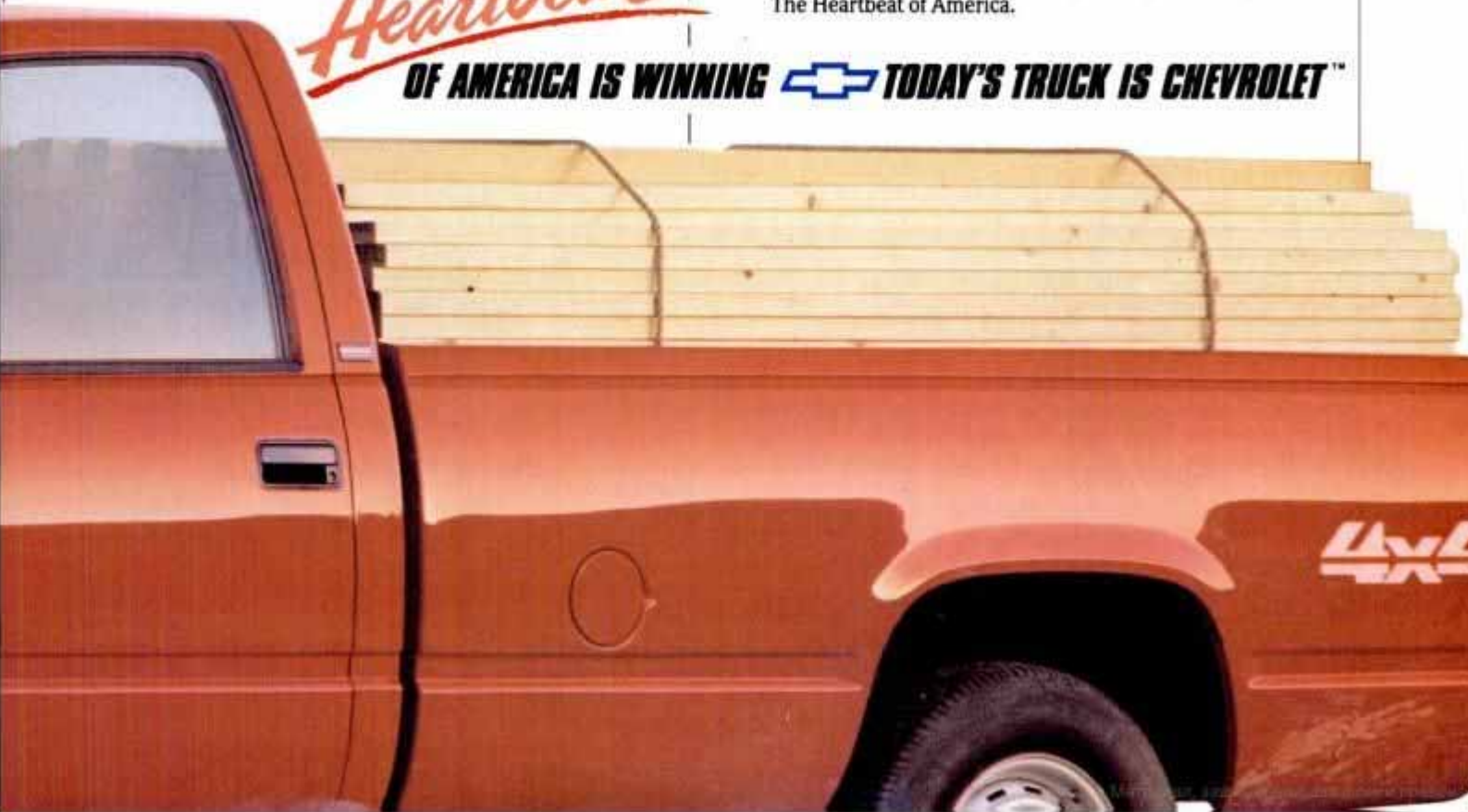
10 Standard shift-on-the-fly Insta-Trac™ 4WD.

Chevy revolutionized 4-wheel drive years ago with Insta-Trac, the first system that lets you shift in and out of 4-wheel drive without stopping or backing up. The new Chevy Work Truck continues that tradition — when the conditions demand, you just shift and keep right on going.

And that's 10 solid reasons why nobody's winning like The Heartbeat of America.

THE Heartbeat

OF AMERICA IS WINNING  TODAY'S TRUCK IS CHEVROLET™



APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Frozen Tube

I have a Wards refrigerator, model No. HMG-2499-4, and the icemaker is model No. HMG-9018. The tube into the cabinet freezes up. I have replaced the tube twice and the water valve once, it is not leaking. Is there a heater in this tube that may not be working?

EDWARD FARNHAM
TRAVERSE CITY, MI

Usually, a freezing fill tube is caused by a faulty water inlet valve that drips a small amount of water into the tube. Over a period of time, the water freezes until the ice seals the opening in the fill tube.

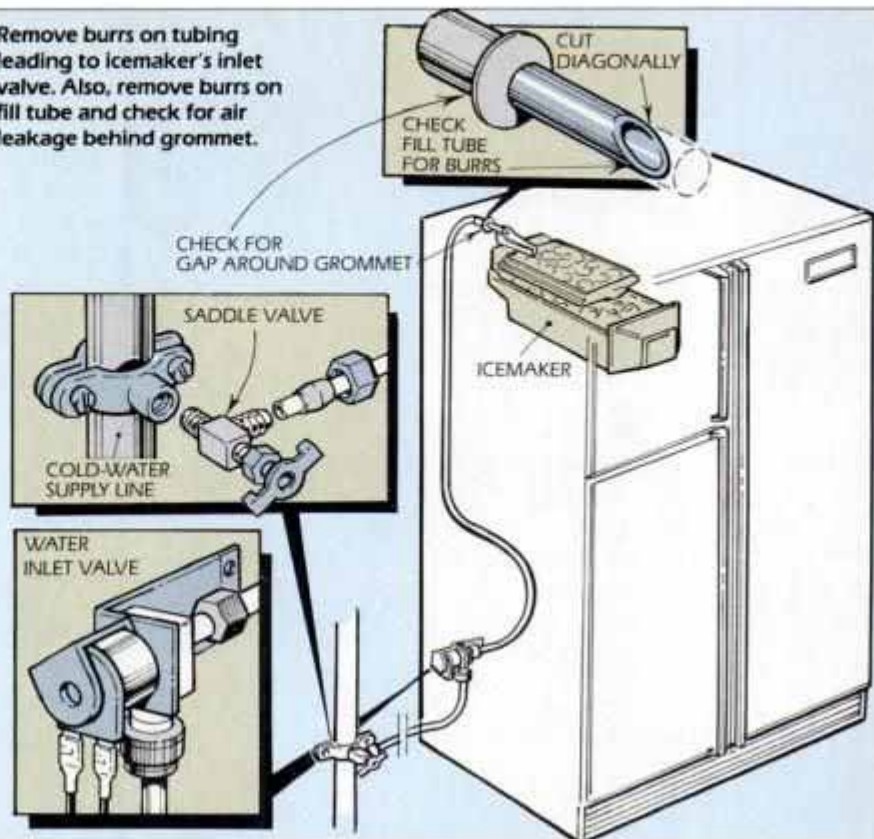
First, check that the water fill valve is not dripping. Water pressure below 20 psi or above 120 psi could cause this. Have your water company or plumber check the house's water pressure.

Shut off the water to the cold-water supply line that feeds the saddle valve and drain it. Disassemble the saddle valve and its clamp and check it. Also, check where the valve mounts to the supply line for mineral deposits that often form around burrs where metal has been cut or drilled. The deposits can constrict water flow to the inlet valve.

Next, check for an air leak around the grommet, and be sure the plastic fill tube is seated all the way against the grommet shoulder. The moisture in warm air leaking past the grommet can condense and freeze, blocking the supply of water to the icemaker. If you find ice has formed in the insulation, melt it with a portable hair dryer and dry out the insulation. If necessary, dig out damp insulation with a pocket knife and re-pack around the grommet with new fiberglass insulation. Seal around the grommet with Permagum (available from most appliance parts stores).

Finally, remove the plastic fill tube, warm it with a hair dryer and cut it at a 35° angle with a sharp knife or fine-toothed hacksaw. Remove any burrs and reinstall the fill tube. This reduces the chance of water hanging on the end of the fill tube and freezing.

Remove burrs on tubing leading to icemaker's inlet valve. Also, remove burrs on fill tube and check for air leakage behind grommet.



No Bags

I have a Westinghouse canister sweeper, model No. SC-2, and I can't find any bags for it. I would like to know where I can get them.

JOHN PETRUNAK
PARMA, OH

Westinghouse has been out of the small-appliance business for more than 20 years. However, stop by your local Sears and buy vacuum cleaner canister bags, part No. 5011. These will slip over your sweeper's inlet and work fine.

Broken Carafe

The glass carafe on my Procter-Silex coffeemaker is broken (part No. 70701). Where can I buy a new glass carafe?

CHARLES KASCH
DARIEN, IL

After checking with the Procter-Silex Co., I learned that they stopped producing the glass percolator carafes many years ago. Their supply of replacement carafes ran out about 10 years ago, and they don't know of a U.S. distributor who can replace them. If they did, they assured me they would get it to you.

Burned Brushes

I have a Fairfax vacuum cleaner by Apollo Vacuum Corp. of Pickering, Ontario, Canada. The brushes and

brush holders are burned out. The vacuum is in excellent condition otherwise. Where can I get new brushes and holders?

DONALD WOODS
WOOLWINE, VA

Write or call Filtex Distributing Co., 4467 N. State St., Jackson, MS 39206; (800) 543-9052. If you write to them, pack the brushes and holders in a box and include in the note the vacuum's brand name and model number. Send the package Attn: Mr. Roderick. This company has been in the vacuum cleaner repair business for 49 years, and there's a good chance they can find brushes and holders to replace yours.

Service Tip

To prevent excessive condensation (sweat) from forming on your refrigerator in hot weather, do the following:

- Use the energy miser switch.
- Be sure the door gasket fits tightly. Replace it if necessary.
- Set your freezer to 0°-5° F. A setting lower than 0° F will cause sweating and waste energy. **PM**

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

PM ILLUSTRATIONS BY ED LIPINSKI

INSTALLING LOW- VOLTAGE LIGHTING

BY MERLE HENKENIUS
PM Illustrations
by George Retseck

WHEN IT COMES to electrical projects, low-voltage landscape lighting is about as easy as it gets. Low-voltage outdoor kits have several real advantages over their 120-volt counterparts, at least from the homeowner's perspective.

