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Popular Mechanics

HOME OFFICE SHOWPIECE



Build Our Rich Oak Executive File Cabinet

STEAM'S BACK ON THE FAST TRACK

TORTURE TEST

Wringing Out The 8 Hottest 4-Wheel-Drive Mini Pickups

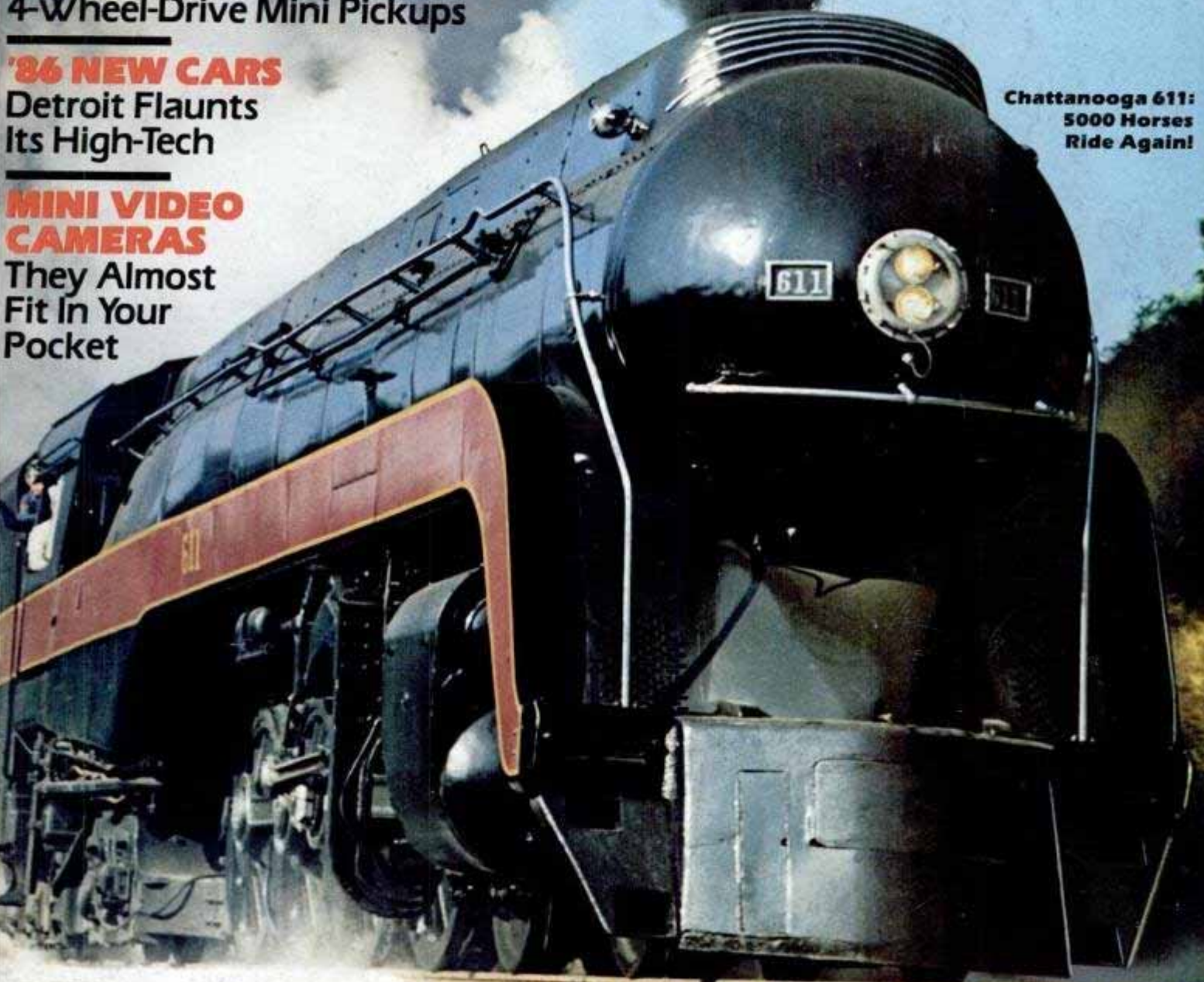
'86 NEW CARS

Detroit Flaunts Its High-Tech

MINI VIDEO CAMERAS

They Almost Fit In Your Pocket

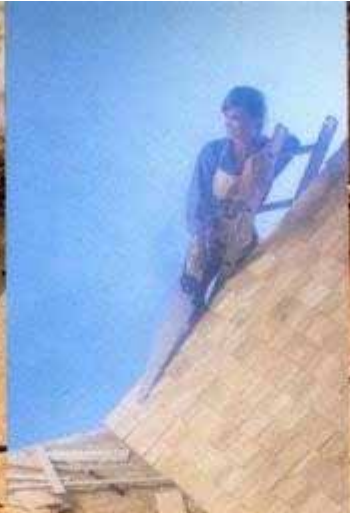
Chattanooga 611: 5000 Horses Ride Again!



SMART PHONES GET SMARTER

Voice-Command Dialing • Household Controls
Intrusion Alarms • Privacy Lockouts • And More



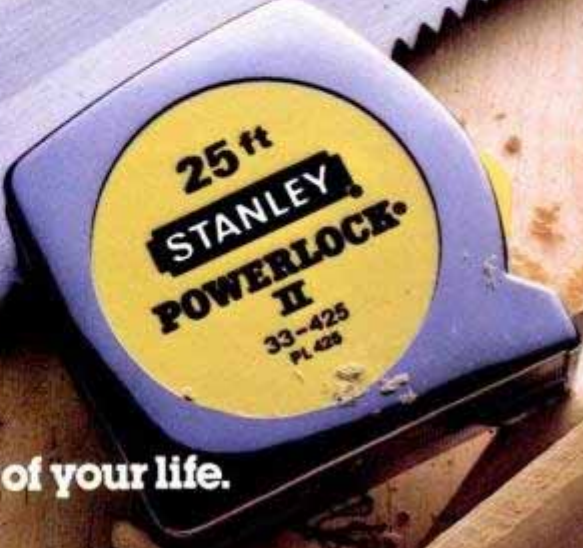


This is what you worked your way up the ladder for. A place you can call your own. And because it means more when you're doing it for yourself, you're doing it right with Stanley Tools.

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STANLEY
Professional™



STANLEY For the quality of your life.

EVERY TIME YOU CHANGE THE BIT, YOU'VE GOT ANOTHER TOOL.



The remarkable device pictured below is a Dremel® Moto-Tool®. With its wide range of accessory bits, this compact power tool provides the kind of versatility you won't find in conventional tools. Not only will it handle a variety of tasks, it'll handle a variety of materials. You see, while ordinary power tools usually run at less than 3,000 RPM, the Dremel Moto-Tool is capable of a range of speeds up to 28,000 RPM. And because the Moto-Tool is so compact, you'll often find it'll do the job, where other tools won't even fit.

The Moto-Tool is available in several different models, including both adjustable and constant-speed versions. Each features a reliable motor, an assortment of useful accessories, and most models come with a rugged carrying case.

So if you want a versatile tool that does the work of many other tools, pick up a Moto-Tool. Once you do, you'll quickly see there's no other single tool like it.



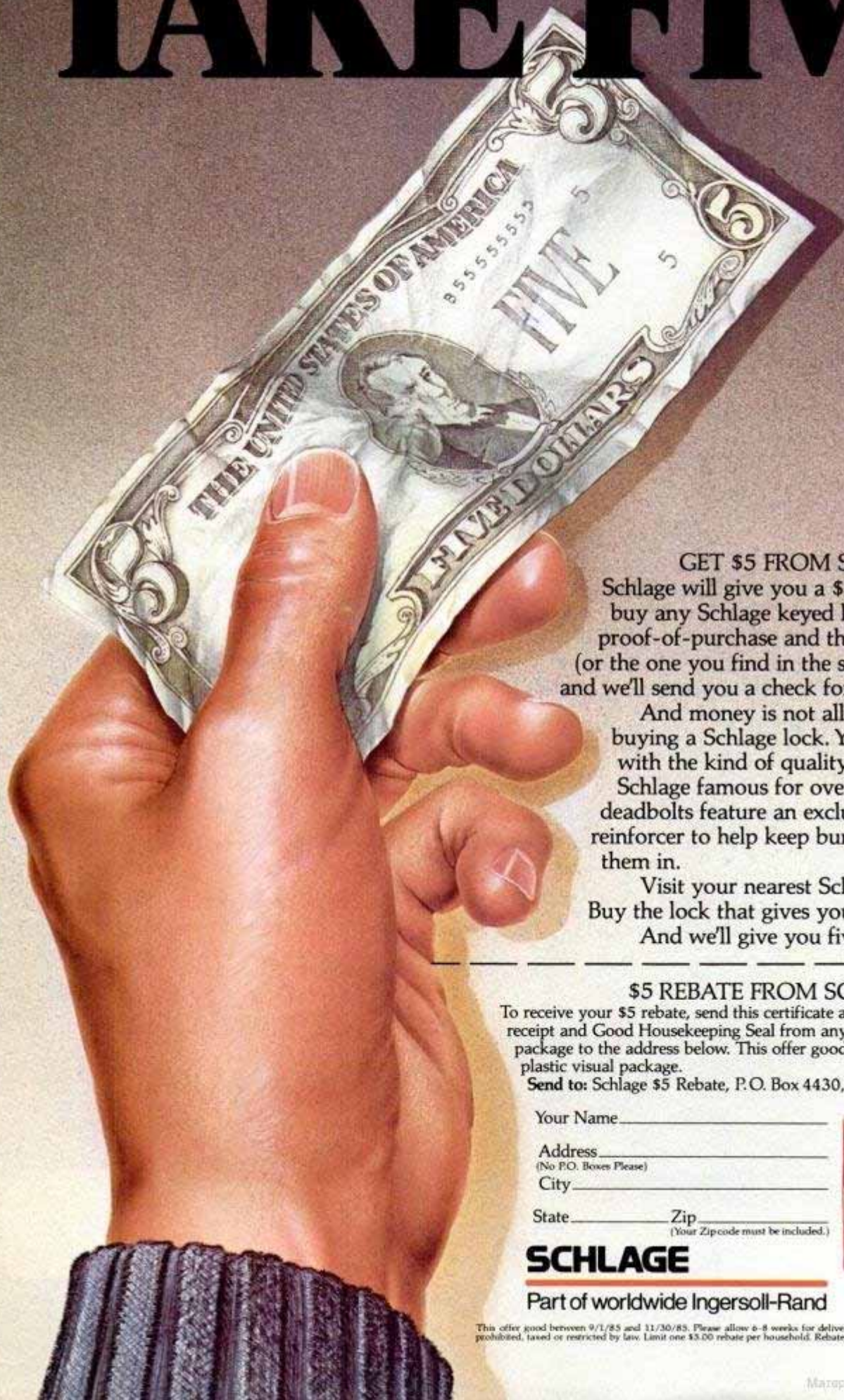
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This One



1HXD-E61-Y631

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ON THE COVER

Black smoke shoots skyward as Number 611 puffs toward Chattanooga. The 25-year-old behemoth was one of the last steam locomotives built in America, but new technology and rising diesel fuel costs may signal a revival of the steam engine. The story begins on page 90.

—Photo courtesy of Norfolk Southern Railway

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84 4x4 torture test



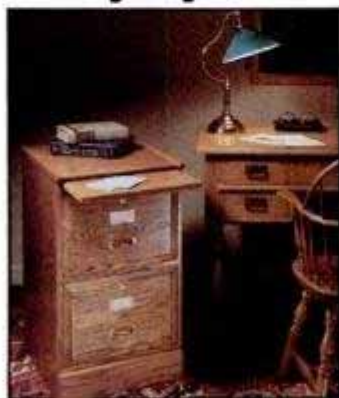
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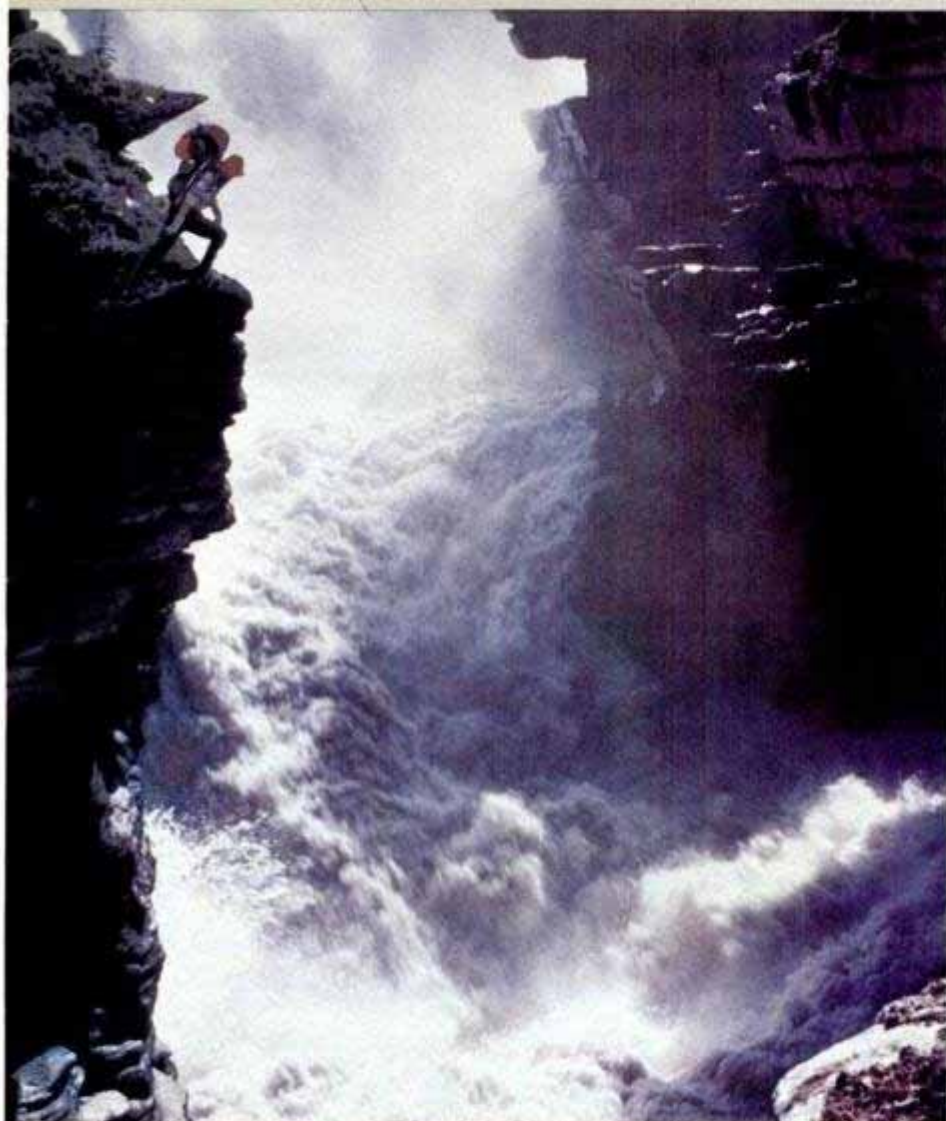
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Athabasca Falls.
A rugged place for
a smooth whisky to start.



ALBERTA, CANADA—Out here, nature's the boss. And you don't ever forget it.

I guess I expected sort of a picture-postcard waterfall. This one roars by like a freight train.

The water is so cold it almost hurts to drink.

It's this water, from the glacier fields, that helps make Windsor Canada's smoothest whisky.

They also use rye grown in the rich, black earth around Calgary. And the air helps, too. Windsor is aged in the cleanest, crispest air I ever breathed.

Out here, nature's the boss. And Windsor is Canada's smoothest whisky because nature makes it that way.

WINDSOR
CANADA'S SMOOTHEST WHISKY.



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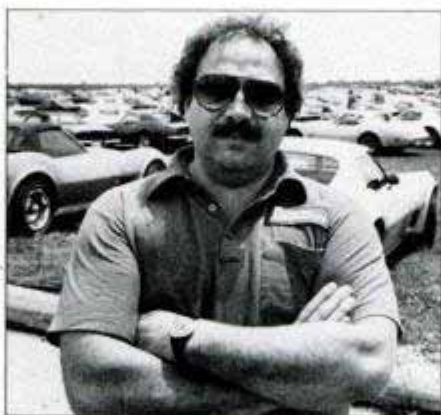
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EDITOR'S NOTES



The deliberations are over, the jury is in, and the verdict is reached. Americans love trains. We may not ride on them enough to make Amtrak a profit (we don't have the time), but we definitely love them nonetheless. I think we love them because a steam locomotive allows us to almost recapture the tranquility of a bygone era, a romantic era cloaked in gentility that was swept aside by the emergence of high-speed trucks, cars that travel intercity routes almost as fast as the planes of 30 years ago, and, yes, the jet plane. But steam lives. Not only are there several steam engines alive and well and operating today, but chances are that number will increase significantly in the future. As this month's cover story (page 90) by William Hoffer points out, new concepts in steam engine efficiency and technology could produce locomotives with greater power and lower operating costs than the diesel and electric engines of today. A prototype is projected to be operational by 1988. . . . **No collector car is hotter** these days than the Corvette. I was in Bloomington, Illinois, recently for what is quite possibly the largest annual gathering of Corvettes in the country. There were thousands of Corvettes there of every imaginable description—literally seas of them. The rarest of the rare were there, too, in glorious *concoctions* condition. How rare? In 1969, Chevrolet built only 20 ZL-1 aluminum-engined 427 Corvettes and sold only two to the public. One of them was at Bloomington. If you're a Corvette freak like me, you must get to this Corvette mecca at least once in your life. . . . Still



At Bloomington, Illinois: There were more Corvettes than I could count.



Tester Rich Taylor (left) and Asst. Auto Editor Norman Mayersohn kept 4x4s going.

on the subject of motor vehicles, our auto editors learned a lot during our 4-wheel-drive pickup truck torture test (page 84)—including how to change flats and clean mud off trucks. Out of eight trucks tested, five got flats. Not exactly a testimonial to the capabilities of today's tires on off-road vehicles. As for the mud, it took over \$100 in quarters and 32 washes to keep it at bay. . . . **It's with a great deal of sadness** that we note the passing after a short illness of Shel Gallagher, a member of the POPULAR MECHANICS family for the past 18 years. Shel was always a gentle soul but a fierce editor. With a blue pencil in his hand, he could take the most disastrous manuscript and make it into a tome dripping with pearls of wisdom. But even more than being a brilliant editor, Shel Gallagher was, simply, a nice guy. It's perhaps fitting that Shel passed from this world doing what he loved best—covering the Paris Air Show for POPULAR MECHANICS. We'll miss him.



Shel Gallagher: gentle soul but a fierce editor.



TOOL VALUE OF THE MONTH





GREEN THUMB

28"

Lopping Shears

Teflon®-coated steel blade resists rust, offers 1 1/4" cutting capacity! Hurry! Offer good from Aug. 10 only while supplies last, at participating True Value Hardware Stores. 523-761

6⁹⁹

HARDWARE VALUE OF THE MONTH



Master Resettable Combination Padlock

Up to 10,000 4-digit combinations! Solid brass with case-hardened steel shackle. Hurry! Offer good from Aug. 20 only while supplies last, at participating True Value Hardware Stores. 175-D

CHARGE IT at participating True Value Hardware Stores. For store nearest you, see "Hardware" in the Yellow Pages.



Which one's the one for you? Mobil 1[®] 5W-30 or new Mobil 1 Formula 15W-50?

They're both 100% synthetic, they're both the same unbeatable quality and they're both turbo and race-proven. Only their viscosity is different.

For years Mobil 1 5W-30 has been taking the checkered flag in SCCA endurance and sprint racing. And now, new Mobil 1 Formula 15W-50 is being used in top Indy race cars. Its higher viscosity gives sophisticated high-tech engines superior high-temperature protection and delivers optimum protection for turbocharged engines, even under extreme

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operating conditions. Both Mobil 1's help protect engines against friction and wear better than any conventional motor oil, so they help engines stay cleaner and last longer. And neither one will thicken up like conventional oil, even way down at 35° below.

So now you have a choice. Mobil 1 5W-30, or if you prefer or require a higher viscosity motor oil, new Mobil 1 Formula 15W-50. Whichever one you choose, one thing's for sure.

You can't get better engine protection than these two Mobil 1 **Mobil 1[®]** and **Mobil 1[®] Formula 15W-50**. You can't give your car better engine protection.

Now there's one for everyone.

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1 Quart

Mobil[®]

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LETTERS TO THE EDITOR



Quick-change pedal car

Here's a photo (below, right) of the pedal car that I made from your plans (*Build PM's Delivery Wagon*, page 62, Aug. '82). It came out very well. I think, but I did make a few changes that may interest other readers. Instead of the pedal drive, I installed a 12-volt starter motor from an old car and a forward-reverse gearbox from a junked riding mower. These drive the car's right rear wheel through a bicycle chain and sprocket arrangement.

I made the upper part of the body removable so it's easy to switch from the delivery wagon to the roadster or pickup version. I also scaled up the

dimensions so that the car is big enough for me to drive whenever I can sneak it away from the kids.

MACO ALLASON
BREMERTON, WA

I built the pickup/dump truck version (below, left) and just wanted you to know how pleased I am with the results. I used bicycle wheels instead of solid wood discs and added a horn.

LAWRENCE MONDA
ASHTABULA, OH

You both did a great job. For others who may be interested, the plans are \$9.95 postpaid from Stevenson Projects, Box 584, Del Mar, CA 92014.



Two versions of PM's convertible pedal car: pickup/dump truck (left) built by reader Monda and delivery wagon (right) built by reader Allason.

Wrong rocket

In reference to your article on the Jupiter probe (*Technology Update*, page 67, Apr. '85), the Galileo package will use a Centaur booster as opposed to the Titan rocket you mentioned. The Centaur is made by the Convair Division of General Dynamics.

ROGER PLACZEK
GENERAL DYNAMICS
SAN DIEGO

Missing ejection seat

I loved your picture of the X-29, but I don't see how Chuck Sewell could have flown the plane as he said he did (*I Flew The World's Hottest Fighter*, page 75, Apr. '85). As a former Air Force mechanic, I couldn't help noticing that there was no ejection seat in the cockpit. I doubt that even a great test pilot

like Sewell would fly an untried aircraft with no means of bailing out.

RONALD J. MASON
STEVENS POINT, WI

Good point. The ejection seat had not yet been installed at the time our photo was taken. It was put in shortly thereafter for Sewell's historic first flight as reported by him in PM.

No-hands gas pump

In *The PM Garage* for March '85 (page 18), you showed a device for holding the trigger open on a self-service gas pump nozzle. Another solution is to wedge the gas tank cap under the trigger. This is free, effective and prevents you from misplacing the gas cap.

EDWIN ROBBINS, M.D.
NEW YORK

A ride on air it's not

In your article *Japan Struts Its Stuff* (page 102, May '85), you said that the HSST maglev train "rides on a cushion of air just above the track." This statement implies that it operates like a hovercraft, which it's not. The train is supported above the track by electromagnetic force, not by any cushion of air.

B.W. THOTT
CUTLER, ME

We wanted to emphasize the fact that the train is separated from the track by a layer of air. You're right, however, that it's magnetic force, not air, that provides the support.

Making it easy

I am 16 years old and have just recently started working with wood, but this doesn't matter because your plans always make everything seem so simple. I built the coffee table shown in your December '83 issue (*Build Our Oak Coffee Table*, page 148).

My high school shop teacher was as much impressed with the way the coffee table turned out as I was surprised that I could make it all by myself. Keep those great plans coming. They're especially useful to us beginning woodworkers.

KEN HOLLEY
RADCLIFFE, OH

The Edsel lives on

What a delightful surprise to find my red and white 1959 Edsel Ranger displayed in your great magazine (*Fun For Car Buffs*, page 126, May '85). Many of my friends and relatives have called to congratulate me on gaining



Still going strong: Reader Celotto's 1959 Edsel proves what loving car care can do.

recognition in a national publication. The picture has given me great joy and I shall treasure it always.

ANTHONY A. CELOTTO
NEW HAVEN, CT

No. 1 power in V-8's. Ford Pickups

For '85 Ford offers not only a wide choice of V-8's but the most powerful V-8's of any pickup truck maker!

And, what a great selection of four high torque engines to choose from:

- The 5.0L V-8, most powerful in its class, with new electronic fuel injection.
- 5.8L High Output V-8* with 4-barrel carb that gives you more horsepower than Chevy's midsize V-8.
- 7.5L engine, with 245 horsepower,** the biggest, most powerful V-8 in any pickup.



- And, the 6.9L diesel V-8, the most powerful diesel in any pickup.

It adds up to more V-8 power for you, more muscle on and off the highway, more get-up-and-go wherever you drive. For '85, America's best-selling full-size pickup,† powers its way to the top with V-8 power to spare—and you're in the driver's seat!

Peak payloads, too!

Ford packs the payload you need for today's

bigger, harder hauls; up to 5,740 lbs. worth! Plus the ability to tow trailer loads as big as 12,500 lb. when properly equipped.

Great choice of comfort!

And, no one tops Ford in offering you so many pickups to pick



from: from roomy Regular Cab models to the exclusive SuperCab with folding rear seat option; or 4-door Crew Cab, now with single or dual rear wheels.

Built Ford Tough.

These big Fords all come with 2-wheel drive, as 4x4's with unique independent front suspension, or Mono-Beam front suspension for those extra heavy duty jobs. And these tough Fords come with galvanized double-wall box in back.

Best-Built American Trucks.

At Ford, Quality is Job 1. A 1984 survey established that Ford makes the best-built American trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1983 models designed and built in the U.S.

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As part of Ford Motor Company's commitment to your total satisfaction, participating Ford Dealers stand behind their work, in writing, with a Lifetime Service Guarantee. No other car companies' dealers, foreign or domestic, offer this kind of security. Nobody. See your participating Ford Dealer for details.

*Not available in California or with manual transmission.

**Horsepower based on SAE Standard J1349. Rated horsepower lower in California.

†Based on final 1984 calendar year manufacturers' reported retail deliveries.



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FORD PICKUP
AMERICA'S TRUCK **BUILT FORD TOUGH**



Get it together - Buckle up!

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IMPORTS & MOTORSPORTS



Sunny Impulse



Isuzu's teaser for '86 is a topless Impulse that's rated X—for experimental.

First, the good news: Isuzu's Impulse is now as fast as it looks. With its new turbo, horsepower is up to 140 from 90. The bad news? The convertible version seen here is just an impulsive bit of experimentation and is not scheduled for production. But, you can always hope. The Giugiaro-styled coupe adapts beautifully to topless treatment and would undoubtedly do very well considering the current convertible renaissance. Meanwhile, you should now be seeing the inter-cooled Impulse Turbo coupe, which you can tell from the standard Impulse by its front air dam, rear spoiler, badges and, inside, a leather trim package. To support the increased power,

Turbo models also have larger clutch and cooling capacity, a new 5-link rear suspension and modified spring rates, antisway bar stiffness and gear ratios. Other Turbo features include its own digital dash—with 140-mph speedometer—and top-of-the-line sound system. Still, the top doesn't go down.



Convertible top stores under molded boot.

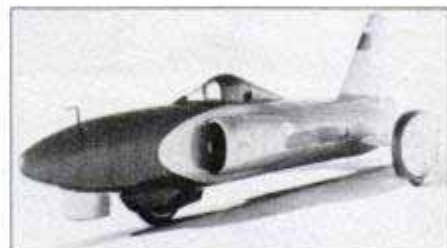
1000 mph on wheels?

The ultimate event in motorsports competition is really quite simple: With unlimited power, cover more ground in the shortest time than any other driver. The result is a land speed record. Right now it officially stands at 633.468 mph, set in '83 by Richard Noble. But a holder of former land speed records—five, in fact—wants to add a full 108 mph to Noble's record to break the sound barrier—about 741 mph at sea level. The driver is Craig Breedlove, of



Craig Breedlove's first goal in this rocket car is Mach 1 (about 741 mph) in spring '86.

course, who first entered the record books in 1963 when he drove the *Spirit of America* to 407.450 mph. The following year he got the turbojet 3-wheeler up to 468.719 and 526.277 mph. Art Arfons took the record away with a 536.710, but in '65 Breedlove was back with the *Spirit of America Sonic I* and ran 555.127 and then 600.601 mph. In '70 Gary Gabelich brought the record up to 622.407 and that's where it stood until Noble's 633.468 mph. Now, Breedlove's back with the *Spirit of America Sonic II* (above) and hopes to crack Mach 1 sometime next spring. Bonneville has been the place to break land speed records ever since Malcolm Campbell went over 400 mph there in 1935, but



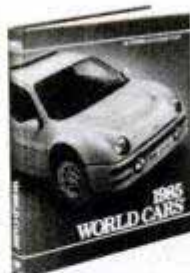
Spirit of America set records in '64-'65.

Breedlove is considering Edwards Air Force Base and Blackrock Desert as possible sites. His program with the 44-ft. Sonic II also includes a look at the 1000-mph mark. How fast is 1000 mph? A mile in 3.6 seconds. **FM**

Facts, figures and Ferraris

The new Ferrari Testarossa is now prancing in the real world with 48 valves keeping rein on 380 horses. The 12-cylinder powerplant, capable of propelling the mid-engine 2-seater to 175 mph, is a flat-12—in contrast to the V12 Ferrari engines, the last of which was available here 12 years ago in the Daytona. The waiting list for a Testarossa is also about 12 months long and that's with an \$87,000 price tag. Ferrari North America (777 Terrace Ave., Hasbrouck Hts., NJ 07604) takes the or-

ders. The Testarossa, surely the most exciting of the cars introduced during the last 12 months, is detailed, right down to tire pressures (40 psi front, 46 psi rear) in the one book that puts the automotive year into perspective. The 1985 *World Cars* volume shows the Pininfarina-designed Testarossa in color in its "New Bodies" section and in "Models Now



World Cars is a 439-page guide to '85 cars.



Ferrari Twelves are back: midships in the new Testarossa.

In Production" you'll find it along with the 208 Turbo, 308 quattrovalvole, Mondial, 400 Automatic i and GTO. *World Cars*, a treasure, is \$45.95 from Herald Books, P.O. Box 17, Pelham, NY 10803.



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PM ELECTRONICS MONITOR



Chicago '85: A pocketful of miracles

Baseball's World Series seldom comes to Chicago. But just past Memorial Day each year, electronics manufacturers from all corners of the globe visit the Windy City to show what's on deck for fall. This season's lineup is strong on miniaturization, and with the rookie 8-mm video format leading off, Sony might clean up with its paperback-sized Mini-8 camcorder.

At this writing, about a dozen companies are pitching 8-mm as the successor to VHS and Beta. The roster includes heavy hitters such as Pioneer, Kodak and Sony. The latter's got the smallest 8-mm product on the market. Pictured here at exactly half its size, the Mini-8 is a self-contained video camera and recorder that weighs about 2 pounds and measures roughly 2 in. thick by 4 in. high by 7 in. long. What helps keep the size down is a CCD (charged couple device) image sensor that replaces the vacuum tube pickup found in conventional video cameras (see *Video Thinks Small*, page 81).

Sony's Mini-8 (CCD-M8U) uses a 6-v. battery to record for up to two hours—that's the longest 8-mm cassette available. To play the tapes, the company offers an 8-mm player/recorder (EV-



Shown half actual size: Mini-8 and cassette.

C8U) 7 in. square by 3 in. high. Package price is \$1800, but each unit is sold separately. Sony also offers an 8-mm home VCR (including TV tuner/timer) that has half-speed recording to double tape time, and digital stereo recording

(for movie soundtracks and up to 24 hours of audio-only recording). The EV-S700U is \$1500.

Tiniest radar detector

Uniden grabbed first place in the race to build the smallest radar detector.

Photographed here to scale with car keys and toll feed is the company's new



The keys and coins provide a size comparison for Uniden's tiny radar detector.

RD-9. The self-contained radar detector measures only 4 1/4 in. long by 2 3/4 in. wide by less than 3/4 in. thick. Its small size and light weight make the RD-9 suitable for mounting on dashboard or

sun visor. Moreover, you can foil would-be thieves by slipping it into a pocket or briefcase when you leave the car. Suggested retail price is \$269.

The RD-9 provides a choice of audible or visible alert (or both) to either X-band or K-band radar. A selector allows you to choose between unfiltered sensitivity for highway travel, or filtered

operation for urban driving. The unit's superheterodyne E.D.I.T. circuitry promises to eliminate false alarms from microwave relay stations, automatic door openers and weather radar.

Switch-hitter

If you're tired of juggling a platoon of remote controls for TV, VCR, CD and hi-fi system, General Electric's ready to lend a hand.

The company's Control Central (\$150) will operate virtually any infrared-controlled component from any manufacturer by learning and memorizing its signals. The G.E. unit provides unity of command over four devices, and can be reprogrammed for new ones. The original remotes retain control abilities. **PM**

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Low Tar
'Enriched Flavor.'
Kings & 100's.

MERIT



Give peace a chance

In the bizarre arena of 20th century weaponry there are no heroes. But let me nominate Sandia National Laboratories researcher J. Pace VanDevender. At a recent conference of Strategic Defense Initiative (SDI) scientists at the University of Rochester, VanDevender dropped a political bombshell for world peace. He proposed a global treaty that would see the launching of SDI weapons—lasers, for example—into orbit. They would be under the control of another satellite with an on-board computer. Nations signing the treaty would each have a secret key code that could turn off the laser weapons when used in conjunction with the keys from the other nations. If any vehicle, be it a ballistic missile or a space shuttle, left earth's atmosphere without permission

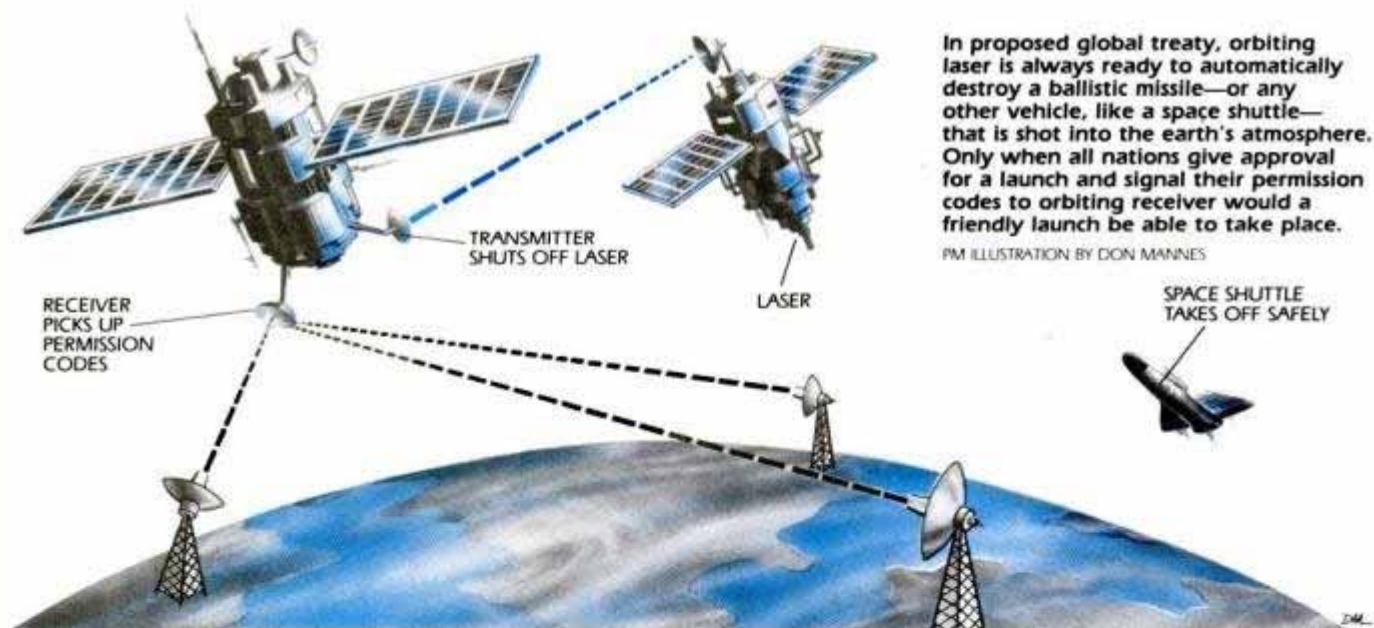
of all the signatories, the vehicle would be blasted by an SDI weapon.

If any nation wanted to launch a peaceful rocket, it would inform all the others and they would log a message to the orbiting control station turning off the weapons. With VanDevender's proposed system, we would need permission of other nations to launch space projects. That may be seen as a restriction on our future space travel. But more important, if any nation took on first-strike notions and launched missiles, they would be destroyed automatically.

There are a number of political problems that would have to be worked out before such a system could be designed. For instance, French scientists attending the conference objected that

the system would render Soviet intercontinental missiles useless, encouraging the Russians to point their entire arsenal at nearby Western Europe. (Russian missiles could hit European targets without leaving the atmosphere). VanDevender's reply to the French: "You could sign onto the international system and also launch a local SDI system to protect Europe."

Critics mock the SDI concept, calling it Star Wars. Such attacks, however, gloss over the fact that SDI weapons are on standby only, prepared to destroy strictly military targets if they are launched. These are peace machines and not weapons. And J. Pace VanDevender, whose proposal was made merely to open a new dialogue in the search for world peace, deserves recognition for an idea whose intentions, at least, are excellent.



In proposed global treaty, orbiting laser is always ready to automatically destroy a ballistic missile—or any other vehicle, like a space shuttle—that is shot into the earth's atmosphere. Only when all nations give approval for a launch and signal their permission codes to orbiting receiver would a friendly launch be able to take place.

PM ILLUSTRATION BY DON MANNES

Halley comes closer

Feast your eyes on the first photo of Halley's Comet taken with a small amateur telescope. Halley is the lefthand blip inside the rectangle. The object on the right in the rectangle is a background star. The incredible photo was taken last March by astronomer Stephen Kent at Harvard's Smithsonian Astronomical Observatory. He used a Bausch & Lomb 8000 telescope equipped with an RCA charged couple device (CCD). A CCD is a silicon chip

that gathers hundreds of light beams and electronically arranges them into a single image.



Object at left in rectangle is Halley's Comet.

Older and wiser

Scientists are cleaning up and carefully studying the bones of what may turn out to be the oldest known dinosaur. The unidentified creature would go back 225 million years. The bones were found last summer in a well-studied part of the Arizona Painted Desert. Scientists who found them had already carefully dated fossilized leaves and pollen in the deposit. Early word is that the creature may represent a previously unknown family of dinosaurs. **PM**

Get down to fundamentals... Experience the joys of woodworking

Are you missing out on the joys of woodworking? Imagine for a moment the shine in your little girl's eyes the first time she sees the rocking horse you built just for her. Or think of the fun you'd have on a deck added to your house — built with your own hands. Maybe the cooks in your family would like a kitchen custom-made to their needs. Or consider how much enjoyment you'd get from your stereo system if you built your own entertainment center.

Unlike many other hobbies, woodworking is a hobby of the imagination as well as the hands. Starting with nothing more than an idea, you create things that express your individuality, creativity and common sense. You solve problems, learn new skills — and save money in the process. But most of all, woodworking is fun.



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HOMEOWNERS' CLINIC



Water seeping under slab floor

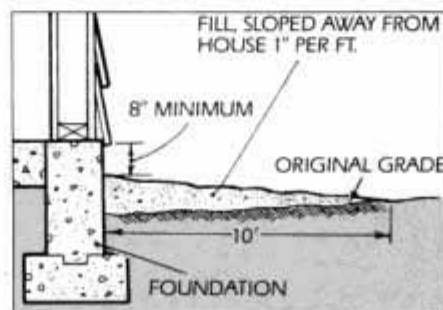
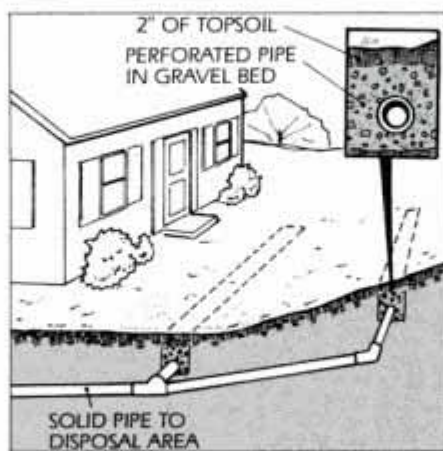
My home is built on a concrete slab. About five years ago, we began to get water seeping under the slab and into the floor heating ducts after a long, hard rain or a sudden deluge. Water enters the ducts on the side where the ground slopes upward, then fills all the other ducts. Can you suggest any way to stop this water from entering the house?—Nathan E. Westover, Choc-taw, OK

The best way to control the problem is to intercept the water before it gets under the slab, and direct it away from the house. But before you go to the expense of putting in a subsurface drainage system, check other possible solutions that are less expensive.

The ground immediately adjacent to the house should be graded so it slopes away, as shown in the lower illustration. This will prevent water from accumulating around the foundation. It also forms a swale, or depression, to carry away surface water. If you do not have gutters to channel roof rain runoff away from the house, they should be installed. If you have gutters, make sure the downspout bases extend far enough to prevent runoff accumulation.

If surface water is not the cause of your problem, you will have to intercept the subsurface water movement. This can be done by installing a curtain drain parallel to the house on the slope that runs toward the house.

Dig a trench to a depth below the house foundation and fill it with a few



Subsurface water that seeps under a slab can be intercepted with curtain drain (top). Surface water can be rerouted by regrading the ground next to the foundation (above).

inches of gravel. Lay a length of perforated pipe in the trench with the holes facing down. Fill the trench to within 2 in. of the surface with gravel, and cover the gravel with topsoil.

Both ends of the perforated pipe should extend beyond the house. One end is capped, the other is connected to a nonperforated pipe, pitched to carry water to a disposal field.

Slow flowing pipes

The iron water pipes in our older home have calcium buildup in them, restricting the water flow to a trickle. Is there some chemical means to flush out the pipes? The pipes otherwise seem to be in good condition.—Patricia Dalton, Lexington, KY

Although the pipes look good from the outside, they are probably deteriorating from the inside out. Besides the calcium buildup, there is probably a heavy rust buildup contributing to the restricted flow.

The only thing that will remove the calcium is acid. However, the acid will also attack the pipes. And if it is not totally flushed out, it could attack you. Also, if you remove the calcium buildup you will probably end up with many leaking fittings, since the calcium seals pitted pipes and leaking joints.

You basically have two choices: don't do anything, or repipe the house. If the water flow is indeed a trickle, I would recommend replacing the pipes.

Patching plaster walls

I recently installed a central heating system in my home. The old heaters, measuring 20 in. X 60 in., are mounted back-to-back in the wall between rooms. Removing these units will leave a huge pass-through between the rooms. I want to frame out the openings and repair the walls so the patch won't be noticeable. Should I use lath and plaster, or should I try to make a flush patch with easier to handle wall-board?—Greg Gibson, Albany, GA

If you want a perfectly smooth wall you should cover the entire wall—from corner to corner—with wallboard. It's very difficult to achieve perfection with a patch. Depending on how light strikes the wall, you will see ripple shadows at the patched joints.

But, if you intend to hang pictures on this wall or cover it with a textured paint or wallpaper, patching would be adequate. Because of the size of the opening it would be easier to fill with wallboard than with plaster. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101.

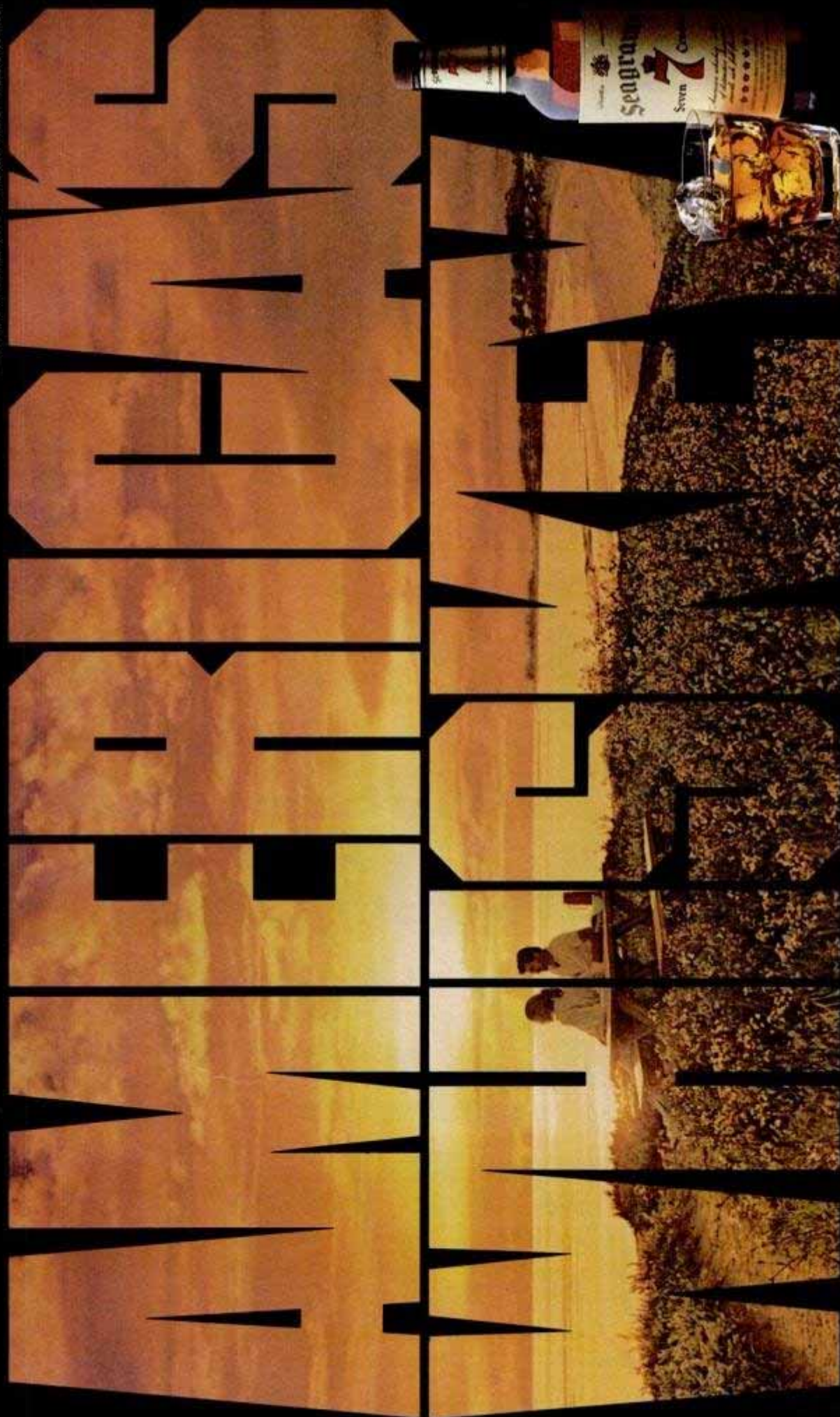
Unwashable air cleaner

I have a problem with the electrostatic air cleaner mounted on the return air plenum of my forced-air furnace. It does a good job of extracting dirt from the air, but it's extremely difficult to clean. The particles become statically bound to the extractor cell plates. Soaking the cell in warm water with dishwasher detergent, as per instructions, fails to remove the particles. The plates must be scrubbed with a narrow brush, which is very time-consuming. Do you have an easier way?—James Hunter, Kitchener, Ontario

Automatic dishwasher detergents such as All, Finish or Electra Sol are

effective for cleaning electrostatic air cleaner cells if they are washed frequently. If not, the particles bake into the plates. The required frequency of cleaning varies in each home, depending on the amount of tobacco smoke, dust, soot and cooking oil in the air. It is usually between one and six months.

If you have problems cleaning the cell, even with more frequent washings, try using a special detergent, available through heating and air-conditioning contractors who install electrostatic air cleaners. This detergent, called Honeywell Liquid Detergent, Part No. 126850, is rather expensive. A one-gallon container costs about \$35.



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ALL OUTDOORS



Backpack protects sleeping bag

A recent weekend fishing trip to the Adirondack Mountains gave me a chance to take a close look at Kelty's



newest backpack, which is intended for use on their workhorse Expedition external pack frame. (A prototype is shown here. It should be available in January '86.) The pack's principal feature is a special sleeping bag compartment that can compress even the bulkiest stuffable sleeping bag inside.

The pack also features a zip-out horizontal divider, which forms two separate compartments, and a string collar opening that shields contents from the elements. Abrasion-proof Cordura adds resistance to tears and scratches. You'll pay \$170 for these subtle but distinctive improvements.

External pack frames made of various grades of aluminum alloy are enjoying a resurgence. Kelty relies on the Expedition frame's H-shape design, but has added certain refinements, such as an expanding top bar for bulky loads.

Also, developments continue in Kelty's line of partial and full-season sleeping bags. Its small 25° bag is shown here inside the full-length pack. A new breathable polyester material called Solar Silk reflects body heat and adds to the bag's overall warmth. A zero-degree bag can also be squeezed onto (or into) packs with little effort. For details, contact Kelty, Rt. 2, 704 Maupin, New Haven, MO 63068.

Kelty's full-length pack and external frame features tough, abrasion-resistant Cordura, and a special sleeping bag compartment.

Cordura shell holster

Serious riflemen like to limit the number of shells they carry into the field (unless you're going plinking, in which case the more the merrier). Recognizing this sportsmanlike frugality, Michael's of Oregon, a shooting accessories maker, has created a tough Cordura shell carrier that attaches to a shooter's belt. The shell carrier holds ten standard and eight magnum



For the serious hunter: Cordura rifle shell holster attaches to your belt.

rounds and keeps shells concealed and out of the weather. The price, at \$7.95, is within most budgets. The manufacturer also offers a handy Cordura belt pouch for .22 shells.

For more information, contact Michael's of Oregon, P.O. Box 13010, Portland, OR 97213.

Inflatable horseshoe

Man-overboard gear that tucks away neatly and can be deployed easily is hard to find on small boats. Survival Technologies Group has recognized this problem by developing the 18-ounce SEAID throwable horseshoe ring. The compact device attaches to a special bracket that is screw-mounted to any easy-to-reach bulk-

head. The container is tossed to a person in trouble and the horseshoe inflates in two seconds on contact with the water. A CO₂ valving system supplies the air. The orange horseshoe has

an oral reinflation stem and a strong closure strap, and can be stowed easily. It's \$89.95 from Survival Technologies Corp., Suite 10, 308 Tequesta Drive, Tequesta, FL 33458.

Folding fillet knife



Most fishermen will agree that carrying an open fillet knife inside a tackle box is unsafe, and would rather clean fish over the kitchen sink than risk injury at the fishing hole. Cleaning and filleting can now be accomplished anywhere quickly and easily with the Coleman-Western Folding Fillet Knife. The 6-in., stainless-steel blade locks in

Small utility knife is big on safety.

place, either opened or closed, and the molded, rubberized handle is checked for better grip. The knife is 12¼ in. when opened and folds to 7 in. It sells for \$25.75 in most retail outlets. Contact Coleman-Western, 1800 Pike Road, Longmont, CO 80501. **FM**



SEAID inflatable rescue horseshoe ring is packed in an easy-to-throw container.

CAR CLINIC



Unwanted escort

I'm getting a buildup of a white foam-like substance on the underside of the oil fill cap of my 1984 Ford Escort. I'd like to know if it's something to worry about, what's causing it and whether there's a way to prevent it.—Larry Meissner, Knox, IN

This condition is characteristic of 1983, '84 and '85 Escorts that are

driven in areas where cold ambient temperatures prevail for long periods. In 1983, the design of the Escort/Lynx venting system was changed. This has led to the formation of condensation on the upper part of the oil dipstick and on the surface of the oil fill cap, because the new venting system allows these areas to retain the cold. Drops of mois-

ture form and mix with the layer of residual oil.

Ford says that as long as the substance is not seen in the oil itself, the condition is normal. If you clean off the substance in the spring or summer, it should not reappear until after a cold snap the following winter. So, don't worry about it unless the substance is in the oil and there's a loss of coolant. That may indicate a cracked block.

Heads-up service

The headliner in my 1976 Plymouth and 1979 Dodge has parted from the moldings and is falling. The Chrysler dealer tells me to take the car to an upholstery shop, but those people want a minimum of \$150 to reattach it. Is this job too complicated for an amateur to tackle? If not, can you tell me how to do it?—Ernest Clutter, Friendswood, TX

Go to a store that sells auto paint supplies and get a can of 3M Spray Trim Adhesive (part No. 08074). Following directions on the can, spritz a small amount on the molding and on the edge of the headliner.

Let the adhesive get tacky. Then, use a small plastic kitchen spatula to tuck the headliner under the molding, but make sure the adhesive you sprayed on both surfaces comes together. The stuff works like a charm.

Camouflage net

Let me relate how a seemingly serious condition turned out to be trivial. Hopefully, readers of your column can benefit from this experience.

Just before the warranty for our 1984 Chevrolet Caprice was to expire, the car developed a jerking between 40 and 60 mph. It was worse in automatic overdrive, but also unpleasant in regular drive. The dealer had the car three times. Each time, we were assured that this was normal performance.

In checking with other Caprice owners, I learned that most were having the same trouble. It started to look as if we had a major transmission malfunction on our hands that Chevy was trying to sweep under the rug.

To make a long story short, I took one final stab and brought the car to a different Chevy dealer who replaced the sparkplug cables of the 5-liter engine. This seems to have corrected the condition. So, what appeared to have

been a major transmission problem turns out to be a relatively minor ignition condition.—D.C. Nunn Jr., Marietta, GA

Your problem may not be over. The cause of the trouble may actually be the sparkplugs—not the cables. I've been told by an engineer at one of the GM divisions that early in the 1984 production run, some defective sparkplugs manufactured by AC made their way into GM engines.

The difficulty that led to the sparkplug problem has since been corrected, but there are still '84 GM engines out there with these plugs, though AC denies that any defective plugs were ever released.

Defective plugs put a great deal of stress on sparkplug cables, which eventually break down. Replacing cables only masks the trouble. So be advised: If the jerking condition reappears, replace the sparkplugs as well as the cables.

Just plain simple

The battery in my 1981 Buick LeSabre went dead recently and was replaced with a new one. Two days later that one went dead, too. The people where I bought the unit recharged it and used their sophisticated equipment to check out the car's electrical system. Everything tested perfectly.

Two days later, the battery died again. I figured that the cause of my problem might be something draining the battery, so I got inside the trunk and had my wife shut the lid. The light stayed on. Problem solved.

So what's my question? Just this: Why couldn't the experts at the battery place find the trouble with all that equipment they use? Sign me Just Plain George (no address given).

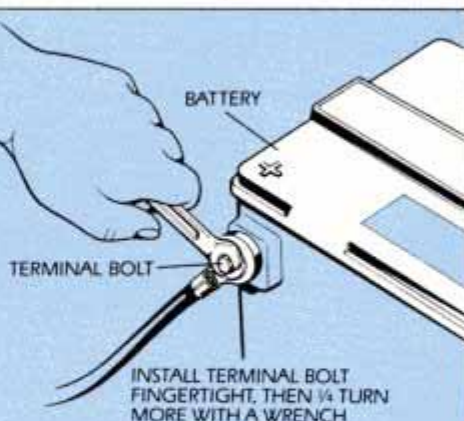
Because the equipment they used either wasn't set to detect, or couldn't detect, the small amount of current

(Please turn to page 26)



I'm on your side

I've received letters from some readers who have installed new side-terminal batteries that failed long before they should have. One fellow describes how, every so often, he has to retighten terminal bolts to get enough juice to start the engine. One reason for this condition is overtightening the terminal bolts to begin with, which cracks the battery case and disrupts terminal continuity. Tightening terminal bolts temporarily restores a



partial reconnection that allows the battery to work.

To avoid this trouble, install side terminal bolts properly. If you have a torque wrench, tighten them to 7 ft.-lb. If you don't have a torque wrench, make them finger tight. Then, give them 1/4 turn more with a wrench.

Ripley's

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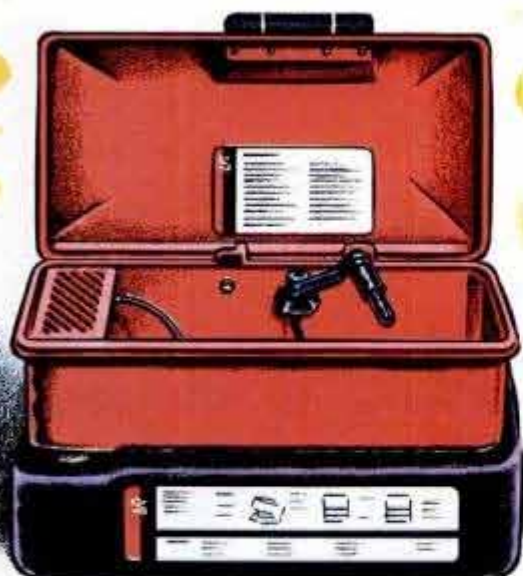
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CAR CLINIC

(Continued from page 24)

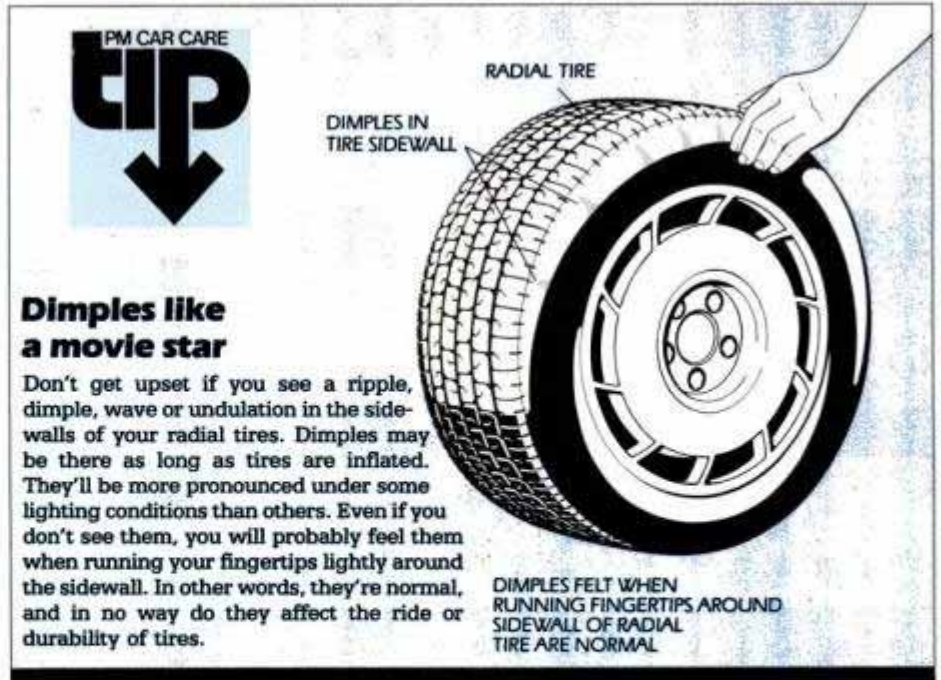
draw caused by the defective switch that was keeping the light on and draining the battery. To my way of thinking, there's nothing like an old-fashioned 12-volt trouble light that costs a couple of bucks to determine if a drain exists.

Be careful of one thing: Some cars have electric clocks that rewind themselves periodically for 60 to 90 seconds. If you do this test while the clock is rewinding, the test light will glow to suggest a drain on the battery.

To use a trouble light, see that the ignition, accessories and lights are off, and that the car doors are shut. Disconnect the battery positive terminal and attach the lead of the test light to it. Hold the test light probe firmly against the battery positive post. If the battery has side terminals, insert the probe into the terminal hole so it's in contact with the plate. If the test light glows, a current drain exists.

Woofing over Sentra

The 1600-cc engine in my 1984 Nissan Sentra stalls badly in cold weather. The dealer replaced the carburetor. No help. Now he wants to replace it again. I think he's barking up the wrong tree.



Dimples like a movie star

Don't get upset if you see a ripple, dimple, wave or undulation in the sidewalls of your radial tires. Dimples may be there as long as tires are inflated. They'll be more pronounced under some lighting conditions than others. Even if you don't see them, you will probably feel them when running your fingertips lightly around the sidewall. In other words, they're normal, and in no way do they affect the ride or durability of tires.

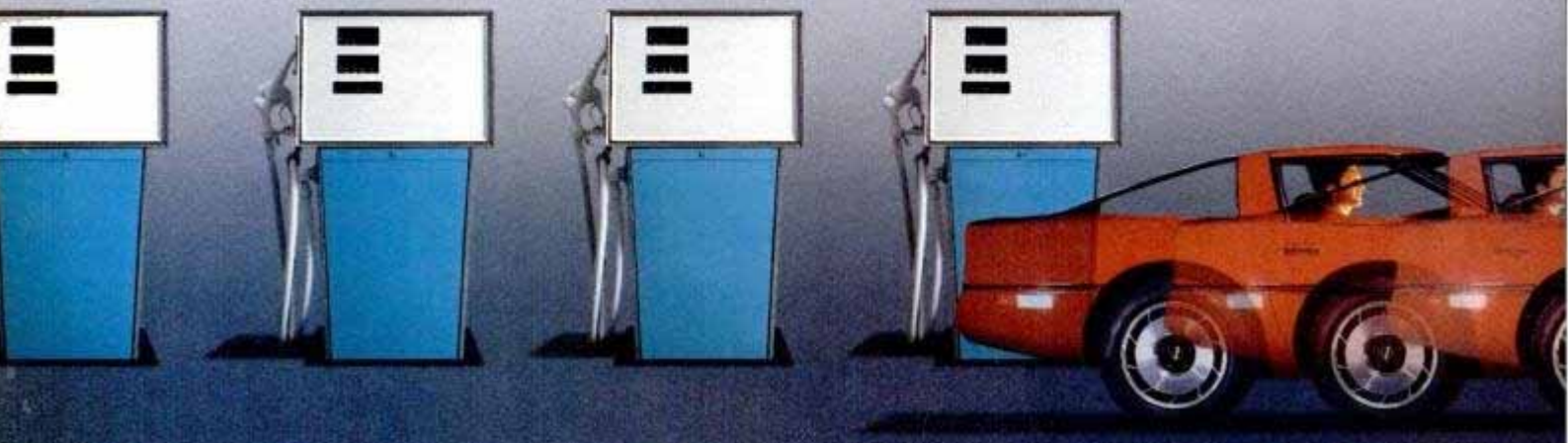
DIMPLES FELT WHEN RUNNING FINGERTIPS AROUND SIDEWALL OF RADIAL TIRE ARE NORMAL

Do you agree?—Simon Beausejour, Rouyn, Canada

I sure do, and I'm really surprised he couldn't come up with the answer. This problem has been so widespread with the 1984 Sentra and Pulsar NX that Nissan issued a technical service bulletin (No. TS84-103 amended by TS85-014) to correct it. Among other things,

the bulletin announces a new sparkplug (NGK No. BPR4ES-09) for use in this engine and the availability of what Nissan calls a countermeasures kit (part No. 24100-34M25 for cars with automatic transmissions and part No. 24100-33M25 for cars with manual transmissions). These kits contain new thermal vacuum valves, back-pressure

Tired of look-alike gasolines?



transducer valves, carburetor enrichment solenoids and several other components. Help your dealer out. Tell him about this bulletin.

