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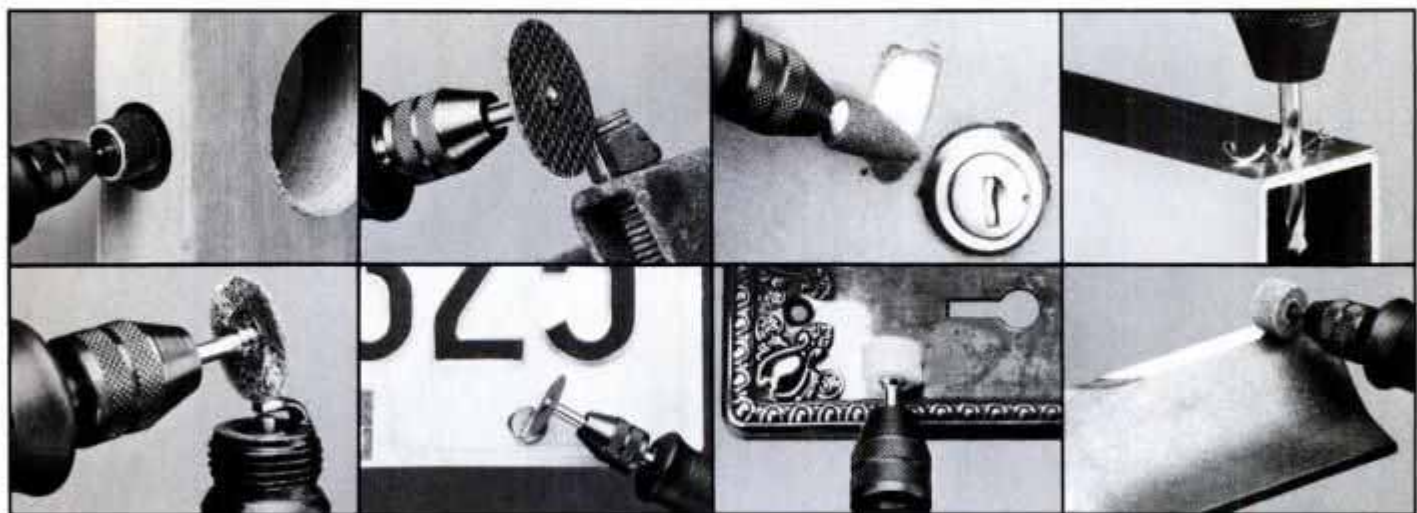
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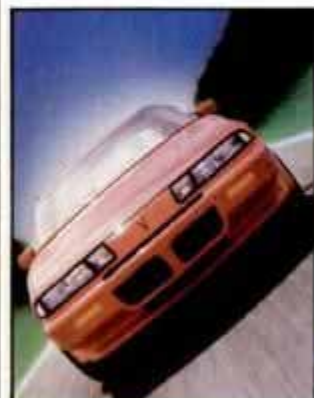
But with a full 40,000-mile limited treadwear warranty, the Norseman A/S is still every bit the rhino.

And ready to keep you rolling on the road, or off.



*See your Armstrong dealer for complete details.





51 COVER STORY

Armed with new body shapes, new suspension technology and new engine designs for 1988, Detroit's car manufacturers are fighting each other in a battle that's sure to make new-car buyers the victors.

—PM photo by Humphrey Sutton



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SPECIAL REPORT: DETROIT '88

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Newly advanced, reworked engines, suspensions and electronics are rolling off the assembly lines at Ford, Chrysler, AMC/Renault and GM. We put their cars on the lift for a close look.

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Wires are seldom the problem with a faulty telephone. Here's what to look for and how to repair it yourself. Also, you can test and troubleshoot electrical appliances like a pro with our tips for using an ohmmeter.

EDITOR'S NOTES

Our special report in this issue on all the new 1988 cars is written by Detroit Editor Jim Dunne. Among the movers and shakers of the auto industry, Dunne is generally considered the dean of Detroit automotive journalists. And although Dunne is a member of our editorial staff, it turns out that he's also one of the best promotion people we have. Other publications write about him all the time. And his photos appear in countless other magazines. Dunne's claim to fame isn't just that he's our Detroit Editor. He's also the world's ace No. 1 car spy photographer. In fact, he invented the field. Examples of his clandestine camera work appear every month in his *Inside Detroit* column, and we gathered some of his newest stuff in an article in our June issue, *Detroit Sneak Preview* (page 76). Dunne has been known to wait for hours in one of his secret spots, camera and 1000mm lens at the ready, on a tip that a certain prototype or experimental car will be passing by. Dunne knows where all the perfect hills, knolls, trees and fences are at all the car manufacturers' proving grounds so that he has just the right perch to get just the right spy shot. The manufacturers know what he's up to and have been known to take measures against his covert operations, planting trees, chopping down trees, putting boards over fences, and flattening hills to lower sightlines. Still, Dunne presses on, bringing us—and you—the best photos available of future Detroit hardware. The most fitting tribute to Dunne's work occurred recently when one manufacturer put up a sign on a particular fence that surrounds a parking lot for prototype and advanced models. The sign reads: "Jim Dunne Memorial Spy Fence." . . . **Thirty years ago this month**, I was a high school student on the day it was announced that the Soviet Union had successfully launched Sputnik, the first man-made satellite to orbit Earth. I remember Mr. Starbuck, my science teacher, going around the room that day asking students what we thought about such a momentous event. Most of us recited some litany about how it demonstrated that the Soviet Union's rocket technology was ahead of ours and that we were now in danger of being hit by rocket-launched missiles. But I also remember one student saying simply, "I think it's wonderful. It's the dawn of a new era for mankind—the space age." How insightful that fellow student was. Sputnik, all 184 pounds of it, certainly did proclaim the dawn of the space age, and truly changed the world, and how we all live. I think you'll find the report on Sputnik, and its aftermath, on page 59 most interesting. . . . **Ever wonder how those**



Dunne: the ultimate tribute.



Loudenslager: penultimate pilot.

wild aerobatic pilots keep down their breakfast as they go through their airshow routines? So did we. So we asked one of them to tell us. And not just any one. We asked the best. Leo Loudenslager is the best, and certainly the most well-known, aerobatic pilot in the world. He's performed at every major airshow and scores of smaller ones. He's won every award you can win for aerobatics and you've probably seen him on television. His Laser 200 aerobatic aircraft is the most advanced in the world. So who better to tell you what it's really like up there. "Til next time.

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Six...to the biggest, most powerful gas and diesel V-8's in any pickup. Nobody beats Ford power!

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Covers powertrains for 6 years/60,000 miles and body-panel rust-through for 6 years/100,000 miles. Restrictions and deductible apply.**

SPECIFICATIONS

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150-hp 4.9L EFI Six
185-hp 5.0L EFI V-8
210-hp 5.8L EFI V-8
235-hp 7.5L EFI V-8
175-hp 7.3L diesel

PAYLOADS

F-Series 4x2 pickups:
1580 lbs. to 5270 lbs.
F-Series 4x4 pickups:
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FORD PICKUPS

AMERICA'S TRUCK: BUILT FORD TOUGH



QS9U-R6U-4CUN

LETTERS

Mission Accomplished

Thank you for your article 'How I Bombed Qaddafi' (page 110, July '87). Our military ultimately guarantees freedom of the press, and freedom and security for us all. It was your July issue, with its top-notch articles, that convinced me I had found the magazine for me.

LAWRENCE J. HOOKER
AMHERST, NY

My oldest brother was killed while piloting a B-17 over Germany on November 13, 1943, so I take a special interest in all missions that our U.S. Air Force flies. This quote from your Qaddafi story appalled me: "The flight surgeon had given us all a couple of go pills, or amphetamines, if we started to get tired. So I took one with a swig of water and felt bulletproof again."

Pilots in the greatest Air Force in the world resorting to amphetamines when the going gets tough? I thought that when the going gets tough, the tough get going!

AUBREY P. MARKS
YALE, VA

The colonel who shared the rigors of his assignment with the readers of PM was asked to fly a long and hazardous mission to help stem terrorist activity in Europe and elsewhere. The nature of the flight—completely around the Iberian Peninsula and back again—called for technical skill, precise timing and physical endurance. Flight surgeons determined that providing our pilots with amphetamines if needed to help them accomplish their very difficult mission was a far better alternative than risking losing a pilot and his airplane because of fatigue and potential fatal error.



Pilot who flew the Qaddafi mission also authored PM story.

Frankly, I was surprised to see an article on the Libyan raid in POPULAR MECHANICS, but I found it fascinating! It's the first account that I have read with so many specific details.

GEORGE SOLAKIAN
MENLO PARK, CA

Tow Away!

Congratulations on your comprehensive May *Car Care* issue. It's an achievement to present such a wealth of information into a limited number of pages. In doing so, some generalizations have to be made, we realize. Unfortunately, you indicated in your *Tow It* article (page 78) that trailers cannot be towed with turbocharged or convertible Saabs, which is incorrect. Our owner's manuals cover thoroughly the procedures to be followed for towing with any of our cars.

STEVEN ROSSI
TECHNICAL SERVICES
SAAB CAR DIVISION

Vice Squad

What a super piece on *The Cars Of Miami Vice* (page 85, July '87)! Thanks for presenting the technical information so I could understand it. I'll be watching for bookcase plans because I want to build one for my daughter's room.

DEBORAH ANN
STEINHAUSER
HOMER, NY

The Cars Of Miami Vice was a nice introduction to your magazine. I didn't like your knocks of the show, so was happy to see Tim Cole's refreshing and needed essay, a good TV review.

MARY PLATT
EAST LANSING, MI

It's always enjoyable to find out the behind-the-scenes details of your favorite TV show. Thanks for the secrets of the cars on "Miami Vice", and thanks for the *Where Cool Becomes Hot* sidebar, an insightful look at the show itself.

DONNA ZALORA
WILKES-BARRE, PA

Well, Don Johnson finally made the cover of POPULAR MECHANICS! I was happy to see that, and especially pleased with Tim Cole's review. He put into words exactly how I feel about "Miami Vice".

MAUREEN MCGINNIS
OAK LAWN, IL

Molding Magic

I'd like to build a floor-to-ceiling bookcase into one wall of my family room. The unit you show in your *Plans and Ideas* brochure looks perfect, and I'm considering sending for the plans. I can adjust the overall dimensions to suit my space easily enough, but I am concerned about the construc-

tion technique. Rather than make a mess of the family room for the weeks, maybe months, it would take me to build the bookcase, I'd rather build it in sections in my workshop and then install and join the sections in the family room.

One problem, though: How would you tilt upright the 8-ft.-high bookcase sections in a room with an 8-ft.-high ceiling?

ALAN GREEN
EAST MEADOW, NY

We built our wall unit in five sections in the workshop, but before starting had to figure the maximum height of the individual boxes for them to be stood upright for installation. Our magic number is 94.5 in., which is an inch and a half less than the floor-to-ceiling height of 96 in. for adequate clearance. You will be left with a gap at the ceiling, which in our installation we covered with the wide molding that continues completely around the family room.

All the dimensions in this popular PM plan take this off-site building technique and installation into account.

The order number is PM-1008. It costs \$5.95 from Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

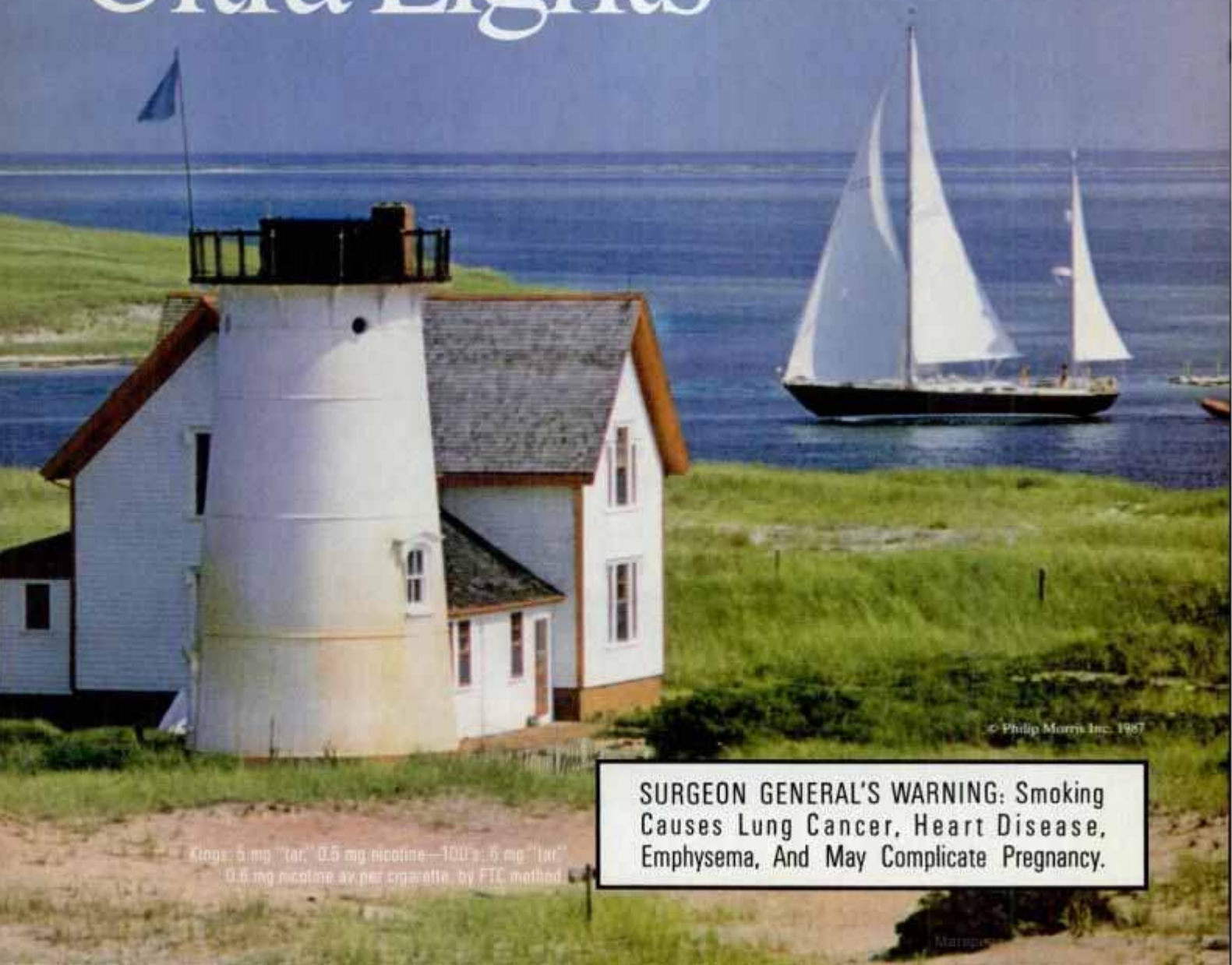


Bookcase wall: Popular project needs molding for tight ceiling fit.

Discover an ultra light with real flavor.



Merit Ultra Lights



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Mariposa

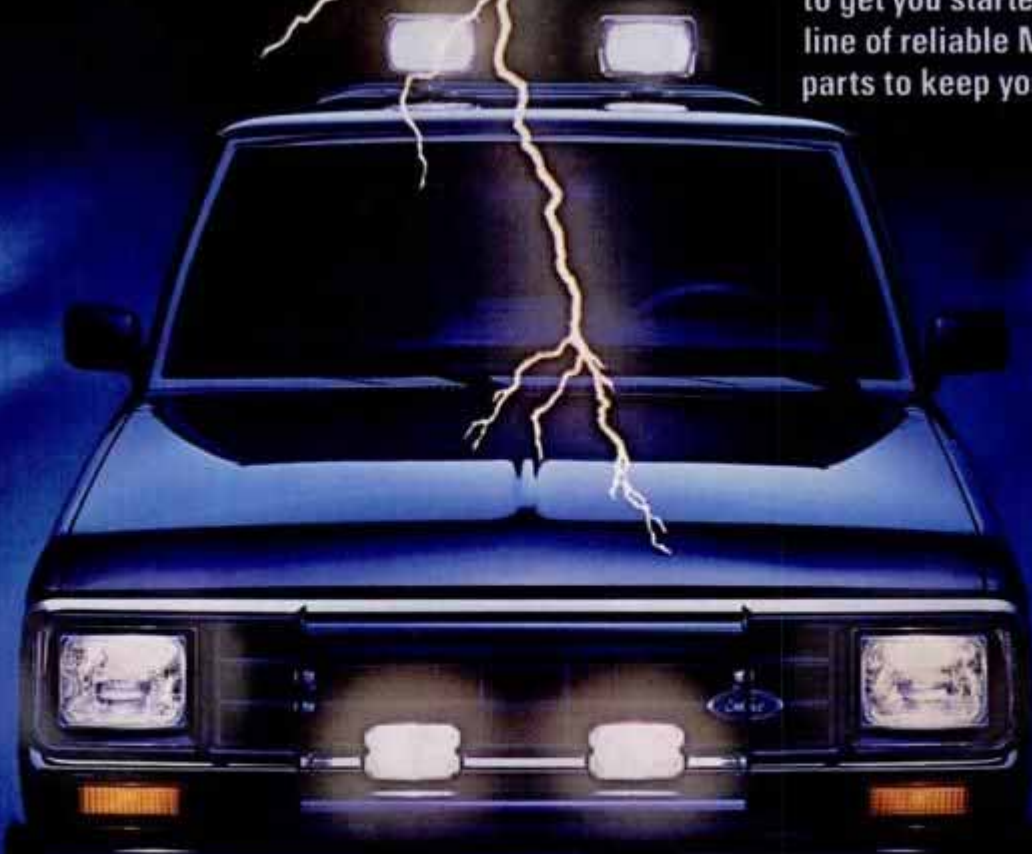


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Motorcraft from Ford
EXCEEDS THE NEED

IMPORTS

BY BILL HARTFORD

Once And Future Mini



Driving headlong into England's West Country is the modern-day equivalent of jousting. You're hemmed in by hedgerows, hurtling along the "wrong" side of ancient country lanes. Oncoming

Austin Rover '90s fwd minicar will get a snub-nose look.

progenitor of current, transverse-engine, fwd minicars, this Legend In Its Own Time is still in production, and differs little from the '50s design by Alec Issigonis. The latest hop-up Mini is the limited-edition Advantage model, now on sale in England. The Austin Mini has been joined by countless other small cars of European and Japanese origin. Among minis on the Motorway, Ford's Fiesta XR2 is a hot setup. The Fiesta range will be restyled for '88, better to compete against Peugeot's 205. Daihatsu's Charade, which comes to the U.S. this year,



More rounded '88 Ford Fiesta.

cars force you to flinch, even in the protective armor of a luxurious Ford Scorpio, as we were recently. Gasping and pulling in your gut doesn't make the car any thinner. That's when you wonder why you're not at the reigns of a skinny Mini. Too often overlooked as the



Daihatsu Charade, seen on the Isle of Wight, is coming here.

flies with its 1.0-liter turbo and 5-speed. Austin Rover Group, meanwhile, is engineering its small cars for the '90s. The smallest will replace the marvelous Mini, slated to fade away soon after its 30th birthday. We hope that its replacement will be just as cheeky.



Mini we have known and loved. Original design dates to '50s.

Peugeot's New Welterweight

If Peugeot's 505 has always been too big and too much of a heavyweight for your lifestyle and driving style, you'll soon be able to "move down" to a Mercedes 190-sized Peugeot that'll fit you like a racing glove. The 405 Mi 16 is a Pininfarina-designed, fwd sport sedan with a slick 0.30 C_d . It'll approach 140 mph, powered by its twin-cam, 16-valve,

1.9-liter Four—the same transverse-mounted, light-alloy block that's in the Turbo 16 rally car. The 405's already on sale in Europe, and enters the ring here next year.



Peugeot 405 Mi 16 wedge will high-tail it with its 160 hp.

Mazda's Clever Convertible

Summer's over and winter's on the way. Perfect time for a convertible —Mazda's new RX-7, that

doesn't let those nasty back drafts get you from behind. Now that there's a nip in the air, the new model is in full production. Dealers will have it this fall. At this



Mazda RX-7 rotary-powered convertible goes on sale this fall.

is. It's exciting enough to be getting a convertible version of this fast, smoothly styled sports car, but this ragtop design gives you something extra: The Windblocker.

The Windblocker is a shield positioned behind the front bucket seats that

writing, only rotary wiz and Mazda President Kenichi Yamamoto and his engineers have cruised in freezing weather, top down, to test it. And they don't mind admitting that it's a simple, but brilliant device that'll allow year-round, open-car motoring.

Tire Under Fire

A short but intense life is what a tire on Porsche's 959 supercar is promised. The tire picked to shoe the 200-mph car is Bridgestone's RE71. The radials have a unidirectional tread to squeeze out water. The ultralow profile tires use a dual compound: tread cap is soft for grip, and base is hard for response. Reinforced sidewalls can run flat and jointless cap under tread gives high-speed durability. Tread life, though, is about 4000 miles. The good die young. **PM**



Bridgestones keep 959 rolling.

IT'S ALL THE PO



POWER YOU NEED.



These are the tools men turn to when they stop playing with toys. Makita cordless tools.

You'll know why the first time you hold one in your hand. Makita tools do more than free you from an electrical cord. They strike the perfect balance between sheer power and precise control.

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Innovations like these helped build our reputation.

And our work record proves it. More professional builders use Makita than any other cordless tool made.

Whether they're building custom furniture or a house to keep it in.

Makita

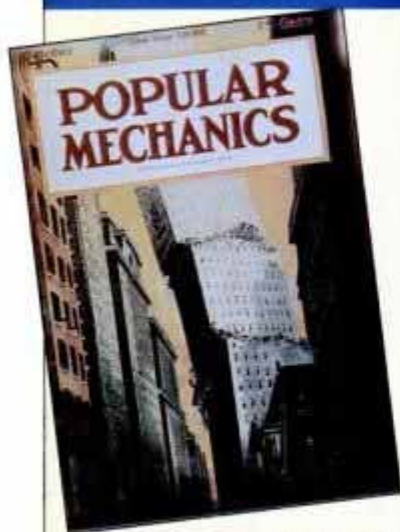
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TIME MACHINE

75 YEARS AGO: October 1912



Collapsing skyscrapers?

Skyline Threats

The century was new and dire predictions were becoming a regular staple in the popular press. POPULAR MECHANICS provided its own vision of disaster with the warning that electrolysis could ultimately destroy America's newest skyscrapers. With an artist's rendering on the cover showing the spontaneous crumbling of a huge new building, our story explained how electrolytic action sparked by electric streetcars was corroding the steel skeletons of many



Automotive testing included the famous dunk drill.

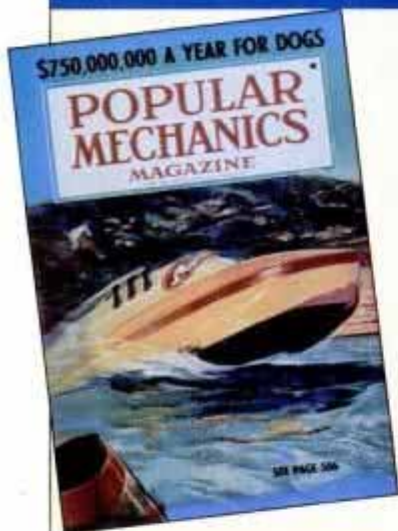
buildings. Sophisticated insulators and construction refinements would later negate the phenomenon, but PM carried the banner.

"... common safety demands protection against this enemy of civilization."

Early Off-Roader

The nation's roadways were still a primitive mix of mud, ruts and dust so early motorists were admonished to equip for the worst. One auto manufacturer in England supplied waterproof magnetos and carburetors. And, as our feature described, each new vehicle was immersed and driven under water. A snorkel supplied air to the powerplant.

50 YEARS AGO: October 1937



Marine record attempt.

Ultimate Quest

Back in the '30s, he was known as the Prince of Speed, holding the land record and, as PM announced, vying for the marine record as well. Sir Malcolm Campbell was his name, and his succession of Bluebirds, on both dirt and water, were acclaimed as truly high tech for the period. Compressed air supplemented air from topside intakes. Power from a rear-mounted marinized aircraft engine was reduced in a V-drive gearbox forward. And metal sheathed the

hull. However, for flotation, Campbell placed 36,000 Ping-Pong balls in 48 pillow cases.

Roller Wheels

Austrian children began using large, single-wheel skates to strengthen muscles used in skiing. Each skate had a brace strapped below the knee and a small platform to stand on.

New Auto/'37

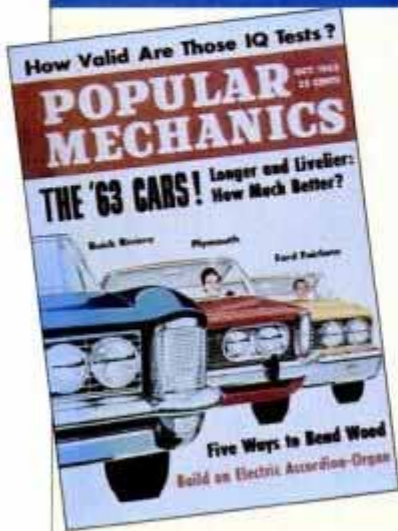
Conscientious drivers who cared about conserving fuel could install a new gas-consumption gauge on their



Variations: Austrian skaters use single large wheel.

dash. "It helps to show the most economical speed."

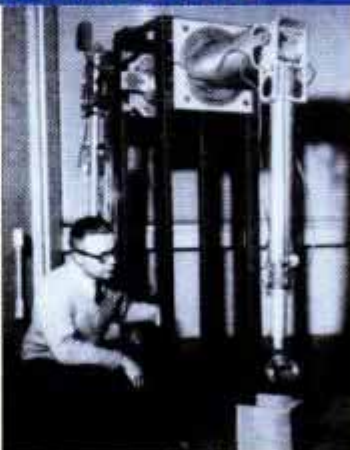
25 YEARS AGO: October 1962



Roadburners past.

Eye On Detroit

PM heralded the 1963 automotive model year with an in-depth evaluation of all the new cars. Our trend spotters observed a dramatic turn toward razor-sharp silhouettes in the Buick Riviera, Dodge Dart and Chevrolet Corvette. Creases were replacing chrome as fins from the 1950s were finally laid to rest. Crisp, uncluttered lines were also evident in the Olds Super 88 and Chrysler New Yorker. Lean conservatism was the philosophical leaning,



MIT's computerized robot.

where "new smooth flanks" lead to a "touch of elegance."

Robots In Infancy

By today's standards in industrial robotics, the experimental hand was rudimentary at best. It relied on a central processing unit and 30 sensors to explore its environment, locate a child's block, determine its size, and place it in a box. Also included in the POPULAR MECHANICS of a quarter-century past were tips on bending wood, and how to make an electric accordion-organ. Exhibiting its usual editorial diversity, PM also asked, "How Valid Are Those IQ Tests?" **PM**

Ford, Mercury and Lincoln owners win again.



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AVIATION

BY FRED MACKERODT

Report From Paris

There's nothing that even comes close to it. The Paris Air Show every two years in June at Le Bourget is aviation overkill.

Picture this: A brand-new A320 twin-engine transport with side-stick controller descends steeply toward mid-field and then, with full power, pitches up as close to

onstrating that it can fly slow, too.

And flying slow can be hairier than flying fast. An Italian Air Force crew demonstrating a Panavia Tornado fighter proves that. It pitches wildly out of control during a low-level maneuver, and plummets toward the ground, disappearing



Plush Seastar personal amphib made her public debut at the show.



Another waterbird, Canadair's firefighting CL-215 does its thing.

vertical as a wide-body jet can get without turning into a helicopter.

A billion-dollar prototype of Dassault's new Rafale jet screams in from left field and executes a 9G turn, trying to keep the envelope tighter than the USAF/General Dynamics F-16C's high-G display the day before. A little later the French jet returns and slogs, nose high, down the centerline at 85 knots with its movable front canard visibly working to keep it out of a stall. The French fighter of the future is dem-

onstrating that it can fly slow, too. Spectators wait for the inevitable explosion, but the Tornado miraculously reappears, seemingly held in the air by sheer willpower. It's the closest thing to an accident at the 1987 Le Bourget Show, and the Italians are thrown off the flightline because of it. There aren't many rules at Paris, but there are a few.

The Soviet Antonov An-124 airlifter, dubbed the "Big Russian," lifts off and almost immediately pulls a



Static display area at Le Bourget was packed with a boggling array of civilian and military flying machines.

wild 60° bank. But this is only a prelude to the aerobatics it will perform as soon as it reaches 2000 to 3000 ft., maneuvers you'd expect from a Pitts or a Citabria but not from the largest airplane in the world.

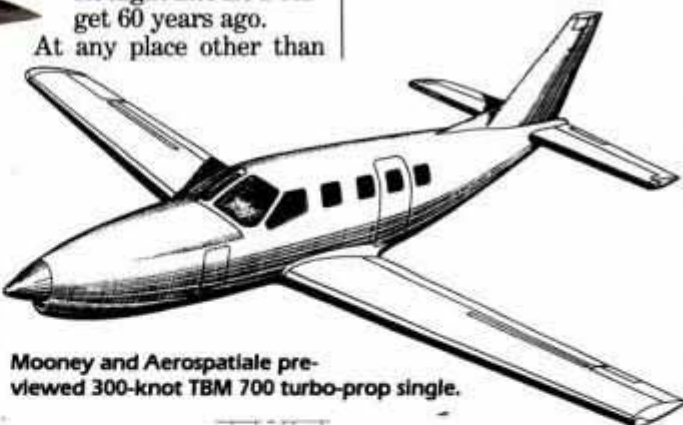
And the Soviets have a real aerobic airplane at Paris, too. The radial-engined Su-26 piloted by Yvgeni Frolov puts on one of the most impressive flight performances at the show.

A replica of the Spirit of St. Louis takes off to commemorate Lindbergh's classic flight into Le Bourget 60 years ago.

At any place other than

Le Bourget, just one of these flight displays would bring aviation addicts from 100 miles away to stare. But the flights happen minutes apart at Le Bourget. We counted 50 separate displays in five hours one day. And the displays go on for 10 days! It gets so that people don't even bother to look up.

In addition to the flight displays, there are usual newsworthy events. The USAF/Rockwell B-1B makes a surprise appearance and flexes its wings for the crowd after flying non-stop from Dyess Air Force



Mooney and Aerospatiale previewed 300-knot TBM 700 turbo-prop single.



Base in Texas. It stands for days under heavy guard on the flightline. The crew of the B-1B visits the cockpit of the An-124 and the Soviet pilot quips, "We showed them our cockpit, how come they won't show us theirs?"

Records also fell at Paris this year. Allen Paulson takes off in a brand-new Gulfstream IV and comes back 45 hours and 26 minutes later with a business-jet record for around-the-world flight the hard way—westbound!

And four men leave from Le Bourget in a 1938 Lockheed Lodestar to go around the world the "easy" way. They come back 88 hours and 48 minutes later, beating Howard Hughes' long-standing 91-hour record in the prop plane.

Anybody who is anybody in aviation comes to Le Bourget. We spent a good deal of time with that grand gentleman of flight, Sergei Sikorsky, son of Igor. Sergei provided us with some insights into the Le Bourget show, which has occurred every other year since 1908. "Spies? There are none," he quips. "But there are lots of technical information specialists. Everybody comes here to stare up each other's tailpipes."

Sikorsky gives us his timetable for happenings in the world of whirlybirds. The tiltrotor, like Bell's Osprey, will be operational in five years. Sikorsky Aircraft will have its X-wing ready in 10 years. This flying machine will take off like a helicopter, the rotor will be stopped when the aircraft gains forward momentum, and the X-wing will proceed to fly to its destination at 300 to 400 mph. Sikorsky also sees a good future for small, owner-flown helicopters.

Camilo Dornier, grandson of the founder of Dornier Aviation, showed us his new Seastar amphibian (photo at the upper left side on page 16). Dornier explains that his new \$2.7-million composite creation, which flew for the first time on April 24, will be sold for commercial use but is also aimed at private owners. "Everyone wants the flexibility that an amphibian can deliver," Camilo says, "and the Seastar is the ultimate personal amphibian." Dornier points out that the new plane is an evolution of his grandfather's original 1922 design which also had twin push-pull engines and a parasol wing mount. In other amphib developments, the Canadians arrived at Le Bourget to push their CL-215 water bomber. A land-based 7-27 water bomber also made a splash in Paris.

Combine all the flight activity, the static displays, the tons of the latest airplanes and equipment, and the aviation greats in attendance, and you have a show that gave 400,000 lucky people the aeronautical experience of a lifetime!

Two Over The Pond

With the six multicomputer-controlled, multicolored EFIS and EICAS screens shining, the cockpit of the Boeing 767-200ER during this night flight has the ambience of a videogame parlor. We are aboard American Flight No. 44 at 39,000 ft. proceeding at Mach .80 on an Oceanic clearance and headed for Paris. It's been 540 miles since we coasted out at SCROD intersection, 180 miles E.N.E. of Goose Bay, Labrador. In another 1100 miles, we will coast in over northwestern Ireland, our first landfall. Capt. Don Rogers, commander of American No. 44, explains that we are approaching our first equal time point—that point where we could in an emergency either go to Sondrestrom Fjord in Greenland, or proceed on to Keflavik, Iceland.