First, low-voltage outdoor kits are far less expensive to operate. A 6-head kit uses roughly the same energy as a single, 100-watt bulb.

Secondly, the complicated weather- and hazard-protection measures required for 120-volt outdoor wiring can be dismissed almost entirely. For example, low-voltage wiring need only be buried several inches deep, versus the 24-in. to 30-in. direct-bury requirements of 120-volt systems.

And finally, low-voltage outdoor kits are safe and easy to install, so much so that little knowledge of electricity is required.

When shopping for a low-voltage landscape lighting kit, you'll quickly find that there are two distinct price categories. Retail outlets catering to the do-it-yourselfer offer inexpensive kits (\$50 to \$80), featuring a limited variety of lamp heads, usually six to eight in number.

Specialty lighting outlets, by contrast, are likely to offer a better quality system that may or may not come in kit form. These systems offer greater creative flexibility when it comes to mixing and matching heads for specific effect, but are substantially more expensive. A single head might cost as much as an entire kit at your local hardware store.

If you're planning a more elaborate landscape lighting design, the high-end systems are clearly worth considering. If you're not planning such an elaborate design, and you are a little timid around electricity anyway, the more modest kits are simpler and easier to install. And, as each landscape lighting kit is self-contained, there is no chance that you'll install more lights on a system than it was designed to support.



1 When using an outdoor receptacle, hang box at least 12 in. above ground. Protect cable to ground with conduit.



2 To bring cable from an indoor control box, bore a hole through rim joist or wall and feed the cable through the hole.

The components

The model we've chosen is an 8-lamp Malibu kit made by Intermatic, Inc., Spring Grove, IL 60081. It has four

floodlamps and four 2-tier walk lamps (\$64.99). The kit also includes 100 ft. of buriable cable and a control box that houses a transformer (voltage re-

ducer) and a built-in timer. The timer automatically turns the lights on and off according to the times you set. The control box accesses house current via a standard 3-prong plug, so that no 120-volt wiring is required.

While the control box is weather-tight and can be installed outdoors, indoor installations are also worth considering. As most kits come with

convenient 120-volt plugs, you'll be able to plug them directly into an outdoor receptacle. The problem, of course, is that an outdoor receptacle, having flip-up weather caps, is only water resistant when caps are closed.

With a transformer plugged into the receptacle full-time, one cap will remain up, exposing the receptacle to driving rains. While most LV kits are

installed in this manner, and are generally acceptable to local codes, an indoor receptacle would avoid the problem entirely. From a basement, utility room or garage, it's easy enough to bring the low-voltage end of the system outdoors, leaving the higher-voltage end sheltered indoors. We've included both methods here. As with any outdoor installation, the receptacle you tap should be ground-fault circuit interrupter (GFCI) protected.

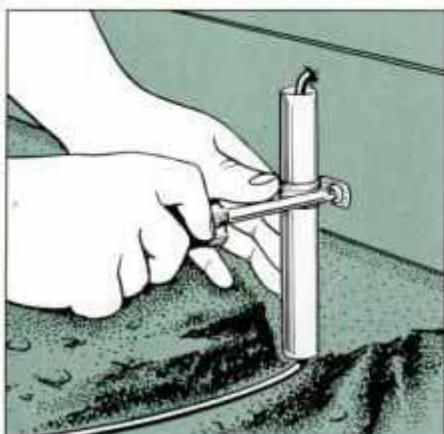
Planning and layout

Before purchasing a lighting kit, you'll want to consider factors of layout and design. Lamps to be positioned along a walk or drive are standard with each kit, as are floodlights. If you have a deck, you might also consider a kit that offers deck lights. Cable for the deck lights can be fed up through the deck and stapled along the underside, out of harm's way.

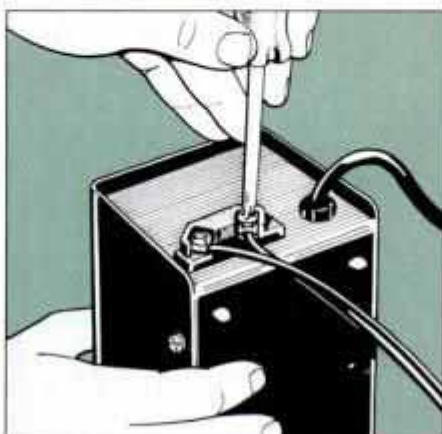
Also, some manufacturers offer a range of different heads that can be adjusted or focused in a number of different ways to yield more dramatic results. Plan your layout several ways, with these options in mind, before making your final selection.

Start your layout with a determination as to the best control box location. If sidewalks and other landscape obstructions will be a factor, position the box on the favorable side of the obstruction.

Measure from your control box location to each lamp location to determine how much cable and how many lamps and lamp styles you'll need. These factors will influence the type of kit you choose. Also, be sure to check your local codes to see if they have any specific requirements for low-voltage installations.



3 Protect the cable drop by running it through conduit. Be sure to secure conduit to building with conduit strap.



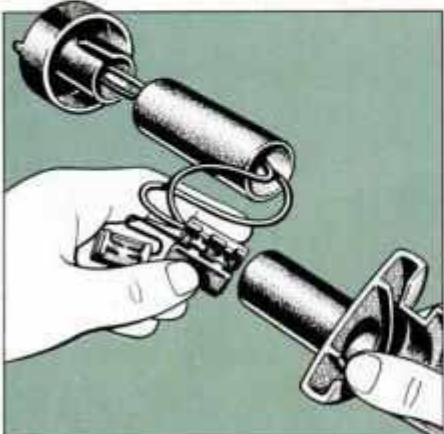
4 To fasten low-voltage cable to control box, turn box upside down and bind each cable wire under a screw terminal.



5 To mount control box, drive screw into wall (and stud behind) leaving 1/8 in. of shank exposed. Hang box on screwhead.



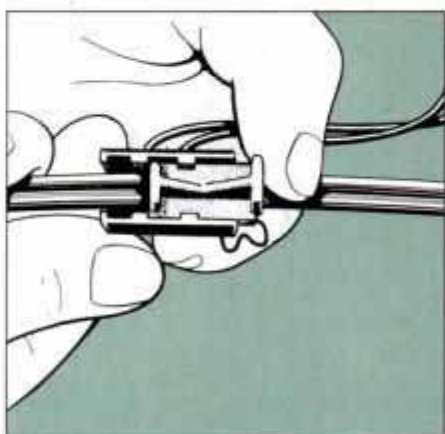
6 To set timer, adjust dial to current hour. Then lift pegs from timer and reset them in desired ON/OFF indicator slots.



7 Begin lamp assembly by sliding connector leads (attached to clip) through riser tube and into platform of stake.



8 Feed cable through stake platform to the desired location. Then remove cover from cable clip to expose contact points.



9 Lay cable into channel on cable clip and slide the plastic cover into place so cable is pierced by contact points.

Installing your kit

Begin the project by mounting the control box on a wall within a foot or so of the chosen receptacle. If mounting the box outdoors, position it at least a foot above ground. Then, to protect the cable from damage, encase it in conduit from the box to just below ground level.

The same is true if you're going for an indoor box installation. Bore through the rim joist or wall of your home and bring cable through the hole. Then, encase the exposed outdoor cable from the rim joist opening to below ground. You'll also want to caulk the cable opening.

With low-voltage wiring, the conduit need not be joined to a line box, or be weather-tight. The object here is to protect the cable from assault by garden tools or pets.

Assembling lamp heads

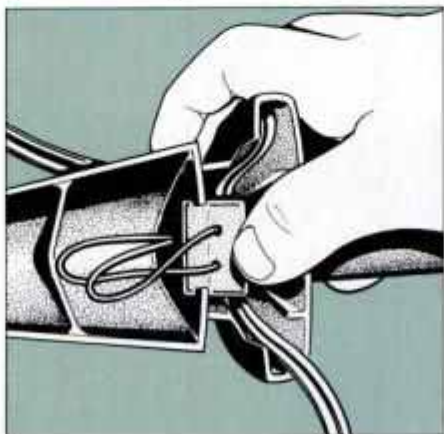
All kits will require some lamp assembly, but don't be intimidated. It'll be a simple step-by-step procedure. In the case of the Malibu kit, the walk lamps come in several pieces: a ground stake, extension riser, bulb socket and electrical leads (with self-piercing cable clip), and the globe. In this case, start by feeding the electrical leads through the riser tube and into the stake.

It's generally easier to make the cable connection before attaching the bulb and globe. Therefore, feed the cable through the opening in the stake platform and slide it through until it reaches the planned tap location on the cable.

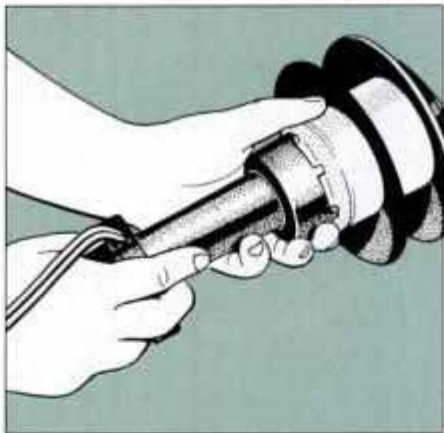
The cable connections on most kits are incredibly easy. Each set of lamp leads contains a channel with self-piercing cable taps built-in. Just lay the cable into the channel and slide a small plastic shunt over it. As the

shunt forces the cable down into the channel, the taps pierce a wire in each side of the cable and make contact. That's really all there is to it.

You'll then press the channel clip into a slot in the stake and tuck the cable neatly under the platform. With the electrical connection made, fold any excess lead wire into the riser and press the lamp socket onto the riser.



10 Press the cable clip into its slot under the stake platform. Then, tuck the excess cable neatly into the platform recess.