Back to basics

I'm having a heck of a time with the 2.2-liter engine of my 1985 Plymouth Reliant when it's cold-started. It will either start and stall, or it will start and idle roughly until it warms up. Then, it runs like a charm. The dealer knows nothing about any technical service bulletins. Help!—Walter S. Piotrowski, Johnson City, NY

He knows nothing about a TSB because there is none. But whoever said that all problems are covered by service bulletins? If I were you, I'd check the following:

■ **Fast idling speed:** Is it too low? Tell the dealer to make the adjustment according to instructions in Section 14 of the service manual.

■ **Choke shaft:** Is it bent? If so, then the choke can't close.

■ **Choke vacuum kick:** Is this part pulling the choke plate open to the specified setting? If it's pulling the choke plate open too much or not enough, the fuel mixture will either be too lean or too rich, respectively. In either case, a problem of the sort you're having would result. Depending on the part number

of the vacuum kick, the setting is .040-, .055-, .060-, .070- or .080-in. Tell your dealer to check the service manual (Section 14).

In search of stickum

As you probably know, the 1981 Ford Escort had a problem with carburetor jets that loosen. This results in rough idling. A service bulletin has been issued that tells how to solve the condition by treating jet holders with a special adhesive. I'm capable of making this repair myself, but my dealer is uncooperative. He beats around the bush when I ask for the name of the adhesive. Can you tell me?—Kevin Cardiff, Baltimore, MD

Sure can. It's Loctite Threadlocker No. 242. There are other Loctite Threadlockers you can use—271 and 640, for example—but I suggest using 242 since it's a medium-strength adhesive. Write Sales Dept., Loctite Automotive and Consumer Group, 4450 Cranwood Court, Cleveland, OH 44128. Refer to this article. The people there will help you. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ Steering-wheel shimmy in Nissan cars equipped with alloy wheels is not normal. One reason for the problem is a front-wheel off-center condition that's addressed in TSB TS85-009. The bulletin gives precise instructions for mounting wheels and emphasizes that alloy wheel nuts must be tightened to 70 ft.-lb. using a torque wrench.

■ Ford says rattling or squealing from the engine compartment of a 1983-84 Escort or Lynx may be caused by a loose or broken crankshaft pulley attaching bolt. The repair, which is covered in TSB 84-24-5, calls for installing a new attaching bolt (part No. E1FZ-6A340-A), which is identified by an M stamped on the bolt. Also, replace the pulley (part No. E2FZ-6A312-A) if it's broken.

■ The 2.3-liter engine in a 1985 Ford Ranger has an unusual way of being primed if it's drained of fuel. If you run out of gas and can't restart the engine, turn the ignition key on for five seconds, then off for five seconds. Repeat this 20 times. Now if the engine doesn't start after 15 seconds of cranking, repeat the key on/key off cycling procedure.

■ The word from GM is that you don't have to put up with rough idle and low-speed performance problems from a 1984 J-car 1.8-liter turbo engine. Replace the computer PROM with part No. 1227176 for a manual transmission—part No. 1227175 for an automatic.

Turn your car into an SU 2000® performer.

Try Shell SU 2000® Super Unleaded gasoline. It's different enough to be patented. It has a high-octane formula designed for smooth, quiet power. And it fights critical engine deposits that can cause knock. For all the performance your car has to offer, try high-octane Shell SU 2000 Super Unleaded gasoline.





Bob Uecker,
"Mr. Baseball"

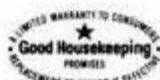
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Rust Magic® brush-on paint with RP-2 is for big jobs. Use it on any metal in or around your house—metal tool sheds, stairs, mailboxes, lawn furniture—wherever rust is a threat.



Rust Magic brush-on paint.
Not even the leading national brand provides tougher,
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DETROIT LISTENING POST

Even more aero T-Bird coming



'87 Thunderbird's smooth silhouette will move it into Camaro/Firebird styling territory.

As if the current slippery Ford Thunderbird wasn't doing enough damage to the competition on NASCAR's high ovals, Ford has an even slicker version up its sleeve for 1987. Not an all-new model, the face-lifted Bird will feature a new, more rounded nose and a bubble-glass hatchback, similar to the ones found on the Capri and EXP. Headlights will be flush aero models, à la the Mark VII.

Engine options will include a new 230-hp turbocharged 3.8-liter V6. By '88, Ford should have a much lighter 2.5-liter 16-valve Four that will produce at least as much power thanks to a turbo and intercooler. Other racy features will include 3-position shocks, 4-wheel disc brakes, speed-sensitive power steering and fat 245/50 radials on 16 x 8 wheels. Come '89, there'll be an all-new Bird.

Caddy Allante snapped

Spy shot of the 1987 Cadillac Allante 2-seater with body by Pininfarina shows a close resemblance to the Mercedes-Benz 380SL and the newly introduced Subaru XT coupe, which must be a



PM PHOTO BY BARRY PENFOUND

Allante 2-seat convertible with hardtop on looks a lot like Mercedes-Benz 380SL.

great shock to the Cadillac people. The convertible will be powered by Caddy's 4.1-liter aluminum V8, mounted transversely and driving the front wheels. Powertrain and chassis parts will be shared with the '86 Eldorado and downsized '85 Fleetwood. Pininfarina will handcraft the bodies in Italy, then air-freight them to Detroit, accounting for part of the rumored \$30,000 to \$50,000 price tag. Annual production will only be 6000 to 8000 cars.

Low-buck ABS

Antilock braking systems (ABS) will be the next technical innovation to sweep the auto industry. Audi, BMW, Mercedes and Lincoln already offer it on at least some models. For 1986, Cadillac Eldorado, Pontiac 6000 STE, Ford Mustang SVO and Chevrolet Corvette will add ABS. The only viable systems so far are from Bosch and Teves in Germany, and are as complex and expensive as you'd expect.

Lucas, the British supply company, has developed a low-tech 2-wheel system that uses belt-driven modules on the front-drive axles instead of high-priced electronics. Ford will have an exclusive on the system for its first year. The Lucas setup costs around \$400, roughly half the price of the 4-wheel electronic systems. But that's not cheap enough for GM Chairman Roger Smith, who has reportedly ordered engineers at the Delco-Moraine brake division to come up with a \$200 system that can be made standard equipment across the board on GM cars. So far, the slide rule boys have it down to \$375, and counting.

Backstopping Shel

As previously reported (*DLP*, page 18, June '85), Carroll Shelby has developed a 16-valve cylinder head and 4-wheel-drive system for Chrysler. Perhaps dissatisfied with ol' Shel's work of late, Chrysler has introduced some friendly competition by engaging Lotus to do the same thing and Maserati to develop yet a third 16-valve head design for the Mopar Four.

Small car, small price

Hyundai will shoot for an out-the-door price of \$5000 for one model when the South Korean subcompact goes on sale in the U.S. early next year. The new front-drive model will be called the Excel, and should not be confused with the rear-drive Hyundai Pony now sold in Canada. The bodies have been designed by Ital Design, the engine by Mitsubishi. In 1987, Mitsubishi dealers will also sell the Excel. There will be three versions—3- and 5-door hatchbacks and a 4-door sedan. All are expected to have AM/FM stereo, rear-window defoggers and a multiyear warranty standard.

GM limiting guzzlers

If you've made up your mind to buy a GM car that gets less than 27.5 mpg, get your order in soon. GM's decided to limit production of cars or engines that don't comply with the government edict on fuel economy, rather than pay a gas guzzler fine for failure to comply with the law. If that happens, there will be a waiting list for low-milers. And when there's a waiting list, dealers usually up the price. GM and Ford have been lobbying to have the mileage rule changed and it's likely there will be some reinterpretation of the law to get them off the hook. But even with an easing of the rules, GM will limit availability of low-mileage big cars and V8s in favor of force-feeding smaller cars and more economical engines in '86 to improve its CAFE (corporate average fuel economy).

Chrysler upsizing

Chrysler has bids out for tooling a new line of upsized J-cars. When's the last time you heard of Detroit bringing out bigger cars? They will be 6-passenger jobs. Chrysler hasn't said so, but the upsizers will replace the last of the

(Please turn to page 31)

Amazing New Third Brake Light Can Save Your Life

by Patrick Killeen

Introducing one of the most fully tested safety devices ever to reach the market.

Gov't approved Mandatory for 1986

Ten years of stringent government tests prove that the third brake light mounted at eye level reduces rear-end accidents by over 53%. The government is so amazed with these test results they are demanding all 1986 cars be equipped with this new third brake light. (These cars will be introduced in September of 1985.)

The NHTSA (National Highway Traffic Safety Administration) believes the third brake light is the biggest safety breakthrough in the history of the agency. Agency estimates predict that this light will prevent 900,000 rear-end collisions a year and 40,000 personal injuries a year. And when accidents do occur, tests show that personal injuries are reduced. Car damage and repairs are also reduced by almost 60%.

Here's why it works

Because it is mounted at eye level, the brake light is bright and easy to see. Also it will shine through your window and directly into the eyes of the drivers in the second and third cars behind you. Lastly, since the light comes on only when you brake, it can't be confused with turn signals or tail lights.



Amazing results — your chance of a rear-end accident is reduced by over 53%.

The Third Brake Light comes on only when you brake, so it can't be confused with turn signals or tail lights.

Reduce rear-enders

Our brake light is the cheapest insurance in town. It can prevent painful whip-lash injuries, remind tail-gaters to back off, and gives the driver behind you better depth perception, day or night.

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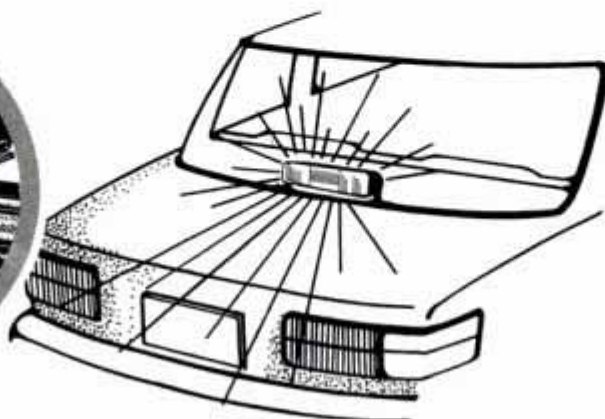
This light meets all FMVSS (Federal Motor Vehicle Safety Standards) including Federal Standard #108. It's available for use in your car now. Check with your insurance company. Many are offering discounts for these lights.

Be first to experience safer driving — it could save your life.

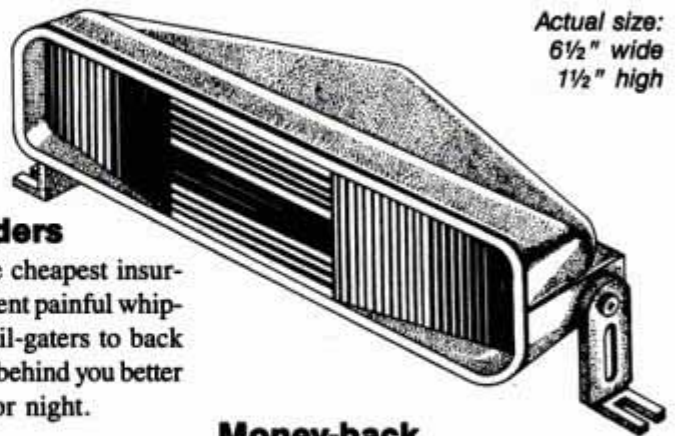
It's easy to install

The eye level brake light mounts inside your rear window — like the new cars, where it is protected from weather, car washes, body damage and theft.

We offer two assembled models — one for cars with red rear turn signals and one for cars with amber rear turn signals. Pivoting legs (with leg extensions) make it adjustable to fit all sedans, hatchbacks, station wagons and pick-up trucks. Good instructions and snap-on wire connectors make this a job you can do with a screwdriver and pliers in just 20 minutes.



Mounted at eye level, the third light is easy to see.



*Actual size:
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1½" high*

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Order today

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 Please send me 2 or more brake lights at \$19.95 each. SHIPPING IS FREE.

2 models:

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_____ For cars with amber rear turn signals (most foreign cars)

Check MasterCard/VISA COD

Card # _____

Exp. Date _____

Name _____

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DETROIT LISTENING POST

(Continued from page 29)

company's rear-wheel-drive vehicles. Chrysler is in good shape on meeting the law on gas mileage, unlike GM and Ford, and has stored up enough CAFE mileage credits so it can develop larger cars. The new full-sizers might be ready by fall of 1988, but are more likely to appear the following year.

Bargain sheetmetal

Smash, bang, crunch! You have an accident and the insurance company tells you to get three estimates, then have the car repaired by the low bidder. What you don't know when you get it back is whether the replacement sheetmetal is original equipment (OE) or a pretty good imitation of OE. As long as it fits and blends in with the rest of the car, who cares if it's OE or SE (something else)? But if you're going to keep the car awhile, you should care.

There's some off-brand, no-brand sheetmetal from Taiwan and Korea that sells for a half to two-thirds the price of Detroit metal. But the steel is thinner gauge and rusts out four to five times faster than Motown metal.

The car companies are in a stew over this because when a non-OE section rusts out, it's the carmaker who takes the rap. Take the competition to court? No, because the lookalikes aren't sold as the real article, so there are no grounds for charging counterfeiting. Detroit's trying to convince insurance companies to alert the car owner if a vehicle is repaired with other than OE metal. Only trouble is, the insurance companies don't care if your car rusts out, because they only have to pay for the original repair.

Corvette giveaway

Want a classic car, but don't have the time to shop around and then restore one? Corvettes @ Carlisle '85 Flea Market will give away a 1965 Corvette convertible with the rare 425-hp, 396-cu.-in. engine, factory knock-off wheels and side exhausts, complete with hard and soft tops.

All you have to do to be eligible is to be at the Carlisle Fairgrounds, Carlisle, PA, on Sunday, Aug. 25, ask for your



Rare, all-original 425-hp '65 Vette could be yours as a door prize if you act fast.

POPULAR MECHANICS • SEPTEMBER 1985

chance at the gate and hang around for the drawing. There's lots of Vette stuff to see, do and buy from Aug. 23 to 25. Admission is \$2 per day. Children under 12 free. For more information, call (717) 243-7964.

Longer warranties?

How do you make the point that Detroit has finally caught up with Japan on quality, assuming that's true? How about a 10/100 guarantee? That is, a 10-year guarantee against rust penetration and 100,000 miles on the engine without an overhaul.

A Chrysler insider claims those goals

aren't more than two years away. And if Chrysler does it, you can bet the other guys won't be far behind.

Naming names

Chrysler says its P-car replacements for Omni/Horizon will be named Plymouth Sundance and Dodge Shadow. More expensive than the Omni/Horizon, they'll go on line in two years.

John De Lorean is looking for a bankroller to revive his stainless-steel sports car. If he finds the funds, he'll have to go to court to use his name on the car. Detroit creditors claim rights to the name and design. **PM**

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Then wash it down with a couple of gallons of water.

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VANTAGE PERFORMANCE COUNTS.

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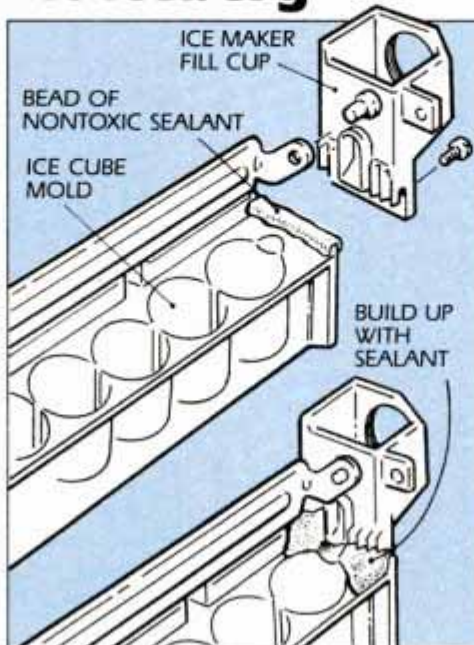
Refrigerator makes iceberg

I have a Hotpoint frost-free refrigerator-freezer, model No. GTE-918KD, serial No. SE509099. The ice maker either leaks or overflows, allowing water to run into the ice cube container below, where it freezes into an iceberg. I had the ice maker unit replaced several years ago, but this has not helped much. Can you suggest a remedy?—J.W. Melton, Houston, TX

It sounds as though you have either a leaking seal in the ice cube mold or a water leak at the back of the ice maker where the fill cup attaches. The first thing to do is check the ice cube bucket to determine the area of the leak.

If the leak is near the back of the ice maker, the ice buildup will begin at the rear of the bucket. Also check for either white or yellowish stains or a mineral deposit at the rear of the ice maker. If these are present, water probably is leaking between the fill cup and the rear of the ice cube mold.

To correct this problem, first disconnect the water fill tube. Then remove the ice maker from the freezer compartment by loosening the two screws at the top of the unit that attach it to the wall of the freezer. Lift the ice maker up and off the screws, and unplug the ice maker's electrical cord from its connection on the freezer wall. Place the ice



Water leaking between the ice maker fill cup and the cube mold causes ice buildup in the container below. Remove the fill cup and seal with a nontoxic silicone sealant.

maker on a table, then remove the two screws at the rear that hold the fill cup to the ice cube mold. Remove the fill cup and carefully brush away any mineral deposits.

Dry the area well, then spread a

heavy bead of nontoxic sealant (such as G.E. Product 361, silicone household glue and seal) on the rear edge of the mold. Reinstall the fill cup, then apply additional sealant to form a dam at the fill-cup front.

Build up and shape the corners tight against the fill cup. Allow the sealant to dry several hours before reinstalling the ice maker in the freezer.

Water leaking or forming icicles from the center of the ice maker mold probably means you have a mold seal leak. To replace the mold seal, you need to remove and partially disassemble the ice maker. And, you have to purchase an ice maker seal kit, G.E. part No. WR29X119, which costs about \$7.

You'll also need two special tools, one to remove a retainer washer which holds the seal in place in the mold, the other to install the new retainer washer after the seal has been installed. The seal-removal tool, part No. WX5X294, costs \$9.50; the seal-installer tool, part No. WX5X260, costs \$9.

Both of these tools are available through any authorized G.E. appliance parts distributor in your area. The ice maker seal kit, in addition to the necessary repair parts, includes illustrated instructions showing the step-by-step installation procedure.

Not-so-hot dryer

Perhaps you can help me revive my Whirlpool gas dryer, model No. W6107600W. The dryer won't get hot. I had the burner checked and it works fine, but it burns for only a short while. Bypassing the 165° safety thermostat in the upper chimney of the combustion chamber allows the burner to reach proper operating temperature. I installed a new 165° thermostat in its place, but the same thing happened—the burner cut off too early. As soon as I bypassed the new safety thermostat, the burner worked well. Is there a higher cutoff thermostat I can substitute?—R.D. Opdyke, Pittsburgh, PA

The safety thermostat with the 165° cutoff is the correct one for the burner of your dryer. Don't replace it with a higher temperature thermostat.

Your problem is more likely a low airflow through the drum. One possible cause for this is a worn rear drum seal.

This would dilute the heat in the drum and keep it below 165° even though the blower is turning at full speed. To check the seal you need to raise the dryer top. The seal is a felt band that encircles the rear outer edge of the drum. The felt should touch the rear bulkhead with a light contact all the way around.

Another possibility is a lint buildup in the air passages, restricting airflow through the dryer. Check for blockage in the duct from the blower to the lint filter, and in the exhaust tubing that leads to the outside.

The last area to check is the blower assembly. Disconnect the belt from the blower pulley. Spin the pulley by hand. It should move freely. There is a bearing on the blower shaft with a lubricating oil wick that requires occasional lubrication. If the wick is dry and the pulley binds, add a few drops of 20-weight nondetergent oil to the wick and turn the pulley until it moves freely.

Lube job for oven door

The oven door spring assembly on my Whirlpool range, model No. RYE4760-WZ, serial No. MK32460627, makes a squeaking noise. I can get the door apart but don't know what to use as a lubricant. I'm guessing that any petroleum product such as oil or WD-40 will smoke at high oven temperatures.—Billy Tarpley, Cotton Plant, AR

Whirlpool has a high-temperature grease designed for noisy or sticking gas valves. It will withstand the high oven temperatures, and should silence your oven door. The grease, part No. 261582, costs about \$6 and can be ordered through any Whirlpool parts distributor in your area.

PM

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

30 Ways To Help You Qualify For A Job That Pays More Money!

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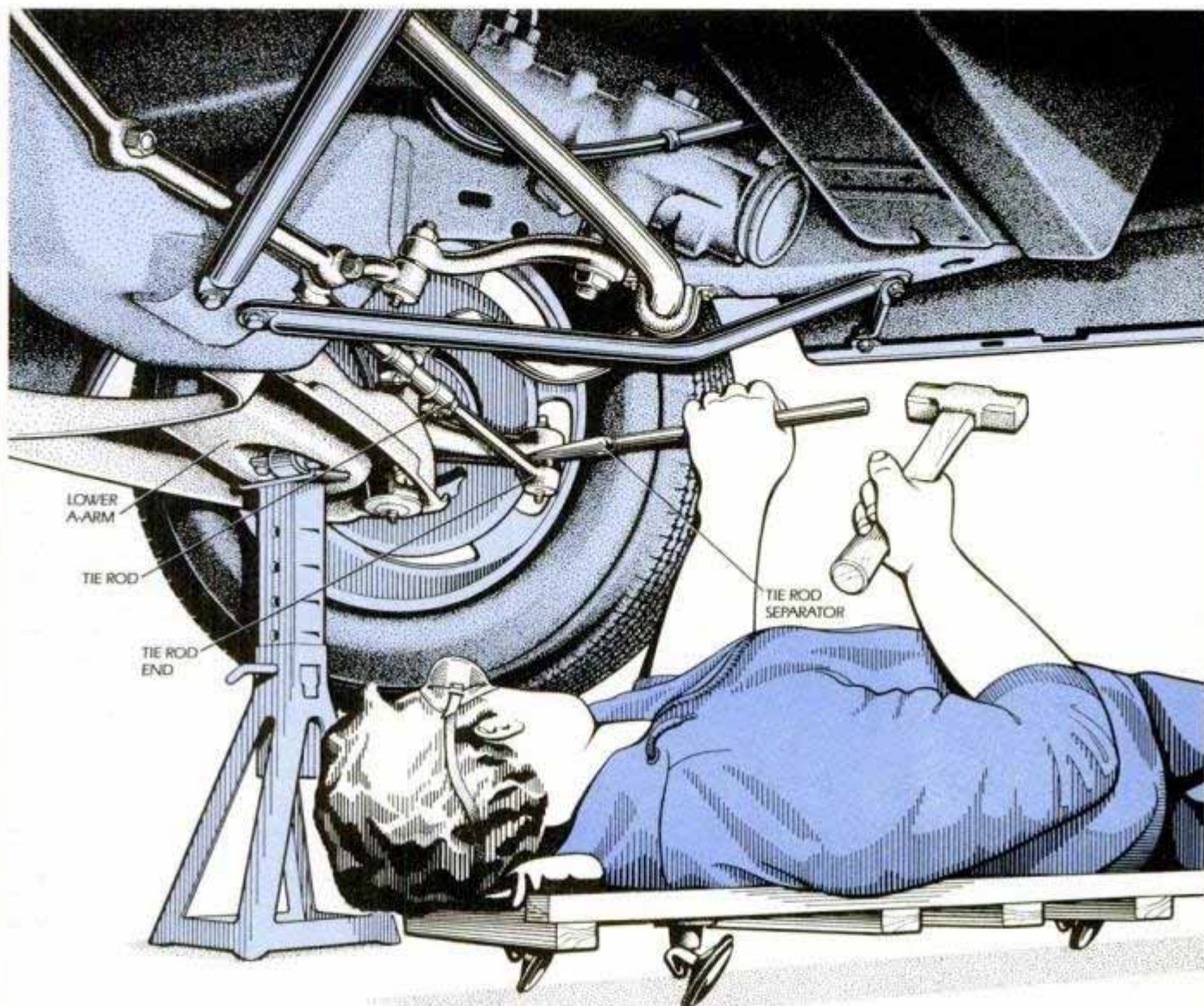
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REPLACING BALL JOINTS

Front suspension rebuilds include servicing tie rod ends, ball joints and the idler arm for a complete steering-system renewal.

BY PAUL STENQUIST

A lot of Saturday mechanics are afraid to attempt steering linkage and chassis component repairs, thinking that these are jobs better left to a professional mechanic. Actually, they're among the easier jobs that the driveway technician might attempt.

On the following pages, we'll tell you how to diagnose and replace faulty ball

joints, tie rod ends, idler arms and sway bar components. Since steering angles can change significantly when new components are installed, a professional front end alignment will be a necessary procedure after ball joint or tie rod end replacement.

Diagnosing front end problems

You should suspect front end problems if your front tires wear abnormally, if your mechanic says he can't align your front wheels because steering linkage parts or ball joints are too loose, if you hear clunks when you turn the wheels or corner, if there seems to be excessive free play in the steering mechanism or if you experience wheel shimmy and/or vibration.

To confirm a suspected chassis part

problem, you're going to have to spend some time under the greasy side. Before raising the car with your hydraulic floor jack or scissors jack, chock the rear wheels and apply the parking brake. Raise the car and locate jack stands in the recommended positions on the frame or frame/body structure. Lower the car until it is resting on the stands, leaving the floor jack in place for additional security.

Examine your steering linkage and front suspension. Most rear-wheel-drive cars use parallelogram linkage—a center link, two tie rods, an idler arm and a Pitman arm (see Fig. 1). This steering linkage is usually used with a coil spring mounted on the lower or upper control arm. Some cars with upper and lower arms have torsion bars

in place of coil springs. Most front-drive and some rear-drive cars are equipped with rack and pinion steering. The steering arms on the wheel spindles are joined directly to the steering rack by a pair of tie rods. The idler arm and Pitman arm are not used. Most front-wheel-drive cars and a few rear-drivers have only lower control arms. A MacPherson strut replaces the spring, shock absorber and upper arm.

Checking ball joints

While cars with MacPherson struts have only one ball joint at each wheel, those with parallelogram steering linkage usually have both upper and lower ball joints. But the two joints don't wear out at the same rate, since only one ball joint carries the full load. If the coil spring is mounted on the lower control arm, the lower ball joint is the load carrier (Fig. 2). If the spring is mounted

on the upper arm, the upper joint is the load carrier. When checking joints for wear, check the load carrier first. If it's okay and has never been replaced, you'll probably find that the unloaded joint is okay as well.

Before you check for wear, inspect the rubber seal of each ball joint. If it's torn, the joint must be replaced.

If your car has wear-indicator ball joints—as many produced after 1973 do—checking them is a simple matter. Before checking the joints, the car must be lowered to the ground or its wheels must be resting on ramps.

Most wear-indicator joints have a collar that protrudes from the lower surface of the joint and encircles the grease fitting (Fig. 3). As the joint wears, this collar sinks below the surface of the joint, indicating that replacement is necessary.

A second type of wear-indicator joint is used on some vehicles, including late-model Chryslers. On this type joint, you merely attempt to wiggle the grease fitting (Fig. 4). If you can move it with your hand, the joint is worn out.

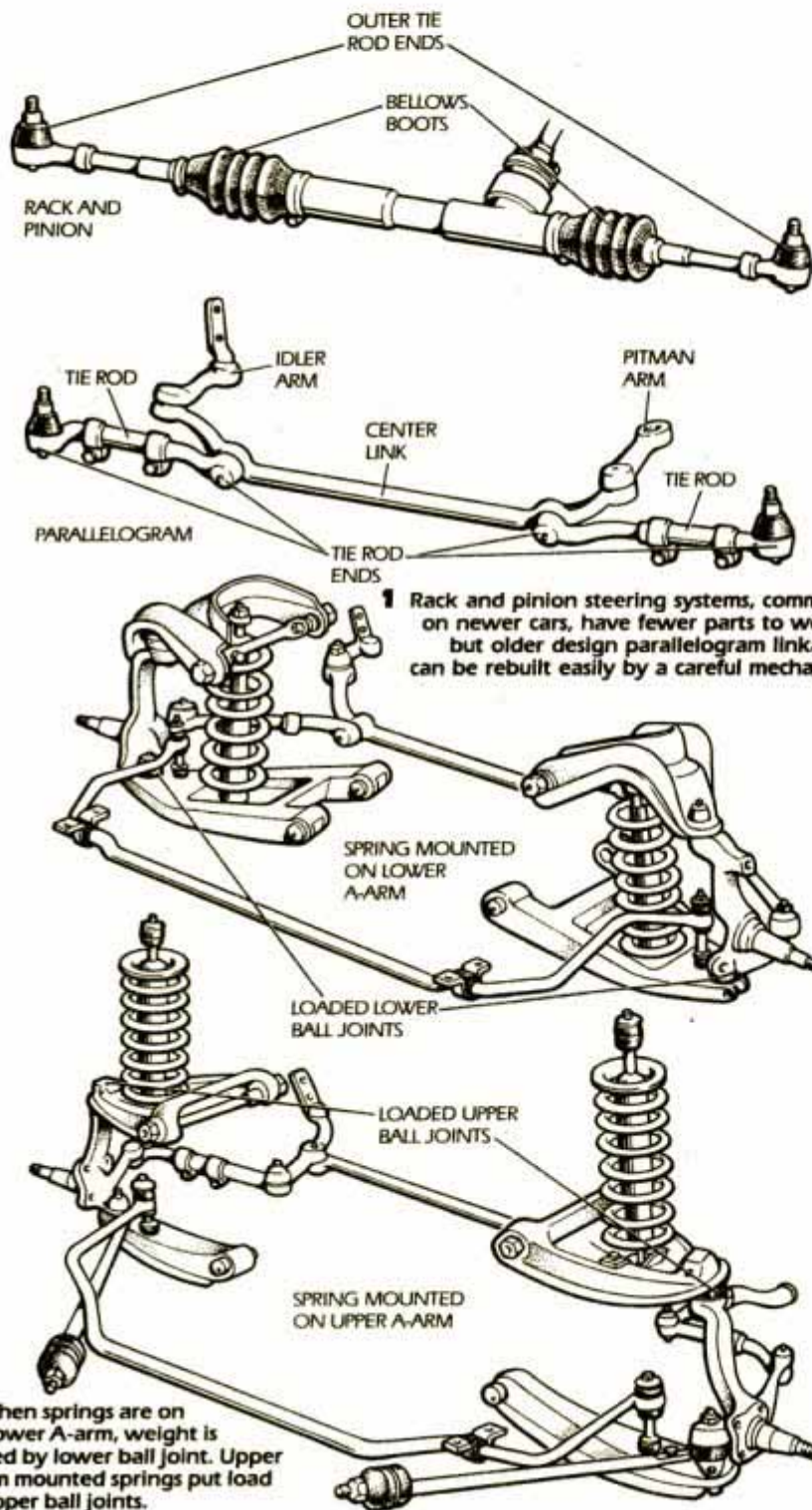
If your car does not have wear-indicator ball joints, you'll have to measure free play with a dial indicator or check it by feel.

The ball joints of most front-wheel-drive cars that are equipped with MacPherson struts should be checked with the wheels off the ground and the car supported on jack stands. Grab each wheel at the top and bottom and shake it in and out while watching for movement of the steering knuckle relative to the ball joint. Any noticeable movement is grounds for replacement.

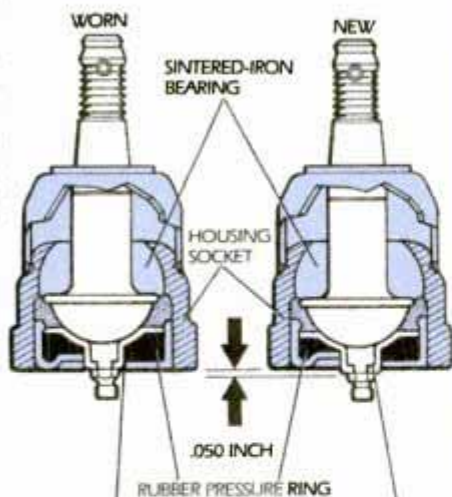
To induce movement in a loaded joint, relieve the load. If your car has loaded lower joints (spring on lower arm), lift the car and relocate the jack stands under the lower control arms, as close to the ball joints as possible.

If your car has loaded upper joints, wedge a block of wood between each upper control arm and the frame, with the wheels resting on ramps or with jack stands under the lower control arms. Then lift the car, locate the jack stands under the frame and lower the car to rest on them.

Ball joints are excessively worn if they permit too much sideways movement (radial play) or up and down movement (axial play). To measure axial movement, mount a dial indicator so that its stem rests against the bottom surface of the spindle assembly (knuckle). The stem should be parallel to an imaginary line that runs through the center of both ball joints. Insert a pry



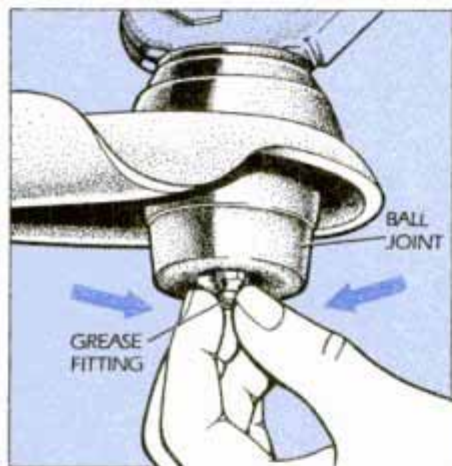
2 When springs are on the lower A-arm, weight is carried by lower ball joint. Upper A-arm mounted springs put load on upper ball joints.



WHEN COLLAR RETRACTS BELOW THIS SURFACE, BALL JOINT MUST BE REPLACED

WEAR INDICATOR (OUT WHEN NEW)

3 Wear-indicator ball joints show condition by position of grease fitting shoulder.



4 Other wear-indicator joints reveal their condition by wiggling the grease fitting.

bar between the bottom of the tire and the floor and lift the wheel. Watch the indicator to see how much movement the joint permits. The figure should be less than the tolerance listed in your service manual.

To check radial movement, mount the indicator so that its stem is in contact with the edge of the wheel and perpendicular to the wheel. When checking an upper joint, the indicator should be located at the top of the wheel. For a lower joint, locate it at the bottom of the wheel. Push the wheel in and out and watch the indicator. (Make sure that any motion is not the result of incorrect wheel bearing adjustment.) Radial movement maximum is 0.25-inch, at the edge of the wheel.

Checking rod ends, idler arms

For most cars, there are no specific procedures for checking tie rod ends

and idler arms, but a little common sense is all that's needed. For the driveway technician, the most practical way to check the four tie rod ends of a car with parallelogram steering or the two outer rod ends of a rack and pinion system is to simply grab the tie rods and shake them vigorously. The tie rod ends should not be sloppy or loose. Rod ends must be preloaded, but even a brand new one allows some horizontal movement. A good joint should show little or no vertical movement. Missing or torn dust boots are also grounds for replacement.

To check an idler arm, push the end of the arm that is attached to the center link up and down. It should show little or no vertical movement.

Examine the bellows boots that cover the inner tie rod ends of rack and pinion cars for cracks, splits or other physical damage. If they're not in good condition, replace them. On cars with power rack and pinion, fluid in the boot can be a sign of leaking seals. Manual racks with lubricant in the boot are normal.

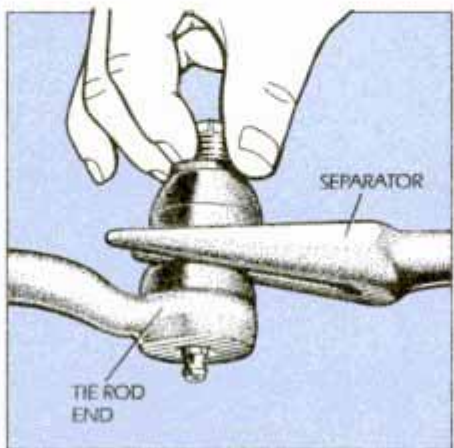
To check the inner tie rod end, squeeze the bellows boot and feel around for the rod end. With one hand on the rod end, push and pull on the tire. If the rod end seems to be loose, it should be replaced.

Checking sway bar components

A loose sway bar will make a clunking noise every time you turn or hit a bump. Check the bushings and links that join it to the control arm and the bushings that secure it to the frame. If any are worn, broken, deteriorated or missing, they must be replaced.

Ball joint replacement

You'll need a ball joint separator—a wide-slot pickle fork—to replace ball joints on any car. For cars that have

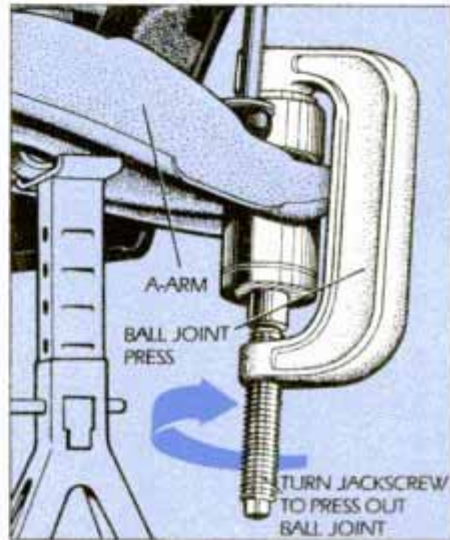


5 To prevent boot tearing, insert separator carefully between rod end and dust boot.

press-in type joints, you'll need a ball-joint press as well. This tool can usually be rented from the parts store when you purchase the new ball joints. Some Chrysler and Ford models have joints that are secured by rivets, so you'll need a good chisel to service these cars. The ball joints used on front-wheel-drive Fords and many Japanese imports cannot be removed. If joints are worn, replace lower control arms.

If you're not sure how the ball joints in your car are attached to the control arm, consult your service manual before attempting the job.

To replace load-carrying lower ball joints on most cars, loosen the lug nuts on both front wheels, and lift the vehicle with your floor jack. Place a set of

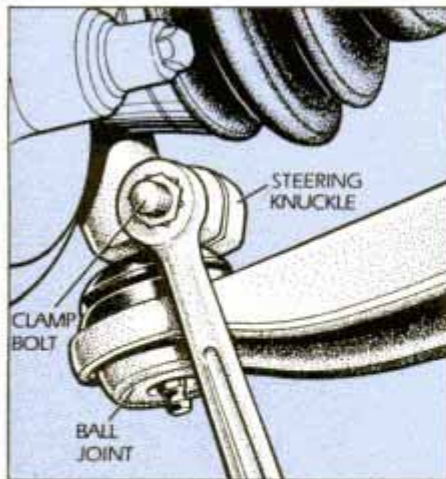


6 A screw-type ball joint press is required for servicing many GM and Chrysler cars.

jack stands under the frame and remove the wheels. Lift the car, remove the stands from under the frame and relocate them under the lower control arms, as close to the ball joints as possible. Lower the car until it is resting on the stands.

Disengage the tie rod ends from the steering arm using a tie rod end separator or narrow pickle fork (Fig. 5). Insert the pickle fork between the rod end and its rubber boot so that you won't tear the boot when you knock the rod end off the steering arm. If you tear the boot, replace the rod end. A more expensive jackscrew-type separator is used for releasing rod ends that will be reused. This tool won't tear the boot.

Make sure that the lower control arm is firmly supported by the jack stand, then remove the cotter pin from the ball-joint retaining nut and unscrew the nut. Reinstall the nut approximately three turns, then insert your ball-joint



7 On many front-drive cars, ball joints are retained in the knuckle by a clamp bolt.

separator between the steering knuckle and ball joint and hammer it in until the joint is disengaged from the knuckle. Unscrew the nut. If you can't unscrew it by hand, the jack stand is not supporting the control arm. Once the joint is completely disengaged from the knuckle, lift the knuckle and upper control arm assembly clear of the ball joint and support them.

If you're working on a car with pressed-in joints, install the ball-joint press on the joint and control arm, following the directions included with the press (Fig. 6). Then, tighten the jackscrew on the press until the ball joint drops out of the control arm. Inspect the tapered hole in the steering knuckle and remove any dirt. If the hole is out of round, the steering knuckle assembly must be replaced.

Once you're sure the knuckle is okay, reverse the press, and, using the appropriate adapters, install the new joint. Torque the nut to spec and install the cotter pin. Don't back off the nut to insert the pin; tighten it a bit more.

On cars with riveted joints, simply chisel the rivet heads off after disengaging the ball joint from the steering knuckle. Be careful not to damage the control arm with your chisel. Inspect the steering knuckle as described above. Then install a new joint, using the bolts that came with it.

A third type of joint, much less common than the other two, has a threaded body and screws into the control arm. It can be removed with a large socket and breaker bar. The new joint must be torqued to spec.

The replacement of load-carrying upper joints is similar. A block of wood is wedged between the upper control arm and frame to relieve the load on the joint so it can be removed. If you're unable to support your upper control

arm in this manner, check the service manual for specific instructions.

The replacement procedure for non-load-carrying upper joints is approximately the same as that for lower joints. Because the rivets used to hold many upper joints are on top of the control arm, you may not be able to reach them with a hammer and chisel. If this is the case, drill them out from below, using a 1/8-in. drill bit. Drill right in the center of each rivet to a depth of about 3/4-in., then drive the rivets out with a punch or drift.

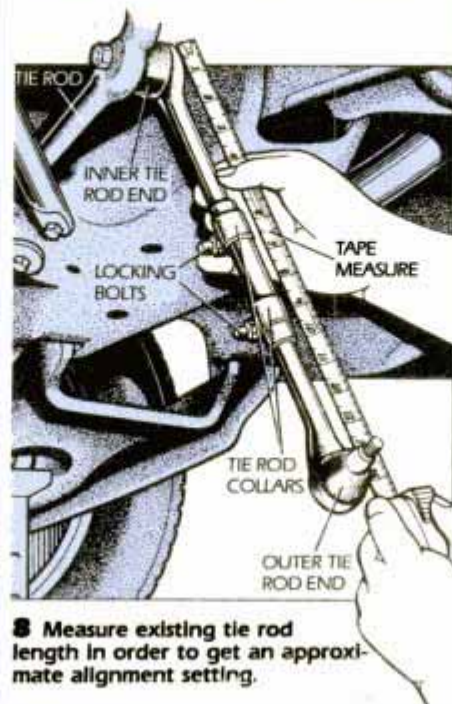
To replace joints on most front-wheel-drive cars with removable joints, unscrew the clamp bolt that secures the ball-joint stud in the steering knuckle and disengage the joint from the knuckle (Fig. 7). You might have to tap it out with a mallet. Then, chisel off the rivets that secure the joint to the control arm or, on cars with pressed-in joints, remove and replace them with a ball-joint press.

Replacing tie rod ends

A separator is needed for tie rod end service. Make sure you get a pickle fork with a narrow slot between the tangs.

To replace any of the four tie rod ends on a car with parallelogram steering linkage or an outer end on a car with rack and pinion steering, remove the nut that secures the rod end to the steering arm or center link. In most cases, you'll have to pull a cotter pin from the nut before you can loosen it. In some cases, you may find that the rod end is secured with a locking nut. Locking nuts cannot be reused.

Separate the rod end from the center



8 Measure existing tie rod length in order to get an approximate alignment setting.

link or steering arm by driving the pickle fork in between the rod end and its mount. On cars with parallelogram steering, measure from the center of the tie rod's other end to the center of the rod end you plan to replace and record this figure (Fig. 8). Then, loosen the locking bolt on the tie rod collar and unscrew the faulty rod end.

On cars with rack and pinion steering, measure from the center of the outer rod end to the boot-retaining groove on the inner rod end, then unscrew the rod end.

Install the new tie rod end and screw it in until the rod length is equal to the measurement you recorded earlier. This will give you an approximate toe setting that will allow you to drive the car to an alignment shop.

Several types of inner tie rod ends are used on cars with rack and pinion steering. Procedures vary significantly, so consult your service manual.

Replacing an idler arm

To replace a worn idler arm, remove the cotter pin and nut or the locking nut that secures it to the center link. Then, use your tie rod end separator to disengage it from the center link. Unbolt the bracket that joins the idler arm to the frame. On some cars, you'll have to access the nuts through holes in the frame. Install the new arm, tightening the retaining bolts to 35 lb. or the spec provided in your manual. Check the taper on the center link for damage before reattaching it to the arm.

Replacing sway bar bushings

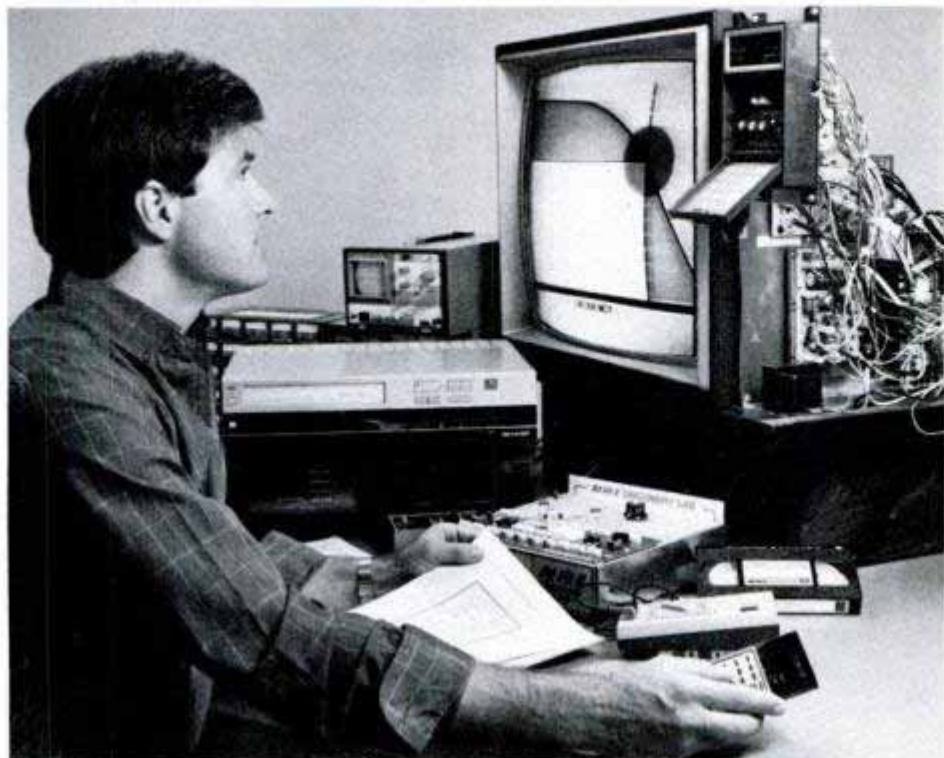
To remove a typical sway bar link, hold the bolt head on one end of the link and remove the nut from the other end. Once the nut is off, remove the link and worn bushings and install the new parts. On most applications, the bushings are installed above and below the sway bar and the control arm. A washer backs up each bushing.

Repeat the procedure on the other side, then remove each frame-mount bracket and replace the rubber bushings that surround the sway bar. If you don't find any bushings when you remove the brackets, the old ones probably deteriorated and fell out. If this is the case, you've located the source of an annoying clunk.

Don't forget that an alignment check is essential following the replacement of tie rod ends or ball joints. Also, chassis parts are only part of the handling and steering equation. Equally important are the vehicle's ride height, springs and shocks, tires and steering box.

PM

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THE PM GARAGE



Convertible pickup cover



Collapsible cap slides on aluminum rails to allow tall loads (top) or lockable storage space (inset).

Cover caps for pickup truck beds always seemed like a good idea to me, but they can be a compromise. In place, they won't allow me to load tall cargo. Stored in the garage, the truck lacks secure storage space.

Slide-A-Top is a collapsible bed cap that gives you the best of both worlds. When extended, the nylon-reinforced vinyl shell provides a lockable, water-

proof covering for the cargo load. Glass windows in the front of the cap and the rear door assure total visibility.

One person can easily extend or collapse the top and a pair of tension rods keeps the material taut in the extended position. Cost is \$495 from R.S. Stephens Associates, 4117 Causeway Drive, Lowell, MI 49331.—N.S.M.

Original jerrycans

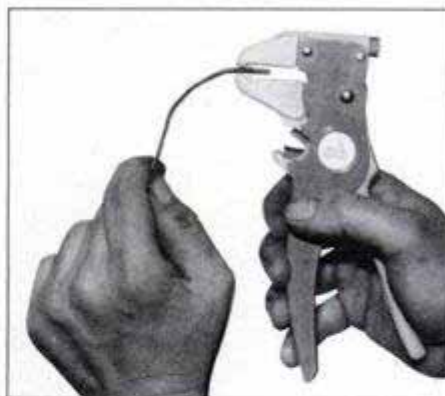
Gas cans don't last long in my garage; either they develop a leak or I forget them at the boat dock. Here's one I'll keep my eye on, though, because it carries a 5-year guarantee against failure. Built in Germany by the company that made the original military gas cans, this is a fully welded 20-liter container. Flexible spouts snap onto the handle for storage. The cans cost \$29.95 and spouts are \$9.95 from East/West Creations, 1626 N. Wilcox, #428, Hollywood, CA 90028.—W.H.



Super-duty gas can carries 5-year guarantee.

Strip, please

Everyone knows the conventional wire stripper with a separate slot for each size wire, and I've seen types with a single set of jaws that automatically adjusts for different thickness wires. But I never saw one that worked well, until I tried a new stripper with an



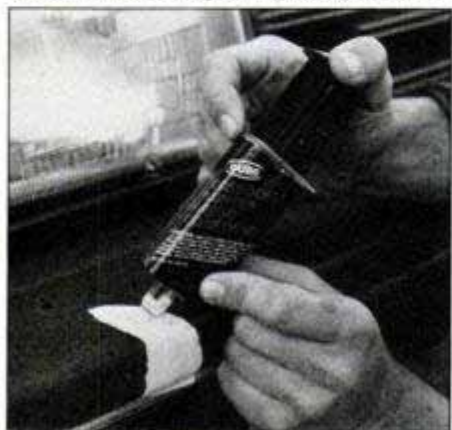
Trick strippers will skin 12- to 22-gauge wires with a quick squeeze of the trigger.

adjusting knob to broaden its range.

One setting worked on 12- to 22-gauge wires. Just put the end of the wire between the jaws, squeeze the trigger and it both cuts through the insulation and pulls it partly off the wire—very nice indeed. It also has a built-in wire cutter. The tool lists for \$9 from S&G Tool-Aid Corp., 43 E. Alpine St., Newark, NJ 07114.—Pete Warren

Put on a happy face

Soft bumpers and urethane fascias take lots of abuse. But sooner or later, some klutz comes along and gives your car a



Easy Does It bumper repair kit fills nicks and gouges in flexible bumpers and fascias.

good whack, at which point you discover it costs big bucks to get your bumper fixed. Not anymore.

Here comes Duro's Easy Does It bumper repair kit, which includes simple instructions plus everything you'll need to put your bumper, fascia or rubber strips back in condition. The two-gun repair compound fills nicks and chinks like body putty but stays flexible. There's no need to remove the entire bumper assembly for the repairs. You even get black dye in the kit but you'll have to supply your own paint if your car's soft parts are body color. Easy Does It costs between \$9 and \$10. The bumper strip grip adhesive is made by Loctite Corp., Automotive and Consumer Group, 4450 Cranwood Court, Cleveland, OH 44128 and is available at most mass merchandisers and also at jobber shops.—M.L.

"TEXACO'S NEW FORMULA HAVOLINE CHALLENGES THE WORLD'S MOST EXPENSIVE MOTOR OILS"

—BOB HOPE



Do you have to pay the high price of synthetic motor oils like Mobil 1 or Amoco Ultimate to get the engine protection your car needs?

Check out these facts.

Both the expensive synthetics and Texaco's Havoline Supreme 10W-30 give you the quality protection demanded by these industry yardsticks:

Both exceed carmakers' warranty requirements for virtually all gasoline-powered cars. Both meet or exceed industry standards in helping prevent wear, keeping engines clean, saving gasoline, and protecting against rust.

But only Havoline comes without the high price. And that you can check out wherever Havoline is sold.

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If all oil stains
protect, what
happened here?

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All stains start out protecting. But soon their ability to repel water wears thin. Even the leading oil base brands start letting water soak in, breaking down the natural beauty of your wood.

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Under accelerated durability tests, Cuprinol repelled water significantly longer than Olympic's best water repellent stain. Detailed results available upon request.



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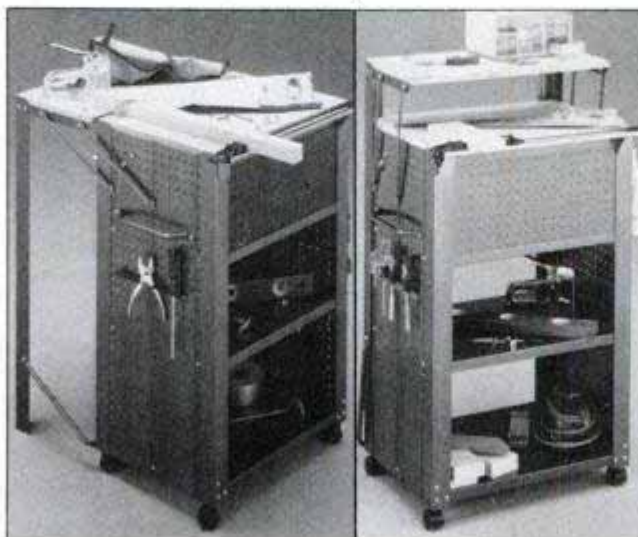
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THE PM WORKBENCH



Wheel-about workshop

Gain additional storage and work space in your shop or garage with the Job Cart portable workcenter. This compact, rollabout cart has a 16 x 22-in. particleboard worktop and features a swing-down shelf that extends the work surface 11½ in. The shelf can be locked in the raised position when not in use or to create a 2-tier workbench. A handy bar clamp is built into the top for securing workpieces.



Space-saving mobile workcart has a swing-down shelf that extends the work surface to 22 x 27½ in. (left). When not in use, the particleboard shelf folds up to create a 2-tier worktop (right).

Additional features include an enamel-finished steel cabinet, swiveling casters, two adjustable, reversible shelves, peg-board storage and a hand-tool storage rack. The cart also is useful to model-makers and handicraft enthusiasts.

The Job Cart workcenter is available

at hardware stores and home centers for about \$80. For a complete list of Job Cart dealers in your area, you should write to Cosco Inc., 2525 State St., Columbus, IN 47201.—J.T.

Quick-change adapter

This slip-on drill bit allows boring pilot holes and driving screws quickly without changing bits or using two drills. The Chuck-Mate slips over any ¼-in.-dia. screwdriver bit so its three prongs



slip the drill bit accessory over screwdriver bit to bore the pilot hole. Then pull off the 3-prong accessory and drive the screw.

fit snugly into the spaces between the drill-chuck jaws. To use, simply bore a pilot hole, pull off the Chuck-Mate to expose the screwdriver bit and drive the screw. Chuck-Mates come in various sizes and styles ranging in price from \$5 to \$12. Contact Chuck-Mate, 4476 Forget, St. Louis Terrebonne, Quebec, Canada JON 1N0.

—Rosario Capotosto

Powerful new saw line

Here's some good news for the active do-it-yourselfer in the market for a new portable circular saw. Skil has just introduced four new models to their line of Skilsaws.

The new line includes a 6½-in., 2-hp saw (No. 5125; \$47) and three 7¼-in. saws: the 2½-hp Model 5150 (\$57), 2½-hp Model 5250 (\$64) and the top-



The 7¼-in., 2½-hp Model 5350 circular saw provides plenty of cutting power for the average homeowner. All-ball-bearing motor ensures smooth operation and long life.

of-the-line, 2½-hp Model 5350 (\$86). Each saw features convenient blade wrench storage, a safety lock-off button, calibrated scales and cutting guides and textured, sure-grip handles. For more information, contact Skil Corp., 4801 W. Peterson Ave., Chicago, IL 60646.—J.T.

A lot of hot air

Calling the Leister Ghibli hot-air tool a heat gun is like calling the Space Shuttle an airplane. This industrial-duty tool is designed to fabricate, weld and repair thermoplastics. But beyond welding plastics, the tool has innumerable uses around the home and shop, such as removing paint and varnish, solder-



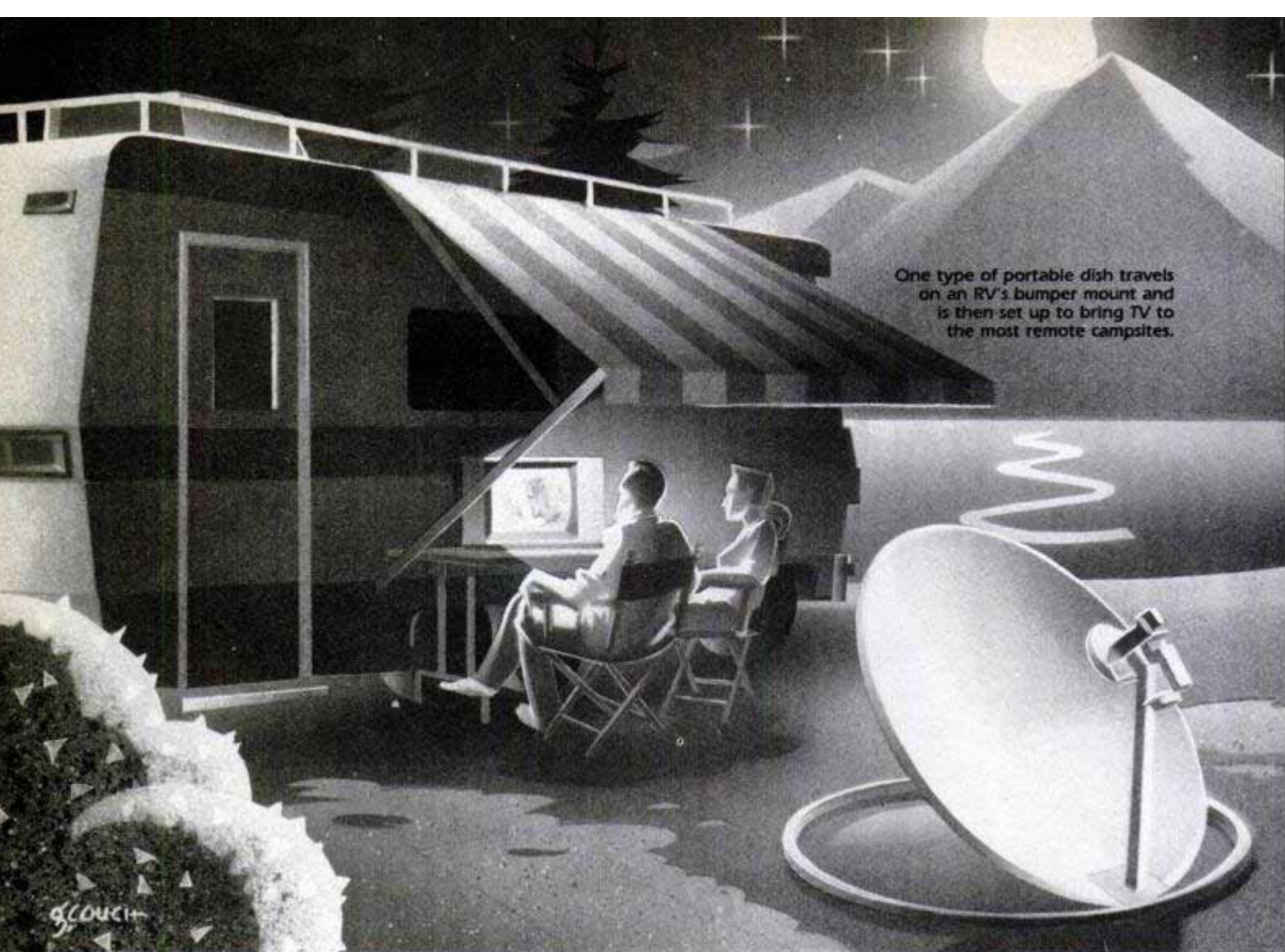
A wide variety of nozzles and reflectors are available for specialized work (above). Use a 5-mm-dia. nozzle to weld plastics (left). The tool has adjustable heat and air-flow control.

ing, stripping wallpaper, curing and softening adhesives, thawing frozen pipes and drying, shrinking and melting various materials.

The electronically adjustable blower has a temperature range from 68° to 1112° F. and comes with a standard 5-mm-dia. nozzle. It costs \$297. For details, contact Brian White Co., 313 Henry Station Rd., Ukiah, CA 95482.

—Rosario Capotosto

If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.



One type of portable dish travels on an RV's bumper mount and is then set up to bring TV to the most remote campsites.

Satellite TV Hits The Road

New downsized dishes for motor homes let you tune in when you pitch camp.

BY FRANK VIZARD
Illustration by Greg Couch

Nearly a million American households now enjoy more than 100 channels of TV entertainment received through large satellite dish antennas planted in their backyards. The latest development in this exciting technology lets owners of motor homes take their favorite satellite programs on vacation.

With a dish antenna mounted on roof or bumper, the TV set in your motor home will always have a picture. No matter how many miles you put between yourself and civilization's nearest transmitter tower, you'll never drive beyond range of the nearly 20 birds that beam movies, sports, news and music to the North American continent.

Dish antennas designed for a stationary installation have diameters as large



Typical roof-mount antenna—this one is a TravelSat dish—is deployed for reception.

as 12 feet. The bigger the dish, the more signal it can collect from more satellites. This is especially important if you live on the coasts, because satellite signals are strongest at the geographic center of the continental United States.