Since it's been just about a year since the 767-200ER has been flying transatlantic for American, we ask Capt. Rogers how he feels about crossing the Pond on two engines. He says he is comfortable with it, but quickly adds that he is not indifferent. In 35 years and 17,000 hours of flying airplanes up to and including the DC-10, Rogers had only one engine quit on him and that happened on a taxiway years ago. He says that the 767's engine-out performance is more than adequate, and that, in the unlikely event that one engine failed enroute, the airplane would make a cruise descent to the 20,000-ft. range, which is the optimum altitude for single-engine flight considering fuel burn and performance. It would then proceed to its emergency alternate.

Rogers enjoys flying the 767. He says it flies like a 2-engine 707 (though with a softer control feel) and has many of what he calls the "fine Boeing characteristics." He points to the 767's excellent climbing ability, and that it will go right up to 37,000 ft. even when fully loaded. Most other transport aircraft near maximum gross weight have to burn off fuel before trying for that altitude.

He also says that the 767 is a delight to land which he later proves at Orly Airport outside Paris by greasing it in.

Most outstanding feature? Rogers likes FMC Co.'s two flight management computers with their extensive North American and European databases. These compare and compute instant course, speed, wind and position data provided by three independent inertial reference systems utilizing ring laser gyros. Error is less than a 1/2-mile in a 10-hour flight.

Rogers points out another advantage of flying American's 767 across the ocean to Paris. "It's a great way to get over to Gay Paree, while leaving some of your fuel money back in the good old U.S. of A."



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OUTDOORS

BY JOE SKORUPA

Shakeout In Big-Money Tournament Fishing

A battle is brewing above and below the waters of the country's big lakes and reservoirs. It wasn't long ago that a regional fish, bass, rose up from the shaded weedlines of the Deep South to successfully win the hearts and minds of a large portion of the nation's fishermen. Now, history may be repeating itself with walleye.

Statistics indicate that trout is still the most popular fish in America, but you'd hardly know it. Bass is clearly the superstar of pro fishermen, fishing manufacturers and the media, and has been for most of the 1980s.

But walleye, once thought of as a Midwestern favorite, is making a serious move into the national spotlight. State fishery agencies, and a growing number of pro fishermen and fishing manufacturers are leaping onto the walleye bandwagon.

One walleye supporter already there is Mike McClelland, all-time money winner on the Manufacturer's Walleye Circuit (MWC). When asked to describe his favorite sport, Mike isn't afraid to compare upstart walleye to top-dog bass. "We fish huge lakes



Though most walleye boats, like Tony Smith's, still run tiller-handle outboards, more side consoles and bigger motors are appearing.

and reservoirs and have to use a great number of sophisticated techniques," he says, "many just to deal with 6-ft. waves and heavy weather. I'd like to see top pros from other circuits compete with us, but I know what the result would be. We wouldn't have much to worry about."

Spurred on by talk like this and letters from readers, such as David Terry, of Jefferson, Ohio, a self-described "walleye fanatic", I decided to visit the capital of walleye fishing, the Upper Midwest, to see what all the fuss was about. I went to Lake Winnebago, in Wisconsin, and fished with some of the pro tour's reigning elite, who assembled in Oshkosh for back-to-back walleye tournaments.

The MWC tournament trail, by the way, attracted

1000, 2-man teams in 1986, in only its second year of existence. This year's championship event, held at a location kept secret till late in the tournament season, has a total payout of \$41,500



Mike McClelland uses this switch to get two transducer views on one flasher.

and \$10,000 to the winners.

Another event, the Mercury Marine National Walleye Tournament, has grown to become the focus of a major civic happening known as Walleye Weekend. This year's tournament, which had a carnival-like atmosphere, featured \$50,000 in prize money and was televised on ESPN.

Why all the interest in ol' marble eyes? Aren't bass also found in Midwestern waters?

"Yes, but walleyes are better fighters than many fishermen realize and can be found anywhere on a lake, so there's a real challenge to locating them," says Jerry Anderson, last year's top fisherman on the tournament circuit.

"Also, there's no better

tasting freshwater fish."

State fishery agencies across the country seem to agree, and are increasing their walleye stocking programs. As a result, in 1985 and '86, eight new state walleye records were set, most outside the walleye strongholds of the Great Lakes states. New marks were set in North Carolina, Wyoming, New Mexico, Washington, Arizona, Mississippi and Virginia.

Next year's records will likely be caught in Texas, Indiana, New York and Montana, where new programs are being implemented.

Without doubt, bass currently dominates the fishing marketplace, but walleye has begun to make serious inroads. To date, at least seven boat companies are building trailerable boats specifically for walleye fishermen. These range from big names, such as Lund, Ranger, Starcraft and Alumacraft, to strong regional companies, like Crestliner, Tuffy and Yarcraft. Fishing lure companies are jumping on the bandwagon as well.

The interesting thing about walleye boats is that they differ so radically from bass boats. As Jim Kalkofen, MWC tournament coordinator, points out, you never see a team enter a walleye tournament in a bass boat. The reason is big water. Walleye boats have high sides and deep-vee hulls for a good reason—so they can ride and fish safely in the 5- to 7-ft. waves common on big walleye tournament lakes and reservoirs.

"The last time a bass boat entered a tournament on Lake Winnebago," says Kalkofen, "was seven years

(Please turn to page 20)



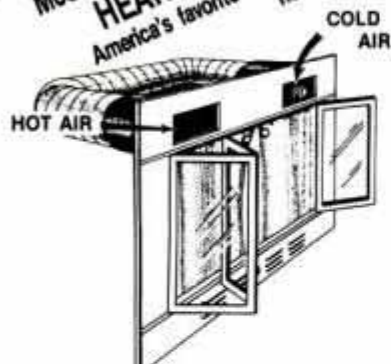
Within reach of Gary Parsons are flasher, chart recorder, trolling motor and 9.9-hp kicker, all of which are needed to win walleye tournament purses that are beginning to rival those on the bass fishing trail.

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OUTDOORS

(Continued from page 19)

ago. It ran 3 miles, took a few over the transom and sank. The wind blew the foundering boat and fishermen 20 miles before they were picked up."

Though each walleye boat reflects an individual's personality, the 17-ft. Yar-Craft owned by Gary Parsons may point to the future of the sport. Parsons, who finished second in the MWC overall rankings in 1985 and '86, is a dentist and avid techie. He runs a 90-hp outboard, though he's about to move up to a 115-hp, from a side console helm, where he's mounted an LCD chart recorder and loran C. In addition to his bow trolling motor, Parsons has a stern trolling motor and 9.9-hp kicker. Like all walleye fishermen, Parsons does a lot of front and back trolling and often runs a combination of two motors at the same time for precise boat control.

Other distinctive features found throughout the MWC tournament trail, include: three batteries, two of which are run in-line for instruments and heavily-used trolling motors; dual heavy-duty bilge pumps; tiller handle outboards for trolling and control; transom splash guards for protection against waves when backtrolling; live baitwells; and rod holders for six rods in the water, where allowed.

While in Oshkosh, I picked up a number of other impressions from a handful of knowledgeable pros, too many to list here. But one comment, echoed by several fishermen, shouldn't be overlooked. Tony Smith, MWC's rookie of the year for 1986, feels that he's "graduated to walleye" after having been heavily involved with other kinds of fish, including bass, trout and salmon. Tony says he's tired of "getting up at 3 a.m. and, besides, walleye are more fun and taste better."

Tony and the other fishermen I talked with believe it's just a matter of time before walleye rivals bass in national popularity. Time will tell.

AC Power To Go

As everyone knows, life's a beach, but unless you've got waterside refreshment service, you're going to miss your blender. The same goes for tailgate parties and boat outings. Gas-powered generators aren't always a hassle-free solution, because many are loud, heavy and bulky.

A new 1200-watt portable inverter called PowerPal is none of the above. It hooks up to a 12-volt DC battery and produces 120-volt AC current. It weighs only 14 pounds, measures 10 in. x 10 in. x 6 in., runs silently and costs less than \$700.



Compact power inverter supplies 120-volt AC current for portable and outdoor use.

Though PowerPal is ideal for running a blender, it can run other house current appliances. For example, outdoorsmen may want to cut timber with an electrical saw, do backwoods carpentry, build a hunter's treestand or, when kids are around, watch TV. PowerPal can handle all of these situations, plus provide emergency power during a blackout.

Though PowerPal is useful for many applications, a number of people will be highly interested in its blender capabilities and, here, the unit proves to be a responsible partner. It turns on a red light to warn if a battery is low and shuts itself off before the battery actually runs down. So, if the user isn't keeping track of how much blender time is being used, PowerPal is. For more information, contact PowerStar, 10011 N. Foothill Blvd., Cupertino, CA 95014.

Japanese Torture Test

How serious is Japan about opening its markets to American products? Sandy Kaye, President of Porta-Bote International, manufacturer of a line of durable 8- to 12-ft. folding boats, discovered that his product had to undergo testing before it could be distributed in Japan. Kaye wasn't fazed, because he guarantees his hulls for 10 years. But then he found out the details of the test.

After assembling the Porta-Bote, which folds to 4-in. flat and weighs 49 to 69 pounds, the Japanese Coast Guard filled it with 600 pounds of concrete, hoisted it 20 ft. and cut it loose to smash into the water. Then, they analyzed it for damage to hinges and hull. When no damage was found they dropped it again. In all, they dropped and scrutinized it three times.

To Porta-Bote's credit it passed the torture test, but it certainly wasn't designed for such abuse. No boat is. "Are Japanese boats tested this way?" Kaye asked his Japanese distributor. The answer was "No."

To find out more about a tough line of folding boats, contact Kaye at the Porta-Bote Bldg., 1074 Independence Ave., Mountain View, CA 94043. **PM**



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CAR CLINIC

BY MORT SCHULTZ

Try Suspenders?

The Buick dealer hasn't been able to find out why my 1984 Skylark 2.5-liter engine has busted five alternator belts in 22,000 miles. Is there something you know that he doesn't know about these belts?

WILLIAM F. MILLER
GREENLAWN, NY

I know of no inherent defect with this engine, or GM's specified belts. The most likely reason for your using so many belts in such a relatively short period lies with one of the following:

■ Belt too tight. Using a gauge to set belt tension to no more than 145 pounds, rather than tightening as much as possible.

■ Pulley misalignment. The alternator mount may have to be shimmed so alternator and shaft pulleys line up, allowing the belt to run straight and true.

■ Pulley damage. A pulley that's nicked, for instance, and is cutting the belt.

That's it. I can think of no other logical reasons for going through five alternator belts in 22,000 miles. If your dealer is finding it difficult to resolve the problem, he can get help by calling the Buick Technical Assistance number. If you want to discuss the situation with someone at Buick on your own, there's a toll-free number, (800) 521-7300, you can call.

Chrysler/AMC Warranties

If you read the past two issues of Car Clinic, you know that in response to a request from T. K. Koerner of Earleton, Florida, I've given a rundown of the present new car warranties offered by GM and Ford. As with GM and Ford, the Chrysler and AMC warranties are divided into four parts: basic coverage (each is for 12 months

or 12,000 miles), emissions control systems coverage (defects in emissions control equipment are covered for five years or 50,000 miles), corrosion rust-through coverage, and powertrain coverage.

Although the parts and systems covered by the Chrysler and AMC warranties are for the most part, the same as with the GM and Ford warranties, the time periods regarding powertrain and corrosion rust-through differ.

Here's how:

■ Chrysler's powertrain coverage takes effect after the basic 12-month/12,000-mile coverage ends and is for an additional 72 months or 58,000 miles with the actual period depending on the time/mileage on the car when the basic coverage is satisfied. The total length of time powertrain components are covered, therefore,

is seven years or 70,000 miles, whichever occurs first. If you need a repair under the terms of the powertrain portion of the warranty—that is, after basic coverage expires—you are responsible for the first \$100 of the cost. The Chrysler outer panel rust-through warranty is good for seven years or 100,000 miles.

■ The 1987 AMC powertrain coverage differs from model to model. Some vehicles (Eagle and Jeep, for example) are covered for an additional 12 months or 12,000 miles beyond the basic 12-month/12,000-mile basic coverage—in other words, a total of two years or 24,000 miles. Others, such as the Renault GTA and Alliance, are covered for up to 48 months or 38,000 miles beyond the basic coverage—a total of five years or 50,000 miles.

A \$100 deductible applies once the basic coverage expires. Corrosion rust-

through coverage also differs from model to model. AMC/Jeep vehicles are covered for a total of 36 months regardless of mileage, Renault vehicles for 60 months or 50,000 miles.

Beginning with 1987 models sold after February 1, 1987, AMC started offering more extensive powertrain and rust-through warranties on Renaults—72 months or 60,000 miles for powertrain components and 72 months or 100,000 miles for outer panel rust-through.

Over There, Over Here

While checking my new Michelins, I glanced at the tire size information on the sidewalls. It is 195/70HR14. The "R" is for radial, but what's the significance of that "H"? My old Uniroyals had no such letter.

PAUL FITZGERALD
SOMERVILLE, MA

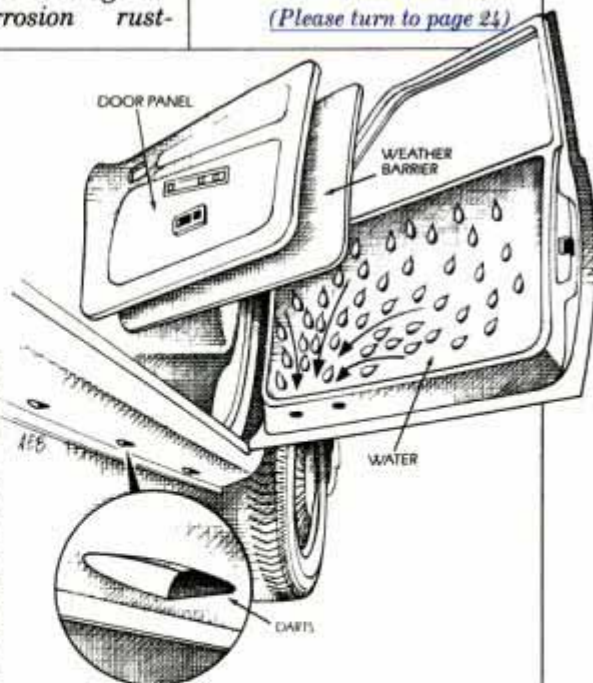
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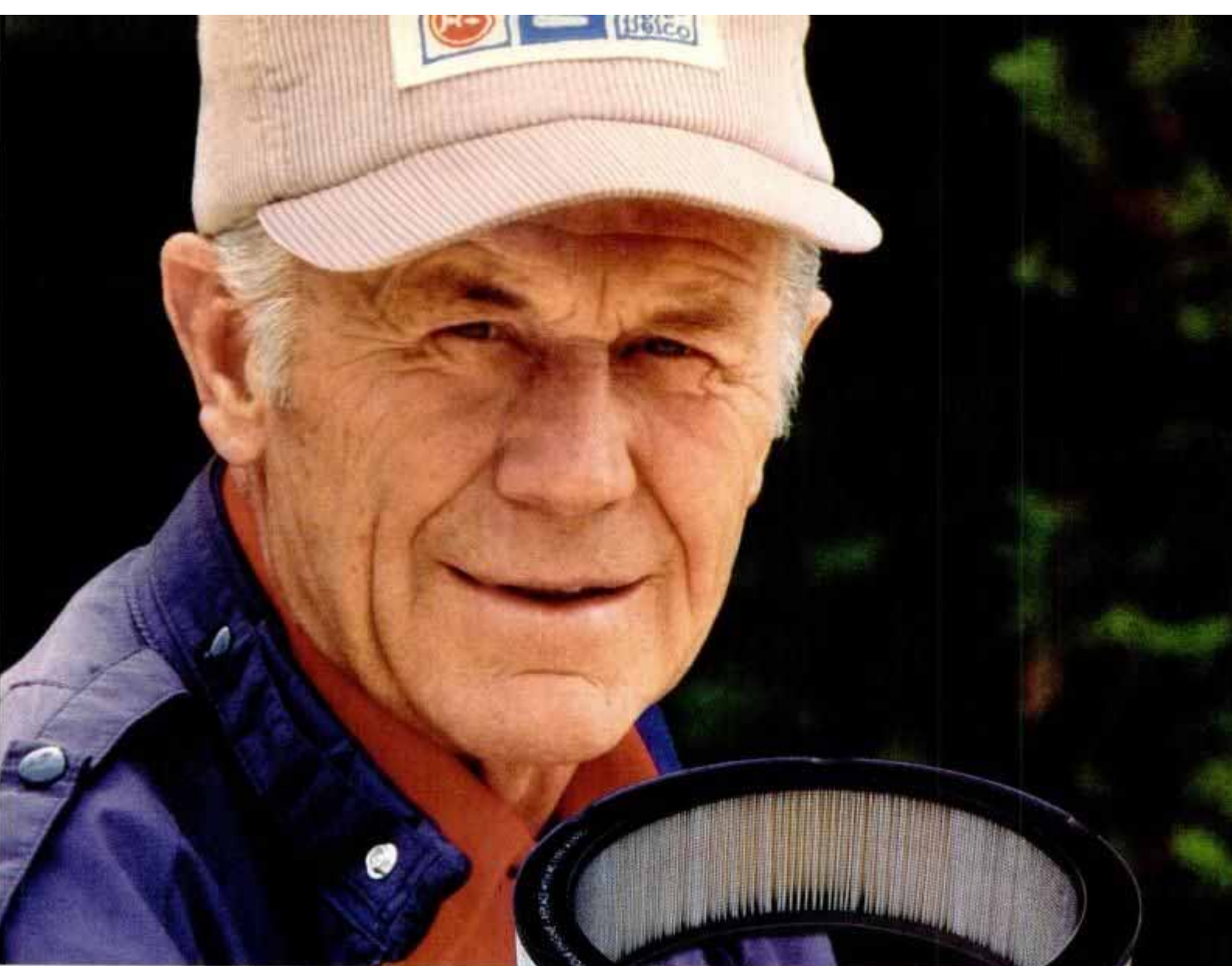
Drain Lanes

It is hoped that if you've been reading Car Clinic over the years, by now you know that there are little holes in the bottom of car and truck doors that allow rain water and condensation to drain—we've said it often enough. But one thing we haven't stressed is that there are also other drain ports called darts (that's what they look like) in rocker panels. If all goes according to plan, water that gets between body panels will work its way down and out through the darts. But the darts have to be open for this to happen. One indication that they aren't open or that the door drain holes are plugged is a sloshing sound as you drive along. Sloshing sound or not, it's a smart move to make it a part of your yearly maintenance schedule to use a small awl and ream junk from door drain holes and rocker panel darts to allow for efficient drainage.

After you have rustproofing/undercoating



applied, invariably most of these holes will be plugged, too. Yes, the rustproofing outfit is supposed to clear them out, but if the rustproofing is gooey and runny enough to work really well, it still will run downhill for a week or two—and plug the holes again.



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CAR CLINIC

(Continued from page 22)

It's a speed rating code. Designations are as follows. "S" means tires are capable of being operated at speeds up to 112 mph, "H" means up to 130 mph, "V" means up to 149 mph, and "Z" means 150 mph or more. Speed ratings have been part of size nomenclature on tires made for use in Europe, because there are no speed limits on some highways over there. Tire manufacturers with corporate headquarters in the U.S.—Goodyear is one—are getting into the act despite speed restrictions over here. One reason is that major tire companies are multinational, making and selling tires in many countries. Michelin, for example, a French company, has manufacturing plants here. Goodyear has manufacturing plants in Europe. Another reason speed ratings are being included, is to satisfy customers: When you replace worn-out tires which have speed rating codes, you may want tires that bear the same code. By and large, there are two points of agreement among tire dealers regarding speed ratings:

1 The higher the rating the better the tire will perform, but the faster it will wear out. You may only get 30,000 miles from "H" rated tires, for exam-

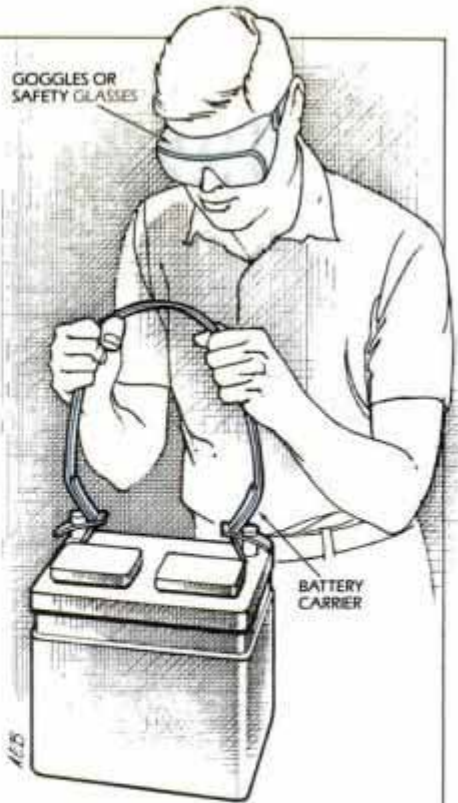


Battery Smarts

Here are five tips that will help keep you safe when you have to handle the battery in your vehicle:

- 1** If you have to remove the battery from the vehicle, use a battery lifting strap or a side-terminal battery carrier to avoid dropping the battery, which will probably crack it—or break your toe. After attaching the strap or carrier, but before you hoist the battery all the way out, lift it just a little to make sure the end clamps have a grip on the posts.
- 2** Always wear safety goggles.
- 3** Keep lighted cigarets, sparks and open flames away from the battery.
- 4** Remove jewelry. Accidentally touching a "hot" spot could weld your ring finger to the battery.
- 5** Don't lean over a battery when it's

GOGGLES OR SAFETY GLASSES



on a charger or being boosted. Consider it a bomb: Batteries produce small amounts of hydrogen gas and, occasionally, explode.

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ple, while someone with "S" rated tires will get 40,000. This assumes the way the two of you drive and maintenance of the tires are the same.

2 Once a tire is repaired, the speed rating no longer applies, since a puncture and repair negate the strength which gave the tire the code designation to begin with. Not that anyone expects you to do 130 mph on your Michelins in this country, Paul.

Maiden Voyage

The only explanation I get from the dealer about an occasional shifting problem with the automatic transmission in my 1986 Mercury Sable is, "It's never happened before." About 12 times over the past 12 months this transmission has failed to upshift from a lower gear.

The situation occurs most often when slowing down to enter an expressway and then accelerating to move into traffic. Since the transmission wouldn't upshift by itself, I've had to pull onto the shoulder, stop the car, turn off the ignition, and start from scratch. Since this has a potential for causing an accident, I need a better reason than, "It's never happened before." MARSHALL D. WARE
DALLAS, TX

Since the condition happens occasionally, you can rule out such obvious

SERVICE TIPS

■ It may not mean anything now because your 1987 GM J-car is still new, but later it may mean that you won't be able to have spark timing accurately set. If your car has a 2-liter engine, VIN code K or M, a new crankshaft damper pulley (part No. 10083143) has been issued to repair outer timing-ring slippage that GM has found exists with the original damper in a certain percentage of vehicles. There are TSB's—for reference, ask your dealer to find the one for your car that coincides with Pontiac bulletin 87-6-48.

■ It may be that the only way you're going to clear up an erratic idling condition in a 1986-87 Chrysler Corp. vehicle with 2.2-liter engine, EFI and automatic transmission is by retarding timing from 12° BTDC to 8° BTDC. So says TSB 18-09-87 Rev. A. By "erratic idling" it is meant that speed fluctuates 100 to 400 rpm when the air conditioner is turned on and the engine is warmed up. The bulletin lists the affected models.

■ All those concerned about hearing several sharp raps on starting the 5-liter Ford engine used in a variety of 1985-87 cars and light trucks should heed this: The noise may be caused by excessive clearances in a No. 1 through No. 4 of the five main bearing journals. The No. 5 journal is not affected.

Ford has issued instructions about what to do for this, including the installation of different main and thrust bearings. Refer your dealer to TSB 87-11-12.

causes as a low fluid level. The situation is more serious than that, and the transmission will probably have to be taken apart for overhaul. The cause will be found either in the valve body or the governor, with some part that sticks once in awhile.

It shouldn't cost you a penny to have it repaired even if your warranty is no longer in effect since you've been on

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, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

record that this has been trouble since the car was new.

You've kept all the repair orders showing the problem, right?

To get some idea of whether the valve body or governor is involved, when it happens again, pull the shift lever to Low—then move it back to Drive. If this action causes the transmission to shift to Drive, the problem is probably governor-related—if not, it's with the valve body. If the dealer still offers his lame excuse for not tackling the repair, call the Ford Parts and Service Division district office, (214) 323-6299, in Carrollton. **PM**

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blizzards and Moroccan sand and we don't intend to let them start slipping now.

Nor did we sit back when it came to the cab. That's why its interior appointments seem to be "almost custom installed" according to the editors at *Road and Track*.‡

So while you're getting America's lowest priced import truck when you buy a P'UP, you should always keep one thing in mind. It didn't come cheap.



*Manufacturer's suggested retail price P.O.E. excluding tax, license and transportation fee. Price as of 7/1/87 and is subject to change. †Except Hawaii. ‡*Road and Track Truck Buyer's Guide*, 1987.

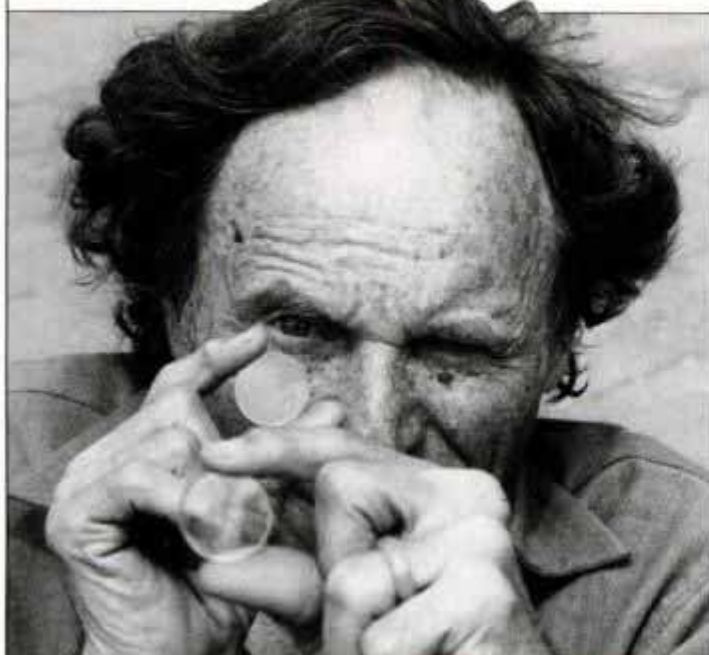
The First Car Builders of Japan.

ISUZU

SCIENCE

BY TIM COLE

Discoveries



MIT's Philip Morrison takes us on a voyage of discovery in "The Ring of Truth," a television series that begins on PBS this month.

Learning about science is an exercise in navigation. Across the great sea of knowledge, we have to rely on certain prepositioned beacons of enlightenment. The invention of the telescope, for instance, or the fundamental relationship between matter and energy, have led to fabulous strides in our knowledge of the universe, creating an ever-increasing expansion of what we know—and continually reminding us of what we don't.

The 6-part PBS series "The Ring of Truth," with acclaimed science educator Philip Morrison of MIT, charts some of these scientific waypoints—the crafting of instruments like the telescope, for instance, and Einstein's theory, along with mapmaking, geologic history and a snoop at the atom. He thus helps us skirt a few shoals on a voyage to greater scientific awareness. "The Ring of Truth," begins airing this month.

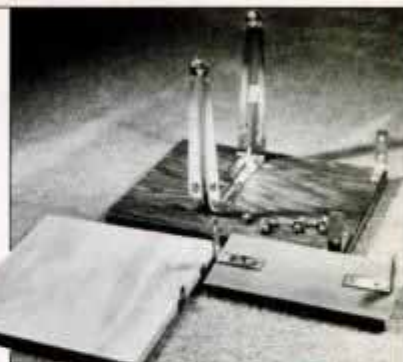
Morrison, a physics lec-

turer by trade and the book editor at *Scientific American* for 21 years, gets people involved with science by explaining the scientific underpinnings behind everyday experience. His objective is to show how some of the great scientific minds across the ages came up with some rather crucial revelations—our aids to navigation, if you will—that have shaped a lot of subsequent scientific thinking. In the sixth and final program, Morrison takes us on a tour of the universe in search of a cosmic recipe to explain what's "out there." "The Ring of Truth" comes full circle, beginning with what is, and finishing with what might be. It's must viewing for anyone who wants to learn—and grasp—the essence of our world and its place among the stars.

Backyard astronomy

One of the things that Phil Morrison makes clear is the fact that an appreciation of science need not be con-

finied to the laboratories and think tanks. PM reader Bryan P. Shumaker of West Bloomfield, Michigan, is a case in point. An amateur instrument-maker in his own right, Bryan has come up with an elegant and inexpensive device for viewing the heavens. A simple pair of binoculars up to 7x50 power will yield impressive star images on a clear night. But Bryan has gone one step further by creating a binocular holder that fixes the field of view so that two people can easily alternate observing the same piece of sky. His binocular holder also relieves arm, neck and shoulder strain. The Shumaker solution? A simple viewing stand that holds a binocular and aims it downward toward a first-surface mirror. A first-surface mirror, unlike



The Sky Scanner—a mirror, a simple bracket and a piece of plywood.



The assembled, inexpensive binocular holder—ready for the stars.

a common bathroom mirror, has its reflective surface on top rather than applied to a backing, which, for astronomical observations, removes the mirror's "ghost" image. Shumaker's "Sky Scanner" can be fastened together for under \$5 using hardware store parts and a mirror he'll supply PM readers for \$20. A total cost of \$25 unlocks new potential for observing the faintest stellar objects. For a "Sky Scanner" mirror and plans, send \$20 plus \$2.50 for postage and handling to Scottbrooke Design, P.O. Box 8177, West Bloomfield, MI 48304.

Also for amateur astronomers, Astro Kits (824 Bronx River Rd., Bronxville, NY 10708) has fashioned a simple, yet durable \$99 camera-drive kit just for amateur astrophotography. A high-quality birch forms an upper deck for mounting your 35mm camera and a lower deck that fastens to a tripod. **PM**



Astro Kits' simple camera motor for astrophotography. Two-hour exposures are possible.

HOME VIDEO

BY JAMES B. MEIGS

Games Bounce Back



Wandering through the exhibits at this year's Consumer's Electronics Show, I got a powerful feeling of déjà vu. The CES is the place where the breakthroughs break through first and the latest trends are trendiest. But one of the hottest products at the show was a blast from the past. Everywhere I looked I saw videogames. I could have sworn it was 1983.

Videogames are indeed back. The current rebirth doesn't approach the frenzy of the game scene in the early '80s, but game designers are scurrying to produce new and better challenges. Some of the names are the same: Activision, Sega and Atari are major forces in the game revival. One of the most exciting systems comes from Nintendo, a company most Americans are just getting acquainted with. Although

Nintendo's game system (above, with scene from "Legend of Zelda") incorporates joysticks, light gun, even a robot for versatile action. Sega's Master System (below) also uses a light gun, for playing 3-D games such as "Missile Defense." Most game makers plan to offer 3-D systems this year.



many of the new games rely on the familiar fight-off-the-aliens or scurry-through-the-maze motifs of yesteryear's games, improved technology has given the games some exciting new twists.

Going 3-D

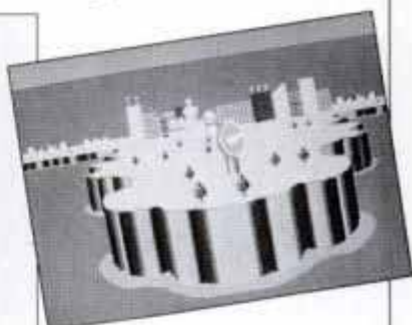
One of the most exciting new trends in home games is the arrival of 3-D games this year (3-D TV Comes Home, page 66, Aug. '87). Game-giant Sega has begun selling its first, "Missile Defense 3-D," and promises more are on the way.

The 3-dimensional system works by using a pair of special glasses with LCD (liquid-crystal display) panels over each eye. They work as electronic shutters, alternating between black and transparent 60 times a second. They make



Arcade Games Come Home

Sega promises that a 3-D version of its popular arcade game "Zaxxon" will hit stores in November. Sega has also introduced several new (non 3-D) games, including the arcade road race hit "Out Run" and a version of the best-selling board game "Monopoly." Both games use Sega's new Two Mega Cartridge, a 2096-kilobyte memory cartridge typical of the massive amounts of computer memory that today's game makers bring to



bear on videogames. More memory means better graphics—more detail, better colors and realism—and more sophisticated game structures.