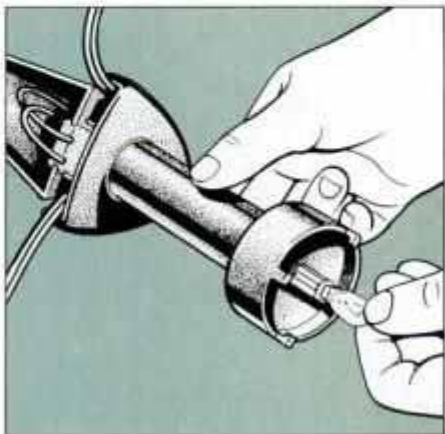


12 After tucking excess leads into riser tube, slide the globe over the lamp socket tabs and twist until globe seats properly.

Follow by inserting the bulb and twisting the globe onto the socket base.

When assembling a spotlight, you'll need to feed two leads through a bridge that spans the head and holds the bulb.

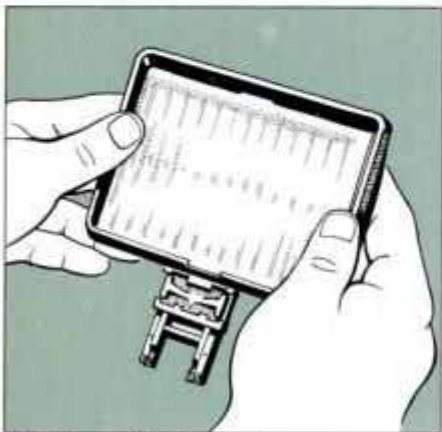
With the leads in place, press a bulb into the bridge and snap the bridge onto the head, with the bulb facing the



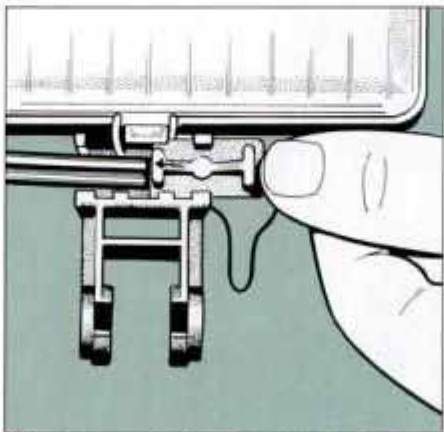
11 Once the cable is secured, insert the bulb into the socket until you feel it seat against its contacts.



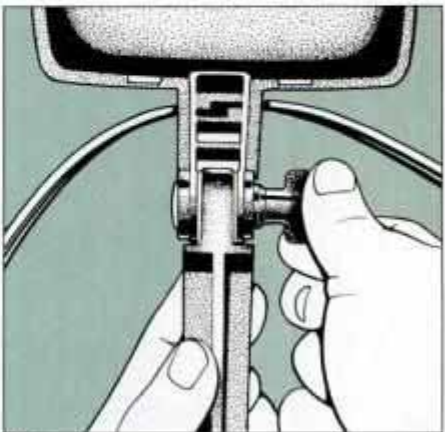
13 To install floodlights, feed wires through bridge and fasten bulb to center leg of bridge. Snap bridge onto lamp head.



14 Then, slide the lens into proper position over the floodlight's lamp head and snap in place. You should hear a click.



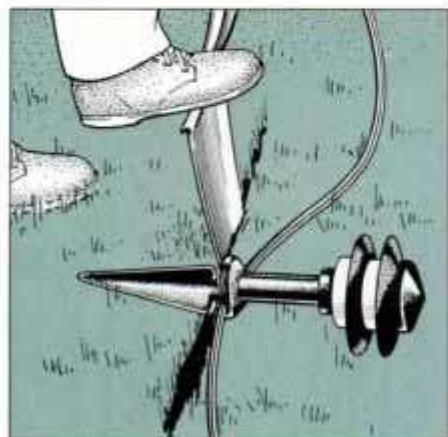
15 Once again, lay the cable in the cable clip on the base of the floodlight and slide cover in place to make electrical contact.



16 Mount floodlight head to stake with bolt and wingnut. Bolt and nut allow for on-site adjustment of light.

back of the reflector. Then, snap the lens in place and fasten the head to its stake.

The electrical connection will resemble that of the walk lamps, but the cable will eventually be draped up one side of the stake and down the other when installed. If these cable loops are in a heavy traffic area, it's a good idea to tape them against each stake.



17 Lay cable, with lamps attached, along future path of lights. Slice through sod and pry seam open slightly.

Burying cable and setting heads

When it comes to burying the cable and setting the lamp stakes in place, you'll have several choices, and may wish to combine methods.

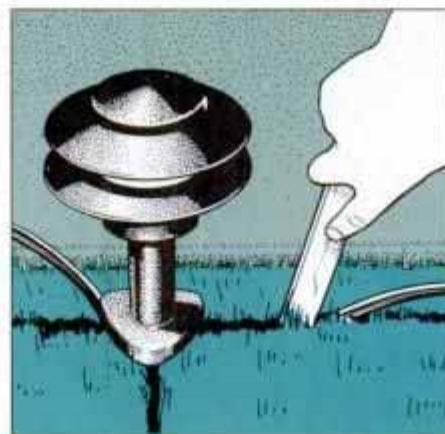
You might choose to slice through the sod and lay the cable into the trench. In this case, you dig a small hole for each lamp stake. Then set the



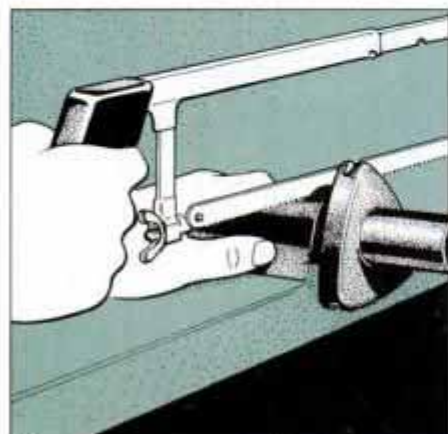
18 Force cable into spade opening with a paint stick or thin piece of scrap wood. Work gently to avoid damaging wire.



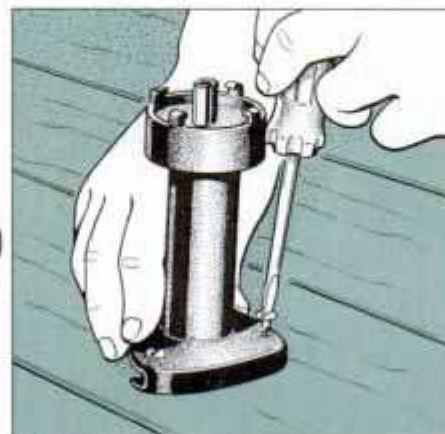
19 After making deep crosscut in sod, press stake into opening until its platform rests at ground level.



20 When laying cable along sidewalk or drive, pry the sod away from edge of asphalt or concrete. Then tuck cable into gap.



21 To convert a walk light into a deck light, cut off stake flush with the bottom of the unit's platform.



22 Make the electrical connection and slide excess cable into fixture tube. Then screw platform to deck out of harm's way.

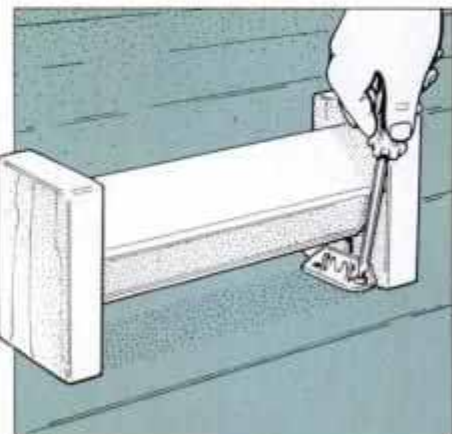
stake and replace the sod along the trench. In areas where frost heaving might push up the stake in winter, you can pack the stake hole with gravel, press the stake into the gravel and cover the gravel with sod.

If you use this method, keep in mind that newly laid sod requires a lot of special care. An easier and less destructive method is to slice into the sod with a flat-nose spade and pry the sod apart slightly. Then, use a paint stirring stick or dull putty knife to force the cable into the crevice so that it's well below sod level. To mount a stake in similar fashion, slice a cross in the sod with your spade, then press the stake into the intersection of the two lines of the cross. When the stakes and cable are installed, tamp shut the gap in the sod.

A deck lamp conversion

As mentioned above, special lamps are available to illuminate decks. These lamps are especially useful for illuminating stairs or in defining different deck levels with light. The kit we installed offers a do-it-yourself conversion of a walk lamp into a deck-mounted lamp. The procedure is quite simple and is a reasonable alternative to buying a special deck kit.

To make this conversion, simply cut off a stake flush with its upper platform. Then, drill three small holes in the platform, attach the cable and screw the platform to the deck. The cable can be brought up through a space between deck planks, or you can drill a hole through the deck and feed the cable up through it. The cable should be buried until it passes under the perimeter of the deck. Once under the deck, staple it to the inner side of a support post and then to the underside of the deck timbers until you reach the lamp location. **PM**



23 Dedicated deck lights are also available. To install, simply position where desired and attach brackets with screws.

Cocaine lies.

After nearly a decade of being America's glamour drug, researchers are starting to uncover the truth about cocaine.

It's emerging as a very dangerous substance.

No one thinks the things described here will ever happen to them. But you can never be certain. Whenever and however you use cocaine, you're playing Russian roulette.

You can't get addicted to cocaine.

Cocaine was once thought to be non-addictive, because users don't have the severe *physical* withdrawal symptoms of heroin—delirium, muscle-cramps, and convulsions.

However, cocaine is intensely addicting *psychologically*.

In animal studies, monkeys with unlimited access to cocaine self-administer until they die. One monkey pressed a bar 12,800 times to obtain a single dose of cocaine. Rhesus monkeys won't smoke tobacco or marijuana, but 100% will smoke cocaine, preferring it to sex and to food—even when starving.

Like monkey, like man.

If you take cocaine, you run a 10% chance of addiction. The

risk is higher the younger you are, and may be as high as 50% for those who smoke cocaine. (Some crack users say they felt addicted from the *first time* they smoked.)

When you're addicted, all you think about is getting and using cocaine. Family, friends, job, home, possessions, and health become unimportant.

Because cocaine is expensive, you end up doing what all addicts do. You steal, cheat, lie, deal, sell anything and everything, including yourself. All the while you risk imprisonment. Because, never forget, cocaine is illegal.