By necessity, the dishes made for motor homes span a manageable 4 to 6



Dish, rotation and elevation mechanisms put great weight on an RV's roof. Wind loading adds stress. Horizontal aluminum bars (above) distribute the burden.

feet. This means you'll have to rough it a bit in the wilds, and scoop your signal from the relatively new generation of high-powered satellites. A handful of these 9-watt and 7½-watt relays have gone aloft in recent years to supplement older 5-watt birds launched when 16-foot dishes were not uncommon.

Even so, you won't lack for programming diversity. For example, up to 24 channels of entertainment are available from the Galaxy I satellite alone, one of
(Please turn to page 50)

OUR SCHOLARSHIP HELPS YOU BEGIN YOUR CAREER AS A LEADING ENGINEER.

An engineering degree will take you far in today's high-tech Army. And with an Army ROTC scholarship, earning that degree can be both less expensive and more valuable.

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It's an excellent scholarship. And it gets you a lot more than an engineering degree. Along with your regular courses, you'll take Army ROTC classes and learn about motivating people, analyzing situations, making confident, informed decisions, and reaching defined goals. In short,

you'll learn leadership and management skills that can't help but enhance your opportunities in the future.

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SATELLITE TV

(Continued from page 48)

the new high-wattage birds. Selections include Home Box Office, Cinemax, The Movie Channel, Showtime, Cable News Network, ESPN (all sports), Black Entertainment Television, Spanish International Network, The Disney Channel and the Nashville Network—and more. Additional high-power birds are scheduled for launch over the next few years, so it's not likely that the mobile dish you buy today will ever lack employment.

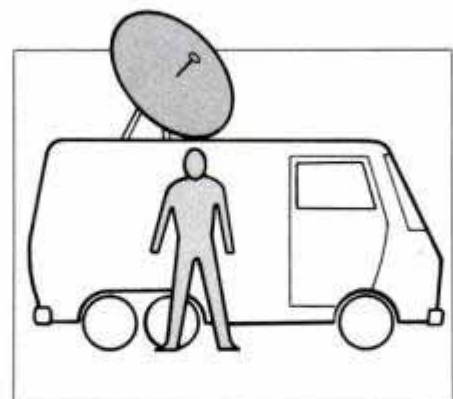
Types of rigs

There are two installation approaches to satellite TV for motor homes. One is the bumper-mounted dish, which you set up on the ground and aim ("sight" in satellite jargon) manually on the satellite of your choice. The second type of dish installation is permanently mounted on the motor home's roof, and sighted by remote control from within the van. The difference between the two is substantial, at least where cost and installation are concerned.

The least expensive approach is typified by the motor-home satellite TV package from Wilson Microwave Systems of Henderson, Nevada. The key element in the Wilson package is a 50-pound dish, 5 feet in diameter. The dish

can be set up manually in a few minutes, and is connected to the satellite receiver inside the van. When not in use, the dish is transported on a bumper mount in the rear.

The price of the Wilson package—dish, support brackets, receiver, and



Besides remote-control sighting, roof-mount dishes have the advantage of height to help see over obstacles such as trees.

additional electronics—is \$1450. A similar package from Aimsat, located in Joplin, Missouri, comes with a 4½-foot-diameter dish and costs \$1100. Aimsat, though, is probably better known for its roof-mount models.

A few days spent deploying and sighting a bumper-mount dish by hand

will let you appreciate the benefits of a rooftop installation. The dish is always in place, and a remote-control device called an actuator enables you to sight the dish by pushbutton while monitoring the results on your television screen. The cost of such convenience is high. Rooftop installations cost about \$3000 with all the electronics included.

Though Wilson and Aimsat supply complete satellite TV packages, companies such as TravelSat of Vancouver, Wash., supply only the dish assembly. This permits you to shop around for the feedhorn, amplifier, actuator and receiver of your choice. Just be sure the gear you choose is compatible. For example, only Chapparral-brand feedhorns can be used with the Travelsat dish. (The Aimsat, TravelSat and Wilson brands are mentioned here because as of this writing, they are the only mobile-dish suppliers who have nationwide dealer networks. It's possible that an independent dealer in your area sells and installs motor-home packages comprised of components he has selected from a variety of dish and electronics manufacturers.)

Installation

Lightweight, bumper-mounted manual systems are tailor-made for the do-it-yourself installer. Assembly's no

S M O

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tougher than putting a ski or bike rack on your car. Roof installations are another matter—but you can trim about \$500 off the cost of a rooftop system by doing the installation yourself.

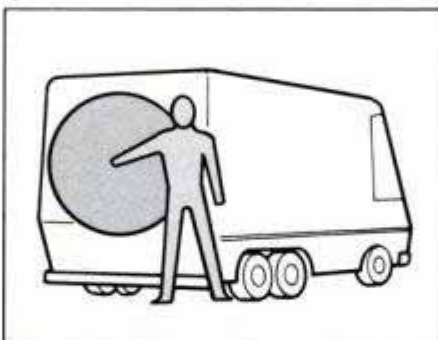
Mounting a dish on the roof of a motor home isn't a one-man job. A 6-foot dish system using Aimsat gear weighs 250 pounds. TravelSat's weighs 115 pounds. Materials account for the difference: Aimsat's dish is constructed of fiberglass while TravelSat's is made of aluminum mesh.

Installing a rooftop satellite system is an all-day job. Figure at least two hours for dish assembly alone if it's a mesh antenna you must construct from grapefruit-like sections. Another three hours will be spent in securing the dish and the motor assembly to the roof.

Although manufacturers supply the basic hardware you'll need to attach the dish and rotating mechanism to your motor home's roof, some suggest installation procedures that go a bit further. The best (read "safest") installations call for a pair of aluminum bars, bolted to the roof as mounting channels for your dish. The bars help distribute the weight and stress more evenly than would be the case if you bolted the dish assembly directly to the roof.

This is very sound advice, when you consider that a dish assembly can

weigh as much as 250 pounds, and will be transported at highway speeds. In fact, some dish and motor home manufacturers say this type of reinforcement is a must for motor homes built before 1982, and for certain pull trailers. The aluminum mounting channels aren't supplied with the dish package, but you



Easy installation and deployment is the strong suit of lightweight, manually sighted bumper-mount dishes. So is price.

can buy them from satellite dish and recreational vehicle dealers. By the way, never attempt to drive your motor home with the dish in anything but the storage position. Even a mesh antenna reacts to wind loading like a solid object at speeds over 30 mph. For this reason, all roof-mount dishes collapse flat to the motor home roof.

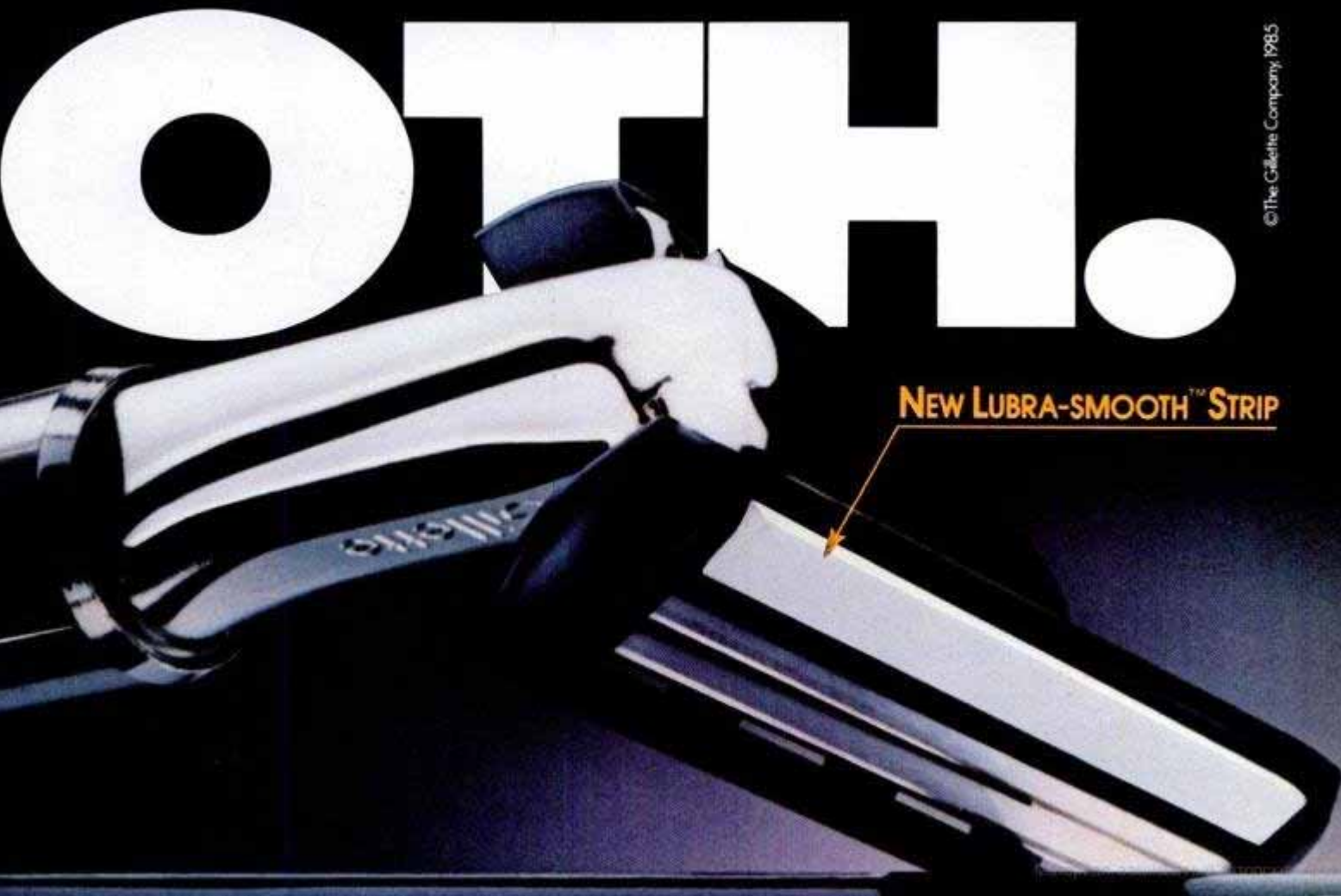
Tuning-in the heavens

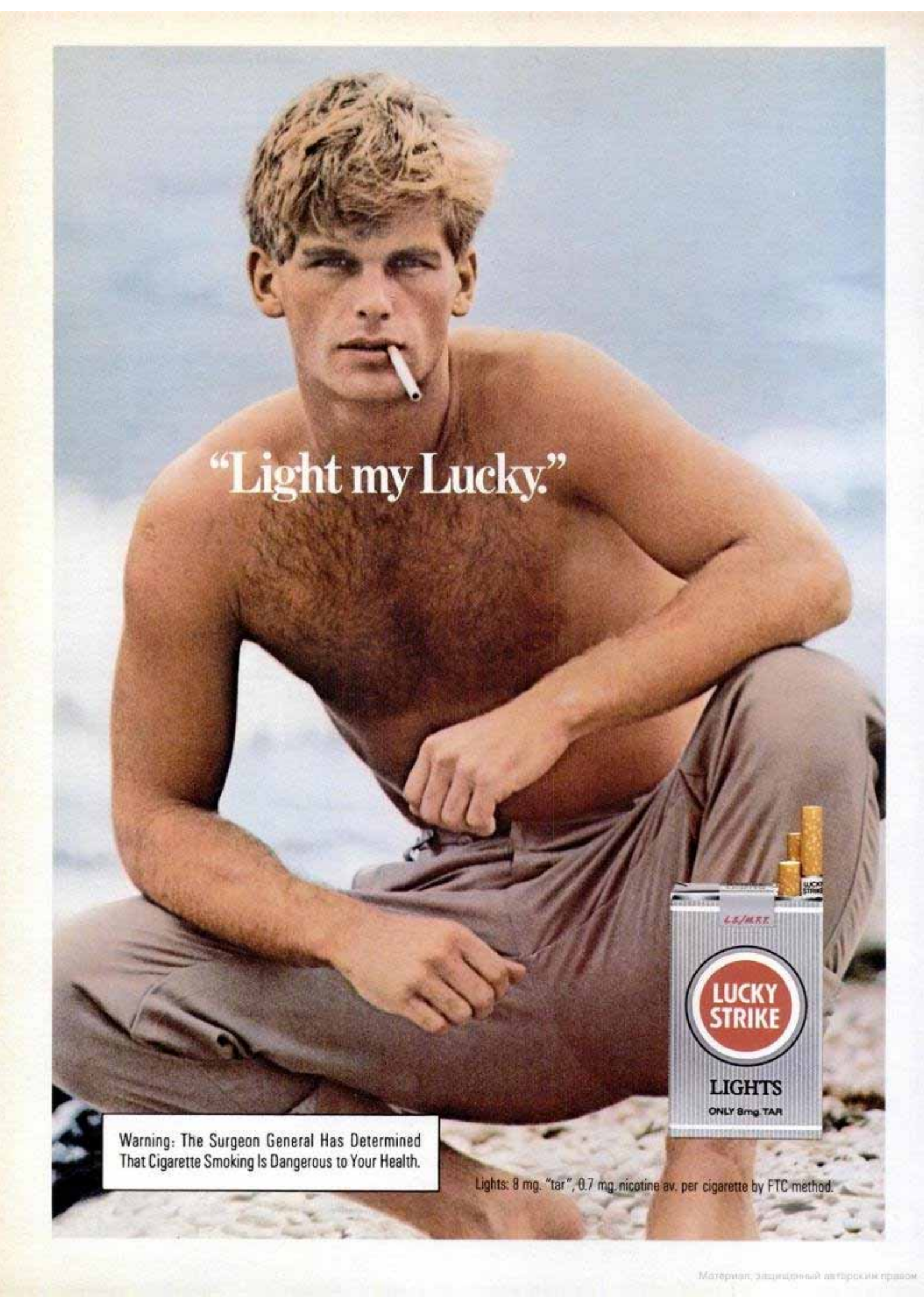
Once your satellite dish is on-line and in the field, scooping the signals from different satellites can make you feel like a starship navigator. For the roving vacationer who is potentially in different territory every evening, an old-fashioned compass broken down into 1° increments is a necessary item.

Actual sighting procedures vary according to the type of equipment you've installed, but the drill required of roof-mount Aimsat users is typical.

To locate a specific satellite you must first take the compass heading of the motorhome dish, and add 160°. Next, add the magnetic deviation for your location, as described in the manufacturer's viewing guide. (If the total is more than 360°, subtract 360°.) This is the number you'll punch into the actuator keyboard—the actuator and dish motor do the rest. If your dish is of the bumper-mount, manually sighted type, you'll get some exercise that you might find welcome after a long drive.

If you're willing to live with the smaller but ample selection of programming from the higher-powered satellites, there are plenty of accessories available to bring the picture to your living room television. With a bit of planning, you can turn a one-dish TV supper into a movable feast. **FM**





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Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

Lights: 8 mg. "tar", 0.7 mg. nicotine av. per cigarette by FTC method.

The perfect-fit door system

Pease Industries has just introduced the first fully adjustable door-frame system that will make door installations quick and easy.

The do-it-yourself system features unique screw-in fasteners called Jamb-Jacks that are used instead of nails to attach the door frame to the rough opening. After positioning the frame in the opening, insert a Jamb-Jack in each of the frame's six prebored holes. Then, screw the Jamb-Jacks into the trimmer studs using a ratchet wrench or an electric drill. Now, simply adjust each fastener, as necessary, to square up the frame. Jamb-Jacks are designed for use on new construction and for remodeling old, out-of-square doorways.



Unique Jamb-Jack fasteners (above, left) are used to attach the door frame to the rough opening. Screw the fasteners to the studs with a ratchet wrench (above, right).



The adjustable door system is available on Pease's Ever-Strait entry door line and Concept hinged patio doors. For further information, you should write to Pease Industries, 7100 Dixie Highway, Fairfield, OH 45014, or call toll-free 1-800-543-1180.

Outdoor furniture kits

Cardinal's ready-to-assemble hardware kits provide an easy, affordable way to build outdoor furniture. Each kit consists of a heavy-gauge tubular steel frame and weather-resistant fasteners. Frame parts have a durable baked-on enamel finish to resist corrosion. Wood parts are purchased separately.



The patio bench and picnic table (each about \$30) shown are only two of the 12 furniture kits available. Other kit pieces include a porch swing, serving cart, end table, patio glider and a variety of benches and chairs.

For information about outdoor furniture kits available, contact Cardinal Home Products, 5185 Richmond Rd., Bedford Heights, OH 44146.



Kits feature bolt-together steel frame.

Double-duty saw

This new space-saving, folding hand saw has two blades—one for cutting wood, the other for metal. A positive, steel locking mechanism holds the blades securely during cutting operations. Both blades fold back into the ABS plastic handle when not in use, making the tool only 6 in. long.

The folding saw (No. 0331) is available at hardware stores and home centers for about



\$15. Replacement blades are available, too. For more information, contact Fiskars Manufacturing Corp., Hand Tools Div., 7811 W. Stewart Ave., Wausau, WI 54401.

Shop insurance

This maximum-protection face mask (\$75) may be the most important piece of equipment in your shop. It combines a full-face shield with a dual-cartridge respirator.

The shield offers eye protection from flying wood and metal chips and irritat-



ing dust particles. The respirator protects against dangerous fumes and vapors produced by paint sprayers, cleaning solvents and wood-finishing products. The disposable cartridges can be changed to offer maximum protection for specific atmospheres. Contact HSC Corp., 107 E. Alexander St., Buchanan, MI 49107.

PM

WORKSHOP MINICOURSE



Using common wood glues

Modern glues for home workshop use have excellent bonding qualities and are capable of making joints stronger than the wood itself. But for good results, you must select the right glue for the job and use it properly.

Common ready-to-use glues that come in plastic squeeze bottles include polyvinyl resin (white), aliphatic resin (yellow) and hide glues. White glue is suitable for use on most porous materials including wood, paper, cloth and cork. Yellow glue is specifically formulated for joining wood. The latter penetrates deeper into the fibers, resulting in a stronger bond, and it will not gum up from heat caused by sanding or sawing. Both types set in 10 to 15 minutes.

For large or complex assemblies, however, a quick-setting glue could prove disastrous—it could dry on some parts before they are clamped together. For these situations, hide glue is the answer. It sets much slower and it has good gap-filling properties, which makes it a good choice for joints that are less than perfectly mated or where a loose-fitting joint is necessary to facilitate assembly.

Plastic resin is a powdered glue that is mixed with water for use. It's very strong and highly water resistant. But when *waterproof* glue is required, resorcinol resin glue is the proper choice. It comes in two parts, a powdered catalyst and a liquid resin. It's strong and it's an excellent gap filler.—Rosario Capotosto



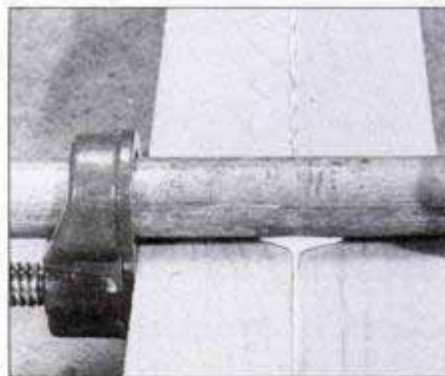
Common workshop glues include (left to right) plastic resin, resorcinol, hide, aliphatic resin and polyvinyl resin.



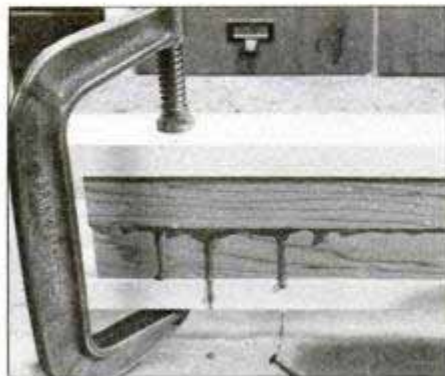
Use hide glue on large assemblies because of long set time. Squeeze out glue, then spread evenly with brush or wood scrap.



Because end grain absorbs glue like a sponge, apply two coats. Let the first sink in and apply the second before first sets.



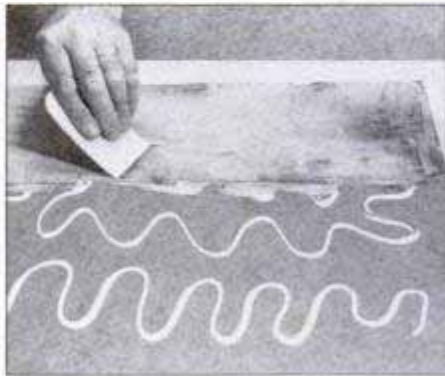
Never allow clamp to touch work surface because a chemical reaction between glue and metal will cause a dark stain in wood.



Excessive glue squeeze-out like this generally indicates too much clamp pressure, resulting in a weak, glue-starved joint.



To remove glue squeeze-out from joint, allow glue to set until surface is dry but still pliable, then shave off with sharp chisel.



Use flexible plastic applicator to spread glue evenly over large areas. Applicators are standard auto supply items for body work.

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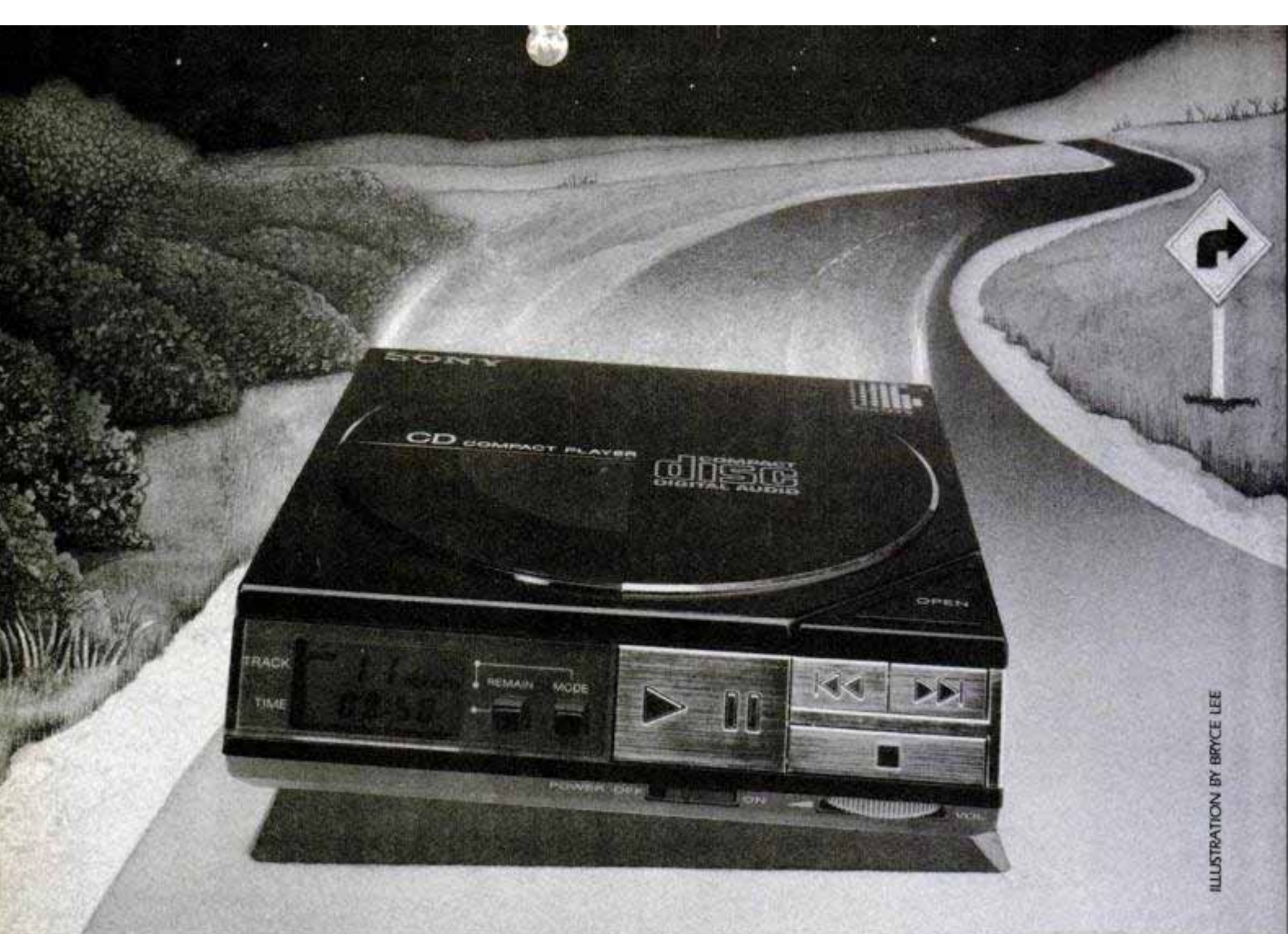


ILLUSTRATION BY BRUCE LEE

CDs GO CRUISIN'

The latest miniaturized Compact Disc players can go just about anywhere. Even for a blast down the freeway.

Want a Compact Disc player that will give you digital sound at home or on the road? For about \$30 in parts, you can adapt Sony's D-5 or the Technics SL-XP7 to your car stereo system.

Each player is a model of portability, measuring about 5 in. square and less than 1½ in. high. Selling below \$300, half the price of car CD players, they're also a frugal way of getting a CD player into your car's sound system.

Versatility is built into these tiny laser audio players. Both run on household wiring to play through home hi-fi systems. Optional carrying cases with batteries provide for headphone listening on the go.

It's the headphone jack and battery connection that let you adapt the D-5 and SL-XP7 for highway hi-fi. Neither player was specifically designed for permanent installation in automobiles. They lack the thermal protection circuits and heavy-duty shock absorbers of specialized in-dash CD

models twice their price. But for temporary, removable hookups, Sony and Technics offer optional adapters that let you power the portable CDs from your car's cigaret lighter. The procedure is similar to the way yesteryear's underdash 8-track and cassette players were installed.

How you connect a portable CD player to your car's sound system will depend on the type of gear already installed. If you've already got a radio/cas-

(Please turn to page 58)



Top: Sony's D-5 is shown only slightly smaller than actual size. Technics SL-XP7, above, is only twice as large as this photo.

BY FRANK VIZARD

What is it?

(Here is a Little Clue.)

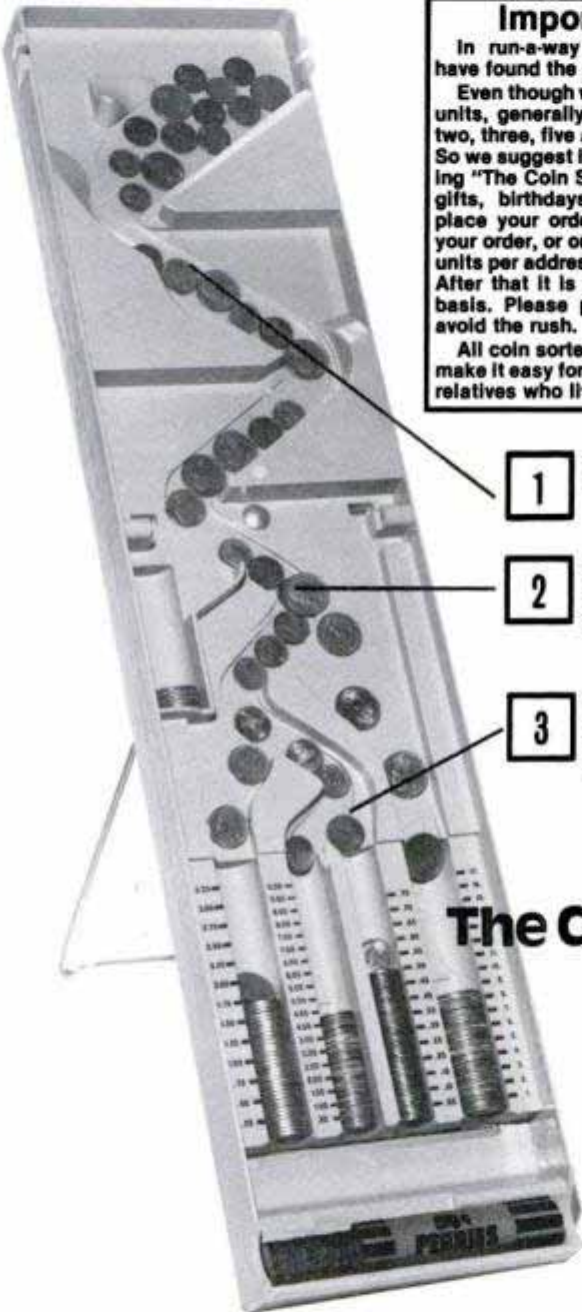
It Counts & Sorts 200 Mixed Coins in 60 Seconds Flat!

Important Notice

In run-a-way promotions like this we have found the supply does NOT last long.

Even though we have ordered one million units, generally our customers will order, two, three, five and even 10 units at a time. So we suggest if you are considering ordering "The Coin Sorter" for yourself, holiday gifts, birthdays, or Christmas that you place your order now. We will guarantee your order, or orders, will be filled, up to 10 units per address, for the next 30 days only. After that it is on a first come first serve basis. Please place your order today to avoid the rush.

All coin sorters are individually boxed to make it easy for shipment to your friends or relatives who live out of state.



1

Toss in all your loose change at the top of the unit.

2

As the pennies, nickels, dimes, quarters and half dollars start to flow down the shoot they will amazingly take different routes.

3

The coin sorter then responds with 100% accuracy and each and every coin is put into its proper tube.

Do you know how much loose change you have laying around the house right now? It may be in old coffee cans, jelly jars, in the back of your bedroom chester drawers, or who knows where. Well I'll tell you, I didn't know and I was completely amazed to find that I had over \$150 dollars just laying around that I was too lazy to count.

But now, life is a lot easier with "The Coin Sorter." Instead of spending my entire Sunday afternoon counting and sorting change, I do it all in minutes just after I come home from work at night.

Here's How It Works

To use the coin sorter, you simply place a handful of mixed coins at the top of the unit. As the pennies, nickels, dimes, quarters and half dollars start to flow down the shoot they will amazingly take different routes. The coin sorter then responds with 100% accuracy and each and every coin is put into its proper tube. It even goes so far as to separate your Susan B. Anthony Dollars from your 25¢ Quarters.

The Coin Sorter is a revolutionary way of saving you hours of time separating, counting and wrapping coins to take to the bank.

We Were Impressed

Quite frankly, we were so impressed with the coin sorter that we gave the manufacturer an order for one million units. We felt with major purchasing power we could pass along the savings to you. The manufacturers suggested retail price of \$34.95 was too high. So we decided to offer it to you for \$9 while they last.

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CDs GO CRUISIN'

(Continued from page 56)

sette player hooked up to a separate outboard amplifier, you're in luck. If not, now's the time to add one—you'll want extra power for a CD.

Normally, your radio/cassette player (head unit) is connected directly to the amplifier. But when you add a CD player, your amp has to know which of the two music sources to amplify.

This is accomplished by routing the output from the CD player and the head unit to a selector switch or 4-pole double-throw relay. The relay, in turn, is

wired directly to the amp. A toggle switch for the relay, easily installed on the dashboard, lets you choose either CD or head unit for playback through the amp and speakers. The relay and toggle switch are inexpensive parts available from Radio Shack and other electronics stores.

Connecting your head unit to the relay is easy enough: Simply disconnect the head unit's wires from the amp and connect them to the relay. A complimentary set of cables running from the relay marries the head unit to the amp.

The relay will provide for another set of cables to route the sound from CD

player to the amp. But to connect the CD player to the relay, you'll need two accessories.

The first is a stereo cable with RCA plugs. One end connects to the relay permanently, the other is left hanging under the dash so you can plug the CD player in and out.

The second accessory is a stereo signal splitter, sometimes called a Y-adaptor. One end has a stereo mini-plug that attaches to the headphone jack on the CD. The other end has RCA-type connectors. These mate with the underdash cable that runs to the relay.

The Y-adapters that come with the Sony and Technics players have male RCA plugs for connection to home hi-fi systems. So if the relay cable is male also, you'll need a double-ended female adapter to make the match. For convenience's sake, leave the mini-to-male splitter at home and get a mini-to-female for the car. This way you'll eliminate excess connections, and you can leave the cables behind when you remove the CD player from the car.

Other connections

If your amplifier has separate input for extra sound sources, you won't need the relay and switch to connect CD and head unit to the amp. In this case, simply use the CD player's Y-splitter (and extension cables, if needed) to patch into the amp directly. But be careful: Never run the CD and head unit at the same time.

Also, make sure you take the output from the CD player's headphone jack when connecting to an amplifier. This enables you to use the CD's volume control to adjust sound levels. Mini-CD players also have line-level output jacks, for connection to a home hi-fi system. You can use the line-level outputs in a car system—and dispense with the relay/switcher setup—only if you have a radio/cassette head unit with auxiliary input jacks for external source units.

Besides volume, this type of head unit lets you control the CD player's tone, left-right balance and, in the case of 4-speaker installations, front-rear balance. (When connecting a CD player directly to an amplifier you sacrifice tone and balance control.) At this writing, Concord's HPL-520 offers input jacks. Other manufacturers, notably Jensen, Nakamichi and Soundstream, plan to offer similar head units that make it easy to patch in a CD player.

Where and how you place the mini-CD player in your car depends on your ingenuity. Ideally, you want to situate the player to minimize movement, shock and vibration. A homespun bed made from foam rubber and cut to fit the console or transmission hump should do the trick nicely. **PM**

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	<i>Greater pressure means quicker response.</i>				
Bore diameter ¹	40.0 mm	34.9 mm	34.9 mm	+14.6%	+14.6%
	<i>Larger diameter means more damping power.</i>				
Monotube construction	yes	no	no	Gas-a-just eliminates aeration	
	<i>Monotube construction eliminates aeration for better performance.</i>				

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¹Source: Competitive advertising *Approximately

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SUSPENSION

A CENTURY OF PROGRESS

100 YEARS

The battle to control wheel hop and shimmy led to shock absorbers, then to computerized suspensions.

BY MORT SCHULTZ; Illustrations by Pat Ruggero

A renowned British surgeon, who had been knighted by Queen Victoria, was convinced of a direct relationship between sound health and driving a car. Dr. William Thomson's observations were made in a 1901 edition of the *Journal of Medicine*:

"I have found my drives to improve my general health," Sir Thomas stated. "The jolting which occurs when a motor car is driven at fair speed conduces to healthy agitation that acts on the liver. This aids the peristaltic movements of the bowels and promotes the performance of their functions."

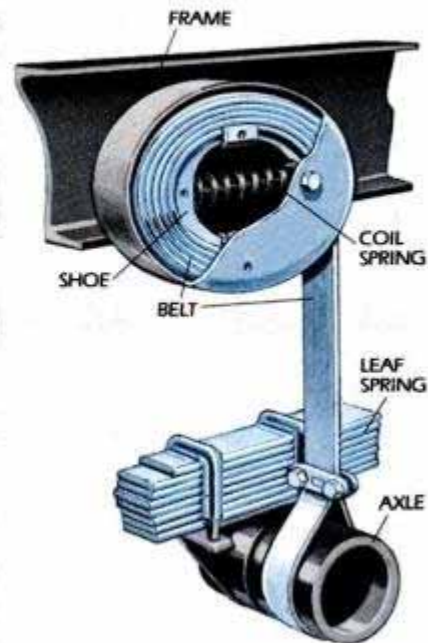
Manufacturers of cars either didn't

read Sir Thomas's report or didn't care for his views, because soon afterward they began using shock absorbers to suppress vehicular jolting.

Since early motor cars were limited to much the same speed as carriages, leaf springs for them could be made of the right proportion to provide relatively jolt-free rides. As roads were improved and speeds shot up, a 1909 edition of *Automobile Engineering* noted:

"When springs are made sufficiently stiff to carry the load properly over the small inequalities of ordinary roads, they are too stiff to respond readily to

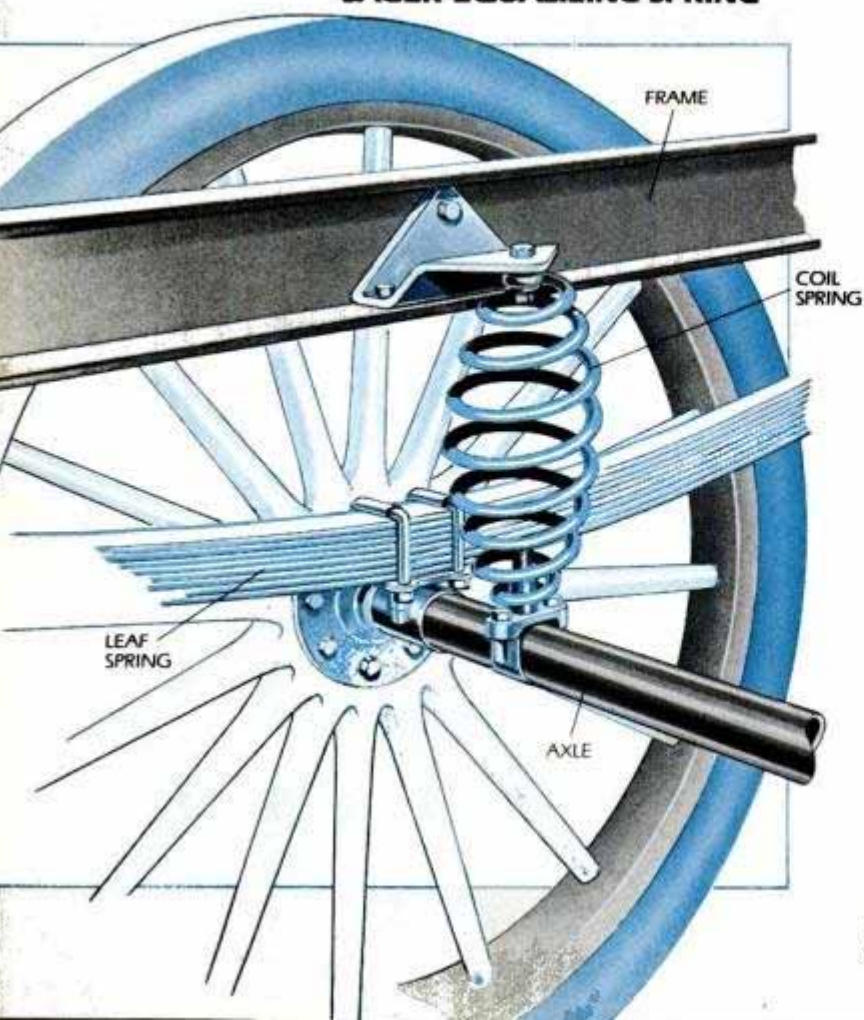
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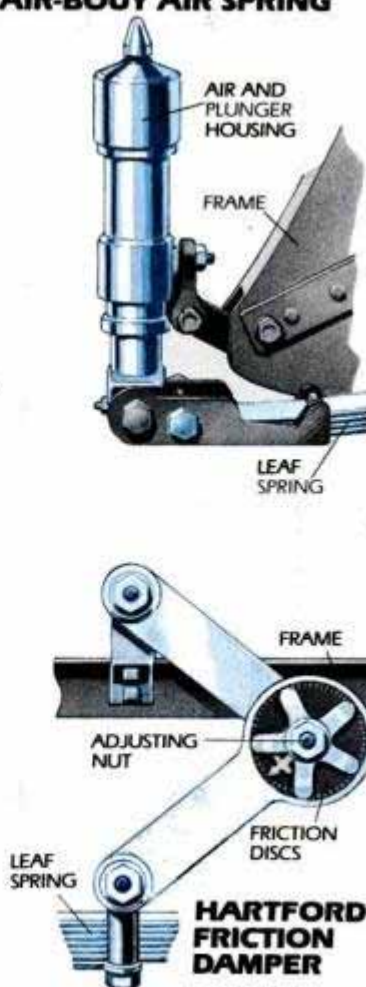
GABRIEL SNUBBER

Attempts to suppress spring oscillation include auxiliary springs and snubbers, friction, pneumatic and hydraulic dampers. Gas shocks combine pneumatic and hydraulic damping.

SAGER EQUALIZING SPRING

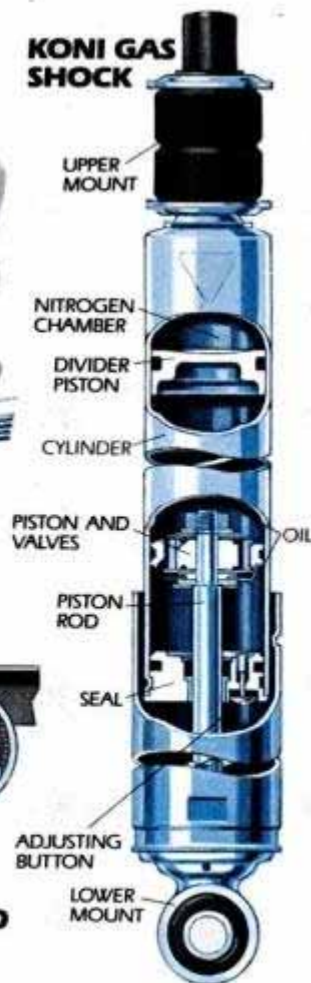


AIR-BOUY AIR SPRING



HARTFORD FRICTION DAMPER

KONI GAS SHOCK



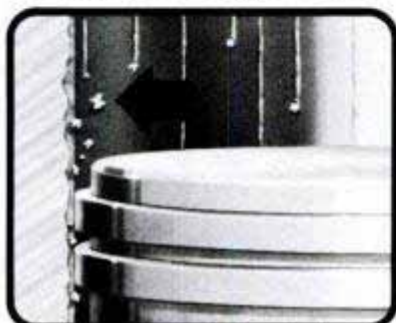
PM thanks the patent library of the Motor Vehicle Manufacturers Assn. (MVMA) for its help in preparing this series of articles.

PROBLEM: Friction and wear cut thousands of scratches in the metal surfaces inside every car's engine. Scratches leak power and rob you of compression and gas mileage

New Engine Restorer & Lubricant restores power and gas mileage

When added to oil, this amazing new product actually fills scratches to seal power-robbing leaks with millions of microscopic, "soft-metal" particles

As moving metal parts rub together, tiny, sharp metal fragments break off and circulate inside your car's engine. These fragments cut thousands of scratches in metal surfaces that "leak power" and rob your engine of compression and gas mileage.



Sharp metal fragments cut thousands of scratches inside your car's engine.

New ENGINE RESTORER & LUBRICANT is an exclusive, secret formula that was developed by a metallurgist. He discovered a way to meld copper, silver and lead into tiny "soft-metal" particles called *CSL. There are millions of these microscopic particles in every can of New ENGINE RESTORER & LUBRICANT. These particles are blended in a quality lubricant that is compatible with all motor oil products.

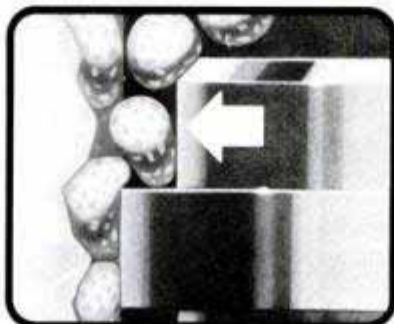


You add new ENGINE RESTORER & LUBRICANT to your oil.

As it circulates inside your engine, these tiny, soft CSL particles seek out the scratches caused by friction and wear. The millions of microscopic metal particles work to fill, pack and seal the damaged metal surfaces, restoring them to near-original condition.

SATISFACTION GUARANTEED. OR YOUR MONEY BACK. © 1983 RESTORE, INC.

New ENGINE RESTORER & LUBRICANT actually rebuilds metal surfaces, which seals power robbing leaks. This restores compression and gives you better gas mileage. Other tiny CSL particles, which have not been smoothed into scratches, work with your engine oil to lubricate like millions of tiny ball bearings even under extreme temperatures and pressures.



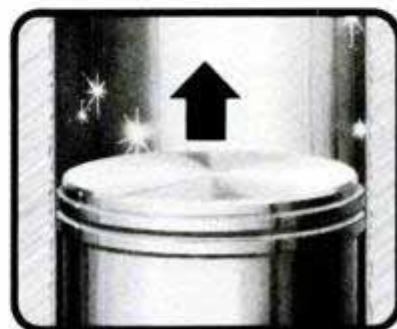
CSL particles magnified thousands of times, show how scratches are filled and sealed.

New ENGINE RESTORER & LUBRICANT will increase engine performance to a point where you can actually feel the difference as you drive. Engines which have been disassembled before and after use, show how scratched metal surfaces have been filled and sealed.

New ENGINE RESTORER & LUBRICANT is totally unique. No ordinary oil-



additive product contains the secret formula of tiny CSL particles. New ENGINE RESTORER & LUBRICANT is the only product in the world that works this way.



Metal surfaces are restored to near original condition.

New ENGINE RESTORER & LUBRICANT represents a breakthrough in "add to oil" technology that will improve the way drivers care for their car's engines. It works effectively wherever friction and wear cut scratches in metal surfaces, such as cylinder walls, crankshaft and bearings.

New ENGINE RESTORER & LUBRICANT is available in a formula for 4, 6 and 8 cylinder cars.

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Introducing the Bosch There hasn't been a break but you can feel the

Compared to all the changes in cars since their invention, the spark plugs that help power those cars really haven't changed much at all.

That is, until now.

Introducing Bosch Platinum Spark Plugs. They're not just new plugs. They're the *ultimate* plugs.

They'll outperform conventional copper-core plugs by *far*. At 0 mph or flat-out, in high temperatures or cold.

That's because the combination of platinum and our new extended insulator design results in

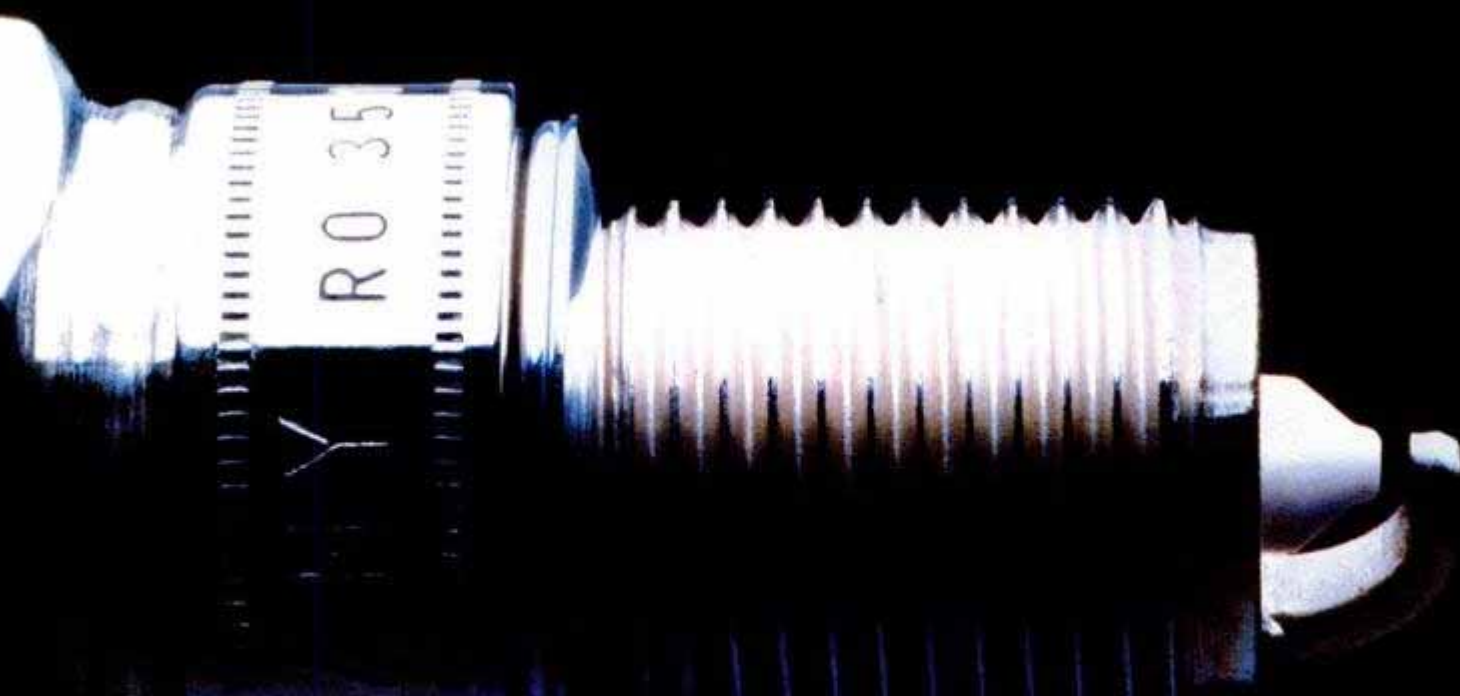
The 99.9% pure platinum center electrode plus our new extended insulator design gives the Bosch Platinum plug a wider heat range than any copper plug. And the effective gap between its electrode and tip remains virtually unchanged over the life of the plug.

a lower ignition voltage requirement and wider heat range than the copper or nickel that's found in



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Platinum Spark Plug.
through like this in 125 years,
difference in seconds.



conventional spark plugs.

So at higher temperatures, where many plugs foul, the Bosch Platinum Spark Plugs merely burn themselves clean.

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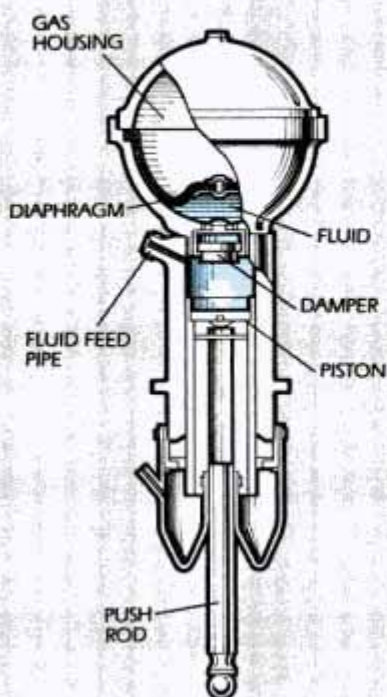
Pick up a set today. There hasn't been a breakthrough like this in 125 years, but you can feel the difference in seconds.

The Ultimate Spark Plug.

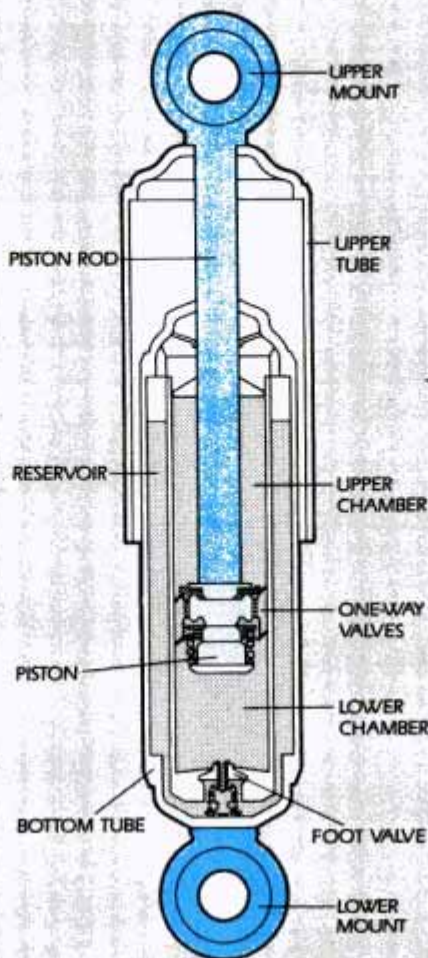


BOSCH

100 YEARS



Citroën's hydropneumatic struts (above) eliminated springs. The push rod acted directly on suspension arm. Fluid pumped into or out of strut adjusts ride height. Simple tubular shock (right) is used on most cars.



the larger bumps. The result is a shock, or jounce, to the passengers. When the springs are made lighter and more flexible in order to minimize the larger shocks, the smaller ones have too large an influence, thus keeping the [car] body and its passengers in motion all the time. These two contradictory conditions have created the field for the shock absorber."

The first shock

The first recorded use of a crude shock absorber is the invention by one A. Gimmig in 1897. He attached rubber blocks to the top of each leaf spring. When the suspension was compressed sufficiently, the rubber bumpers hit bolts that were attached to the frame. Rubber bump stops are still used in many modern suspensions, but their effect on ride control is minimal.

The first true shock absorbers were fitted to a racing bicycle in 1898 by a Frenchman named J.M.M. Truffault. The front fork was suspended on springs, and incorporated a friction device that kept the bike from oscillating constantly. In 1899, an American automobile enthusiast named Edward V. Hartford saw one of Truffault's bikes win a marathon race at Versailles. Hartford immediately recognized the auto-

motive potential of the friction device. Hartford and Truffault got together and by the next year Hartford had outfitted an Oldsmobile with a variation of Truffault's device. This first automobile shock absorber consisted of a pair of levers that were hinged together, with a pad of rubber placed at the pivot point. One of the lever arms was attached to the frame, while the other was bolted to the leaf spring.

A bolt placed at the hinge point could be tightened or loosened to increase or decrease the friction, providing a stiffer or softer ride. The Truffault-Hartford unit was, therefore, not only the first automotive shock absorber, but the first adjustable shock.

Hartford brought the car to America, where he opened his own plant, the Hartford Suspension Co., in Jersey City, New Jersey. His first big contract came from Alanson P. Brush, who installed shock absorbers along with front coil springs on the 1906 Brush Runabout (see last month's *Suspension*, page 58). The ride given by the car was called "magnificent" in a critique written by Hugh Dolnar for *Cycle and Automobile Trade Journal*.

From then on shock absorber designs came fast and furious. Among them:

- **Gabriel Snubbers**—This consisted of

a housing that contained a belt wound into a coil. It was kept under tension by a spring. The housing was fastened to the frame and the outer end of the belt was attached to the axle to limit the degree of rebound from a jolt.

The Gabriel Co. started operation in 1906 making accessory auto horns. The founder, Claude H. Foster, named his firm after the horn-toting angel Gabriel. When the pushbutton horn came along in 1914, it killed the Gabriel and all other body-mounted horns. Foster looked for a product to keep his company in business and came across the Snubber.

- **Equalizing springs**—These were auxiliary coil springs used in addition to the leaf spring. Since each spring had a different harmonic frequency, they tended to cancel out one another's oscillations. But they also added to ride harshness and soon fell out of favor.

- **Air springs**—Air springs combine spring and shock absorbing action in one unit and were often used without metal springs. The first one was developed by Cowey Motor Works of Great Britain in 1909. It was a cylinder that could be filled with air from a bicycle pump through a valve in the upper part of the housing. The lower half of the cylinder contained a diaphragm made of rubber and cord which, because it was surrounded by air, acted like a pneumatic tire. Its main problem was that it often lost air.

The newest air spring, developed by Goodyear, is found on some late-model Lincolns. Like the ones that have preceded them, these ride-on-air units are more costly than conventional springs and hydraulic shock absorbers.

- **Hydraulic shock absorbers**—M. Houdaille of France gets credit for designing the first workable hydraulic shock absorber in 1908. Hydraulic shocks damp spring oscillations by forcing fluid through small passages. In the popular tubular shock, a piston with small orifices is attached to the chassis and a cylindrical oil reservoir is attached to the suspension or axle. As the suspension moves up and down, the piston is forced through the oil, resisting the action of the spring.

One-way valves allow different orifices to be used to control suspension jounce and rebound. This is called a double-acting shock. The latest wrinkle is to add a chamber of compressible gas at one end of the fluid reservoir to cushion the damping action.

Monroe built the first original equipment hydraulic shocks for Hudson in 1933. By the late 1930s the double-acting tubular shock absorber became common on cars made in the United States. In Europe, lever-type hydraulic shocks prevailed into the '60s. They

(Please turn to page 74)

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THE STATUE OF LIBERTY

PEWTER SCULPTURE

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The Danbury Mint is proud to offer a magnificent pewter sculpture of the Statue of Liberty, entirely clad in copper from the actual Statue in New York harbor! Indeed, a collectible of such meaning, beauty and interest may never come your way again.

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In 1886, President Grover Cleveland dedicated the Statue of Liberty, a gift from France honoring our democratic traditions. Today, the Statue of Liberty is being restored. In 1986, her centennial, she will be rededicated. The Danbury Mint is offering this beautiful sculpture in honor of this historic occasion.

Fully clad in copper from the actual Statue of Liberty

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Handcrafted with precision in American pewter

Each sculpture is meticulously crafted from rich American pewter, unsurpassed in its dignity. No other metal could have imparted to this sculpture the same noble bearing and stateliness.

Your purchase contributes to the Statue of Liberty's restoration

You'll be pleased to know that a percentage of the sculpture's purchase price will be contributed to the Statue of Liberty — Ellis Island Foundation, Inc. Consequently, your purchase contributes to the Statue of Liberty's restoration. Accompanying your sculpture will be a Certificate of Authentic Materials, signed by Lee A. Iacocca, the Foundation's chairman.

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The original issue price of *The Statue of Liberty Pewter Sculpture* — complete with hardwood pedestal — is \$150. This is an exceptional value when you consider that its authentic copper could make it irreplaceable in the years to come.

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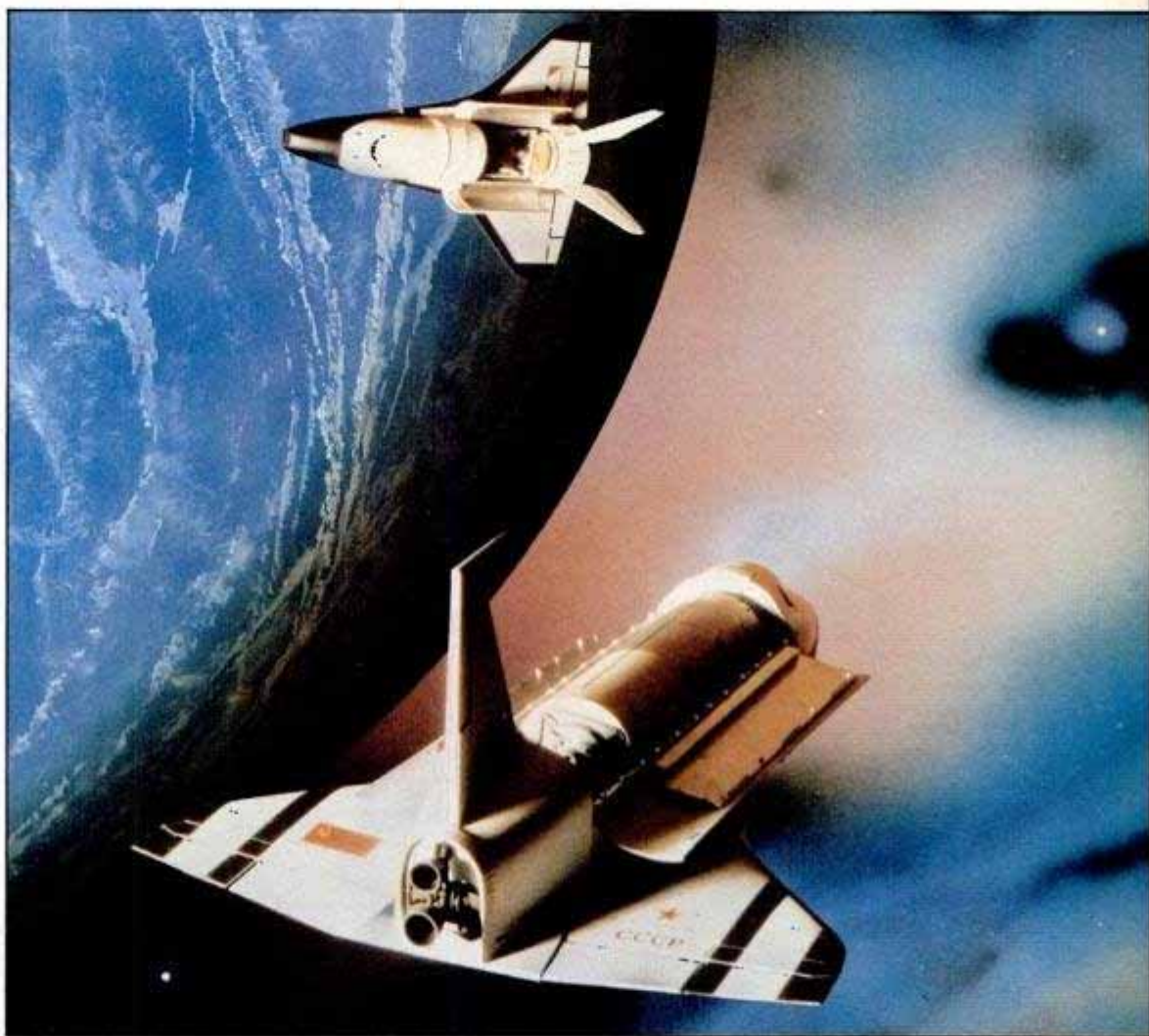
AEROSPACE

Space ferries for the 1990s

The initial success of America's Shuttle program has spawned similar efforts in France and the USSR. While both projects are only in planning or test phases, both countries already envision using a returnable vehicle within the next 10 years.

A Soviet prototype is reported under construction. When complete, the vehicle is expected to resemble the model at right (foreground). The actual 1-ton Kosmos 1614 space plane is shown (black and white reconnaissance photo below) during a recovery mission in the Black Sea. According to spokesman Roald Sagdeyev, head of the Moscow Space Institute, the Kosmos flights will determine profitability of a reusable system. At present, Sagdeyev says, reusable shuttles are not profitable. But the Soviets are watching the American Shuttle program in hopes of building on what NASA is learning from experience.

The proposed French vehicle, a delta-winged Hermes, is a 50- to 60-foot returnable craft (a mock-up is shown at right, above the Russian model). The French expect to use Hermes for high-orbit transfer



Recon photo shows Soviet ship recovering space plane.

of crews and supplies to manned space stations and in-orbit servicing of platforms and satellites. The French are considering two designs, both similar to NASA's orbiter. With the success of both programs, travel and work in orbital space will amount to nothing more than a ferry ride.

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Steve Eskow, Richard Schrader

3M, GM share

General Motors will use 3M Corp.'s Chemical Reaction Chamber to test the effects of microgravity on nylon production during a Shuttle flight in November. GM scientists say the experiment will show the effect of crystal structure on the wear-resistance and elasticity of nylon, which is important to automotive components. Also, 3M will use the electrically heated chamber to continue crystal growth experiments begun aboard a



PM ILLUSTRATION BY BRIAN SULLIVAN

Shuttle flight last fall. Above, 3M researchers place 6-experiment chamber in a self-contained canister.