Nintendo, the videogame system that's one of the most popular electron-

(Please turn to page 30)

Below, sneak preview of Sharp's new TV/game-console combo, due this year.



sure that the left eye is clear when the left-eye part of the 3-D image is being displayed and the right eye is unobscured when the right-eye perspective appears on the screen. The 3-D game is programmed to alternate between left- and right-eye views at the same rate. The glasses must be connected to the game system with a cable in order to stay in sync. The end result is a very convincing 3-D image, although it's darker than a normal TV picture and has a visible flicker.

Board games that use videotape include "VCR Quarterback."





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HOME VIDEO

(Continued from page 28)

ics products ever sold in Japan, expanded its game catalog with several new games at the CES. Three of them combine the action of arcade games with the more reflective challenges of computer games. "Kid Icarus," "Metroid" and "The Adventure of Link" all involve the elements of role playing and fantasy that mark many successful computer games. On a more physical level, Nintendo also bowed a home version of its boxing arcade game "Punch Out."

Part of the secret behind Nintendo's popularity is the number of interesting components that make up the system. In addition to the basic console, which Nintendo calls the Control Deck, the deluxe system includes handheld controllers, a light-sensing handgun for target games (such as the company's popular "Duck Hunt") and "R.O.B."—a 10-in. wireless robot that can be programmed to assist the player in certain games.

Nintendo also showed prototypes of new 3-D game systems: One used the familiar blue/red plastic lenses, like those used for some 3-D movies. The other employs the LCD shutter system used by Sega and others. The company demonstrated an exciting road race game, called "3-D Racer" and promised to deliver its 3-D technology by the end of the year.

Partly because of its popularity in Japan, the Nintendo system is fast becoming one of the hardware standards in the game industry. Activision has announced that it will soon start selling games for the Nintendo system and several other game makers are also beginning to produce software for the system.

Set For Games

One of the most unusual game products unveiled at the CES didn't come from a game maker at all. Sharp displayed a 19-in., monitor-style TV set with a videogame console *built-in*. You simply plug any Nintendo-compatible game into the cartridge slot below the screen and pick up one of the attached joysticks. The novel set is scheduled to arrive late this year for about \$550. (If you were around during the previous boom in videogames, you may recall that Magnavox made a similar attempt to combine a color TV set with the Odyssey game system. But that combo didn't fly.)

Computer Games Going Strong

One of the biggest changes since the original heyday of videogames in the early '80s has been the growth of the

personal computer. With relatively inexpensive, reliable PCs now installed in so many homes, schools and offices, there are plenty of people who like to take an occasional break to try out the latest game software. And anyone who has tried out Microsoft's "Flight Simulator" knows that these "games" can be far more complicated—and educational—than your average joystick shoot'em-up.

Activision is one company that has managed to lure computer users with a series of interesting games. It recently introduced a new line of games for Apple and Atari computers.

Atari has also worked to bridge the gap between computers and games, introducing hardware that can handle both tasks, as well as exciting games. At the CES, Atari introduced 40 new games. The company also sells one of the most powerful game systems available, the new XE, featuring a remarkable 64-kilobyte memory. That's enough power to run full-fledged computer games such as "Flight Simulator." Atari is in the process of converting other disc-based computer games to the plug-in cartridge used by the XE system. (Serious computer-game players can buy a disk drive for it for \$99.)

The entire XE system is priced at about \$150 and includes both a keyboard and a light-sensitive target gun for shooting-games. For that price, Atari also throws in three popular game cartridges: SubLogic's "Flight Simulator II," the classic "Missile Command," and a new XE game, called "Blast 'Em."

VCR Games Take Off

Not all videogames require computer chips and joysticks. Game makers have also turned to the VCR.

Now that over 40 percent of American homes have at least one VCR, manufacturers have begun producing board games that are played in conjunction with a videocassette.

One of the most popular is "VCR Quarterback," by VCR Enterprises. The game uses a board to track the progress of an imaginary football game. But many of the plays are drawn from the videocassette, which includes actual footage of nearly 400 plays by NFL teams.

VCR Enterprises also offers "VCR Hockey" and "VCR Basketball," which use NHL and NBA footage respectively. Both carry a \$44 list price. And just in case playing major league sports on a small board doesn't seem realistic enough, the hockey game includes a small plastic puck for players to flick in the goal, and the basketball game includes a small basketball and hoop for foul shots.

PM

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BY JIM DUNNE

Caprice Goes Aero In 1991

You will have to wait until 1991 for the change to happen, but Chevy plans to remake the full-size Caprice model to be just as sleek as Ford's Taurus. This despite some GM officials' remarks about the "melted candy bar" appearance of Taurus. If imitation is the sincerest form of flattery, Ford should be feeling good. It isn't often that GM copies any competitor when it comes to exterior body design. The 1991 Caprice appears just as long and roomy as today's spacious six seater, but the body lines make it look just as modern as any of the smaller cars on the road.

Its hood lines are softly rounded, and the hood drops down in front to a low-mounted grille. Bumpers are plastic coated and painted the same color as body panels, a radical departure from today's chrome plated bars. Headlights and parking lights are housed together inside curved lenses that match the shapely hood and fenders. The soft lines in front are carried all the way to the rear of the car. Side glass is severely rounded and fits flush with its frames. The rear appearance is dominated by a large bustle trunk. In what looks to be a Chevrolet design signature, the C-post swoops rearward at its base in a line similar to that of the Beretta. Running models of this V8-powered prototype use a front-mounted V8 engine and rear-wheel drive to continue the present powertrain layout. One construction feature that is a departure for any GM car is the hood-grille arrangement. In the Caprice, the grille is attached to the front of the hood and lifts up



1991
Chevrolet Caprice

1989 Buick Century



1989 Oldsmobile
Cutlass Ciera



when the grille is raised.

Buick Century '89

A moderate facelift planned for the 1989 Buick Century mimics the front end of the new Regal and the Riviera. Buick wants to set up a family resemblance between the models in its lineup, and the grille design seems to be the focal point. Note also that Buick will have a version of the 2-door hardtop body style that has been an Olds Ciera exclusive.

Olds Ciera '89

A "freshening" is the word Olds insiders use to describe the changes slated for the 1989 Olds midsize cars. While new, the grille is recognizable as pure Oldsmobile. At the rear, the windows and fenders

have a different shape, more formal than that of the 1988 model. Look for Ciera to also get a higher power version of the 2.3-liter Quad-4 engine as an option to the 2.8-liter V6.

No Mazda Mustang

Ford will definitely not use the Mustang name for the sporty car that Mazda will build. Mustang is considered an American name, not one to be put on a car made by a foreign company. Instead, the Capri badge will grace the hood and deck of the so-called Mazda Mustang.

Since the car will be sold through Mercury dealers, the choice of Capri is a natural. Mercury dropped the U.S. Capri from production at the end of the 1986 model year.

Ten Cylinders?

Yes, that is a strong proposal at Chrysler. Engineers want to build a V10 engine that will have enough power to run medium-duty chassis-like motor homes and small vans. Now, Chrysler has only the 360-cu.-in. V8 to use in those vehicles. Ford and Chevy are able to offer V8s in the more suitable 400-cu.-in. size. So Chrysler's plan is to add two more cylinders to the 360 V8, and come up with a 405-cu.-in.

V10. A big selling point to Chrysler management is the low cost of building the engine. By using the V8 machining line to build the V10, at least \$100,000 can be lopped off costs. So for a minimum investment, Chrysler can get back into the medium-duty chassis business where it once was a sales leader. Why not resurrect the old 426 hemi or 440 V8s for this project? Those engines have not been built for years, and the small number of engines needed to meet demand does not justify the cost of taking the lines out of mothballs.

How Things Go Wrong

Owners of recently built Toronados may find that the front-seat ashtray pops open by itself. That surprise usually happens when the car runs over a moderate bump in the road. Olds engineers say the problem lies in two small plastic rub strips at the sides of the ashtray that hold the tray in the instrument panel. The supplier who makes the plastic strips changed to a different plastic without telling Olds. The new material worked fine for a while. But when the plastic was heated on hot days, its properties changed. Then it could no longer hold the

(Please turn to page 35)

INSIDE DETROIT

(Continued from page 32)

ashtray in position. The result is a lot of surprised owners, low marks for quality against Olds, and a severely chastised plastic supplier. If your Toronado ashtray pops open this way, see the dealer for replacement of the two plastic strips.

Ford Probe

Ford will use the Probe moniker for its new 4-place sports convertible. Developed under code name Barchetta, the Probe will be built in Australia by Mazda, and imported to the U.S., in fairly small numbers, probably less than 10,000 per year. Look for a price at about \$10,000, or something well below sport models like Fiero.

Reatta Convertible

Buick is testing a prototype convertible version of its 1989 Reatta sports car, preparing the car for introduction in 1990. Like the Cadillac Allante, the Reatta will have both a soft top and removable hardtop roofs. Unlike the Allante, the Reatta will not compete in price with the Mercedes 560 SL. Instead of \$55,000, expect the Reatta to list out at less than \$35,000. Powerplant for this model will be a high-output version of the Buick-developed 3.8-liter V6. If that engine is offered with turbocharging, the Reatta will probably outperform its more expensive cousin from Cadillac.

Rollback

Chrysler and GM admit that odometers on some of their vehicles were rolled back or were disconnected while the cars were driven by employees for "testing" purposes. GM claims that "less than 1 percent" of its vehicles, are put through a test drive before they are sold. Those vehicles, according to GM, must not accumulate more than 80 miles, and the eventual buyers must be given credit on the warranty for those miles. Some of the abuse of "test driving" came about because employees drove vehicles home overnight. If overnight occurred on a weekend, there was a chance the mileage would be much greater than that needed for testing. At GM, the abuse became so sophisticated that one employee was congratulated by superiors for figuring a better way to get by "tamper-proof" odometers.

Allante Power

Cadillac is still working to make its 2-seat convertible more competitive with the Mercedes 560 SL. Next year its 170-hp V8 engine will get multi-point fuel injection, which should give the extra power reserve the car has

needed. In addition, an automatic ride system that adjusts to road conditions will be added to the 1989s. Later, Cadillac will install 4-wheel drive.

Criticism Noted

GM body designers are taking much of the blame for look-alike models that give customers little feeling of distinction when choosing between brand names like Olds Calais and Buick Somerset and even the Cadillac Eldorado. GM's top executives told designers the company's cars look too much alike.

You'll see their reaction when the 4-

door models of the W-cars—Regal, Grand Prix, Cutlass Supreme and Monte Carlo—are on the streets in late 1989.

No look-alikes here.

The cars are as different in appearance as if they were products of different styling studios. Most surprising is the difference in design between 2- and 4-door styling for the same car. The Cutlass Supreme looks sporty in the 2-door version, with glass wrapping completely around the C-post. The 4-door appears more elegant, richer and has a completely different rear window shape. **PM**

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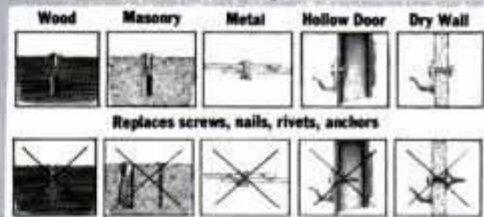


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OLD HOUSE RESTORATION

BY BOB VILA

Dealing With Old Chimneys

If your house was built in the early 1900s or before, its old masonry chimneys are probably unlined. Although an unlined brick chimney was okay in its day—when labor was cheap and we often saw the chimney sweep—it is considered substandard these days.

In many cases, old bricks and mortar have deteriorated and cracked. This creates spots where smoke and other flue gases can escape into your home. Should a chimney fire occur in an unlined system, the gaps become passageways for smoke and fire. When you couple the ravages of old age with the fact that today's stoves and fireplace inserts create conditions that an unlined chimney just wasn't made for, I think you'll agree that they should be brought up to par with current safety standards.

Whether you use your fireplace just to create a little atmosphere or plan to upgrade for heat efficiency, safety should always be your No. 1 concern. The shape your chimney is in, both inside and out, along

with an awareness of the changes an airtight appliance will make in the system, all play an important part in safety.

Spotting trouble

Ideally, the time to check the chimney system is before you purchase your home. At the very least, an unlined old house chimney will need a flue lining. At the worst, a badly deteriorated stack will require a costly rebuild. A visual inspection of the chimney in the basement, attic and the section protruding through the roof is usually sufficient for a certified chimney sweep to discern if the latter situation exists.

In addition to checking for external deterioration, you should also make sure 2-in. clearance to combustibles exists on all sides of an internal chimney. Surprisingly enough, I've seen old

and new homes alike that violate this very important safety rule. You need that 2-in. clearance to allow heat from the masonry to dissipate. If your chimney doesn't adhere to this, some modifications and reframing work are necessary.

As far as the internal condition is concerned, if the chimney already has a liner it should also be inspected. It may need repair or replacement due to a chimney fire or improper installation. A new electronic video scan system, where a camera records the inside of the flue, is probably the best way to detect problems. This operation is done by qualified chimney sweeps. Depending on location, the costs of a video scan on a 2-story home stack range from \$35 to \$85.

If a chimney is unlined, you can eliminate this step, since you should line it anyway. This is a national fire safety standard, set up by the National Fire Protection Assn. (NFPA). But before you choose a flue lining, decide if you want to add a wood stove or high-efficiency insert to the fireplace. If you do, this decision will affect the size and style liner you choose.

Adding a stove or insert

Adding a woodburning stove or an insert to a fireplace changes what happens in the chimney. Since these appliances use a smaller, controlled amount of air than an open fireplace, they create less heat and draft than a roaring open fire. Because the flue gases don't move through the chimney as quickly, they have time to cool and, due to the lower stack temperatures, condense on the flue walls forming creosote.

Contributing Editor Bob Vila is host of public television's "This Old House."

The safest and most efficient way to operate a heating appliance is with an insulated liner. It must be sized properly for the stove or insert's flue outlet and it must extend all the way to the top of the chimney.

Creosote builds up faster in an oversized flue, where there's more space to heat. An insulated liner combats the condensation by keeping stack temperatures warmer.

Incidentally, if you're adding an appliance to an already lined chimney and find the flue is larger than three times the cross-sectional area of the stove or insert collar, reline to meet modern safety standards.

The inside story

Now that you understand the basics of woodburning and the changes an airtight appliance makes, you should be ready with the aid of your chimney sweep to choose a flue lining system. Basically, there are three types of liners available for masonry chimneys: clay tile, stainless steel and cast-in-place.

The first, clay tile, is most commonly used in new construction. It's available in rectangular 2-ft. sections, $\frac{3}{4}$ in. thick and of various widths. For these to be installed properly, the chimney should be opened up every 2 ft. so the joints can be sealed with refractory mortar.

Stainless-steel liners, available in either rigid or flexible lengths, are commonly insulated with a cement-like mixture or ceramic wool blankets. Like clay tile, uninsulated stainless steel creates a cooler chimney and the likelihood of more creosote.

The newest type of flue lining systems are the cast-in-place liners, which create an insulated flue. They're installed a couple of

(Please turn to page 38)



One great way to check the chimney's creosote build-up is with video scanning equipment, operated by a certified chimney sweep.

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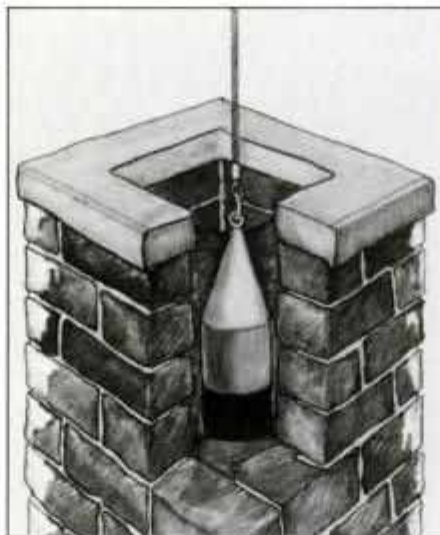
(Continued from page 37)

different ways. One involves placing an inflatable form in the chimney to the required flue size. A cement-like mixture is pumped around the form and allowed to harden. The form is then removed, creating the flue.

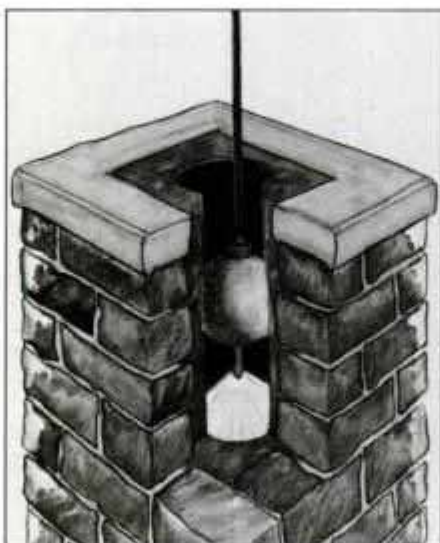
The other installation uses a vibrating bell to form the flue opening. A ceramic coating is added to seal the concrete from moisture penetration, thus forming a second liner.

Handling the hazards

Before relining, the chimney or existing flue must be cleaned to prevent creosote from igniting between the two layers. Although lining an old masonry chimney generally betters the system, adding a stove or insert may increase the risk of chimney fire. This stands to reason when you consider the likelihood of creosote formation,



New cast-in-place liner is formed by pouring cement-like mixture in flue then pulling up a vibrating bell to form the rough opening.



Next a glaze-setting liquid is sprayed onto the liner wall to prepare it for the ceramic coating that follows.

coupled with the fact that an airtight appliance is usually burned continuously, rather than intermittently like a fireplace. This constant use means the chimney is always warm. This heat, in turn, can penetrate the masonry. A properly insulated lining system with the proper sized flue will dramatically reduce heat transfer to combustibles around the chimney, and should reduce the risk.

Don't connect a stove or insert to a chimney that's not 100 percent as it should be. In most regions, you'll need a permit for this installation. In any event, a certified chimney sweep or home inspector should take a look at the system before it's used.

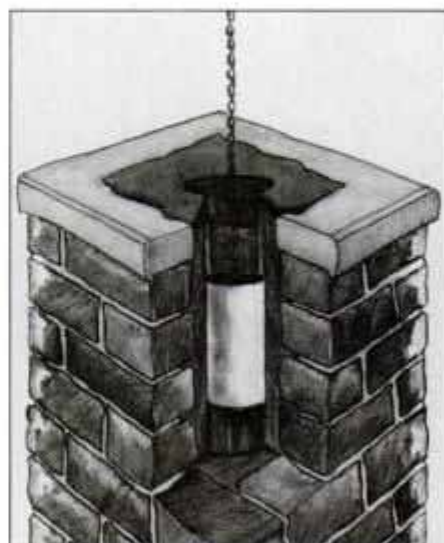
Although insurance rules vary, some firms are concerned enough about wood heating to require an inspection of such a system when it's added to your home. To be on the safe side, notify your insurance company before this change is made to make sure what you plan to do will meet the company's requirements.

Maintenance

Finally, keeping a chimney clean has a major affect on its safety. According to NFPA standards, all masonry chimneys should be inspected once a year and cleaned when necessary. If you're using an airtight appliance for the first time, check the chimney every two weeks using a mirror and flashlight to see how fast you're building up creosote. Afterwards, a visual inspection every two months should be sufficient to detect dangerous levels of accumulation. Only 1/8 in. of creosote means it's time to clean! **PM**

SOURCE LIST

- Video Sean Equipment: Estoban Corp.—Chim Sean, Box 509, Fairfield, IA 52556
- Cast-In-Place liner: Ahrens Chimney Technique, Inc., 200 Industrial Ave., Sioux Falls, SD 57104.



Finally, a sponge applicator is drawn through the flue to apply ceramic coating. This seals the flue from moisture penetration.



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ELECTRONICS

BY STEPHEN A. BOOTH

Kodak Electronic Photos



Progress in the emerging field of still video—sometimes called electronic photography or filmless photography—has frequently been the subject of this column over the past three years. Every small advance in the technology of storing pictures on a 2-in. magnetic disc has been reported here. You've seen experimental color prints from Konica, Fuji, Hitachi and Sony in various states of development. You've seen prototype still-video cameras from the world's photo-equipment and electronics manufacturers. This reportage reached its high point last summer when Canon introduced the first system for taking, storing, transmitting and printing photographs electronically—but it didn't end there. Throughout this coverage, the \$64,000 question remained: Where is Kodak?

That question recently was answered in a way that leaves no doubt about the Rochester, New York-based company's ability to juggle electrons as well as photons. Father Yellow has entered the electronic imaging business in a big way, and although the initial products are intended for

Kodak's electronic prints from magnetic disc use thermal dye transfer instead of conventional developers and photosensitive paper. Actual print size is $3\frac{1}{2} \times 4\frac{1}{4}$ in., plus $\frac{1}{4}$ -in. border.

commercial and institutional users, the final result—the prints themselves—demonstrate the high-quality images that electronic snapshooters can expect in the future.

You can see those prints yourself, reproduced on this page. We've maintained the three to four height-to-width proportions of the originals. The macro-shot of the quarter-dollar is shown 75 percent of the actual print's size, the others 50 percent. The originals measure $3\frac{1}{2} \times 4\frac{1}{4}$ in., not including a $\frac{1}{4}$ -in. white border.

Of all the many still-video prints I've seen, these are the best in detail rendition and color quality. Additionally, the usual video scanlines running across left to

right are barely visible.

Instead of using conventional developer chemicals and photosensitive paper, Kodak's prints are made by the thermal dye-transfer method. Tiny pins, each representing a pixel or picture element, transfer dye to the paper by generating varying amounts of heat that produce up to 256 different levels of color tone. Among other things, it's the 512 pins each capable of 256 tone-levels that account for the high resolution, continuous-tone prints. The process takes $1\frac{1}{4}$ minutes



per print—and they're as permanent and as stable as conventional prints. By way of comparison, the still-video prints made with Konica's system take the image from a magnetic disc and develop it with conventional chemicals on photosensitive paper. These prints are excellent, but take about 7 minutes each.

Kodak has not yet introduced a still-video camera for sale. Until then, images come from the conventional motion-video cameras (freeze-frame) and other

video sources, or photo prints and transparencies transferred to video by telecine converters (the coin print comes from a 35mm slide copied onto magnetic disc). But the prototype mag-disc camera I handled during Kodak's recent demo might change the way we take pictures physically as well as technologically. Where other companies have designed their still-video cameras in the image of 35mm SLRs—rather clunky and heavy ones at that—Kodak has abandoned such preconceptions and styled its prototype to be held the way binoculars are held. Controls are top-mounted, for comfortable operation. Information displays are rear-mounted—right before your eyes. From the way it handles, you'd never suspect it weighs 4 pounds.

While we're waiting for still-video cameras to reach the stores, somebody ought to consider this design for video movie cameras and camcorders.

3-D Goes Laserdisc

Sanyo has succeeded in taking the flicker out of 3-D video programs. And the Japanese company is doing it with lasers.

In PM's August issue (*3-D Comes Home*, page 66), contributing editor and video columnist Jim Meigs explained how videotape and VHD-format videodisc (a format available in Japan only) are used to store stereoscopic images. Basically, the left-eye and right-eye views are stored separately on alternating, successive video fields. You wear a set of eyeglasses with liquid-crystal shutters, which open and close in sync with alternating fields so that each eye sees only the view intended.

(Please turn to page 44)



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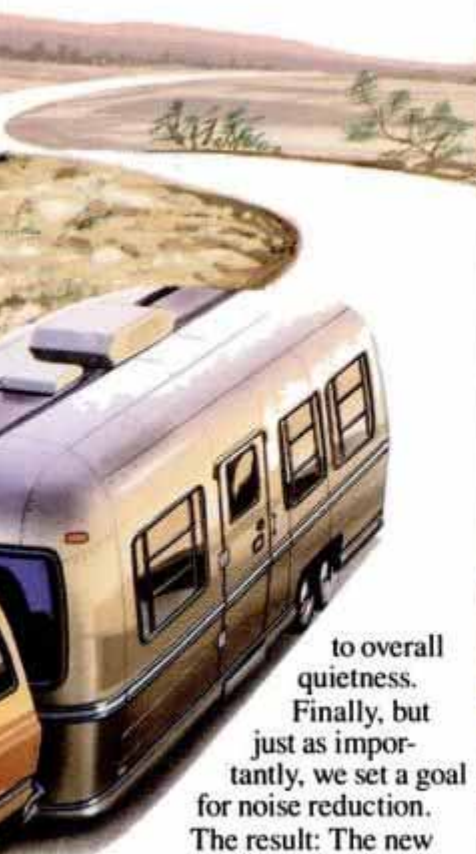
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to overall quietness. Finally, but just as importantly, we set a goal for noise reduction. The result: The new Wrangler LT, a strong, rib-designed radial that offers long mileage, good handling and traction, plus a smooth, quiet ride. It is a tire that goes a long way towards pushing back the final frontier.

Underneath is the strength of our on- and off-road tire.

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For long life, we also added a cool running subread compound. For good air retention, we added a butyl liner. And for better stability in the bead area, we added a new lower sidewall design. This improved sidewall design, together with the reinforced sidewalls, gives you responsive steering. Although the new Wrangler LT rib radial is designed for use on any axle position, it can be used in pairs

capacity of 3,042 lbs. per tire. But no matter which size you choose, you'll get the benefits of a strong, smooth-riding radial that has been engineered to bring you the sounds of silence.

The best surprises are quiet surprises.

Out on the highway, and over the long haul, the new Wrangler LT will come as a very pleasant, quiet surprise. We also believe that you'll be pleasantly surprised by the traction



just on the steer axle. It can also be used on all of the axle positions of the vehicles you may tow. The Wrangler LT is available in a wide variety of widths, sizes, and load capacities, up to a maximum load

the Wrangler LT gives you. You can see the new Wrangler LT radial at your Goodyear dealer. Where you will discover that some of the best surprises are quiet surprises.



Take me home.

The quiet way.



ELECTRONICS

(Continued from page 40)

The problem with this system, as Meigs pointed out, is that each eye sees only one field of a 2-field video frame. The result is a flickering image that some viewers find annoying and even fatiguing. The solution would be to double the TV scanning rate, from 60 to 120 fields per second, so that each eye independently sees a full-frame image (525 vertical scanning lines) every $\frac{1}{30}$ of a second, just as in conventional TV.

Sanyo, in conjunction with NHK

(Japan's public broadcast system), has succeeded in doing just that. Though the storage medium for the enhanced 3-D system is 12-in. laser videodisc, there's no technological reason it can't be adapted for Super VHS and Extended Definition Beta videotape.

Meanwhile, the Sanyo/NHK system scored another big improvement for 3-D home viewing. Those liquid-crystal spectacles no longer require a connecting cord that tethers the viewer to the TV. Instead, Sanyo sends the synchronized signal to the glasses via infrared light. The entire system,

including 30-in. diagonal TV and videodisc player and goggles, will be introduced for industrial applications first at about \$7000.

Mini CDs

Compared to LP records, the $\frac{4}{4}$ -in. digital audio compact disc might seem small enough. But as we've reported in the past, there's work underway to make the CD even tinier.

The new downsized disc measures 3 in. in diameter and is called the CD Single—which partially explains its reason for being. Record companies feel they need a digital equivalent to the 7-in. 45-rpm single, and with 17 minutes of music time available, the 3-in. CD can flexibly fill the gap.

You're ahead of the game if you've already surmised that a 3-in. CD permits hardware manufacturers to build smaller portable CD players, for use with headphones. And you score an extra point for seeing the CD Single's utility in jukebox operation. In case you're wondering, the CD Single is compatible with conventional $\frac{4}{4}$ -in. CD players, but you'll need an adapter. Whereas 45-rpm platters needed a center-hole adapter to latch onto $3\frac{3}{8}$ -rpm spindles, CD Singles pop into an external adapter ring at their circumference.

The first CD Single hails from Digital Music Products (DMP), a Stamford, Connecticut, label that specializes in jazz music. In PM's August *Electronics* column (page 29), I pointed out how important microphone placement is to good recordings, especially for low-noise digital CDs. The jazz discs produced by DMP are about the best you'll hear anywhere—it's CD the way it oughta be. That DMP is the first label to sell the CD Single just says that sometimes, less can be more. DMP's mini-discs are pressed by Sony. Other labels will follow.

Space Alert

There's a new television show for satellite TV system owners. It's called "The Satellite Show" on Westar 5/Transponder 3 twice a week.

According to Chaparral Communications, producer of both the show and of sat-TV equipment, the hour-long program covers new technology and gear, new entertainment programming, plus ways to get the most out of your satellite set-up. It airs Tuesdays at 9 p.m. Eastern time and is repeated Saturdays at noon.

End of An Era

The RCA and General Electric Consumer Electronics brands have been sold to Thomson-Brandt of France. That leaves Zenith as the only U.S. maker. Stay tuned. **PM**

Whoever
said
that
what
you
can't
see
can't
hurt
you
never
drove
down a
narrow
winding
road
on a
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night.



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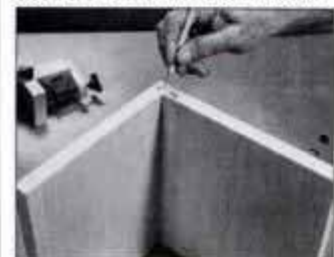
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TOOL TEST

Dialing For Dowel Joints

With the wide variety of doweling jigs available today, you might wonder, as I did, why the world needs another. However, after testing General Hardware's new Dial-Setting doweling jig (model No. 841), I was pleasantly surprised by its easy-to-use design and, more importantly, its accuracy.

The jig is designed specifically for assembling right-angle corner butt joints, as shown, and T-joints—right-angle joints used, for example, to join a shelf to a cabinet side. Unlike many other doweling jigs, this one can be used on boards of unlimited width.



Before boring the dowel-pin holes, mark each board with a letter or number to avoid any confusion during final assembly.



Doweling jig accepts stock from $1\frac{3}{32}$ in. to 1½ in. thick. Set calibrated dial to stock thickness and the dowel holes are centered automatically. The jig comes with three drill stops and hex-key wrench.

The jig has dowel-hole capacities of $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$ in. Use it on stock from $1\frac{3}{32}$ in. to 1½ in. thick. Note



With the boards held securely in a vise, clamp the jig in place. First, bore the dowel-pin hole in edge of the board, as shown.

that the jig has two sets of dowel holes so you can bore holes simultaneously in both mating boards. To se-



Then, without moving the jig, bore a mating hole in the other board. Shift the jig and bore the next pair of dowel holes.

lect the proper size dowel hole, simply turn the color-coded dial to the desired hole diameter. The dial adjusts both holes automatically to the stock thickness. For example, set the dial to $\frac{1}{4}$ in., and the holes are centered for use with $\frac{1}{2}$ -in.-thick stock. Turn the dial to $\frac{5}{16}$ in. for $\frac{3}{8}$ -in.-thick boards and $\frac{3}{8}$ in. for use with $\frac{3}{4}$ -in. stock. The jig isn't designed for making edge-to-edge joints efficiently, so it won't replace a standard doweling jig. But it's a worthwhile complement to it. The jig (\$38) comes with three drill stops for boring holes to precise depths. Contact General Hardware, 80 White St., New York, NY 10013.

—Rosario Capotosto



Assemble the joint with glue and fluted or spiral-grooved dowel pins. Don't use sections of plain dowel rod as dowel pins.

This Gun's For Hire

If you think that electric

hot-melt glue guns are convenient, wait until you try the new Loctite cordless glue gun. Unlike any other cordless tool, this one doesn't run on a rechargeable battery. Instead, it comes with a plug-in power base that heats up the glue gun. Place the gun on the power base unit and wait about 4 minutes for the gun's solid-state heating element to warm up.

The gun will dispense glue for about 10 minutes before it needs re-heating and heats

automatically each time it's returned to the power base. I used the glue gun on small repair and assembly projects and was very satisfied with the results. The gun accepts standard $\frac{7}{16}$ -in.-dia. × 4-in.-long glue sticks. The sticks cost about \$5 for two dozen.

It costs \$20 at hardware



Hot-melt glue is excellent for assembling small workpieces. The glue bonds in just a few seconds. No clamping is required.

stores and home centers. Loctite, 4450 Cranwood Ct., Cleveland, OH 44128.

—Rosario Capotosto **PM**



Hot-melt glue proved to be surprisingly strong. The partially assembled frame shown supported 13 pounds without falling.



Lightweight, cordless glue gun comes with a plug-in power base. The gun heats up automatically each time it's returned to the base. Gun accepts standard-size glue sticks.

NEW/HOME

Log-Home Living



Today's log homes have come a long way to dispel the "cabin" image. Most of the log homes built now are primary residences with all the comforts and conveniences of conventional housing. One manufacturer, Wilderness Log Homes, offers kit homes with a difference: Insulog construction.

Insulog homes feature cedar or pine half logs that give the appearance of full logs. The logs are nailed to 2 x 6-in. wall studs sheathed with 1-in.-thick insulation board. The walls have a full



6 in. of fiberglass insulation. As a result, an Insulog home provides superior energy efficiency.

Another benefit of using half logs, as opposed to full logs, is that you have a choice of interior wall finishes. Finish the walls with



paneling or drywall and paint or wallpaper. If you prefer the look of full logs, simply install half logs to the interior walls.

Wilderness Log Homes offers more than 50 kits with over 500 floor plans. The homes can be constructed by experienced do-it-yourselfers or by a building contractor. Wilderness has architects to help you design a custom log home, too. For details, contact Wilderness Log Homes, Route 2, Plymouth, WI 53073. Or, call toll-free (800) BEST-LOG.