There's no way to tell who'll become addicted. But one thing is certain.

No one who is an addict, set out to become one.

C'mon, just once can't hurt you.

Cocaine hits your heart before it hits your head. Your pulse rate rockets and your blood pressure soars. Even if you're only 15, you become a prime candidate for a heart attack, a stroke, or an epileptic-type fit.

In the brain, cocaine mainly affects a primitive part where the emotions are seated. Unfortunately, this part of the brain also controls your heart and lungs.

A big hit or a cumulative overdose may interrupt the electrical signal to your heart and lungs. They simply stop.

That's how basketball player Len Bias died.

If you're unlucky the first time you do coke, your body will lack a chemical that breaks down the drug. In which case, you'll be a first time O.D. Two lines will kill you.

Sex with coke is amazing.

Cocaine's powers as a sexual stimulant have never been proved or disproved. However, the evidence seems to suggest that the drug's reputation alone serves to heighten sexual feelings. (The same thing happens in Africa, where natives swear by powdered rhinoceros horn as an aphrodisiac.)

What is certain is that continued use of cocaine leads to impotence and finally complete loss of interest in sex.

It'll make you feel great.

Cocaine makes you feel like a new man, the joke goes. The only trouble is, the first thing the new man wants is more cocaine.

It's true. After the high wears off, you may feel a little anxious, irritable, or depressed. You've got the coke blues. But fortunately, they're easy to fix, with a few more lines or another hit on the pipe.

Of course, sooner or later you have to stop. Then—for days at a time—you may feel lethargic, depressed, even suicidal.

Says Dr. Arnold Washton, one of the country's leading cocaine experts: "It's impossible for the nonuser to imagine the deep, vicious depression that a cocaine addict suffers from."

Partnership for a Drug-Free America

HOME VIDEO

Shrinking The Globe

Now you can play videotapes from anywhere in the world.

BY STEPHEN A. BOOTH, Contributing Editor

A LOT OF PM readers have asked us how they might view a videotape recorded in the PAL or SECAM systems that are used overseas.

In the past, our answer has been discouraging. Because the PAL and SECAM systems have more scanning lines and operate at a slower frequency than the NTSC system used here, they can't be played in VCRs or viewed on TVs designed for the U.S. market. You either had to purchase an expensive multistandard VCR and TV, or pay a high fee to a professional video service that could transfer the foreign tape to the NTSC standard.

Now, Panasonic has shrunk the world electronically with its PV-2050 "global" TV/VCR combo (price not available at press time). The unit mates a 20-in., color television with a 4-head, VHS-format videocassette recorder in a single chassis. The VCR, thanks to digital processing, can play tapes recorded in the world's three major video standards. It records in the NTSC standard only.

For the time being, the PV-2050 will find a home mainly among families in the U.S. with relatives abroad, and American families who have lived overseas and returned with extensive collections of foreign cassettes. Embassies, news bureaus, schools and other institutional users also constitute a market.

Eventually, though, the existence of multistandard VCRs opens the way for a lively international trade in movies and other programming on videocassette. Programs of interest only to a group too small to warrant high-volume transfer and translation can be marketed in their original standard and language. An underground for such tapes already exists in the U.S. In New York City, for example, Irish



Panasonic's "global" TV/VCR.

bars import PAL tapes of sporting events recorded in Ireland and air-expressed for viewing in the Bronx and other boroughs the next day.

The Berlin Wall of video is the incompatibility of the various systems used throughout the world. The PV-2050 is the first crack in that wall.

Theater Sound At Home

You're probably familiar with the spacious soundtrack and special sonic effects that accompany a movie at a commercial theater. In most cases, the audio technology that enhances your visual experience is Dolby Stereo. It's encoded right on the film, and works its magic after it is decoded and then played through multiple amplifiers and loudspeakers.

As good as the Dolby system sounds, the extra equipment required and the wiring of ex-

tra speakers have kept "home theater" out of a lot of homes. Now, the Technics division of Panasonic offers a way to have your cake and eat it too. It's called the SY-DS1 Digital Signal Processor (\$250)—a device that looks a bit like E.T., and delivers surround-sound effects from a single, sleekly contoured, black box.

No, the SY-DS1 does not pretend to be a Dolby system. But it does deliver good surround effects and is versatile—it can enhance the sound of older, monaural TVs and VCRs. The 7-

pound module contains two 4-in., full-range speakers, each driven by a built-in, 8-watts-per-channel amplifier. It connects to audio outputs of your VCR and TV.

Once the signal processor is in place, you'll have to fiddle with the volume, reverb time and effect-level dials to get the degree of surround sound that seems correct to your ears. You'll probably have to adjust the settings for the different programs you watch. In the case where you're using the surround-sound module to complement the frontal sound from the TV speakers, you should balance the volume of each unit so that the SY-DS1 doesn't predominate. The surround effect is obvious only when it's off, and the soundstage collapses to the front of the room. **PM**



Technics SY-DS1 offers non-Dolby surround sound in a package.

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Rich. But not expensive.

SUBURBAN CHIC

(Continued from page 59)

the expensive Range Rover as an alternative to luxury sedans—sort of a macho Jaguar. However, its outstanding off-road capabilities limit comfort on pavement.

The Range Rover is the shortest vehicle in this group except for the Cherokee, and the body is mostly aluminum. Yet it's also the heaviest, except for the LaForza, which limits 0-60 performance, as well as mpg.

When it comes to rough going, though, the Range Rover is first rate. Unlike any of the others, the Range Rover has full-time viscous 4-wheel drive, coupled with a 3.9-liter version of the Rover V8. This drive system is the most flexible, forgiving and sophisticated in this bunch.

Other strong points are 4-wheel ABS disc brakes that work even in 4wd, a somewhat cramped but thoroughly spiffy Connolly leather interior (optional), and exterior styling that has remained remarkably attractive for two decades. It also accelerates and brakes well by 4x4 standards, though hardly in the Jaguar XJ-6 league.

Price tends to limit our appreciation of this excellent vehicle versus

the competition. For about the same money, you could buy a Ford Explorer and a Ford Taurus wagon.

But of course, Range Rover buyers are interested in more than mere competence, or a bargain. They're buying status. And when it comes to this sort of intangible, the Range Rover delivers like no other.

LaForza

Designed and built by Carrozzeria Pininfarina in Turin, the limited-production LaForza is then shipped to Michigan where C&C (formerly Cars & Concepts) installs a 185-hp version of Ford's 5.0-liter V8 and a Ford 4-speed automatic transmission.

The result is a \$45,000, 5200-pound station wagon trimmed in rich Florentine leather intended to skim the Range Rover market.

In our opinion, it misses its mark. Although it's posh, LaForza is too heavy, even for the Ford V8. Plus, its on-demand 4wd and suspension aren't in the Range Rover's league.

We were also disappointed in the quality control of our test vehicle, from electronics to basic fit and finish. Buyers expect more in vehicles costing as much as this one. When they don't get it, the vehicles tend to disappear from the market. Quickly. **PM**

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Rough-And-Ready Cameras

Here's some gear for adverse conditions.

BY GEORGE SCHAUB



ited depths. Take them swimming, snorkeling or sailing. The Nikon Action-Touch (\$322) is waterproof to 10 ft., has autoexposure, auto-advance and rewind, and a built-in flash. The Minolta Weathermatic Dual 35 (\$303) offers the advantage of two lenses in one—a moderate wide angle (35mm) and tele (50mm) setting. You can easily switch from one to the other to get the best framing on your shots.

The Weathermatic Dual 35 can be submerged to 16 ft. Upon contact with water, the camera's positive meniscus lens recognizes the higher refractive index and

automatically shifts the camera's focus from infinity to 5.9 ft. Objects beyond 10 ft. are not likely to photograph well. Range can also be further limited by murky waters. The Minolta camera also floats—handy if you happen to drop the camera over the side.

These cameras take all sorts of film, but my advice is to stick to color print film when shooting underwater. These films have more exposure leeway, and usually yield better results in tricky underwater shooting conditions. Also, use the built-in flash whenever you're snorkeling. Even at limited depths, color begins to fade, and the flash will provide just the right light to bring out the best in colorful fish and coral.

If you don't want to make the investment in these submersible cam-

YOU'RE PACKING FOR a trip to the beach, or finally heading out on that camping vacation, and it's time to pack the camera gear. Though you may have a full-fledged 35mm SLR, with a host of lenses to match, you might hesitate to bring it along. You know that windblown sand at the beach, or the chance splash of water coming into the canoe can quickly ruin some very expensive equipment. Enter the weatherproof 35mm, a rough-and-ready breed of camera that allows you to concentrate on landing that fish or hitting the beach without always checking that the camera gear is secured from the elements.

Weatherproof cameras are constructed with the outdoors in mind, and shrug off water, grit and even the occasional hard knock. Some can even take a dip in the water, and can be submerged to limited depths—handy for snorkelers and for the occasional tipover suffered by even the best windsurfer or boater. Unlike conventional cameras, these all-weather models have hard-shell or rubberized exteriors, with seals that keep water from seeping in and ruining both film and camera mechanisms. Most have a supertight loading-latch, to keep the interior snug even on the worst of days, plus special clear-glass covers

over the lens. Loading and unloading these cameras still must be done on dry land, away from water and sand.

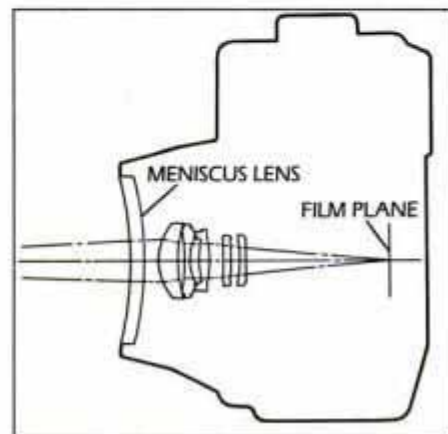
All-weather cameras

Cameras in this category come in a fairly wide price range—the more expensive units have features such as autofocus and rapid-fire shutter release. (Prices shown are manufacturer's suggested retail—you can often find these cameras for less.) The Keystone LeClic Tuff (\$49.95), has autoexposure, auto-advance and rewind, and a built-in flash. The Kodak Explorer (\$119.95) is a new entry with similar automatic features.