PM ILLUSTRATION BY ED VALIGURSKY

ENGINEERING

Longest tunnel

In 1988, travelers between Japan's northernmost island of Hokkaido and the main island of Honshu will span the 33½-mile gulf of open ocean using the world's longest underwater tube, the Seikan tunnel. A

completed portion of the tunnel is shown in the photo at right. Vehicles and passengers will board bullet trains and speed to their destinations, avoiding the storm-plagued ferry service above. The trip will take one-third the time. Horizontal tubes will connect the main tunnel with a service tunnel (illustration above) for emergency repairs or evacuation. Construction



began on the tunnel 21 years ago, boring through fracture-prone rock called tuff.

Sound magic

Sonic waves can move or lift things, and Cal Tech jet propulsion researcher Taylor Wang has devised a sound chamber which amplifies and directs sound to lift light objects. The future is unlimited, says Wang. Acoustic levitation in space can move objects and mix chemicals. On earth, it may generate heat.

SPECIAL REPORT: ADVANCES IN LASERS

Laser aids in fusion

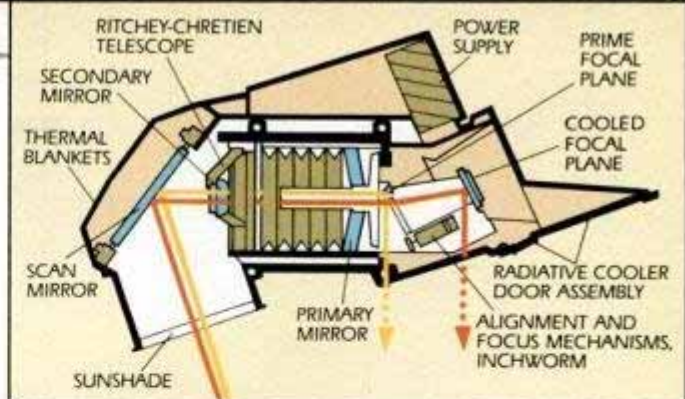
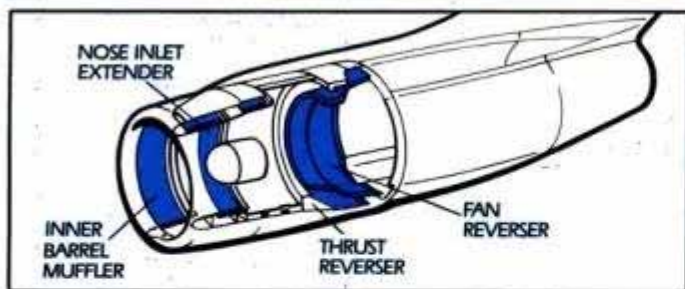
University of Rochester scientists' attempts to create a fusion reaction using an infrared laser beam proved fruitless until frequency converters (below, right) were employed to boost the energy of the 24-beam laser array (bottom) to ultraviolet wavelengths. The full energy of the beams was focused on a target pellet (photo right) and a successful fusion reaction was initiated.



Forecast: light trickle

Farmers can save miles of pipes and conserve water using the computerized, solar-driven Traveling Trickle Irrigation System (TTIS). The system uses a laser guidance mechanism to guide the TTIS towers between the crop rows. In addition, solar cells provide power for moving the TTIS over the fields. Infrared thermometers, traveling atop the TTIS towers, are used to calculate the crop's exact water needs and are proving valuable in the Southwest.





ACOUSTICS

Sh! 707 at work

In order to meet Federal Aviation Administration noise requirements, Tracor Aviation devised a kit for aircraft oper-

ators that serves as a muffler for the Boeing 707. The noise reduction kit is made up of parts coated with sound-absorbing DynaRohr. A nose inlet extender adds 14 inches to the engine cowling. The inner barrel, thrust reverser and fan reverser are replaced with coated components.

THERMODYNAMICS

Energy-wise windows

The Solar Energy Research Institute has developed a win-

dow which turns opaque when low-voltage current is passed over the semiconductor-coated panes. This electrochromic window screens sunlight and traps heat. It can cut heating and cooling costs by 25 percent.

PHOTOGRAPHY

Mapping earth resources

The photo at right may look like an amoeba, but it's actually a high-altitude, multispectrum image of Death Valley, California. It was produced by Hughes Aircraft's thematic mapper on board the Landsat-D satellite orbiting at 438 miles. The mapper is protected from sunlight by thermal blankets and a radiative cooler. A scan mirror collects reflected light and thermal energy through a sun-shaded the opening. It's reflected to a



Ritchey-Chretien telescope directly onto the prime focal plane and through a 2-mirror reflective relay onto the cooled focal plane. A detector then converts and amplifies the low-level electrical signals for transmission to the ground.

Less work for robot

As robot tasks become more intricate, so does the need to measure performance and accuracy. The National Bureau of Standards believes it has an answer with its 3-D laser tracking system. A tracking mirror and laser source rotate on a tripod to keep the laser trained on a target mirror attached to the robot wrist. A computer measures variations in movement. The device gives almost human accuracy to the movement of a robot arm.



High-tech dance floor

Brookhaven National Laboratory's new polarized-beam neutron spectrometer doesn't have feet, but it can dance on a film of air measuring less than a thousandth of an inch. The spectrometer consists of four massive machines (above) that must be positioned relative to each other and oriented with respect to an incoming neutron beam

from Brookhaven National Laboratory's High-Flux Beam Reactor.

To align the spectrometer elements, a sheet of air is blown under pressure between element air pads and the epoxy-based floor. A laser-sensing, computer-controlled motor precisely positions the machines. The increased precision is expected to yield data on the physical properties of matter previously believed unobtainable.

Laser 'bullets'

Soldiers practicing with blank ammunition don't have to pretend when they're hit—they know it. Their rifles fire harmless laser beams to simulate live ammunition. Sensors on their uniforms beep if a hit is scored. The training aid was developed by Loral Electro-Optical Systems of Pasadena, California.





MILITARY

Missile shuffle

How do you protect your missiles from enemy attack? Instead of storing them in fixed silos, you keep moving them around in mobile launchers so the enemy never knows

exactly where they are. At left, above, is a joint Boeing/Goodyear concept for a low-slung, tractor-drawn launcher capable of operating over rough terrain.

To fire the missile, the launcher is raised hydraulically to a vertical position. Not to be outdone, the Russians are developing a similar wheeled launcher (right).



Luftwaffe orders better radar

West Germany is improving the combat efficiency of its F-4F Phantoms with Hughes' APG-65 radar system. APG-65, in the nose of the F-4F

above, is an all-weather sensor designed to incorporate air-to-air and air-to-surface features. It will provide look-down/shoot-down capability

as well as the ability to track 10 targets at once, displaying eight. The upgrade will keep the F-4F in service to the end of the century.



The Phantom strikes again

The 25-year-old McDonnell Douglas F-4 Phantom fighter has proved so rugged and reliable that it's now about to get a facelift that could extend its operational life well into the next century.

To be called the Super Phantom, it will, in the next two years, get more powerful engines and advanced avionics, as shown above.



Red hot chopper

The Russians are about to field a potent new attack helicopter, according to U.S. Defense Department intelligence reports. Known as the Mi-28 Havoc, it has an unusual 5-bladed rotor and a laser guidance system for delivering antitank missiles with pin-

point accuracy. In size, speed and striking power, it is believed to be comparable to our own Hughes AH-64A Apache helicopter, making it a deadly adversary.

Like the Apache, the Havoc is powered by twin turbines and has a 2-man, tandem cockpit with stepped seats so the gunner in back can see over the pilot.



Blimp boat

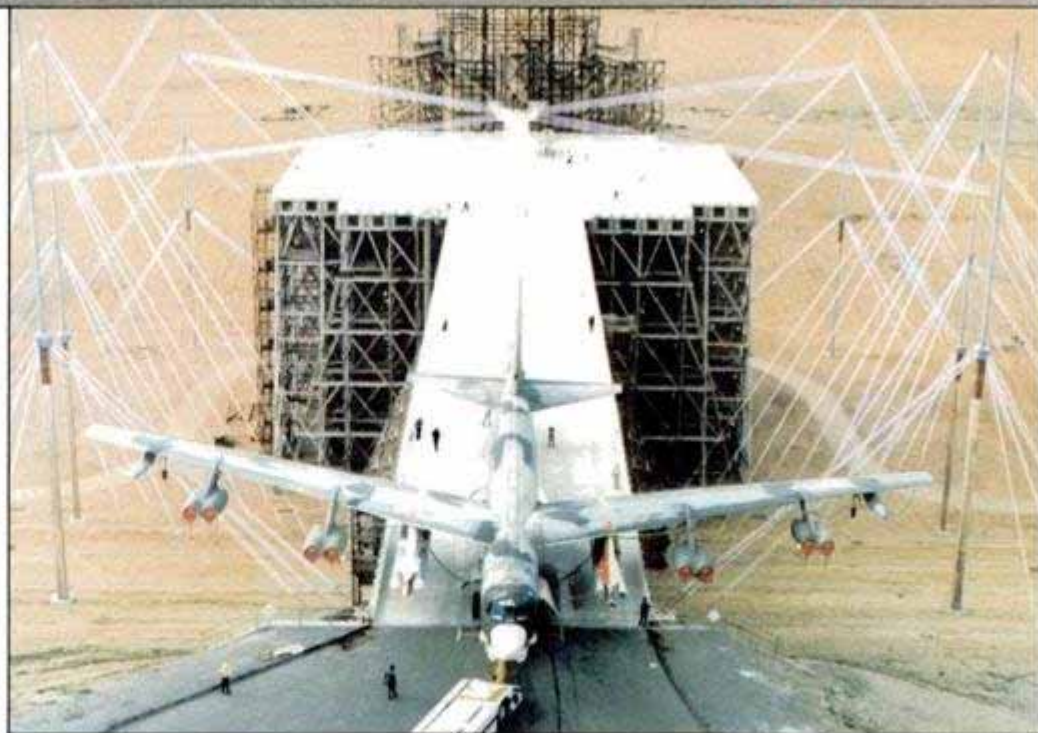
When this British coastal patrol blimp wants to search a vessel or rescue a shipwreck victim, it doesn't have to call for help. Hidden under the gondola is a small, fast speedboat that can be lowered into the water quickly. Developed by Airship Industries of London, the system is under study by the U.S. Navy.

AVIATION

Bombed bomber

Why is a B-52 bomber being backed onto a 118-foot-high trestle? It's about to be bombarded by 5-million-volt charges to simulate the electromagnetic pulses that are generated by high-altitude nuclear blasts.

From these tests, Air Force scientists can better tell how to protect the bomber's delicate electronic equipment from the harmful effects of such blasts. The wood trestle, which is said to be the largest ever built, is necessary to isolate the bomber from ground interference that might affect the test results.



OPTICS

Giant reflections

The trend toward larger telescopes has fostered a need for larger mirrors. University of Arizona researchers are developing spinning-oven techniques to accommodate the optical giants. One (right, top), fuses mirror sections. A second (bottom), melts mirror blanks into a paraboloid surface. Inexpensive telescopes between 15 to 25 meters may be the result.



WEATHER

Tempest in a lab

National Bureau of Standards researchers are using reduced-current lightning bolts to test power utility response to lightning and power surges. Test materials are connected to a standard lightning generator. Transient voltage simulates a lightning strike and special instruments measure the surge effect. Such testing may eliminate blackouts and brownouts.



ROBOTICS

New joint for robots

Backlash and jerking movements have limited robotic arm usefulness. But a gearless, direct-drive robot, developed at MIT, is faster and more flexible than its predecessors. It has no transmission at the joint shaft, uses friction coupling found in many video recorders and eliminates gearing between the motor and load. The friction joint permits performance of precision tasks and will improve welding and product transfer.



Smoothing vibrations

Large mechanical robotic structures are subject to vibrations which may cause inaccurate couplings or affect intricate operations. MIT researcher James Hubbard Jr.

has developed a piezoelectric polymer film which will produce a spatially uniform bending movement. It has been tested on a scale-model satellite (above) at MIT. Hubbard's dampener will be useful in robot arms used in space and aircraft and satellite construction.



THE INTELLIGENT WINDOW:[™] THE PERFECTLY CLEAR CHOICE.

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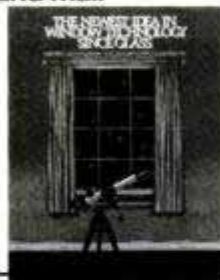
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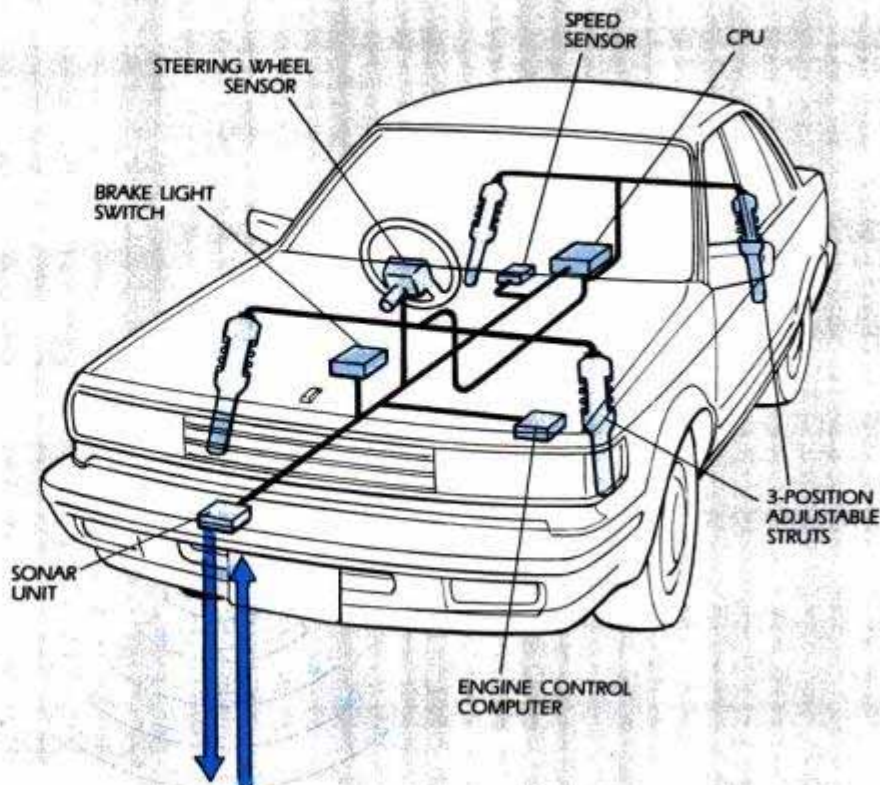
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100 YEARS

SUSPENSION (Continued from page 66)



Several Japanese cars have shocks that can be adjusted by the driver. Nissan's computerized system uses sonar to detect bumps and potholes, then adjusts struts automatically.

resembled the Hartford friction shock, but used hydraulic fluid instead of a friction pad.

■ **MacPherson struts**—With the advent of front-wheel-drive cars, manufacturers in the 1970s and '80s started using MacPherson struts. MacPherson, a GM engineer, developed this unit in the 1960s. It combines the coil spring, hydraulic shock absorber and upper suspension arm into a single compact device. The main advantage is that it allows the necessary space for positioning the front-drive transaxle.

Several Japanese cars now feature

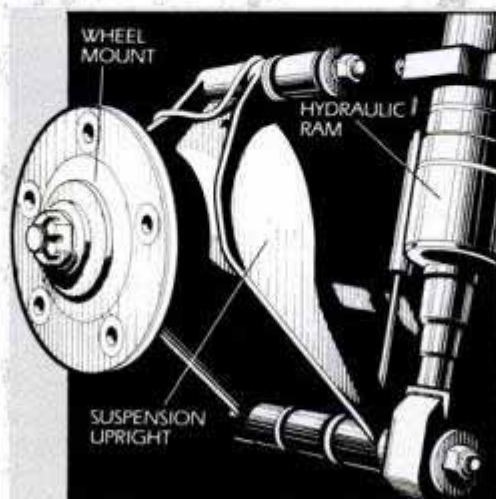
struts with shock valving that can be adjusted from soft to firm by electric motors while the car is moving. The driver has a choice of three settings, but a signal from the speedometer usually overrides the manual control at highway speeds to set the shocks on firm.

The Nissan Maxima sold in Japan has electronically controlled shocks that automatically provide a soft, medium or firm ride depending upon road conditions, speed and driving style. A sonar unit under the bumper monitors the road surface, while other sensors check speed, acceleration, steering angle and brake use.

Data are fed to a central processing unit that decides if you are driving gently or aggressively, then activates shafts in the shock absorbers that alter the size of fluid passages.

The Lotus Active Suspension System does away with springs and shock absorbers altogether. Eighteen motion-sensing transducers send data to four computer-controlled hydraulic rams. The system distinguishes roll, dive, jounce and bump, and valves in the rams adjust the ride accordingly. These valves can change position as much as 250 times per second.

The Lotus system has the uncanny ability to keep a car level in a tight turn or even bank it toward the inside of the turn, rather than leaning to the outside as other cars do.



Lotus Active Suspension uses a computer-controlled hydraulic ram at each wheel.

IF YOU CAN DRIVE IT, AUTOLITE MAKES A COPPER PLUG FOR IT.

England is a country renowned for building unusual cars.

But, even there, this one raises a few eyebrows.

It's the Aston Martin Lagonda Bulldog, and it's propelled by an extremely modern, highly-efficient engine. Which, like all modern, high-revving engines, whether British, Japanese, or German, can develop a problem. If you use the wrong kind of spark plug.

When you do a lot of short trips, ordinary plugs can develop something called "carbon fouling." This means that carbon can build up at the spark plug tips and cause misfiring, or even prevent the engine from starting at all. The answer? Autolite *copper* spark plugs. Autolite makes plugs for today's smaller engines that not only have copper in the center electrode, but they also have a longer insulator, to help burn off carbon fast.

And they also have something no other major American-made plug has.

Copper either in the seal or the gasket, because it does a great job of conducting heat and electricity.

The result is a plug that helps cars like this Aston Martin perform as beautifully and efficiently as they were designed to.

A plug that will perform equally well in your car.

Autolite *copper* spark plug.

Autolite Division, Providence, Rhode Island 02916.

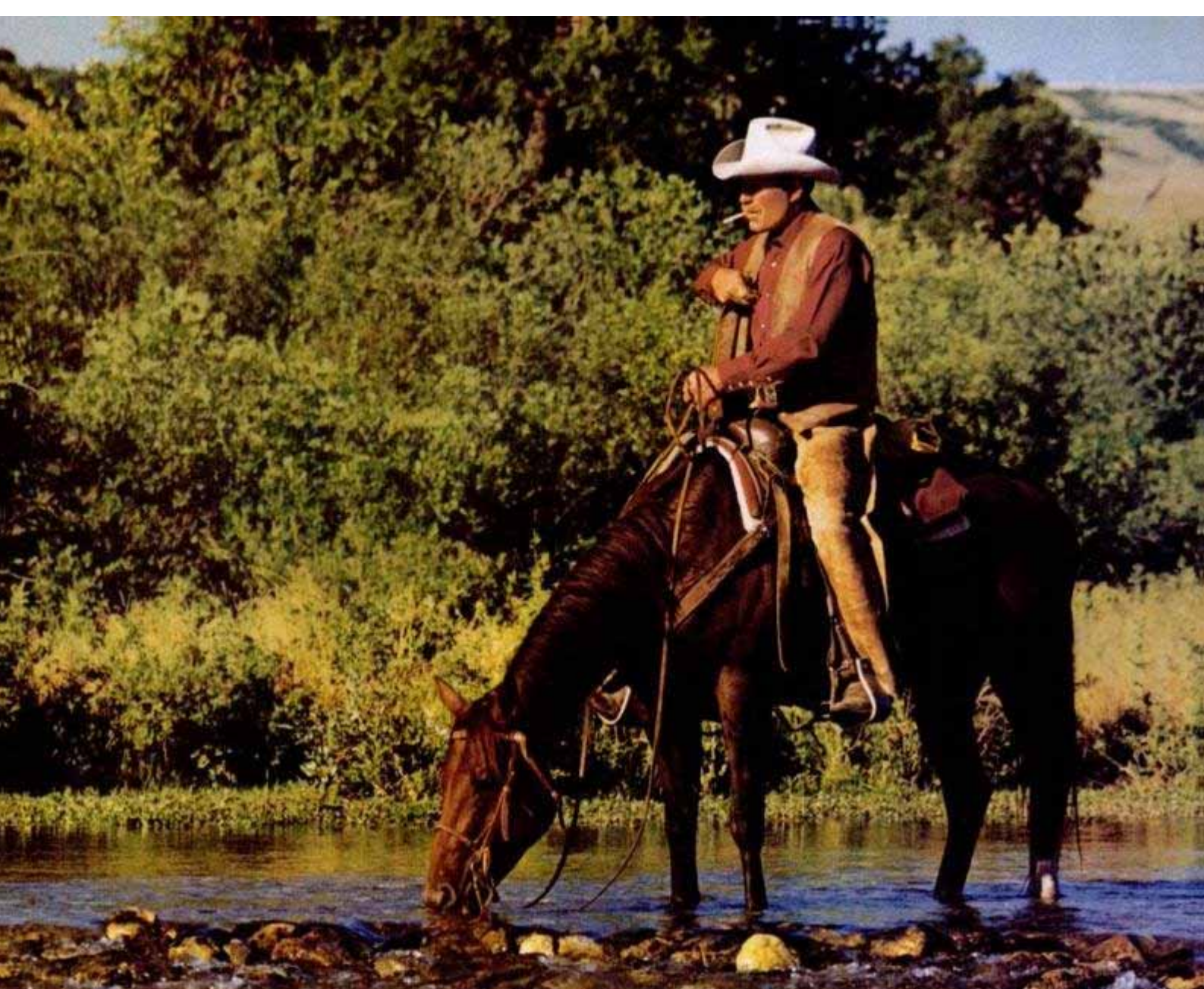


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DETROIT 87 88 AMERICAN TECHNOLOGY TAKES CHARGE

GM downsizes Toronado/Riviera and LeSabre/Delta 88. Chrysler polishes its image.



Toronado for '86 echoes the hidden headlights and horizontal-bar grille of the original '66 model.

BY WADE HOYT, Auto Editor, and MICHAEL LAMM, West Coast Editor; Photos by Don Green

The year 1986 will signal a full-scale technology attack on the imports by Detroit. Engineers, computers and even robots have been recruited to join the battle on many fronts, from improved engine performance, ride and handling to European-style aero headlights and even electronic gadgetry that out-techs the Japanese. We've got the latest efforts from Buick, Oldsmobile and Chrysler to report on this month. Next month

we'll check in with the other U.S. companies and go into the technical highlights in more depth.

General Motors rolls into 1986 with two entirely redone car lines: the E-car and the H-car. E-cars include the Buick Riviera, Olds Toronado and Cadillac Eldorado specialty coupes. The new H-cars are front-wheel-drive replacements for the Buick LeSabre and Olds Delta 88 family sedans and coupes.

DETROIT
1986



GM's E-cars

Buick's chief engineer, Dave Sharpe, told us the new Riviera is aimed at America's young technotypes and, with that target in sight, will take Buick into the 1990s. Same holds for the Toronado and Eldorado.

All three of the 1986 E-cars weigh 600 to 700 pounds less than the '85 models they replace and use a 3.8-liter V6 with Bosch port fuel injection, mounted transversely. The old Toronado and Eldorado had longitudinal engine placement.

Driving the front wheels through a 440-T4 overdrive automatic transaxle, the E-car V6 rests in a 6-point, rubber-bushed front sub-frame. The engine-mounting system includes a single telescopic shock absorber acting as one of the engine supports, all of which helps isolate powertrain noise and vibration from the passenger compartment.

The three new E-cars also boast 4-wheel disc brakes, tripod inner and Rzeppa outer joints for the fwd axle shafts, fully independent

rear suspensions, plus a single transverse fiberglass rear spring, similar to the Corvette's.

GM will offer several different suspension levels in various car lines this year—some standard, some optional. For example, the Toronado and T-Type Riviera use Level III (F-41 and FE-3) suspension and steering components. Level III includes 215/60R15 Eagle GT tires on alloy wheels, firmer front strut

valving, heavy-duty Delco rear shocks, heftier front and rear stabilizer bars, and more power steering feel.

Level II, meanwhile, uses 14-inch wheels and goes one notch softer on all the above items. And the Level I suspension gives a traditionally smooth boulevard ride. Each division develops its own suspension levels independently of the other divisions.

According to Olds and Buick chief engineers, the Level III package results in .88g and .85g lateral acceleration capabilities for the '86 Toronado and Riviera, respectively. We drove Toronado and the T-Type Riv prototypes in Arizona with Level III suspensions and found both amazingly responsive and stable in high-speed turns.

There was almost no body roll and very predictable, controllable breakaway on gravel surfaces. On pavement, it's hard to make the tires lose their grip at all. These are tenacious, fine-handling automobiles. And most surprising of all, the Level III suspension still gives a comfortable and not



Main difference between the Buick Riviera [above] and Olds Toronado [previous page] is the front end. Both have new low-profile headlights, but the Buick's are out in the open.



Chrysler's biggest change for '86 is in the Laser XT, a sporty package that includes, spoiler, louvers and T-top.

particularly jiggly ride. The E-car's 0-to-60 capability runs in the 10- to 11-second range. With 142 hp and 200 ft./lb. of torque on tap, the 4-speed automatic gives spirited though not overwhelming performance. EPA fuel mileage figures beat last year's by an average of 4 mpg. A 5-speed manual transaxle built under license from the German firm Gertrag will be available later in the model run not only at Buick and Olds, but on many Pontiac sports models, too, including Fiero, Grand Am and Sunbird Turbo.

TV dash display

The '86 Riviera comes standard with an interesting touch-sensitive CRT screen on the instrument panel. CRT stands for cathode ray tube, and Buick's in-dash screen is basically like those on office computers. The CRT lets you choose from six main computer menus plus over 30 pages of sub-menus. The whole system replaces 120 conventional switches and buttons that would exist otherwise. By simply touching the proper readout on the screen, you can control not only every function of the standard Delco sound system but also interior temperature, two trip computers, and the car's diagnostic functions.

The CRT is great fun to play with and



The rear-drive Buick LeSabre and Olds Delta 88 have been replaced by front-drivers with familiar GM transverse V6 engines. The 2-door coupes (Buick shown above) feature sportier looks and handling than the traditional 4-doors.



a lot more practical than we'd anticipated. It's easier to read and use than the usual squint and peck mini-buttons on conventional dashboard computers.

The '86 Toronado's answer to the Riv's CRT screen is an all-pushbutton system that contains the same basic functions as Buick's but isn't nearly so easy to see nor fun to use. For example, to override the Toro's automatic temperature control, you have to push buttons that match little green pictographs on the LED instrument panel.

Among the E-car's subtler features are slide-in license frames, translucent sunvisor extensions, mini quad halogen headlamps (under electrically retractable headlight doors on the Toronado), and rear-seat vent outlets.

An interesting Riviera option consists of reversible cushion inserts on its bucket seats. Packard had similar flipflop cushions in its early-'50s Caribbeans, but the Riviera's seats use Velcro to hold the reversible center sections in place, and the seats themselves—supplied by Hoover Universal—are among the most adjustable we've ever sat in. They're so adjustable, in fact, that they need two sets of pushbuttons—one on the seats themselves and another on the door armrest.

The new E-car's roofline looks like the N-car's (Grand Am/Somerset Regal/Calais), but no sheetmetal interchanges. GM designers purposely re-



peated the N-car's greenhouse and adapted it to the new E-car (or GM-30) platform, which was probably a mistake—why make an expensive car look like a cheaper model?

LeSabre and Delta 88

GM's other major changeling for '86, the H-car (GM-70), has been downsized and has gone to fwd for the first time. Earlier LeSabres and Delta 88s have shared GM's rear-drive B-bodies with Chevy's Caprice and Pontiac's Parisienne since 1977. The Parisienne will switch to the H-body for 1987.

The 1986 H-car uses the 1985 fwd C-car platform (Electra/98/deVille) with the same 110.8-inch wheelbase and

"California Lancer" (top) is a special appearance package of spoilers, wheels and a roof wing that makes the Dodge sports sedan look like an AMG Mercedes.

Buick Riviera (above, left) and Olds Toronado (right) have the same "formal" GM roofline that makes them look like less expensive N-cars. Buick treatment flows more smoothly from roof to fenders and looks less like the low-priced car.

Riviera buckets (left) have reversible seat cushions, held in place by Velcro. Just zip 'em out to change decor or clean up.

very similar overall dimensions. Basically H- and C-cars are now identical—certainly in terms of overall size. Like the C-cars, the '86 H uses a 6-mount front subframe and MacPherson struts fore and aft. The variable-rate rear coil springs are barrel-shaped to save space, and electronic level control (ELC) is optional. The new H-car is 22 inches shorter but only about 110 pounds lighter than the 1985 rear-drive B-car it replaces, showing how hard it is to save weight on a car that's already been downsized once.

H-cars for '86 come in two body styles: sedan and coupe. The coupe and sedan share basic suspension compo-

(Please turn to page 116)

VIDEO THINKS SMALL

Light enough to juggle, small enough for one-hand shooting, vidcams have better-than-ever performance.

BY CLIFF GROMER; Photos by Brian Kosoff

Point-and-shoot simplicity has to come to videocameras, and the latest vidcams are almost as small and light as their cousins in the film family. What made the downsizing possible is a flat semiconductor chip about the size of a postage stamp that has replaced the large vacuum tube for picking up images. The new breed of videocameras weighs in just over 2 pounds, can be operated comfortably with one hand and transported more conveniently than tube cameras.

Meanwhile, the miniaturization doesn't sacri-



Lightweight handheld videocameras are, clockwise from bottom, RCA's CLC020, Sanyo's VSC800 and CCD-G5 from Sony.

VIDEO THINKS SMALL

fice any of the functions of the larger models. In fact, eliminating the pickup tube makes it possible to cram in even more operating features. And with new vidcams now as simple to operate as still cameras, they might do for home moviemaking what the Brownie did for snapshots.

At this writing fewer than a dozen tubeless models are available, though some camcorders (one piece camera/VCR combinations) also use solid-state semiconductor pickups. Before discounts, tubeless vidcams cost from \$900 to \$1500, but it's the number of operating features that determines price, not the semiconductor sensor. Generally speaking, solid-state cameras cost just a bit more than comparably featured tube models.

How they work

At the heart of any vidcam is the pickup (or imaging) device, which may be either tube or solid-state. Though solid-state sensors are physically and operationally different from pickup tubes, the goal is the same: Each is meant to convert the light reflected from moving images into electrical impulses that can be registered on magnetic tape in a videocassette recorder.

Tubes come in a variety of types and sizes, the smallest being about 3 inches long by $\frac{1}{3}$ -inch in diameter. Generally, the larger the tube, the better its ability to record color images in low light.

In a videocamera, the pickup tube is located behind the lens, where it operates like a TV set in reverse. The camera's lens focuses light (the image) on a target plate. The varying intensity of light in the image creates resistance differences across the plate. Meanwhile, an electron beam generated by the tube passes through a color-stripe filter and scans the target plate from left to right and top to bottom, twice every $\frac{1}{30}$ of a second (the frame transmission rate of TV). But instead of projecting images on the plate (as it would on a TV screen) the electron beam detects the location and intensity of light entering the camera, and converts the resistance differences to voltage differences. This information is amplified, passed on to the VCR and stored on magnetic tape.

Semiconductor pickups

Solid-state pickups come in two varieties: the charge coupled device (CCD) and metal-oxide-silicon semiconductor (MOS). Despite functional differences between the two types, the pictures they produce are hard to tell apart.

CCD and MOS sensors even look alike physically. Each chip is about $1\frac{1}{2}$ in. long by 1 in. wide and $\frac{1}{16}$ in. thick. Dead center on the chip's surface is the imaging optic, measured diagonally

and either $\frac{1}{2}$ or $\frac{3}{8}$ in. depending on the maker. Embedded within the optic are nearly 200,000 light-sensitive picture elements, arranged by rows in the same three-to-four height-to-width ratio as a TV screen.

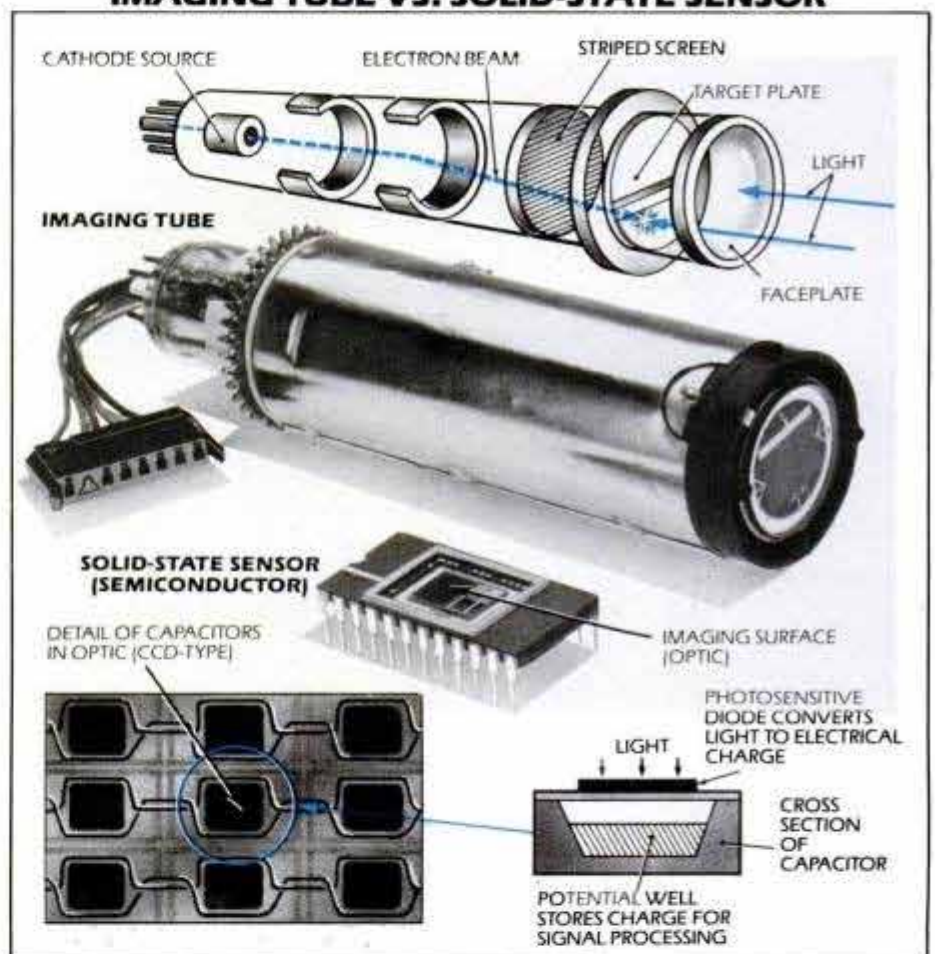
The optic is the business end of a solid-state sensor. It's located behind the camera lens and performs a function similar to that of a pickup tube's target plate. Light entering the camera passes through a color separation filter and strikes the optic, where each light-sensitive element builds up an electrical charge proportionate to the intensity of light at that location in the image. This is where the similarity ends, because a solid-state sensor needs no fast-scanning electron beam to read the light-generated charges, convert them to

transmission rate of TV, thereby feeding moving images to the VCR and tape. With MOS imaging devices, quick-pulsing registers shift horizontally and vertically across the picture-element grid, continuously sampling momentary changes in the strength of the stored charges and passing this information along to the video recorder.

Semiconductor image sensors offer several advantages over pickup tubes. Size and weight are the obvious ones. Another, not-so-evident benefit is lower energy consumption—an important consideration when you're making movies on battery power.

Operationally, solid-state devices also have the upper hand. Unlike tubes, semiconductors don't require warm-up time. They can also tolerate much more

IMAGING TUBE VS. SOLID-STATE SENSOR



The relative size difference between tube and solid-state pickups is shown above. The need for an electron beam to scan images accounts for the tube's bulk. But semiconductors send data directly to VCR from 200,000 light-sensitive picture elements.

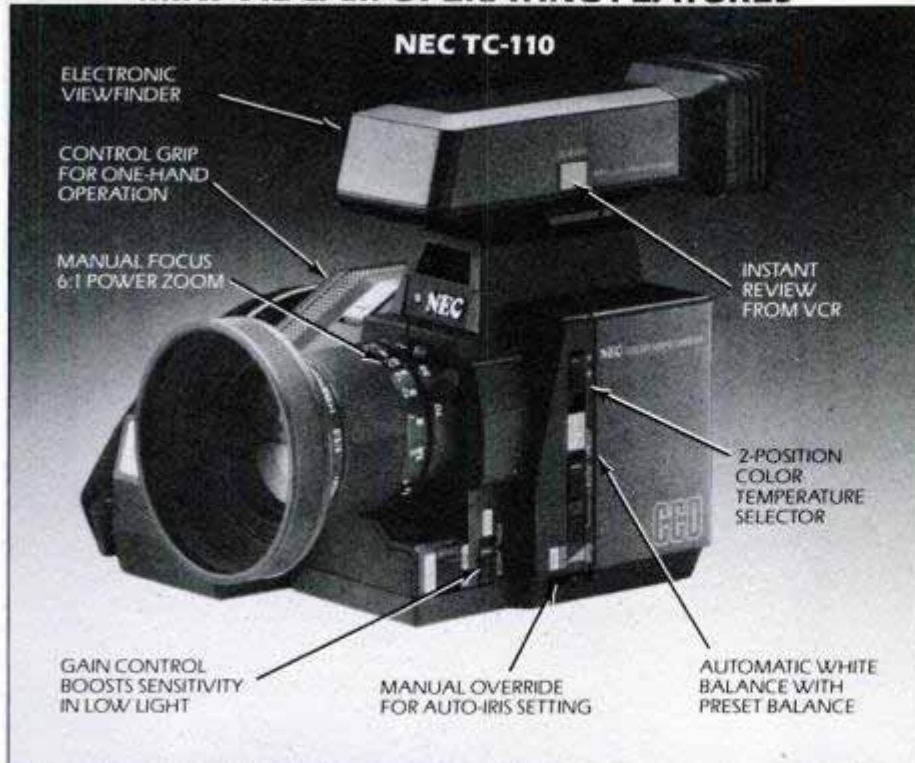
voltage and pass them on to the VCR.

Instead, the charge built up in each picture element is stored in the potential well of a capacitor. In the case of CCD pickups, a voltage applied to the potential wells sends each stored picture element scampering from one capacitor to the next in bucket-brigade fashion. From left to right across each row, the image fragments migrate from the top to the bottom of the optic at the

physical abuse. Compared to delicate vacuum tubes, chips are less susceptible to damage from shock and vibration. Semiconductors also suffer no after-image lag, or streaking, comet-trail effect when the camera is passed across lights or bright images.

More important still, a solid-state sensor won't burn out or sustain permanent injury if it's aimed directly at a bright light, such as the sun. This could

MINI-VIDCAM OPERATING FEATURES



Price differences depend on number and sophistication of features. Compare the tubeless handholds above. NEC's (\$949) has manual focus, two-position color temperature selector. Hitachi's (\$1125) has auto-focus, four-temperature selector, more.

severely damage or destroy a tube.

How does solid-state imaging quality compare to that of tube pickups? At this writing, it's no better and, depending on the way you use your camera, no worse.

Until recently, tubeless cameras were noisier and less sensitive in low-light conditions than the best conventional cameras. In other words, cameras with large-diameter pickup tubes did a bet-

ter job of reproducing colors in low ambient light. Lately, though, manufacturers have improved the low-light sensitivity of their tubeless cameras. For example, RCA rates its CLC020 at 10 lux—a match for any tube camera.

The question of low-light color quality is really academic—unless you plan to do most of your moviemaking by candlelight. An understanding of light ratings will make this apparent.

For videocameras, the minimum amount of light needed to record an image is expressed in *lux*. Think of it in terms of the ASA ratings on photographic film, with one exception. The higher the ASA number on a roll of film, the more capable it is of producing images in low light. With vidcams, the lower the lux number, the better the camera's low-light performance.

Lux is a metric equivalent of the footcandle measure. One footcandle is the illumination a single candle sheds over 1 foot in a dark room. It takes about 10 lux to make a footcandle.

Let's put lux in perspective, starting with 10, since that's the best rating of any vidcam available (most camera's on the market today are below 60 lux).

It's generally agreed that the illumination level of a softly lit, moderately sized room is about 60 lux—100 if the light is fluorescent. Church interiors, and amusement parks at night, measure about the same. Offices and department stores hit 500 to 700 lux. Sunlight outdoors one hour before sunset registers 1000. One hour after sunrise it's 2000—in cloudy weather. High noon on a sparkling day is tens of thousands of lux brighter.

Given these examples, it's obvious that most indoor and outdoor shooting situations are well within the capability of any videocamera—including the tubeless type. So for the present, you'll have to balance the benefits of reduced size and weight against extreme low-light sensitivity.

Wave of the future

In the long run, though, solid-state pickups are the wave of the future. They make possible such marvels as Sony's new Mini-8—a 2-pound camcorder the size of a paperback dictionary (see *Electronics Monitor*, page 12). Imaging quality has nowhere to go but up. Today's optics contain about 200,000 picture elements, but prototypes with twice that amount have been demonstrated by Fuji and Philips. The latter company, in fact, speculates that such tiny, powerful sensors will make it possible to build a videocamera no larger than a pack of cigarettes.

As it is, space is pretty tight on the tiny tubeless vidcams. That's because semiconductor imaging is pretty much confined to top-of-the-line models loaded with convenience features such as auto focus, auto-iris exposure control and automatic color balancing.

Ease of operation is important in a videocamera, and only you can decide if the size and placement of the controls is convenient. There's no substitute for hands-on testing. If you rent a tubeless vidcam before you buy, you'll be able to judge operating ease and video quality at the same time.

PM

S. CHEVY vs



DODGE vs. FORD vs. ISUZU vs. NISSAN vs. SUBARU vs.

4-WHEEL-DRIVE PICKUPS **TORTURE TEST**

We took 8 mini pickups into the woods to see what they could do.

Let's talk trucks. Specifically, mini pickups with 4-wheel drive. You can buy a 4-wheel-drive mini for less than \$10,000, and it will do just about any job you can think up, from running down to the store for groceries to running down to Tierra del Fuego.

A 4x4 mini will get you to that remote cabin at the lake and out again, or into a muddy construction site with half a ton of equipment. It will earn you admiring glances on Main Street, in Atlanta or Anchorage.

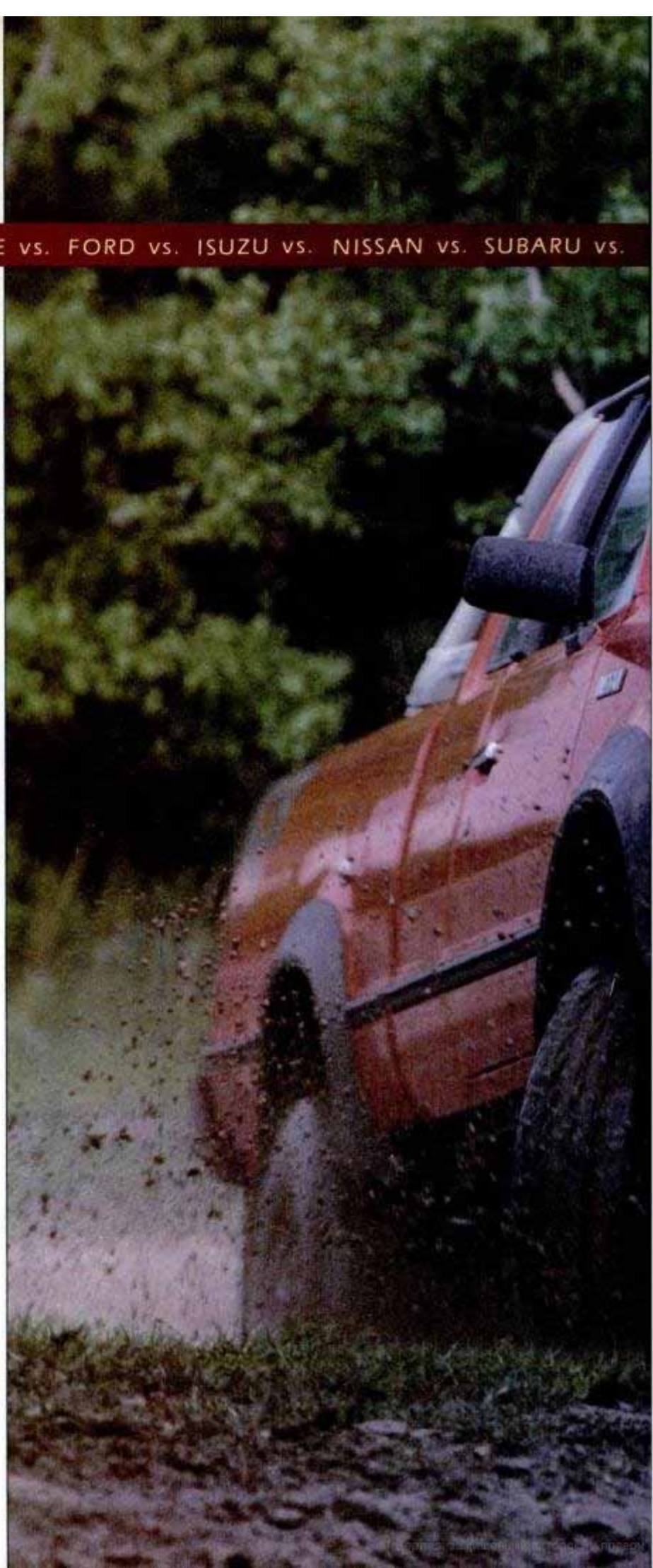
It will also get your kids safely to school in the middle of a snowstorm, or your wife to the airport when the roads are flooded. Indeed, a 4x4 mini is just about the most versatile vehicle that you can buy. It is the ultimate combination of go-anywhere practicality and do-anything fun.

We identified eight 4x4 minis currently offered on the U.S. market—four built in America and four in Japan. The newest is Jeep's Comanche. We borrowed AMC's only Comanche prototype months before it was driven by any other reporters. We also had the best-selling Chevrolet S-10 and Ford Ranger, as well as Nissan's made-in-Tennessee King Cab.

From Japan came the Dodge Power Ram 50—also sold here by Mitsubishi dealers—plus pickups from Toyota and Isuzu. To round out the group, we included Subaru's little BRAT. It's not a pickup truck in the conventional sense, but if it's not a 4x4 pickup, then what *is* it?

To see how they worked, we assembled all eight trucks at Camelback Mountain in Tan-

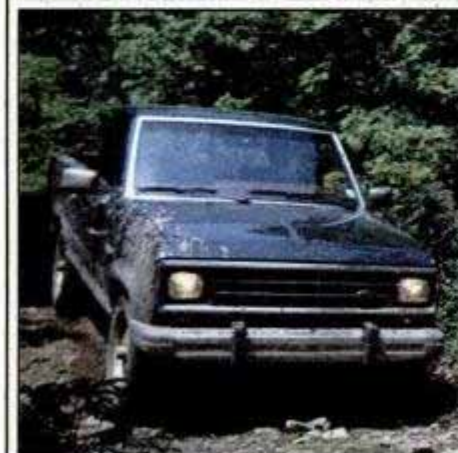
Nissan ST pickup was one tough truck off-road (right), despite long wheelbase for extended cab. High-riding Toyota (top) was set up best for off-road work, but suffered on pavement as a result.



CHEVY vs. DODGE vs. FORD vs. ISUZU vs. JEEP vs. NISSAN vs. SUBARU vs. TOYOTA vs.



TORTURE TEST



Clockwise from upper left: Dodge/Mitsubishi took all the abuse we could deal out. Extended-cab Chevy S-10 was a backwoods limo. Isuzu performance was surprising, despite diesel power. Subaru's BRAT kept up with the big boys. Jeep's new Comanche is a good all-around design. Ford's Ranger was ultraplush, but it could have been optioned tougher to handle off-road work.



nersville, Pennsylvania, where we drove them over forest trails, fire roads, abandoned railroad beds, an Interstate Highway and a winding 2-lane asphalt road at everything from a low-range crawl to high-gear hang-on-and-pray. We went through mud, rock, gravel and tall grass, not to mention high water.

In addition, our art director had us bouncing, sliding and jumping trucks for the photographers—torturing them in diabolical ways you'd never dream of if they were your own. Did you know that when you jump a Nissan 8 feet in the air it will land on all fours, but a Power Ram will try to barrel roll to the left? You'll have to take our word for it.

Amazingly, all eight trucks and drivers survived two days of this "testing." We blew four tires, bent a couple of tie rods and scratched some paint.

We ranked each truck separately for its on-road and off-road performance, then combined the two to come up with

our overall rating. All three ratings represent a consensus of the group, rather than one man's opinion. Here's how our testers picked 'em, listed in order of preference.

Chevrolet S-10

We found out that it's always important to check the right boxes on the order blank. Our S-10 4x4 had a stretch cab, 2.8-liter V6, top-line Sport interior, optional alloy wheels and Off-Road Chassis Package. All of these are the right options. The option we shouldn't have ordered was the 4-speed automatic. Next time we'll get a 5-speed manual for greatly improved driveability and economy.

The S-10—which is also available from GMC dealers as the S-15—was rated the best mini for on-road driving.

Produced by the PM Auto Dept.
Text by Rich Taylor
Photos by Peter Tenzer

Its extremely long 122.9-in. wheelbase gives it a much smoother ride than shorter wheelbase trucks, though the off-road suspension is harsh over expansion joints and potholes.

We liked just about everything else about the S-10. The exterior styling was called "timeless and attractive, boxy without being chunky." The interior was "consistently attractive and functional throughout." We liked the full instrumentation, terrific Delco sound system and Camaro-like bucket seats.

The best feature of the S-10 is the stretch cab, which adds 15 in. of priceless inside storage. The two fold-down jump seats are more comfortable than the back seat in some 4-passenger cars we could name, but when you strap kids back there they tend to bang into the walls at every quick start or stop. On-road, the S-10 stretch functions as a 2+2 GT car, which just happens to have a half-ton load rating and lots of room to

(Please turn to page 121)

'Mr. Watson, Come Here, I Want You.'

Today's high-tech phones let you dial with your voice. The latest cordless models keep strange voices off of your line. And home control is just a call away.

BY MARC STERN; Photos by Layman/Newman

Yes, Virginia, this is a telephone! TTC's voice recognition phone means hands-free dialing.



Alexander Graham Bell didn't have to dial when he surprised his colleague Watson with the first phone call back in 1873. Bell would feel right at home today with the latest telephones PM has been checking out.

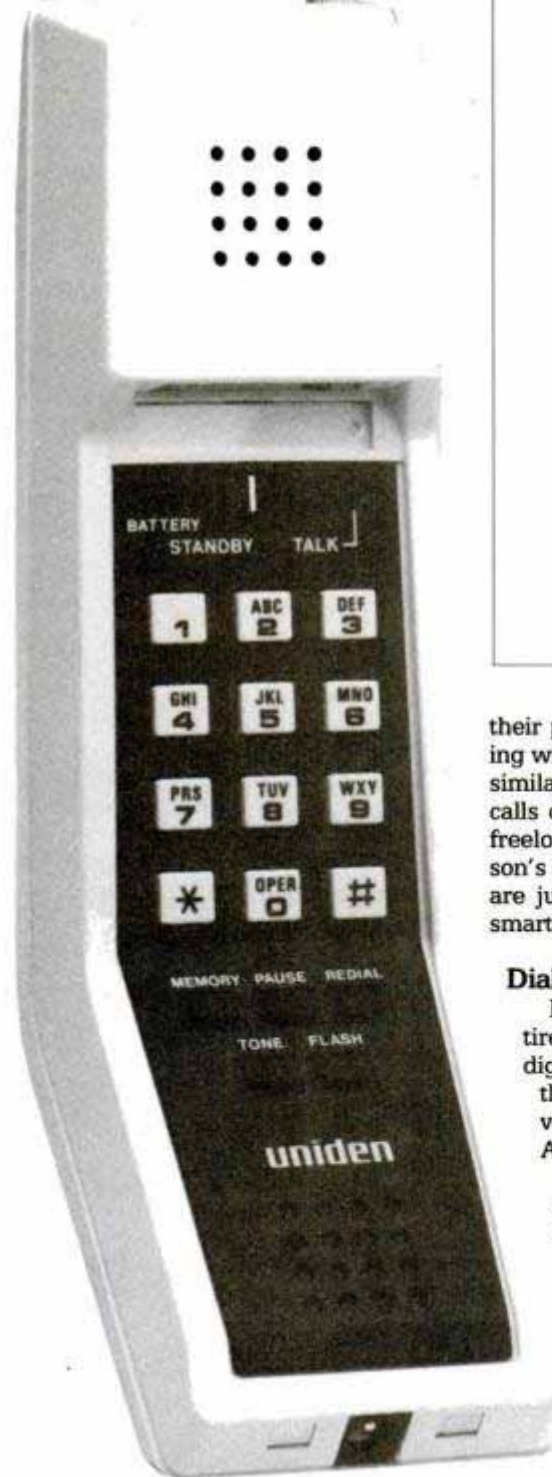
Instead of dialing his assistant's number, Bell could merely say "Watson," and a supersmart phone would recognize the spoken name, match it to the right preprogrammed number and make the call. In his vacation home miles away, Watson would no longer

have to hang around the house waiting for Bell to ring. Instead, he might choose to speak to the boss from poolside over his state-of-the-art cordless phone.

The call would go through, even if Watson's neighbors were using their cordless phones. That's because the latest models will scan 10 frequencies for a clear channel. Bell and Watson wouldn't worry about another cordless user accidentally picking up their conversation: Digital scrambling between the cordless receiver and its base unit in the home would ensure

PHONES

The latest cordless telephones, like Uniden's EX-3810 (below), offer 10 channels between the base unit at home and the portable receiver. They'll keep your conversations private by scrambling the over-the-air radio signal. And freeloaders can't make calls on your security code. Cordless telephones, though, aren't ready for voice recognition yet.



Mura's cordless MP-900 and multifeatured base unit.



Unitech's CPR-2700 cordless has AM/FM clock radio.

their privacy. Moreover, no one sneaking within range of the base unit with a similar cordless phone could charge calls on Watson's dime. The would-be freeloader would have to know Watson's personal security number. These are just a few of the tricks the latest smart phones can perform.

Dial-less phones

Relief is on the way for fingers tired of walking through 10 or more digits to dial or punch a call. Right at the cutting edge of technology are voice-recognition telephones from Audec and TTC.

Voice recognition is a lot more sophisticated than voice activation. With the latter, simple sound triggers a device (such as a room light) to begin operating. In comparison, voice-recognition products are programmed to respond to human language.

To accomplish this, the voice-recognition device analyzes your voice print, converts it to a

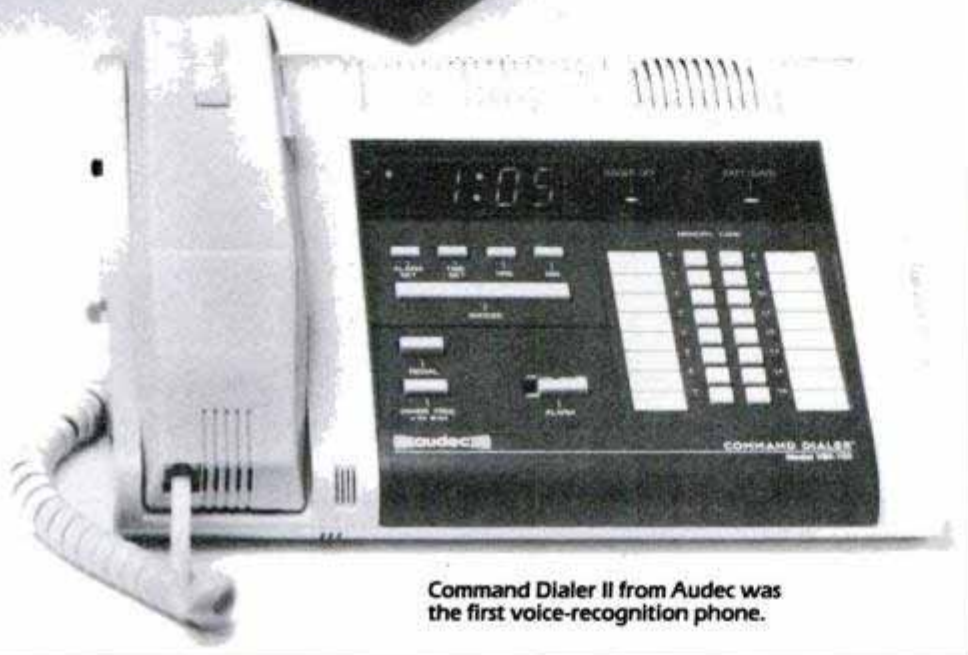
digital code and memorizes the pattern during the programming stage. Any subsequent command is compared against the original prints. When the device finds one that matches—let's say, the particular voice-print pattern that represents 555-1212—it executes the command. There is, by the way, an inherent security factor in this: The device can respond only to the voice patterns it has memorized.

TTC's "dial-less" phone will recognize up to four different voices. Audec's Command Dialer II can memorize several. These phones aren't dial-less in the true sense (a regular keypad is concealed under the TTC's front panel) because, in fact, you need a dialing mechanism to program them.

With either phone, you punch in a number then say the party's name—"Mom," for example. TTC's top-of-the-line model can store 80 numbers; Audec's holds 16. To complete a call, you say, "Dial." As an extra security measure, both phones require you to identify yourself with a code number.



Quasar's phone wakes you up to black-and-white TV.



Command Dialer II from Audec was the first voice-recognition phone.

Cordless improvements

Cordless technology is much improved today compared to what was available just a few years ago. This owes in large part to the switchover to the 46-49 MHz (megahertz) band from the 1.7 MHz frequency where cordless phones made their debut. Cordless phones are really low-power radiotelephones. The base unit connected to the wall jack at home transmits to the cordless receiver over radio waves, with 1000 feet the maximum range.

One problem that plagued the old 1.7 MHz phones was overcrowding. Only three send/receive channels were available on that frequency, so if a lot of cordless phones were in use within range of each other, some users might not get a channel. Worse yet, they might get someone else's conversation.

The shift to 46-49 MHz eases the overcrowding by opening 10 send/receive channels for cordless communication. Top-of-the-line units will scan the 10 channels to find a clear one.

There's always the danger, though,

that overcrowding in a tight vicinity might lead to inadvertent conference calls among neighbors. The best cordless phones use digital technology to scramble conversations at the base unit and unscramble them at the receiver end. And a security code must be used before an outside call can be made.

What's next?

With cordless phones selling at the rate of 5 million a year, industry experts predict that overcrowding will re-emerge within the next two to five years. But maybe it won't: By the time you read this, Mura Corp. will have introduced its Anywhere Phone.

Instead of using radio waves, the portable phone receives conversations through household AC wiring. Household wiring, in fact, promises to make the telephone more than a communications medium. For example, Quasar's smart phone will wake you to TV or radio. Telephone's next act is home control and security.

There are already several smart

phones that will, at the press of a panic button, instantly dial a preprogrammed number and play a message you've recorded requesting assistance. In the not-too-distant future, some of the home control and security systems just now being demonstrated will make those calls themselves (see *Make Your Home A Smart House*, page 98, Apr. '84). For example, the system would monitor noise levels, locks and windows. If something's amiss, the system will make a call to any number you've designated and report the situation in a synthesized voice.

How home control systems operate is another subject entirely, but the telephone represents the remote link. By Christmas, in fact, you'll be able to call home and switch on the lights, turn up the heat or control just about any appliance. Mura's soon-to-be-released F-6 phone will connect to a control module plugged into a nearby wall outlet. Codes punched into a touch-tone phone will send commands over household wiring to any appliance.

It may be time for you to dump that old dial phone. **FM**



Comdial's Series 2001 tabletop speakerphone will let you wander as you converse.

STEAM'S BACK ON THE FAST TRACK

A revival of the steam engine is promised by new technologies and a longing for the romance of the old locomotives.

BY WILLIAM HOFFER; Photo by Roy Blanchard

The journey to Paradise begins with a jolt.

This is no smooth-as-silk start such as you get with a diesel-electric locomotive. A steam locomotive needs leverage. Indeed, that is why railroad cars have always been built with flexible couplings, so that a steam locomotive can nudge them backward and then use the resulting bounce to set its pistons into motion.

If a few modern railroad visionaries realize their dream, you may soon feel that delicious jolt once more as a new generation of steam locomotives—more efficient to operate than diesel-electrics—comes into service on American railroads.

At present, the American steam engine is a romance that stirs memories in any heart that ever thrilled at a great white puff billowing from a giant smokestack.

Banking on that devotion, a growing number of tourist lines offer nostalgic rides into the past, pulled by steam locomotives such as old Number 90, which took me to Paradise, Pennsylvania, on my quest for the story of new railroad technology. Built in 1924 by the Baldwin Locomotive Works, it stands 14 feet, 10 inches tall and weighs in (with its tender) at 106 tons. The locomotive can carry 8571 gallons of water and 18½ tons of coal to feed its voracious appetite.

For the first 40 years of its existence, Number 90 hauled sugar beets across Colorado for the Great Western Railway. Today, it lumbers slowly along standard-gauge track through the Pennsylvania Dutch country of Lancaster County. It passes the Red Caboose Lodge, where the motel rooms really are genuine red cabooses. It climbs a slight grade to Cherry Hill where the station sign reads "Pop. 17 (more or less)."

Amish farmers wave from their horse-

drawn buggies. Number 90 is pulling a full load of passengers today, as it does every weekend, on a nine-mile-round-trip tourist jaunt from Strasburg to Paradise and back.

But the Strasburg Rail Road, chartered on June 9, 1832, is much more than just another tourist line. "We're an honest-to-goodness railroad," notes Vice President Ellis Bachman. "We are a public utility regulated by the Interstate Commerce Commission."

One of the original short-line railroads, the Strasburg line still serves this little community as the link to the old Pennsylvania Railroad main line at Paradise. Its major freight cargo is plastic pellets, shipped from Texas to the General Battery Co. "There are 100 tons of plastic in each boxcar," Bachman says. "We usually pull five or six cars at a time. Our biggest run ever was 900 tons."

The fact is, for all the problems they created with noise, steam and ashes, for all their voracious guzzling of coal and water (which limited their range to 100 miles or less between fuel stops) steam locomotives have never relinquished their advantage in one critical area. No one has ever built a diesel-electric locomotive that can outmuscle the grand old steam locomotive. Because of that fact, and because the cost of diesel fuel has skyrocketed in past decades, designers are taking a brand new look at an old technology. The steam locomotive just might be making a comeback.