A Pearl Of A Paint

Until recently, interior wall paint has been available in three finishes: flat, eggshell and semigloss. Benjamin Moore just introduced a fourth: pearl. Regal Aqua-Pearl is a latex paint that has a luster softer than semigloss. It comes in nine shades of white and 28 colors. AquaPearl costs about \$20 per gallon. Contact Benjamin Moore, 51 Chestnut Ridge Rd., Montvale, NJ 07645.



Cold Remedy For Windows

Now you can insulate windows from the *outside* with 3M's Outdoor Window Insulator kit. The easy-to-install kit includes a sheet of clear plastic-insulating film and water-resistant, double-stick tape. First, apply the tape to the trim around

the outside of the window. Then, cut the film slightly oversized and press it onto the tape. When installed properly, the kit cuts air infiltration as much as 87 percent and increases R-value by 86 percent over a single-pane window, according to the manufacturer.

Both the film and tape are designed for easy removal at the end of the winter.

The kit comes in three sizes: 42 x 62 in. for a single window (\$4.50), 62 x 210 in. for five average windows (\$12.50), and 84 x 112 in. for use on patio doors (\$10.50). For details, contact Home Products Division, Bldg. 223-4S, 3M Center, St. Paul, MN 55144.



What A Drag

As anyone who cuts his own firewood knows, the real work begins after the tree is felled. Just getting the tree out of the woods can be a backbreaking chore.

With log tongs, however, you can drag a limbed tree out of the woods quickly and safely—with one hand. Simply push the tongs onto the log and lift up. The two steel hooks grab the log

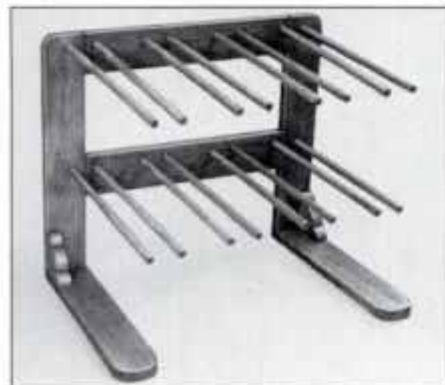


automatically. The log tongs are available at Stihl chain saw dealers in two sizes: 7 in. (\$10.70) and 10 in. (\$14). For details, contact Stihl, Inc., 536 Viking Dr., Virginia Beach, VA 23452. **PM**



HINTS FROM READERS

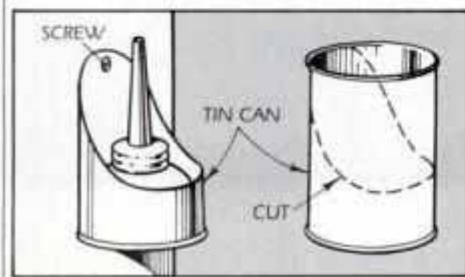
Storage For Stemware



This storage rack for stemware makes terrific use of limited space. It consists of two rows of $\frac{1}{2}$ -in. dowel on which the glasses are hung upside down. The height and depth of the unit should be tailored to your specific shelf space and glass size. Construct the support frame from 2-in.-wide stock of the same type found in the cabinet. Use dowel joints to fasten the frame pieces and brace the two bottom corners with small blocks. —*Ralph S. Wilkes*

Oil Can Holder

A tin can cut as shown makes an ideal receptacle for an oil can. When screwed to the shop wall, it will help prevent the oil can from leaving oil rings on the workbench, while keeping it close at hand. —*Victor LaMoy*



If you'd like to know more about the way we make whiskey here in Tennessee, just write.

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SMOOTH SIPPIN'
TENNESSEE WHISKEY

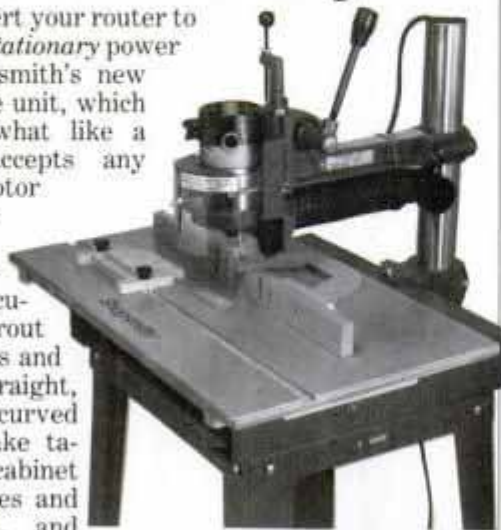
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Router Arm Expands Versatility

You can convert your router to a versatile *stationary* power tool with Shopsmith's new router arm. The unit, which operates somewhat like a drill press, accepts any round router motor that's 2½-in. to 4-in. dia. The router arm provides a safe, accurate way to rout decorative edges and surfaces on straight, round and curved workpieces, make tabletops and cabinet doors, bore holes and carve recesses, and make various wood joints such as a dado, rabbet, dovetail, half-lap, spline and mortise-and-tenon.

Use the router arm for pin-routing operations, too. This is an excellent way to make repetitive parts quickly and accurately. The basic router arm comes with a plywood worktable, clear safety



guard, chip collection chute, fence, guide pins and starter pin for about \$299. It's \$399 with a steel leg stand. The unit doesn't include a router, but a 1½-hp to 2½-hp router is recommended. An instructional video is available for \$49.95. For details, contact Shopsmith, 3931 Image Dr., Dayton, OH 45414.

Portable Guide Perfects Hand-Tapped Threads

Repair and maintenance jobs often require you to tap threads in metal to accept machine screws and bolts. General Hardware recently introduced a portable tapping guide that greatly improves the accuracy of hand tapping while reducing the instances of broken taps. The guide can tap and ream at right angles (90°) and adjust to angles up to 45°. It comes with two keyless chucks that accept taps ranging from No. 4 to ½ in. dia., and two extension rods. It also has a depth stop that prevents bottoming out and V-shaped blocks that hold round stock securely. The tapping guide (No. 170) costs about \$53. General Hardware, 80 White St., New York, NY 10013.



All-Purpose Locking Pliers

No tool box or workshop would be complete without a pair of locking pliers. Foley-Belsaw now has a new style of locking pliers with interchangeable jaws.

The adjustable locking pliers come with five sets of jaws including large, flat jaws for clamping, bending and crimping sheetmetal and other thin stock, straight jaws for general-purpose clamping jobs, and curved jaws for use as a pipe wrench

and to clamp round stock securely. The pliers also come with a pair of long-nose jaws for use on small, thin parts and a pair of superlong needle-nose jaws for hard-to-reach spots. Note that both have serrated areas for gripping odd-shaped workpieces. The pliers with the five pairs of jaws, called the All-Grip locking tool (model No. 5848004), costs \$22.45 post-paid from Foley-Belsaw, 6301 Equitable Rd., Box 593, Kansas City, MO 64141.



Cutting The Cord

Milwaukee has expanded its line of cordless power tools with a new *electronic* ⅜-in. driver/drill.

The tool (model No. 02121) is a variable-speed, reversing drill that has a 6-position adjustable clutch. The clutch allows you to select the proper torque when driving screws, thus, avoiding stripped screwheads. An electronic feedback system maintains a constant speed under various loads.

The drill/driver is powered by a 9.6-volt nickel-cadmium battery and weighs slightly less than 4 pounds. It has a variable no-load speed of 50 to 1000 rpm. The tool comes with a battery and a plug-in charging stand. Recharge time, from dead to full power, is one hour. Buy a second battery, for about \$62, to use while the weak one is recharging.

Other optional accessories include a 12-volt battery charger for use in a car or truck cigaret lighter, a holster that you can wear on a belt, and a polyethylene carrying case. The cordless drill/driver costs about \$209 at Milwaukee dealers. Contact Milwaukee Tools, 13135 W. Lisbon Rd., Brookfield, WI 53005.



PM



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THE PRIORITY IS DESIGN



Lincoln Continental is all new, and has it all together for '88.

Cars get better as styling makes way for design.

BY JIM DUNNE, Detroit Editor

Watch out, Cadillac. Ford is taking careful aim at the luxury-sedan buyer for 1988 with an all-new Lincoln Continental Sedan. Armed with a new body shape, new suspension technology and a new engine, Ford hopes to match the success of its mid-size Taurus. Only instead of competing against mid-price sedans, Ford is aiming right for the heart of the luxury-sedan class: Cadillac's deVille.

The new model is a full-size, 6-passenger sedan. Wheelbase is a moderate 109 in., but the front-drive layout leaves plenty of room for front- and rear-seat passengers. Under the hood is a new 140-

hp, 3.8-liter V6 hooked to a 4-speed automatic overdrive transmission. Independent rear suspension and an antilock braking system are standard equipment.

Unique to the Continental in the American luxury-sedan class are air springs on all four wheels, and new features of speed-variable power steering, and automatically adjustable ride control. The latter two put Lincoln a jump ahead of any other luxury sedan built in this country.

The automatic ride control is most impressive of all. Drivers will note an ultrasmooth ride on level roads, but without the bounce and heave that

usually accompanies that type of suspension. The old boulevard ride is still there, but with an important change: When the road gets rough, or the road surface becomes uneven, a firmer ride automatically sets in. We found it on a par with Mercedes sedans, or even a little firmer still.

Our first ride was in a prototype Continental last June. Ray Nicosia, Ford's engineer in charge of the automatic ride system, demonstrated it in a specially equipped car that was actually used for



Ford Tempo and Topaz look larger without actually growing in size. Mustang GT Convertible still has big 5.0-liter V8, rear-wheel drive. Balance shaft in Continental 3.8-liter, 90° V6 (above) hides in vee above camshaft, was necessary for a shake-free front-wheel-drive car with V8-quality ride.



FORD TEMPO

PHOTO BY BILL ASH



FORD MUSTANG

PHOTO BY RICH COX



FORD MOTOR CO. PHOTO

Jack Telnack, responsible for Ford's aerolook cars: highly successful Taurus/Sable, nontraditional new Continental.

Continental's Spare Is In The Trunk

The 1988 Continental breaks new ground in design for an American luxury sedan. Ford calls it the "first elevation of the aerodynamic look into the luxury car." It's a move you'd expect after the highly successful Taurus/Sable set new standards for aerodynamic shapes in U.S. sedans.

But even before Taurus/Sable was introduced in 1985, Ford's design studios in Dearborn had already pretty much decided on the shape and appearance of the 1988 Lincoln Continental. Under the direction of Jack Telnack, Ford vp of design, who is widely acclaimed as the father of the Taurus/Sable shape, the final design of Continental was set in steel. If Taurus/Sable was acceptable, they figured, the Continental would surely appeal to the luxury-car buyer. But there were questions then, and still. Would buyers look for the round tire in the trunk sheetmetal? Would the Rolls-like grille be a goner too?

"One thing I can tell you is that the tire in the trunk was never put into clay," Telnack recalls now. "Sure we talked about it, and wrote many memos. But by the time the final designs had to go to clay modeling, the tire was long gone."

Telnack and Ford took a chance there. It

remains to be seen whether a Continental buyer, said to be among the least willing to accept change, will miss that styling touch. But, for better or worse, the rear identity is gone. The car looks somewhat common when viewed from that angle, and Telnack will be watching buyer reaction closely to see if Ford has gone too far in abandoning this trademark.

"We couldn't put that Lincoln horse collar (grille) on the aero body," one Ford executive commented. "They just don't go together. The hoodline is too low and rounded to accept a rectangular box opening."

Telnack chose Continental's understated grille, one that blends in with the shape of the sheetmetal. Even so, Telnack points out that the vertical-bar theme of all the Lincoln car lines is carried over in the new grille.

Whatever criticisms Ford will hear about details of Continental styling, the overall appearance of the car will prevail as a good one in the minds of luxury-car shoppers. Criticism is nothing new for Telnack. The Taurus/Sable met strong negative as well as positive reactions when that line was new to the public. Now Taurus/Sable styling is considered the standard, not a precedent, in the midsize market.—J.D.



CHRYSLER NEW YORKER

New Yorker and Landau have Mitsubishi 3.0-liter V6, while last year's smaller New Yorker, now called Turbo, has 2.2 turbo motor.

development of the system.

It was a real eye-opener when the Continental hit a severe dip in the road at 35 mph. I could feel the body start to follow the suspension down into the dip, and prepared myself for a bottoming out, then a heave skyward as the car rose again to road level.

Just as soon as the front wheels dropped, the suspension setting changed from soft to firm. I could actually feel the change. The car seemed to catch itself in mid dive, then control the dip with all the suspension manners of a highly tuned sports car. Coming up on level pavement once again, there was no bouncing or recovery needed. It was as if the obstacle never occurred.

Unlike other adjustable suspensions, Lincoln's is not speed sensitive. You can cruise at 65 mph and get the limousine ride—but without the heave and sway of the old fashioned rides that use springs with fixed rates.

The new suspension maintains a flat attitude in hard curves when compared with the 1987 Continental. Controlling body lean is one of the keys to good handling. Keep the body level, and the suspension stays in its design attitude where springs and shocks and geometry work best.

Steering effort is light at low speeds, so that you can see-saw into a tight

parking spot without doing pull-ups on the steering wheel. At higher speeds, the effort goes up so the driver has more feel of how the tires are gripping the road surface.

All in all, the Ford engineers came close to their goals. The Continental ride captures the best features of both a luxury car and a sports sedan, and the handling approaches that of a much smaller size sedan.

In performance though, more may be better. The new 3.8 V6 engine will pull the Continental from 0-to-60 mph in about 12.5 seconds, not acceptable for a modern American luxury car.

Critics of body design may note that the shape of the Continental body is not as aero sleek as it could be. They see a boxy profile in the greenhouse, especially in the rear-window area. Ford designers say that even so, it has a "very acceptable .36 coefficient of drag." Apparently for now, the limit of aero shapes has been reached. Today's designers are choosing more appealing body forms over the aero banana shape.

Ford also upgraded the appearance of its compact Tempo and Topaz 4-door models with new skins to make the cars look bigger. Grilles, hoods, fenders, doors, quarter panels and taillights are more rounded while the overall dimensions remain the same as the 1987s. The

glass in the back-window area is more upright on both models, which gives a longer appearance to the trunk and balances the front and rear of the car when viewed from the side. Automatic seat belts that "motor" into position when the door is closed are now standard on Tempo and Topaz. Multipoint fuel injection ups power to 98 from 86.

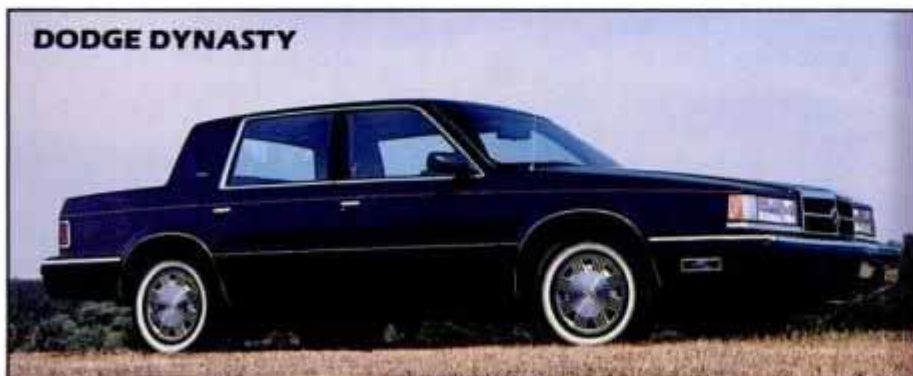
Taurus, Sable, Thunderbird and Cougar all get the new 90° 3.8-liter V6. This engine has multipoint fuel injection that helps deliver more power, and a balance shaft to offset some vibrations.

Chrysler/AMC

Chrysler Corp.'s buyout of American Motors will create a single, strong model lineup to compete for more than 90 percent of new-vehicle buyers in the U.S. With the addition of Maserati and Lamborghini badges to the pentastar logo, Chrysler is embarking on exotic new markets where it has never competed before. How Chrysler works this out, putting which cars into what kinds of dealerships, remains to be seen.

Newest models from Chrysler's design studios are the 6-passenger Chrysler New Yorker, New Yorker Landau and Dodge Dynasty 4-door sedans. These are top-of-the-line cars to compete against full-size GM and Ford models, from the Caprices and LTD Crowns, all the way up to the Continentals and deVilles.

Appearance of the Chryslers tell much of their story. They are designed for the conservative buyer who is comfortable with advanced styling, but still likes the look of elegance. To Chrysler planners that means an upright rear window, fairly long hoodline, and sharp angles in the shape of the body. Body details include flush-mounted glass for windshield and backlite and a movable panel in all four fenders that is spring loaded to swing out of the way when the bumper is pushed inward. In low-speed accidents, the bumper can slide inward a couple of inches, then rebound to its



DODGE DYNASTY

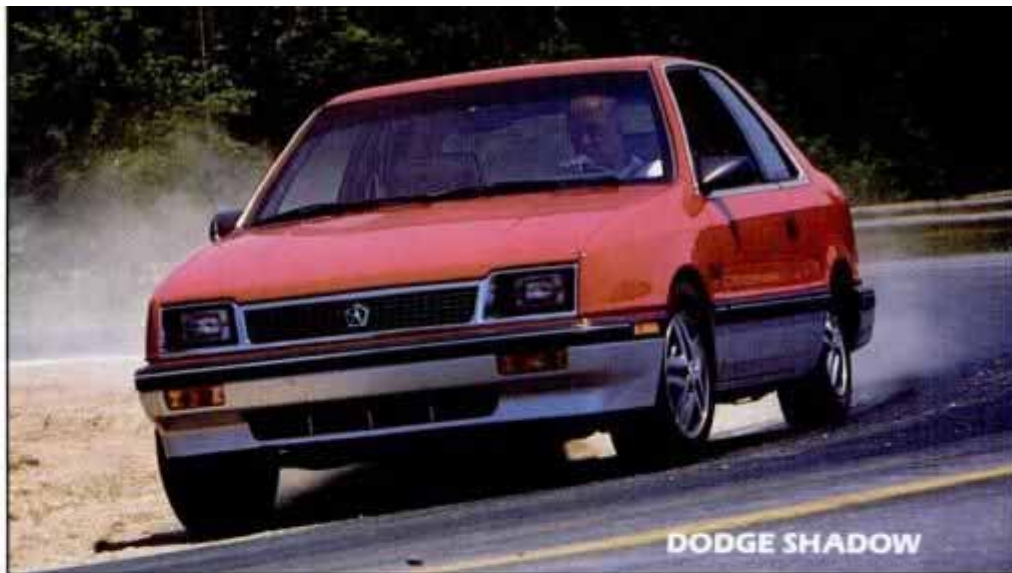
Dynasty moves into Bonneville/Delta 88 territory with four doors, fwd. It seats six.



design position without causing damage to the sheetmetal.

Chrysler will make a 3.0-liter V6 engine standard equipment on all New Yorkers except the New Yorker Turbo, while Dodge offers the 3.0 liter as an option over the Chrysler 2.5-liter Four. The V6 is imported from Mitsubishi, and is the same engine that was introduced on the Chrysler minivans earlier this year. The 181-cu.-in. 60° V6 develops a creditable 136 hp at 4800 rpm. Performance is not sluggish, though 0-to-60 mph is in the 12-plus second range.

Front drive is the answer to so many questions for the new Chryslers and Dodges that rear-wheel drive was never considered as a possibility. First, there is more room inside the car for passengers since that transmission hump and driveshaft housing are eliminated from the floor. "We also eliminate the vibrations from the long prop shaft," explains one Chrysler engineer. "Then you get rid of the heavier rear axle, and make a bigger trunk. Finally, there are many traction advantages." For a car driven in the U.S., those reasons make sense. Chrysler is building a car of basic



DODGE SHADOW



DODGE SHELBY LANCER

Dodge Shadow gets new look. Lancer is available with 2.2, 2.2 turbo or 2.5-liter engine. Lancer Shelby version has a 174-horsepower engine.

What Will Chrysler Do With All Those Chips?

Gobbling up three car companies—AMC, Maserati and Lamborghini—as Chrysler did in the past year, sounds easy enough. If you have the cash, just lay it on the counter and take over. But digesting that size of purchase may pose a bigger problem. Chrysler could end up with too many cars in the same showroom. Where will Alliance, Medallion, Eagle, Premier and the whole Jeep line, including Wrangler, Cherokee and pickups, fit in?

Here's the way the stories that are circulating around Chrysler and AMC headquarters in Detroit read now: Jeep is secure. Both the name Jeep, and the products in its present lineup—especially Wrangler, Cherokee and Comanche—are the real jewels of the AMC treasury. Chrysler recognizes that, so the Jeep line will remain pretty much intact. Jeep will continue as the 4x4 leader even if/when Chrysler takes over. One chink in Jeep's shield is the J-10 and J-20 pickup trucks. They are duplications of more modern Dodge pickups, and probably will be dropped from production.

Jeep's Grand Wagoneer, the top-of-the-line utility vehicle that has been in production for almost 25 years could live on. "There is a lot of profit in that vehicle," one AMC official admitted. "Some five or six thousand [dollars]. Sales have held steady, so it looks like a good money maker for the near future as well."



If you can't build a better Italian car, buy it!

Another money maker is the Eagle 4-wheel-drive sedan. It is almost as profitable as the Grand Wagoneer, according to AMC insiders, but lower sales figures—9000 per year—are not in its favor when Chrysler weighs the alternatives. One big alternative is a 4-wheel-drive Medallion that is due to be imported in late 1988. This could push the Eagle out of the picture as early as spring 1988.

"Alliance is a duplication," as one AMC insider confides. "We look for Chrysler to keep the Omni/Horizon as its entry level cars." That's clear enough. Alliance may not even get through the 1988 model start-up before it is dropped.

Lamborghini and Maserati sports cars pose another problem. Chrysler owns all of Lamborghini, so the Countach and Jalpa sports cars and the 4-wheel-drive LM-002 can be brought into the U.S. as Chrysler wishes. There will be changes in those models, especially in the Countach since, as Iacocca says, "It's getting to be an old design."

Chrysler is still trying to get its Chrysler/Maserati sports car in production. Only one Maserati, the 2-seat convertible, will be sold here.

AMC had a slick sports car, the rear-engine Renault Alpine, in its plans. But the latest word is that Chrysler turned thumbs down because the Chrysler/Maserati and the Lamborghinis will cover the sports car market.—J.D.

RENAULT PREMIER



design that gets the basic jobs done without fuss and without a high price. As for price, look for Chrysler to sell the new models at a level well below competitive cars from GM and Ford.

Joining the new Dodges and Chryslers in the 1988 lineup, is the AMC Premier. This 5-place, 4-door sedan is built at a new assembly plant in Bramalea, Ontario, Canada, just outside Toronto. Based on the Renault 25 chassis, the Premier features a body designed by Ital Design of Turin, Italy, especially for the American market. Its shape and overall appearance are those of a modern European sports sedan, which will serve it well as it competes against cars like Ford's Taurus/Sable now, and later when a 2-door version lines up against General Motors' GM-10s—Grand Prix, Cutlass Supreme and Regal. While the car has a strong aero appearance, aerodynamic features were downplayed when quality or style were affected. For example, glass-to-body surfaces are not completely flush, to avoid assembly problems that may result in poor quality, and body lines have a crisper appearance than they would if only wind tunnel data were followed.

Standard engine in a front-wheel-drive powertrain will be AMC's own 2.5-liter, 150-cu.-in., fuel-injected Four that develops 111 hp at 4750 rpm. AMC points out that this output is higher than many Ford or GM midsize cars.

Optional on Premier is a fuel-injected, 3-liter, 90° V6 that generates 150 hp at 5000 rpm. This engine is the latest version of the V6 developed jointly by Renault, Volvo and Peugeot and has been in production for at least 10 years (the De Lorean was powered by a version of this V6).

Its aluminum block has iron cylinder liners while the crankshaft has its piston journals offset 30° to reduce vibration and promote long life.

Other technical highlights include independent rear suspension and 4-wheel disc brakes. Transmissions are a 5-speed manual and a 4-speed overdrive automatic.

Premier's interior is roomier than any of its competitors in the midsize class, and could qualify as a large car under EPA classifications. Seats are, in the French manner, more comfortable and body holding than those of U.S. cars. Cushions are thicker, while the contours fit more snugly at the sides.

A heavy dose of electronics faces the driver in the Premier instrument panel. Devices like speedometer, turn signals, heater warmup delay, trip computer and temperature control are electronic.

Premier's turn signal is unique, but its operation takes some getting accustomed to. The signal lever does not remain in a down or up position when a turn is signaled.

Instead it switches on the turn signal, and immediately returns to its centered position. A gong sound indicates cancellation after a turn.

Other models in the Chrysler/AMC lineup remain pretty much unchanged for 1988, though some may be models dropped as Chrysler merges the lineup.

One car that seems certain to be kept in the company for an indefinite time is Chrysler's L-body. That is the Horizon/Omni nameplate. "We've had those cars

Premier, needed as part of AMC lineup, may be an orphan because of takeover.

in the casket a number of times, but public demand keeps them alive," one Chrysler official reassured writers at the 1988 preview in June. "It's one of the best basic transportation buys on the market." Chrysler will build the car at an AMC plant and offer a number of incentives to price shoppers. New this year is fuel injection.

Look for the Plymouth Sundance Rally Sport and Dodge Shadow ES specialty models to attract buyers who want the room of a sedan and sporty styling. Sundance Rally Sport has a new front fascia with fog lamps, 2-tone paint and a luggage rack as standard. Shadow ES has a similar front fascia with fog lamps, in addition to lower-body and front wheel well flares, deck-mounted spoiler and unique styling. Wheels on the ES are 15-in. aluminum alloys.

One of Chrysler's hottest performing models is the Dodge Lancer Shelby. For power it has a 174-hp intercooled and turbocharged engine. Ride height is lower than the standard Lancer, even though 15-in. tires are standard. Sway



JEEP WRANGLER

Wrangler Sahara, unlike some of the remaining Jeep lineup, definitely won't be orphaned.



BUICK REGAL

New GM-10 cars are mechanically related, but finally get separate sheetmetal. For example, note different rear-window/C-pillar treatments: Buick Regal's conservative, Pontiac Grand Prix is aggressively sporty, and Cutlass gets the aero look, all in keeping with divisions' new identities.

bars are solid steel rather than tubular. You get a stiff ride, but the car holds its own in fast company.

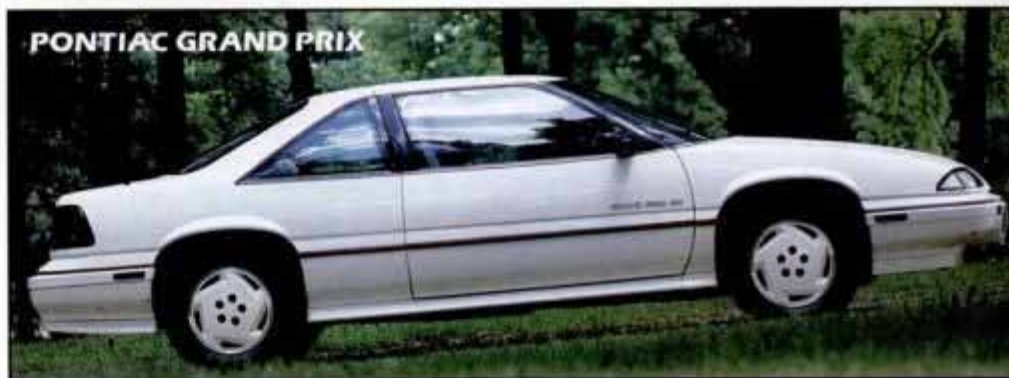
General Motors

Don't count out the champ. For 1988, GM has enough new models to convince most skeptics that it is ready to reclaim dominance in the U.S. market. And the corporation is zeroing in on what got it to the top of the heap—performance and styling. Here's what to look for:

- Three new personal coupes from Buick, Oldsmobile and Pontiac.
- Restyling of the Eldorado, and more power for Cadillac's aluminum V8.
- A significant new engine design in the Olds Quad-4.
- Major freshening for 2-door Cavalier and Sunbird.
- More power for the 3.8-liter V6.
- 4-wheel-drive on the Pontiac STE.

First thing you notice about the new Regal, Cutlass Supreme and Grand Prix is how different they look—both from last year's models and from each other. The big differences in appearance did not happen by chance. GM knows that it can't continue making cars that look alike. Dealers, buyers and the opposition's television commercials drive that point home. The message came back so strong, that GM told its divisions what they should stand for, and that is what you see in the contrast in shapes.

Buick will concentrate on building



PONTIAC GRAND PRIX



OLDSMOBILE CUTLASS

cars for the more conservative buyer who values elegance above sportiness. You see that in the traditional look of the 1988 Regal, with the more formal roofline, and a balance between the lengths of the hood and deck. However, chassis details are not conservative. Regal, like the other GM-10 cars—Grand Prix and Cutlass Supreme—uses a fuel-injected 3.8-liter V6 engine, rack-and-pinion steering, rides on 4-wheel independent suspension, and has 4-wheel disc brakes. A disappointment is the performance of the V6 engine. It develops a weak 125 hp, well below what you

would expect for a personal coupe. The sole transmission is a 4-speed automatic, but GM is planning to add a manual transmission to the options.

In a switch from earlier practice, the Regal will not share any of its exterior sheetmetal with the other two GM-10 cars, a result of the decision to make each car as distinctive as possible even though they may share the same chassis and powertrain.

For all its traditional body lines, the Regal is no slouch when aerodynamic numbers are compared. The new body is said to be 33 percent more aerodynamic



CHEVROLET CORVETTE



CHEVROLET CAVALIER



PONTIAC SUNBIRD

Corvette gets 17-in. wheels to make room for bigger brakes. Cavalier gets sheetmetal changes, and revised C-pillar on its hard-roof models. Sunbird gets new rear sheetmetal.

than the older Regal, thanks mainly to the flush-mounted glass and the "doors-into-roof" construction. Taken together, the 2.8-liter engine, 4-speed automatic transmission and improved aero shape result in 29 mpg on the highway, 20 in city driving. Last year, the best fuel economy the Regal offered was 19 city/24 highway.

Under a new plan at GM, Buick will have the Regal in showrooms this fall, while the Grand Prix will be available in mid-winter. Cutlass Supreme will be

out next spring. The staggered introduction dates are caused by each car having its own assembly plant. Buick's plant will be ready for production first, so it will have the first model on sale.

Grand Prix is the sporty styling leader of the GM-10s. The hoodline drops more steeply, while the rear window has a flatter, more streamlined profile. That, plus other less obvious touches, keep the Pontiac version distinctively different from its cousins. Three versions will be built, the base Grand Prix,

the LE and the SE. The three levels differ in instrumentation, exterior appearance, wheel and tire options, and paint schemes. SE is the Grand Prix with the sportiest appearance. Special styling for this model includes aero panels all around the bottom of the front and sides, dual exhaust pipes and 1-color paint for the car and its 15-in. cast-aluminum wheels.

The Grand Prix 3.1-liter turbo, a one-of-a-kind concept car, illustrates what is possible in a GP of the future. The engine is modified by McLaren Engines, Inc. It's a 3.1-liter GM V6, which is both turbocharged and intercooled. Output is muscular 205 hp. Transmission is a 5-speed, Getrag-designed manual that is built by GM. Add-on body parts lower the front air dam and skirt the entire lower perimeter of the car. Pontiac uses its top-rated suspension gear with stiffer springs, altered shock valving and larger stabilizer bars. For traction, there are Goodyear 16-in. tires with a 50 aspect ratio. The significance of the McLaren GP is that it tests the limits of horsepower that can be controlled—then ultimately mass produced—in a front-wheel-drive chassis.

Oldsmobile's role under GM's master plan is to concentrate on selling cars that are slightly ahead of competition, both in appearance and technology. In the styling of the Cutlass Supreme, you can see the shape of that plan. Most distinctive is the modern interpretation of the Olds split grille. Smaller headlights give this part of the car a lower, more horizontal appearance. At the rear, the shape of the backlite and C-post are distinctive. The wraparound glass of the backlite is similar the Celica, and imparts the same ahead-of-the-pack appearance that Olds is looking for.

Like the Grand Prix, Cutlass Supreme will be built in three versions, the base coupe and two upscale models with SL and International-Series badges.

Cadillac does not have a complete new car to match the GM-10s, but the luxury division of GM has been busy tidying up two projects that need attention. Engine power is one. The workhorse engine for Cadillac is the aluminum V8 that is used in deVilles, Eldorados and Sevilles. Its 1988 version is 4.5 liters in displacement, bigger by 10 percent than the 4.1 liter in the 1987 models, and more powerful by 20 percent.