If you like the convenience of autofocus, check out the Chinon Splash AF (\$274.95). The Olympus Infinity II (\$260) has autofocus plus a closeup mode, useful for shooting as close as 1.6 ft. This comes in handy for dramatic closeups of flora and fauna you might come across on your hikes. The Infinity II and Splash AF also allow you to use a wide range of film speeds through their DX-code reading system. For example, the Infinity II sets up and selects correct exposure for films in the ISO 50 to 3200 range. With the fastest films, you can get shots around the campfire without a flash.

Submersible cameras

These cameras have all-weather capability and can be submerged to lim-



Minolta Dual 35 changes focus in water.

eras and just want an extra camera for a trip to the beach, consider the Kodak Weekend 35, a single-use (or so-called disposable) camera shielded inside a tight plastic casing. The Weekend 35 comes already loaded with ISO 400 film, and you return the whole package to the lab for film processing and get back only film and prints. The price is \$13.95 for camera and film, processing not included. This package can be submerged up to 8 ft., and is perfect for the kids at the beach or in the pool. You'll be seeing the Weekend 35 in gift stores at beaches and parks this year.

Want to take your camera to explore Davey Jones' locker? You'll have to make the investment in a Nikonos V, from Nikon (\$620 for the body, \$187.50 for a 35mm lens), or a Sea & Sea Motormarine II (\$550), plus flash and assorted accessories. These cameras go as deep as 150 ft.

Photo Notes

■ **Beating Red-Eye**—Compact lens/shutter 35mm cameras are mighty handy and have taken the worry out of the family snapshot. But if you've used these cameras for closeup shots indoors with flash, you've probably run into the bothersome problem known as red-eye. Red-eye makes

even the most angelic child seem a bit devilish. Red-eye is caused by the built-in flash being too close to the lens, combined with the fact that your subject's eyes have dilated to compensate for dim indoor illumination.

The easiest way to beat red-eye is to turn up the light level in the room. This causes the pupil to constrict and diminishes the red-eye effect.

Of course, the best way to eliminate this problem is to have the flash mounted farther away from the lens, but this would defeat the compact concept of these cameras. Recognizing a problem of their own making, camera manufacturers have recently begun to produce anti-red-eye flash systems, which send out a burst of light prior to the full flash used to illuminate the picture. This pre-flash causes the pupil to constrict. The first camera to incorporate this system is the Olympus SuperZoom 330, but other manufacturers are expected to follow suit.

■ **Party Camera**—Want to capture the action at a party without having to take the picture yourself? Instead of hiring a professional photographer or drafting a friend, you might want to employ the services of the new Kanpai 35mm compact camera from Konica. The more noise you make at

your party, the more candid photos you're likely to get.

The Kanpai, Japanese for "cheers," features a built-in microphone that triggers the shutter release on the camera. The sound-activation mode has low-, medium- and high-volume settings corresponding to sound levels lasting either 0.2, 0.3 or 0.5 seconds in duration. In order to keep the number of possible exposures to a reasonable amount, the Kanpai uses a built-in timer that limits the number of pictures taken to an average of 24 over a 20- to 40-minute period.

The Kanpai also gets into the swing of things by rotating on an included tripod about 40° randomly to the right or left after each exposure. This feature allows the Kanpai to capture the party action all around the room, for example.

This swivel effect is defeatable, so that the Kanpai can take pictures from a fixed perspective. A framing monitor on top of the camera allows you to set up photos without looking through the viewfinder—a handy feature if the camera is positioned in a corner.

■ **3D Addendum**—The Nishika 3D camera mentioned in May's Photography column (page 129) lists for \$229.95, not \$129.95 as originally stated. **PM**

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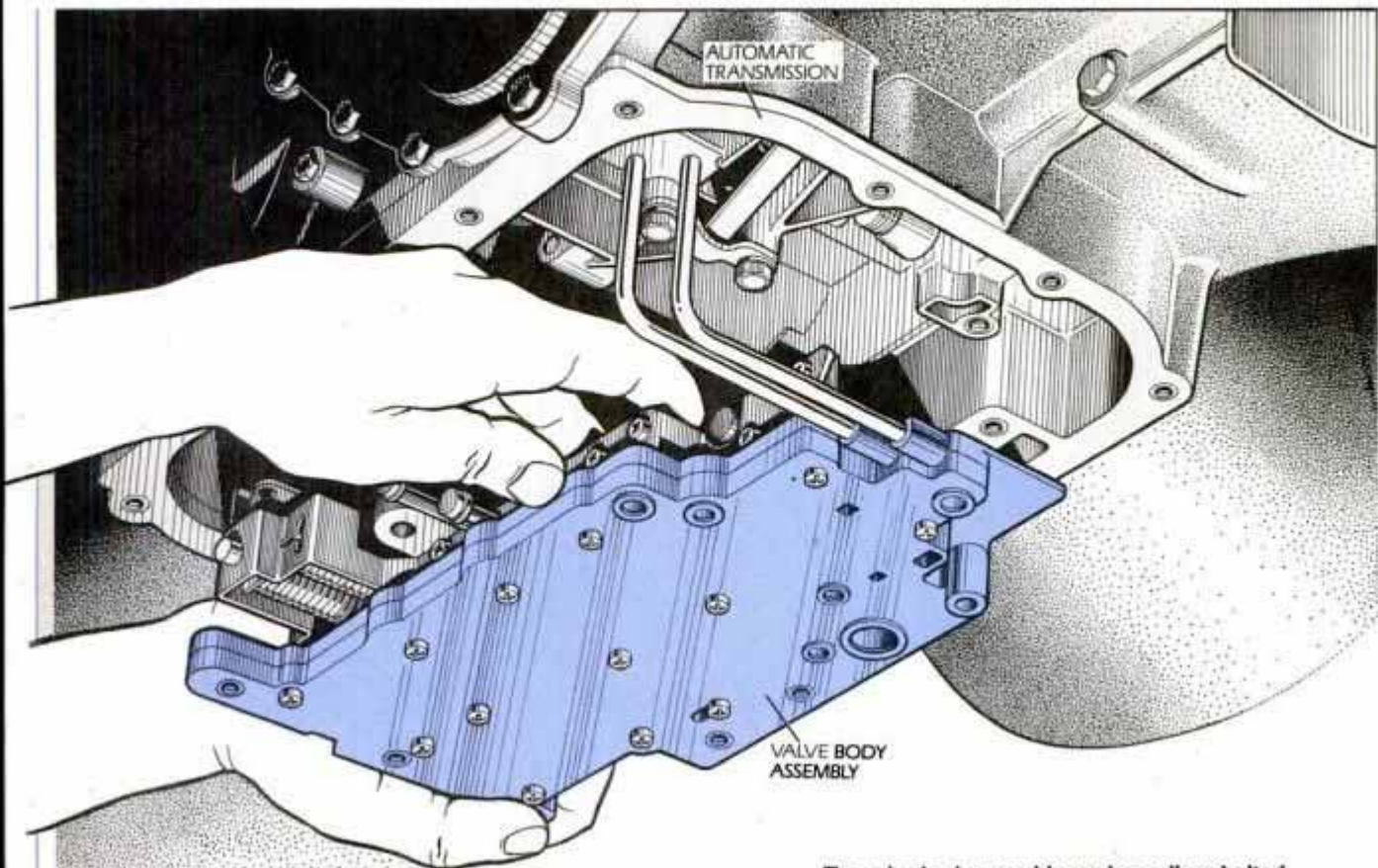
Dodge Cummins Turbo diesel pickup is the best thing that ever happened to the business end of a trailer hitch.

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*We're talking about the 1989/1990 J.D. Power and Associates Light Duty Truck Customer Satisfaction With Product Quality & Dealer ServiceSM Surveys ('88/'89 models). **We're also talking comparisons of comparable regular cab 4x2 models, here. Please buckle up for safety. And thanks for reading the fine print.



The valve body assembly can be easily unbolted from the bottom of the transmission. Always reinstall with new gaskets and seals.

WHAT TO DO WHEN YOUR AUTOMATIC TRANS WON'T SHIFT

BY PAUL STENQUIST; PM Illustrations by Fred Wolff

MAYBE THE FIRST thing you notice is that pause when you pull the shifter back into DRIVE on a cold morning. Maybe there's a long, slow shift between First and Second, or perhaps even no shifting at all. Automatic transmission trouble. It's enough to send shivers up your spine.

Sometimes, if you're an experienced driveway technician and you haven't let the problem progress too far, you can resolve some slippage and shifting problems without removing the transmission from the car.

But be forewarned: If a slippage problem continues over an extended period of time, clutch and/or band wear and damage will result, necessitating a costly professional tear-

down. And remember, a lot of automatic transmission problems cannot be resolved *without* teardown. But experience suggests that the percentage of those that can be solved on the creeper is significant enough for you to have a go at it.

One more preliminary note: If your engine isn't running correctly, fix it *before* you attempt to repair a trans slippage or shift problem. Some engine problems, like a vacuum leak, can dramatically affect transmission operation.

Check the fluid

Before you start looking for a problem, you should check the condition of the trans fluid. If it smells like rotten

eggs and appears grossly discolored, it's probably already too late for a quick fix. But some of the fluid used today turns rather dark and smells pretty bad even in normal use, so don't condemn your trans on the basis of fluid condition alone unless it's extreme.

Other things you should look for while checking the fluid are air bubbles or a milky pink color. Air bubbles suggest that a suction line is leaking. This can cause erratic shifting, but usually won't cause a constantly repeatable slippage or shifting problem. A milky color indicates that water has gotten into the fluid somehow. If this is the case, you can attempt a fluid and filter swap, but chances are that the

water has already caused seal failure or other internal damage.

Of course, a low fluid level can cause shifting and slippage problems. Make sure you check the fluid level following specific recommendations in your owner's manual. In most cases, this means checking the fluid level with the transmission hot, the car parked on level ground, the engine at slow idle speed, and the transmission selector lever in PARK. It requires at least 15 miles of highway driving to bring the fluid to what is considered hot temperature. Some manufacturers also provide a cold dipstick position for checking, but this isn't as accurate as a hot fluid check.