"The day we make our first successful run, the diesel plants will be on the way to being obsolete," predicts Ross E. Rowland, Jr., a man with a steam-powered dream. Last January, Rowland, who is a member of Amtrak's board of directors, fired up Number 614 for a

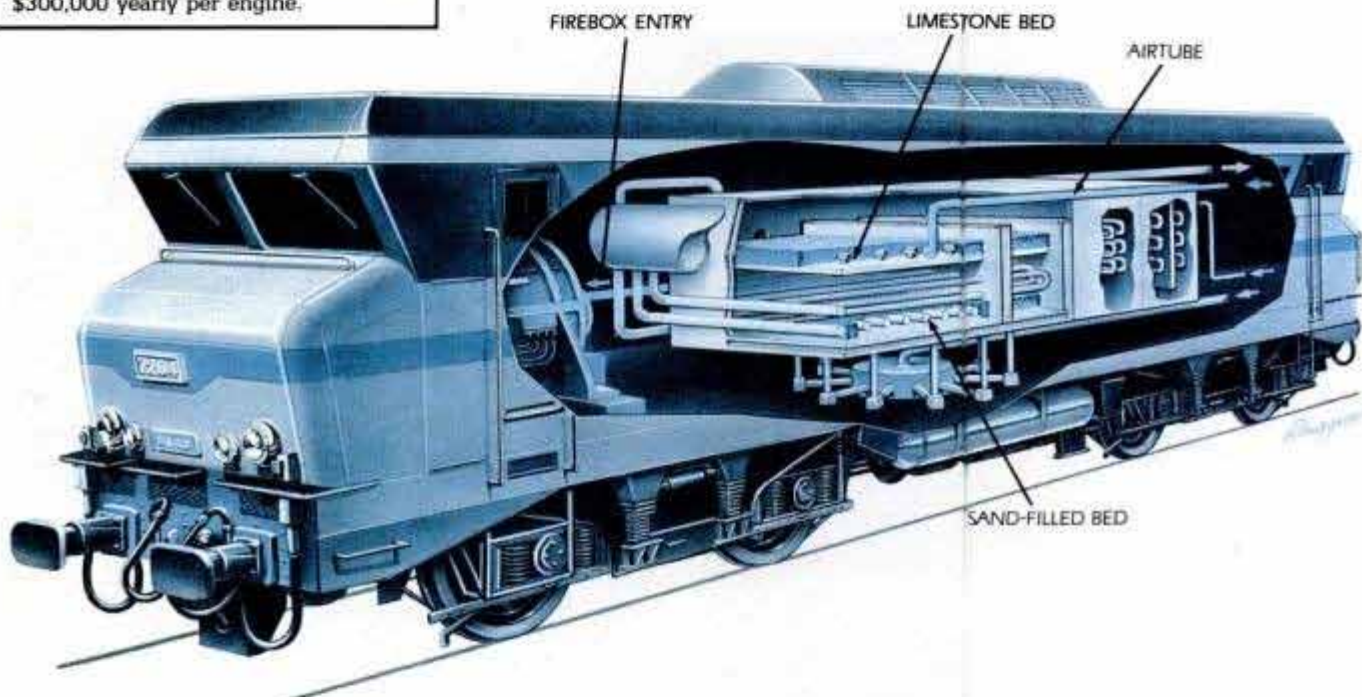
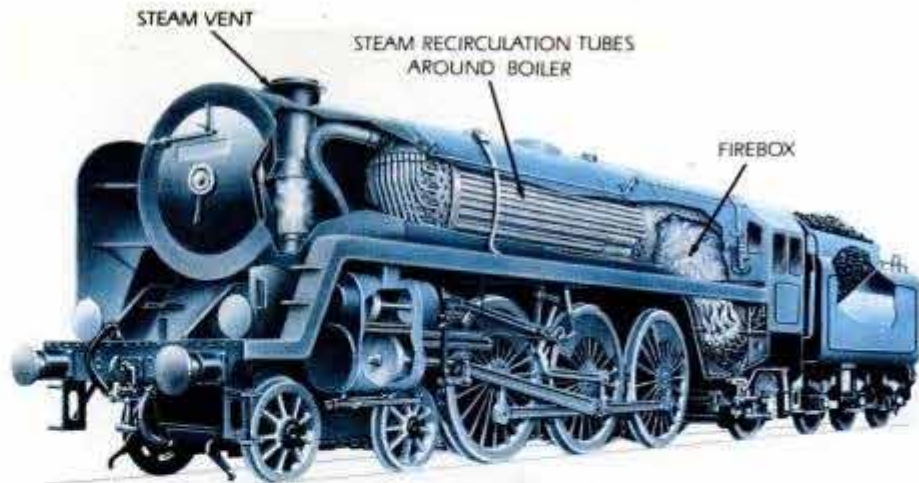
Engine Number 90 consumes 18½ tons of coal on a day's run. The engine, once in retirement, now hauls tourists.



How new engines work

Artist's conception of two future steam engines shows newest technologies. The American Coal Enterprises engine (top) would put out little steam, since it would be recirculated through pipes around the boiler. A steam vent would bleed off small amounts. Prepackaged coal would be fed into the firebox automatically from a coal tender. The ACE engine's operation costs would be half that of diesel.

The National Steam Propulsion engine would process fuel through a pair of air-blown "fluidized beds," a limestone bed on top and a sand-filled bed on bottom. The system makes coal-burning a clean process. The waste product is gypsum and limestone, which can be used to make construction materials. The system, known as the Wormser Grate, would make it possible to burn the cheapest fuels to save more than \$300,000 yearly per engine.



The Chattanooga Choo Choo And Smoke Gets In Your Eyes

Number 611 chugs along at the head of an elongated train of 21 coaches, pulling nearly 1000 nostalgia buffs along 150 miles of track between Atlanta and Chattanooga. This is one of 90 steam locomotive excursions that Norfolk Southern Railway will run this year between various U.S. cities. This particular trip is cosponsored by the Atlanta Chapter of the National Railroad Historical Society. Tickets are hard to come by.

Families dig into their picnic coolers. Grandparents shepherd wide-eyed children through the crowded aisles. Scores of sightseers cluster on the two old-fashioned open coaches where, through eyes protected by goggles, they can get a better view of Number 611 at the head of the procession. Everyone along the route pauses to stare at the relic reminiscent of the glory years of American railroading. No one can resist a wave.

"I cut my teeth on steam locomotives," Bill Purdie declares from his seat in the VIP club car. "Diesels, well, yeah, they save the railroads. But they're not as personable as steam locomotives." Purdie is retired now from his career as a master mechanic for Norfolk Southern, but he well remembers the day in 1981 when Number 611 was towed into his roundhouse in Birmingham and he was given the job of restoring her.

"There were 14 of her class built, but all the others were

scrapped," he says. "If they'd have just stayed with the steam locomotive a little longer, they'd have improved it. And the diesel would've had a tough time taking over."

Three hours into her journey to Chattanooga, Number 611 stops on a deserted straightaway near Phelps, Georgia, for a photo run-by. Passengers disembark and gather alongside the track. Number 611 slowly backs up, preparing to roar past the onlookers at full speed.

Puffs of black smoke suddenly shoot skyward from the stack of Number 611 as, in the distance, the streamlined behemoth begins her run. Her ball-bearing construction—an innovation when she was built in 1950—allows her to gain speed much more quickly than her primitive ancestors.

You can feel the power—perhaps even more than you can hear the accelerating, approaching roar. Down the track she comes, her sharp chugging sound echoing off the distant Appalachians, her steam whistle shrieking the banshee call of a past age of glory.

Suddenly, she is *there* encompassing your every sense, a more powerful presence than any diesel-electric locomotive ever built. Her sheer size is staggering. She explodes past, spewing a thick black cloud that quickly descends upon her band of admirers.

Cinders attack your clothing and lodge in your hair.

Smoke gets in your eyes.—W.H.



150-mile run from Huntington to Hinton, West Virginia, pulling 3500 tons of coal along the tracks of the Chessie System. Children lined the route to see the glorious sight of the old-fashioned train as it bellowed smoke out over the countryside. Rowland delighted them by tooting the steam whistle frequently.

Number 614 was one of the last steam engines built in America. The Lima Locomotive Works popularly referred to it as a "Super Power" locomotive. It had an overly large firebox and improved features to utilize as much steam as possible for power. When the Chesapeake & Ohio Railway took delivery of Number 614 in the summer of 1948, it immediately put it into service on its passenger line running between Hinton and Charlottesville, Virginia, the most rugged section of the C&O main

line, rising up and over two separate mountain ranges. Due to its excellent performance, the C&O was able to extend Number 614's run all the way to Newport News, Virginia, a total distance of 347 miles. Weighing in at 434.2 tons, its drive wheels standing 74 inches tall, Number 614 was nonetheless doomed to a short life. New technology reared its head.

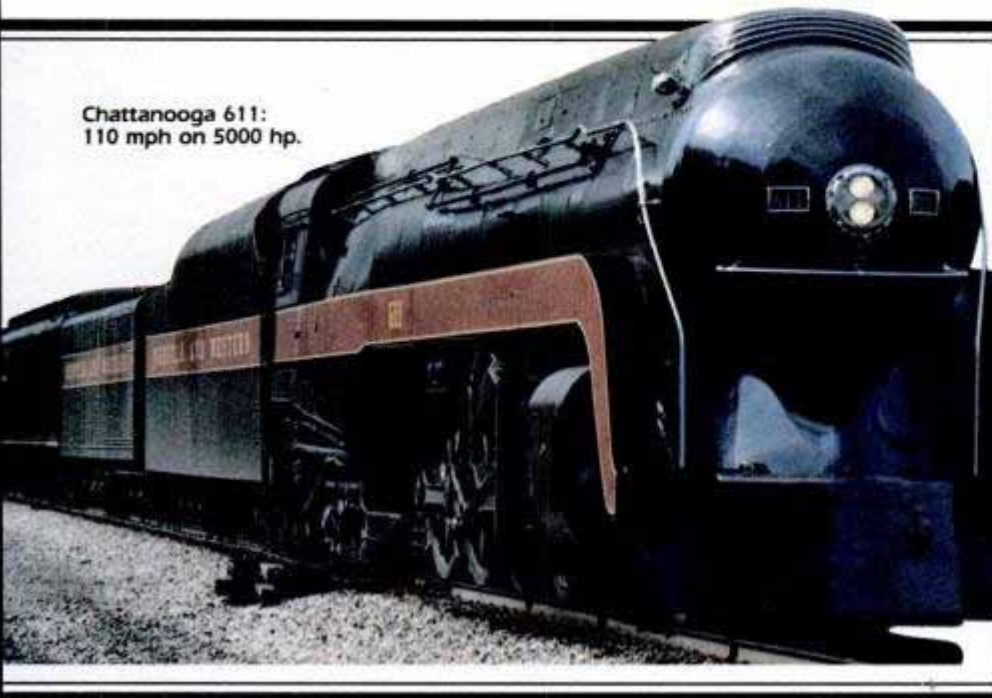
In 1952, after only four years of service, Number 614 was bumped off the elite passenger line by the incoming diesel-electrics. It hauled coal for another four years before being shunted off to early retirement.

Most who came to view it at the B&O Railroad Museum in Baltimore saw it as a relic of the past. Rowland, however, had a special vision. When steam locomotives were discarded three decades

The Strasburg Railroad (above) carries a full line of passengers each weekend. The railroad maintains its own shop (below).



Chattanooga 611:
110 mph on 5000 hp.



ago, their death knell sounded so quickly that no one thought to apply new technology to them.

But Rowland had never forgotten the big, beautiful beasts. In 1966 he founded the High Iron Co., which restored steam locomotives and ran them on nostalgic excursions throughout the Northeast. The Freedom Train was Rowland's contribution to the American bicentennial celebration. The half-mile long, red-white-and-blue train was pulled by a steam locomotive through 48 states.

But nostalgia was not enough for Rowland. In 1980, he founded American Coal Enterprises (ACE) and announced his ACE 3000 program to combine 150 years of locomotive development experience with major engineering advances that have occurred in the last 40 years.

Thus it was that Number 614 lum-
(Please turn to page 114)

COASTAL KAYAKS

Bigger than their whitewater cousins, these 1- and 2-man paddle boats are designed for long-haul seaside excursions.



PHOTO BY EASTERN AT SEA

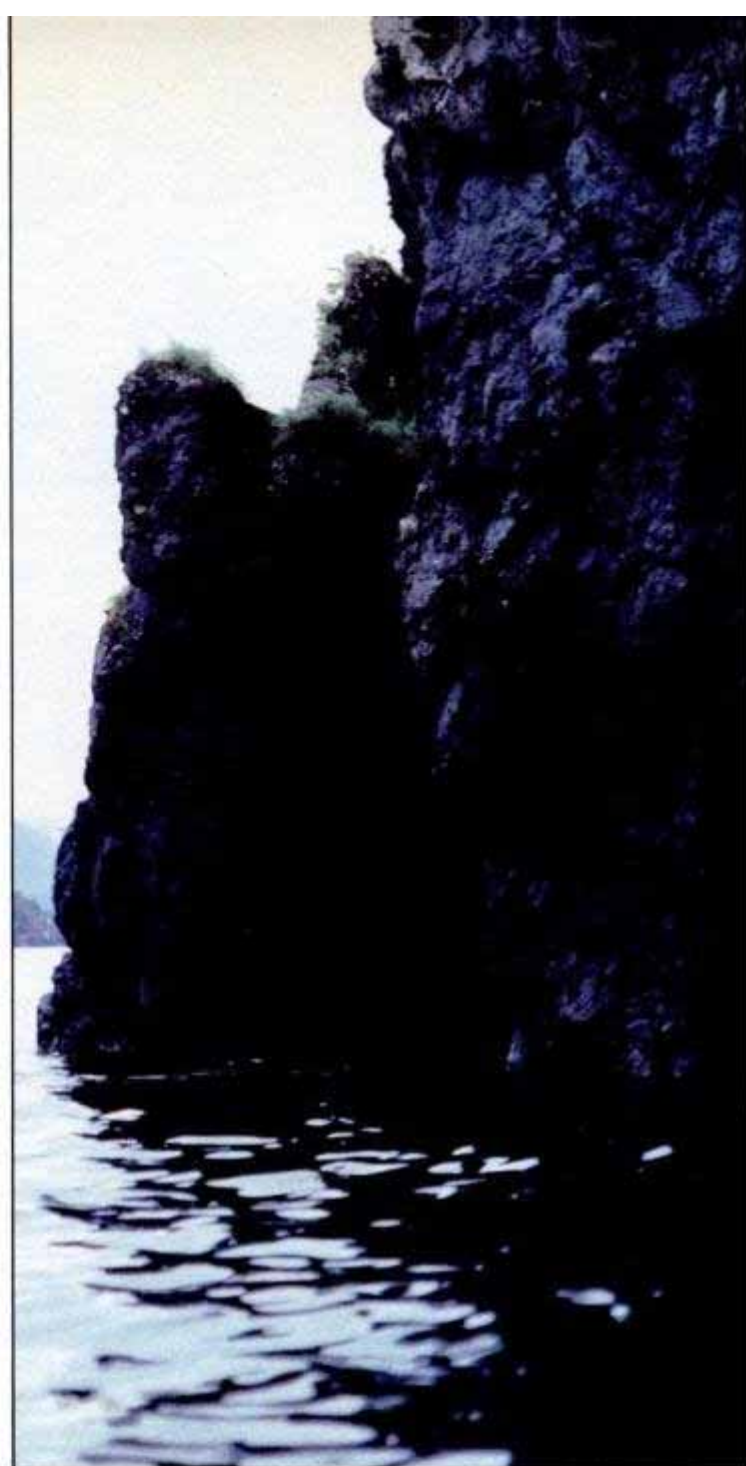
Sea kayaker in Maine aboard a Dirigo 17. Note boat's volume, high cockpit coaming.

BY CLIFF GROMER

It's lunchtime on the Kenai Peninsula, and we've just become the *plat du jour*. Paddling our kayaks around a corner in the craggy shoreline of Prince William Sound, Alaska, the awesomeness of the landscape suddenly takes a back seat to the awesomeness of 15 killer whales coming at us on the surface like a pack of torpedoes. Our tight formation of seven kayaks disintegrates into a frenzied rout.

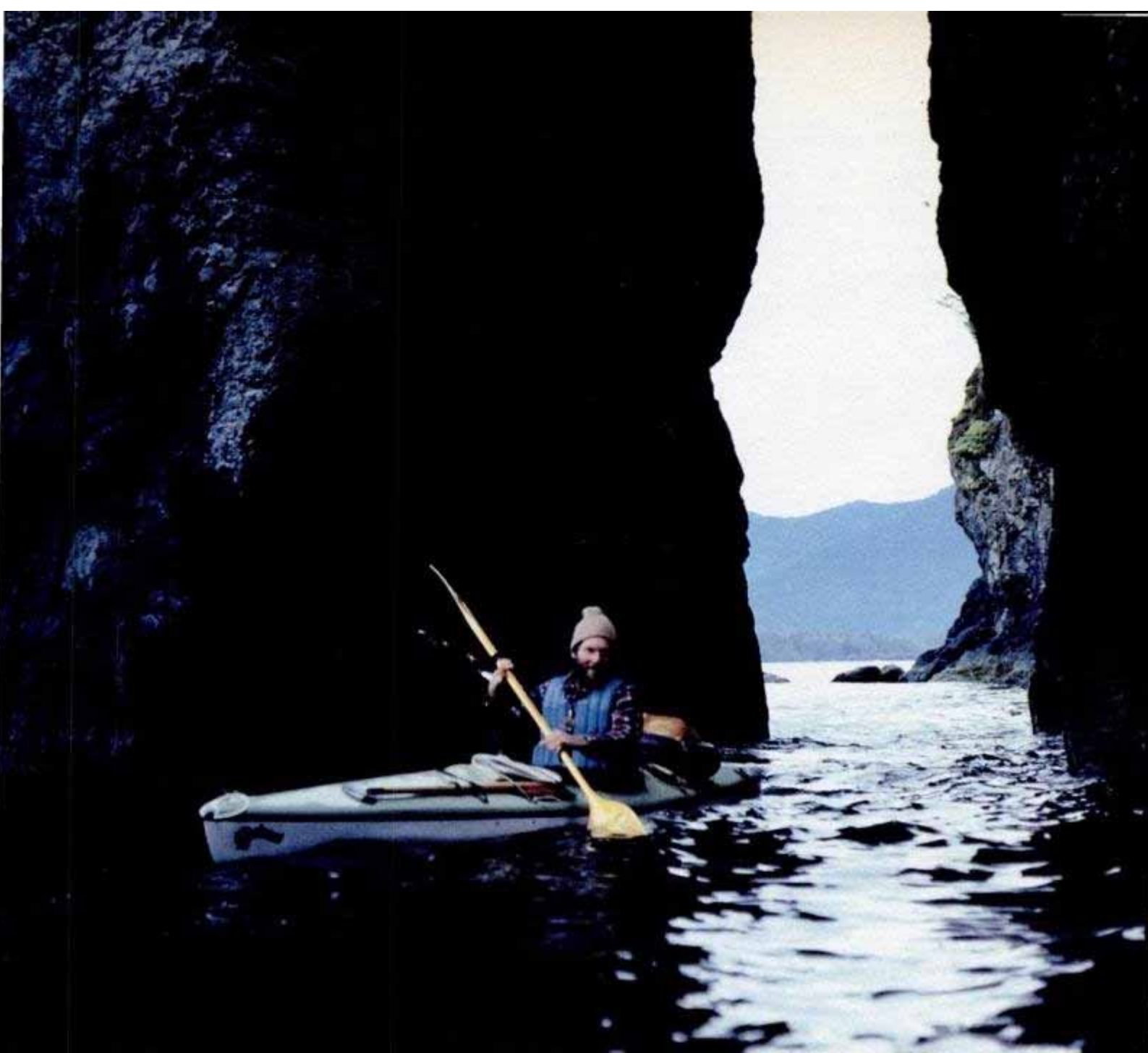
The whales keep coming until, 20 feet away, they pass underneath us and reappear on our other side. Welcome to sea kayaking. If you're looking for a new challenge, you've come to the right place.

Unlike river kayaking—battling raging rapids engulfed in cascades of whitewater whipped up by some invisible giant mixmaster—sea kayaking offers a different kind of ride. Our route takes us some 250 miles around Alaska's Prince William Sound and captures the essence of cruising in kayaks. We forgo the short bursts of roller-coaster entertainment—craved by the river kayaker—for the long haul of



touring, exploring and experiencing from a waterline perspective an unpolluted shoreline. We paddle through herds of killer whales and drift through masses of sleeping sea otters. We also sneak up and startle a bear foraging on a beach and get close enough to the seagulls to touch them with a paddle. Even more spectacular than the wildlife is the sight of "calving" glaciers. Accompanied by terrific noise and spray, they release masses of ice into the water. In our sea kayaks we can get close to the action—but obviously not too close. Wildlife. Ice floes. The rich scenery. We can achieve a special intimacy with the environment because of the characteristics inherent in the modern sea kayak.

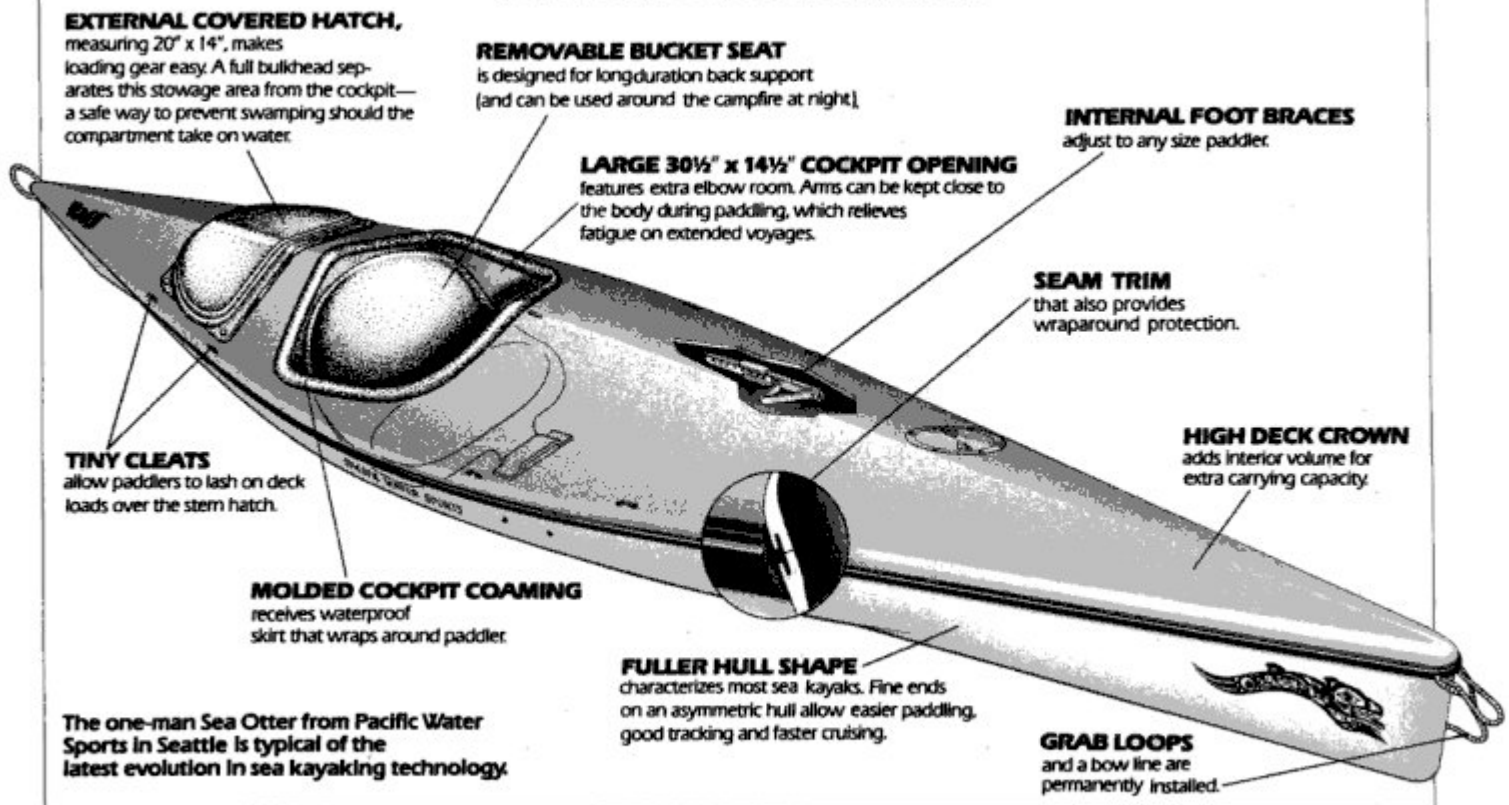
Sea kayaks are longer than their river-running cousins, about 17 feet overall. Hull shape is usually either rounded or V-shaped. They are not as responsive as river kayaks; their mission is to carry paddler and gear in straight lines over long distances. The boats come in folding as well as rigid models.



PHOTOS BY LEE MOYER

A paddler on Alaska's Prince William Sound cruises aboard a single-place Sea Otter. This 16-foot fiberglass model features a special stern hatch for gear. A larger version, the 2-place Sisiuti, joins the Sea Otter in camp (left).

ANATOMY OF A SEA KAYAK



Tried and true sealskin hulls have given way to materials that would leave the Eskimoes of old scratching their heads. Fabrics such as Hypalon—a specially coated nylon used in inflatable boat construction—offers abrasion resistance and won't deteriorate from exposure to ultraviolet rays. While high-strength, low-weight Kevlar is finding its way into the kayaking field, fiberglass has become the material of choice.

Kayaks also come in 1- and 2-place models. Aside from differences in carrying capacity, lower volume boats put the paddler closer to the water and have narrow hulls. While faster and more responsive, they feel more tippy.

If you plan on doing any touring, you'll want a dry spot to stow your gear. Equipment is normally carried in the ends of the boat inside the hull, although, as the photos illustrate, some

gear can be lashed to the kayak's deck. A rudder system on some models, operated by foot pedals attached to cables leading to a stern-mounted rudder, adds directional stability, particularly in a strong crosswind or big sea.

Paddles also come in a wide variety of styles and materials so you can fine-tune paddle selection according to your needs. Graphite models now join traditional wood and fiberglass construction, and blade size is an important factor, especially on long trips. Most women, for example, who don't have the shoulder power men have, may find a feather paddle with a narrow blade easier to use over the long haul.

If you're a first-time kayaker, or just thinking about trying on the sport for size, you'll be amazed at how easy it is. Kayaks are easier to paddle than a canoe, and because they have a lower

profile, they aren't as prone to steering errors caused by windage.

But kayaking is not without its dangers for first-timers. Because it seems so simple, it's easy to get into a situation you may not be able to handle. The biggest danger is capsizing in open water. River kayaking, with all that crashing whitewater, may look a lot more dangerous, but it's not.

If you should capsize at sea, your best chance of survival is to roll the kayak back upright, which can be no small matter when fully loaded. If you fail to roll upright, you have to exit the cockpit, which means tricky currents can separate you from your boat. On top of everything, you're facing the biggest killer of all—hypothermia.

Moreover, sudden wind shifts and tidal changes can turn a placid body of water into a hostile snare. Suddenly, you're in over your head. You might not intentionally paddle out far enough to lose sight of land, but what do you do when an unexpected fog bank rolls in?

The solution is simple. Prepare yourself ahead of time. If you're going to be doing some distance paddling, get two small but well-built compasses—hand-bearing and fixed—and learn the basics of coastal navigation.

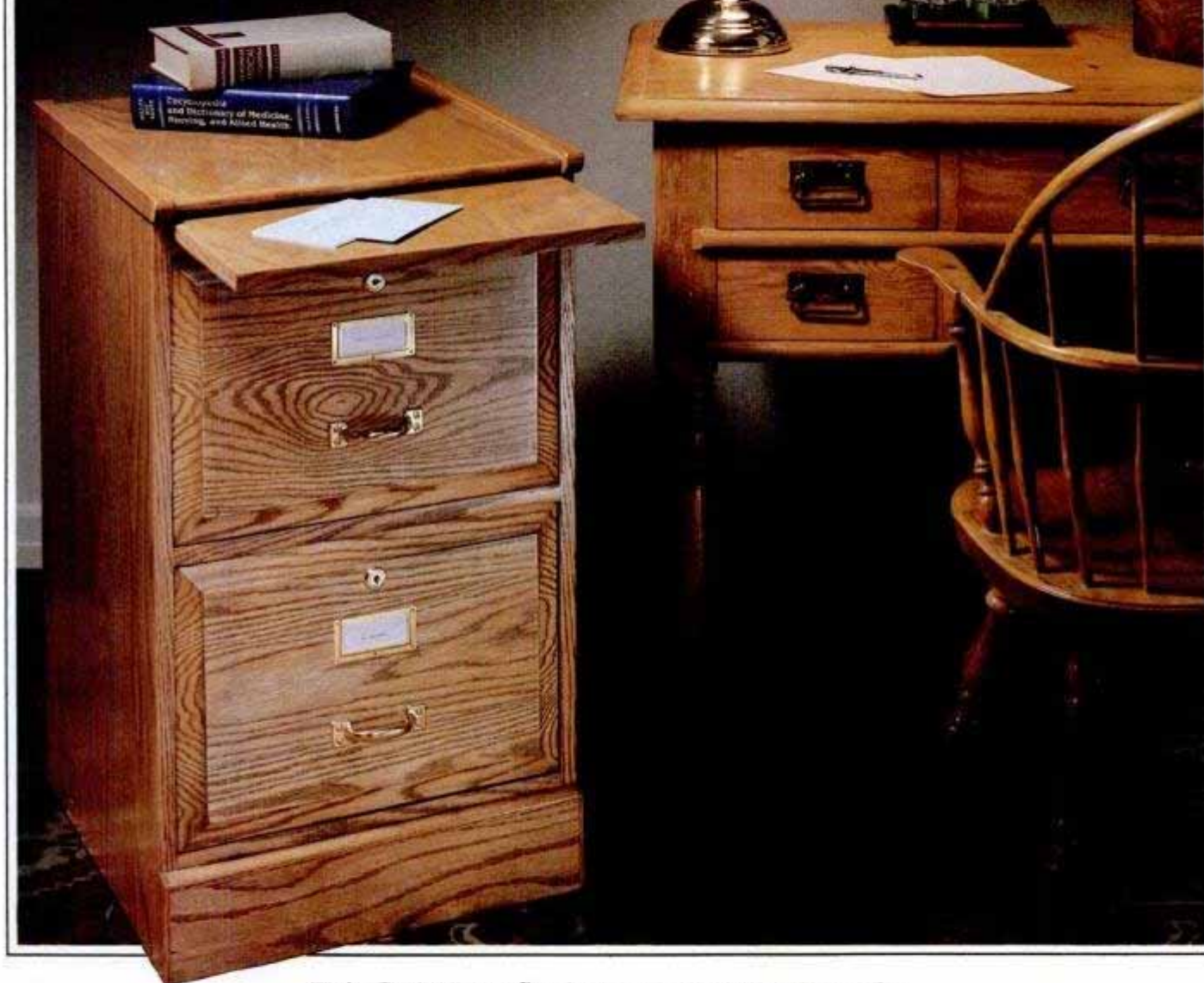
Used with proper judgement, sea kayaking can open up new vistas. You'll be able to navigate areas that are impossible with larger boats. The kayak's shallow draft gives it mobility through marshlands and you'll see more wildlife than you ever knew existed. **PM**

SEA KAYAK MANUFACTURERS

- Aqua Terra, P.O. Box 1357, Easley, SC 29640.
- Dirigo Boatworks, P.O. Box 205, Blue Hill, ME 04614
- Dunn's Custom Built Kayaks, 8991 Gowanda State Rd., Eden, NY 14057
- Easy Rider Canoe & Kayak Co., P.O. Box 88108, Tukwila Br., Seattle, WA 98188
- Ecomarine Ocean Kayak Center, 1668 Duranleau St., Granville Island Maritime Mkt., Vancouver, B.C., Canada V6H 3S4
- Eddylane Kayak Works, Paine Field South Complex #302, Everett, WA 98204
- Feathercraft Kayak Co., 1334 Cartwright St., Vancouver, B.C., Canada V6H 3R8
- Folbot, Inc., P.O. Box 70877, Charleston, SC 29405
- Bart Hauthaway, 640 Boston Post Rd., Weston, MA 02193
- Hans Klepper Corp., 35 Union Square West, New York, NY 10003
- Mariner Kayaks, 1005-X East Spruce, Seattle, WA 98122
- Nimbus Kayak Specialists, #6-2330 Tyner St., Port

- Coquitlam, B.C., Canada V3C 2Z1
- Northstar Kayak And Canoe Co., 40 Ayer Rd., Locust Valley, Long Island, NY 11560
- Northwest Design Works, 12414 Hwy. 995, Everett, WA 98204
- Northwest Ocean/White Water Kayaks, 14307 N.E. 193rd Pl., Woodinville, WA 98072
- Ocean Kayaks Ltd., 47-664 Kam Highway, Kaneohe, HI 96744
- Ocean River Sports #166-560 Johnson St., Victoria, B.C., Canada V8W 3C6
- Pacific Canoe Base, 2155 Dowler Place, Victoria, B.C., Canada V8T 4H2
- Pacific Water Sports, 16205 Pacific Hwy. South, Seattle, WA 98188
- Sea Trek Ocean Kayaking Center, Schoonmaker Pt., Foot of Spring St., Sausalito, CA 94965
- Seaworthy Design Ltd., 1911 North 63rd, Seattle, WA 98103
- West Side Boat Shop, P.O. Box 157, Station B, Buffalo, NY 14207

BUILD A Classic Record Keeper



This 2-drawer file has a pullout manuscript shelf and a hideaway fireproof box.

Once upon a time, file cabinets were made of oak. They had the warmth and elegance of an earlier age—before metal and plastic took over our lives. This reproduction file cabinet harks back to that time. It's made of solid red oak and red oak-veneer plywood.

The cabinet is designed to hold a letter-size security box. We used a Sen-

BY JOHN CAPOTOSTO

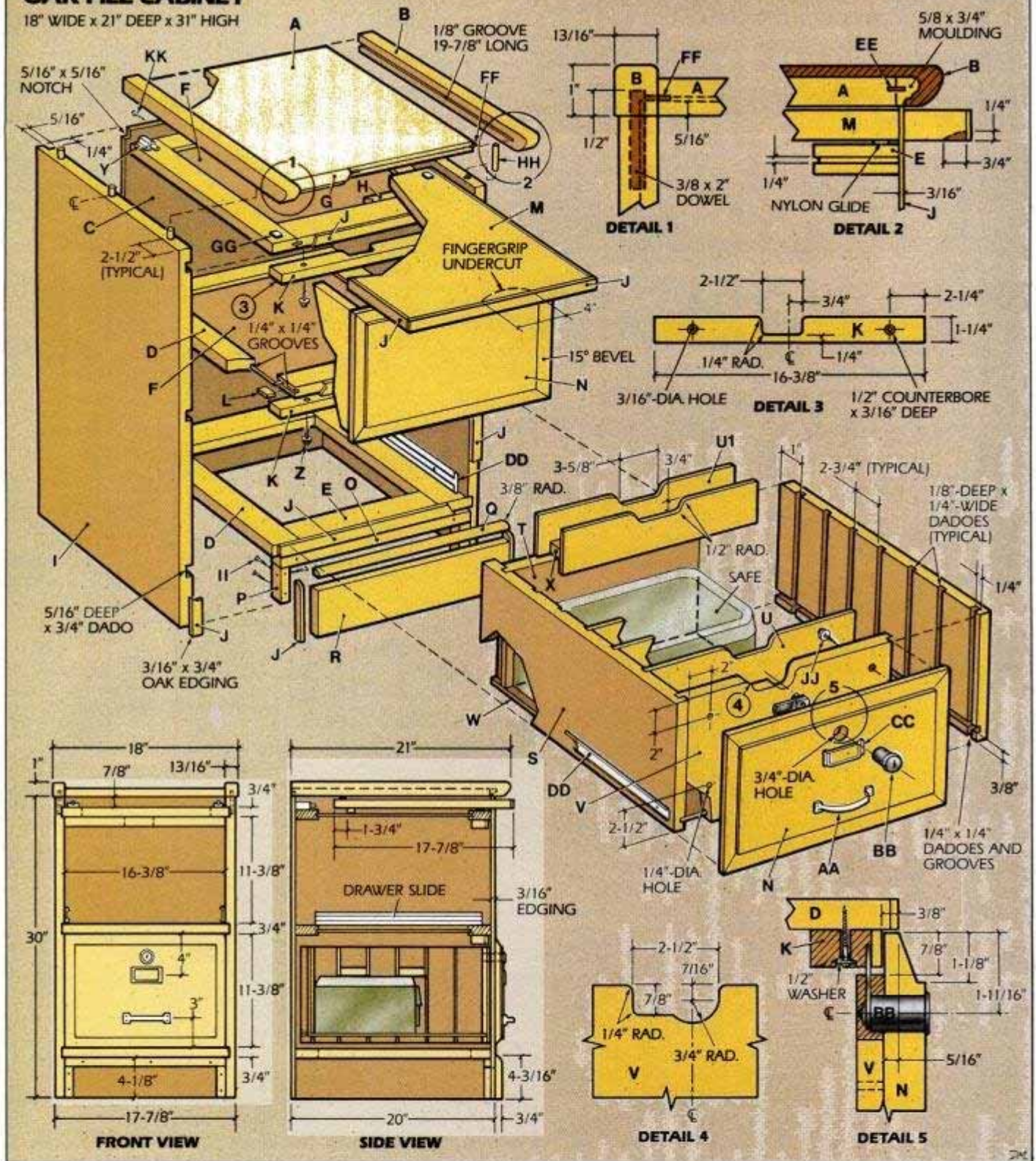
try Safe model 1150, by John D. Brush & Co., E. Northport, NY 11731. It's fire safe for 30 minutes at up to 1550°F., and costs about \$35 at hardware and office supply stores. The safe hides under dummy dividers, which you can camouflage with short file folders. Of

course, if you don't use the safe, make all the dividers full size. Other features include drawer locks, full-extension drawer slides and a manuscript shelf that pops out, activated by a pair of concealed touch latches.

Black and white photos: John Capotosto
Color photos: Harry Hartman
Photo stylist: Gabe Henick
Technical art: Don Mannes

OAK FILE CABINET

18" WIDE x 21" DEEP x 31" HIGH



MATERIALS LIST—OAK FILE CABINET

Key	No.	Size and description (use)
A	1	3/4 x 16 3/16 x 19 7/8" oak plywood (top)
B	2	3 3/16 x 1 x 21" oak (side trim)
C	1	3/4 x 17 x 30 1/4" lauan plywood (back)
D	6	3/4 x 2 x 19 9/16" pine (frame side)
E	6	3/4 x 2 x 13" pine (frame front/back)
F	2	1/4 x 13 7/16 x 16" lauan plywood (dust panel)
G	1	5/8 x 3/4 x 16 3/8" oak (molding)
H	1	1/4 x 5/8 x 11" oak (shelf stop)
I	2	3/4 x 19 13/16 x 30" oak plywood (side)
J	12 ft.	3/16 x 3/4" oak (edging)
K	2	1 3/16 x 1 1/4 x 16 3/8" oak (strike plate)
L	12	1/4 x 1/2 x 1 3/4" lauan plywood (spline)
M	1	3/4 x 15 15/16 x 17 11/16" oak plywood (manuscript shelf)
N	1	1 3/16 x 11 5/16 x 16 5/16" oak (drawer face)
O	1	3/4 x 3/4 x 16 3/8" pine (bottom cleat)
P	2	3/4 x 3/4 x 3 3/8" pine (side cleat)
Q	1	7/16 x 3/4 x 17 1/2" oak (base trim)
R	1	3/4 x 3 3/4 x 17 1/2" oak plywood (toe-board)
S	4	1/2 x 9 3/4 x 19 1/4" lauan plywood (drawer side)
T	2	1/2 x 9 1/4 x 14 7/8" lauan plywood (drawer back)
U	6	1/4 x 9 1/4 x 14 7/8" lauan plywood (divider)
U1	4	1/4 x 3 x 14 7/8" lauan plywood (divider)
V	2	1/2 x 9 3/4 x 14 7/8" lauan plywood (drawer front)
W	2	1/4 x 14 13/16 x 18 1/2" lauan plywood (drawer bottom)
X	2	3/4 x 2 3/4 x 11 1/2" pine (spacer)
Y	2	1 x 1 1/2" touch latch
Z	4	1 1/4" No. 8 rh screw and washer
AA	2	1 x 4" brass-plated pull
BB	2	3/4" dia. x 1 1/2" brass-plated cam lock
CC	2	1 3/4 x 3 1/2" brass label holder
DD	2 pr.	18" full-extension drawer slide
EE	1	1/2 x 1/2 x 15 7/8" oak (spline)
FF	2	1/2 x 1/2 x 19 7/8" oak (spline)
GG	4	1/2 x 5/8" nylon glide
HH	6	3/8 x 2" hardwood dowel
II	14	1/4" No. 6 fh screw
JJ	8	1" No. 8 rh screw and washer
KK	9	5/8" No. 4 fh screw

Drawer slides, pulls, locks, touch latches and nylon glides available from Armor Products, Box 445, East Northport, NY 11731. Request price list #10.

Begin by cutting the cabinet and web frame pieces to size. Mark the position of the six dadoses, and cut them with a $\frac{3}{4}$ -in.-dia. straight bit in a router or a dado blade in a table saw. Cuts must be accurate to ensure a square cabinet and precision-fitting drawers. Also cut $\frac{1}{4}$ -in. \times $\frac{5}{16}$ -in. rabbets in the cabinet sides and top to receive the back.

Cut $\frac{1}{4}$ -in. \times $\frac{1}{4}$ -in. grooves in the frame members. If the plywood for the dust panels and splines is slightly less than $\frac{1}{4}$ -in. thick, adjust the width of these grooves accordingly. Glue and clamp the frames together with the splines and dust panels in place and check the frames for squareness. Do not glue the dust panels—they should float freely in the grooves.

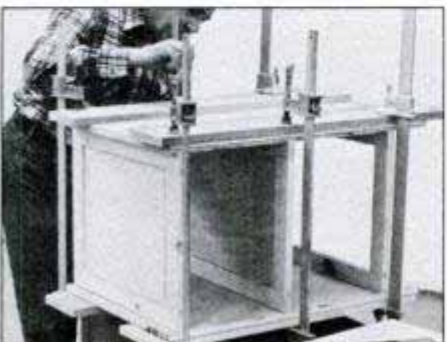
Slightly sand the sharp edges of the frame side pieces with 220-grit abrasive paper. Then, glue the frames into the dadoses and clamp the cabinet.



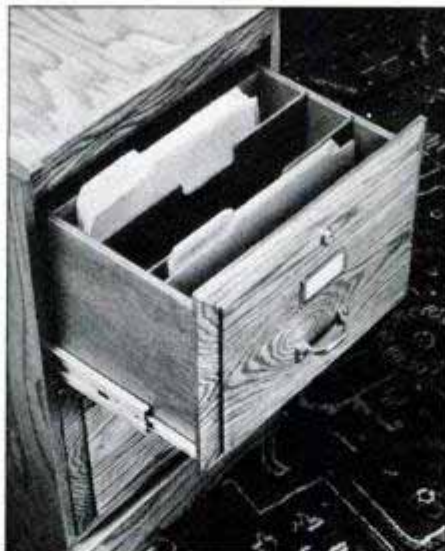
1 Clamp guide blocks to inner surface of cabinet sides and cut dadoses for web frames using a router and straight $\frac{3}{4}$ -in.-dia. bit.



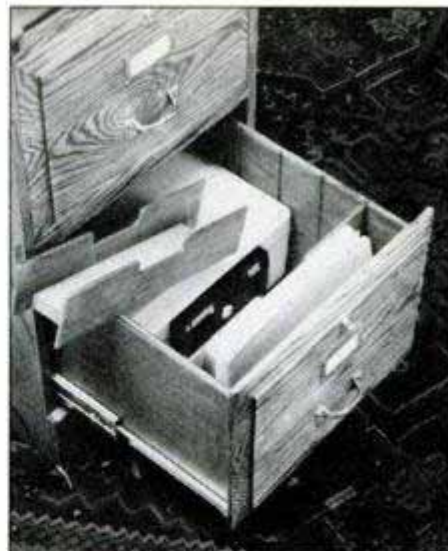
2 Cut $\frac{1}{4}$ -in. grooves in web frame pieces for dust panels and splines. Adjust groove width for under-thickness plywood.



5 Tap opposite side in place and clamp, using boards to avoid marring veneer. Check squareness; shift clamps if necessary.



Lockable file drawers have dadoses cut into sides for $\frac{1}{4}$ -in. lauan plywood dividers. Raised panels and beveled edges of the solid oak drawer faces are cut on table saw.



Fire-safe box fits lower drawer, concealed under dummy dividers. Full-extension slides on both drawers permit easy access to items stored at the back.

Check for squareness, and shift the clamps to bring it square if necessary.

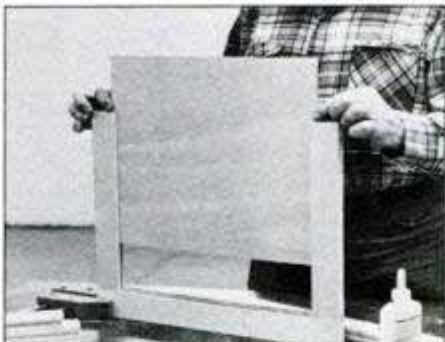
Rip the $\frac{3}{16}$ -in.-thick edging from solid oak. Then, rip these pieces slightly wider than $\frac{3}{4}$ in. so they can be sanded flush easily after they are applied to the plywood. Glue the edging pieces in place and tape them down with strips of masking tape at 2- to 3-in. intervals.

Glue and clamp the top trim (Q) to the toeboard (R). Apply edging, then round over the top trim with a $\frac{3}{8}$ -in.-rad. rounding-over bit. Mount the toeboard to cleats glued and screwed to the sides and lower frame.

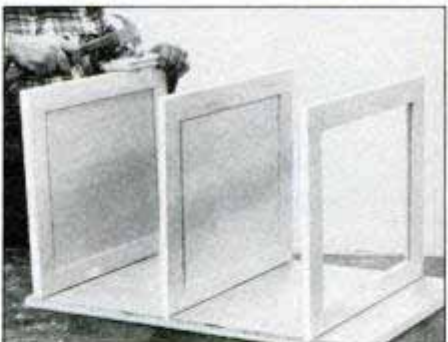
Undercut the front edge of the manuscript shelf to serve as a finger grip using a rasp or spokeshave, then apply edging to the front and side edges of the shelf. Groove the front and side edges of the cabinet top for $\frac{1}{8}$ -in.-thick splines. Cut corresponding grooves in the side trim. Then, glue and clamp the top assembly together.

Bore dowel holes in the top edges of the cabinet sides with a doweling jig. Transfer the holes with dowel centers to the underside of the top trim boards. Check the top for fit, but do not glue it in

[\(Please turn to page 120\)](#)



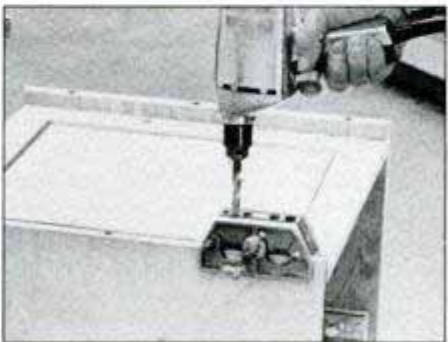
3 Glue up frame with splines. Insert dust panel and clamp square. Leave panels unglued for expansion and contraction.



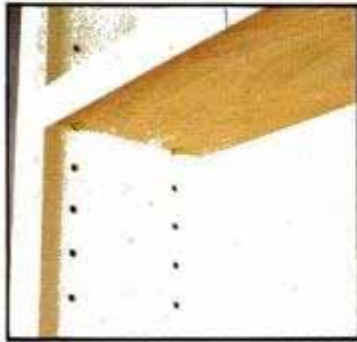
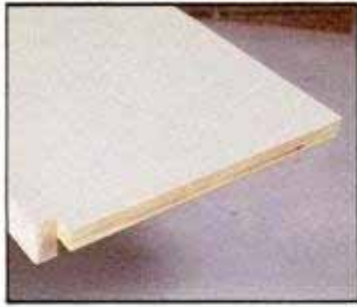
4 Apply glue to dadoses and frame edges and tap frames into place. Align all front edges. Bottom frame has no dust panel.



6 Rip edging strips a hair wider than $\frac{1}{4}$ in. Glue to side, then frame edges, and clamp with strips of masking tape until dry.

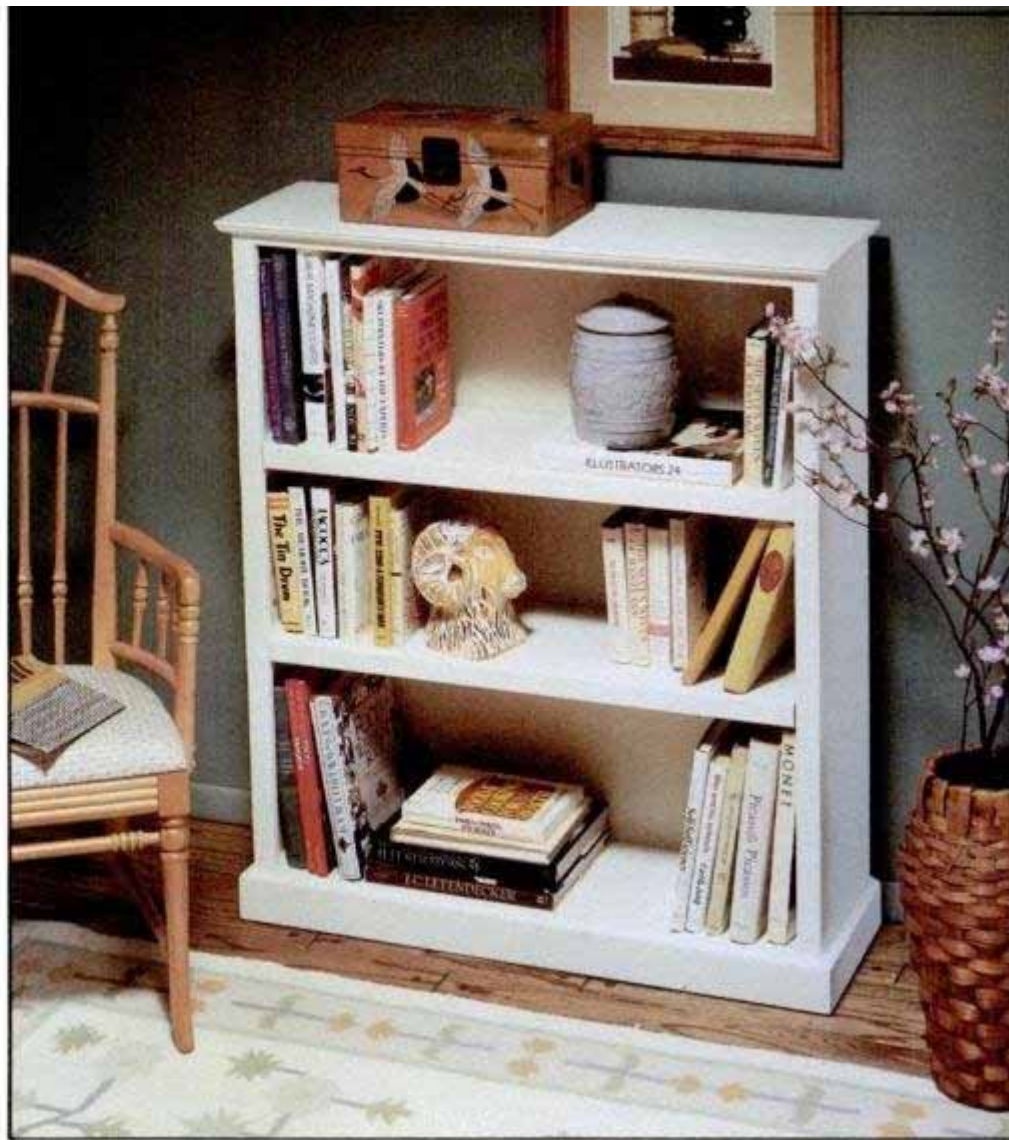


7 Bore dowel holes, then transfer hole locations to top assembly using dowel centers. Glue top down after finish is applied.



Our easy-to-build bookcase has two adjustable shelves that rest on removable shelf pegs. The pegs fit neatly in brass grommets (above). Detail (top) shows that the stiffener is cut short to allow shelf to fit behind the cabinet's stiles.

Color and black and white how-to photos: Rosario Capotosto
Color bookcase photo: Harry Hartman
Stylist: Gabe Herrick
Technical artist: Don Mannes



1 Insert bookcase bottom into the dado cut in the cabinet side. Then, mark bottom for cutting the end notches.



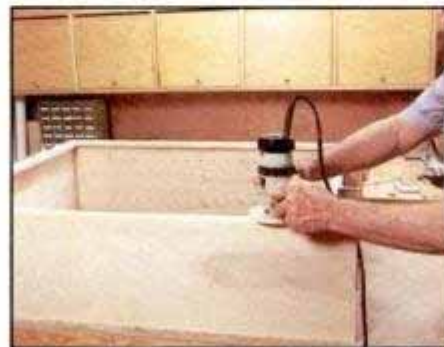
2 Cut the various rabbets and dados on a table saw using a dado blade. Note the homemade, 1/2-in. plywood table insert.



3 Use this simple pin and block jig to bore evenly spaced shelf peg holes. Position the block so the pin is 2 in. from the bit.



7 Sand stiles with a finishing sander or by hand with a sanding block. Avoid rounding over edges that receive trim.



8 Rout the edges of the stiles with a 3/16-in. rounding-over bit. Be sure not to shape the front edge of the cabinet bottom.



9 Shape the decorative trim and base with a roman ogee router bit. Rout a wide board first, then rip the 3/4-in. trim to size.

Guide To Shelving Systems

SPACE PROGRAM

Start your own space reclamation project with this guide to shelf construction and installation. Then, build our traditional painted bookcase from the plans included.

Nearly all homeowners share a common problem—lack of storage space. Regardless of the size of the house, it seems there is never enough room to store everything. This is true especially for condominium owners and apartment dwellers. Fortunately, easy-to-build shelving systems offer an effective, inexpensive remedy for the do-it-yourselfer.

Presented here are more than two dozen ways to build and install shelving. The techniques shown require no special skills or tools and they all can be built using readily available hardware and standard-size lumber and moldings.

Shelving materials

Shelves are most commonly made from particleboard, plywood or solid lumber and are either $\frac{3}{4}$ or $1\frac{1}{2}$ in. thick. Edge treatments are often applied to shelves (see the photos on page 103) for one or more of the following reasons: to conceal an exposed plywood edge, to add rigidity and increase the shelf's load capacity, and to create a decorative detail. The exact shelf design you

BY ROSARIO CAPOTOSTO

choose is determined by the weight of the items being stored and the look you desire. But remember, it's always better to overbuild the shelves slightly to prevent sagging and possible collapse. See the chart on page 103 to help you determine the proper shelf construction.

When the shelves' appearance isn't important, such as when making utility shelves for the basement, garage or workshop, No. 2 common pine is quite suitable. This grade pine has knots of varying sizes, so be sure to hand-pick the boards carefully to avoid loose or oversized knots that will weaken the shelves. Note that if the pine is to be painted, first seal each knot with shellac to prevent bleed-through.

Particleboard is the most economical shelving material and is often used under plastic laminate. The disadvantage to particleboard is that it's heavy and tends to sag if it isn't supported properly.

When the look of fine hardwood shelves is desired, choose hardwood-veneer plywood. This cabinet-grade plywood is less expensive and lighter than solid hardwood and it's warp-free. Also, extra-wide plywood



4 Assemble the bookcase with glue and 4d finishing nails. Tape the back panel in place temporarily to hold the cabinet square.



5 Glue and nail $\frac{3}{4}$ -in. blocks to the front edge of the sides. The blocks bring the sides out flush with the cabinet bottom.



6 Glue and nail hardwood stiles in place with edges overhanging slightly. Then, plane stiles flush to cabinet.



10 Miter the ends of the trim pieces after routing the decorative edge. A homemade mitering jig ensures safe, accurate cuts.



11 Glue and nail the trim to the cabinet. Be sure to bore pilot holes first. Then, set the nails and fill the holes with wood putty.



12 After painting the bookcase, tap the grommets into the shelf peg holes. Countersink the holes slightly.

GUIDE TO SHELVING

shelves are made easily without having to edge-join boards together. Conceal the plywood's exposed edge with any one of the 12 methods shown in the photos on the facing page.

Fixed vs. adjustable

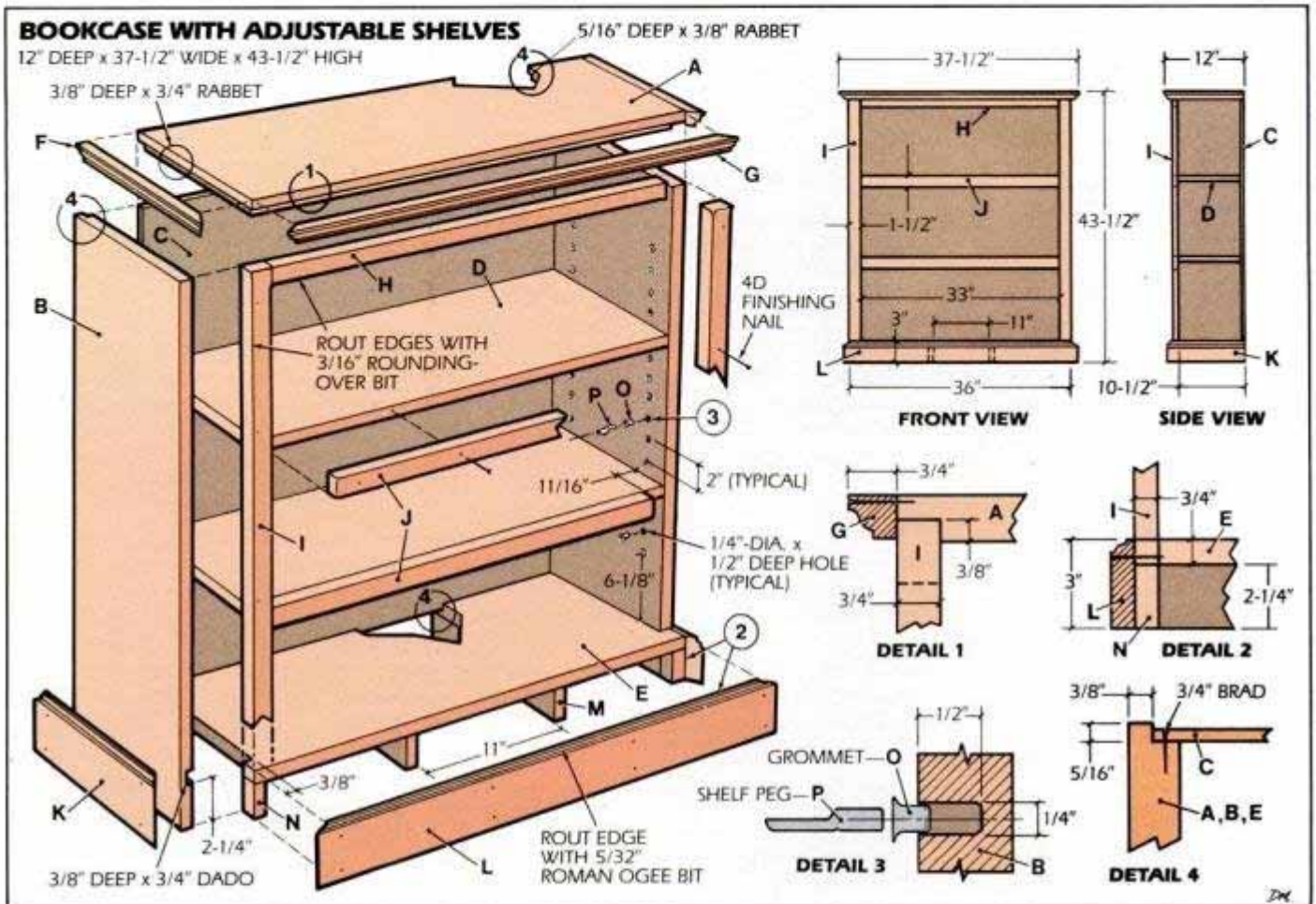
Shelves can be installed as perma-

nent fixtures in a cabinet or as separate components that can be adjusted or removed, if necessary.

Large cabinets or cabinets without backs often have several adjustable shelves and one fixed shelf. The fixed shelf adds rigidity and strength to the unit. Fixed shelves for small, light-

weight cabinets can be attached with simple butt joints using glue and screws. However, for a much stronger assembly, you should use dado joints to install permanent shelves.

The two most popular ways to support adjustable shelves are with shelf pegs set in holes bored in the cabinet



MATERIALS LIST—BOOKCASE

Key	No.	Size and description (use)
A	1	3/4 x 11 1/4 x 36" birch plywood (top)
B	2	3/4 x 10 1/2 x 43 1/2" birch plywood (side)
C	1	1/4 x 35 3/16 x 40 7/16" birch plywood (back)
D	2	3/4 x 10 1/4 x 34 3/4" birch plywood (shelf)
E	1	3/4 x 11 1/4 x 36" birch plywood (bottom)

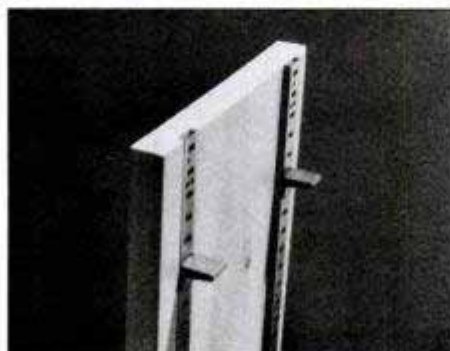
F	2	3/4 x 3/4 x 12" birch (side trim)
G	1	3/4 x 3/4 x 37 1/2" birch (front trim)
H	1	3/4 x 1 1/2 x 33" birch (apron)
I	2	3/4 x 1 1/2 x 40 1/8" birch (stile)
J	2	3/4 x 1 1/2 x 33" birch (stiffener)
K	2	3/4 x 3 x 12" birch (base side)
L	1	3/4 x 3 x 37 1/2" birch (base front)

M	2	3/4 x 2 1/4 x 11 1/4" birch plywood (bottom support)
N	2	3/4 x 3/4 x 2 1/4" birch plywood (corner block)
O	60	1/4"-dia. grommets
P	8	Shelf peg
Misc.		Carpenter's glue, 100- and 120-grit abrasive paper, primer undercoat, acrylic latex paint (we used Ox-Line satin eggshell paint, No. 645-18).