Horsepower is now 155 at 4000 rpm. Cadillac claims that the new engine will accelerate the Eldorado from a standing start to 60 mph in just over 10 seconds. That is the kind of performance Cadillac drivers have missed for more than a decade, and the kind that gave Cadillac its long-held preeminent position among luxury cars. Just as important is the fact that Cadillac's aluminum V8 is now the highest rated in GM's engine lineup for



CADILLAC ELDORADO

Cadillac Eldorado sports revised look in response to a survey of shopper's comments.

quality, reliability and durability, a complete reversal from where the engine was two years ago. Because of the added power, Cadillac reset its powertrain so that there is less downshifting, and less need for high revving when using part-throttle acceleration. That means, in passing situations the car does not downshift as readily, yet the power to accelerate is equal to that of a lower gear in the 1987 engine. The overall effect is a quieter engine, and less

transmission shifting. The Eldorado is a car that's longer, wider and overall more elegant and substantial. Yet the only major change in E-body dimension is that the rear fenders are 2 in. longer. More defined horizontal lines in the fenders and hood, and a bolder grille do the rest, making the car look bigger.

Oldsmobile engineers, under chief Ted Luckes, developed the Quad-4 engine to be one of GM's workhorse engines of the future.

The 2.3-liter 4-cylinder has some of the latest passenger car technology in its design, including double overhead camshafts with 16 valves for high-speed operation and freer breathing. Hydraulic lifters cut down on valve noise, while the shape of the combustion chamber permits an unusually high, for regular fuel, 9.5:1 compression ratio. The engine has no sparkplug wires, and requires no timing adjustments. Luckes claims that the Quad-4 develops 150 hp, and that when matched up with a 5-speed manual transmission, accelerates the Cutlass Calais from 0-to-60 mph in an impressive 9 seconds. With the automatic transmission, which is a tick slower in acceleration, fuel economy is rated at 24 city and 33 highway by the EPA. The Quad-4 will be optional on GM's subcompact Calais, Skylark, Grand Am cars in 1988, but will be in more models as production accelerates.

Chevrolet's Cavalier and Pontiac's Sunbird coupes and convertibles have new skins that give the cars a more up-to-date appearance for 1988.

Aero shapes for coupes and convertibles are more modern in appearance with all new sheetmetal, flush headlights and integrated lower body panels. The hatchback model has been dropped. Station wagon and 4-door sedans have new front ends that match those of the sportier 2-door models.

Power increases seem to be the order of the day for GM. The 3.8-liter V6 that is used in big Pontiacs, Oldsmobiles and Buicks was bumped up 10 percent in horsepower to 165 for 1988. Buick, the lead division on this engine, claims that the changes that brought about the increase are so sweeping that the engine has a new designation—3800 V6.

The 3800 is the same size and shape—3.8 liters, 90° V—as the V6 used in last year's cars. But changes are no less than sweeping. They include:

- Twenty-three percent less reciprocating mass and a gear driven balance shaft for more smoothness.
- Repositioned fuel injectors.
- Increased power that allows transmission changes for smoother shifts.
- Left-side pistons set farther forward than matching right-side pistons.

Crankshaft journals are still offset 30° in the V6 to reduce vibration, but the addition of the balance shaft and the repositioning of the pistons leads to even more smoothness. Buick claims the engine now has all the smoothness of a V8, but continues the fuel economy of a Six.

Pontiac's 6000 STE is available with a 4-wheel-drive system. An independent rear suspension uses a composite fiberglass rear spring similar to Corvette, and modified truck front axles. The full-time system has a stroked version of the 2.8 V6 that displaces 3.1 liters for 180 lb.-ft. of torque, up from 160. **PM**

Eldorado: Still Going For The Gold

The quick fix. You have to look closely to see the results—a slight refinement in the shape of the fenders, grille, hood and taillights for a longer, more massive look.

What you don't see is the 51-week, record time that Cadillac took to develop Eldorado's new appearance. Within weeks of the current Eldorado hitting dealer showrooms, negative buyer reaction told Cadillac that the car needed a change, and in a hurry. It looked too small, not elegant enough, and its appearance was too close to that of other GM models that sold for thousands of dollars less than the Eldorado's \$25,000 tag. Buyers wanted more. All the handling advantages of the new Eldorados were great, but the cars did not have the impressive appearance of the past.

"What we did was make subtle changes, just enough to alter the car slightly," says Dennis Little, Eldorado's design chief. "But the car is basically fine. We didn't want to change its character radically."

Those subtle changes are in the shape of the fenders, hood, grille and taillights. The front fenders have a small ridge on top, lifting the line just enough to define the fender when viewed from the side.

"The hood has a slight 'power blister' in the middle, where the driver sees it all the time," Little points out. "We found that a bulge of that sort is important to drivers, a big improvement over the smooth hood of last year. You may not notice it when driving, but that little kickup means power."

In the same way the grille has a beefed up appearance. "We added a plan view (more shape) with a peak at the top and put in some more bright metal.

What we were trying to do is to get the cues of the old Eldorado in the new car

—make it look longer." One major change that gives the car a longer look is the line at the top of the rear fender. It carries forward into the body instead of curving upward at the rear window. That line leads the eye to think the trunk is longer, ends the breakup of lines between passenger compartment and rear fenders. Finally, says Little "we added 2 in. to the rear fender extensions, then put in wraparound taillights that bring back some of the jewelry of the old car."

With all its performance boosts and styling refinements, Cadillac still has a long way to go before it reaches the "Standard of the World" level it held for so long. What it needs is a new kind of car, one that is truly "world class" both in execution and price. From what Cadillac insiders are saying, that car is on the way.—J.D.



Dennis Little made all the possible changes he could to restyle Cadillac's Eldorado.



SPUTNIK

The Little Sphere That Changed The World

Early in the evening of October 4, 1957, an American clinked the side of a glass, silencing the reception room at the Soviet Embassy in Washington, D.C. Geophysicist Lloyd Berkner faced an elite crowd of scientists who had been discussing plans for launching rockets and satellites to study the Earth.

"I wish to make an announcement," Berkner said. "I am informed by *The New York Times* that a satellite is in orbit at an elevation of 900 kilometers."

No one had ever heard such news before. But the real shock came in the rest of Berkner's short speech. "I wish to congratulate our Soviet colleagues on their achievement."

As a satellite, *Sputnik I* was little more than a bulky thermometer attached to a simple radio transmitter. It carried no sophisticated instruments. Much of the interior space inside a sealed aluminum casing 22.8 in. in diameter was taken up with chemical batteries, bathed in gaseous nitrogen, powering the

Thirty years ago this month, a tiny silver orb launched from the Soviet Union signaled man's introduction to the Cosmos. Today, satellites affect nearly every aspect of modern living—from improved communications to managing Earth's resources.

BY GURNEY WILLIAMS III
PM Illustrations by Dean Ellis

A battery, a thermometer, a transmitter—*Sputnik* had no real scientific value. But it did move man's thinking beyond Earthly confines.

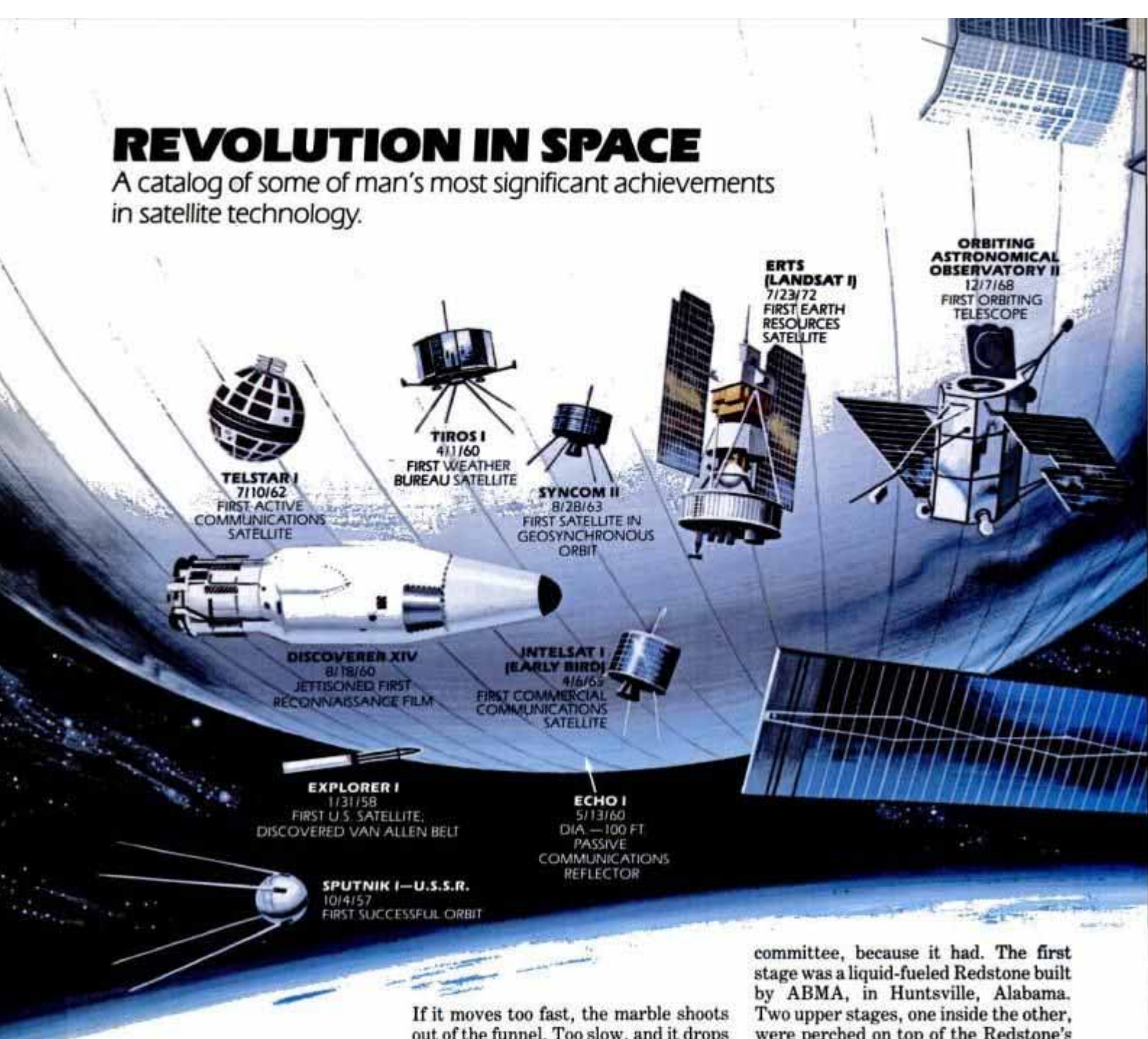
2-frequency radio. The radio quit in little more than three weeks. The satellite stayed up for just 92 days.

But the successful orbiting of the Soviet sphere changed the course of American history in ways that could be appreciated only in later years. The Soviet RD-107 rocket that launched *Sputnik* illuminated our ignorance, and launched us into a fearful, heady flight to catch up. It spawned dozens of UFO reports, and melodramatic fights over who owned the new territory of space. The Soviet feat boosted the political fortunes of a 49-year-old Texas senator named Lyndon Johnson.

Long before "Star Wars," it fueled a young and secret movement of military experts urging President Dwight D. Eisenhower to develop a defensive shield against a Soviet missile attack. And it set off a little-known search for an American satellite strong enough to survive a wild ride atop a prototype, intermediate-range ballistic missile.

REVOLUTION IN SPACE

A catalog of some of man's most significant achievements in satellite technology.



TELSTAR I
7/10/62
FIRST ACTIVE COMMUNICATIONS SATELLITE

TIROS I
4/1/60
FIRST WEATHER BUREAU SATELLITE

SYNCOM II
8/28/63
FIRST SATELLITE IN GEOSYNCHRONOUS ORBIT

ERTS (LANDSAT I)
7/23/72
FIRST EARTH RESOURCES SATELLITE

ORBITING ASTRONOMICAL OBSERVATORY II
12/7/68
FIRST ORBITING TELESCOPE

DISCOVERER XIV
8/18/60
JEFFERSONED FIRST RECONNAISSANCE FILM

INTELSAT I (EARLY BIRD)
4/6/65
FIRST COMMERCIAL COMMUNICATIONS SATELLITE

EXPLORER I
1/31/58
FIRST U.S. SATELLITE; DISCOVERED VAN ALLEN BELT

ECHO I
5/13/60
DIA — 100 FT PASSIVE COMMUNICATIONS REFLECTOR

SPUTNIK I—U.S.S.R.
10/4/57
FIRST SUCCESSFUL ORBIT

Soviet Premier Nikita Khrushchev had given warning. "We will bury you." But capitalism seemed to be working well in the months and weeks before *Sputnik* took off. Engineers just out of college could aspire to a starting salary of \$10,000 a year. It was enough to live well. A half-chicken dinner at Howard Johnson's in New York cost \$1.95. A Chevy 2-door V8 sport coupe went for \$2399. The sticker price on Ford's Custom 2-door V8 sedan was \$1772. The cover price of *POPULAR MECHANICS* was 35 cents.

American scientists had good reason to be confident. More than a year before *Sputnik*, U.S. rocket designers were closer than most people knew to overcoming the technical problems of launching a satellite. As it was explained to high school students in the mid-1950s, the problem was like trying to keep a marble circling inside a funnel.

If it moves too fast, the marble shoots out of the funnel. Too slow, and it drops down the funnel's hole. Step One in satellite science is accelerating the satellite to the precise speed where centrifugal force balances gravity. *Sputnik's* elliptical path through space required an injection-into-orbit speed of 18,000 mph, or 5 miles a second.

The algebra of such an achievement was second nature to the former German rocket designer Wernher von Braun. Recent interviews with his contemporaries indicate that in the early 1950s, he worked on detailed plans for launching an American satellite, although an informal security-classification system had prevented him from describing the plans publicly. But von Braun and many members of the team of the Army Ballistic Missile Agency (ABMA) knew that they could have lofted a satellite on September 20, 1956.

That was the date of a highly secret test flight of a 3-stage rocket that looked as though it had been put together by

committee, because it had. The first stage was a liquid-fueled Redstone built by ABMA, in Huntsville, Alabama. Two upper stages, one inside the other, were perched on top of the Redstone's nose as if a juggler had been able to balance an oil drum on the point of a huge gumdrop. These stages, the "oil drum," had been built by the Jet Propulsion Laboratory in Pasadena, California. The first upper stage was a ring of 11 small, solid-fuel rockets, scale models built for testing another Army missile called the Sergeant. Nested inside this cluster was the second upper stage, comprising three more mini-missiles. A small, 84-pound dummy nose cone was perched on top of the two rocket bundles. Adding to the impression that the rocket was a juggling act, the upper stages were kept spinning, at 750 revolutions per minute.

"The upper stages had no guidance capability of their own," says Walter J. Downhower, who now does strategic planning and analysis for JPL. "So we spun them up just as a rifle bullet is spun as it goes down the barrel of a rifle."

Strange as this craft looked, it rose



ATS-VI
5/30/74
BEAMED TV SIGNALS
TO SMALL
GROUND RECEIVERS

COSPAS—U.S.S.R.
6/30/82
FIRST SEARCH AND
RESCUE SATELLITE

SBS I
11/11/82
FIRST SHUTTLE—
DEPLOYED SATELLITE

SPOT—FRANCE
2/1/86
FIRST COMMERCIAL
RECONNAISSANCE
SATELLITE

NAVSTAR
LATEST DEVELOPMENT
IN PRECISION
NAVIGATION
(DEPLOYMENT
PENDING)

**DSCS III
(PRECURSOR TO MILSTAR)**
HARDENED SATELLITE FOR
MILITARY COMMUNICATIONS
(DEPLOYMENT PENDING)

perfectly off the pad at Cape Canaveral that day in September, more than a year before *Sputnik*. The Redstone burned through the lower atmosphere, then leveled off and broke away. The upper stages fired in precise succession, their spinning evening out the irregularities in the burn patterns of the solid rockets. The acceleration continued to a velocity just short of the speed needed to balance gravity and remain in orbit. The dummy nose cone coasted on, over a range of 3400 miles, reaching a record height of 682 miles.

"Had we replaced the 84-pound payload of the missile by a fourth stage, this same missile would have been able to orbit," von Braun reported later, and current JPL rocket experts agree. But President Eisenhower had ordered a strict separation between satellite and ballistic missile programs, partly to prevent leaks of military secrets when an American satellite went into orbit and drew the attention of the world.

Project Vanguard, the Naval Research Laboratory satellite effort, was still months away from its first launch attempt when the Soviets fired the first

shot and let this country know how little we knew about space. Amid widespread ignorance about rockets, satellites and their capabilities, rumors sprouted like tailfins. Sky watchers in Texas, New Mexico and other states said they had seen an egg-shaped object several hundred feet long. A Coast Guard cutter reported a fast-moving, bright object over the Gulf of Mexico. Scientists in several countries speculated that the Russians planned to bomb the moon.

At first, President Eisenhower and his close advisers made head-in-the-sand responses to the Soviet news and subsequent American jitters. The day after the launch, Ike played golf while relaxing at his Gettysburg, Pennsylvania, retreat. Defense Secretary Charles Wilson tried to be reassuring. "Nobody is going to drop anything down on you from a satellite."

But Americans worried.

And Democrats sniffed out a rare opportunity, once-confidential material shows. A couple of weeks after the

launch, Lyndon Johnson's political adviser George Reedy wrote the senator and future president: "The issue is one which, if properly handled, would blast the Republicans out of the water, unify the Democratic party, and elect you president."

Even fellow Republicans pushed Eisenhower, who was genuinely surprised at all the surprise, to take decisive action. For example, Republican Senator Jacob K. Javits wrote the president a week after *Sputnik's* launch that the U.S. should establish a crash program to develop a defense against Russian ICBMs. A month after the launch, Ike received similar, top-secret advice from a blue-ribbon commission. The group headed by H. Rowan Gaither Jr., chairman of the board of the Ford Foundation, painted an alarming picture of the Soviet threat. And the report, presag-

(Please turn to page 91)

RIDE



THE WIND

Dacron flies as we make a full-rigged assault on five of America's hottest small sailboats.

BY CHRIS CASWELL; PM photos by Skip Gandy



Flying on one hull, the Hobie 17 slashes the water with sailors hiked way out on the cat's new wing-like racks.

Sailing has a bold new image, today. Instead of yachting caps and blue blazers, it's hard-driving America's Cup athletes, and high-flying catamaran sailors who hike out over speeding airborne hulls like a balancing act on the highwire. Because of this newfound vigor, sailing is experiencing a resurgence in popularity and an infusion of new boat designs. PM decided to take a close look at five of the hot, new, small sailboats and test them, appropriately, in the city where the America's Cup now resides—San Diego, California.

For our test, we chose boats that represent distinctly different approaches to sailing. They are the 12-ft., 11-in. Zuma, the Holder 14, the Hobie 17 catamaran, the Super Ray 17 and the 18-ft. Prindle 18-2 catamaran. Each has its own strengths and weaknesses, as you'll see.

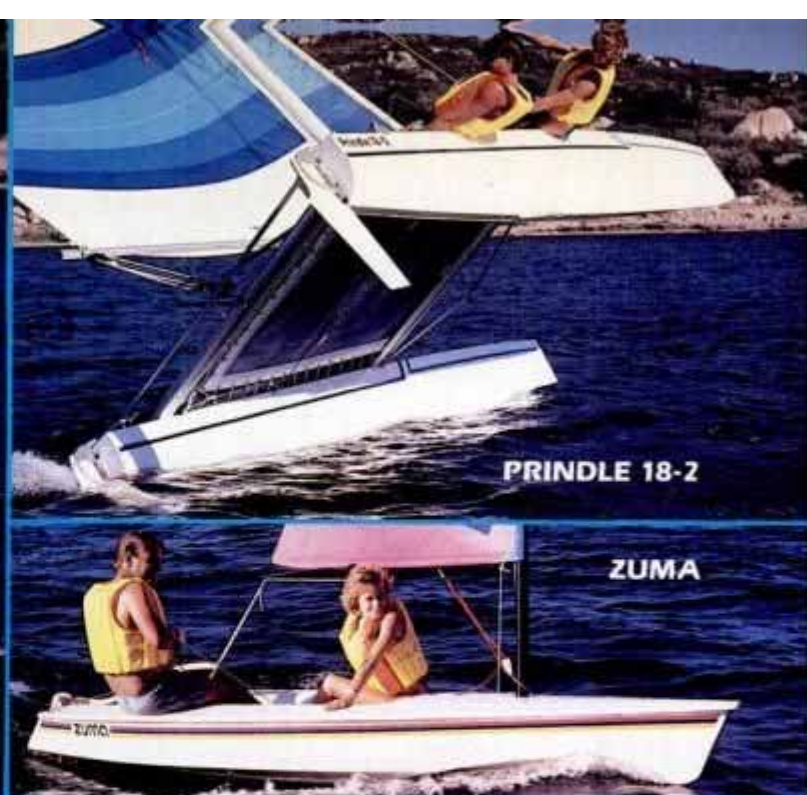
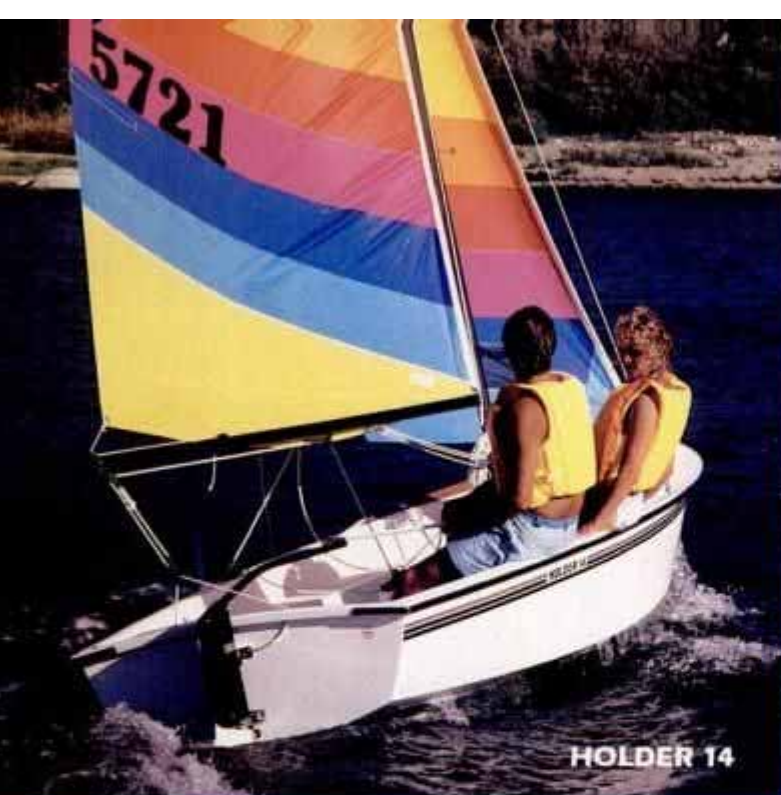
Zuma

Zuma is the newest offering from Alcott Sailboats. It arrived at our testing site perched jauntily atop one of the smallest import cars on the road and was ready for launching within minutes.

In the water, the Zuma's hard-chined hull and substantial beam give it excellent stability. And for a small boat, its cockpit is surprisingly roomy. Other clever design elements are a reversed transom, like those on America's Cup yachts, and a kick-up rudder assembly that attaches to a unique, easy-to-use spring-loaded pintle.

Under sail, the Zuma was just what you'd expect from a boat aimed at novice sailors, sensitive but forgiving, and fast enough for some family fun.

As the least expensive boat in our test (\$995), idiosyncrasies we discovered were probably



caused by price constraints. The cockpit is supposedly self-bailing, but water continually seeped in through a transom flap, and the mainsheet blocks jammed.

Most surprising was the lack of non-slip surface on the foredeck, which became as slippery as ice when wet. Aside from this omission, the finish on the easy-to-sail Zuma was superb.

Holder 14

Created by racing designer Ron Holder, the hard-chined Holder 14 is both forgiving and fast enough to embarrass many racing dinghies. It also has a 6-ft. beam and a huge cockpit with enough room to handle a family of six.

Sloop-rigged, the Holder has an optional roller-furling jib that works like a

window blind, and the top 25 percent of the mast features the nonconductive Hobie Comp Tip, which protects against the dangers of overhead power lines.

As immense as the Holder's cockpit is, it has a teak-covered well for the spring-action centerboard that's an unexpected obstacle when crossing under the boom. Despite this, the sprightly, ultrastable Holder still had the most comfortable cockpit in our fleet, with wide seats and backrests.

Super Ray 17

Dockside next to the other boats, the Super Ray looked like a red-hot Lamborghini in a parking lot full of VWs.

Designed by racing sailor Glenn Henderson, this scorcher's most striking

features are its radically winged side decks, which flare out to a beam of nearly 8 ft. from a waterline width of just 4 ft. The result is that the crew has plenty of space for sitting or hiking out.

Every element on this innovative boat features superb performance design: sloop-rig with tapered aluminum mast, roller-furling jib and healthy 191-sq.-ft. spinnaker; cutaway self-bailing transom; and a clever system of color-coded lines and cleats for pinpoint control of the sails. Get the Super Ray trimmed and in a groove, and it's an exhilarating boat to sail.

The only complaint we had was with a slightly wobbly tiller, which could be cured with a few well-placed shims.

Not a person walked by the Super

TEST PARAMETERS

Each boat sailed the waters of Mission Bay, in San Diego, California, and Lake Morena, a mountain reservoir about an hour from the city. The boats were subjected to a wide variety of wind and water conditions, and trailering. Sailing was done solo and with a crew over a course that required tacking, jibing, close reaches and downwind runs. Direct comparisons were not made because of the varying hull shapes and sail areas.



SAILBOAT MODEL	SUPER RAY 17	HOBIE 17
LOA/Beam/Draft/Weight	17'7"10"4"/320 lb.	17'8"1'6"/300 lb.
Rig/Sail Area/Mast Height	Sloop/162 sq. ft. + 191 sq. ft. spin./23'6"	Cat/168 sq. ft./27'7"
Cockpit Size	12' long with 3' rolled side tanks and wings	5'7" x 6'8" tramp, plus 8' x 15" racks
Stowage Area	21" x 15" deck hatch for cooler and more	None
Seating Space	4 adults; race with 2; roomy and weight sensitive	4 adults; race single-handedly; spacious but low boom
Under Sail	Racey, responsive, top performer in single hull	Tacks easily; sensitive to crew weight; solid performer
Rigging Characteristics	Swift and simple; need 2 people to step mast	Awkward halyard lock; need 2 people to raise mast
Price As Tested	\$6900	\$3995
Address	14231 60th St. N., Clearwater, FL 33520	Box 1008, Oceanside, CA 92054



SUPER RAY 17

Ray without stopping to admire its radical wings and splashy appearance.

Hobie 17

The Hobie 17 is a cat of a different stripe compared to catamarans of the early 1960s. This new, second-generation version has razor-thin hulls and a streamlined deck arrangement. The result is a high-performance boat that's intended to be raced by a single person, though it's large enough to carry four.

Like the Super Ray, the Hobie has wings or racks—a pair of curved aluminum frames with a vinyl seating area that supports 350 pounds. Also new are centerboards in each hull.

Despite its cat rigging—a single mainsail without jib—the 17 snaps

around like a monohull, a vast improvement over earlier cats, which tended to die during a tack. One drawback is that the low-swinging boom requires the crew to flatten on the deck.

Our only other problem was with the locking arrangement for the mainsail, which was difficult to raise and then refused to lock or release easily. However, a little wax on the sail slot should cure the problem.

Prindle 18-2

Largest and fastest of our fleet was the Prindle 18-2, another second-generation catamaran. Unlike the Hobie, the Prindle has a sloop-rig and double trapezes for racing with skipper and crew. A clever hinge holds the 29-ft. mast in

the proper position for stepping and makes it an easy boat to rig. Its halyard lock system allowed the mainsail to click easily in and out of place.

Under sail, the Prindle was balanced, responsive and easy to tack. Its knife-like bows sliced through Mission Bay waters during close reaches and the wake stretched out behind like twin white jet trails. Then, when flying a hull and powered by a sudden gust, it took off like a rocket. For sheer ecstasy of speed, you can't beat a well-designed catamaran.

So that's our lineup of hot, small sailboats. Pick the speed you want to go, the price you want to pay, and take your choice. You can't go wrong riding the wind with this fleet. **FM**



PRINDLE 18-2

18'8"6"2"1"/365 lb.

Sloop/233 sq. ft./28'9"

6' x 7'1" trampoline

6" access ports in hulls plus trampoline pockets

4 adults; race with 2; spacious

Fast and powerful; tacks easily; superb racer

Excellent hinged mast; need 2 to raise mast

\$4000

848 Airport Rd., Fall River, MA 02720

ZUMA

12'11"5"26"/127 lb.

Cat/65 sq. ft./18'

4'9" long with 15" side tanks

6" access hatch into foredeck

2 adults or 3 children; space enough to move

Stable, forgiving, wet, superb trainer

Simplest in the fleet

\$1195

South Leonard St., Waterbury, CT 06708

HOLDER 14

13'8"6"2"3"2"/365 lb.

Sloop/107 sq. ft./18'7"

8' long with 12" molded seats

2' x 9" x 34" molded bin

6 adults; race with 2; copious

Surprisingly fast daysailor with superb stability

Simple rigging; hinged mast can be raised alone

\$2590

Box 1008, Oceanside CA 92054



HIGH ROLLER

A national aerobatic champion describes what it takes to stay on top in one of the world's most demanding sports.

BY LEO LOUDENSLAGER

It's a typical air show, one of the 20 air shows where I perform each year, and once again only one thing—flying well—takes on any real importance. I get the canopy latched down and I'm ready to go. The chute might be jamming me in the back, the harness might be pulling at my shoulders, but the only things I feel are my left hand on the throttle, my right hand on the stick, and my two feet on the rudder pedals. I'm cramped inside the cockpit of my Laser 200, but I'm so intent on what I have to do that I don't notice anything else.

My routine usually starts when I talk to the crowd over the radio while I'm positioning the Laser at the end of the runway. Then I power up, put the smoke on from the exhaust manifold, and as the plane begins to roll, I perform a general check to see that everything is in the ballpark.

When I get positioned properly and the speed is right—boom! I hit it. I pitch up and get the show on the road. From there on, I rarely look back. If I place the airplane correctly at the beginning of the routine, and the numbers are what they're supposed to be, I don't even have to look at the ground.

Knife edge—bang!—snap roll off that—wham!—come back with a half-loop roll, push outside, a five-eighths loop, right roll, outside snap roll, down inside loop and—zap!—a snap on top of it. Multiple verticle rolls, spin off the top, come back down, 4-pointed horizontal roll, then inside to a five-eighths loop. After that, it's an outside one-and-a-half snap roll to upright, to a vertical square loop, inverted roll-and-a-half—woosh!—to a 4-point hammerhead. Then hang on tight for a down, full inside snap, an octagon loop, two points of a 4-point roll, to a horizontal cap off. A quick speed check and then push down to a two-and-a-half inside snap with an invert-



Leo Loudenslager represents the best in a pursuit that requires determination, skill and courage.

ed recovery. Pushing out, I finish upside down 20 ft. off the ground. Throughout, hands, eyes, feet are in a constant dance inside the tiny cockpit, mind and muscle in tune with my machine. I like to think of it as my violin, the instrument I use to express myself.

I'm exhausted when I get back on the ground. Sweat runs into my eyes, and on cold days the canopy fogs over with condensation. But the fatigue and bruises are worth it. As long as I've been an aerobatic pilot, I've never lost the thrill.

But there's more to this kind of flying. Sure, an airplane is an airplane. But the difference in flying aerobatic is that it's an expansion of all the basics. It's not a completely different world. It's just going farther out. Where flying a Cessna 150 is a certain number to the third power, flying the Laser through an aerobatic routine is the same number, but to the fourth power or the fifth power. The number is the same, the power that you raise it to is different.

And flying aerobatic requires a different type of psychological equipment. You kiss the ground with the wrong attitude and that's the last time. You don't get any second chances. Only when I agreed with myself that flying aerobatic planes was worth dying for, could I control the fear and fly at my best. Heavy stuff for anybody to come to grips with, and not necessarily on the list of choices I thought I'd ever have to make.

I started out as a fat teenager from Columbus, Ohio, with a big dream. I joined the Air Force and worked as a B52 mechanic, meanwhile taking flying lessons on my own and building experience. I attended the Reno Air Races in 1964 and marveled as Bob Hoover did his aerobatic routine. Later, in 1967, at an air show at Burke Lakefront Airport in Cleveland, I saw Harold Krier and Charlie Hillard

to learn how to fly like that!

It took me about three years to build my original airplane. It was a Stephens Akro and it has evolved into my present Laser 200. Today there's very little left of the original.

In one year—1975—we sawed it in half, threw away the front, and began redesigning the plane from the tail forward. Between 1971 and 1976, I tried three different prop spinners, five props, three cowlings, three instrument panels, two new wings, two forward fuselages, two canopies, two tails, three engines. I've modified and remodified it over the years to the point where it's one of the most capable aerobatic airplanes flying today. It has been copied widely.

There never was anything really exotic about the airplane. It's made primarily of fabric-covered 4130 chromemoly tubing for the majority of the fuselage and wood for the wings.

Wood in this day and age of composites? Sure! Because it gets the job done in a lot of places as well or even better than anything else available. Wood is relatively light, and it's really great for taking the kind of G loads an aerobatic airplane develops.