If you do find a low fluid level, check carefully for leaks. They may be hard to pinpoint because the airstream under the car spreads the fluid all over. Many leakage problems, including rear seal, bad pan gasket, leaking cooler lines and even transmission case porosity, can usually be resolved without removing the trans.

Among the most common causes of trans fluid leaks are bad cooler lines. These connect the trans to the oil cooler that is usually located in the radiator. The lines are under pressure and a pinprick leak can make quite a mess. Because they sometimes rub against chassis parts and are subjected to a lot of road debris thrown up by the wheels, they can easily fail.

Checking the TV cable

No, we're not talking about the cable that brings television into your cave. We're talking about the throttle valve

cable (or linkage) that helps determine when and if your transmission will shift on most cars. If it's out of adjustment, it can cause slippage, erratic shifting or no shifts.

If your car has a TV cable or linkage, you'll find it between the throttle linkage and the transmission linkage (Fig. 1). It modulates the operation of valves within the transmission depending on how hard you're pushing on the throttle pedal.

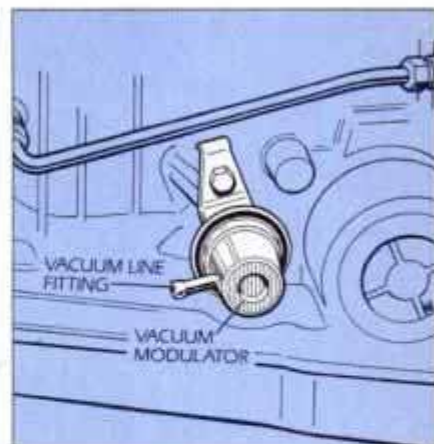
Once you've located the TV cable or linkage, make sure it doesn't bind or stick. If it does, see if you can determine why and correct the problem. With mechanical TV linkage, a little lubrication may be all that's needed.

Often, a sticking TV cable is due to a sharp bend in the cable, damaged housing or misaligned bracket parts.

When you've determined that the cable or linkage mechanism works smoothly, you can adjust it. You can find specific instructions for your adjustment in your Motor or factory service manual. There are too many variations to cover here.

Vacuum problems

If there are any vacuum lines connected to your transmission, check them for splitting, cracking or loose ends that could cause leaks. If the lines are connected to a device that looks something like the vacuum advance mechanism on a distributor, your trans has a vacuum modulator that could be causing your problems (Fig. 2). A bad modulator will cause harsh and delayed upshifts or no upshifts. On some cars it can also cause an early upshift.



2 To check for a bad modulator, remove the vacuum line from the modulator and look for trans fluid at the connection point.

Some modulator failures will also cause exhaust smoke, as trans fluid may be drawn into the engine. Because all modulator failures will cause at least some fluid to be drawn into the modulator vacuum line, you can check your modulator by removing the vacuum line and looking for fluid at the modulator/vacuum line connection. If the modulator is leaking, replace it.

Shift linkage

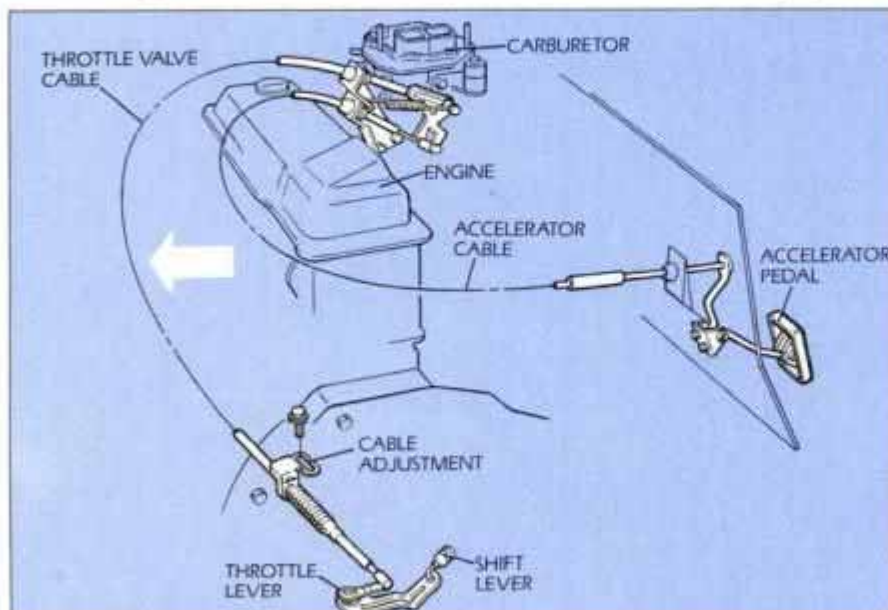
The next thing to check is shift linkage adjustment. If the linkage detents prevent the transmission valves from moving into place, all kinds of shifting problems can result. To adjust the gearshift linkage of most cars, shift selector lever to PARK. Then, disconnect linkage from trans. Locate the trans shift lever in PARK.

With trans and linkage in PARK, locate the linkage on the trans shift rod, shortening or lengthening the linkage until it fits. If your car has a cable linkage, the cable adjuster changes the linkage length. If your car has mechanical linkage, you'll probably find a rod that screws in or out of its rod end or a stud and nut that slide in a slot.

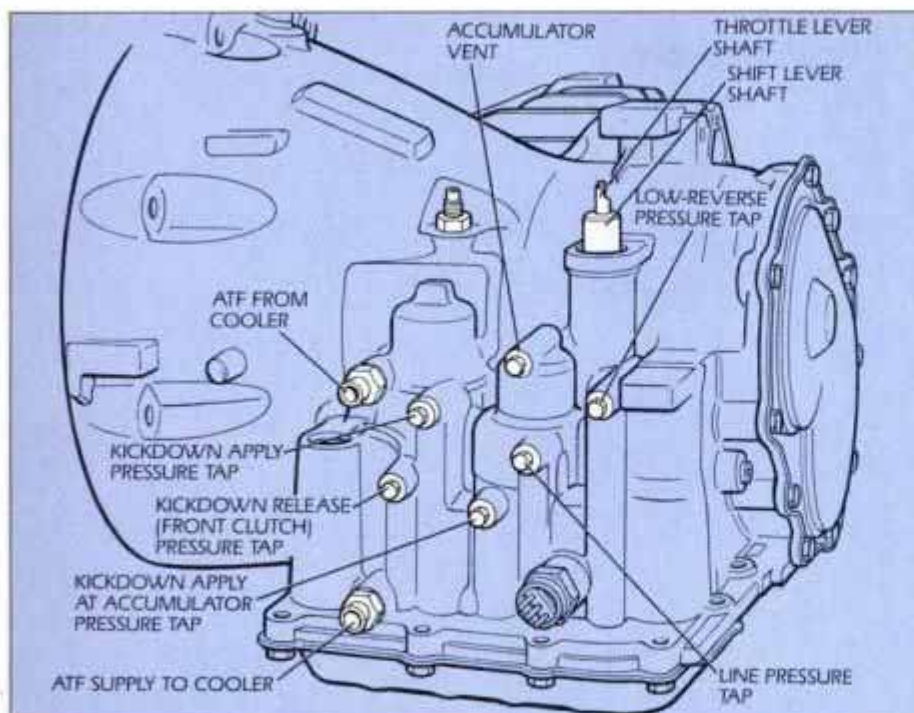
If you can't determine how to adjust the linkage by eyeballing it, check your shop manual. This may also be necessary with some Fords, which are adjusted with the selector lever in the DRIVE position.

Pressure test

How do the pros diagnose automatic transmission problems? The best technicians test drive the car, then pressure test it. By comparing symptoms and pressure reasons, they can usually narrow down the possible causes of a shift problem. The pressure test is performed by attaching a gauge to pressure ports on the outside



1 Many cars are equipped with an adjustable throttle valve cable or linkage that helps determine shifting. If the adjustment is incorrect, shifting problems can result.



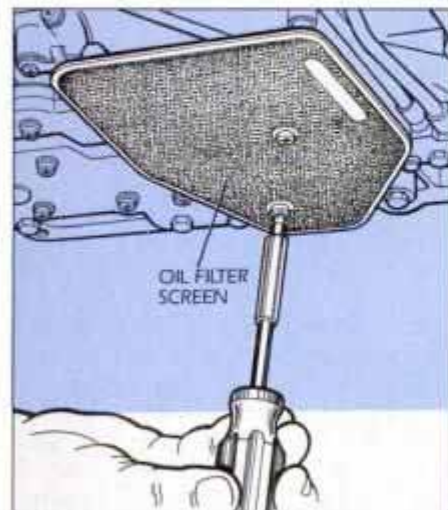
3 This Chrysler transaxle is fitted with a number of pressure ports on the outside of the transmission case for checking fluid pressure in various hydraulic circuits.

of the transmission case (Fig. 3).

You can determine probable causes of slippage and shifting problems by pressure testing your transmission, but you'll need some special tools to do the job. First, you'll need a tachometer. Second, you'll need one or more pressure gauges. For some models, a 150-psi gauge will suffice. For others, you'll need a 300-psi gauge. Third, you'll need a Motor or factory service manual, which provides a chart showing you how to interpret the results.

Once armed with all the necessary tools and charts, drive the car 15 miles to raise fluid to operating temp.

Then, raise the vehicle securely on



4 Most transmission filter screens are secured to the valve body with a couple of screws. This is the only filter in the system.

heavy-duty jackstands or, better yet, on a car hoist that allows the drive wheels to turn. Consult your service manual for specific jacking instructions, and don't attempt this job unless you can raise and support the car in the approved manner.

Install an engine tachometer and position it so that you can read it while you test. Disconnect the TV cable and shift cable or linkage from the transmission levers so they can be controlled from outside the car. Finally, attach the gauges to the ports required for the test being conducted, and perform the tests as described in your manual.

In interpreting the results, you can limit possible sources of the problem according to what pressure readings you obtain in the various prescribed tests. For example, on most cars, if you have correct pressure minimum and maximum on any one test, you can assume that the pump and pressure regulator are okay.

On many cars, if you have low line pressure in all positions and on all tests, you may well have a clogged filter which is easy to repair. Of course, this condition can also be caused by a bad pump or stuck regulator valve. Other results may suggest leakage in one particular circuit. Sometimes, a circuit leakage problem can be corrected by replacing or cleaning the valve body and/or spacer plate—another job that can be performed with the transmission in the car. (See the

lead illustration on page 115.)