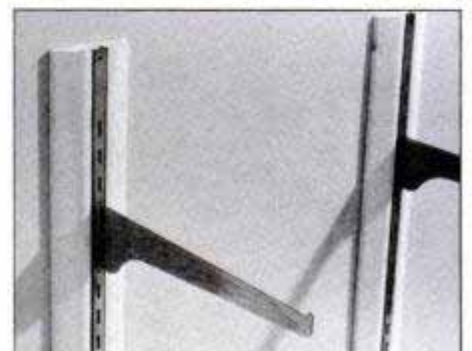
ADJUSTABLE SHELVING



Adjustable shelf pegs are available in a variety of styles at hardware stores. Make homemade pegs from dowel sections (left).



Here are two ways to install adjustable metal standards: flush-mounted set in a groove (left) or surface-mounted (right).



Metal standards with adjustable brackets can be screwed directly to the wall or set in attractive hardwood uprights, as shown.

sides, or with metal standards. Shelf pegs are inexpensive, easy to install and suitable for nearly all cabinets. Metal standards are more costly, but they are available in two styles. One style holds flat metal clips for use in cabinets. The second standard accepts brackets to permit installing shelves on walls without a cabinet.

Bookcase construction

Our modest-sized painted bookcase requires slightly more than 3 sq. ft. of floor space, yet it provides nearly 9 sq. ft. of book storage (almost 12 sq. ft. if you use the top surface).

The bookcase cabinet and shelves are made of birch-veneer plywood faced with 3/4-in.-thick solid birch. The two adjustable shelves rest on shelf pegs set in holes bored 2 in. on-center.

Start by cutting the plywood parts to size as given in the materials list. Next, cut a 3/4-in.-wide dado in each cabinet side 2 1/4 in. from the bottom edge. Mark the cabinet bottom for cutting 3/8-in.-deep notches in each end, as shown in photo No. 1 on page 100. Then, rabbet all four edges of the cabinet's top. Note that the top's rear edge rabbet is only 5/16 in. deep to accept the 1/4-in. birch-veneer plywood cabinet back.

Now bore a series of evenly spaced shelf peg holes in the cabinet sides *before* assembling the bookcase. To ensure accuracy, bore the holes using a drill press or a portable drill fitted with a drill guide accessory. Although most shelf pegs fit 1/4-in.-dia. holes, purchase the pegs first and check their shank diameter before boring the holes. We used shelf pegs that fit into brass grommets, which add a clean, finished look to each hole. Install the grommets after the bookcase has been painted. (The peg and grommet system is manufactured by Ferum Hardware, Box 698, Pine Brook, NJ 07058. Write to them for a list of retailers in your area.)

Assemble the bookcase with wood-working glue and 4d finishing nails. First, tape the back panel to the top and bottom to hold the cabinet square. Next, glue and nail the sides to the bottom and attach the top. Leave the back taped in place until the glue dries. Be

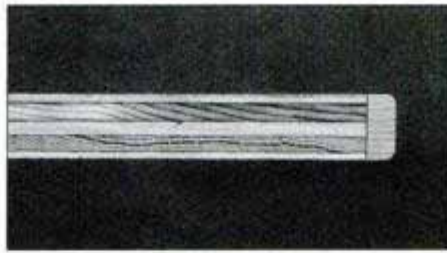
(Please turn to page 110)

MAXIMUM SPAN RATINGS

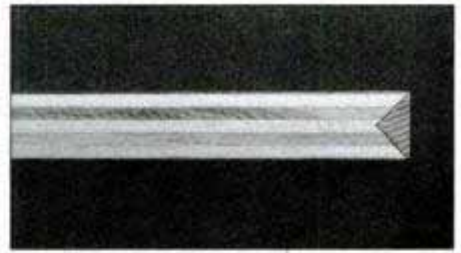
Shelving Material	Maximum Span Between Supports*
3/4-in. particleboard	24 in.
3/4-in. plywood or 3/4-in. solid lumber	32 in.
1 1/2-in. solid lumber or glued-up, double 3/4-in. plywood	60 in.

*These dimensions apply for a 10-in.-wide nonreinforced shelf with a load of 30 pounds per linear foot. Increase the dimensions by 50 percent for a shelf that is reinforced with a 3/4 x 2-in.-wide stiffener along the front edge and a 3/4 x 2 x 6-in.-long support cleat under the rear of the shelf at the middle of the span.

SHELF-EDGING OPTIONS



Attach 1/4-in.-thick hardwood strip using glue and brads to conceal plywood's edge.



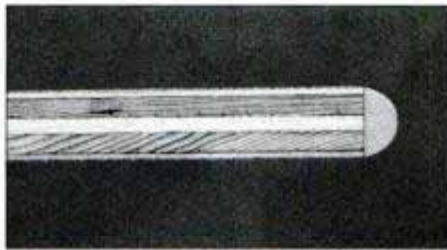
Cut V-groove in shelf's edge on a table saw. Then, attach a triangular edging strip.



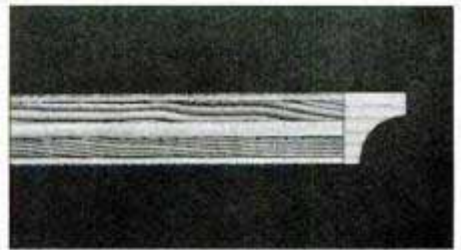
T-molding, available in plastic or aluminum, fits into a slot in the shelf's edge.



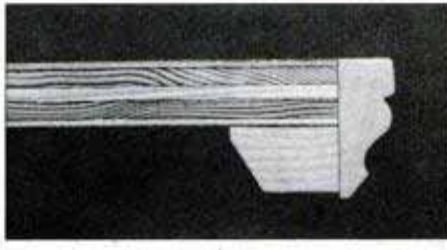
Solid wood shelving can be shaped using a router to form a carved, decorative edge.



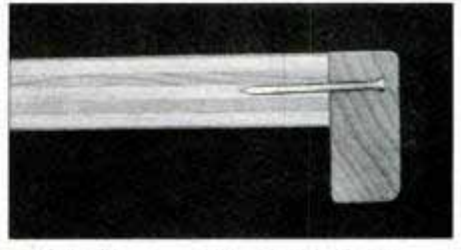
Attach 3/4-in.-dia. half-round molding to a plywood shelf to form a bull-nose edge.



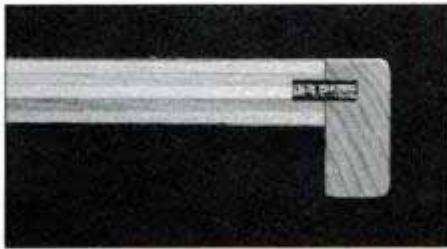
Affix cove molding with glue and 1-in. brads driven through the upper flat area.



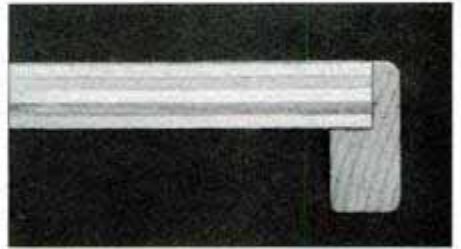
Attach a wide molding to create a thick-looking shelf. Backup block adds support.



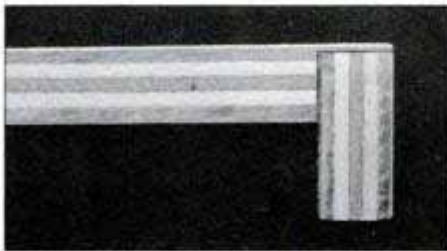
Add rigidity to a 3/4-in.-thick shelf by attaching a 1 1/2-in.-wide hardwood stiffener.



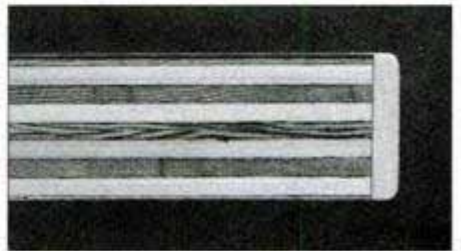
Here's how to attach a stiffener without nails: use glue and 1/4-in. plywood spline.



A rabbeted solid hardwood stiffener is an effective way to prevent sagging shelves.



To assemble with only veneer showing, cut an 1 1/16-in.-deep x 3/4-in. rabbet in shelf.



Double 3/4-in. plywood shelf has a plastic laminate top and a 1/4-in. hardwood edge.

Backyard Banquet For The Birds

Build 3 super feeders that money can't buy.

BY DURRAE HENRY

Every year more and more people are taking advantage of the "cheep" entertainment and tuition-free education provided by birds that visit backyard feeders. By observing these feathered dynamos, you'll lay to rest the phrase "eats like a bird." Birds actually consume as much as twice their weight in seeds and insects every day. They may have no problem finding plenty of food in summer. However, in winter when natural food is scarce, the birds need extra help. Birds are colorful, fun to watch, and by supplying them with a regular source of food you may encourage them to remain year 'round, providing the best and safest control available for pests such as moths, wasps, ants, aphids, mosquitoes and grubs.

If you've been thinking about feeding birds, now's the time to do it. With our plans you can build a feeder to attract most of the common and even some of the rarer birds. Of course, not everyone will have

the same species in his or her backyard. West of the Rockies, Chestnut-backed Chickadee, Pine Siskin and Bushtit will find your banquet. In the East, Tufted Titmouse, Cardinal and Blue Jay are common. Bobwhite, Hermit Thrush and Red-bellied Woodpecker frequent the Southeast, while the Southwest hosts California Quail, Plain Titmouse and Scrub Jay.

However, since birds aren't aware of geographical boundaries, some ranges overlap. The birds illustrated here are considered the most common for the respective areas, but a bird enthusiast in any locality may well be treated to 20 to 30 different species in a single feeding season. Habitat, also, will determine what kinds of birds you'll entertain. Rural and wooded areas will attract woodpeckers and titmice, while urban and suburban areas will tend toward cardinals, jays and House Sparrows.

No matter where you live, it's crucial

WINDOW FEEDER

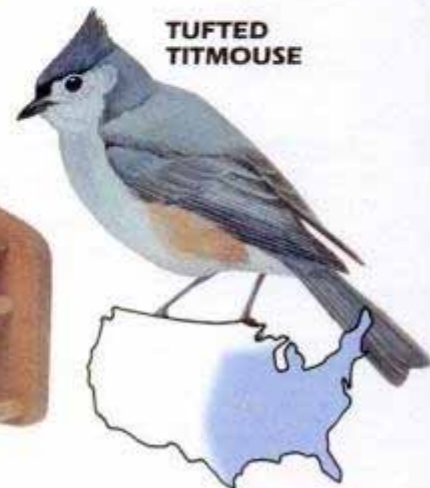
Designed to discourage larger birds, our window feeder (below) will be popular with the Black-capped Chickadee, White-breasted Nuthatch and Tufted Titmouse (right), especially when stocked with their favorite food—sunflower seed. The Red-breasted Nuthatch and House Finch will also zero in on this feeder, which offers complete protection from the elements.



WHITE-BREASTED NUTHATCH



BLACK-CAPPED CHICKADEE



TUFTED TITMOUSE

HANGING FEEDER

The extended roof of our hanging feeder (left) offers protection from rain and snow for birds the size of the Dark-eyed Junco and Purple Finch (right). It also shields them from harsh winter winds. The suet will attract the Downy Woodpecker (below) as well as chickadees and other species of woodpeckers.



PURPLE FINCH



DARK-EYED JUNCO



DOWNY WOODPECKER



PLATFORM FEEDER

Larger birds such as the Evening Grosbeak, Blue Jay and Northern Cardinal pictured below prefer a platform feeder (right), which will give them stability in landing and, as cautious birds, an unobstructed view of their surroundings. Many other birds will be attracted to this open feeder, including the American Goldfinch and House Sparrow.

Feeder designs
Durrae Henry
 Feeder construction
Rosario Capotosto
 Color photos
Paul Sciacca
 Black and white photos
Rosario Capotosto
 Technical art
Eugene Thompson
 Winter range maps
Sally Onopa
 Bird illustrations
Arthur Singer
 Reprinted by permission
 from *Birds of North America*,
 Western Publishing Co. Inc. (1966)

EVENING GROSBEAK



BLUE JAY



NORTHERN CARDINAL



BIRD FEEDERS

that once you've begun to feed them in the winter, don't stop, because the birds will come to depend on finding food in your backyard.

Like people, birds have preferences for certain foods. Some, like goldfinches, cardinals and House Finches, will dive into a pile of sunflower seeds but turn up their beaks at cracked corn. Birds that normally eat insects—nuthatches, chickadees and woodpeckers—often change their diets to seeds in winter. It's important to fill your feeder with the correct seed if you want to attract more than just snow.

There are as many outlets for buying seed as the type of seed itself. Most supermarkets carry an all-purpose mix that usually contains filler—seed that even the hungriest bird won't eat. It's wise to read the label and avoid any package that has the most common filler—milo. Bulk lots and specific types of seed can be found at better hardware stores, garden centers, feed and grain mills, or through the Yellow Pages under *Seeds* or *Pet Supplies*. Also, there are two notable mail-order suppliers: Audubon Workshop, 1501 Paddock Dr., Northbrook, IL 60062, and Duncraft, Penacook, NH 03303. Write them for their catalogs.

Seeds aren't the only food attractive to birds. Insect-eaters such as woodpeckers, chickadees and nuthatches like suet, which is available at most meat counters and often is free. Soapy beef suet is best, but remember to remove it during extended periods of warm weather since it spoils quickly. One large chunk should last the winter.

Pieces of fruit (orange halves, raisins, cherries) are appealing to woodpeckers in winter and tanagers and orioles in summer. Almost all birds will enjoy stale baked goods, and all but the ground feeders will relish peanut butter mix. For this high-protein, high-energy food, melt 2 cups of suet and add to it 1 cup of peanut butter, 2 cups of yellow corn meal and 2 cups of fine cracked corn. Pour into forms, chill until hardened, then place on dowels connected to your feeder or in a suet holder.

Also, because birds lack teeth and need some coarse material to grind their food, some type of grit is necessary to round out your feeding program. Without grit, birds can actually starve at even the best stocked feeders. Commercial grit is available, usually crushed oyster shells that sell for about \$7 for 10 pounds. Or, you can use masonry sand mixed at a ratio of 1 pound per 10 pounds of seed. The grit can also be supplied in extra dishes or trays like we show on two of our feeders.

Location of the feeder is as important as the seed you put into it. The type of feeder you use will determine where to

place it. All feeders should allow you to see the birds easily. Sheltered areas are best not only because birds won't tolerate strong winds, but a hanging feeder may be blown about and lose much of its seed. All feeders should be at least 5 feet from the ground and 10 feet from the nearest tree or overhanging branch. With the exception of the window feeder, stations should also be placed 10

feet from any buildings. This discourages squirrels, which are fond of seed and able to get at almost anything. It's also best to place the feeder 15 feet away from brush or thick bushes since you don't want to offer your feathered guests as fast food for a hungry cat.

farther south than usual. This can produce a larger variety at your feeder. Most likely, the less cautious sparrows and starlings will be the first guests, but others like cardinals, chickadees and jays will soon follow. Since you'll want the birds to find your feeder before cold weather sets in, September is a good time to start stocking it with food. Some people stock their feeders

Feeders and Feed

The most common birds, their preferred food and type of feeder.

SPECIES	FEEDERS										FEED									
	HANGING	WINDOW	PLATFORM	GROUND	SUNFLOWER—STRIPE	SUNFLOWER—OIL	CRACKED CORN—FINE	MILLET—WHITE PROSO	MILLET—RED PROSO	CANARY SEED	SUET	SUNFLOWER—STRIPE	SUNFLOWER—OIL	CRACKED CORN—FINE	MILLET—WHITE PROSO	MILLET—RED PROSO	CANARY SEED	SUET		
American Goldfinch	*		*		*	*														
American Tree Sparrow			*	*			*	*	*	*										
Black-capped Chickadee	*	*	*		*	*	*											*		
Blue Jay		*	*		*	*	*													
Brown Thrasher			*	*			*	*	*											
Chestnut-backed Chickadee	*	*	*	*	*	*	*											*		
Chipping Sparrow			*	*			*	*	*											
Common Grackle			*	*	*	*	*													
Dark-eyed Junco	*		*		*	*	*	*												
Downy Woodpecker	*					*												*		
European Starling			*	*			*													
Evening Grosbeak	*	*	*		*	*														
House Finch	*	*	*		*	*	*						*					*		
House Sparrow	*		*		*	*	*	*	*	*										
Mourning Dove				*	*	*	*	*					*	*	*					
Northern Cardinal			*	*	*	*	*	*					*							
Pine Siskin	*	*	*		*	*	*	*										*		
Purple Finch	*		*		*	*	*	*										*		
Red-bellied Woodpecker	*	*	*		*	*	*	*										*		
Red-breasted Nuthatch	*	*			*	*	*	*												
Scrub Jay	*		*	*	*	*	*	*												
Song Sparrow			*	*			*	*	*				*	*	*					
Steller's Jay	*	*	*		*	*	*	*												
Tufted Titmouse	*	*	*		*	*	*	*										*		
White-breasted Nuthatch	*	*			*	*	*	*										*		
White-crowned Sparrow	*		*	*	*	*	*	*	*	*										
White-throated Sparrow	*		*	*	*	*	*	*	*	*										
Yellow-bellied Sapsucker	*		*															*		

feet from any buildings. This discourages squirrels, which are fond of seed and able to get at almost anything. It's also best to place the feeder 15 feet away from brush or thick bushes since you don't want to offer your feathered guests as fast food for a hungry cat.

You've made a feeder, hung it in its proper place, and loaded it with seeds birds dream about, but there are no birds. Be patient. To let them know you're open for business, sprinkle bread crumbs on the ground or place some seed in a shiny pan. Your feeder won't be an immediate success, but as Northern birds' food grows scarce, many will move south to their wintering grounds—your backyard. Harsh Northern winters often force certain species

all year, while others stop in April or May or whenever natural food becomes available for the birds.

Feeding birds doesn't come without its share of frustrations. Squirrels can be an ever-present problem around even the best located feeders. To deter these pests from hogging your station, place cobs of corn or peanuts in the shell for them around your property, far from all feeders. Also annoying are starlings and House Sparrows. Once you've attracted these aggressive gluttons, it's hard to get rid of them. By using sunflower seeds only, they will avoid the feeder, but so will some of the more desirable species. One remedy is to place their favorite food—bread crumbs or dried dog food—away from

feeding stations. Also, unlike most birds, starlings feed late in the morning and early in the afternoon. By putting out a small amount of seed early in the morning and, if necessary, again in late afternoon, you'll give the preferred birds a head start.

You may be alarmed to find an occasional hawk grabbing your favorite junco. There's very little you can do to

discourage them. But remember, hawks are an important part of the balance of nature, and they are protected by law. They actually strengthen bird populations by feeding on weaker and slower birds and can be a thrill to have as visitors.

Other than refilling, your feeder needs no maintenance. Our stations are made of decay-resistant redwood and

will provide years of troublefree feeding. Don't use commercial stains, sealers or paints on your feeders. They contain chemicals that are harmful to the birds. Keep your feeders and feeding area clean. Seed spilled on the ground will provide food for ground-feeding birds, but don't let it accumulate because it can become moldy or attract rodents. Deep snow should be

Hanging Feeder

This feeder was designed to keep both the seed and birds dry during feeding. The aluminum screen allows any water to drain through immediately and the removable roof section is joined to the top with a ship lap joint that makes refilling easy while keeping water out. A grit tray and suet holder are positioned on each end and the feeder is hung from two eyebolts so it will be balanced to prevent seed loss.

To build it, begin by cutting all parts to the sizes given in the materials list. Then nail the sides to the seed diverter and one of the acrylic support rails. Next, nail the peak and other support rail to the fixed roof panel. Join all base parts and rout the rabbet for the screen; staple the screen in place. Join the roof to the sides, slide the acrylic panels in place and glue the filler blocks into the bottom of the grooves so the acrylic rests 1/4 in. above the screen. Screw the feeder to the base as shown, then slide the removable roof in place and install the roof pins. Hang the feeder with aviation cable as shown.

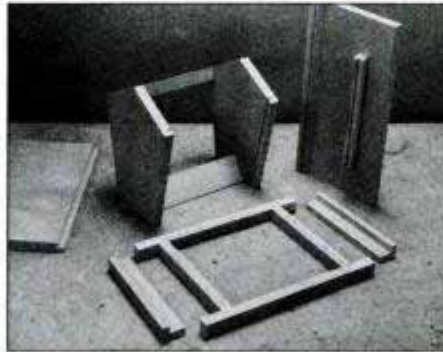
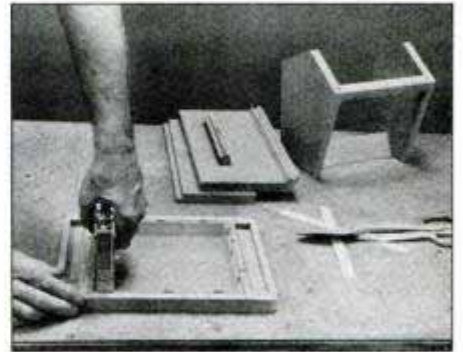


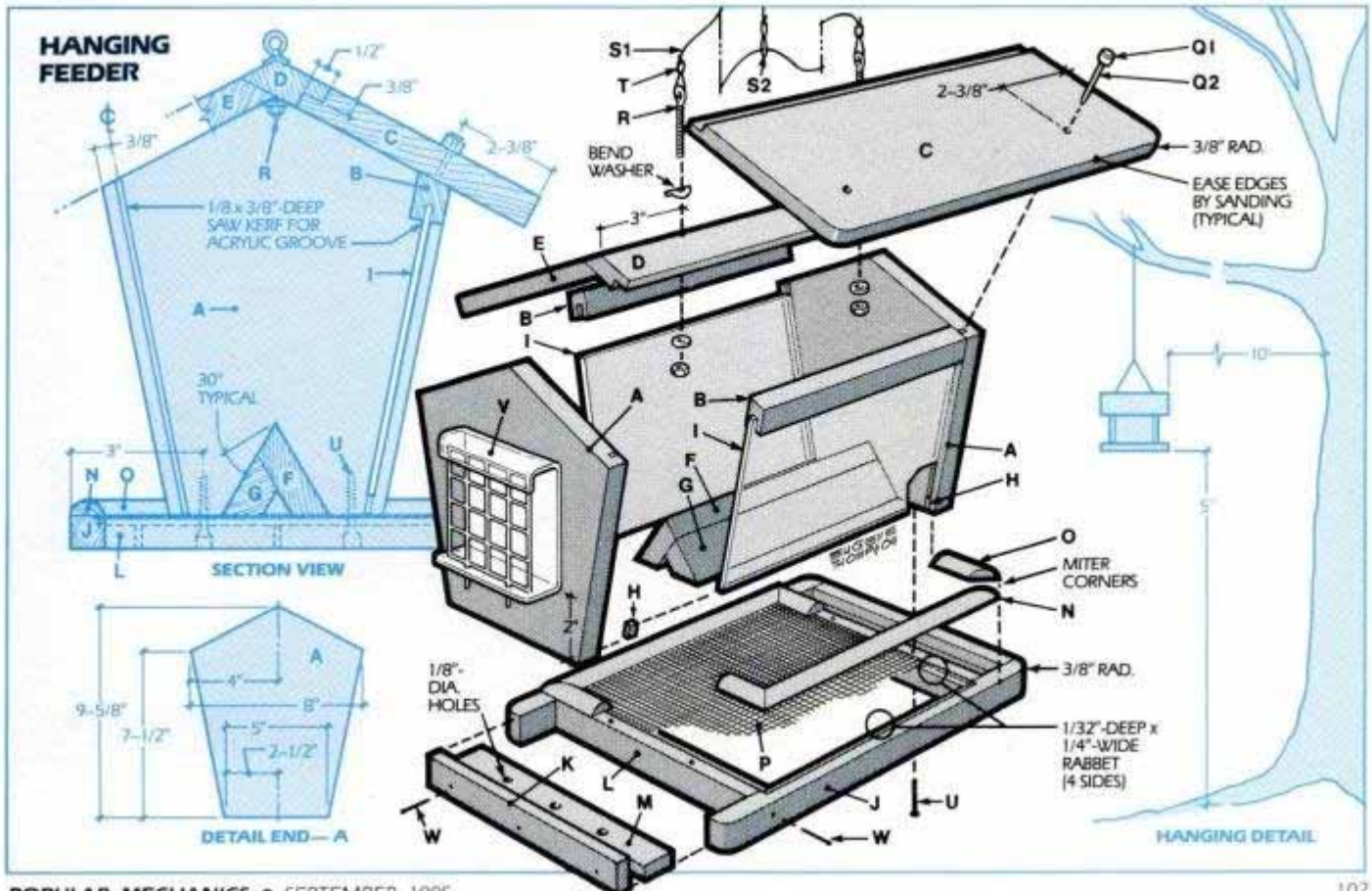
Photo shows subassemblies ready for final assembly. Note that peak is joined to fixed roof panel before panel is attached to sides.



Attach screen to shallow rabbet in base using 1/4-in.-long staples. Most utility staples are coated for weather resistance.

MATERIALS LIST—HANGING FEEDER

Key	No.	Size and description (use)		
A	2	3/4 x 8 x 95/8" redwood (end)	O	4 3/4 x 2 1/4" redwood half-round molding
B	2	3/4 x 1 x 8 1/2" redwood (side rail)	P	1 8 1/2 x 9" aluminum screen, attached with 1/4" staples
C	1	3/4 x 6 1/8 x 14" redwood (removable roof)	Q1	2 1/2"-dia. x 3/8" dowel (pin bushing)
D	1	3/4 x 1 7/8 x 14" redwood (roof peak)	Q2	2 8d aluminum casing nail (roof pin)
E	1	3/4 x 6 1/2 x 14" redwood (fixed roof)	R	2 1/4 x 2" eyebolt, 2 washers, 1 nut
F	1	3/4 x 2 3/8 x 8 1/2" redwood (seed diverter)	S1	1 3/32"-dia. x 24"-long aviation cable
G	1	3/4 x 1 3/8 x 8 1/2" redwood (seed diverter)	S2	1 3/32"-dia. x length to suit aviation cable
H	4	1/8 x 1/4 x 3/8" redwood (filler block)	T	4 3/32"-dia. lead ferrule
I	2	1/10 x 7 x 9" acrylic sheet (side)	U	4 1 1/2" No. 8 fh screw
J	2	3/4 x 7/8 x 13" redwood (base side)	V*	2 1 1/2 x 4 x 5" suet holder
K	2	1/2 x 7/8 x 8" redwood (base end)	W**	4d galvanized finishing nails
L	2	3/4 x 7/8 x 8" redwood (divider)		*Called Suet Sidekick, available from Duncraft, Penacook, NH 03303, for \$4.95 each plus shipping.
M	2	1/2 x 1 x 8" redwood (tray bottom)		**As reqd.
N	2	3/4 x 10" redwood half-round molding		



BIRD FEEDERS

cleared from underneath feeders to make ground seeds accessible to juncos, sparrows and towhees that feed there.

Since different birds feed at different heights, use more than one feeder to attract several species. A well-balanced program includes a platform feeder 5 feet from the ground, a window feeder and a hanging feeder 5 to 8 feet high.

Platform Feeder

Some birds prefer an open platform feeder. But when seed is exposed to rain and snow, the moisture can cause rot. This feeder features an aluminum screen tray that provides great drainage and can be removed for cleaning. (Because birds can stick to cold surfaces, it is wise to coat the screen with vegetable shortening during severe cold snaps.) Also featured are built-in grit trays and sharpened dowels for adding corn cobs, baked goods and fruit to the feeder sides. The dowels should be removed when not in use to prevent injury to playing children.

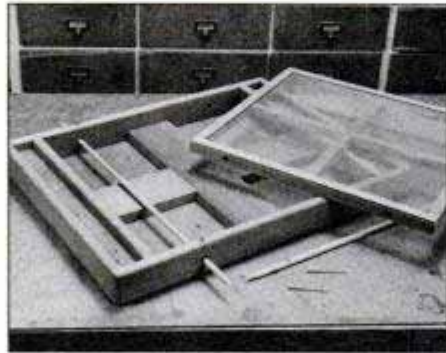
Begin building by cutting all the parts to the size given in the materials list, then assemble with resorcinol glue and nails. To make the squirrel baffle, transfer the drawing pattern onto aluminum and cut the shape with tin snips. Then bend the aluminum into a cone as shown and drill the rivet holes. Install the rivets and attach the baffle to the pipe with the hose clamp. Add the pipe flange, then prime and paint the pipe and baffle. Attach the feeder.

Now that there are birds coming to your feeder, you might want to know a chickadee from a nuthatch. Many excellent field guides are available. In addition to photos or illustrations of each bird, the better books include range maps and voice and habitat descriptions. Most also feature checklists so you can record each species you see.

Among the more popular guides are

Roger Tory Peterson's *A Field Guide To The Birds*, with a separate edition for east and west of the Rockies; *Birds Of North America* by Robbins, Bruun and Zim, which includes all North American species; and *The Audubon Society Field Guide To North American Birds*, also with volumes for eastern and western regions. All can be found at, or ordered

(Please turn to page 113)



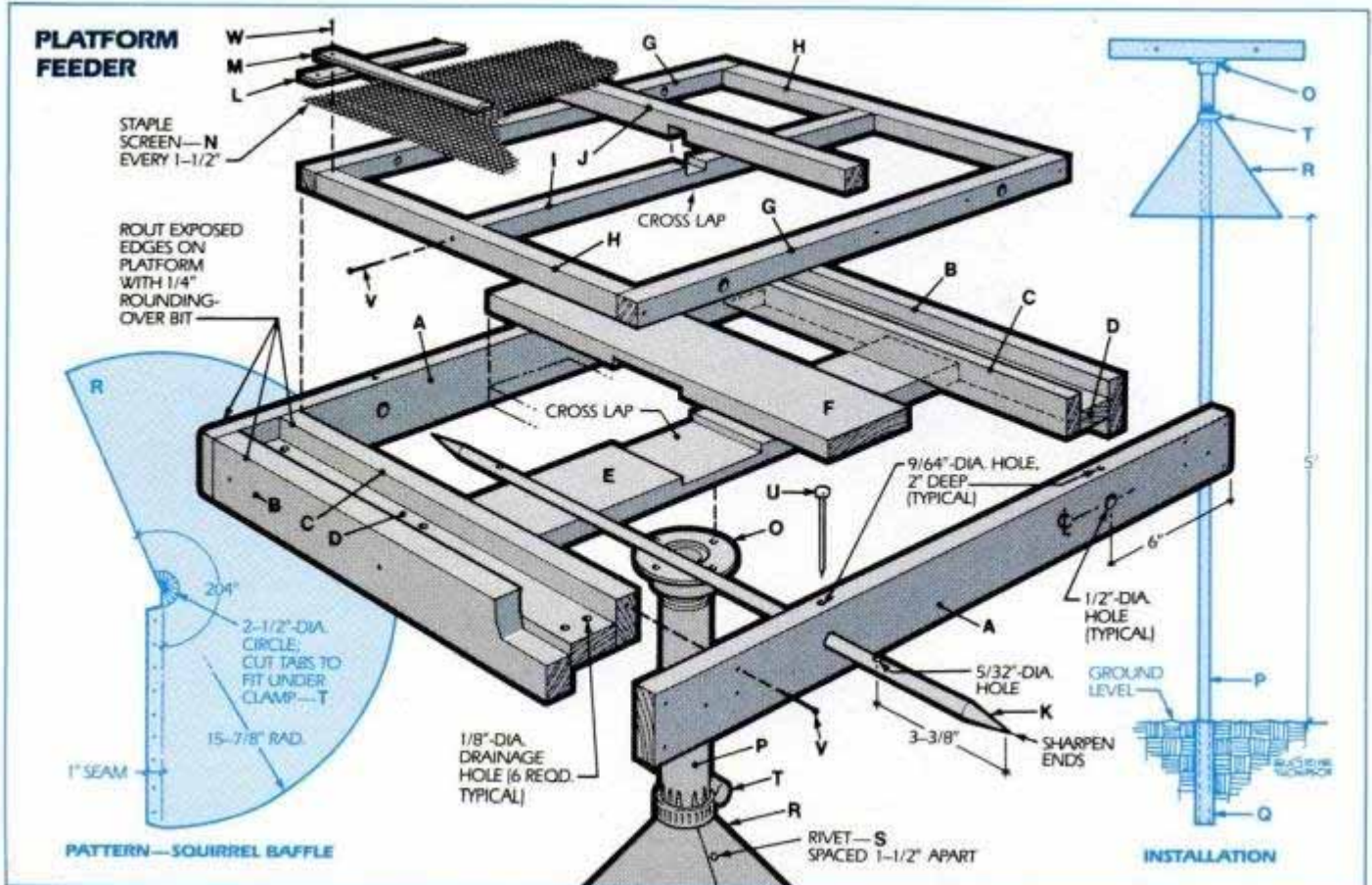
Completed platform shows how dowels slide through assembly. Screen tray, with matching dowel holes, fits inside platform.



To make baffle, cut shape using pattern, then bend aluminum into cone shape. Tape ends together and drill rivet holes.

MATERIALS LIST—PLATFORM FEEDER

Key No.	Size and description (use)		
A	2 3/4 x 2 1/4 x 24" redwood (side)	O	1 1"-dia. galvanized pipe flange
B	2 3/4 x 2 1/4 x 16 1/2" redwood (end)	P	1 1"-dia. x 96"-long galvanized pipe
C	2 3/4 x 1 1/2 x 16 1/2" redwood (divider)	Q	1 1 1/4"-dia. x 12"-long galvanized pipe
D	2 3/4 x 1 1/2 x 16 1/2" redwood (bottom)	R	1 .020 gauge x 24 x 36" sheet aluminum
E	1 3/4 x 3 3/4 x 22 1/2" redwood (support)	S	9 1/8"-dia. aluminum pop rivets
F	1 3/4 x 3 3/4 x 16 1/2" redwood (support)	T	1 stainless-steel adjustable hose clamp
G	2 3/4 x 3/4 x 17 7/8" redwood (tray side)	U	4 8d galvanized casing nails
H	2 3/4 x 3/4 x 14 7/8" redwood (tray end)	V	4d galvanized finishing nails
I	1 3/4 x 3/4 x 16 3/8" redwood (support)	W	3/4" galvanized finishing nails
J	1 3/4 x 3/4 x 14 7/8" redwood (support)		*As reqd.
K	2 3/8"-dia. x 24" hardwood dowel		
L	2 1/8 x 3/4 x 17 7/8" redwood (molding)		
M	2 1/8 x 3/4 x 14 7/8" redwood (molding)		
N	1 16 3/8 x 17 7/8" aluminum screen,		





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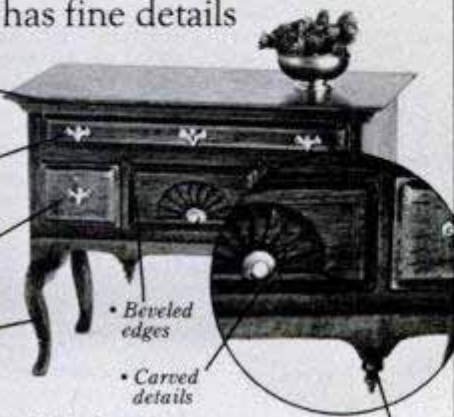
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SHELVING

(Continued from page 103)

sure that the cabinet is square.

Now glue and nail the stiles, apron and stiffeners to the front edge of the cabinet's sides, top and shelves. Also, attach two support braces to the underside of the cabinet bottom and corner blocks (parts N in the materials list) to the bottom's lower, front edge. Next, mill the decorative trim (F,G) and base (K,L) pieces using a router fitted with a $\frac{5}{32}$ -in. roman ogee bit. Miter the corner joints and attach the pieces to the bookcase. Then, set all nails and fill the holes with wood putty. When the putty dries, sand it flush with the wood.

Now apply one coat of primer to the bookcase, shelves and back panel. After the primer dries, sand all surfaces *lightly* with 240-grit abrasive paper, remove the sanding dust with a tack cloth and apply one coat of acrylic latex paint. Apply a second coat, if necessary. Finally, attach the back with $\frac{3}{4}$ -in. brads, insert the brass grommets into the shelf peg holes and install the shelves.

Wall-to-wall shelf

A short span between two walls is perfect for a wall-to-wall shelf. This sturdy, easy-to-make shelf functions as a buffet serving area, writing desk or worktable. It installs quickly on two cleats screwed into the side walls.

The shelf shown measures 3 x 18 x 38 in. and consists of a $\frac{3}{4}$ -in. plywood frame sandwiched between a $\frac{1}{2}$ -in. fir plywood bottom and a $\frac{1}{2}$ -in. oak-veneer plywood top. A $\frac{3}{4}$ -in.-thick hardwood oak face attached to the shelf front conceals the side wall cleats.

When spanning a distance greater than 48 in., use $\frac{3}{4}$ -in. plywood for the top and bottom and increase the shelf's thickness to 4 in. Also, recess the plywood frame $\frac{7}{8}$ -in. from the shelf's rear edge to allow installing a $\frac{3}{4}$ -in.-thick cleat along the back wall.

Assemble the shelf using glue and 4d finishing nails. The top and bottom members overhang the frame by $\frac{7}{8}$ -in. on each end to form channels for the cleats. Screw the cleats securely to the side walls. Then, slide the shelf onto the cleats and secure it by screwing through the bottom into the cleats. **PM**

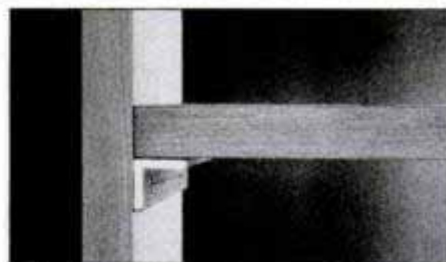


3 Screw the hardwood cleats securely to the side walls. Be certain to use a torpedo level to position the cleats accurately.

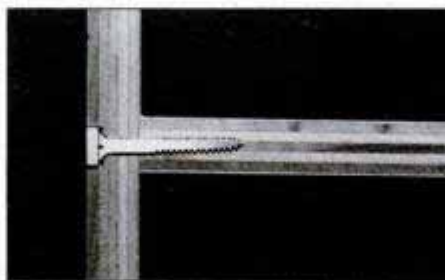
SHELF-TO-CABINET JOINTS



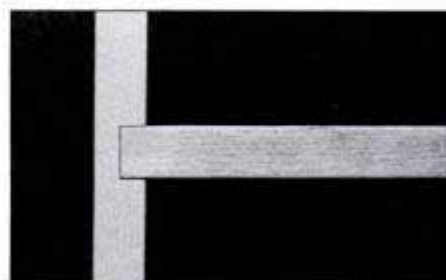
Glue and nail a cleat to the cabinet side. Then, once the glue has dried, nail the shelf to the cleat. Prebore all nail holes.



Aluminum angles make it easy to assemble and disassemble shelving. Secure angle and shelf with flathead screws.



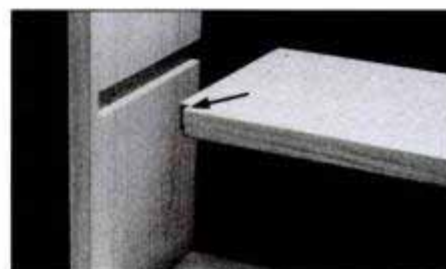
Use the glued-and-screwed butt joint for light- to medium-duty shelves only. Conceal the screwheads with hardwood plugs.



Dado joints provide one of the strongest shelf-to-cabinet joints. Assemble the parts using glue and finishing nails or screws.



Cut a stopped dado within $\frac{3}{4}$ -in. of cabinet's front edge to form recessed shelves. Chisel dado end square to match shelf profile.



To assemble stopped dado joints with flush shelves, notch each shelf (arrow) so that it comes out flush with the cabinet edge.

WALL-TO-WALL BUFFET SHELF



1 After assembling the shelf's plywood frame, glue and nail on hardwood face. Be sure the frame is centered on the face.



2 Glue and nail the top and bottom panels to frame. Use fir plywood for the bottom and hardwood-veneer plywood for the top.



4 Slide the finished shelf onto the two cleats. Then, secure the shelf by screwing through the bottom and into the cleats.



5 The sturdy shelf can be used as a buffet server, writing desk or as a workcenter for hobbies, handicrafts and sewing.



Small Wonder

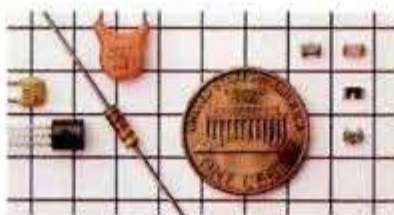
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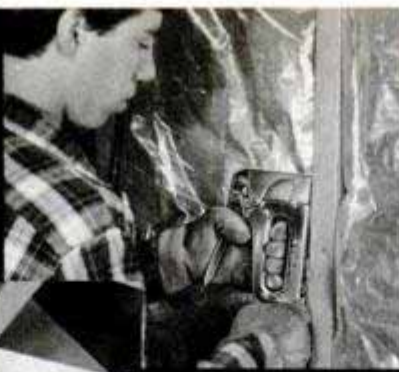
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STEAM'S BACK ON TRACK

(Continued from page 93)

bered across the West Virginia mountains three times a week last winter. It made 24 trips in all, but it accomplished far more than merely hauling 48,000 tons of coal. Unseen by the thousands who lined the tracks, Number 614 carried on board a wide variety of computerized sensors to study the dynamics of steam locomotion as never before. And it carried a crew of mechanical engineers and other specialists who learned firsthand the enormity of a locomotive's task. This was no simple run along straight track. This was the locomotive's real world, a world of ups, downs, arounds and throughs—a world of countless stops and starts. "It never gets routine," says Rowland. "You have to concentrate 100 percent of the time. This train can't stop on a dime."

When the experimental runs had ended, Rowland declared that "the 614 experience confirmed to all of us at ACE that we can build the finest locomotive in the world. This engine is going to pull us into the 21st century."

New steam locomotives

Using data gained from Number 614's test runs, ACE engineers are now designing the Mark I and Mark II, two prototypes of a brand new kind of steam locomotive, one that boasts a net thermal efficiency more than double that of conventional steam locomotives.

What's more, it would be far more economical than a diesel-electric. The relative prices of diesel fuel and coal would allow the ACE 3000 locomotives to operate at about half the cost of today's diesel-electrics—and would allow American railroads to tap into an abundant, domestic source of fuel.

Externally, the new generation of steam locomotives might look much like present-day diesel-electrics. Rowland's patent No. 4,425,763 calls for two units placed back to back. One would contain the steam engine and the other would act as a tender, but they could travel in either direction.

The cab is located up front because there is no need for a fireman to stoke coal by hand. The ACE 3000 locomotives will use coal that is prepackaged into large modules and automatically fed into the firebox along a drive track.

The power unit contains a furnace and combustion system, an ash storage system, a gas cleanup and exhaust system, a boiler and steam generator, steam engines and a jet condenser. Spent steam is condensed, cooled and recycled into the system; therefore, there is no need for a smokestack. All the controls are computerized.

ACE hopes to have the prototype working by 1988 and to begin production soon thereafter.

There are skeptics. "You're either very pro steam or you get apoplexy at the terminology," says G. Richard Cataldi, an energy engineer with the Research and Test Department of the Association of American Railroads. "Old-timers remember the steam locomotive as messy, inefficient and something that required hordes of workers. They were powerful beasts, and the railroads remember that, but they also remember how hard they were to run."

On the Atchison, Topeka and Santa Fe, for example, regular runs took the trains across more than 1000 miles of desert. With the range of steam locomotives limited to no more than 100 miles, the line had to regularly run carloads of purified water just to fill up its own tanks. The ATS was the first major railroad to convert to diesel-electrics.

Of today's major railroads, the three that have exhibited particular interest in the new steam technology are the Norfolk Southern, Burlington-Northern and CSX Corp., which operates the Chessie System and the Seaboard System. Both CSX and Burlington-Northern provided initial backing for ACE 3000, but only CSX remains active.

Even steam proponents, however, are unsure that Rowland's reciprocating engine is the way to go. Another approach is under study by the National Steam Propulsion Co. of Woburn, Massachusetts. The concept of the CE-635 is to retrofit diesel-electric locomotives to become steam-electric locomotives, burning coal instead of diesel fuel.

The locomotive will fire two tons of coal an hour to produce 32,000 pounds of steam. Powerplant efficiency on early models is estimated at 18 percent (which would make it very competitive due to the difference in fuel costs) and envisioned improvements could increase the efficiency to 27 percent.

The key component is the Wormser Grate, manufactured by Wormser Engineering, also of Woburn. The grate separates the chemistry of combustion from that of desulfurization by employing two shallow beds. The lower bed is filled with sand; the upper bed is filled with limestone. High-velocity air passing through the two beds fluidizes the sand and limestone, causing them to resemble, says the company, "gently boiling porridge."

Coal is fired at 1700°F in the lower sand bed. This is below the temperature at which oxides of nitrogen are formed and ashes fused, so no clinkers are created. Hot gases rise up through

the limestone bed where sulfur dioxide in the combustion gases combines with limestone to form calcium sulfate—ordinary gypsum. The spent limestone can be used to make concrete.

The process would allow the CE-635 to burn the cheapest high-sulfur coals cleanly. The company believes that it can save a railroad \$300,000 to \$400,000 per locomotive per year.

Despite vast internal modifications, the engineer of the CE-635 will notice few differences. The internal processes will be regulated by computers, and operator controls will mimic those of current diesel-electrics.

In the meantime, pure romance beckons hundreds of thousands of Americans. Jim Bistline, manager of steam operations for the Norfolk Southern line, in 1966 began to organize nostalgic tours featuring steam locomotives. This year, the 70-year-old Bistline supervises 98 weekend runs between cities all across America.

One of the featured attractions is Number 4501, built in 1911 for Southern Railway, sold in 1947 to the Kentucky & Tennessee Railroad, and rescued from oblivion in 1966.

Its partner is the monstrous Number 611, one of the last steam locomotives built in America. It rolled out of Norfolk & Western's Roanoke, Virginia, assem-

bly shop on May 29, 1950. It could pull a 1015-ton, 15-car passenger train at over 100 mph. Number 611 was retired in October 1959 and lived for two decades in the Roanoke Transportation Museum until Bistline made it the pride of Norfolk Southern's nostalgic fleet.

Railroad buffs pack these excursion trips. Each year Bistline has to schedule more of them to satisfy the demand.

And that same undying devotion to the steam locomotive has kept the Sierra Railroad in business. Based at Jamestown, California, this old short line formerly served the mining communities east of San Francisco. Today, its five steam locomotives are hard-working television and movie stars, having appeared in hundreds of films, including "High Noon," "The Great Race" and "Finian's Rainbow." The most popular actor is Number 3, with its old fashioned diamond smokestack, box headlight and colorful trim. Number 3's TV credits include "Petticoat Junction," "Gunsmoke," "Bonanza" and "Little House on the Prairie."

The Sierra Railroad likes to call Number 3 the most photographed locomotive in the world, but that distinction could be lost in the next few years if a brand-spanking-new high-tech steam locomotive of the 1990s rolls off the production line. **PM**

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DETROIT '86

(Continued from page 80)

nents, but the coupe's is Level II while the sedan gets the Level I. The coupe's overall feel is thus firmer and more sporting than the sedan's. Buick chief engineer Sharpe explains that his division has aimed the sedan at the traditional LeSabre buyer, who values a smooth, quiet ride. The coupe, meanwhile, is intended for the younger customer who wants to feel and communicate with the road beneath him.

An optional Level II package is also available for the LeSabre and Delta 88 sedans. The Level II package includes alloy wheels, Goodyear Eagle GT tires, different steering valving, and a leather-wrapped wheel. As with the H coupe and standard Riviera, the Level II translates into less body roll, quicker steering response, a higher degree of road feel, and a slightly firmer ride.

The H-car's base engine is a 3.0-liter, 130-hp V6 with GM/Bosch port fuel injection. A 150-hp 3.8 single-point-injected engine is the alternate powerplant choice.

Another optional 3.8 V6, available in the '86 LeSabre, Century and Delta 88, has roller valve lifters instead of conventional hydraulic lifters. Sharpe expects the more efficient roller lifters to spread to other lines soon and, in fact, told us Buick currently is working on several interesting new engine projects, including 4-valve heads, twin-overhead-cam V6s, superchargers and turbochargers.

Olds chief engineer Ted Louckes hinted that his division has similar engine studies under way. He expects at least some of them to go into production soon. Oldsmobile, he said, hopes to regain some of the engine and technical R&D lead it enjoyed back in the 1950s.

Also in the wings is Buick's 1987 2-seater Riatta coupe, which shares not only the Riviera's fwd platform but also its CRT screen and its high degree of electro-sophistication.

Chrysler's '86 tuneup

When it comes to technology, the New Chrysler Corp. has been on the leading edge for some years now, switching most of its fleet to front-drive well before the competition, producing three times as many turbocharged engines as all other U.S. companies combined, dealing only in all-electronic radios for the last four years, and generally pushing ahead with fuel injection and corrosion protection.

Although most Chrysler products are now variations on two basic front-drive platforms, the Corporation's been no slouch on new models either, having reintroduced the convertible, virtually

(Please turn to page 118)



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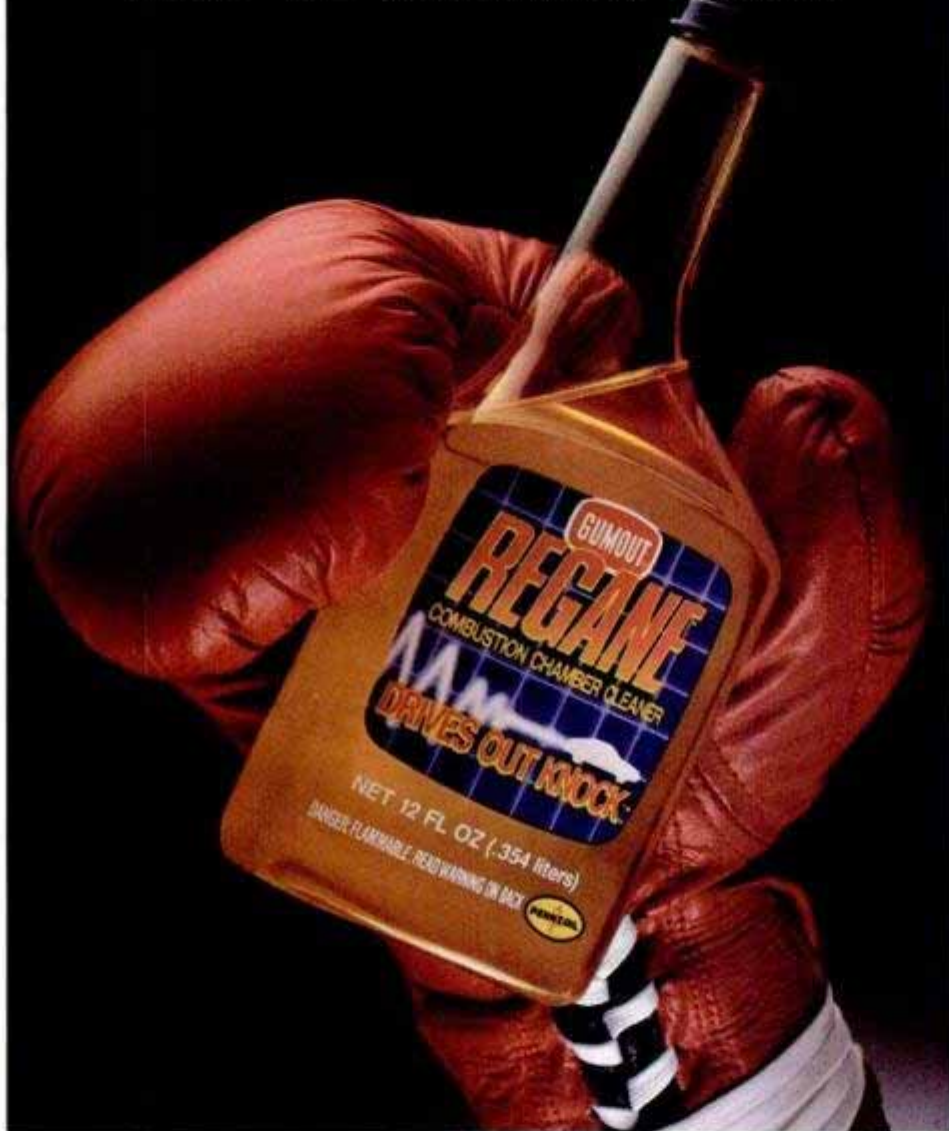
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*Based on average miles driven per tank. Source: Motor Vehicle Manufacturers Assn. 1982.

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DETROIT '86

(Continued from page 116)

invented the modern minivan and offered the first downsized limousines. So perhaps they deserve a bit of a rest period, and 1986 seems to be it as far as new models are concerned—there are no all-new cars from Chrysler.

Under the familiar skin of the '86s, however, Chrysler is tuning up its technology with a number of innovations, including a new 2.5-liter engine, a fast-burn cylinder head design, an improved throttle-body fuel injector, electronic load-levelling and climate control, plus new distributors and starters. We'll cover most of these next month in greater detail in our '86 Detroit Underhood Report.

New engine

The 2.5-liter engine is a stroked version of the familiar 2.2-liter Four, producing 100 hp at 4800 rpm and 136 lb.-ft. of torque at 2800 rpm. To offset the vibration usually found in big-thumper Fours, Chrysler has designed a pair of counter-rotating balance shafts into the 2.5. The shafts are located below the crankshaft, in the oil pan, neatly skirting Mitsubishi's patents on in-block balance shafts and working just as well.

The 2.5 engine is only 12 mm taller than the 2.2, and looks identical to it. Both engines sport new low-profile plastic air cleaners instead of the old "pots." The 2.5 will replace Mitsubishi's 2.6 Four as an optional engine everywhere except the minivans, which will retain the 2.6 until the new Mitsubishi V6 is available in 1987. The 2.5 gets about 3 mpg better fuel economy than the 2.6 and is lighter, too.

Chrysler's turbomotor will remain a 2.2 next year, although a turbocharged, intercooled, 16-valve 2.5 with up to 225 hp is rumored for the future, probably in the upcoming Chrysler-Maserati 2-seater convertible.

Both the 2.2 and 2.5 engines can be built on the same assembly line, which will give Chrysler more flexibility to meet customer demand, and dealers less parts to stock. A 1.8-liter version of the same engine is also in the works. It will be used in the 1987 Dodge Shadow/Plymouth Sundance replacements for the Omni/Horizon, in place of the 1.6 engine presently bought from Peugeot. That means, of course, that eventually there will be a 2.5 and/or turbo Shelby performance version of the Shadow/Sundance, since the engines all fit on the same mounts and take up the same amount of space.

Facelifts

Getting back to 1986, the most visually different car is the XT performance version of the Chrysler Laser, which

features a number of aerodynamic add-ons as well as optional rear window louvers, a T-roof and 15 x 6½-in. cast-aluminum wheels. Both the Laser and Daytona offer a performance suspension setup with fat 225/50-15 Goodyear "gatorback" tires, solid front and rear antisway bars, and gas shocks. Suspension rates are increased by 30 percent and cornering roll reduced 10 percent. It's a rough and ready package that goes like stink and is highly recommended with the turbomotor.

Elsewhere, an appearance package of all-white spoilers, wheels and a rear wing will be test-marketed on Dodge Lancer in California, then released nationwide if it's a hit. Since it makes the car look like a Mercedes customized by AMG, we say it can't miss.

Other H-car improvements include a 125-mph speedometer and childproof rear door locks—simple mechanical devices that prevent the doors from being opened from inside once a lever on the door jam is flicked. The rear window wiper on the H-cars, minivans and Laser/Daytona get an intermittent setting, which is a thoughtful touch. When a car's moving, very little rain hits the rear glass, and previous wipers were always cranking away at top speed over lightly misted glass. The Caravan/Voyager also gets an optional 60/40 split front bench seat that brings maximum seating capacity up to eight, to match Chevy's bigger Astro van.

The front end of the Dodge 600/Chrysler LeBaron has been slightly revised (but not so you'd notice unless you had the '85 and '86 side by side). A number of models get 4-way adjustable headrests (they now pivot 60° front to back as well as going up and down).

Lube news

Following GM's lead, Chrysler now recommends 5W-30 motor oil instead of 10W-30 in most of its engines. Cold-room tests show that cam lobe oiling time is cut in half and starting time reduced 40 percent using the lighter oil. However, turbos, high-performance and truck engines will stick with 10W-30 "pending further investigation," and so would we.

On the financial and quality fronts, Chrysler was happy to announce that its warranty costs have dropped 44 percent since 1979, despite a 5-year/50,000-mile warranty. Meanwhile, its market share has increased from 9.4 to over 13 percent. Earnings per car have soared to \$1180 for Chrysler, compared to \$890 for Ford and about \$800 for GM. Although the Motor City seems to be Fat City right now, for once the car companies are seriously planning ahead to meet future competition with their much-touted Saturn, Liberty and Alpha projects. **PM**

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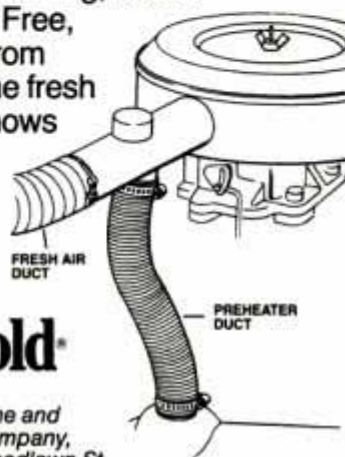
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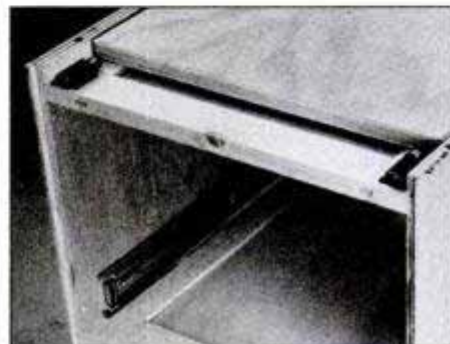
CLASSIC RECORD KEEPER

(Continued from page 99)

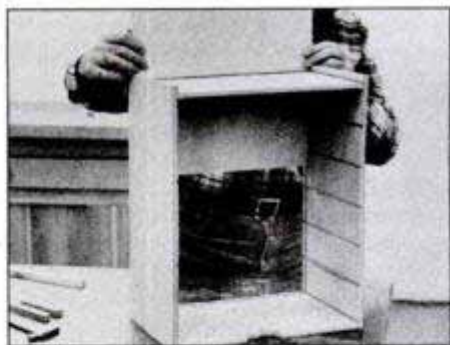
place until after you've applied the finish. Install the spring-loaded touch latches on the top web frame, and the stop (H) on the bottom of the shelf.

Cut the drawer parts. Rabbet the fronts and backs, and cut grooves and dadoes in the sides. Shape the front top edges and divider tops. Assemble with glue and 4d finishing nails.

Edge-glue and clamp together oak stock for the drawer faces. When dry, sand them smooth with a belt sander and cut them to size. Cut the beveled edges on these face boards by raising the table saw blade 1 1/8 in., then tilting it 15°. Set the fence 5/16 in. from the blade. Cut all four edges, then adjust the blade to 0° and 1 1/4 in. high, to remove the wedge. Cut test pieces on scrap wood first.



8 Mount spring-activated touch latches on top frame. Make sure the shelf, in closed position, is flush with cabinet face.



9 Glue drawer sides to back and front and secure with 4d finishing nails. Slide bottom in place immediately to square drawer.

Bore holes for the locks, then attach the drawer faces to fronts with 1-in. No. 8 rh screws and washers, driven through the back of the front into the back of the face. Cut and fit lock strike plates, mount the drawers with full-extension slides, then test-fit the locks. Install the locks, along with other external hardware, after cabinet is finished.

After sanding the assembled parts with 220-grit abrasive paper, we finished them with a golden oak stain, darkened slightly with burnt umber. We followed this with two coats of sanding sealer, then two coats of clear semigloss polyurethane varnish. **PM**

4x4 TORTURE TEST

(Continued from page 86)

put it in. Off-road, the S-10's long-travel suspension never bottomed out, the V6 had lots of low-speed torque and the extra-long wheelbase turned out to be no problem at all even on abrupt elevation changes. Ground clearance was generous and the 235/75R15 Goodyear Wrangler Radials performed adequately on every surface we attempted.

If we were going to buy a 4wd mini pickup, we'd buy a stretch cab S-10 with V6 and 5-speed. It's as comfortable as a Cadillac, yet it will scramble off-road with the best of them. As one of our testers summed it up, "This is my idea of roughing it—air conditioned comfort and Madonna on the tape deck, while the landscape floats by. It's like being transported through the woods in my living room."

Nissan King Cab 4x4

Nissan's King Cab is very similar to Chevy's S-10 stretch in size, layout, performance and feel. It's slightly smaller and less expensive, but as our testers said, "Feels solidly put-together, looks tough and has great off-road performance."

Our particular Nissan had a stylish gray plaid interior. We especially liked the seating position, convenient controls and full instrumentation. The supportive bucket seats might have been borrowed from the Stanza sedan, and there was plenty of elbow and head room, not to mention luggage room behind the seats.

On-road, the Nissan has a smooth, effortless ride. The overdrive fifth gear keeps the smooth 4-cylinder barely turning over at highway speeds, which does great things for fuel economy, durability and noise levels. There's a good sound system, and all the amenities of a middle-class automobile. Like the S-10, it wouldn't be a hardship to use the King Cab for everyday driving.

Off-road, the Nissan came in second. Summed up one tester, "This was fun to 4-wheel drive, due to excellent weight distribution, great balance, good ground clearance, adequate torque and beautiful operation of the transfer case. The King Cab is a very competent truck."