The engine in the Laser is straightforward. It's a Lycoming IO-360-A1A. The "I" stands for fuel injected, "O" for opposed cylinders, and the 360 is the cubic-inch displacement. It's basically the same 4-cylinder engine used in your everyday Piper Arrow.

Where things change is in the heavier crankshaft and in the lubrication system. You have to insure a good oil supply even when the engine is operating upside down, and that's not easy. In the old days, we'd consider ourselves lucky if we got 100 hours out of an engine. Today, thanks to the work of guys like Frank Christensen, who builds the Christen Eagle and Pitts Special, we're

The fuel system in my plane will hold 10 gallons, but we'll put in only four or so during a show because we're so weight critical. It's rigged so that the fuel feeds through a 1-gallon tank that seals off when the plane goes inverted, making sure that we have at least that gallon to fly with upside down.

With its midwing design, the Laser is shaped very much like an arrow. There are a lot of advantages to having an aerobatic airplane symmetrical in all planes. Most airplanes are configured asymmetrically in a number of ways to offset various factors encountered in flight—engine offset to counteract torque, for instance, or wing twist between root and tip to improve stall characteristics. But it's a problem with an aerobatic airplane. When you're flying upside down half of the time, left becomes right and right becomes left. Up becomes down and down becomes up. Everything is reversed. It's best to keep things perfectly neutral so that the same control pressures produce the same results, no matter what attitude the airplane is in.

When people ask me how flying the Laser feels, I tell them it hurts a lot. I often get bruises across the top of my shoulders from the shoulder harness.

And there is a lot of pressure, especially with the negative Gs. Negative Gs push the blood into your head. Positive Gs push the blood out of your head and down toward your feet. Some experts say the shorter you are the better off you are as an aerobatic pilot for this reason. Positive Gs can cause gray-out, and finally the dreaded blackout. A combination of positive and negative Gs in quick succession can cause disaster.

When I began flying years ago in really hard competition, the whites of my eyes would get almost solid red from broken vessels. That doesn't happen anymore. I know I've become resistant

show work is also less demanding physically than competition.

In competition, aerobatic pilots pull nine to 10 positive Gs and up to eight negative Gs. The negative Gs are the ones that really tear you up. About the worst situation you can get yourself into is an outside maneuver with plenty of negative Gs, followed by a really hard pull which produces the positive Gs.

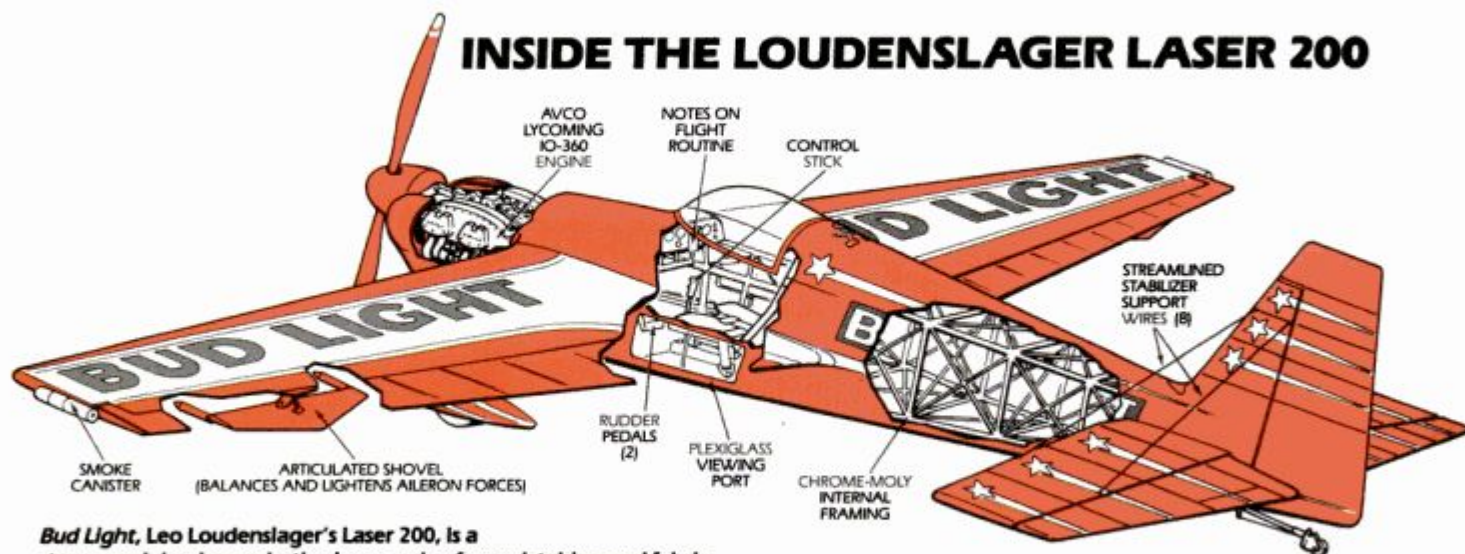
The mental game can be just as important to success in competition, in air shows—and in ultimate survival. Before I get in the plane, I like to be alone. I'm getting myself psychologically set to fly.

I go over my routine in my head. A good pilot, a smart pilot, doesn't ad-lib. He knows exactly what he's going to do. He's got all the air-speed numbers and everything else right on the money. When a few seconds can be the difference between life and death, you don't have the luxury of thinking things out. From beginning to end, the aerobatic pilot has to have everything down pat. I've been accused of being antisocial, of being a recluse, because of this. But it has to be that way. Only one thing is important. The flying.

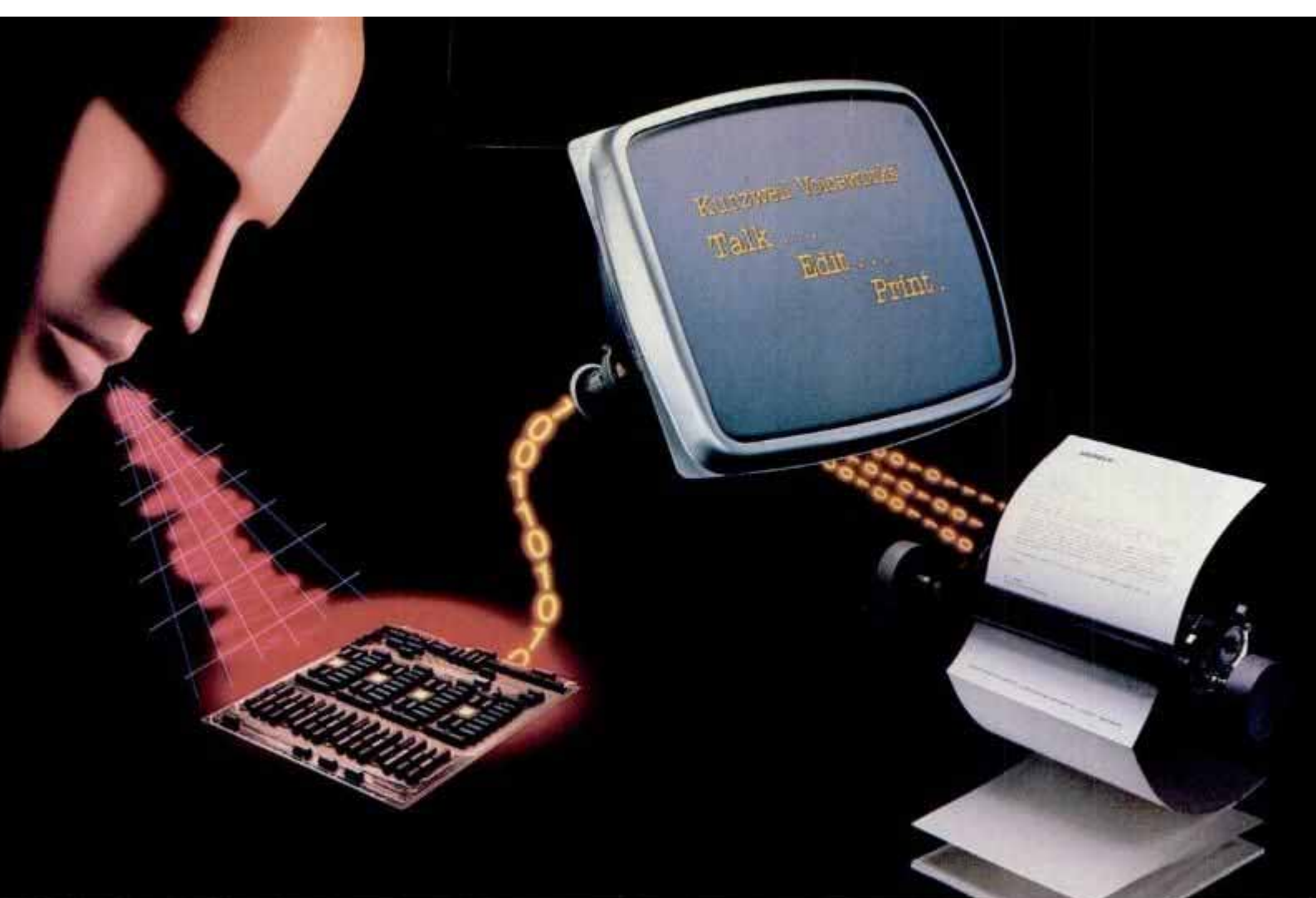
They say the very moment you think you've attained humility is the point that you've lost it. I think it's the same with perfection. The moment you think you've attained it, is the moment you've lost it. But it's the striving for perfection that I enjoy most. One degree here, two degrees there. It all adds up to trying to do your best.

How long will I do this? As long as I can put on a first-class performance. When I feel my performance is second class, when I'm just sluffing off, just getting by, it will be time to hang it up. But as long as my flying can raise the hair on someone's arm, including my own, I'll be out there pulling Gs with the best of them. **PM**

INSIDE THE LOUDENSLAGER LASER 200



Bud Light, Leo Loudenslager's Laser 200, is a strong and simple aerobatic plane made of wood, tubing and fabric.



ITS MASTER'S VOICE

In his Waltham, Massachusetts laboratory, not far from historic Concord Bridge, Raymond Kurzweil is contemplating revolution. Neither soldier nor politician, Kurzweil is an inventor who has been compared to Edison and Marconi. His specialty is artificial intelligence, or machine intelligence. Kurzweil creates machines that think. Realization of this once impossible concept, he and others are certain, is the shot that will trigger a second industrial revolution worldwide.

"The first industrial revolution spawned machines that multiplied our physical capabilities, extended the reach of our muscles," Kurzweil explains. "The new age is multiplying our mental capabilities."

One artificial intelligence expert, he notes, prefers to call machines that think "power tools for the mind."

Some of these machines will also serve as a declaration of independence for the handicapped. In the 1970s, while still in his 20s, Ray Kurzweil developed a reading machine that might be the most important development for the blind since Braille. It can identify words on a printed page, then read them aloud by means of speech synthesis.

With his voice-activated typewriter and other "power tools for the mind," inventor Raymond Kurzweil is plotting the second industrial revolution.

BY DAVID LANDER

Kurzweil's newest product reverses the steps of his earlier invention. His Voiceworks, expected to go on sale this fall, identifies spoken words and sentences, displays them on a computer screen for verification or editing, then prints them out on paper. It is, in effect, a voice-operated typewriter, with a vocabulary of up to 20,000 words.

The term artificial intelligence (AI) was coined at a Dartmouth College conference in 1956. Marvin Minsky, a professor at the Massachusetts Institute of Technology and a former teacher of

Kurzweil's, has defined AI as "the art of creating machines that perform functions that require intelligence when performed by people." Kurzweil himself prefers to distinguish the type of intelligence exhibited by human beings from that association with machines.

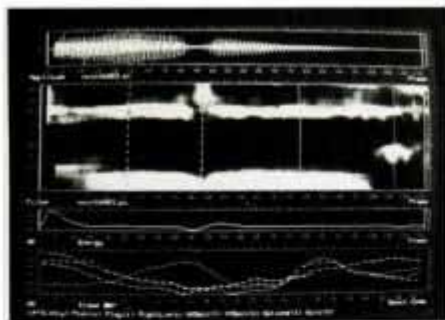
"Machine and human intelligence have different strengths and will for the foreseeable future," says the 39-year-old inventor. He points out that while the human mind operates over a broad spectrum, computers can only be programmed to work expertly in narrow "domains" or areas of specialization. Just a single step outside its particular domain, a computer's expertise collapses altogether.

"Human beings have what you might call a softer landing," Kurzweil says. "They may also have areas of expertise, but if you go outside them, they can fall back on more general methods of solving problems. They don't suddenly fall apart and become complete idiots."

Today's computers, Kurzweil says, are capable of prodigious feats of calculation. Their memories, speed and accuracy far outstrip human capabilities, and they never tire.

Now, suggests Kurzweil, combine

ITS MASTER'S VOICE



Computer (above) learns spoken words by analyzing their structure. Musician Stevie Wonder plays digital synthesizer keyboard he challenged Ray Kurzweil (at Stevie's right) to invent.

these attributes with "narrow degrees of intelligence—well-defined intelligence within certain parameters—like being able to recognize printed shapes, spoken language. That's a very powerful combination."

This is the threshold to which visionaries such as Raymond Kurzweil have brought the field of artificial intelligence. His VoiceRAD, an earlier invention, provides a good example. This device, on sale less than year, is similar to Voiceworks except its vocabulary is far more limited and it has been programmed especially for radiologists. It allows the doctors to dictate, edit and print out X-ray reports entirely by voice, without a human transcriber.

As can Voiceworks, VoiceRAD has learned to recognize "trigger phrases"—words that can cause entire sentences or paragraphs to appear on a computer screen instantaneously. Patricia Peabody, a training expert at Kurzweil Applied Intelligence, demonstrates VoiceRAD for POPULAR MECHANICS.

"Listen to me," Peabody says into her microphone, and the machine stands by to do her bidding. "Yesterday," she enunciates, and the date of yesterday's examination is on the screen before us.

Peabody says the words "head CT scan," and they leap to the screen in capital letters.

"I-plus," she continues. The screen instantaneously informs us that "SCANNING OF THE HEAD WAS CARRIED OUT FOLLOWING INTRAVENOUS CONTRAST INJECTION OF 300 CC OF RENO-M-DIP."

The trigger phrase "minimal atrophy" immediately produces "THERE IS MINIMAL GENERALIZED CEREBRAL AND CEREBELLAR ATROPHY. NO ABNORMALITIES ARE NOTED."

"Insignificant," say the operator. "IMPRESSION: NORMAL EXAMINATION," the machine displays.

"Signature." Peabody's name, the



time of day, today's date and the date the report was generated appear. This entire process has taken about 7 seconds and has eliminated any need for the steps normally occurring between dictation and the typing of an edited report, steps that could take days.

Learning to scrawl

A computer technique called pattern recognition is central to the operation of the Kurzweil Reading Machine, as well as VoiceRAD and Voiceworks. Pattern recognition enables machines to identify the most basic characteristics of images it sees or sounds it hears, and thereby distinguish between them.

The Kurzweil Reading Machine identifies those patterns common to the letters of the alphabet. Because it has learned to recognize the lowest common denominators, the shapes that form an A, B, Y or Z, it can read books or manuscripts regardless of typescript.

Ray Kurzweil began experimenting with pattern recognition while still in high school. He devised a computer program that examined musical scores, first identifying melodic patterns common to a given composer's works, then actually composing new works based on those sequences of musical sounds.

His lifelong interest in music later became manifest in an invention that followed the Reading Machine. The Kurzweil 250 is a keyboard synthesizer that not only reproduces the sound of an actual concert grand piano, but also can be programmed to sound like any instrument played into its memory.

Because VoiceRAD and Voiceworks recognize individual voices, they must

be "trained" by each user. Operators enter their names via keyboard then speak words aloud into a microphone as they appear on screen.

VoiceRAD, limited to a 1000-word vocabulary, is provided with a series of "lexicons," each containing the particular words it will need for one or another specialty areas within radiology. Even though a user must read the entire lexicon to VoiceRAD, training the machine is less tiresome than it might sound, and typically takes about 1 1/4 hours.

Voiceworks is normally provided with a core vocabulary of 1200 words, including necessary commands. Other words must be taught to the machine. This can be done by typing them on disk (the conventional computer date entry method) or by feeding them in through existing files of letters or memos. In this way, Voiceworks adapts to a particular corporate vocabulary, typically containing words common to an individual industry and perhaps even a company itself. Teaching Voiceworks to recognize words that may not be common, but tend to recur in the vocabulary of a particular user can be done at any time: Just type them directly into the machine's memory and speak them aloud.

Voiceworks is trained to recognize individual voices in the same manner as VoiceRAD, and both use the same method to identify spoken language. This process is controlled by a trio of what computer specialists refer to as "expert systems."

As the operator speaks into the microphone, the sound is first amplified then sampled 16,000 times per second and converted to binary digital code—a

(LEFT) KURZWEIL APPLIED INTELLIGENCE PHOTO; (RIGHT) MLSA-BORCHERS PHOTO



Speaking into microphone, quadriplegic Bill Yee (left) tells voice-controlled robot to serve him a drink. Ray Kurzweil (above) with Voiceworks—his "power tool for the mind."

process similar to that used to record music for digital audio compact discs. It is then fed through a set of digital filters to divide it into a proprietary number of frequency bands. Then the process of pattern recognition, a function of the expert systems, begins.

The domain of the first such system is acoustics. Its role is to identify basic sounds or phonemes, to distinguish Ah from Oh, for example. A second expert system, the domain of which is phonetics, identifies sequences of phonemes—the sounds of entire words.

This still leaves the problem of homonyms, words that sound alike, such as to, too and two. Distinguishing between these is the province of the third expert system, which applies the rules of grammar to determine the correct choice.

When speaking to Voiceworks, operators must leave spaces of $\frac{1}{10}$ to $\frac{2}{10}$ of a second between words. This is to prevent the machine from breaking single words with internal spacing (hipbone, for example) into two words.

As spoken words flash on screen, a series of other words, numbered one through five, appears below them. These are alternate choices deemed most probable by the machine's expert systems. If the first word-choice is incorrect, the user can pick from the group under it by saying, for example, "take three" (indicating the word numbered three). If all the machine's choices are incorrect, the operator says "scratch that" and repeats the correct word. Should Voiceworks keep missing it, the operator says "train word," and types it in then speaks it aloud.

All this is part of educating

Voiceworks, which actually learns from its own experience. Corrections for mistakes are assimilated by the memories of the expert systems, thus training them to be more accurate in the future.

AI's potential

Voiceworks can record about 60 spoken words per minute in the free speech mode (that is, when no trigger phrases are used) and costs between \$10,000 and \$20,000, depending on how much of its own associated computer equipment a customer chooses to integrate with the "acoustic phonetic analyzer" and related software that can be said to compose its ear/brain system.

This is obviously a far cry from what Robert Steingart, a Kurzweil Applied Intelligence staffer, calls the "holy grail product"—a voice-controlled word processor for home use that could be spoken to more rapidly, would possess an unlimited vocabulary and sell for about \$500. Nonetheless, if the Kurzweil Reading Machine was the first commercial artificial intelligence product, VoiceRAD and Voiceworks mark a second generation in what Ray Kurzweil predicts will eventually reshape offices, schools, hospitals, even our homes.

Already, artificial intelligence as represented by Kurzweil's voice-recognition technology is incorporated in a robot to help the handicapped and in a simulator to train aircraft-carrier landing officers. The Advanced Robotic Aid, a joint effort between the Veteran's Administration and Stanford University, is being developed to perform numerous vital services for quadriplegics who retain the power of speech. Since the

handicapped individual cannot control the robot's movements physically (by means of joysticks and levers), Kurzweil's voice-recognition technology enables the robot to understand spoken commands and execute them.

Though it's limited now to following minute and tedious directional commands, researchers expect that the robot eventually will be able to perform tasks assigned as a single directive and expressed in everyday language.

Meanwhile, the U.S. Navy should soon take delivery of a voice-driven simulator designed to train the landing signal officers of aircraft carriers. The trainee works with a computer-generated image of the plane that responds to vocal commands instantaneously, as the pilot of a real plane would.

The simulator, developed by the Systems and Simulation Division of Gould, Inc., uses a 25-ft.-wide wraparound screen to show a 190° panorama of the carrier deck, aircraft, sky and sea. It can even display simulated weather conditions—and recreate the high-volume noise of a flight deck. One important attribute of the voice-recognition system Kurzweil designed for the simulator is that it can operate under these taxing noise conditions.

These are but two of the potential applications for machine intelligence. Necessity and imagination no doubt will spawn many others.

"One thing worth pointing out," Kurzweil remarks, "is that human intelligence is not changing at any rate that we can perceive, whereas computer intelligence is changing very quickly." Anyone skeptical about the growth in computer brain power need only spend a few minutes with one of Raymond Kurzweil's smart machines, devices that may very well be thinking their way into the second industrial revolution. **PM**





Bedtime Story

A distinctive arched-headboard bed that you can build.

BY NEAL BARRETT

One glance at our ash spindle bed is enough to capture the imagination of any woodworker. The eye-catching, arched headboard sets this piece apart from the norm both in appearance and construction.

While bending wood may be something you've been hesitant to try before, we'll guide you through the steps and open a new world of possibilities for your home workshop.

The bowed-headboard frame on our bed is shaped by a method often thought of as strictly an industrial process. Here, veneers are glued together and clamped over a form of the desired shape until dry. This laminated structure is very strong due to the fact that the grain runs parallel to the curve.

Constructing the form

We used $\frac{3}{4}$ -in. particleboard to make the form, but you could substitute most other types of panel stock. It's comprised of a base section and double thicknesses of edge sections to create a $2\frac{1}{4}$ -in.-thick form. Because the base section is larger than can be cut from a single 4x8 sheet, it must be made in two sections.

Lay out bow centerlines $28\frac{15}{16}$ in. in from one edge and one end on a panel at least $57\frac{7}{8}$ in. long. Bore a $\frac{1}{2}$ -in. hole at the

Color photo: J.R. Rost
Black-and-white photos: Neal Barrett
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick

BEDTIME STORY

intersection. The $28^{15/16}$ -rad. arc is cut with a $1/2$ -in. straight bit mounted in the router, which in turn is mounted on a trammel arm that pivots in the base panel hole. Remove the base plate from the router and mount the router so the bit passes through a hole bored in one end of the trammel arm. Then, bore a $1/2$ -in. hole $28^{15/16}$ in. from the inside cutting edge of the bit. Place a $1/2$ -in. dowel in the base panel hole to act as a pivot pin. When cutting the circular profile, be careful to stop at the arc diameter. Next, extend the base panel to its required size by attaching an extension panel cross-crested underneath. Then, lay out and cut the straight edges of the form extending down from the bow diameter. Trim the bottom of the form in a smooth curve with rounded corners as shown in the drawing.

This rounding over helps when tightening the band clamp.

Screw fasten the first of two additional layers of roughly 5- to 6-in.-wide pieces around the perimeter of the form base and trim to the base outline with a router and flush trimming bit. Repeat this procedure with the second layer. Use a sabre saw to cut out sections for clamp access as shown in the drawing. To help hold the laminations in place during assembly, attach ledger blocks around the arc, each with a 3-in.-long dowel centered 2 in. in from the edge. Finally, apply duct tape around the outside of the form to prevent the laminates from being glued to the form.

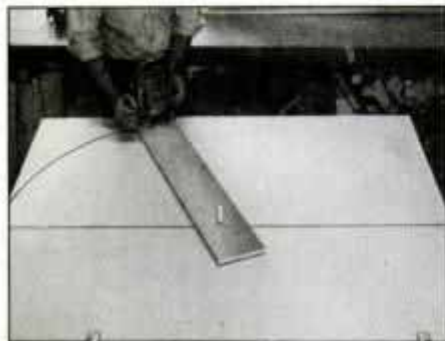
Laminating the bow

Although you can rip the 17, 2-in.-wide laminations from solid stock, buying $1/16$ -

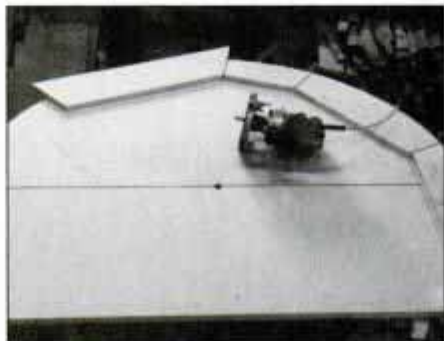
MATERIALS LIST—SPINDLE BED

Key	No.	Size and description (use)
A	2	3 x 3 x 24" ash (head post)
B	2	3 x 3 x 15 1/4" ash (foot post)
C	2	1 1/4 x 6 x 56 1/2" ash (head/foot rail)
D	2	1 1/4 x 6 x 74 3/4" ash (side rail)
E	1	1 1/4 x 1 1/4 x 56 1/2" ash (rail)
F*	1	1 1/8 x 1 1/8 x 142 1/4" ash (bow)
G**	1	1 1/4 x 1 1/4 x 33 3/4" ash (spindle)
H**	2	1 1/4 x 1 1/4 x 32 3/4" ash (spindle)
I**	2	1 1/4 x 1 1/4 x 32 3/4" ash (spindle)
J**	2	1 1/4 x 1 1/4 x 31" ash (spindle)
K**	2	1 1/4 x 1 1/4 x 28 3/4" ash (spindle)
L**	2	1 1/4 x 1 1/4 x 25 3/4" ash (spindle)
M**	2	1 1/4 x 1 1/4 x 21 3/4" ash (spindle)
N**	2	1 1/4 x 1 1/4 x 16 3/4" ash (spindle)
O	15	5/16 x 1 1/4 ash (bow wedge)
P	15	1 x 2" ash (rail wedge)
Q	6	2 x 4 x 4" 1/4"-thick steel (hanger)
R***	1	Set of rail support hangers

Misc.: 3/4" particleboard, 1/2" dowel, 1/4 x 1 1/4" lagscrews, 2" No. 8 fh wood screws. *Veneer available from the Wood Shed, 1807 Elmwood Ave., Buffalo, NY 14207. **Approx. 1" over-size—trim after assembly. ***No. 125-062 (\$13.40 ppd) from Woodworker's Supply, 5604 Alameda, N.E., Albuquerque, NM 87113.



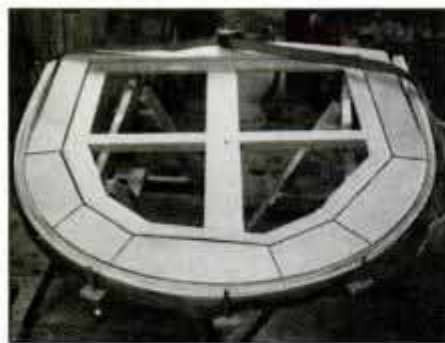
1 Mount the router with straight bit on a trammel arm to cut the radius on the bow form. Stop the cut at the arc diameter.



2 Screw 5-in.-wide pieces around the perimeter and flush trim with router. Add two layers to create 2 1/4-in. form depth.



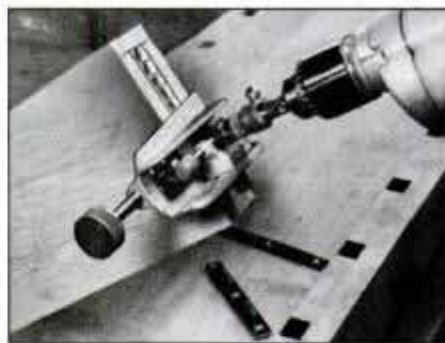
3 Cut the veneers to a uniform width by first stacking them and securing with tape. You'll need 17 12-ft. strips.



4 After applying glue, bend veneers around form and secure with a band clamp. Make sure strips are seated on ledgers.



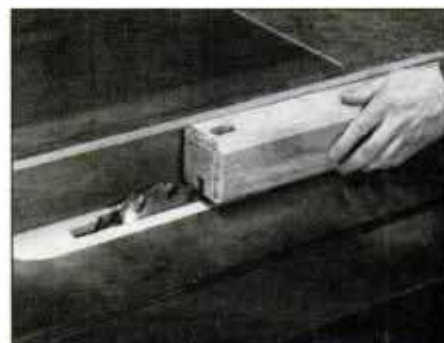
5 Start applying clamps at one end and work your way around the form. Use as many clamps as possible for a uniform joint.



6 Use a dowel jig and drill to begin the mortises in the rail ends that house the hangers. Bore overlapping 1 1/8-in. holes.



7 The mortises in the legs are started on the drill press by boring 3/4-in.-dia. holes. Use a sharp chisel to clean up waste.

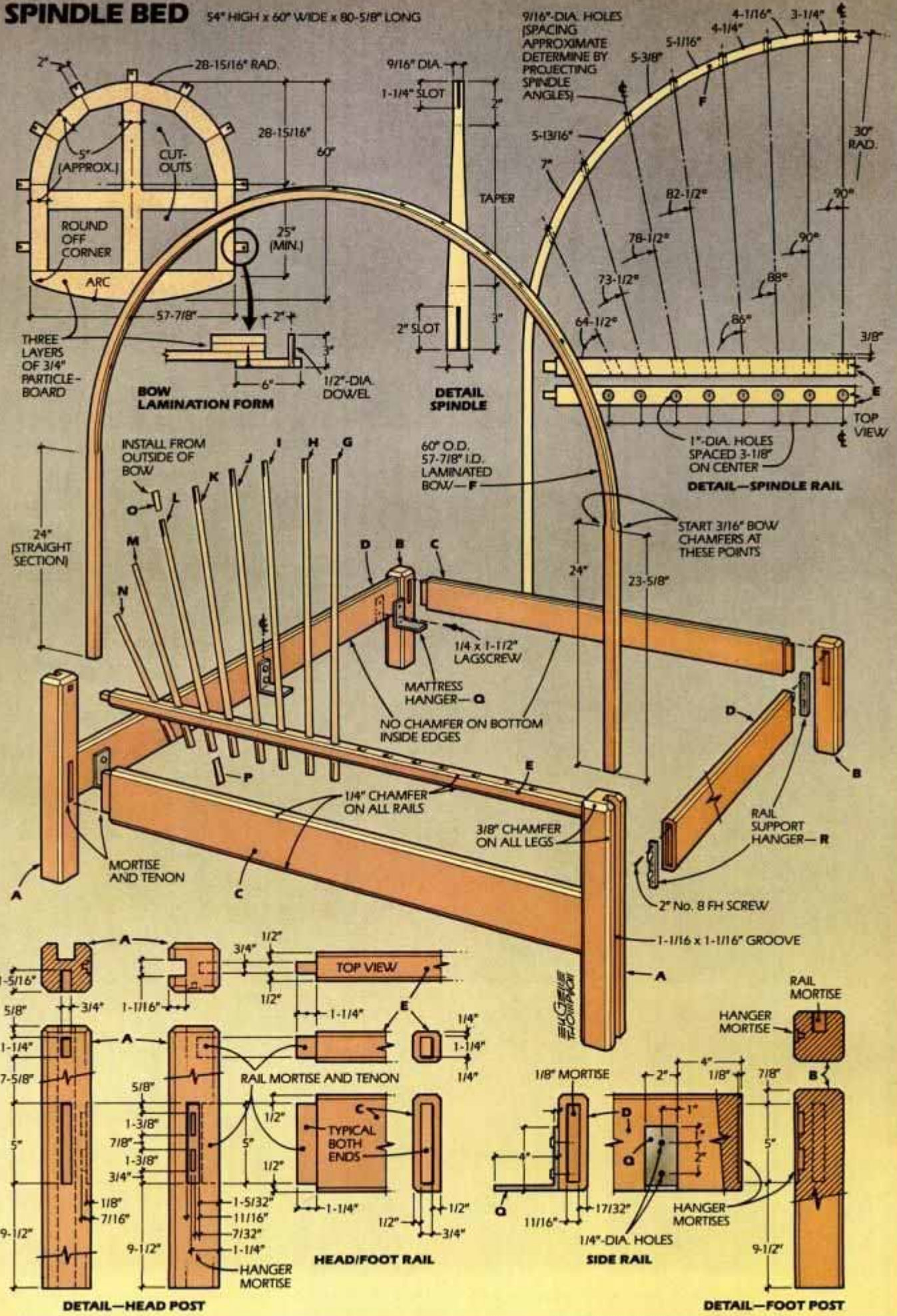


8 The bow is fit in a groove cut in the headboard legs. Use a dado blade in the table saw and make several passes.



9 When the glued-up bow has completely dried, clamp it to the worktable and hand plane one edge square and flat.

SPINDLE BED 54" HIGH x 60" WIDE x 80-5/8" LONG





New, shallow-profile refrigerator fits behind doorway casing, creating custom look.



Food preparation area has a wall-mounted microwave and clear expanse of countertop.



Gas range with outboard countertops occupies a neutral corner away from traffic flow.

Kitchen Kudos

A common-sense approach to remodeling your kitchen that yields a well-tailored space at a fraction of normal costs.

BY ELIZABETH AND EUGENE THOMPSON

When we bought our 50-year-old, brick colonial house we knew that the kitchen would need a complete renovation, but we chose not to tackle it right away. Instead, we lived with it for a while to get to know its limitations and figure out possible options to resolve them.