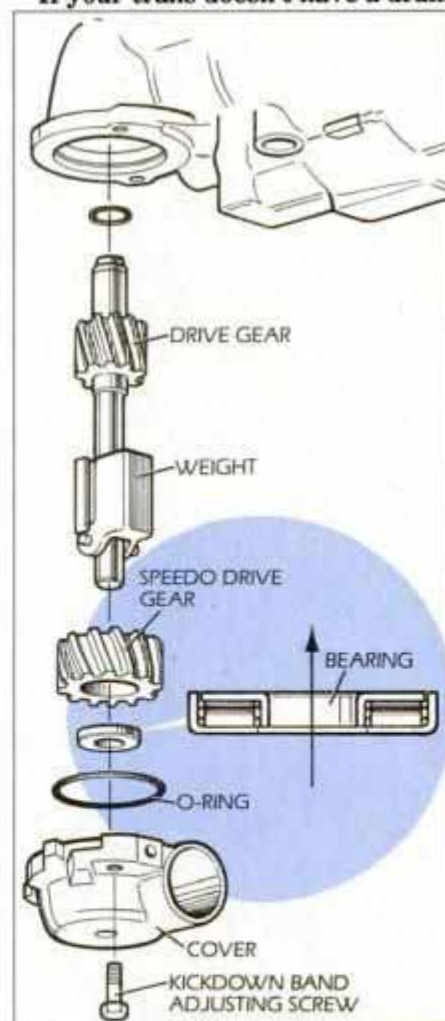
Some repairs not listed here can be made in the car on certain transmissions. If your pressure test points to a specific part as a possible cause, check your service manual to see if it's a job you can do yourself. Many shop manuals have a section devoted to in-car service that lists all parts that can be replaced without pulling the trans.

Filter and fluid swap

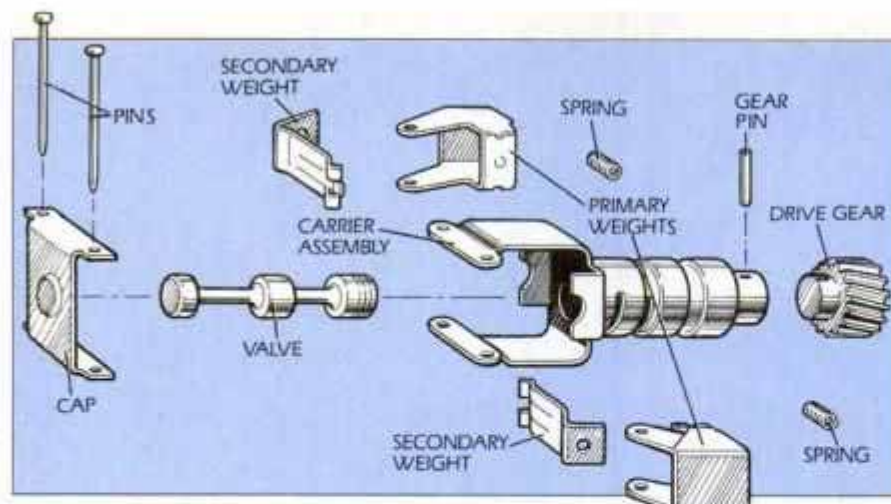
If the pressure test reveals low line pressure in all positions, you might try a filter and fluid swap before resorting to a costly out-of-the-car tear-down. Even if you're not equipped to do the pressure test, but you have shifting or slippage problems, and your trans fluid and filter haven't been changed in the past 20,000 miles or so, the procedure can sometimes provide a fast and inexpensive fix.

If your trans has a drain plug in the pan, you're all set. Just make sure you have a huge drain pan to hold the 10 or more quarts of trans fluid.

If your trans doesn't have a drain



5 The governor can be removed by unbolting the governor cover and dropping the governor assembly out of the transaxle case.



6 General Motors' THM125 governors are calibrated at assembly, so individual parts other than the drive gear shouldn't be replaced.

plug, you can remove all the pan bolts except two in two opposite corners of the pan. Then, with a drain pan under the opposite corner, slowly unscrew the two remaining bolts. Allow the opposite corner of the pan to drop gradually as the fluid pours out. You may have to tap the pan a bit to break the gasket seal, but make sure the two remaining bolts are still well into the trans before you begin to drop the corner of the pan.

When the fluid has drained, carefully remove the two remaining bolts while supporting the pan.

Once the pan is off, you can remove and replace the filter pickup screen (Fig. 4). If it's clogged with friction material, you may have found the source of your problems.

Some clutch material in the pan is normal. Even a little bit of metal from thrust surfaces is normal in some transmissions. A large quantity of clutch material and metal is, of course, a sign of other more serious problems.

Governor

A bad governor can cause shifting at incorrect speed or no First-to-Second shift. Some transmissions have a port for checking governor pressure.

Some governors, including many of those on GM transmissions, can be cleaned or repaired without removing the transmission from the car (Fig. 5). On some models, you'll have to drop the driveshaft and the trans tailshaft (while supporting it with a jack) to remove the governor.

Possible governor faults that could cause no shifting are numerous. On most cars you can look for binding weights, missing springs, missing or damaged O-rings and bad drive gears (Fig. 6).

Some governors, including the illustrated GM 125C governor (Fig. 7), require adjustment of fluid circuit inlet and exhaust ports.

Valve body

If the governor itself seems okay, but symptoms and pressure tests suggest

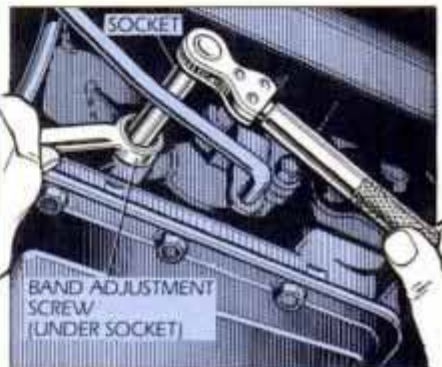
a governor problem, it could be that one of the governor oil circuit orifices in the valve body spacer plate is plugged. Other pressure test results that seem to indicate a leaking or clogged circuit might also be caused by a valve body or spacer problem.

The valve body and spacer plate can be removed with the trans in the car (lead illustration), but unless you find obvious blockage, it's going to be tough to tell if you've accomplished a cure without road testing.

To get the valve body off the trans, you'll have to remove the oil pan, filter and the shift mechanism.

Band adjustment

Most GM transmissions don't have band adjustment capability. A lot of Ford and Chrysler transmissions do, however, and some models have a



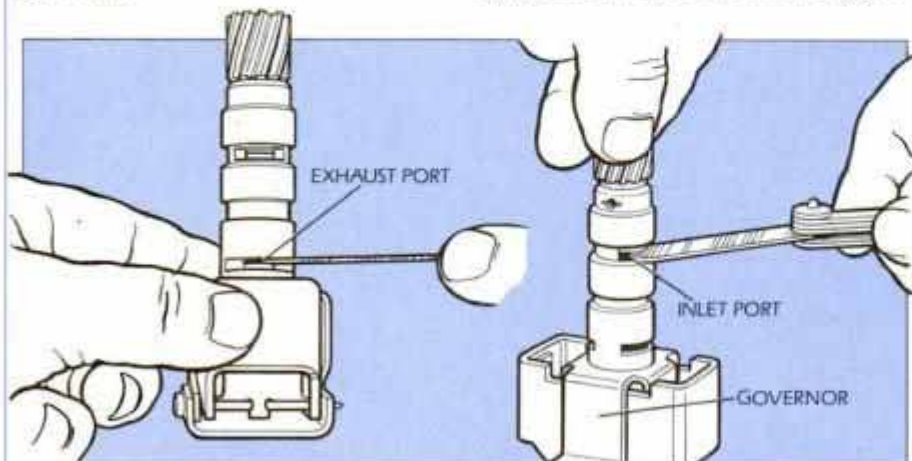
8 Band adjustments are done by loosening the locknut, adjusting the screw with a socket, and tightening the jam nut.

band adjustment procedure as scheduled maintenance.

In many cases, band adjustment can help solve a minor slippage or sloppy shifting problem—but only if you get to it before the situation has gotten out of hand. The longer a band slips, the more it wears. And when the friction material is gone or deteriorated, no amount of adjustment is going to help.

Some bands, like the intermediate band on the pictured Ford C5 transmission (Fig. 8), can easily be adjusted with a torque wrench while the trans is in the car. For most band adjustments, which require torque in the neighborhood of 10 ft.-lb., an in.-lb. torque wrench is recommended.

The procedure usually calls for loosening a locknut, then tightening the band adjustment screw to a specific torque figure. Once the torque figure has been reached, the screw is backed off a specific number of turns, then held in position while the locknut is tightened.



7 Before reinstalling the GM 125C transaxle's governor, check inlet valve opening with weights extended completely outward. It should be 0.020 in. Check exhaust opening with weights held tightly inward. It should also be 0.020 in.

Dreamplane

Lopresti Piper's Swiftfury is the light plane of the future—if we're lucky.

BY FRED MACKERODT, Contributing Editor



LOPRESTI PIPER PHOTOS

SO HERE I AM, typing this column on my notebook computer in Piper's new Swiftfury airplane. We are at this very moment streaking down the Florida coast at 210 mph with azure waves 5000 ft. below us.

Two minutes ago, I was sitting on this 6-pound box of microprocessors. If I hadn't been, it would have been floating around the cockpit at ear level. I was at that instant getting the inverted view of the Florida coast.

Smooth as silk, with a flick of the stick, I had rolled this little sucker upside down. Move over, Yeager.

This is one problem with the Swiftfury. When it finally gets manufactured a year-and-a-half from now, it will make some pretty average pilots aviate like astronauts—even if they don't deserve to.

Which is not to say that flying this airplane won't require a little practice. After all, the craft does have dual control sticks instead of the steering wheel yokes found in most general aviation aircraft. (Allow at least 2 minutes to get used to the sticks.) And it is a tailwheel machine with all the special ground handling and landing characteristics this configuration entails. (A couple of hours shooting touch and gos should suffice here.)