Dodge Power Ram 50

This is an interesting vehicle, sold as the Power Ram 50 at Dodge dealers and as the SPX 4x4 at Mitsubishi dealers. They're identical except for minor trim and options. Unlike most of the competition, the Power Ram 50 is available in only one length, and now that the turbo diesel has been dropped, with only a 2.6-liter Four with 4-wheel drive.

In 4wd, the Dodge/Mitsubishi's front

wheels are driven by a unique chain-drive, and there are balance shafts in the engine. Otherwise, it's so conventional you could use it for an illustration of a generic mini pickup.

Our testers put it second on the road behind the S-10, and fourth off-road. That put it third overall. While the Dodge was called "pleasant but bread-and-potatoes bland in appearance," it was also praised as a "straightforward, useful truck."

Specifically, everyone thought the unpretentious styling and interior would hold their appeal over the long run, and that the comfortable seats, terrific shifter and excellent steering made the Dodge fun to drive. The normally aspirated Four has good power and effortless driveability, and there are rumors that the Conquest's turbocharged 2.6 may soon be offered.

On the other hand, we got comments like "overall feel is cheap and tacky, it doesn't inspire faith that it will last in hard use" and "seams in the pickup box are a rust trap. The front suspension already seems loose and is rattling. I wonder about durability over the long term, particularly considering the kind of abuse a pickup is likely to receive."

Jeep Comanche

Jeep's brand-new pickup was rated fourth overall by our testers, and engendered the most disagreement. It was the only truck in the test to be picked first by some testers and last by others, averaging out in mid-field. The ones who liked the Jeep thought it was "modern, peppy and comfortable, easy to drive and a lot of fun." The others called it "old fashioned, uncomfortable and underpowered—the Harley-Davidson of mini trucks."

The truth lies somewhere in between. Everyone agreed that the Comanche is a gas guzzler, and that it feels "more like a full-size pickup than the rest." The controls came in for universal criticism, especially the balky transfer case shifter and the matching door lock and power window buttons. The lack of a tachometer detracted from an otherwise legible dashboard, and though the price has not yet been set, we'll bet it's substantially higher than the competition.

The seats were called "comfy and supportive," the steering "smooth with power assist" and the engine performance "excellent—this truck has more poop than most." The huge pickup bed reflects the Comanche's larger size. Perhaps this is the first true "midi pickup."

The best summation was: "AMC has built a pickup version of the Cherokee: it's stiff enough for true off-roading, comfortable enough for all-day driving

(Please turn to page 122)

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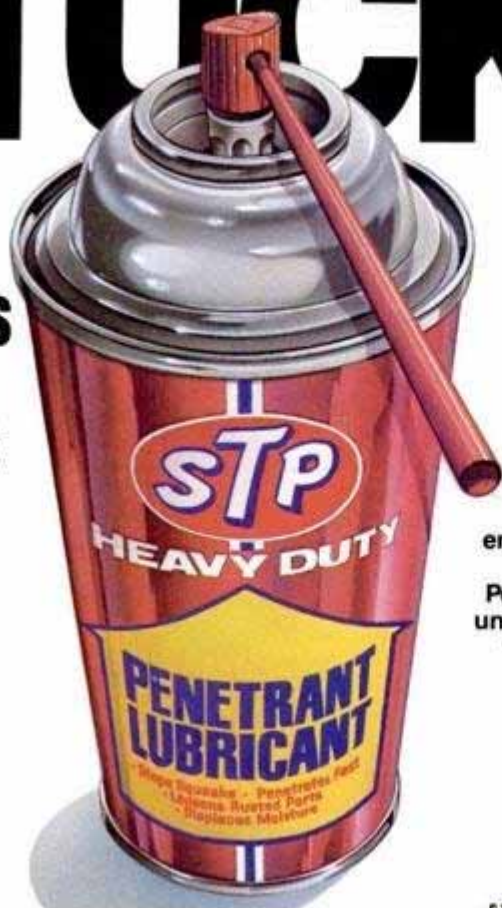


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4×4 TORTURE TEST

(Continued from page 121)

with the peppy GM 2.8-liter V6. They've kept the true Jeep feel, but civilized it. It's a neat compromise, sure to appeal to the traditional Jeep buyer."

Toyota SR5 Pickup 4×4

By the time you read this, Toyota will have made two major changes to its truck. The engine will have more horsepower and the front suspension will be independent, rather than the rigid axle on leaf springs that our test truck had. This will make the '86 Toyota peppier and softer, more of an on-road cruiser than an off-road slogger.

The Toyota was optioned up (or down) to be the most single-purpose truck in our group. It finished a strong third in the off-road section, mostly because of its stiff suspension, high ground clearance and feeling of absolutely unbreakable confidence. On the pavement, however, it was rated worst of all, a rough-riding horror capable of giving you whiplash over freeway expansion bumps. This truck is *stiff*.

Off-road it was great. We had a stripped model, with washable rubber floor mats, vinyl bench seat and nothing to fall off, break or go wrong. This was by far the most practical off-roader, as the cloth interiors in most of the other trucks were marred by mud stains after two days. The Toyota simply cleaned up with a damp cloth.

It also had lots of ground clearance, good low-speed performance and an obvious "last forever" sturdiness. It was the only truck in this group to still use manually locking front hubs, which require you to get out and stand in the mud in order to shift into 4wd.

Still, our testers agreed that this was probably the toughest off-roader in the group. "The one I'd choose for full-time off-roading. It's rough and primitive to live with, but a good choice if you plan to use it off-road 90 percent of the time. On the street, it just beats you up."

Ford Ranger

The Ranger seemed like a compromise that didn't work well off-road or on. The spare tire, for example, is bolted into the pickup bed, easy prey for thieves. The patented Twin Traction Beam front axle may be stronger than independent A-arms, but it doesn't work as well.

Overall, we put the Ranger into sixth place, both on-road and off. The engine was called "gutless," the steering "vague" and the handling "ponderous." The interior had "too much burlled plastic and red mouse fur." The ergonomics are poor, the 4-wheel-drive system unrefined and the ride exceptionally bouncy.

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For all its "truck tough" image, the Ranger wasn't a very good off-roader. It simply didn't inspire confidence. The suspension has a weird ride motion, presumably from the Twin Traction Beams, and it bottomed repeatedly in spots where the Toyota, Chevy and Jeep just rolled through.

Isuzu P'up 4x4 Diesel

We were originally set to test Isuzu's new 2.3-liter gas 4x4, but Isuzu missed our deadline, so we tried the 2.2-liter diesel. Our group turned out to be a bunch of closet oil burner fans who thought diesel clatter was just the right music for driving a pickup off-road. The diesel is slightly noisier and slower than the gas Isuzu on the highway, but off-road the economy, dependability and longevity of the diesel are distinct advantages.

Unfortunately, the rest of the Isuzu isn't up to snuff. We found it "uninspired and out-of-date." The cramped cab came in for special attention. "Makes you appreciate the stretched cab of the Chevy and Nissan," we said. The seats were called "dopey," the instrumentation "spotty" and the driver's position "dreadful."

At 60 mph on-road, the Isuzu was almost as uncomfortable as the Toyota—strained and bouncy, with unpredictable handling. Off-road, at speeds under 30 mph, it worked like a whole different truck. One tester said, "There's a nearly perfect compromise between shock isolation and road feel, and off-road it handles like a sprint car on a dirt track—easy and fun to drive. And the diesel clatter warns the deer to jump out of the way."

The Chevy S-10 chassis is very similar to Isuzu's, perhaps because Isuzu is partially owned by GM. In the best of all worlds, Isuzu would buy 2.8 V6s from Chevy and put them in the P'up. Popped into the new stretch cab Isuzu pickup, with the addition of nicer interior trim, beefier controls and suspension, this would make a very competitive truck. The P'up is almost there, it just hasn't been upgraded in five years, while the rest of the mini truck market is two generations further along. It's time for Isuzu to redo the P'up.

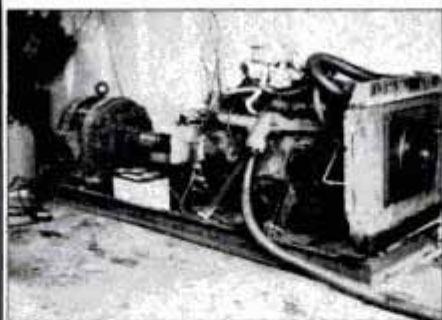
Subaru BRAT GL

The BRAT is a 4-wheel-drive Subaru station wagon with the back cut off. This does not make it into a pickup truck, but rather a 4-wheel-drive car in which the rear seat passengers (there are two seats permanently mounted in the bed) get wet when it rains.

As a 2+2 fun car, the BRAT scores very well. It's fairly inexpensive, "cute as a bug" and equipped with every possible electronic convenience option.

(Please turn to page 150)

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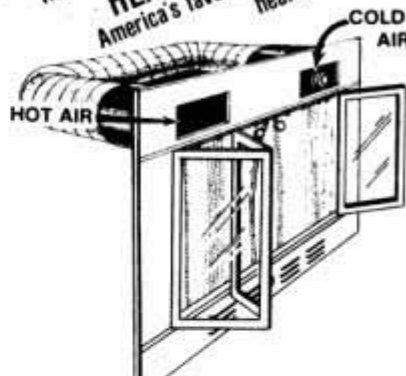
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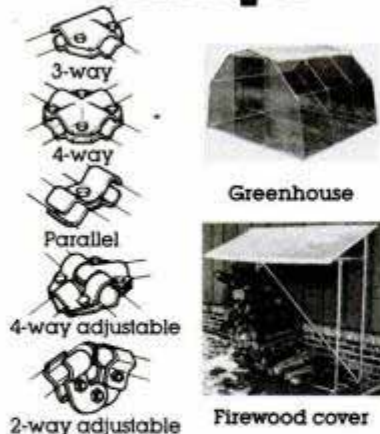
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Always keep the muzzle pointed in a safe direction regardless of the position of the safety, and never rely on any mechanical safety device to justify careless handling of any firearm.

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PM PHOTO HINTS

Kitchen helper



Grit in the threads of a screw-in lens attachment can freeze the accessory in place. The small rims of these items are difficult to grasp, but a rubber jar-lid opener will remove the most stubborn.—*Kenn Oberrecht*

Tripod tote



A tripod can be cumbersome to carry. Secure the legs together with a twist-tie or heavy rubber band, attach a camera strap to each end of the tripod and sling it across your back.

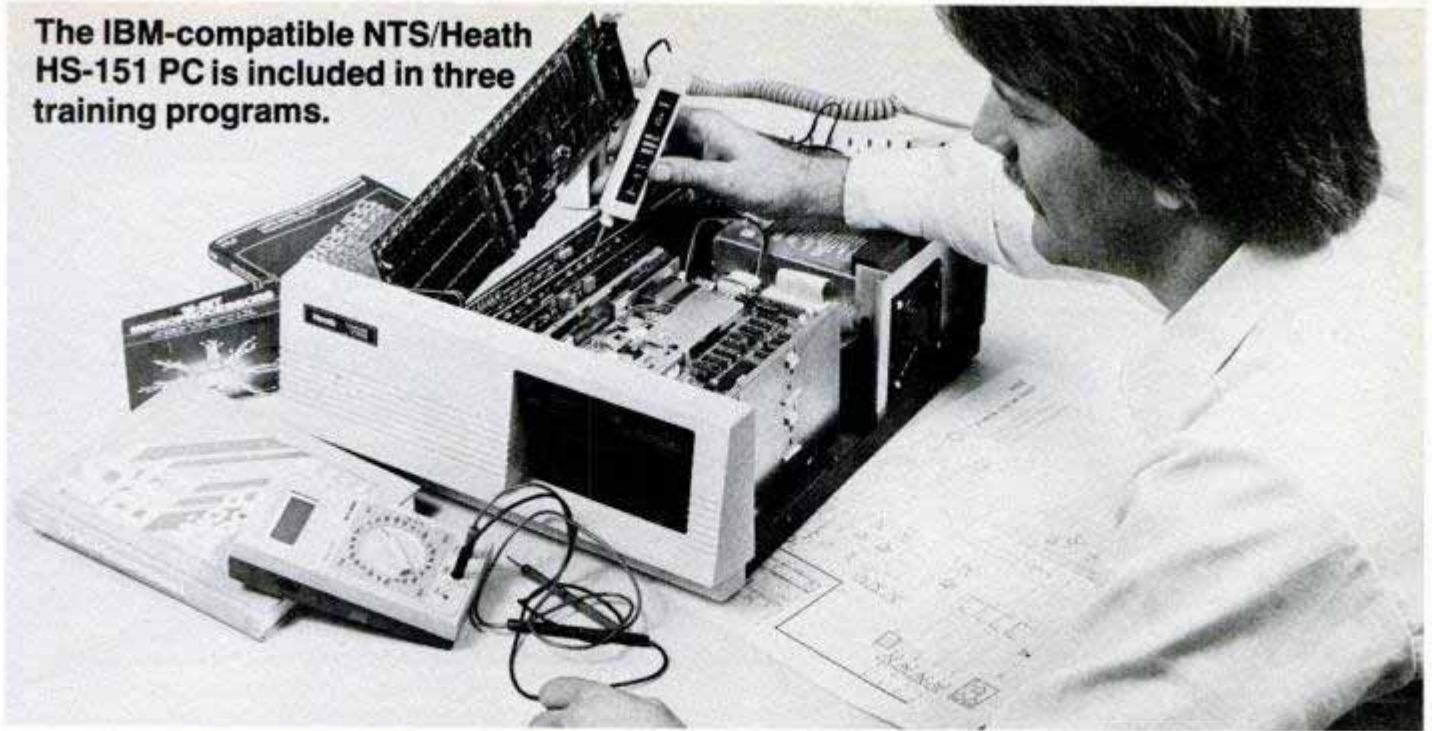
—*Bob "Greenie" Grewell*

Recycled soup



Most color developing chemicals can be used over again by extending processing time. Collect the soup in a wide-mouth container and cover tightly to retard oxidation.—*John Kirwin*

The IBM-compatible NTS/Heath HS-151 PC is included in three training programs.



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Home For The Harvest

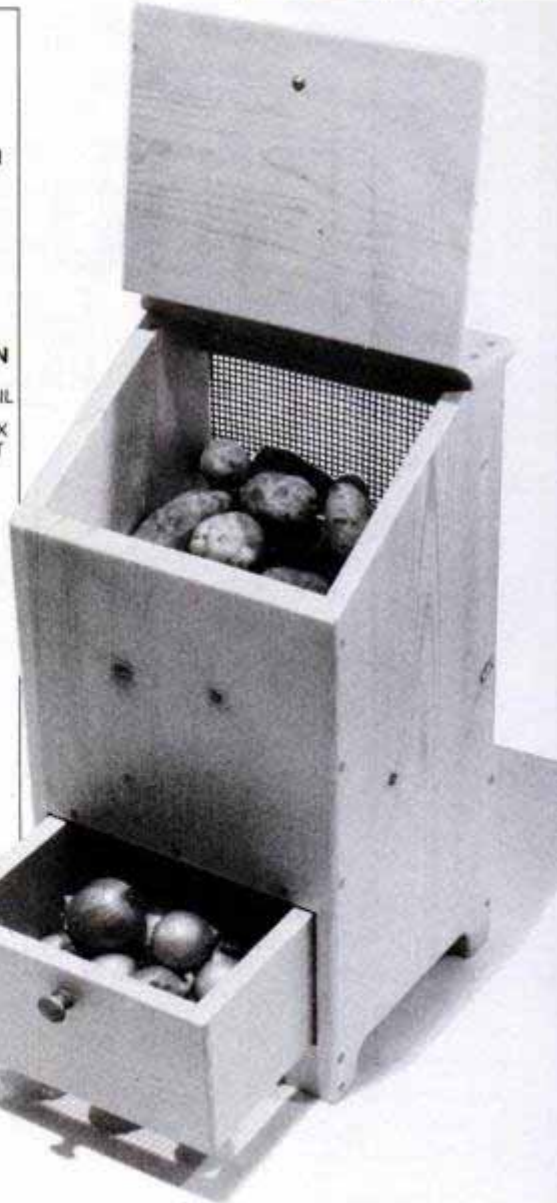
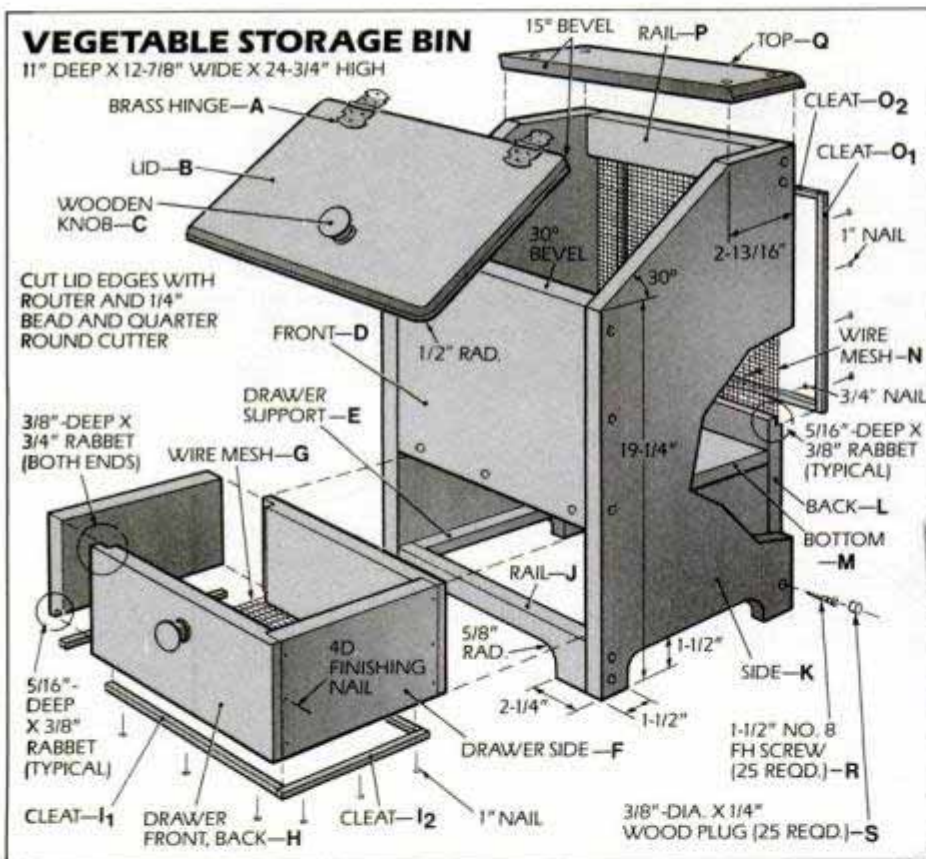
This easy-to-build storage bin keeps your fruits and vegetables just-picked fresh.

Our double-compartment fruit and vegetable bin, compact though it is, holds a pile of produce. And it's an attractive piece to honor a corner of your kitchen where you can conveniently lay your hands on foods that keep best out of cold storage. A wire-mesh back and drawer bottom assure good air circulation, to prevent spoilage.

The bin is constructed of No. 2 common pine. Choose your stock carefully, selecting boards that are attractively grained, and free of warp and large, loose knots.

Begin construction by ripping all the boards to width, then crosscut them to length. Mark the bin sides for the 30° slope of the lid; cut the angles on a table saw or radial-arm saw. Mark the cutouts in the bottom rail and the side

(Please turn to page 130)



MATERIALS LIST—VEGETABLE STORAGE BIN

Key	No.	Size and description (use)	I2	2	1/4 x 3/8 x 9 5/8\" pine (cleat)
A	2	1 3/16 x 2 7/8\" Stanley No. CD5317 brass hinge	J	1	3/4 x 2 1/4 x 11\" pine (rail)
B	1	3/4 x 10 x 12 3/4\" pine (lid)	K	2	3/4 x 11 x 24\" pine (side)
C	2	1 1/4\"-dia. wooden knob	L	1	3/4 x 9 1/2 x 11\" pine (back)
D	1	3/4 x 11 x 11 3/4\" pine (front)	M	1	3/4 x 9 1/2 x 11\" pine (bottom)
E	2	3/4 x 3/4 x 9 1/2\" pine (drawer support)	N	1	11 5/8 x 13 5/8\" wire mesh (back)
F	2	3/4 x 5 1/2 x 9 5/8\" pine (drawer side)	O1	2	1/4 x 3/8 x 13 1/4\" pine (cleat)
G	1	9 1/2 x 10\" wire mesh (drawer bottom)	O2	2	1/4 x 3/8 x 11\" pine (cleat)
H	2	3/4 x 5 1/2 x 10 3/4\" pine (drawer front/back)	P	1	3/4 x 2 x 11\" pine (rail)
I1	2	3/4 x 3/8 x 9 1/4\" pine (cleat)	Q	1	3/8 x 3 x 12 3/4\" pine (top)
I2	2	3/4 x 3/8 x 9 1/4\" pine (cleat)	R	25	1 1/2\" No. 8 fh screw
			S	25	3/8\"-dia. x 1/4\" wood plug
			Misc:		1\" and 3/4\" nails, 4d finishing nails, 1 1/4\" No. 8 fh screws, 120- and 220-grit sandpaper, carpenter's glue.

Design: Cindi Myers; Text and photos: August Capotosto; Technical art: Don Mannes

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by Richard Kruger

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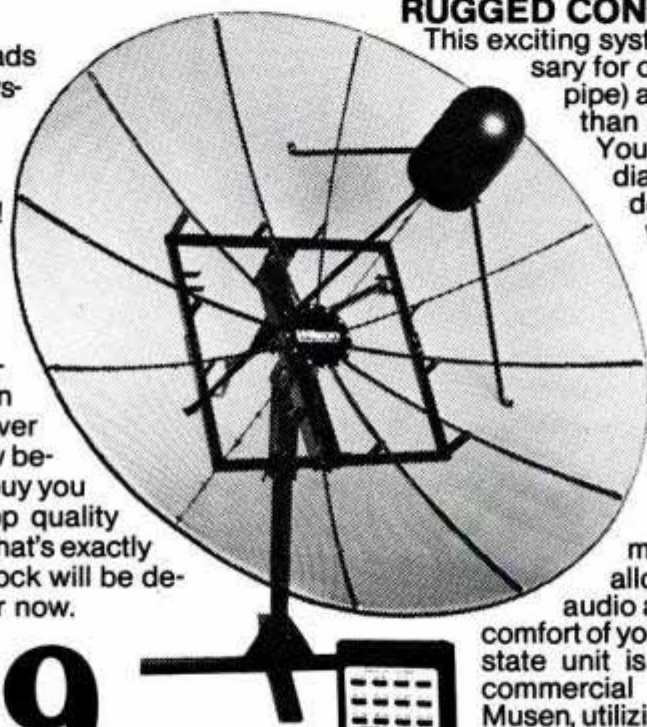
This exciting system includes all parts necessary for completion (except mounting pipe) and can be assembled in less than a day.

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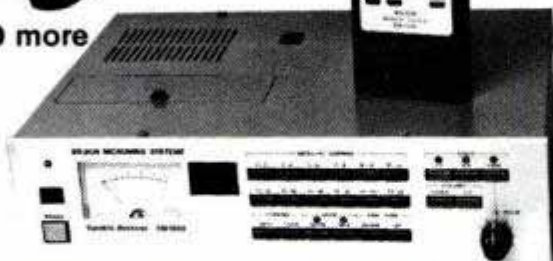


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HOME FOR THE HARVEST

(Continued from page 128)

bottoms. Cut them with a jigsaw or band saw, and sand smooth.

Bevel the butting edges of the lid and top 15°, and cut a 1/2-in. radius on the two bottom corners of the lid. Then, rout the two sides and bottom edges of the lid and the two side edges of the top with a 1/4-in. bead and quarter-round bit. Cut a 30° bevel on the upper edge of the bin front.

Dry-assemble the bin sides, front and back pieces with clamps. Tap all the pieces into alignment, and check for squareness. If necessary, shift the clamps slightly to bring the assembly square. Then, bore screw-clearance holes and pilot holes, and counterbore for 3/8-in.-dia. wood plugs.

Assemble the front and back pieces with glue and screws. Then, install the bin top and bottom—first dry-assembling and boring holes before gluing and screwing the pieces in place.

Glue 3/8-in.-dia. wood plugs into the screwhead counterbores. You might want to cut plugs from a scrap of darker wood such as walnut or mahogany to contrast with the lighter colored pine. When they dry, sand plugs flush with a belt sander or sanding block.

Cut 3/8-in.-deep x 3/4-in.-wide rabbets on the ends of the drawer front and back. Assemble the drawer with glue and 4d finishing nails. Set the nailheads and fill with wood filler. After the glue



Mark the position of the slanted edges on bin sides, then make cuts with table saw miter gauge or radial-arm saw blade at 30°.

has dried, cut 5/16-in.-deep rabbets along the inside bottom edges of the drawer for the wire mesh bottom and cleats. Use a router and a 3/8-in. rabbeting bit. Use the same bit and router setting to cut similar rabbets around the back opening. Install the wire mesh on the back and drawer bottom with cleats and 1-in. and 3/4-in. nails.

Mount the drawer supports to the inner sides of the bin with glue and 1 1/4-in. No. 8 fh screws. Prebore pilot holes and clearance holes, and countersink screwheads slightly.

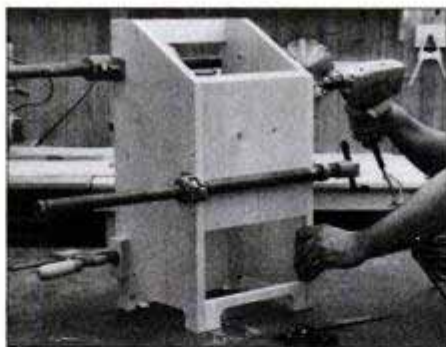
Ease the vertical edges of the bin, the bottom cutouts, and the edges of the drawer front with a 1/4-in. rounding-over bit in a router. Sand the bin, drawer and lid, first with 120-, then 220-grit sandpaper. Slightly break with sandpaper all the corners that have not been previously eased or beaded.

Stain all the bin parts to suit your taste, then apply two coats of polyurethane varnish, sanding lightly between coats. If you choose not to use a polyurethane top coat, use an oil finish instead. Be sure to leave the insides of the bin unfinished to prevent stain odors from entering the food.

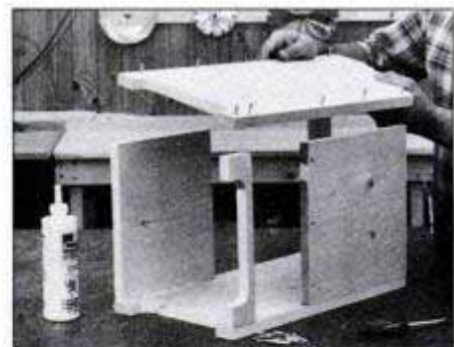
After the finish dries, mount the lid with brass ornamental overlay hinges. Bore holes for the wood pulls and attach them with screws through the back of the lid and drawer front. **PM**



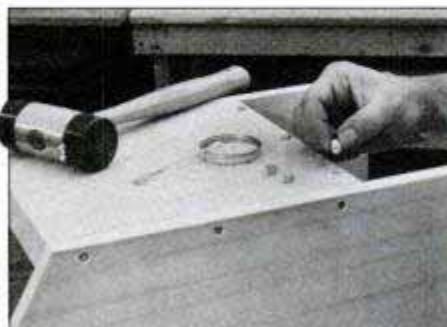
Cut the curves on the sides and the front rail with a jigsaw. Then smooth with sanding drum, or a rounded sanding block.



Dry-assemble, check squareness, then bore screw-clearance and pilot holes. Counterbore for screwheads and wood plugs.



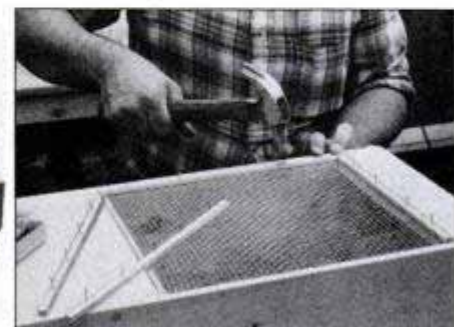
Join the front, back and rails to one side piece with glue and screws. Then, attach the opposite side panel.



Glue 3/8-in.-dia. wood plugs into screw holes, and sand smooth. We cut plugs from darker colored wood to create contrast.



Cut a 5/16-in.-deep x 3/8-in.-wide rabbet around the back opening for wire mesh and cleats. Square corners with a sharp chisel.



Mount wire mesh with 1/4 x 3/8-in. cleats. Fasten with 1-in. nails into sides, and 3/4-in. nails into back and top rail.

HOW WE TEST CARS

A combination of driving experience plus computer-derived information go into every PM road test.

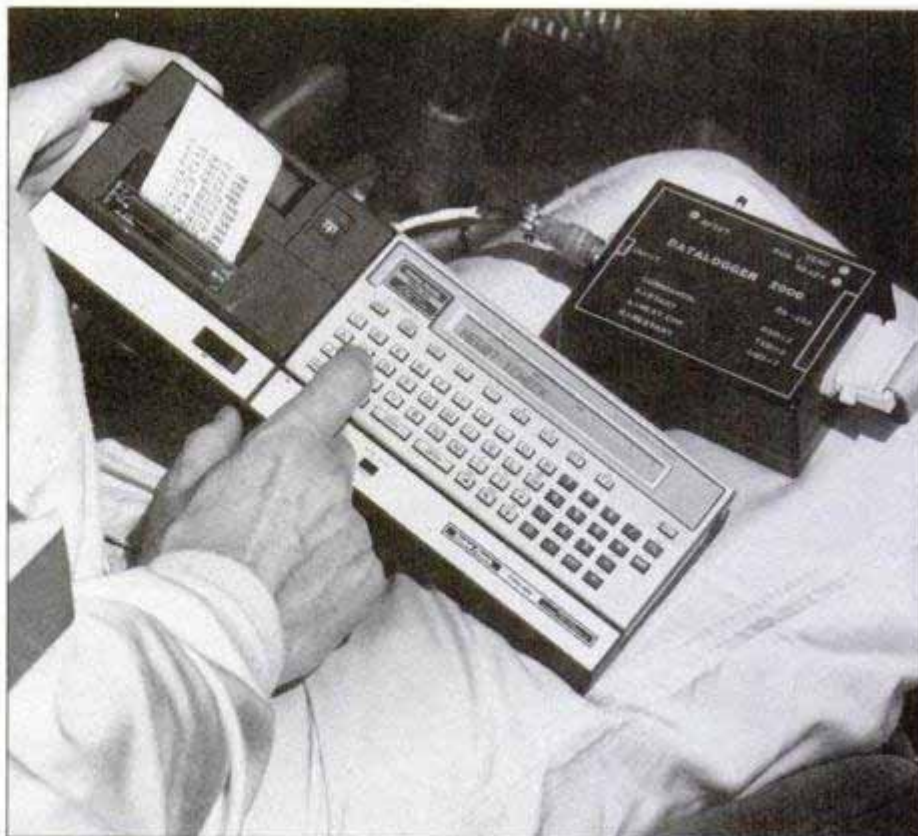
In a typical year, **POPULAR MECHANICS** will test or evaluate over a hundred new cars—a more extensive automotive test program than even car buff magazines. We're most proud of our group tests, in which we test, compare and rank anywhere from six to 16 vehicles, usually all the cars for sale in one particular market segment.

No other magazine—and no car manufacturer—does comparison testing on this scale, this often. It takes an intimidating amount of organization, time and manpower to do these tests successfully. But we're convinced that a head-to-head comparison is the only way to achieve results that can really help you decide which new car to buy.

Our comparison testing is divided into two parts: objective and subjective. Objective car testing is just like any other controlled test, except our laboratory is a race track. We're as careful as any scientist to maintain consistent conditions that ensure the repeatability of data. Here's how we do it:

Quarter-mile acceleration

We do most of our performance testing at one of the best dragstrips in the country—Raceway Park in Englishtown, New Jersey. For our acceleration test, we use Raceway Park's highly sophisticated Chrondek timing equipment, which is accurate to thousandths of a second. As a backup, we often use a computerized fifth wheel built for us by



Radio Shack computer and printer spew out test results after every 20 runs down the track.

former Chevrolet racing engineer Paul Van Valkenburgh. It consists of three basic parts: the wheel, a data buffer and a computer/printer.

A fifth wheel is just that: an extra road wheel temporarily added to the car. The purpose is to have a corrected source of distance data that can be measured accurately. We just have to compare this distance to time, and we can calculate speed.

Van Valkenburgh's fifth wheel is a high-tech sandwich of aluminum and balsa wood, fitted with a bicycle tire. It pivots from an aluminum swing arm, which is fastened to the car with either a suction cup or bumper bracket. A simple transducer counts each revolution of the wheel.

The transducer feeds its information into a data buffer that stores the raw

data. We collect the data with a Radio Shack TRS-80 PC-2 pocket computer, where it is automatically analyzed and transformed into useful test results via a software program Van Valkenburgh developed. We then print out the results on a Radio Shack printer.

The Van Valkenburgh system can store up to 20 acceleration and braking runs, enough to test a few cars at a time before the data must be printed out. There are other data points available, which we don't use: acceleration to 150 mph in 10-mph increments, for example, or braking from any speed to 0.

In some ways, our sophisticated fifth wheel is technological overkill, but Van Valkenburgh's racetrack-derived equipment gives the most accurate possible data, even if we're just testing a Yugo

(Please turn to page 134)



The computer gets its raw data from the fifth wheel—a high-tech sandwich of aluminum and balsa wood that trails along behind the car on acceleration and braking runs.

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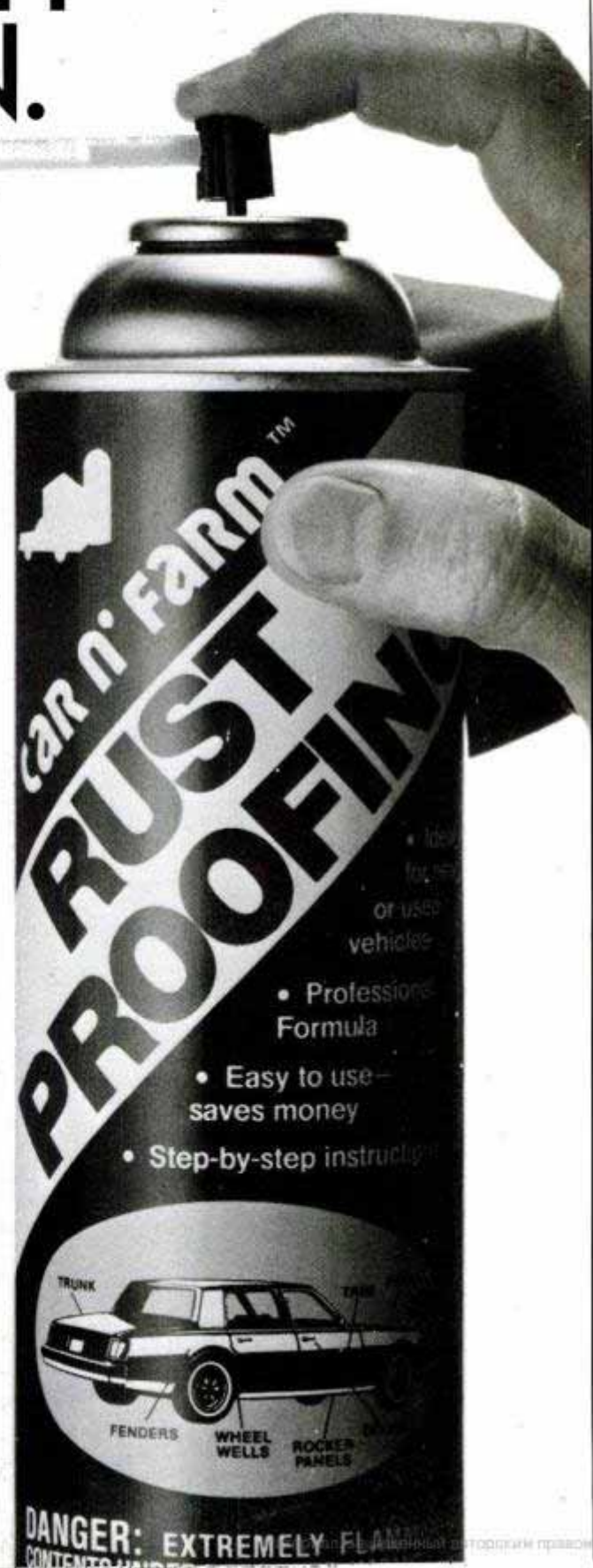
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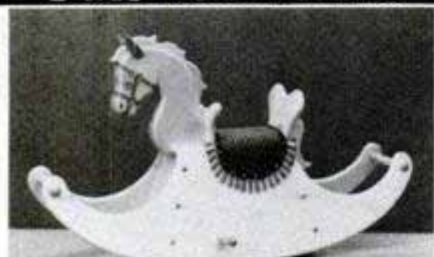
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HOW WE TEST CARS

(Continued from page 132)

GV from 60 to 0, not a Lamborghini from 0 to 150.

We record four to six acceleration runs, depending on whether we feel we need more experience with the car. The figures we publish are the best single-run figures for that car, not an average.

Automatic transmission cars are driven off the line and left to shift for themselves. We don't wind up the torque converter at the start line or manually shift gears. Manual transmission cars are driven off the line at around the torque peak—usually 3000 to 5000 rpm—slipping the clutch just enough to maintain optimum traction. We don't sidestep the clutch, power-shift or abuse the car.

The quickest and fastest production car we drove in recent years was a 1985 Corvette which took 14.447 seconds to cover 1320 feet, and was traveling 93.55 mph as it crossed the quarter-mile finish line. Compared to muscle-cars from 15 years ago, which were capable of quarter-miles under 14 seconds at over 100 mph, this is pretty tame. But in 1985, any production car that can do the quarter in under 16 seconds at over 85 mph ranks as a high-performance machine.

700-ft. slalom

The 700-ft. slalom consists of cones placed at 100-ft. intervals down the center of the dragstrip, with a 15-ft.-wide gate made from two cones at the beginning and end. The object is to weave left/right/left through the cones as quickly as possible, from a running start of up to 60 mph. Photoelectric cells hooked to an electronic digital stopwatch measure the time between the two gates in hundredths of a second. We make four to six runs, depending on whether we feel we can do better with a slightly different technique.

The slalom is a laboratory measure of transient handling response—a car's ability to turn quickly from side to side. As you might expect, long, heavy cars are more difficult to weave between the cones than short, light, well-balanced cars. Small cars with fat tires do the best in the slalom test.

We convert slalom time to speed using the formula, $\text{mph} = 3600 \div \text{seconds} \times 7.54$. A typical big car will have to slow down from its 60 mph entry speed in order to get through the cones without spinning out, while a small, high-performance car will be accelerating. Average speeds range from around 50 mph to our current best, a 63.84-mph run by the Omni GLH Turbo (see *PM Comparison Test: Pocket Rockets*, page 76, Aug. '85).

(Please turn to page 136)



Braking test measures distance needed to stop from 60 mph without skidding (top). Slalom measures average speed while snaking through seven cones placed 100 ft. apart (center). Skidpad measures maximum cornering ability of a car around a 200-ft. circle; crew member at center of circle records lap time, which is converted to g-forces.

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HOW WE TEST CARS

(Continued from page 134)

60-0 braking

Our tests are always done in a specific order, because the braking and skidpad are tough on tires and we want everything as equal as possible. Braking is done in the unused lane of the dragstrip, with the fifth wheel attached to the test car. We accelerate to an indicated 65 mph, then apply the brakes. The fifth wheel gives us a computer printout from 60 to 0 mph, which is measured in feet.

The trick is to keep all four tires on the edge of adhesion without actually locking up—exactly what the new ABS brake systems do by computer. This produces shorter stopping distances than either pumping the pedal or a foot-to-the-floor panic stop.

Cars with good brakes are very undramatic—the car just stops—while those with brakes that fade or lock prematurely will go sliding sideways, to the great delight of the photographers. We make three runs—enough to heat up the brakes and tires for maximum performance.

After three runs, most cars begin to encounter brake fade. We've seen stopping distances of more than 220 ft., as well as 120 ft. from our current champ, the Honda Civic S. Most cars are in the 130- to 160-ft. range.

200-ft. skidpad

Skidpad testing is always done last because it absolutely eats up tires. More than once we've had to buy a new set of tires to drive home. As you might expect, front-heavy, front-wheel-drive cars are the worst offenders, since they corner primarily on the outside front tire. Well-balanced cars—the Bertone X1/9 or Mazda RX-7, for example—wear all four tires equally.

We run four circles in each direction. Typically, the first lap in each direction serves to warm the tires to maximum traction temperature, the second and third give us our best figures, and by the fourth circle the tires have gotten overheated and slippery. The skidpad puts passenger car tires through such an extreme heat cycle that traction is permanently lessened. We have to get it right the first time.

The skidpad is far more than a test of tires. What we're really exploring is the steady-state cornering limits of the automobile, which are dependent not only on the tires, but how well those tires are kept in contact with the road surface by the suspension.

Factors that have to be optimized for good skidpad performance are front-to-rear weight distribution, chassis stiffness, body lean, camber change, shock

(Please turn to page 138)

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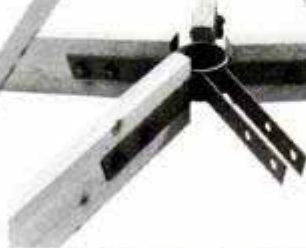
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PM-9

HOW WE TEST CARS

(Continued from page 136)

damping and bump steer. The skidpad is also a test of the car's throttle response, differential efficiency and steering predictability.

On the skidpad, we can tell whether a car oversteers (rear skids first) or understeers (front skids first), and whether or not it will be easy to drive or a handful at high speeds. It's significant that the one test road racers use to set up their cars is the skidpad, because it really does test every suspension and chassis component in a controlled laboratory environment.

A typical passenger car will circle the 200-ft. circle at around 40 mph in second gear, taking between 12 to 14 seconds for a lap. We use photoelectric timers to record lap times, then convert to g-forces using the formula, $g = 122.5 \div \text{time}^2$.

We use the single best run in each direction for our published figure. On many cars, the counterclockwise figure is higher because the driver's weight is on the inside for flatter cornering and his sightline to the cones is better, so he cuts a more precise circle.

Nearly all modern cars can corner at over .70g. The average is around .77g and high-performance cars routinely break .80g. The highest skidpad figure we've seen for a production passenger car on street tires is .88g posted by Volkswagen's Golf GTI.

Interior space index

While we're at the track, we measure the passenger compartment and luggage area of each car using formulas we've developed ourselves. To measure the interior, we use a tape measure to find length, width and height.

We measure from armrest to armrest, front and rear, and from seat cushion to roof, front and rear. We also measure legroom from brake pedal to the base of the driver's seat back, with the seat pushed all the way back, and from a point on the floor beneath the driver's seat to the rear seat back.

These measurements are then inserted into the formula, front seat width x headroom x legroom + rear seat width x headroom x legroom ÷ 1000 to produce an Interior Space Index. Two-seaters can score under 60, intermediate sedans around 120 and the roomiest car we've tested lately, the Buick Electra T-Type, scored 177.36.

Trunk-capacity index

We measure the trunk by seeing how many standard-size grocery bags can stand up in the trunk, with 1-in. crush space permitted.

We feel this is an ideal test of trunk

(Please turn to page 142)

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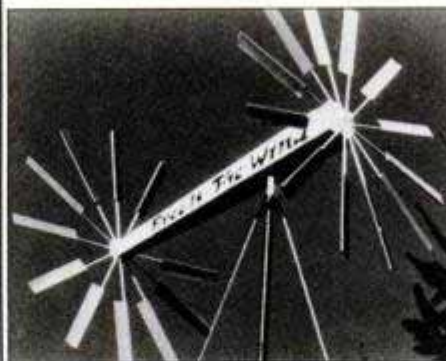
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WARNING!

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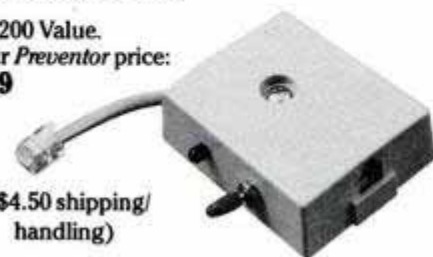
Adapted from the military model actually used in sensitive diplomatic circumstances!

Just plug your phone into the Telephone Bug Preventor and plug the Telephone Bug Preventor into any modular jack. Of course a red light goes on if someone lifts an extension while you're talking, but that's only the beginning.

When someone tries to invade your privacy with a telephone line powered "bug" (hard-wired or transmitting), the bug is paralyzed by the Telephone Bug Preventor. The person trying to spy on you will hear *nothing*.

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Commodore 64 Accessories



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Summer Sizzler Sale

Sale Positively Ends 9-15-85

Prices will go back to regular sale prices

	List	Reg. Sale Price	Summer Sizzler Sale
C128 Commodore Computer Expandable to 512K, runs C-64, CPM, and 7.0 Programs. (Add \$10 Shipping)	\$349 ⁰⁰	\$299 ⁰⁰	\$289⁹⁵*
15 1/2" Commodore 150-170 CPS Printer Near Letter Quality, Multiple Pin Tractor / Friction Feed. Best Printer Value in U.S.A. (Add \$17.50 Shipping)	\$895 ⁰⁰	\$299 ⁰⁰	\$249⁹⁵*
Commodore-64 IEEE Interface Allows you to run Pet Peripherals on the C-64, including the One Megabyte Disk Drive and 15 1/2" Printer	\$109 ⁹⁵	\$69 ⁰⁰	\$65⁹⁵
Juki Printer/Typewriter Letter Quality, daisy wheel, use as typewriter and/or printer (auto correction) (Add \$10 Shipping)	\$349 ⁰⁰	\$249 ⁰⁰	\$229⁹⁵*
SCM 80 CPS Printer Tractor / Friction 10" Famous Name Printer does Graphics w/ Interface. (Add \$10 Shipping)	\$299 ⁰⁰	\$159 ⁰⁰	\$149⁹⁵*
Cardco G Plus Interface Converts Commodore to centronics for use with most printers, plus does Commodore graphics on graphic printers	\$109 ⁰⁰	\$59 ⁰⁰	\$49⁹⁵
Alphacom 40 Column Printer Thermal technology - does graphics. (Add \$7.50 Shipping) Alphacom C-64 or Atari Interface \$8.95.	\$99 ⁰⁰	\$24 ⁹⁵	\$22⁹⁵
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One Megabyte Disk Drive (1000K) Double sided drive hooks up to C-64 with IEEE interface, perfect as a second drive. (Add \$10 Shipping)	\$889 ⁰⁰	\$199 ⁰⁰	\$179⁹⁵*
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Voice Synthesizer Allows you to talk through your computer. Optional software lets you play talking adventure games (Zork, etc.)	\$89 ⁰⁰	\$49 ⁰⁰	\$39⁹⁵
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Musicalc I Software The Best Musical Software for the C-64, allows you to change all parameters.	\$59 ⁹⁵	\$29 ⁹⁵	\$14⁹⁵
Oil Barrons Software Better than Monopoly, comes with game board, disks and instruction manual. Strike Oil or Live in the Poor Farm	\$49 ⁹⁵	\$19 ⁹⁵	\$9⁹⁵

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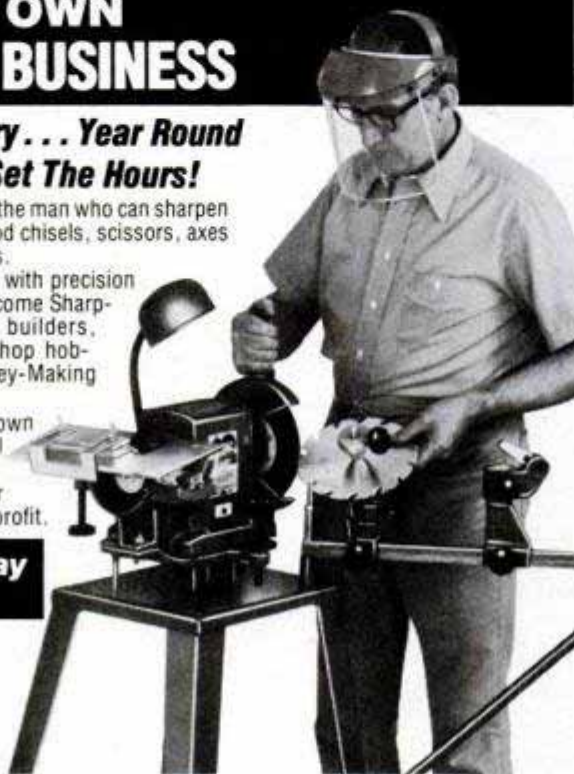
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HOW WE TEST CARS

(Continued from page 138)

room. It gives us a standard unit of measurement that everyone is familiar with, and it measures the space in a way that tells its usefulness. What good is a huge-looking trunk, if the configuration is such that all it can hold is golf balls or grains of rice?

The lowest number we've seen so far was two grocery bags in the mid-engine Fiero 2-seater. Most cars will hold 10 to 15, in either the trunk or hatchback, while the most capacious trunk we've stuffed was on the full-size Chevrolet Caprice/Pontiac Parisienne, which swallowed 20 bags—surely enough to feed a family of four for a week.

Fuel mileage

We figure fuel mileage during our subjective driving loops, not at the track. We top up all the cars in a test, record the mileage, then caravan over our 15-mile test loop. Each driver drives each car, so that our fuel-economy figures reflect anywhere from 90 to 180 miles of driving by six to 12 drivers over the same loop each time.

Then we fill the tanks again, record mileage and gallons, and calculate miles per gallon, just as you do. The inevitable leadfoot is balanced out by a balloonfoot or two, so our mileage figures represent as close to a meaningful average as you're likely to find. We've found that our overall figure—which represents a mix of street and highway driving—is usually slightly less than the EPA city figure.

Test-track ranking

At the end of the day, we rank the cars in the group in order for each of the seven test categories, then add these together to arrive at a Test Track Ranking. Each category—acceleration, slalom, braking, skidpad, interior space, luggage space, fuel economy—is weighted equally.

Road-test ranking

Most road tests you read in car buff magazines are written by one person, and reflect his personal bias. We eliminate the one-man's-opinion approach by using a group of testers with varied backgrounds and tastes in cars as well as different physical characteristics. We have a regular test group of six drivers, to which we add to depending on the number of cars involved.

We've developed a standard test loop outside Princeton, New Jersey. It's just over 15 miles long and includes a stretch of divided highway, straight 2-lane, winding back roads, stop-and-go traffic, a railroad crossing and half a dozen stop signs and traffic lights. In

(Please turn to page 157)

THE HEAT IS ON

The comfort and dependability provided by a water heater often is taken for granted. That is, until the water turns ice cold while you are in the middle of a shower.

Although many repairs are best left for the professional service technician or plumber, there are several minor repairs and adjustments that you can make to keep your heater operating efficiently and smoothly.

Water heaters have relatively few components and are fairly easy to service. When problems arise, however, a water heater sends out a mixture of confusing signals. The troubleshooting charts on pages 145 and 146 will help

Keep yourself in hot water with PM's troubleshooting guide to gas and electric water-heating systems.

TEXT AND PHOTOS
BY MERLE HENKENIUS

you diagnose the heater's ailments.

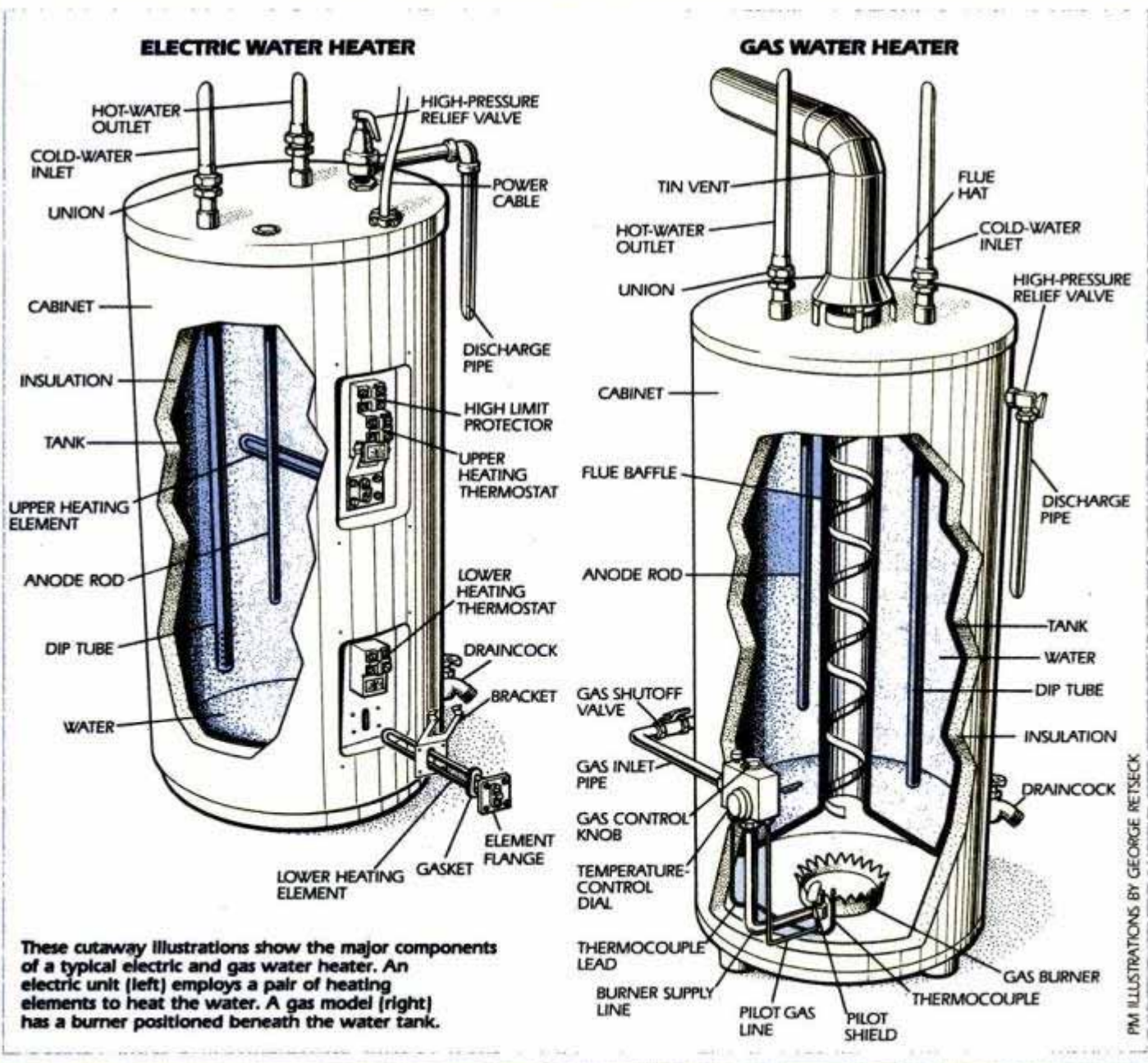
Because problems can occur in any part of your hot-water system, it helps to think of the system in terms of its three basic elements: the piping system, including all faucets and hot-water

appliances; the tank; and the heat source—either gas or electricity.

The piping system

Some problems commonly attributed to the water heater are actually caused by the piping system. For example, high operating costs are often traced to a dripping faucet or leaking pipe. A faucet that drips at a rate of only one drop per minute wastes nearly 800 gallons of hot water per year. In such a case, a simple, inexpensive faucet repair will pay for itself many times over (see *How To Stop Any Faucet From Leaking*, page 149, Apr. '83).

Long, uninsulated piping runs also



waste hot water. When you draw water from a faucet at the end of such a run, hot water from the tank must first push the cooled water through the pipe. So, in order to get a quart of hot water, you must draw several gallons from the tank which, in turn, could cause the heater to turn on. Prevent the pipe from dissipating heat so quickly by applying pipe insulation to all hot-water pipes.

Tank troubles

Sediment—An aging water system may carry sediment into the tank, or sediment may collect as flakes of calcium and lime. In electric models, sediment-covered heating elements will burn out quickly. In gas heaters, sediment accumulates in the bottom of the tank and forms a barrier between the heat source and the water. Air bubbles, created by the heat, percolate through the sediment and cause a continuous rumbling sound. So, if your electric heater burns up lower elements frequently, or if your gas heater rumbles, sediment may be the culprit.

To remove sediment, first drain as much water as possible from the tank. Next, with the draincock still open, turn the water on full pressure in the tank. Then, reduce the pressure by half and, finally, shut off the water and allow the tank to drain completely.

Fallen dip tube—A dip tube is a plastic pipe that delivers incoming cold water to the heat source near the tank bottom. Occasionally, a dip tube will slip through the cold-water inlet fitting and fall into the tank. When this happens, cold water entering the tank is drawn through the hot-water outlet without being heated. To replace a dip tube, disconnect the inlet pipe from the tank. Then, cut a length of 1/2-in.-dia. soft copper pipe long enough to reach within 12 in. of the tank bottom. Flare the pipe end so it's slightly larger than the inside diameter of the inlet fitting. Insert the tube into the fitting and reconnect the inlet pipe.

Faulty anode rod—Late-model water heaters are equipped with a magne-

sium anode rod that coats voids that may develop in the porcelain tank lining. An anode rod acts as a sacrificial element to prevent rust and prolong the tank's life. These rods seldom cause problems, but when they do, it's often due to an adverse chemical reaction to a combination of acids and minerals in the water. As a result, the water will have a gassy odor or taste. To correct this problem, unscrew the magnesium rod and replace it with an aluminum rod. Aluminum anode rods are available from most retail plumbing outlets.

Faulty relief valves—A relief valve keeps the heater from exploding in the event the thermostat becomes stuck. When pressure builds and the water gets too hot, the relief valve opens until the pressure is equalized. However, the spring mechanism in some valves weakens with age and release water with the slightest variation in pressure. To correct this, simply remove the old valve with a pipe wrench and thread in a new one.

Common problems with gas water heaters

Insufficient secondary air—For a gas heater to burn evenly and efficiently, there must be an ample supply of secondary air. If your water heater shares space with a furnace and clothes dryer, then a continuous air supply is especially important. A clothes dryer draws a great deal of air through its exhaust system and, therefore, competes with the heater for air. When a heater is starved for air, the flame will burn orange, jump and pop. An orange flame means higher operating costs. Be sure that the heater has a sufficient supply of secondary air by opening doors in confined areas or by installing louvered vents in the doors.

Clogged flue—A clogged flue is generally caused by rust or debris that accumulates at tight bends in the flue piping. *Caution:* A clogged flue is a serious health hazard. Deadly carbon monoxide and other poisonous gases, unable to vent through the roof, are

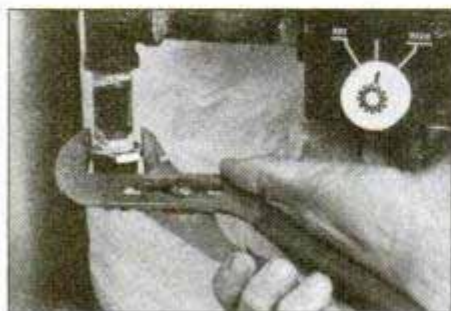
forced into the living quarters. An easy way to check if the flue is working properly is to place a lit match or cigaret near the flue hat while the heater is on. The smoke should be drawn up the flue. To locate an obstruction, turn the heater to pilot, disassemble the tin vent pipes and inspect and clean each piece.

Dirt in the gas system—Dirt and metal flakes inside the gas pipes often make their way into the heater's gas system. A dirty pilot line or burner line will cause the heater to burn unevenly or to stop burning entirely. To clean these lines, disconnect them from the regulator and slide a thin wire through each line. Then, blow air through the lines. If dirt is lodged in the gas control valve, call a plumber. Control valves are delicate mechanisms that can be dangerous if serviced improperly.

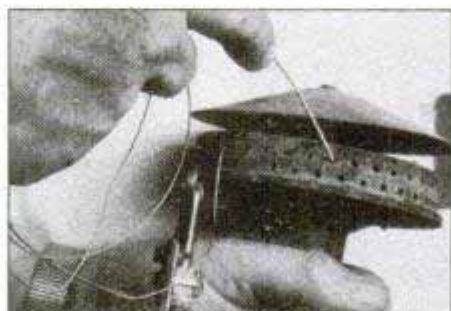
Faulty thermocouple—A thermocouple is a thick copper wire that has a heat sensor on one end and a plug on the other. The heat sensor is positioned in the path of the pilot flame. Heat from the flame sends a tiny millivolt charge through the wire, which causes the plug to open the control valve. When a thermocouple's sensor burns out, the heater's magnetic safety valve remains closed and the pilot light won't stay lit.

To replace a thermocouple, turn off the gas and disconnect the pilot line, burner line and thermocouple lead from the control valve. This will cause the entire burner assembly to drop out for easy service. Remove the thermocouple from its retainer clip and snap in a new one. Be sure to position the sensor directly in line with the pilot flame.

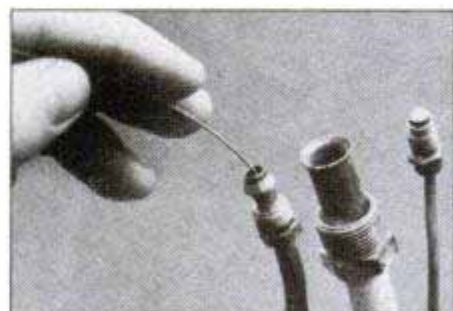
Gas pipe leaks—If you smell a strong gas odor, leave the house *immediately* and call the gas company. If you smell only a slight trace of gas, it may be a leaky pipe joint. To detect the leak, brush every joint with a mixture of dishwashing detergent and warm water. Bubbles will appear around the leaky joint. Next, shut off the gas at the meter and bleed the line at the union located above the heater. Open all windows and doors and ventilate the area.



1 To prevent rust, dirt and condensation from entering the heater, install a dirt trap near the gas control valve. Make the drip leg from a short nipple and end cap.



2 Slide a thin wire into the gas burner's openings to clear away rust and dirt deposits. Then, remove all surface rust from the burner's housing using a stiff wire brush.



3 Clean dirt from the pilot line and burner line to keep the heater operating smoothly. Remove the lines and push a thin wire through each line to dislodge dirt.