In the beginning, our thoughts centered around enlarging the kitchen by either bumping out and incorporating an existing patio—to create an informal greenhouse garden kitchen and entertainment center, or by removing the common wall between the dining room and the kitchen—to create a great room effect for cooking and eating. We abandoned both ideas as we began to understand that these expansive, multipurpose rooms did not suit the tailored architectural simplicity of the house. The house design worked best with separate rooms for separate functions. The kitchen needed restoration and an update with new appliances and better cabinet-counter arrangements, not larger space.

We began by measuring and drawing up the old layout in a floor plan and with elevation views of each wall. The kitchen space, a corridor-or galley-type layout measured 9 × 13 ft. overall. It was easy to see why the kitchen felt small. The entry coming from the rear hall was partially blocked by a protruding refrigerator on one side and an old-fashioned double-oven, 6-burner range on the other side. Both appliances interrupted traffic flow and interfered with each other's operation.

During the initial planning stages we sent for brochures, looked through magazines and books, and visited kitchen showrooms to look at appliances and kitchen products. We redesigned the kitchen on paper first, then pursued the products that would make the design work. By working with just the bare shell and the "immovable" location of bearing walls, stairwells and window and door openings, the kitchen began to take shape along the two long walls.

Essentially, three centers were developed: The main cooking center with the range and hood, flanked by two 15-in.-wide counters; a new sink counter wall that would also contain a built-in dishwasher; and, a third center, where the old range had been, became a food preparation center with a wall-hung microwave. (See the floor plans on the next page.)

We also decided to replace an inoperable casement window

over the sink with a new vinyl slider purchased from a local manufacturer. It not only provided good ventilation but also allowed a pass-through to the barbecue area on the patio.

We were fortunate to find our new refrigerator—and other appliances as well—at Sears. The refrigerator is loaded with good features, but for us its most important attribute was its shallow depth. This allowed it to fit nicely in a very tight corner. Even though this model was expensive, because we

were saving money by doing the work ourselves, we could opt for the top-of-the-line appliances.

The cabinets were all stock sizes from a local manufacturer that specializes in selling cabinets uninstalled. Many such places exist across the country. They are a real boon to do-it-yourselfers because they sell high quality merchandise at a fraction of the installed price. Delivery was within a week of ordering and we were even able to replace a cabinet that was damaged during installation, within a day, months after the original order was processed.

We decided on 6-in.-sq., slightly textured, white ceramic tile for the counter tops. The tile offered us several advantages: quick and easy clean up and an ever-ready place for

a hot dish taken from the range or microwave. To complement the ceramic tile, we chose a light-colored vinyl wallpaper, and decided to add a picture molding to the walls, 6 in. down from the ceiling, to repeat an architectural detail found throughout the house.

Lighting, in general, was a major consideration. We needed to upgrade the electrical system, adding new circuits to take each of the new appliances, as well as add further lighting under each cabinet. A great find were the slim line fluorescents that recessed under each cabinet.

The floor was our biggest mystery until we removed all of the 50-year-old linoleum and its black adhesive and discovered original Southern yellow pine flooring underneath. We decided to strip the floor, then refinish it with a light, white pickling covered with polyurethane topcoats.

We planned to do the entire remodeling ourselves in order to maintain control over the expenses, the design and the quality. We did use a licensed electrician to upgrade the electrical system and a plumber to move the range gas line, install new undersink plumbing, and hook up the dishwasher.



Sink location remained unchanged, but dishwasher and a new vinyl window were added.

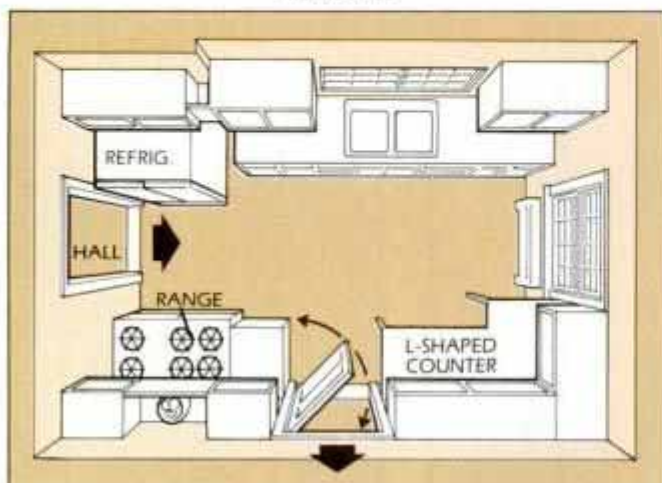
Color photos: Robert Grant
Black-and-white photos: Elizabeth Thompson
Technical art: Eugene Thompson

Sears Kenmore appliances: Ultra Wash dishwasher, No. 15965;
Spacemaster microwave oven, No. 87453; Limited Edition gas range, No. 73979;
Sears Best range hood, No. 52358; Limited Edition refrigerator, No. 76198.

A Change Of Plan

A quick look at the before floor plan reveals an inefficient use of space and poor location of appliances. The refrigerator door and oven door could not be opened at the same time and still have room for someone to walk through. The swinging door to the dining room created a hazardous bottleneck and the L-shaped counter next to the side window had no base cabinets underneath. Furthermore, there was a paucity of countertop space near the refrigerator for depositing groceries.

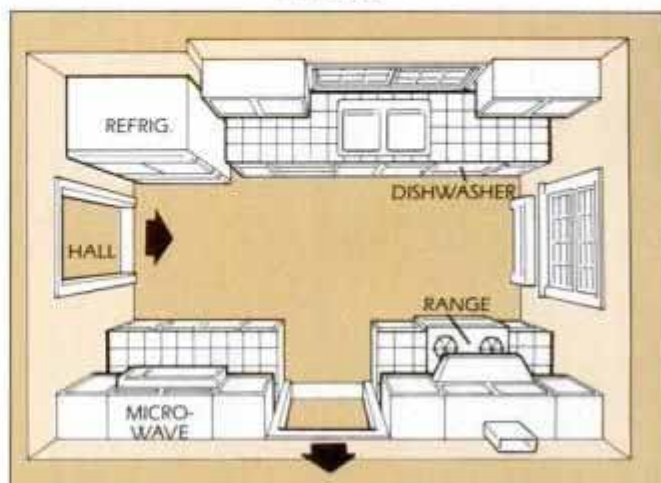
BEFORE



DINING ROOM

By simply moving the range, as shown in the after plan, the room took on a more logical design. Traffic could flow through without passing the hot cooking area and the free countertop space across from the refrigerator created a convenient spot for groceries. Also, the built-in microwave allowed this counter to act as a dedicated food preparation area. The addition of a dishwasher, next to the sink and under a wide expanse of tile countertop, provided a sensible arrangement for handling even the toughest clean-up jobs and eliminated the swinging door to the dining room.

AFTER



DINING ROOM

Site Preparation

Planning and preparation are two very important steps in any undertaking but are particularly crucial when you try a full-scale demolition-restoration project like this on your own. Debris can overwhelm anyone quickly, so check your local *Yellow Pages* under "Rubbish Removal" to arrange for a dumpster to haul away all the major debris.

We began by stripping the walls, the lower two-thirds of which were covered with old ceramic tile imbedded in cement. Removing this was strenuous, time consuming and very messy. But it did teach us a valuable lesson right at the beginning, namely, close off your work area from the rest of the house as much as possible. We covered both doorways with heavy-duty, clear plastic sheets and kept them in place whenever

we created any dust. Next we pried off the original window and door casings, labeled them for easy reassembly then took them to the garage for stripping and refinishing. We did the same for the metal radiator cover.

All hardware and doors were removed from the wall and base cabinets. Then face frames were pried off and the shelves were knocked out. A hammer, prybar and wrecking bar were used to take out the sides and tops of the wall cabinets and open up the soffits. A portable saw cut away the counters.

Then the water supply to the kitchen was shut off while the sink was propped securely in place with a temporary framework. The water was turned back on and the remainder of the base cabinets were taken apart.

The electrician was called in while the walls were open and plans for all the

new appliance circuits and other outlets were determined.

We also established the location for the new ceiling lights and ceiling fan. The electrician designed the new circuits, ran new wire and installed the hardware for the ceiling fixtures.

The entire ceiling was checked for water-damaged plaster because the bathroom plumbing above it had leaked many times over the years. Huge areas were chipped away until solid plaster edges were left. Next, the old exhaust vent was pulled out and its hole in the ceiling was covered over with a board. We did not repair this hole because it would be covered by the new soffit later on. A new vent hole was cut in the ceiling over the new range location. Fortunately, the new vent could be attached to the existing venting system for the old hood.



Remove old cabinets first. Use a flat pry bar or wrecking bar to pry off face frames. Then remove the bottom, sides and tops.



Scrape off all old paint build-up and loose plaster using hand scrapers. Cover doorways to prevent dirt and dust from spreading.



Fill all minor cracks and depressions with joint compound. Deeper holes require patching plaster first, then compound.

Next, we closed up the walls and ceiling. A double layer of ½-in. drywall was used on the open lower two-thirds of each wall. We shimmed the wall studs as necessary so that the original plaster and the new double drywall would be at the same surface level. The drywall was cut and put up with construction adhesive and drywall screws. We filled the long horizontal joints between the old

and new walls with plaster. When these patches were dry, we applied self-adhesive fiberglass mesh over the joint and covered the mesh with joint compound. When dry, the surface was sanded smooth with a clever Sears finishing sander that can be hooked up to a shop vacuum. This reduced quite a bit of plaster dust. All other wall joints and deep holes and cracks in the ceiling were han-

dled in a similar manner.

All the old linoleum was peeled off and discarded and the black adhesive left behind was removed with hand scrapers. This scraping was difficult but we knew if we tried to sand it off, we would foul the sandpaper immediately. Once the floor was reasonably clean, we covered it with cardboard to protect it while other work was proceeding.



First, chisel off all loose plaster from ceiling, then fill with patching plaster to ¼ in. of surface. Finish with joint compound.



Plan location of all outlets carefully. It's much easier for the electrician to run these lines when the inside of the wall is accessible.



Make large patches using drywall that matches the thickness of old plaster. Clean joints with vacuum cleaner before finishing.



Fill all joint gaps with plaster to within ¼ in. of surface. Smooth with a wide joint knife and let the plaster dry thoroughly.



Apply self-adhesive fiberglass mesh tape over joint and cover with joint compound. When dry, apply a second coat.



Sand surface smooth using fine-grit sandpaper. Sears vacuum sander attachment (shown) eliminates nearly all the dust.

Installing Cabinets

Once the kitchen was prepared for restoration work, we moved the new base cabinets into position and laid temporary counters across them so that the kitchen could continue to function.

The range center was first. We fastened a leveled temporary ledger to the wall to help support the wall cabinets as they were mounted and to maintain a uniform cabinet line. The cabinet backs were marked and cut out for wiring, and the over-the-hood cabinet was cut out for the vent.

While the walls were open we made sketches of the stud layouts. We used these sketches to locate and prebore the mounting holes. The inside corner wall cabinet was positioned with the electrical wire for the under-cabinet light threaded through the back hole. The cabinet was plumbed and leveled, then fastened to the studs with lagscrews. If we couldn't catch a stud, we used toggle bolts. We used at least four fasteners

per cabinet. The outside wall cabinet was next. The shallow over-the-hood cabinet was clamped in position, then fastened to the wall. The cabinets were fastened to each other with 2-in. drywall screws driven through prebored holes in the face-frame stiles.

The vent assembly for the hood was next. Following the manufacturer's directions, the range hood was mounted and vent assembly connected.

The base cabinets that were to flank the range were moved into position. The plumber came and moved the gas line for the range to the new location and helped move the new range into position. The base cabinets were shimmed level and plumb, then fastened to the wall with lagscrews. The old range was disposed of, opening up space for the preparation center with the microwave.

The wall cabinets were leveled, plumbed and fastened to the wall and each other as described for the range center. The shallow center cabinet had cutouts for the microwave outlet. The

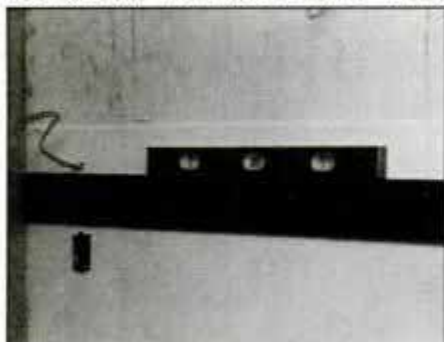
base cabinets were moved in place as a unit and clamped together. This unit was shimmed level, then the face frames were joined together with 2-in. drywall screws. The back edges were also joined by toenailing through the corner blocks. Finally, this cabinet bank was fastened to the wall with lagscrews and toggle bolts. Following the manufacturer's directions, the microwave was raised and mounted between the wall cabinets.

The sink cabinets were last. The large wall cabinets were hung as described above. The water to the sink was cut off, and the sink was removed. The old plumbing was cut out, to be replaced with new fittings later. We did, however, leave the supply line risers in place. We were without a kitchen sink for about one week. Next, the base cabinets were moved into place. The first two cabinets were fastened to each other at the front and back as described above. Then they were attached to the wall with lagscrews and toggle bolts. A space was left between the sink cabinet

KITCHEN KUDOS

and the right-hand corner cabinet for the dishwasher. The dishwasher's manual explained what this space should be. Also, the slim under-cabinet fluorescent fixtures were mounted and connected under each wall-hung cabinet.

Over each wall cabinet, soffits were framed out with 2x2 lumber. These



Mount temporary ledger on wall to support cabinets during installation. Check that ledger is level and at proper height.

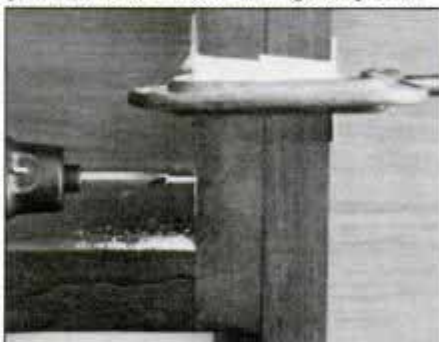
were attached to the top of the cabinets and to the ceiling. We located them $\frac{3}{4}$ in. back from the cabinet fronts to allow for $\frac{1}{4}$ -in.-thick hardboard panel and a $\frac{1}{2}$ -in.-thick drywall surface. Once the hardboard was screwed in place, we used construction adhesive and drywall screws to attach the drywall. The resulting soffits were flush with the cabinet face frames. All seams were finished



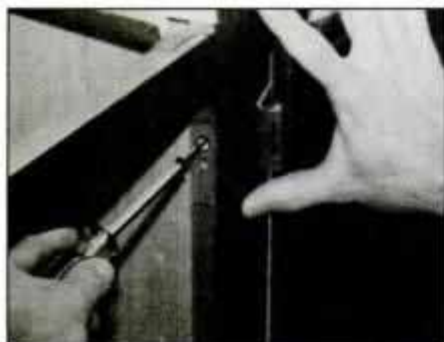
Prebore holes for stud locations in the back of the wall cabinets. Then lift into place and attach with lagscrews and washers.

with tape and joint compound and, when dry, they were sanded smooth.

The ceiling molding—that matched the other rooms in our house—was cut to length and glued and nailed 6 in. below the ceiling. Next, we installed the stripped and refinished window and door casings. The ceiling, moldings and tops of the walls were primed, then painted with a latex semigloss paint.



Join wall cabinets together with screws driven through face-frame stiles. Clamp together temporarily for perfect alignment.



Clamp base cabinets together, check for level and shim as necessary. Screw cabinets together through the hardwood stiles.



Toenail rear of base cabinets together with 6d finishing nails. Clamp and use thin spacers between cabinets, if necessary.



Fasten base cabinets to studs with lagscrews—or toggle bolts, if no stud can be found. Shim cabinet back if wall is not straight.

Countertop & Tile

Our countertops were made up in our basement workshop, then carried upstairs and installed. To determine their overall depth, we added the dimensions of four 6-in.-sq. tiles, plus the thickness of the $\frac{3}{4}$ -in.-thick particleboard backsplash, which sits on top of the counter. By using all full tiles front to back, we minimized our tile cutting and still wound up with a good overhang on the front of the cabinets. Our backsplash tile sits on top of the counter tile. So to determine the height of the backsplash we added the height of one tile plus one tile thickness; approximately 6 in. and $\frac{1}{4}$ in., respectively. Also, by planning to have the backsplash tile on top of the counter, we created a better watertight seal. The counter lengths were determined by the cabinet runs, plus the overhangs on any exposed ends.

All counter parts are cut from $\frac{3}{4}$ -in.-thick particleboard. We used a table saw for ripping to width and a radial-

arm saw for crosscutting, both fitted with carbide-tipped blades. But a portable circular saw, fitted with a carbide-tipped blade, and a straight cutting guide will work just fine.

We cut each counter to size, then cut enough 3-in.-wide strips to double up the front and back edges. Also, 6- to 8-in.-wide strips were cut to fall over each cabinet joint and at each end. Since the sink counter was longer than 8 ft., it had to be pieced together. We used a 24-in.-wide piece of particleboard to reinforce this joint.

We assembled the parts for the countertops with glue and $1\frac{1}{4}$ -in. drywall screws spaced 6 to 8 in. apart. We wiped away any glue squeeze-out with a water-damp cloth. We then joined the backsplash to top rear counter edge—and the appropriate side edges—with glue and 3-in. drywall screws. These were driven from below about every 12 in. We used a square to keep the splash alignment as we worked. After assembly, we lightly sanded all cut

edges and holes with a belt sander to remove particleboard splinters.

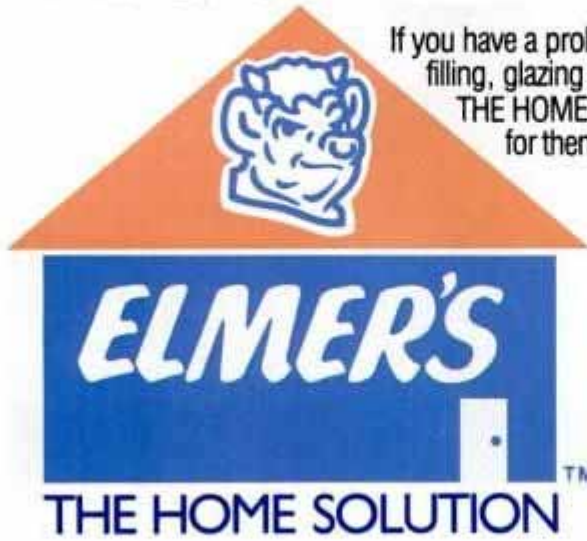
Next, the corner blocks of all the base cabinets were prebored to receive the screws that hold the countertops in place. Then the counters were set in place and fastened from inside the cabinets using 2-in. drywall screws. With the sink counter in position, we traced around the outside edge of our stainless-steel sink. Then we bored a 1-in.-dia. access hole just inside the outline, and used a sabre saw to cut out the sink opening. Once this cutout was complete, we sealed the counter backsplash joint by running a bead of clear silicone caulk along the joint, smoothing it with a wet fingertip.

The countertops were edged with solid cherry molding and the backsplashes have a cherry top cap. We cut these moldings from cherry stock and shaped them along the top edge with a rounding-over bit in the router. Each piece was cut to length and mitered as necessary. We fastened the counter edging in

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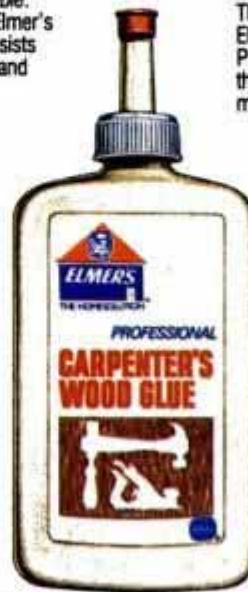
Problem: How to protect your hands from paint, oil and grease.
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Problem: How to attach Formica® to a countertop.
THE HOME SOLUTION™: Elmer's Contact Cement. Forms a strong bond.



Problem: How to glue the arm back on the armchair.
THE HOME SOLUTION™: Elmer's Carpenter's Wood Glue. Penetrates wood deeply for a strong bond.



Problem: How to glue protective felt to the bottom of the statue.
THE HOME SOLUTION™: Elmer's Glue-All™ It's the ideal all-purpose household glue.

KITCHEN KUDOS

place with glue and 6d finishing nails driven through prebored holes.

We finished the edging and the cap to match the prefinished cherry cabinets. This required experimenting with several different colored stains mixture on scrap cherry pieces. Once we found a good match, the edging and cap were sanded smooth with 220-grit sandpaper, then wiped with a tack cloth. We applied the stain mixture, allowing it to soak in for 5 to 10 minutes, then wiped away the excess. We repeated the staining a total of three times with 8 hours between staining. Then we finished the edging and cap with three coats of satin-finish polyurethane.

The tiling was next. We laid out the countertop tiles on each counter before

applying the mastic to check for the best looking arrangement. We used a tile cutter to score and snap the straight cut tiles to size, and nibbling pliers to cut the shaped tiles around the sink opening to size. Both of these tools were available from our local tile store. We removed the tiles and stacked them in order, to be able to replace them in their original position.

Following the manufacturer's directions, we applied premixed ceramic tile mastic using a notched trowel to spread the mastic evenly. We spread mastic on an area that could be tiled within 20 minutes. Starting at the front edge of a counter, we laid tile rows front to back. Any tiles that required slight cutting fell along the back of the counter and were concealed by the backsplash tiles. We laid each tile in the mastic with a

slight twisting motion to imbed properly. When a counter was finished, we used a piece of scrap 2x4 laid on top of the tile and a rubber mallet to uniformly set the tile into the mastic bed. Only soft blows are required.

If you strike the board too hard, the tiles can break. When all the counters are tiled, we went back and spread mastic on the back splashes and tiled them. Any mastic that squeezes up between the tile joints should be removed immediately with a clean cloth. The tiled countertops were allowed to dry for 24 hours.

Following the manufacturer's directions, we mixed the dry-set grout with a latex additive and a bonding agent. The additive strengthens the grout. We mixed the grout in a plastic dishpan and stirred it to the consistency of sour



Position the last tile—which must be cut—against counter end, under previous tile. Trace cutting line onto tile with a pencil.



Tile cutter requires running over tile a couple of times to score glazing, then pressing down on handle to break or snap tile.



Use nibbling pliers to shape curves around sink cutout. For best results, work slowly, removing just 1/4- to 1/2-in. at a time.



Spread premixed ceramic tile mastic onto countertop using a notched trowel held at a 45° angle. Make sure to spread it evenly.



Set tile into mastic with a slight twisting motion to imbed the underside tile grooves in mastic. Do not slide tile in place.



Use flat wood block to span four to six tiles. Then tap board lightly with a rubber mallet to seat the tiles uniformly in the mastic.



After mastic has set for 24 hours, apply grout using rubber float. Work grout well into joints, holding float at 45° angle.



Wipe off excess grout right away using sponge and fresh water. Buff off the dried haze after several hours with coarse cloth.



Install trim—in this case prefinished cherry boards—to backsplash. Use glue and finishing nails. Set and fill all nailhead holes.

cream. A rubber float or rubber-faced trowel was used to spread the grout, forcing it into the tile joints. Hold the rubber trowel on a 45° angle and run it down each joint. In another plastic pail we had clean water and a sponge to wipe up the excess grout. We checked that all the joints were grouted, then let the grout dry for several hours. The haze that formed on the tiles was buffed off

with a clean cloth.

After 72 hours we went back and brushed a clear silicone sealer onto all the grout joints. The sealer was allowed to sink in, then the excess was wiped away. Such a sealer should be applied every six months to protect the grout from stains.

Next, we reseated the double-basin stainless-steel sink in the sink opening

using plumber's putty. Then the countertop holddown clips were installed from underneath and tightened securely. By seating the sink ourselves we saved about an hour of the plumber's time. After the dishwasher was rolled into position we called the plumber and he installed the new sink plumbing fittings and hooked up the dishwasher.

Tile: American Olean Tuscany Cloud.

Wallpaper

We began by preparing the walls with a latex-base primer sealer so that the paper on the new drywall would not absorb the wallpaper paste.

We set up two long work surfaces, one "dry" table to layout, mark and cut the wallpaper strips to length, and the other "wet" to layout the cut strips and apply the wallpaper paste. A plastic dishpan made a convenient container for mixing the wallpaper paste. Another pail held clean water for wiping the excess paste off the covered wall sections. To begin, we snapped a plumb chalk line on the starting wall to determine a vertical straightedge for hanging the first piece. Then, we measured the height of the wall and cut the first strip to length, plus a generous allowance for adjusting the pattern. We held the dry strip up in place and adjusted the pattern at the top. Then trimmed the excess to leave about 1½ in. on top and bottom.

We prepared the paste following the manufacturer's directions, and stirred it well to work out any lumps. We brushed the paste onto the middle of the top of the strip, spreading it out to the edges. When slightly more than half the strip was pasted, we folded over the top half by bringing the top edge back to the middle of the strip. The strip was then moved up and paste applied to the remaining half. We folded over the second half, stopping just short of the first fold. This makes the strip easy to carry, unfold and hang. Next, we hung the strip by unfolding the upper fold and aligning one edge of the strip along the plumb line. We positioned the top edge 1 in. above the bottom edge of our ceiling molding. We smoothed the strip with a smoothing brush, working down the entire length of the strip, unfolding the second fold as we went.

The 6- and 10-in. joint knives we used for plastering were helpful in pressing the wallpaper edge snugly against the molding line. We then used a sharp utili-

ty knife to trim away any excess wallpaper. We changed the blades of the cutting tool frequently to avoid tearing the paper and to yield the cleanest edge.

To force excess paste to the edges of the strip, we used a rubber roller, then wet sponge to wipe away the paste squeeze-out. We washed and smoothed the entire strip with a sponge, changing the water often to avoid having it become too sticky with paste.

The next strip was cut, matching the pattern along the edge. The procedure was the same for applying paste and folding the strip. We butted the seam edges flush. Because wall corners are not perfectly straight, on the inside corners we turned the corner with a ½- to 1-in. lap, then we started the next wall with a full sheet width that we first positioned over the lap, then aligned the other edge along a plumb line on the new wall. We worked around the room until all the wall surfaces were covered.

Wallpaper: House of Mayfair, pattern No. 5-010432-387858.



Cut away excess wallpaper leaving 2- to 3-in. allowance for trimming. Note the rounded corner is less likely to tear when wet.



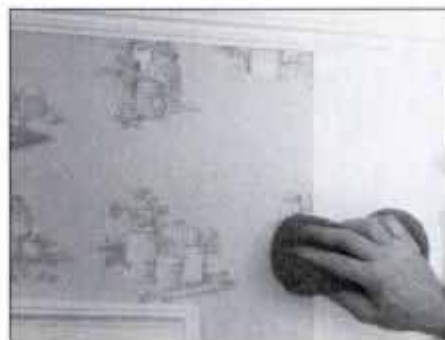
Cut wallpaper corner back at angle to permit fitting neatly along the door frame casing molding. Don't stretch the paper.



After fitting the top edge of strip, adhere rest of wallpaper following plumb line previously marked on wall for right edge guide.



Use metal straightedge, like a 10-in. taping knife, to press paper against trim or ceiling. Then cut edge with sharp utility knife.



Wipe away any paste squeeze-out at edges of strip, then sponge entire strip surface to remove any excess paste and smooth out.



Cut small "X" in wallpaper above receptacles and other fixtures. Then carefully smooth the wallpaper and trim away any excess.

KITCHEN KUDOS

Floor

As mentioned earlier, the old linoleum was removed and its adhesive scraped away with hand scrapers during our demolition phase. With everything else complete, including the installation of all the new appliances, it was time to refinish the floor.

Because the exposed floor was so small we decided against renting a drum sander. Instead we used a heavy-duty portable belt sander with its own dust bag. We used rough-grit paper first, then medium sandpaper, sweeping and vacuuming thoroughly after each sanding. Around the cabinets and appliance bases some hand scraping was required. A third sanding was done, then another vacuuming to remove the dust.

The final finish sandings were accomplished using a palm-type finishing sander. We started at 100-grit, then moved to 120- and 180-grits. Again, we swept and vacuumed between each change.

We had had to block up the range to bring it to counter level and the edges of the plywood blocks showed. Our solution was to cut and miter 1/2-in. quarter-round molding to finish these raw edges. This molding was tacked in place along the front and side edges.

There were several long gaps between the floorboards and a few darkened nail holes which we filled with a

latex-base wood filler. We worked the filler into the defects with a spackling knife, then went back over the floor with a water-dampened coarse cloth to rub off the excess filler.

We let the filled floor dry overnight, then hand-sanded it lightly with 220-grit sandpaper. We vacuumed and dusted the floor thoroughly.

We decided to "pickle" the floor to give the room a lighter, more contemporary feel. We diluted a latex-base flat white paint to achieve the pickling, and tested an area behind the refrigerator until we were satisfied with our technique.

Working one 2-ft.-sq. section of floor at a time, we brushed on a generous amount of diluted paint, using a scrubbing action to work the color into the floor. Before each section was completely dry, we wiped off the excess paint with an absorbent rag, feathering out the edges. We continued over the entire floor, blending into the previously worked areas. The floor dried overnight and we did a final light sanding and clean-up.

We used a satin-finish polyurethane, five coats in all, as the protective finish. With the room well-ventilated, we poured out the polyurethane into a disposable paper bucket and gently stirred it. The satin-finish polyurethanes have ingredients—that give them their characteristic low-luster—which tend to settle out to the bottom of the can. So it's best to frequently stir your supply to

keep it at a uniform consistency.

We applied a 50-percent thinned coat first to ensure good penetration, and applied the successive coats as they came from the can. We kept the brush full of the finish and, to avoid air bubbles, did not work the brush back and forth.

We allowed each coat to dry eight hours, then lightly sanded with 220-grit sandpaper and dusted with a tack cloth before applying the next coat. The final coat we let dry 48 hours before walking on it.

We were now down to the final touches. With flat black enamel we touched up the black toekick on all the base cabinets, and bought new baseboard and shoe molding for the walls, which were measured and cut to length. We primed and painted these moldings in the workshop with a semigloss white enamel. We installed the baseboard with 6d finishing nails driven into the wall studs, then added the shoe molding, tacking it to the floor with 4d finishing nails. All the nail holes were filled and the molding touched up with paint.

We had purchased extra prefinished cherry molding—that had been used to trim the wall cabinets—to make a cherry shoe for the base cabinets. The molding was 1/4 x 1 1/2 in. with both edges rounded, so for the shoe, we trimmed off one rounded edge. We then cut the pieces to length, mitered the ends as necessary, and installed them with finishing brads. The nail holes were filled using a colored Blend-Fil stick. **PM**



Use a latex woodgrain filler that matches wood floor to fill cracks and joints. Wipe off any excess with a damp cloth.



Apply flat white latex paint to floor, scrubbing in with an inexpensive brush. Work in floor sections that are about 2 ft. sq.



Remove excess paint by rubbing with a soft cloth in the direction of the wood grain. Do not let the paint dry before removing.



Tone down dark spots and any wild grain using additional paint. Work with a small brush and remove excess with a rag.



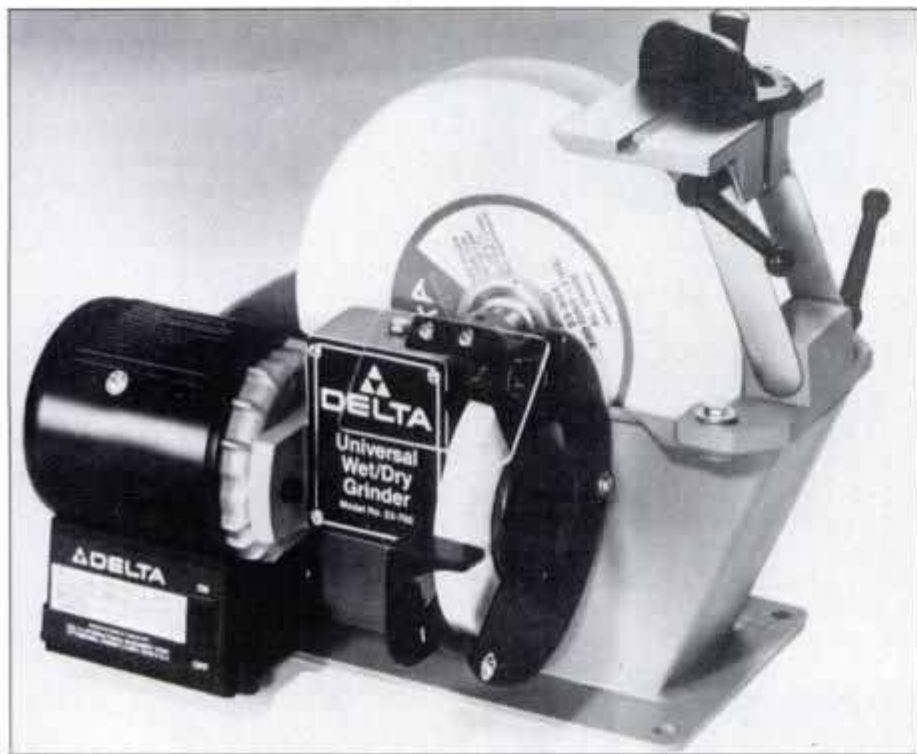
Sand floor lightly to remove any raised grain from "pickling" process. Vacuum carefully, then wipe thoroughly with a tackcloth.