Sticks and tailwheels in a modern airplane? Sure. Sticks are much better than steering wheels. In fact, a lot of experts track a lot of pilot technique problems to the adoption of nosewheels in the 1950s, when pilots began driving airplanes onto runways, rather than flying them on.

In any case, the Swiftfury is an eye-opening combination of something old and a whole lot new. Designwise, it is based on an airplane called the Globe Swift—an underpowered, quirky handling aircraft of which 1500 were built beginning in the mid-1940s. But to say that the Swiftfury is related to the original Swift is like saying that Michelangelo's masterpiece statue, the Pietà, was once a rock. The Swift-



Swiftfury cockpit boasts clean, canted instrument layout and silky-smooth control sticks.

fury is as close as anybody has come so far to building the perfect all-around personal airplane.

First, some facts: The Swiftfury is a 2-place airplane powered by a 200-hp IO-360 Lycoming engine. It has a top speed of 217 mph and will cruise at 200 mph with a fuel burn of 10 gph, giving it a range of about 1000 miles. Pains-taking design and construction are key to this outstanding performance.

The design process utilized the latest in computational aerodynamics and intensive pressure field studies that shaped each centimeter of skin to minimize drag. Engine cooling drag, which can add up to a third of the drag of some general aviation aircraft, was cut by enclosing the engine in a doghouse under the cowl and accelerating the air exiting the engine compartment by aerodynamically ramping the flow. Though the engine is very tightly cowled, cooling is not a problem, even during a full-power climb-out on a 90° Florida day.

Every last bit of power has been eeked from the engine. During our flight test at 5000 ft., with the throttle firewalled, the engine manifold pressure read 24 in. of mercury and the airspeed registered 160 knots. I

(Please turn to page 120)

reached down and activated the ram boost valve. This little device switches the air intake from under the cowl to an opening just behind the propeller. It also takes the air filter out of the system, which is okay, because the air at 5000 ft. is clean. Reducing the backpressure by switching to unfiltered air, and utilizing the pulsing of the propeller to push air into the forward intake, immediately lifted the manifold pressure to 26 in., and the speed crept up to 170 knots.

Fighting Trim

Construction is all flush rivets and butt joints, painstaking techniques more associated with jet fighters than everyday airplanes.

But then again, the Swiftfury is closer to a fighter than a conventional aircraft. For one thing, it is stressed for 6 positive and 3 negative Gs. It will roll and loop with the best of them.

Like a fighter, it is one of the most pilot-sensitive airplanes I've ever sat in. Even with the obligatory parachute on—we flew the one and only prototype—the cockpit is roomy and comfortable. Visibility, one of the most important factors in airplane safety, is fantastic. Gauges are canted toward the pilot for maximum readability. The handgripped HOTAS (a

military acronym for Hands-On Throttle and Stick) throttle control incorporates switches for wing flaps, speed brakes and lights. The control stick has switches for pitch trim, transponder ident, microphone and an autopilot kill switch.

A great deal of the development work on the Swiftfury went into the control system. There is a minimum of friction, no backlash, no downsprings and no bobweights. The aerodynamic forces come right through to your hand. The feeling is the closest anyone has come to making an aircraft control the extension of a pilot's arm—or better yet, fingers. The smallest movement of the stick does something. It's the result of painstaking design work—all tubes, bell cranks, ball bearings and some fantastic hardware hogged out of aluminum blocks.

Chief test pilot Curt LoPresti took the controls as we lined up to land on Vero's Runway 22 left. The gear went down smoothly. On the old Swift, when the gear dropped out of the wing, the gear door stayed open, leaving a gaping hole under the wing. When the pilot attempted to pitch up, or flare, just before landing, the airflow got into this hole, the wing would stop flying instantly, and the plane would land with all the grace of a shop-

ping cart falling off a loading platform. Thus, 3-point landings were almost impossible in the Globe Swift.

In the Swiftfury, the gear door is sequenced. It opens, the gear extends, and it closes again to cover the wheel well and smooth out the landing. Curt LoPresti made a perfect 3-point landing to demonstrate.

The Swiftfury is the work of aeronautical wizard Roy LoPresti, the patriarch of the LoPresti clan, with the bucks and moral support supplied by general aviation visionary Stuart Millar, owner of Piper Aircraft.

LoPresti has designed many flying machines—from spaceships to the innovative Grumman Tiger of the mid-'70s. At Mooney, he finessed that 4-place airplane into a 231-mph rocket. And at Beech, as chief engineer, he worked on the original Starship.

But the Swiftfury is LoPresti's dream, and Millar, who works across the field at the Vero Beach Airport, is financing that dream. Trouble is, Millar is also trying singlehandedly, with one wallet, to preserve private flying and flight instruction in the U.S.

If everything goes well, Swiftfury deliveries will begin in late 1991, or early 1992. If everything doesn't, an amazing piece of American ingenuity might be lost to posterity. **PM**



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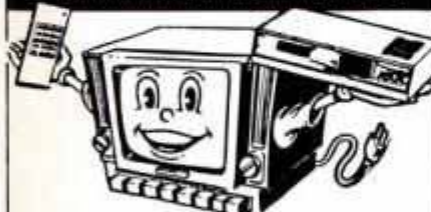
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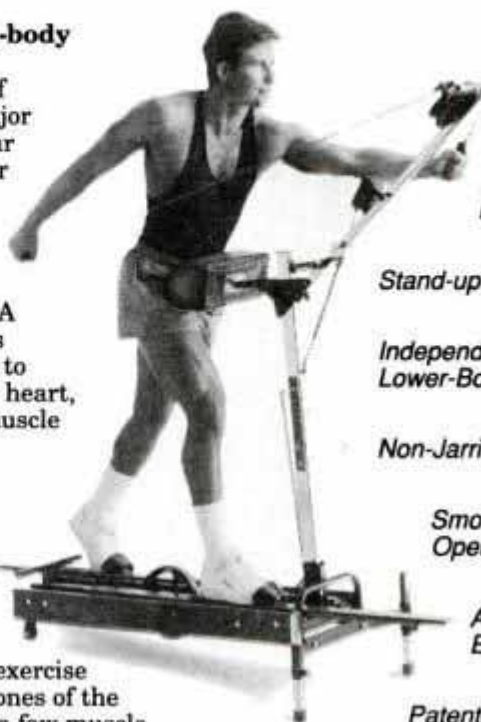
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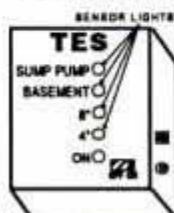
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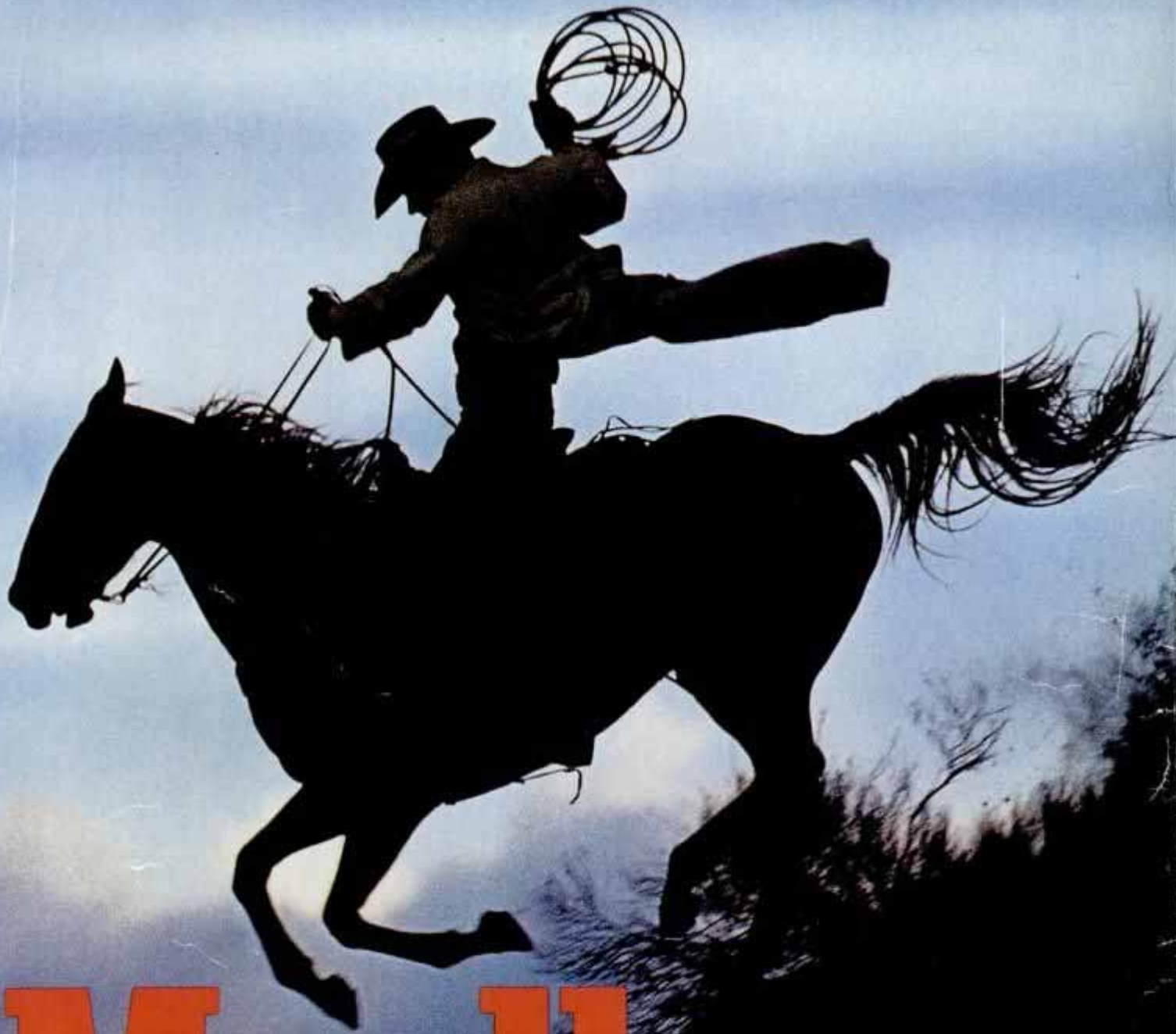
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