Troubleshooting Guide To Gas Water Heaters

CAUSES	SYMPTOMS AND CONDITIONS														SOLUTIONS			
	Burner will not light	Burner flame floats—Lifts off	Burner flame yellow—Lazy	Burner flame noisy	Burner flame too high	Flame pops when turned off or on	Pilot will not stay lit	High operating costs	Insufficient hot water	Slow hot-water recovery	Pounding and steaming at faucet	Thermostat fails to close	Condensation	Combustion odors		Smoking—carbon formation	Pilot flame too small	Pilot flame too large
Insufficient secondary air																		Provide ventilation
Dirt in main burner orifice																		Clean—Install dirt trap
Dirt in pilot burner orifice																		Clean—Install dirt trap
Flue clogged																		Remove—Blow clean—Reinstall
Pilot line clogged																		Clean—Install dirt trap
Burner line clogged																		Clean—Check source and correct
Wrong pilot burner																		Replace with correct pilot burner
Loose thermocouple																		Finger tight-plus 1/4 turn
Defective thermocouple lead																		Replace thermocouple
Defective thermostat																		Replace thermostat—(Call plumber)
Improper calibration																		Replace—(Call plumber)
Thermostat set too high																		Adjust temperature setting
Thermostat set too low																		Adjust temperature setting
Heater in confined area																		Install vent in wall or door
Heater not connected to flue																		Provide and connect to proper flue
Sediment or lime in tank																		Drain and flush—Repeat
Heater too small																		Upgrade to larger heater
Leaking faucets																		Repair faucets
Gas leaks																		Check with utility—Repair immediately
Excess draft																		Check source, stop draft
Long runs of exposed piping																		Insulate hot lines only
Surge from washer solenoid valve																		Install air cushion pipe
Faulty relief valve																		Install rated T & P valve—Scrub
Dip tube broken																		Replace dip tube

Then, if you can't unthread the pipe from a nearby union, use a hacksaw to cut the pipe a few inches away from the leaking fitting. Unscrew the bad fitting and thread a new fitting in its place. Now thread the pipe end that was cut. Reconnect the new fitting to the newly threaded pipe with a short nipple and union. Finally, turn the gas back on,

bleed the air from the line and retest all pipe joints with the dishwashing detergent mixture.

Common problems with electric water heaters

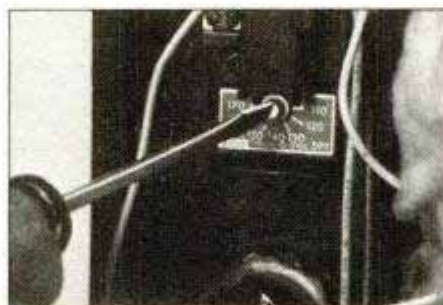
If your electric water heater fails, first check for burned-out fuses or tripped circuit breakers at the house's main

electrical panel. If breakers or fuses aren't the problem, press the reset button on each thermostat and listen for a ticking noise due to expansion as the elements begin to heat up. If this procedure doesn't produce hot water, the problem may be in the wiring, thermostats or elements.

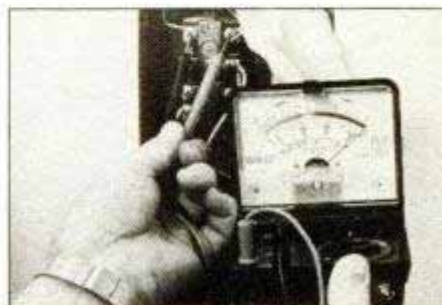
Check visually to be sure that no wire



4 Remove the heater's thermocouple by loosening the screw on the retainer clip. Install the new thermocouple so that its heat sensor is in the path of the pilot flame.



5 After installing a new thermostat, set the temperature indicator to 130° F. Wait about 45 minutes and then test the water temperature with a meat thermometer.



6 Use a voltage ohmmeter (VOM), as shown, to test the high-limit switch. Then, check the thermostat and elements. The VOM will detect a faulty component.

Troubleshooting Guide To Electric Water Heaters

CAUSES	SYMPTOMS AND CONDITIONS														SOLUTIONS				
	No hot water	Insufficient hot water	Slow hot-water recovery	Steaming and pounding at faucet	High operating costs	Dripping relief valve	Excessive relief valve operation	Condensation	Element failure	Blown fuse—Tripped circuit breaker	Service wires charred or hot	Continuous operation	Singing thermostat	Wet heater insulation		Gas odor or taste in water	Fluctuating temperatures	Floppy or discolored water	Furming-pounding in tank
No power	•									•									Check fuses/breakers—Reset
Undersized heater		•		•															Install larger heater
Undersize elements		•	•																Replace with rated element
Wrong wiring connections	•	•		•					•	•	•								See manufacturer's instructions
No relief valve				•															Install relief valve—Soon
Leaking faucets		•		•										•					Locate and repair
Leaks around heating elements	•	•		•				•						•					Tighten tank flange
Wasted hot water	•	•	•																Repair faucet leaks—Insulate pipes
Sediment or lime in tank		•		•												•	•		Drain and flush—Water treatment?
Lime formation on elements		•	•													•	•		Replace elements
Thermostat not flush with tank		•	•	•	•														Reposition
Faulty wiring connection	•	•	•	•	•			•	•	•									Locate, reconnect
Faulty ground		•	•	•	•														See maker's grounding instructions
Short	•			•	•			•	•	•									Locate short circuit/correct
Thermostat set too high				•	•														Adjust temperature setting
Thermostat set too low		•	•																Adjust temperature setting
Gas from magnesium anode rod														•				•	Install aluminum anode rod
Damage from electrolysis																•			Install dielectric unions
Excessive mineral deposits			•														•		Flush tank—Install water filter
Improper calibration	•		•	•	•	•					•								Replace thermostat—(Call plumber)
Eroded anode rod															•	•			Replace
Faulty thermostat	•	•	•	•	•	•									•		•		Replace—(Call plumber)
Faulty high limit (ECO)	•	•	•	•	•										•		•		Replace
Open high limit (ECO)	•	•																	Reset button or replace
Dip tube broken		•	•		•													•	Replace dip tube

has come loose from its terminal. If a wire is loose or disconnected, turn off the electrical power to the heater *before* refastening the wire.

To determine if the problem is in the element, thermostat or high-limit protector, test each part with a voltage ohmmeter (VOM). If you don't have a VOM, here is a quick way to determine if the trouble is in the upper half or lower half of the tank. If the heater produces plenty of warm water but no hot water, then the top element or thermostat is defective. If you get a few gallons of very hot water followed by cool water, then the bottom element or thermostat needs replacing. Since elements fail much more often than thermostats, assume a faulty element.

To replace a defective element, first shut off the power and water supply to

the heater. Next, open all of the hot-water faucets and drain the tank to a level below the element that's being replaced. Disconnect the wires from the terminals and unscrew the element. Pull the element *straight* out of the tank. Now clean the gasket surface, coat it lightly with pipe joint compound and seat a new gasket. Fasten the new element to the heater and reconnect the wires to the terminals. *Important:* Before turning the power back on, refill the tank with water and bleed all trapped air through the faucets. An element that is energized when it's dry will burn out in seconds.

Finally, replace the insulation, thermostat protection plates and access panel. Then, turn on the power. If after 45 minutes you still don't have sufficient hot water, then a replacement

thermostat is what your unit needs.

Shut off the power and disconnect the wires from the thermostat's terminals. Pry out the old thermostat and snap in the new one. Then, reconnect the wires, replace the insulation and turn the power back on.

New thermostats require a new temperature setting. Allow both elements to complete their heating cycles and then test the water temperature at the faucets using a meat thermometer. Re-adjust the thermostat, if necessary, until the water temperature is between 130° and 140° F.

All things considered, electric water heaters are more difficult to service than gas models. But no matter which type heater you own, careful and accurate diagnosis is the key to safe do-it-yourself repairs. **PM**

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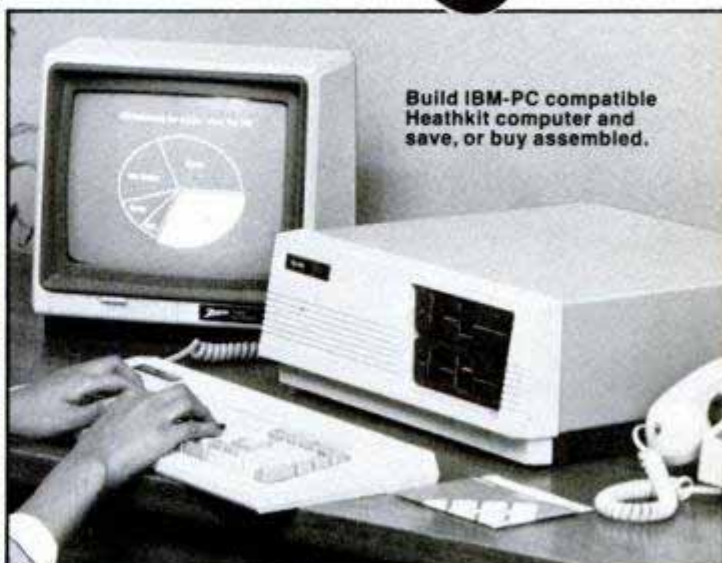
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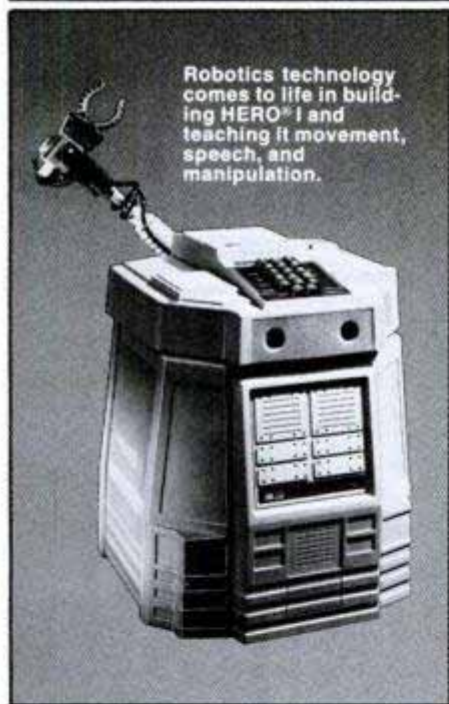
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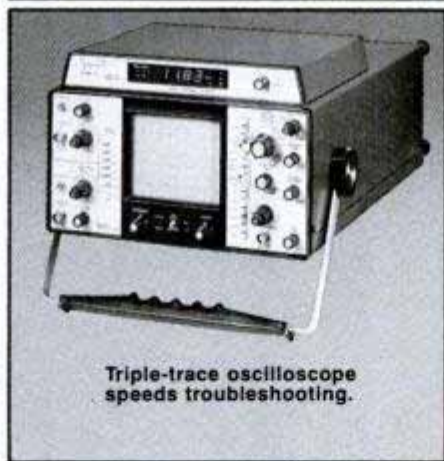
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4x4 TORTURE TEST

(Continued from page 123)

The BRAT handles well, the performance is tepid, but Subaru has a great reputation for durability and reliability. Fuel economy is good, the unique glass T-roofs turn the BRAT into a quasi-convertible, and unless you really push it hard, it all works together for everyday street driving.

The Subaru 4x4 system is the easiest to use, simplest and most durable in the automobile industry—you just push a button to shift into or out of 4-wheel drive at any speed up to 50 mph. It

gives great snow traction, and is a real safety feature for street driving.

In the woods, however, the Subaru is simply outclassed. It's limited by its ground clearance, and spends most of its time slithering along on its belly, sparks flying from the low-hung sump unless you were wise enough to fit the optional skid plate.

Our BRAT was fitted with oversize 195/60HR14 Continental TS740s and a 2-inch lift kit in the suspension, and it still bottomed constantly. As a Subaru defender wrote, "Unfair! The BRAT is in the wrong test." It did, however, manage to go everywhere the real

trucks went without getting stuck.

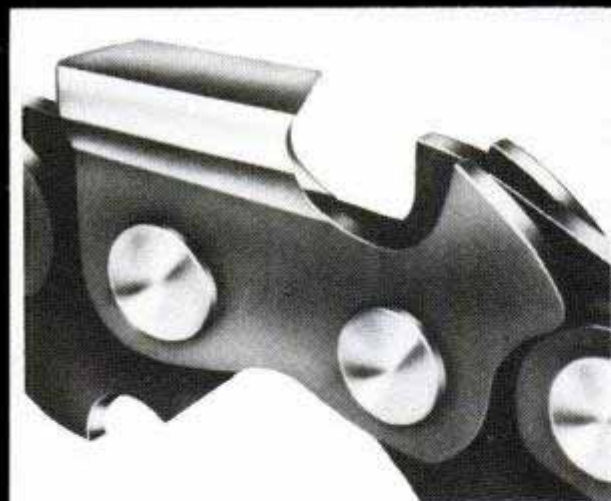
If you were going to buy a vehicle to do what the BRAT does, you'd be better off with a Subaru wagon. It's the same size, the same price, can be had with a turbocharger for better performance and has more load-carrying capacity because the rear seats—unlike those in the BRAT—fold down out of the way. The BRAT is unique, clever, cute, solid—and the answer to a question nobody asked. It's no truck.

Conclusion

A stretch cab really makes a difference in comfort, utility and security, and

TEST RESULTS

TRUCK	GAS MILEAGE EPA city/PM test (off-road)	BED LOAD SPACE (cu. ft.)	INTERIOR CAB SPACE (cu. ft.)	ON-ROAD RATING	OFF-ROAD RATING	OVERALL RATING
Chevrolet S-10 4x4	16/13	35	58	1	1	1
Dodge Power Ram 50	19/16	41	43	2	4	3
Ford Ranger 4x4	19/11	45	42	6	6	6
Isuzu P'up 4x4 Diesel	27/20	41	39	5	7	7
Jeep Comanche	16/7	50	46	4	5	4
Nissan Pickup 4x4	19/13	40	53	3	2	2
Subaru BRAT GL	21/16	32	41	7	8	8
Toyota Pickup 4x4	20/15	38	41	8	3	5



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Adelindo Orsi, Jr.,
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Frank R. Bishop,
Holt, Mich.

we can't imagine buying a pickup without it. Our favorite was the Chevy S-10 but with about \$2000 fewer options. We'd also consider the similar Nissan. That's if we were going to spend most of our time on-road, with occasional forays off-road, which is the way most buyers use these pickup trucks.

Realistically, none of these trucks is

truly equipped for serious off-roading, not even the stripped-for-action Toyota. To go into the true outback and be sure of getting out, you need 6-ply bias tires with better resistance to sidewall cutting than the street/trail radials on our test trucks.

You should also have stiffer shocks, higher ground clearance, stronger skid-

plates and a larger gas tank. We'd also recommend a power winch, an after-market hydraulic jack, a good first aid kit, multiple spare tires and a real roll bar, not the cosmetic "light bars" supplied by some manufacturers in the dual-purpose compromise trucks we tested. Only then should you break out the maps of the Andes. **PM**

SPECIFICATIONS AND DIMENSIONS

TRUCK	BASE PRICE	PRICE* AS TESTED	ENGINE	TRANSMISSION	WHEEL-BASE (in.)	LENGTH (in.)	WEIGHT (lb.)
Chevrolet S-10 4x4	\$8756	\$15,670	OHV 2.8-liter V6	4-speed automatic	122.9	194.1	3000
Dodge Power Ram 50	\$8743	\$10,403	SOHC 2.6-liter inline-4	5-speed manual	109.4	184.6	3050
Ford Ranger 4x4	\$7546	\$11,780	OHV 2.8-liter V6	5-speed manual	107.9	175.6	2700
Isuzu P'up 4x4 Diesel	\$8769	\$9780	OHV 2.2-liter inline-4 diesel	4-speed manual	104.3	174.4	2700
Jeep Comanche	N/A	N/A	OHV 2.8-liter V6	5-speed manual	119.4	194.0	3000
Nissan Pickup 4x4	\$10,595	\$10,795	SOHC 2.4-liter inline-4	5-speed manual	110.8	187.0	3150
Subaru BRAT GL	\$7783	\$9723	OHV 2.4-liter flat-4	4-speed manual	96.3	174.2	2350
Toyota Pickup 4x4	\$8368	\$8368	SOHC 2.4-liter inline-4	5-speed manual	103.0	174.6	2750

*Prices rounded to the nearest dollar.

PM OWNERS REPORT:

TOYOTA COROLLA

Toyota's reputation for reliability and
buyer satisfaction grows with highest-
ever scores for the front-drive Corolla.

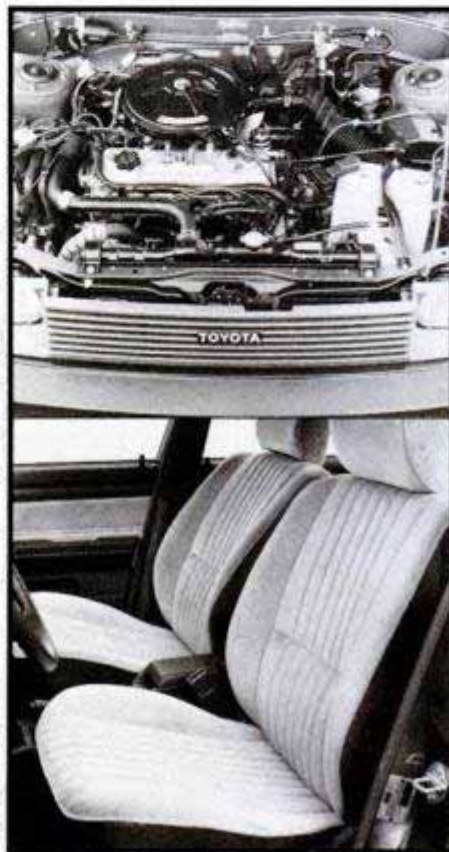
BY MICHAEL LAMM, West Coast Editor

Toyota's done it again! In all my 13 years of compiling *Owners Reports*, I've never seen anything like this. You can talk about your Mercedes, your Porsches, BMWs, Hondas and the rest, but no automaker—none—has ever come close to Toyota for total dependability and overall owner satisfaction.

Back in 1981, the Toyota Starlet walked away with the best score in that year's *Owners Report Roundup*. And the Celica Supra did the same for 1982. Both these Toyotas outscored Cadillacs, Continentals, Maximas, Imperials and a host of other cars in every category we asked about.

Now, here comes the fwd Corolla. It's a brand-new model in its first year of manufacture. Yet, according to our survey, it's almost completely bugfree. Owners unanimously agree that they've discovered another worldbeater. The Corolla racks up a tremendous number of points in the all-important areas of reliability and the lack of any need for service, and it has owners vowing they'd buy it all over again.

In more than a million miles of driving, nearly 85 percent of fwd Corolla owners told



Front-wheel drive and transverse engine mounting are both new in the Corolla line, but have proved bugfree and reliable for buyers.

Comfortable seating accommodations, along with quality workmanship and economical operation, led everyone surveyed to answer "yes" to the idea of buying a Toyota again.

us they had no mechanical problems at all—absolutely none. That lucky 85 percent had never taken their cars back to the dealer for anything but routine maintenance. No other mechanical attention, major or minor, was needed. And

(Please turn to page 154)

PM PHOTOS BY BILL ASHE





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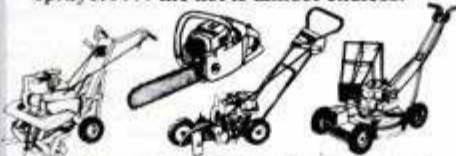
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That's right — there are over sixty-five million 2-cycle and 4-cycle small engines in service across the U.S.A. That's the official count from the Engine Service Assn., and new engines are being built at a rate of one-million per month! With fully accredited and approved Foley-Belsaw training, you can soon have the skill and knowledge to make top money servicing these engines. Home-owners and businessmen will seek you out and pay you well to service and repair their lawnmowers, tillers, edgers, power rakes, garden tractors, chain saws, mini-bikes, go-carts, snowmobiles, generators, snowblowers, paint sprayers... the list is almost endless.



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TOYOTA COROLLA

(Continued from page 152)

that, folks, is a record in our book for troublefree, worryfree driving.

When we asked those same owners

whether they'd buy another Toyota next time, *nobody* said no. Ten percent said maybe, but no one said no. That's never happened before. The statistic speaks for itself regarding owner satisfaction and loyalty.

When we asked what made these people choose Toyotas in the first place, we got another surprise. Nearly 21 percent told us they'd bought their cars because other owners had told them how pleased they'd been with their

SUMMARY OF 1984 TOYOTA FWD COROLLA OWNERS REPORTS*

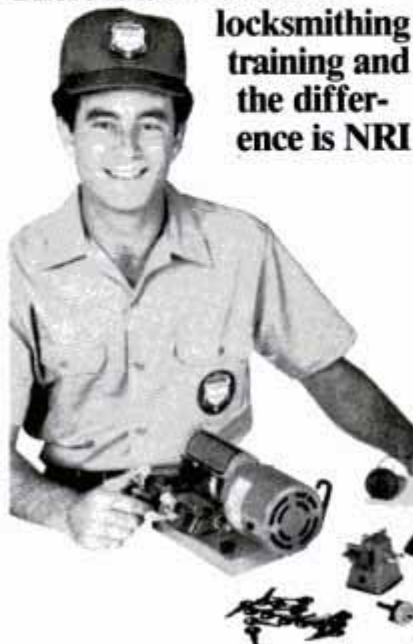
Total miles driven 1,049,346	Why did you choose this car?	Workmanship opinion:	Dealer service opinion:
Average miles per gallon (by engine)	Economy 28.5%	Excellent 70.9%	Excellent 43.3%
1.6-liter ohc Four	Reputation, experiences 25.2	Good 27.3	Good 34.6
In town 30.5	Styling 23.4	Average 1.4	Average 15.4
On the highway 37.7	Price 22.0	Poor 0.5	Poor 6.7
1.8-liter diesel ohc Four	Recommended by friends 20.6	Comfort opinion:	Number of vehicles owned:
In town 40.9	Specific likes:	Front seats	This car only 34.5%
On the highway 46.0	Economy 64.4%	Excellent 65.2%	Two cars 37.9
Average miles per gallon (by transmission)	Styling 42.5	Good 30.0	Three cars 16.8
5-speed manual	Handling 39.7	Average 4.3	Four or more cars 10.8
In town 32.8	Comfort 34.2	Poor 0.4	Makes of other cars owned:
On the highway 40.1	Ride 23.3	Rear seats	Toyota 36.4%
3-speed automatic	Performance 23.3	Excellent 31.6%	Chevrolet 34.4
In town 29.3	Specific dislikes:	Good 55.6	Ford 16.6
On the highway 36.1	No complaints 20.6%	Average 10.7	Buick 13.9
Engine choices:	Engine noise 10.0	Poor 2.2	Volkswagen 11.9
1.6-liter gasoline ohc	Poor radio reception 7.2	Had any mechanical trouble?	Would you buy another Corolla?
Four 96.0%	Not enough horsepower 5.6	No 84.4%	Yes 78.4%
1.8-liter diesel ohc Four	Car size too small 5.0	Yes 15.6	No 0.4
4.0	Mini spare tire 4.4	What type of trouble?	Maybe 21.1
Transmission choices:	What changes would you like?	Engine noise 16.7%	Would you buy another Toyota?
3-speed automatic 54.3%	No changes 34.5%	Transmission 11.1	Yes 89.8%
5-speed manual 45.7	More comfortable seats 5.2	Hard manual shifting 8.3	No 0.0
Body-style choices:	Quieter ride 4.6	Air conditioner 8.3	Maybe 10.2
4-door sedan 89.1%	Car is "too light" 3.6	Fuel system 8.3	Age distribution of owners:
5-door wagon 10.9	Side mirror controls 3.6	Dealer repairs satisfactory?	Under 29 years 31.5%
	How much did you pay?	Yes 54.5%	30-49 years 44.5
	Average \$8,648	No 45.5	50-plus 24.1
	Range \$6,900-11,000		

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

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Toyotas. This is the first time word of mouth has been statistically significant in our *Owners Reports*.

Economy heads list

Economy topped the list of reasons why our respondents choose the fwd Corolla. Besides the standard ohc, 1.6-liter gasoline engine, Toyota now offers a 1.8-liter diesel. As it turned out, though, only 4 percent of the owners we queried had chosen the diesel. And transaxle usage registered a 45/55 split between the 5-speed manual and the 3-speed automatic. Despite the Corolla automatic's lockup torque converter, drivers with manual gearboxes got about 4 mpg better fuel economy, and diesel owners bested their gasoline-engined cousins by 10 mpg.

The Corolla's workmanship won high praise from our respondents, with 70.9 percent rating it *excellent* and 27.3 giving it a score of *good*. An Alabama credit manager volunteered, "I believe Toyota makes the best cars for the money anywhere in the world. My last car, an '81 Reliant K, spent more time in the shop during its first month than my 1976 Corolla SR5 did in the eight years I owned it."

On the topics of ride and handling, the following comments were offered. "I like the Corolla's front-wheel drive," said a Georgia word-processing specialist. "The car handles very well. The seats feel comfortable and are easily adjusted. Rear seats have lots of room."

According to a Wisconsin claims adjuster, "It pulls through snow with little or no skidding."

Tips for the dealers

When we asked owners to recommend changes that might improve the Corolla, a record 34.5 percent said, "Don't touch it!" Several people did, however, have some tips for their dealers. A Missouri office manager explained, "The car itself is very good, but the dealers are terrible. Due to the import quotas, there's more demand than supply, and the dealers know they've got a good product. They milk the demand for all they can."

A California administrative assistant said, "My dealer packed my car with stuff I didn't want. I had to take *his* radio, *his* color choice, and *his* expensive aluminum wheels."

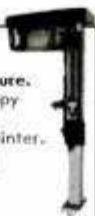
A Texas pressman observed, "The lockup torque converter takes a little getting used to. At 35 to 40 mph, the automatic transmission can't decide whether to lock up or stay loose, and this causes a jerky sensation."

It's all summed up in the statement of one respondent, who drew a smiley face at the bottom of his questionnaire and signed off with, "I've never met a dissatisfied Toyota owner!" **PM**

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PM PHOTOGRAPHY UPDATE

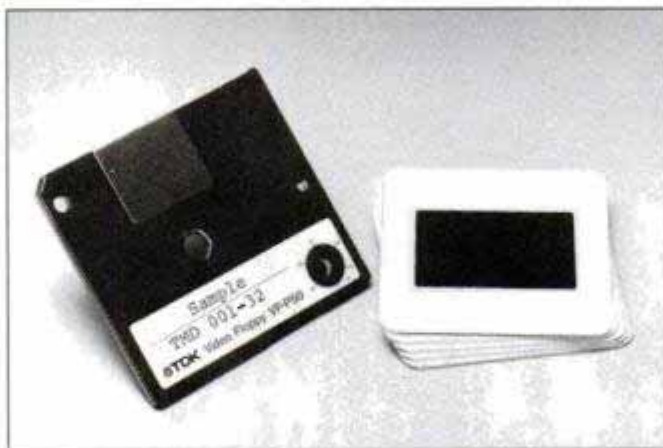
Filmless photos advance

Electronic still cameras, the experimental devices that take pictures on tiny magnetic disks instead of film, have come closer to reality since we reported on them in February (*PM Photography Update*, page 70). And potential applications for the technology go beyond simple snapshot-taking.

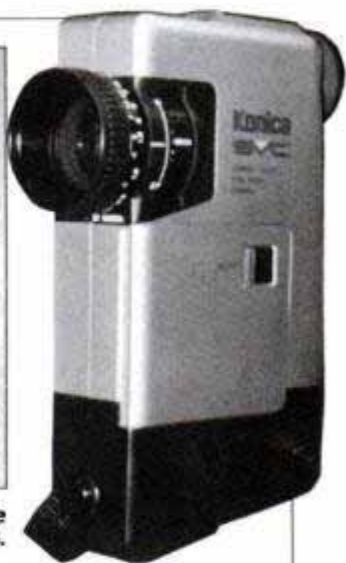
At the heart of every ESC (electronic still camera) is the video floppy, a magnetic disk housed in a 2-in.-square jacket and weighing a quarter of an ounce. The video floppy records 25 to 50 still images and, unlike film, can be erased and used again.

Eventually, ESC owners will be able to preview their pictures on any home TV, and even develop color copies on a home printer. It's also likely you'll be able to bring the floppy to a local photofinisher for processing.

At this writing, ESCs are bulkier than conventional 35-mm SLRs. The pictures they produce lack the fine resolution of film cameras—and they're not as sensitive in low light (ESCs have an equivalent film-speed rating of about 100 ASA). But recent improvements by Konica, Fuji and Philips have addressed the first two handicaps.



Video floppy (left), not much larger than a 35-mm slide, can store up to 50 images taken with an ESC like Konica's.



Konica's prototype Still Video Camera weighs 2 pounds and measures about the same as a thick paperback novel. The battery-powered unit can shoot eight frames per second through its 3:1 F/2.8 power zoom lens.

The business end of the Konica camera is a CCD (charged couple device) image sensor with 180,000 pixels of resolution (solid-state image sensors are explained in *Video Thinks Small*, page 81). While that number is fine for moving video images, it's not enough to produce highly detailed still pictures. Recently, though, Japan's Fuji and Hol-

land's Philips have demonstrated sensors with as many as 400,000 pixels. Manufacturers are looking for ways to improve its low-light performance.

They've already found a way to record sound on a video floppy—10 seconds for each image. And the next step is computer applications. Currently, the tiny disk can store nearly two megabytes of information—almost the equivalent of four 5¼-in. floppies. Using the perpendicular method of recording now under development, the video floppy's storage would increase to 20 megabytes.

Amphibious camera

Heavy-duty aptly describes Fuji's new HD-M compact 35-mm camera.

The rugged three-



Fuji's HD-M: waterproof down to 6 feet.

quarter-pounder is more than water-resistant—it's rated waterproof down to 6 feet so you can take it snorkeling. The shock-resistant HD-M's motorized film advance enhances its underwater suitability. So does its ability to use superfast ASA 1600 film—which ex-

tends the effective range of the built-in flash to 50 ft.

Exposure metering is automatic, with preprogrammed shutter speeds ranging from $\frac{1}{8}$ to $\frac{1}{1000}$ of a second. The 38-mm F/2.8 lens is located close to the viewfinder to minimize parallax error. When fitted with filters or an optional close-up lens, the image in the viewfinder will be nearly identical to what registers on film. Suggested retail price for the HD-M is \$300.

Micro-macro

Ever wish your 35-mm compact could take close-up pictures like an SLR fitted with a macro lens? You can get within a foot of your subject with the pocket-sized XA-4 from Olympus.

The 8-ounce mini lets you take pictures just the way a spy camera would—but move over Minox! The XA-4 uses regular 35-mm film (from 25 to 1600 ASA) instead of the nonstandard 8-mm rolls that require special process-

ing. Moreover, the XA-4 operates like a regular camera for more conventional snapshot-taking.

The new Olympus compact has a 28-mm F/3.5 lens to provide depth of field with a wide-angle panoramic view. For macrophotography, at 12 or 18 inches, lens aperture is programmed for F/5.6 to enhance depth of field (the carrying strap determines macro distances, like the Minox measuring chain). Preprogrammed exposures range from $\frac{1}{750}$ to 2 seconds. The XA-4 costs \$180. **PM**

Olympus XA-4 shown half its actual size.



HOW WE TEST CARS

(Continued from page 142)

other words, this one short loop incorporates just about every common road condition you'll encounter. All our over-the-road testing is done at legal speeds.

Each driver is equipped with a rating sheet for each car. These sheets contain 23 different categories to be rated on each car. The categories are: exterior styling, exterior fit and finish, interior styling, interior fit and finish (including trunk), entry/exit ease, driving position, seats, interior room (including rear seat and trunk), controls and convenience features, instrumentation, shifter, steering, handling, driveability, engine performance, noise level, braking performance, visibility (front and rear), ease of maintenance, overall comfort rating, overall driving rating, features particularly liked and features particularly disliked.

Fifteen miles may seem like an awfully short exposure to a car, but when you're concentrating and evaluating every second, directly comparing with the cars you've just driven, we've found that less than 10 miles of driving is usually enough.

Occasionally, two or three cars will rank very closely, so some testers may want a second or even third round in a particular car. However, that's rare. The 15-mile loop we use also allows each driver to sample all of the cars on the same day—which is important for accurate comparisons.

After each driver has driven each car and written down his comments, he ranks the test cars in order of preference. We add all these individual rankings together to come up with the group's Road Test Rankings. The comments the testers have written on their rating sheets become the basis for our article, and we try to publish appropriate quotes direct from the testers' rating sheets.

The article that appears in POPULAR MECHANICS is written by one tester and edited by two others, using input from all the rating sheets. Ideally, it reflects a consensus of the group about styling, handling, quality, performance and all the other factors that go into making one car better than another. Our goal is to tell you not only which car we preferred to another, but *why*.

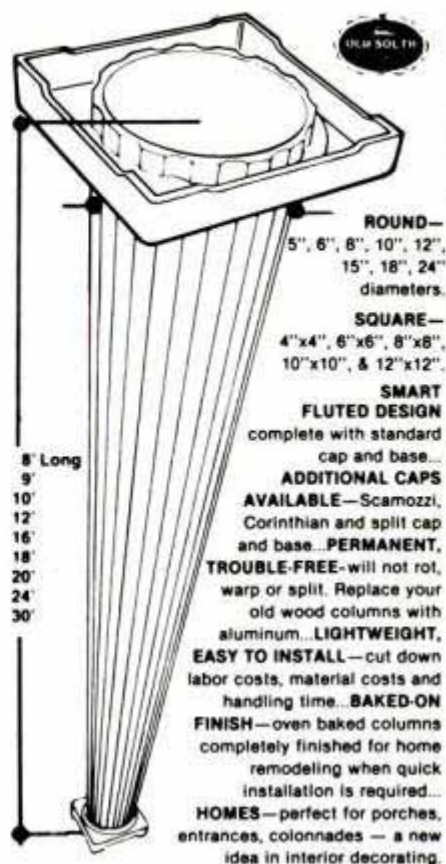
Overall test ranking

To arrive at an overall ranking, we average together the Test Track Ranking and the Road Test Ranking, equally weighted. In other words, we give the same emphasis to our objective numbers and our subjective feelings. We think that's a pretty fair way to evaluate an automobile. **FM**

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1262	12"	7"	22 1/4"	4 lbs.	8.50
1263	12-13"	7"	25 1/4"	5 lbs.	10.00
1264	13-15"	9"	28 1/2"	7 lbs.	17.50

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1251	2000 lb.	2	3	\$24.00/pr
1252	3000 lb.	2	3	\$27.00/pr

HIGH SPEED TRAILER WHEELS and TIRES

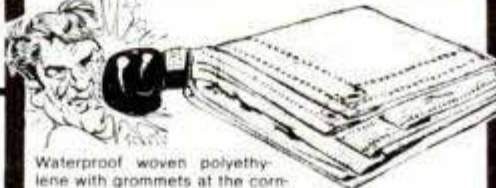


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Item #	Size	Ply	Cap.	SALE	Tire Only
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1216	480x12	4	780 lb	\$39.95	\$24.95

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1773	12'x 16'	8 lbs.	\$9.95
1774	12'x 20'	11 lbs.	\$12.95
1775	16'x 20'	12 lbs.	\$19.95
1776	20'x 30'	23 lbs.	\$39.95
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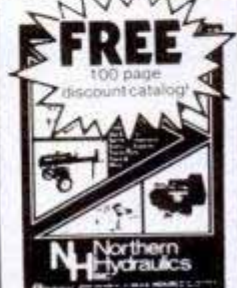
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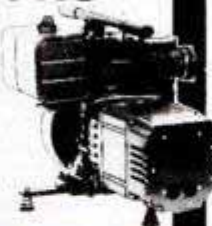
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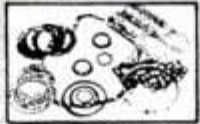
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1 1/4"		\$7.00/C \$9.00/C
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MOPAR 6 CYL 78-83	FORD MOPAR	
FORD V8 82-84		\$3.95
V8 78-84		

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Available For Most Domestic 6 CY & V8 Engines		
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UNASSEMBLED 350 CHEVROLET 4 BOLT MAINS

9 or 10:1 COMPRESSION RATIO

SHORT BLOCK KIT

350 4 bolt main block based oversized, honed for Molly Rings. Decked (line honed, polished) phase pistons, outside factory orange. Fitted Cam bearings & brass freeze plugs. Flanged T-Bolt, pistons fitted to PAW heavy duty connecting rods with A.R.P. Chrome Molly rod bolts. Chrome Molly rings, crankshaft custom ground on rod & main journals. Micro polished with Chrome 77 rod & main bearings for perfect fit. Double roller timing chain set, your choice hydraulic or solid camshaft. Assembly balanced for maximum performance.

SHORT BLOCK KIT - YOUR LOW PRICE \$995.00

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As above with cylinder heads, performance valve job. New valves 1 5/16" intake & 1 5/8" exhaust. Hi-performance springs. 160 locks. Chrome Molly push rods, lifters, 1/2 volume oil pump. Complete gasket set & ring seal rocker arms.

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34.95 set 16
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Kit Includes Arms, Bells, Nuts

ROCKER ARMS

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Adjustable Rockers

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Kit
STREET/STRIP/COMPETITION SHORT BLOCK

• BLOCK: Rebuilt to a level beyond what you can do. One honed rod main, honed crank, air bearing honed pistons, honed cam bearings in place. Cam Bearings in place.

• PISTONS: Assembled in place. One block compression ratio. Four Piston Seal Kit.

• PISTON RINGS: One compression with overhead timing setup. Cuts ring endplay, eliminates oil consumption.

• CRANKSHAFT: Custom ground on Rod & Main Journals. Micro polished with chrome 77 rod & main journals. Micro polished with chrome 77 rod & main journals.

• BEARINGS: Two-way. Bronze/Steel. In place. Bearings for perfect fit.

• TIMING CHAIN SET: Gear, gears, and chain. American made.

• CAMSHAFT: Your choice. Solid lift. Lift and base in place.

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	380	509.00	548.00
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	300-340-350	509.00	514.00
	400-401-425-430-435	583.00	684.00
CADILLAC	390-424-472-500	583.00	684.00
CHEVROLET	199-232-250	476.00	504.00
	287-290-304-327	499.00	504.00
	343-360-411	499.00	504.00
	390-400-422-427	614.00	526.00
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FORD	144-172-200-250	476.00	499.00
	260-289-302-316	476.00	499.00
	301C-351M-430	476.00	519.00
	430-439	499.00	499.00
	429-460	509.00	549.00
	481	509.00	549.00
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	343-360-411	509.00	539.00
	440	509.00	579.00
OLDSMOBILE	300-350	509.00	539.00
	343-360-411	509.00	539.00
PONTIAC	270-290	476.00	504.00
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Kit Includes:

- PISTONS & PINS
- CONNECTING RODS
- ROD & MAIN BEARINGS
- CAMSHAFT
- CAMSHAFT-LIFTERS-SPRINGS
- TIMING CHAIN SET
- OIL PUMP
- CAM BEARINGS
- GASKET SET

Four Low Price CAST FORGED PISTON PISTONS

AMC	199-232-250	471.00	548.00
	287-290-304-327	509.00	548.00
	343-360-411	509.00	548.00
	380	509.00	548.00
BUICK	483.00	504.00	509.00
	300-340-350	509.00	514.00
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CHEVROLET	199-232-250	476.00	504.00
	287-290-304-327	499.00	504.00
	343-360-411	499.00	504.00
	390-400-422-427	614.00	526.00
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FORD	144-172-200-250	476.00	499.00
	260-289-302-316	476.00	499.00
	301C-351M-430	476.00	519.00
	430-439	499.00	499.00
	429-460	509.00	549.00
	481	509.00	549.00
	170-184-225	408.00	504.00
	273-318-340-380	499.00	529.00
	343-360-411	509.00	539.00
	440	509.00	579.00
OLDSMOBILE	300-350	509.00	539.00
	343-360-411	509.00	539.00
PONTIAC	270-290	476.00	504.00
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Kit Includes:

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- CONNECTING RODS
- ROD & MAIN BEARINGS
- CAMSHAFT
- CAMSHAFT-LIFTERS-SPRINGS
- TIMING CHAIN SET
- OIL PUMP
- CAM BEARINGS
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Four Low Price CAST FORGED PISTON PISTONS

AMC	199-232-250	471.00	548.00
	287-290-304-327	509.00	548.00
	343-360-411	509.00	548.00
	380	509.00	548.00
BUICK	483.00	504.00	509.00
	300-340-350	509.00	514.00
	400-401-425-430-435	583.00	684.00
CADILLAC	390-424-472-500	583.00	684.00
CHEVROLET	199-232-250	476.00	504.00
	287-290-304-327	499.00	504.00
	343-360-411	499.00	504.00
	390-400-422-427	614.00	526.00
	454	614.00	549.00
FORD	144-172-200-250	476.00	499.00
	260-289-302-316	476.00	499.00
	301C-351M-430	476.00	519.00
	430-439	499.00	499.00
	429-460	509.00	549.00
	481	509.00	549.00
	170-184-225	408.00	504.00
	273-318-340-380	499.00	529.00
	343-360-411	509.00	539.00
	440	509.00	579.00
OLDSMOBILE	300-350	509.00	539.00
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Four Low Price CAST FORGED PISTON PISTONS

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OLDSMOBILE	300-350	509.00	539.00
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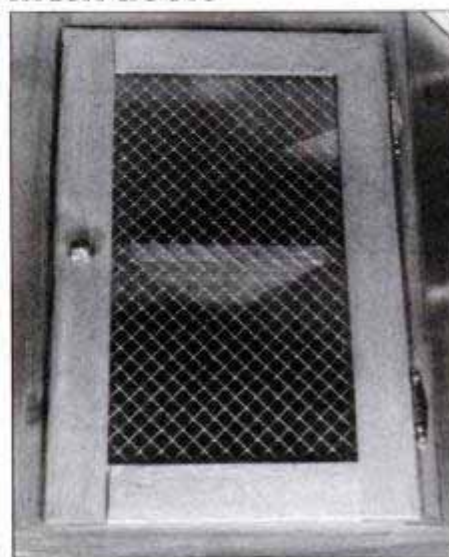
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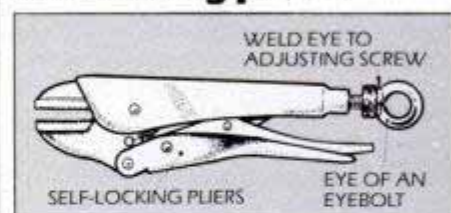
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Give cabinet doors decorative panels of diamond mesh by sandwiching one piece of hardware cloth between two pieces of glass or acrylic sheets for each door. The first step is to cut the mesh hardware cloth at a 45° angle to produce the diamond pattern.

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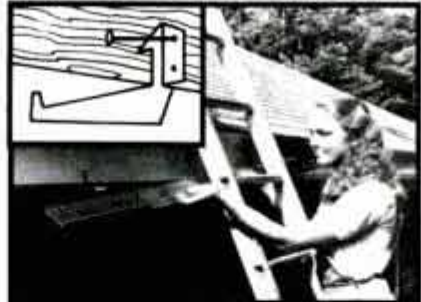
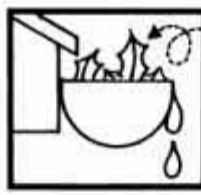
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- Works to prevent ice damage
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Ordinary Gutter

THERMAR Weather-Foil



STOPS TRENCHING. EROSION.

Air Foil designed THERMAR WEATHER-FOIL breaks up water sheet which usually runs from roof edge. Weather-Foil DISPERSES WATER—produces millions of tiny droplets which fall harmlessly to earth—pleasantly as a light spring rain. NO DOWNSPOUTS NEEDED! Eliminates TRENCHING, EROSION. Helps prevent basement water leakage too.

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In winter snow can freeze on roof edge making gutters ineffective. Heat "leaking" from inside home and through roof causes some melting where ice and roof meet. Water trapped inside this ice blanket can then flow under shingles causing costly damage. WEATHER-FOIL'S "WEB" design helps prevent ice dams.

NO CLOGGING, NO CLEANING.

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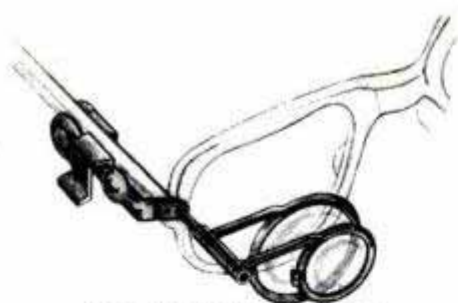


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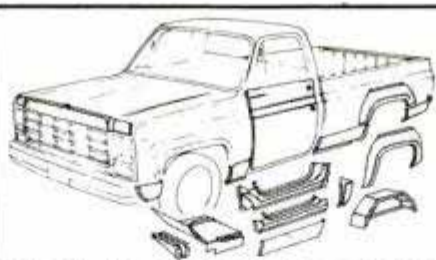
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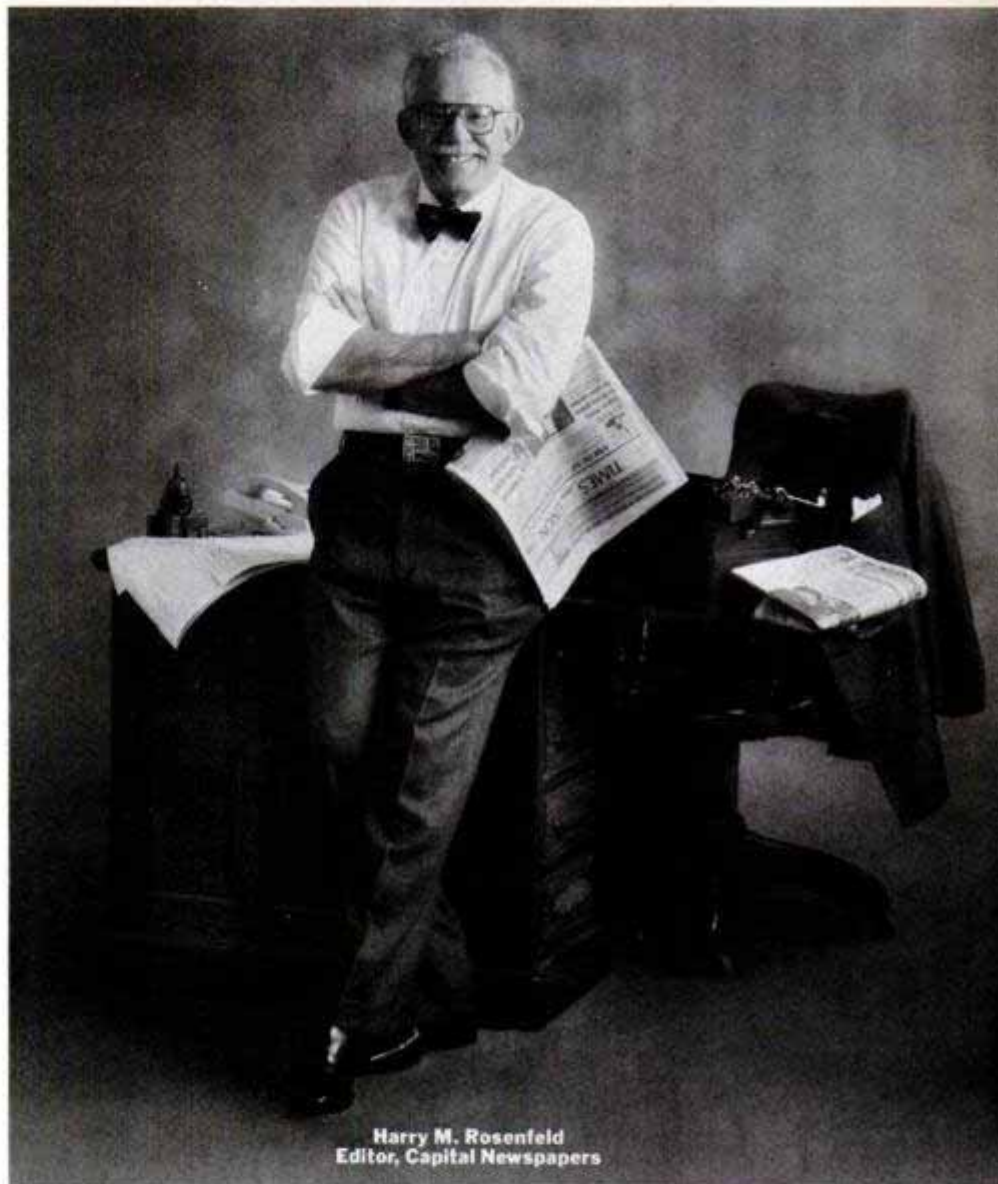
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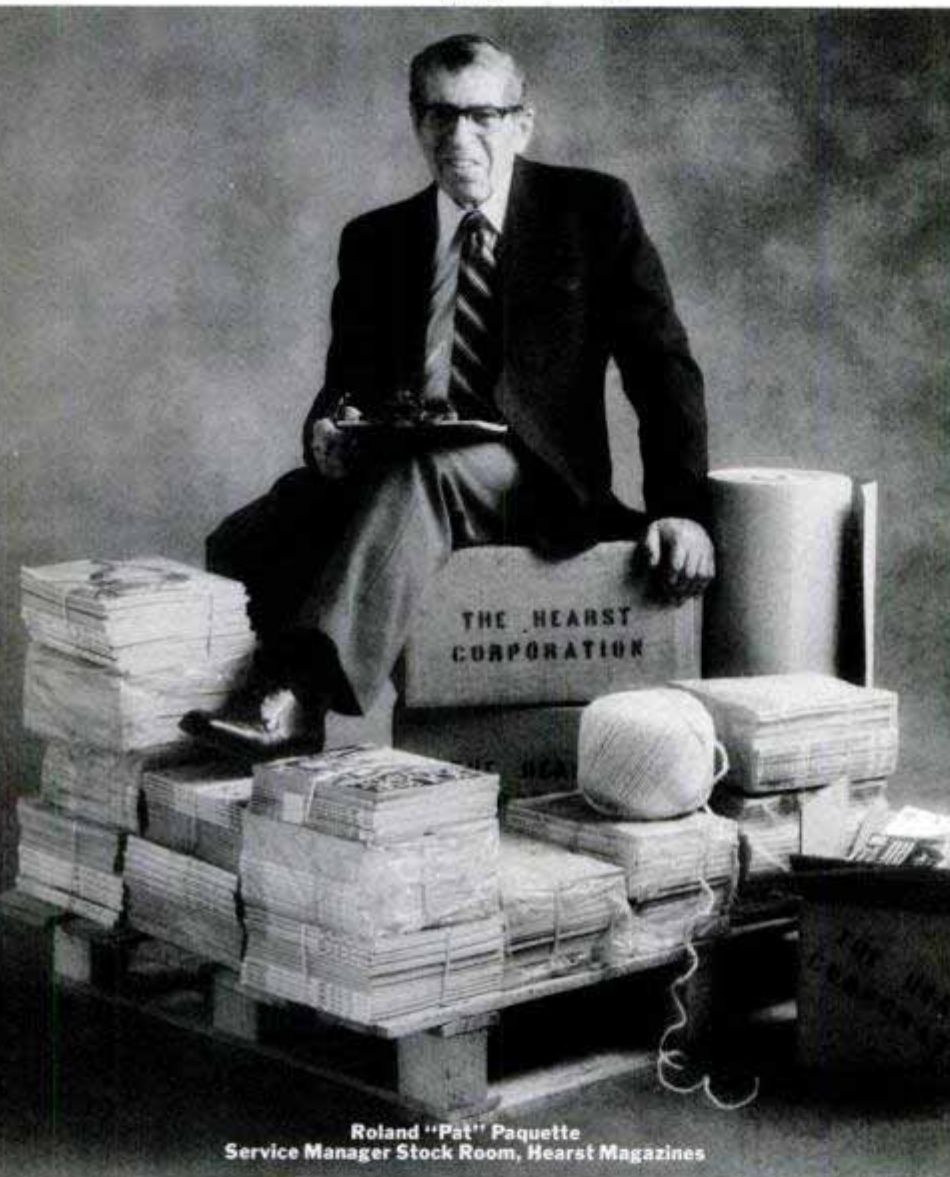
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Model 1982 Police Revolver, Patent # 3,842,848; 3,842,849; 3,842,850; 3,842,851; 3,842,852; 3,842,853; 3,842,854; 3,842,855; 3,842,856; 3,842,857; 3,842,858; 3,842,859; 3,842,860; 3,842,861; 3,842,862; 3,842,863; 3,842,864; 3,842,865; 3,842,866; 3,842,867; 3,842,868; 3,842,869; 3,842,870; 3,842,871; 3,842,872; 3,842,873; 3,842,874; 3,842,875; 3,842,876; 3,842,877; 3,842,878; 3,842,879; 3,842,880; 3,842,881; 3,842,882; 3,842,883; 3,842,884; 3,842,885; 3,842,886; 3,842,887; 3,842,888; 3,842,889; 3,842,890; 3,842,891; 3,842,892; 3,842,893; 3,842,894; 3,842,895; 3,842,896; 3,842,897; 3,842,898; 3,842,899; 3,842,900; 3,842,901; 3,842,902; 3,842,903; 3,842,904; 3,842,905; 3,842,906; 3,842,907; 3,842,908; 3,842,909; 3,842,910; 3,842,911; 3,842,912; 3,842,913; 3,842,914; 3,842,915; 3,842,916; 3,842,917; 3,842,918; 3,842,919; 3,842,920; 3,842,921; 3,842,922; 3,842,923; 3,842,924; 3,842,925; 3,842,926; 3,842,927; 3,842,928; 3,842,929; 3,842,930; 3,842,931; 3,842,932; 3,842,933; 3,842,934; 3,842,935; 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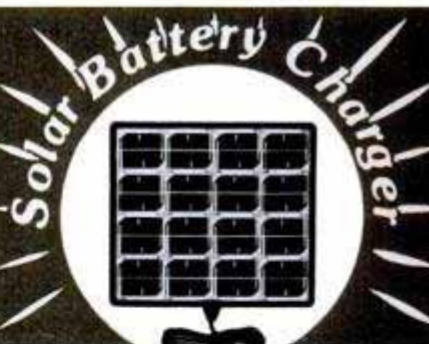
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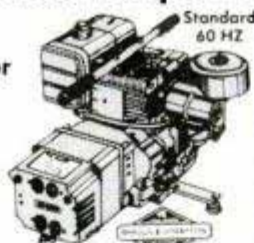
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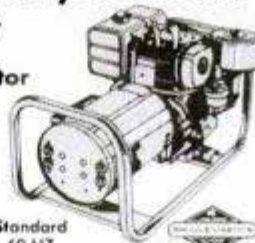
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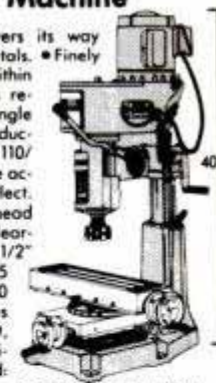


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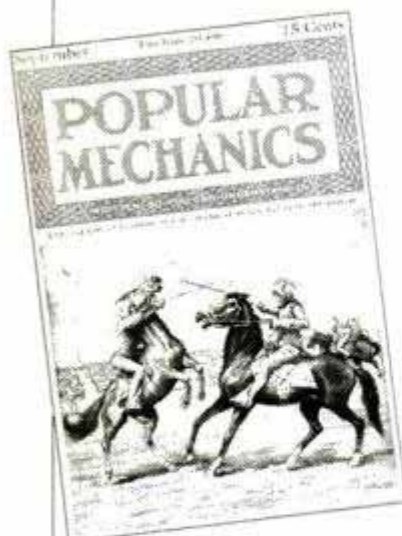
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PM'S TIME MACHINE

75 YEARS AGO: September 1910



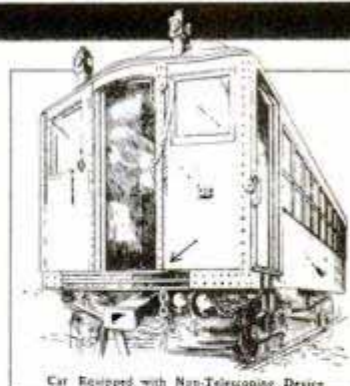
U.S. cavalrymen have at it.

Army shows muscle

No, it isn't a medieval jousting tournament. They were U.S. cavalrymen demonstrating their prowess. Gen. Frederick D. Grant sought to correct John Q. Public's "wrong impression as to the character of the American soldier." Grant held a military tournament in Chicago at which GIs demonstrated construction and demolition of a bridge, the making and breaking of a camp, wall scaling and other Army procedures. The highlight was the Sixth Cavalry's "almost reckless exhibition of fencing on horseback."

Sub sets record

The USS *Salmon*, a new edition to Uncle Sam's naval force, completed a remarkable record-setting submarine journey of 1600 miles from Bermuda and back. The round trip consumed more than 6000 gallons of gasoline and the sub averaged 10 knots per hour. The *Salmon*, 135 feet long, was the fastest underwater vehicle of its time. It ran 13.5 knots afloat and 11 to 12 knots submerged. Today, the Russian Alpha class nuclear submarines hold the record of 42 knots submerged and a range of 6250 miles.

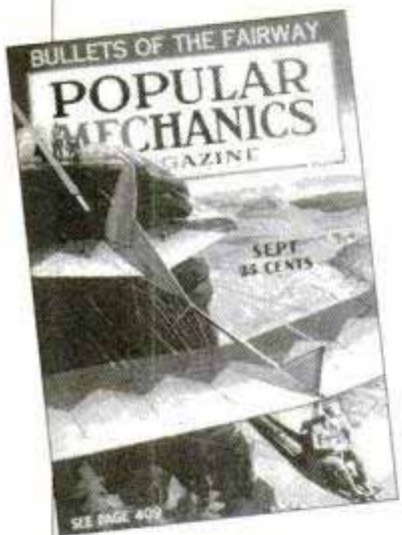


Car Equipped with Non-Telescoping Device

Subway interlock

A collision in a New York subway tunnel prompted this invention: a series of teeth at the end platforms of each car which interlocked upon collision and prevented the cars from telescoping.

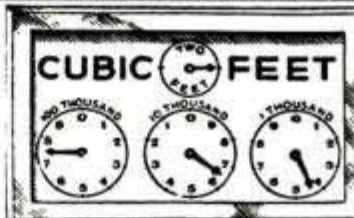
50 YEARS AGO: September 1935



Glider slides into space.

Down and away

The pilot must have had courage. The glider was launched by sliding it down a greased plank off a 1000-foot precipice. The 20-foot board slanted toward the runway from the top of an automobile. Although gliders are now launched by auto or aircraft tow, in 1804, Sir George Calley flew one of the first gliders kite-style. In 1808, Calley persuaded his coachman to fly the glider untethered across a 300-foot chasm. Armed with new courage, Calley also began to fly the untethered glider. The coachman quit.



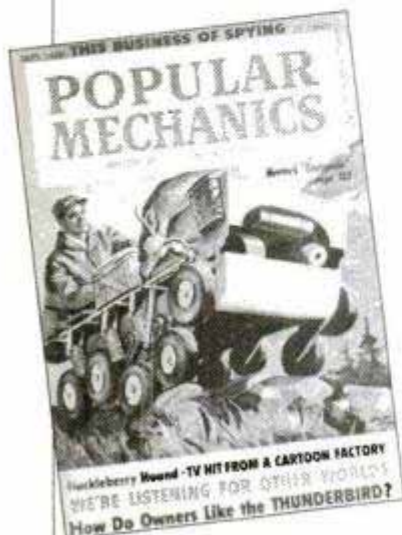
Meter-reading tips

It was easy. The ordinary gas meter had four dials. The 2-foot dial was used for test purposes. The other three dials were used to measure gas usage in ten thousands, thousands and hundreds of cubic feet. If the dial was between numbers, you used the lower number. These tips are still accurate.

A long way

Television For Millions described efforts to bring the medium to millions of New Yorkers. A 10-kilowatt London station with a 30-mile radius had success bringing artistic and entertaining programs to the city dwellers. The article assured that one drawback, electrical interference from automobiles, would be eliminated, when the station increased its power to 30 kilowatts. In the 1980s, television is not only available to millions of people but hundreds of TV stations can be captured with a satellite dish.

25 YEARS AGO: September 1960



Accident spawns pack horse.

Mechanical insect

Ted Duke was injured in an accident that prevented him from climbing or riding into the mountains. Undaunted, Ted created his Centipede, a 10-wheel mechanical pack horse that was capable of carrying large quantities of equipment over rough terrain. Eight rear wheels provided the power. Each operated independently. Like a tractor, the Centipede was steered by disengaging the clutch for either side of the vehicle. The two front wheels were used when the machine nosed into an obstruction.

Cartoon stars

Yogi Bear and Huckleberry Hound in PM? Yup. They were the subjects of an article about the Hanna-Barbera cartoon factory. Bill Hanna and Joe Barbera pioneered an economical, but entertaining, method of bringing animation to the small screen. Hanna-Barbera invented shortcuts called planned animation. Before, a cartoon was more expensive to shoot than a live action movie of the same length. By eliminating much of the background, the animators could avoid creating numerous drawings.



Flying lab

The Bristol 188 was an English-built airplane made of stainless steel designed to aid engineers in developing a supersonic airliner. The single-seat jet was expected to exceed 1500 mph. **PM**



Rickie Smith's Motorcraft Pro Stock Thunderbird



Willy T. Ribbs
Chris Knerfel
SCCA Trans-Am
Mercury Capri



Wally Dallenbach Jr.
John Jones
IMSA Mustang GTO



Ricky Rudd's NASCAR
Motorcraft Thunderbird

All these winners go with winners: Motorcraft parts.

The Motorcraft Mustang didn't win by just a mile at the 1985 Daytona 24-Hour. It left competition 135 miles behind as Dallenbach, Jones and Bundy took the GTO class. The same car also finished miles ahead of competition in the 12 Hours of Sebring. Mercury Capris flying Motorcraft colors are out to capture the SCCA Trans-Am manufacturer's championship again this year. Motorcraft is on the 1985 NASCAR Winston Cup Circuit with Ricky Rudd in his Thunderbird. Bud Moore, one of the most promising new-comers, is teamed with veteran car builder driver to break the 180 mph and 8 second barriers—is driving his Pro Stock Motorcraft Thunderbird in '85 NHRA and IHRA events. All of these are proof positive of Motorcraft parts' exceptional performance under all types of rugged racing conditions. Get Motorcraft's out-to-win performance going for you out on the street. Motorcraft. Quality parts for all makes of cars and trucks.



Motorcraft

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