Apply polyurethane with a disposable foam brush. Do not over brush, and be sure to stir polyurethane frequently as you work.

SHOP STUFF

The latest and the hottest shop tools and accessories.



Get The Edge With Wet/Dry Grinder

Now there's a single tool to handle all sharpening jobs. Delta's Universal Grinder (\$169) has two aluminum-oxide wheels that provide high-speed *dry* grinding and slow-speed *wet* grinding. For general-purpose grinding, a $\frac{5}{8}$ × 5-in.-dia. dry wheel operates at 3450 rpm (lower left). Use it to sharpen drill bits, knives, scissors and lawnmower blades.

A 2 × 10-in.-dia. wet wheel runs partially submerged in water at 70 rpm.

The slow, wet wheel allows careful grinding without fear of drawing the tool's temper. An adjustable tool rest and miter gauge permit precise sharpening of chisels, plane irons and turning tools (lower right). The grinder is powered by a $\frac{1}{5}$ -hp, 2-amp. motor. It measures about 12 in. wide × 13 in. high × 14½ in. and weighs 32 pounds. Contact Delta International, 246 Alpha Dr., Pittsburgh, PA 15238.



Step-Up Tool Tote

The clever Tool Stool is a combination step stool/tool box. It features a bolt-together steel frame and durable fiberboard top. The top is hinged to allow easy access to a large storage compartment and lift-out small-parts tray. A slotted tool rack, mounted to the end of the stool, holds several small hand tools. The stool has a highly visible orange enamel finish and mar-resistant, non-slip feet.

The easy-to-assemble Tool Stool (model TSB-1) measures 11 × 14½ in. high × 25 in. long and costs about \$26 at hardware stores and home centers. For more information and details, contact Hirsh Co., 8051 Central Park Ave., Skokie, IL 60076.



Double-Duty Stapler

You'd expect an electric stapler to drive staples, but here's one that drives brads, too. The Parker TRE-300 stapler drives five sizes of staples ranging from $\frac{1}{4}$ to $\frac{9}{16}$ in. long, and two sizes of brads: $\frac{1}{2}$ and $\frac{3}{8}$ in.

A swing-away base makes it easy to load the tool and clear jams. The stapler features a convenient power-control setting that allows you to regulate the driving force for hard or soft materials. The flush-nose design permits stapling in tight spots and corners. Use the TRE-300 to apply flooring, paneling, ceiling tiles and fabrics.

It's available at hardware stores and home centers for about \$25. For more information, contact Parker Manufacturing, 149 Washington St., Box 644, Worcester, MA 01613.



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Crossbred Saw

Cross a power miter saw with a radial-arm saw and you'll get the Sears radial-arm saw. This unique saw crosscuts, miters, bevels and cuts compound angles. Cutting capacity is 2 1/2 in. thick x 8 3/4 in. wide at 90° (crosscut), 2 1/2 x 6 3/16 in. at 45° (miter), and 1 3/4 x 8 3/4 in. at 45° (bevel). The 7 1/4-in.-dia. blade is powered by a 1 1/2-hp motor that delivers 5000 rpm. The saw costs about \$250 at larger Sears stores and through the Sears tool catalog. Contact Sears, Roebuck and Co., Sears Tower, Dept. 703-PM, Chicago, IL 60684.



A Bit Tougher

Vermont-American claims its titanium drill bits will last up to six times longer than standard high-speed bits. A special titanium-nitride coating is applied to high-speed steel in a high-vacuum, ion-bonding process. As a result, according to Vermont-American, the bits cut cleaner with less friction, drill faster with less pressure, work cooler at high speeds, and start cutting quicker because of a 135° split-point. The bits range in diameter from 1/16 in. (\$1.75) to 1/2 in. (\$14.85). Also available: 13-piece (\$28) and 29-piece (\$152) bit sets. Contact Vermont-American, Box 340, Lincolnton, NC 28093.



Hobby Saw

Delta now offers a compact, affordable scroll saw for home and shop use. The 15-in. saw (model No.40-500) is designed for hobbyists, modelmakers and all lightweight woodworking. It will cut a variety of materials including wood, metal and plastic. The 3-in.-long blade can be installed facing forward, or left or right for ripping. The depth-of-cut capacity is 1 1/2 in. and the 8 x 9 1/2-in. sheet-steel worktable tilts 45° left and right. And, with optional accessories, the saw can sand, buff and operate a flexible-shaft.

The 15-pound saw is powered by a 3/5-amp motor and cutting speed is adjustable from 1100 to 2000 strokes per minute. The tool comes with three saw blades and three sanding discs with a backing pad and adapter. It costs about \$105 and is available wherever Delta tools are sold. For details, contact Delta International, 246 Alpha Dr., Pittsburgh, PA 15238.



One-Touch Wrench

This unique, adjustable wrench features 1-hand operation. Simply press the button located on the tool's spine to open the jaws—there's no knurled nut to rotate. Release the button and the jaws close and adjust automatically to the specific size nut or bolt head. Coarse-tooth jaws provide a nonslip, nonstrip grip. The wrench is made of drop-forged, heat-treated steel. It's available in three sizes: 6 in. (\$6), 8 in. (\$9) and 10 in. (\$10).

The One-Touch wrench is sold at hardware stores and home centers. For more information, contact Great Neck Manufacturing, 165 E. 2nd St., Mineola, NY 11501.

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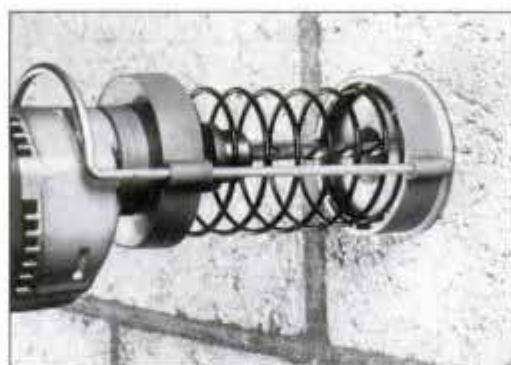
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The base has a nonslip surface to prevent wandering. Two V-shaped notches allow the guide to fit on round objects. It costs about \$11 at hardware stores and through mail-order catalogs. Contact Themans, Inc., 5721-G Bayside Rd., Virginia Beach, VA 23455.

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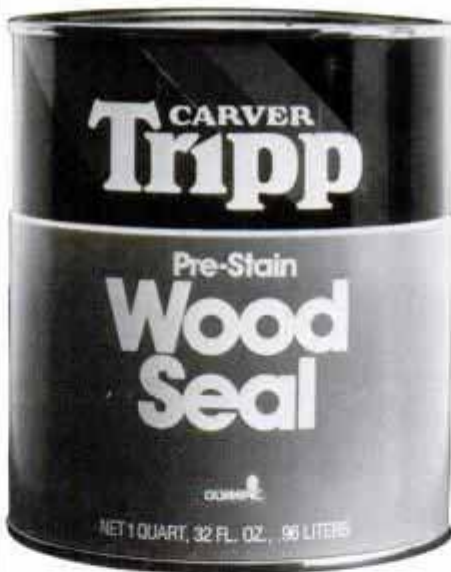
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Wood Seal comes in half-pint (\$3), pint (\$4) and quart (\$6) cans. For details, contact Carver Tripp, Box 5, Somerset, MA 02726.



Clean-Cut Blade

Here's a saw blade that's designed specifically for use on a radial-arm saw. The 10-in.-dia. blade, called Radi-All, has 60 carbide-tipped teeth that have a hook-angle design. This helps to reduce over-feed—the tendency of the blade to feed faster than it can cut—while producing a clean cut. The smooth-cutting blade will handle precision trimwork and general-purpose sawing, too. Use it to cut softwoods, hardwoods, plywood and composition boards. It fits 3/8-in.-dia. arbors. If a saw tooth is knocked off, a new one can be brazed on at a relatively low temperature, thus avoiding blade distortion.

The Radi-All blade costs about \$84. For a DML distributor near you, call toll-free: (800) 233-7297. For details, write to DML, Inc., 1350 S. 15th St., Louisville, KY 40210.

SHOP STUFF



Hot Shot

Blazer is a handheld, refillable butane mitorch that produces a 2500° F flame. A pushbutton, electronic ignition eliminates the need for matches. The 1½-in.-dia. × 5½-in. torch will burn up to two hours before refilling is required. Use it for precision soldering and welding jobs, including jewelry work, model-making and plumbing repairs. The portable torch will also remove paint, thaw frozen locks and soften window putty. It costs about \$60 through mail-order tool catalogs. Contact Blazer Products, Box 4, New York, NY 10021.



Diamond Studded

Dremel recently introduced eight diamond-studded wheel-points that are designed for cutting, carving, etching and engraving a wide variety of materials. Use these bits to etch and engrave steel, glass, ceramics, cast iron, porcelain, jade and other hard materials. In precision woodcarving, diamond wheel-points don't grab and skip, but work smoothly and cleanly, according to Dremel. The bits have 3/32-in.-dia. shanks to fit most rotary power hand tools. They're sold at hardware stores and hobby shops. Prices range between \$10.50 and \$15.50 each. For more information, contact Dremel, 4915 21st St., Racine, WI 53406.

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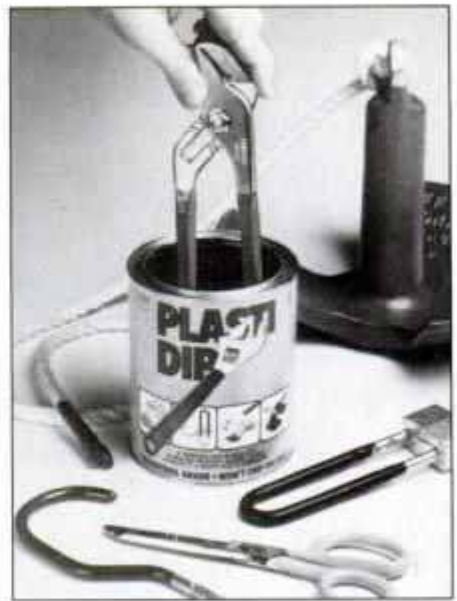


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Woodcarvers' Friend

Tuff-Carv wood filler is formulated to repair damaged wood and carving mistakes. Simply mix the quick-setting, 2-part polyester-resin filler with a little hardener and apply it with a putty knife. Once it has dried, the filler can be carved, sawed, sanded and bored easily. The pine-colored filler comes in a quart can with a 1-ounce tube of hardener for \$12.95 postpaid.

Additional tubes of hardener cost \$2.95 each. For details, contact Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

SPUTNIK

(Continued from page 61)

ing President Reagan's Strategic Defense Initiative by more than a quarter of a century, said that several proposed defensive systems "appear to have the capability of intercepting ballistic-missile warheads at sufficient distances to prevent their doing serious damage." Eisenhower called the report "useful," refused to release it publicly, and largely ignored it.

But the president did make one critical decision immediately after *Sputnik's* launch. On October 8, according to his memoirs, he designated the Redstone—with the JPL upper-stage package balanced on its nose—as a "backup" for Vanguard. Within a short time, JPL's Downhower set off on a secret odyssey to Vanguard laboratories around the country, looking for a satellite designed for the Navy but strong enough to survive a battering from the Army Sergeant rocket clusters.

"The ride we were going to give it was pretty rough by today's standards," Downhower recalled recently. "We were spinning it at a full 750 rpm. The payload was not under a shroud. It was directly exposed to the aerodynamic forces. The second-stage ignition provided about 20 Gs, burned out at 40 Gs. The fourth stage started to get up toward 80 or 90 Gs. The rockets only burned from 5½ to 6 seconds. You couldn't carry a fragile package on top of this, because it wouldn't survive."

After a tough search and delicate negotiations with scientists under contract with the Navy, the JPL team including Downhower found the most promising design in the Iowa laboratory of James Van Allen. He was a pioneer in sending instrument packages up on sounding rockets to measure the atmosphere. The small rockets Van Allen had been using were about as brutal on payloads as the Sergeant models. Van Allen instrument packages "were basically rugged little things, so they lent themselves reasonably well to survival," Downhower says.

Once the JPL-Army team settled on Van Allen's satellite, the Pasadena laboratory's personnel noticed that the pace of work picked up as if the mission itself was riding the Redstone. Something of the old, American fighting spirit had taken hold at JPL late in 1957. Just 80 days after the Army was finally ordered to try to launch, the Redstone/Sergeant rockets hurled Van Allen's tough, little *Explorer* into orbit. The U.S. was back in the race.

After 30 years, we can see that *Sputnik I* was a prelude, more powerful as a symbol than as a work of science. Within a few months of the first Soviet launch, (Please turn to page 92)

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SPUTNIK

(Continued from page 91)

data began falling from space in a crescendo from *Sputnik's* successors from many nations. They gave us views of space and Earth never seen before. They linked nations with the most powerful communications networks in history. They strengthened national defense. Some of them saved lives.

Some of the most significant of those later satellites are seen in our Revolution In Space illustration:

■ **Explorer** Launched January 31, 1958, by the Redstone/JPL spacecraft, the 30.8-pound, 6-in.-thick probe sent down mysterious data on its cosmic ray measurements. Over California, the counts were only 30 to 40 per second, but over South America, the count rose to more than 35,000, blanking out the instrumentation. This cloud of radiation discovered by America's premier satellite became known as the Van Allen Belt.

■ **Discoverer** The first in this Air Force series flew on February 28, 1959. *Discoverer XIV* was the first to eject heavy capsules that were snatched in midair as they fell carrying film and biological specimens from space.

■ **Tiros I** Launched April 1, 1960, it was the first operational weather-bureau satellite, raining down nearly 23,000 TV pictures of cloud covers during its 78 days of operation.

■ **Echo** The earliest communication satellite, launched May 13, 1960, bounced radio waves off of the aluminum skin of a 100-ft.-dia. inflated sphere.

■ **Telstar I** Launched July 10, 1962, the first commercial satellite did more than reflect: It amplified signals from Earth before actively transmitting them. TV programs were sent instantaneously over oceans for the first time.

■ **Syncom II** *Syncom I's* communication package failed. But *Syncom II*, launched August 28, 1963, worked beautifully from geosynchronous orbit 22,230 miles over Earth, where the satellite's speed matched the Earth's rate of rotation. It became the first satellite to establish communications between Africa and North America.

■ **Early Bird** The debut of the Communications Satellite Corp.—Comsat—was a geosynchronous satellite launched April 6, 1965. Powered by 6000 silicon-coated solar cells, it provided a 240-circuit, 2-way voice link between North America and Europe.

■ **Orbiting Astronomical Observatory II** This orbiting telescope, launched December 7, 1968, was used to study young, hot stars, interstellar gas, and to create a pictorial map of more than 700 stellar bodies. It demonstrated the value of looking at deep space from the

clear vantage above the atmosphere.

■ **ERTS** The first *Earth Resources Technology Satellite*, launched July 23, 1972 and later renamed *Landsat I*, took repeated pictures of the entire Earth in four spectral bands. It provided a rich harvest of data on land usage, urban growth, mineral deposits and oceanography. The *Landsat* series also helped map territories never charted before.

■ **ATS-VI** Launched in 1974, the 3000-pound *Applications Technology Satellite-VI* was something new in communications satellites. Its "umbrella" antenna, 9 meters in diameter, could transmit directly to small ground receivers, not just large ground relay stations. The satellite was the first to transmit information on medical techniques to doctors in remote areas.

■ **SBS** Beginning in 1980, the *Satellite Business Systems HS 376* satellites have offered business communications services to large American companies. Each offers 10 channels with the capacity for 1250 2-way telephone conversations per channel, or 10 color TV transmissions, or a combination of TV and telephone communications. An SBS satellite was the first to be launched from the Space Shuttle, in 1982.

■ **Cospas** Soviet weather satellites in the *Cosmos* series (renamed *Cospas* in their search-and-rescue role) work in tandem with U.S. Advanced *Tiros* weather satellites to listen for radio distress beacons from Earth. By helping to locate downed pilots or ships in distress, the system has saved hundreds of lives internationally since it went into operation in 1982.

■ **SPOT** Since its launch on an Ariane rocket in February, 1986, the French *Système Probatoire de la Terre* has offered the view from orbit to anyone who can afford it, not just governments. The U.S. representative in Reston, Virginia, (703-620-2200) sells black-and-white photos of any area on Earth (with a resolution of 10 meters) and color and near-infrared photos (with a resolution of 20 meters). Prices range from \$200 and up.

■ **Navstar** When the *Navstar* system is fully operational, it will enable ground users, equipped with the right equipment, to calculate their positions within tens of feet, their velocities within inches per second.

■ **DSCS III** This military communications satellite (a prelude to *Milstar*), to be launched in the future, is designed for improved, highly jam-resistant communications, particularly in the event of enemy attack, and even in the face of attempts to disrupt communications. Details remain highly classified.

All of these highly useful satellite systems were the subject of fanciful conjecture in the fall of '57, when a tiny orbiting sphere called *Sputnik* changed the world forever. **PM**

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BEDTIME STORY

(Continued from page 74)

in. veneer for this purpose is by far an easier way to get smooth gluing surfaces and consistent thickness in the 12-ft. lengths required. To adequately clamp the veneers, you'll need at least 24 hand clamps and a long band clamp. Slow-setting plastic resin glue will give you the time you need to get the laminations in place on the form.

Apply glue to the veneer surfaces and stack them so their edges are aligned. Next, bend the stack around the form so it rests on the ledger blocks. Slip the band clamp around the laminations and tighten. Now, starting at one end of the bow, apply clamps to draw the veneers tightly together. Use cauls at the straight sections and $\frac{1}{4}$ -in. hardboard under the clamps that go around the arc

to prevent flat spots. Leave the clamped-up lamination in place for 24 hours. Because of the excessive moisture imparted to the wood in this process, let the lamination set for 72 hours after removal before dressing the bow to size.

Posts and rails

The 3-in.-sq. bed posts are each made by gluing together two pieces of $1\frac{1}{2}$ -in. stock. Cut the stock oversize, glue and trim to exact dimension. Next, rip the rails, dress the sawn edges, and cross-cut to exact length.

Lay out the mortises for the side rail hangers and the mortise-and-tenon joints for the head, foot and spindle rail. Before machining the mortises, cut the chamfered profiles with a router as shown in the drawing.

To cut the mortises in the side rail

ends, first bore overlapping holes with a brad-point drill guided by a doweling jig. Then, use a sharp chisel to clean away the remaining waste. The $\frac{1}{8}$ -in.-deep hanger mortises in the posts are cut with a router, edge guide and $\frac{1}{8}$ -in. straight bit. Then, mark and cut the $\frac{1}{4} \times \frac{7}{16}$ -in.-deep recesses for the hanger hooks using the router and $\frac{1}{4}$ -in. bit.

Clamp a fence to the drill-press table and bore overlapping $\frac{1}{4}$ -in. holes to start the mortises which house the head, foot and spindle rail tenons. Remove the waste with a sharp chisel. Next, cut the $1\frac{1}{16} \times 1\frac{1}{16}$ -in. groove in the head posts with a dado blade mounted in the table saw. Use at least two passes to complete each groove. The tenon cheeks can be cut with the dado blade also. Cut the tenon shoulders with a band saw or backsaw.

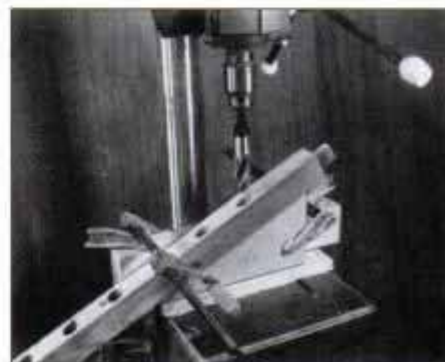
(Please turn to page 96)



10 Install an oversize fence on the table saw. Rip and saw bow to width. Make sure the bow rests on table at the saw blade.



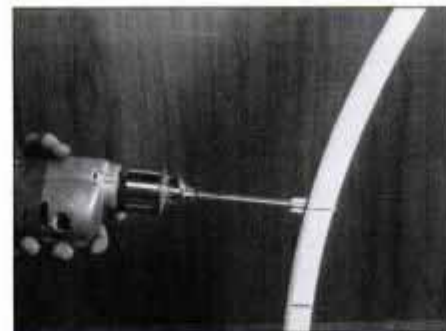
11 Insert the bow in the headboard-leg grooves and mark the starting points for the chamfers. Cut chamfers with a router.



12 After marking the hole centers, secure the spindle rail at the appropriate angles and bore the 1-in.-dia. spindle holes.



13 Transfer the spindle positions to a layout board. Clamp the bow in place and mark the spindle-hole positions on bow.



14 Bore the bow-spindle holes by following the spindle angle marks. Drill until point protrudes and complete from inside.



15 Turn short spindles completely on the lathe. Turn only long spindles, ends and shape with a drawknife and spokeshave.



16 After gluing up headboard legs, rail and spindle rail, insert spindles. Glue and clamp the completed bow in place.



17 Pass the spindles through the bow-spindle holes and drive wedges in the slotted ends at bow and spindle rail.



18 Cut the spindle ends nearly flush with a fine dovetail saw and use a sharp chisel to trim them flush with the surface.

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The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!

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"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road: The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

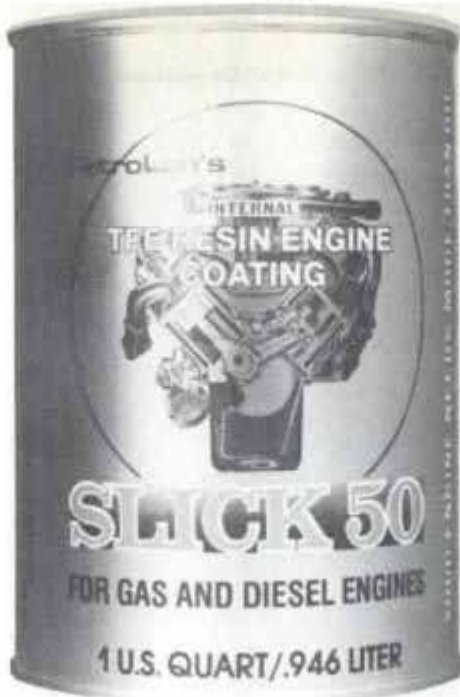
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #3349). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

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Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)

3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine

4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

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THE DEPENDABLES.

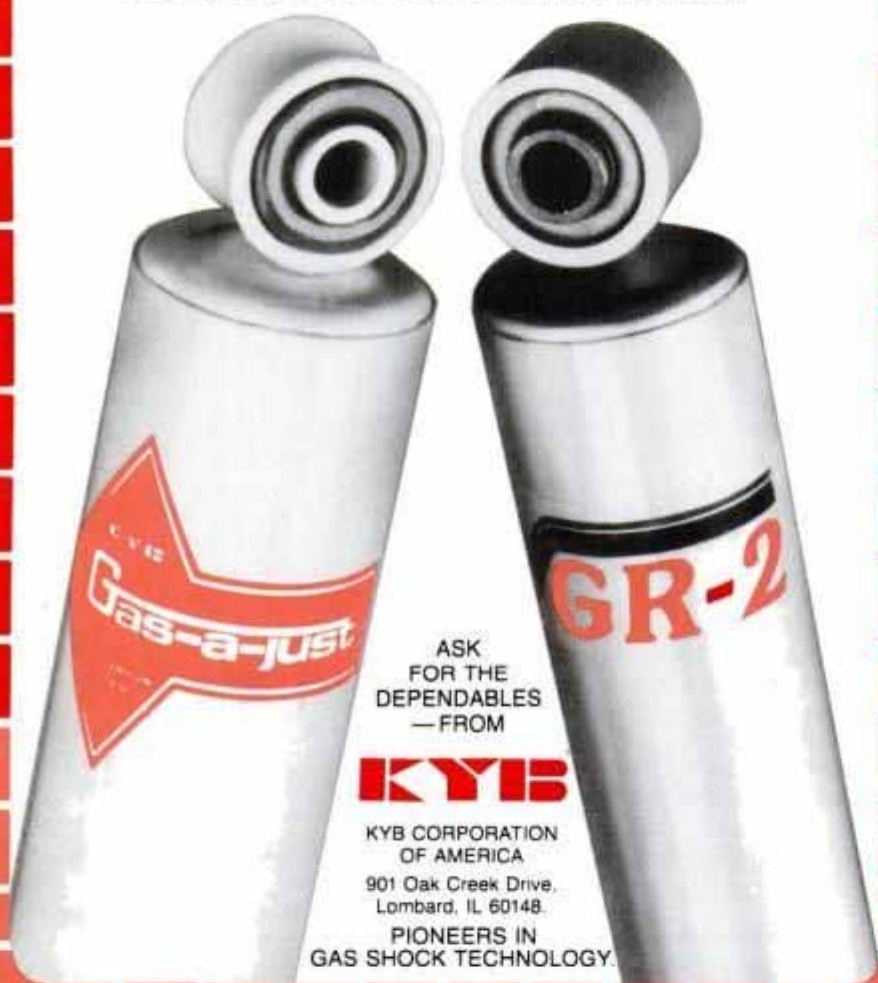
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BEDTIME STORY

(Continued from page 94)

Assembling the headboard

Clamp the bow to the worktable and plane one edge flat. Then, prepare the table saw for ripping the bow to width by attaching a tall, wide auxiliary fence to the regular rip fence. As you cut, keep the stock flat against the table as it passes by the blade. Trim the straight ends of the bow to length and test fit in the head-post grooves. Mark the starting points for the bow chamfers and cut them with a router.

Next, clamp a fence to the drill press table at right angles to the axis on which the table tilts and bore each spindle hole at the specified angle. If your drill press lacks a tilt-table feature, construct sloped supports at the required angles that you can clamp to the table.

Make a full-size layout of the spindle angles and positions on a piece of plywood or particleboard. Then, clamp the bow in place being careful to position it on the layout accurately. Transfer the spindle hole positions and angles from the layout to the bow. This is a good time to note the spindle lengths. Next, use a $\frac{9}{16}$ -in. spade bit and follow the angles transferred from the layout to bore the holes in the bow. Bore only until the point pokes through the opposite side and complete the hole from the inside.

The shortest three spindles can be turned entirely on the lathe. The longer ones, however, will tend to chatter. Turn only the tenons on these and shape the tapers with a drawknife and spokeshave. Each spindle is locked in place by wedges that are driven into slots cut in the ends of the spindles. Cut the slots with a backsaw keeping both the top and bottom slot on each spindle parallel. Set the miter gauge on the table saw to cut 2° wedges, $\frac{9}{16}$ in. wide for the top, and 1 in. wide for the bottom.

Now, apply glue and assemble and clamp the head and spindle rail with the head posts. Place each spindle in its hole in the spindle rail. Apply glue to the grooves in the head posts and clamp the bow to the posts until the glue sets.

Slide the spindles into the holes in the bow and align the wedge slots at right angles to the grain direction of the bow. Apply glue to the wedges and tap them into the slotted spindle ends. After the glue has set, trim ends flush with a dovetail saw followed by a sharp chisel.

Sand the entire bed, first with 120-grit, then, 200-grit paper. We finished the bed with three coats of polyurethane varnish, thinning the first coat with mineral spirits. Lightly sand between coats. The mattress hangers can be fabricated at a steel supplier at modest cost. Install them with $1\frac{1}{2} \times \frac{1}{4}$ -in. lag-screws. Finally, install the bed rail hangers with 2-in. No. 8 fh screws. **PM**

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The experts are unanimous

No matter what anybody says, there is, in fact, no detector on the market that's "just as good as" Escort and Passport. And you needn't take our word for it. In 1987, three respected magazines have published comparison tests of radar detectors.

What Car and Driver says

In April, *Car and Driver* rated Passport highest of nine miniature models, saying, "At \$295 direct from the factory, it's the most expensive piece of electronic protection in the group, but it's worth every nickel in roadgoing peace of mind."

What Roundel says

In June, *Roundel* ranked Passport and Escort first and second respectively in a comparison of 14 detectors. About Passport the author said, "It remains the State of the Art, a true quality product, American ingenuity at its best." Regarding Escort, "It is an excellent detector in its own right and continues as a pacesetter in the detector market."

What Popular Mechanics says

In July, *Popular Mechanics* rated Escort first and Passport second in a group of 11 brands. The magazine concluded, "Clearly, the Escort is the best radar detector around. The best of the minis was the Passport..."



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In every 1987 magazine test of radar detectors, Escort and Passport have been rated highest. See for yourself. For complete copies of the tests (not excerpts or selected quotes), showing ranking of all brands, just call us toll free.

Money
MAY 1987

99 THINGS THAT AMERICANS MAKE BEST

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7/70



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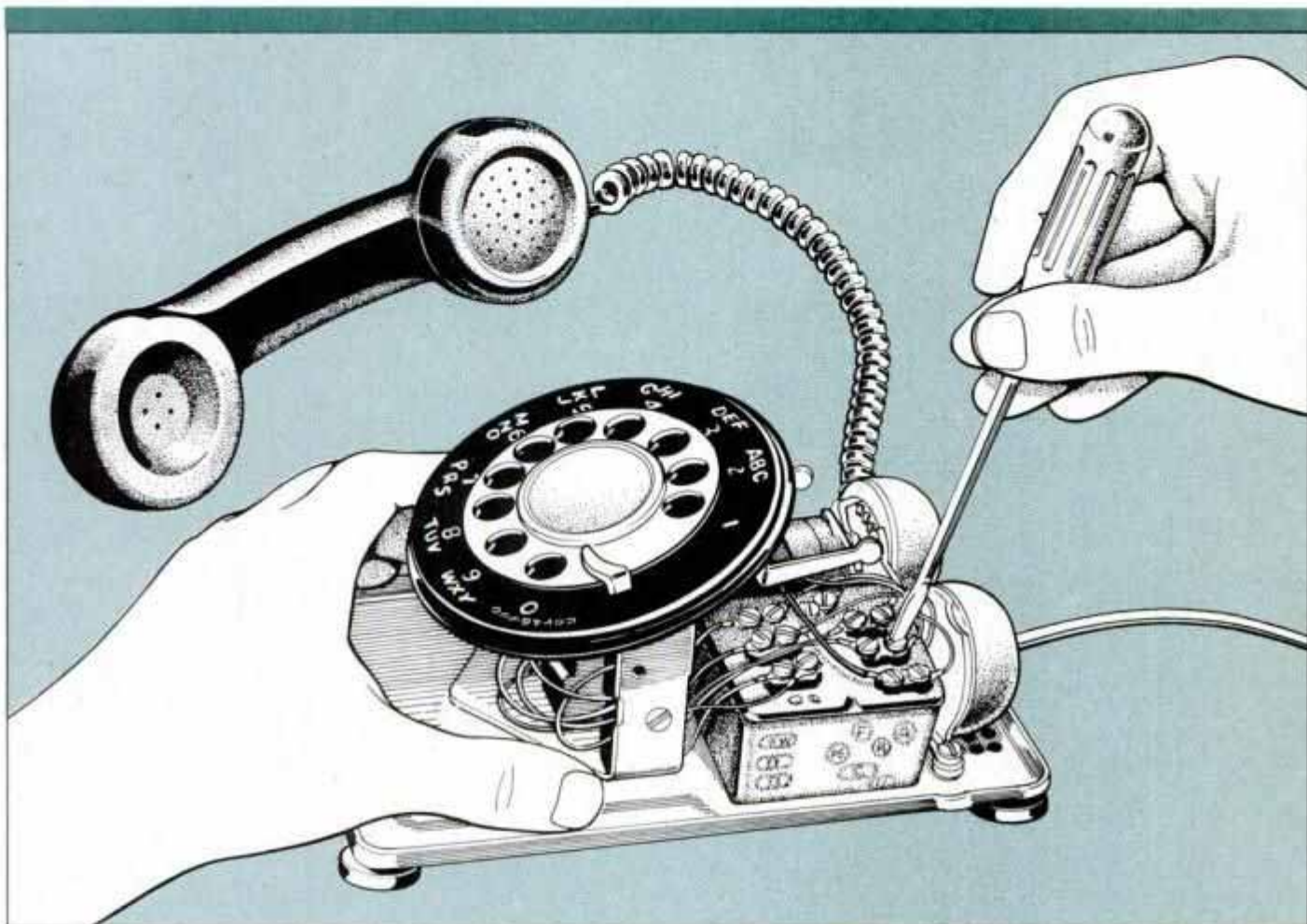
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THE BETTER HOME



How To Repair TELEPHONES

In these days of planned obsolescence, it's nice to know that some things are built to last. Long before the introduction of the now-popular electronic telephone, the telephone company had installed millions of model 500 (rotary dial) and model 2500 (Touch-Tone) desktop phones. Both phone models have an estimated life span of 25 years, but most have lasted years beyond that. However, the best thing about these old, reliable telephones is that you can often fix them yourself—something that's almost impossible with an electronic phone.

The repairs for a rotary-dial or Touch-

BY MORT SCHULTZ
Illustrations by George Retseck

Tone (pushbutton) phone are basically the same. Just don't be intimidated by the tangle of wires inside the phone. Besides, the wires are seldom the problem with a faulty phone.

Preliminary checks

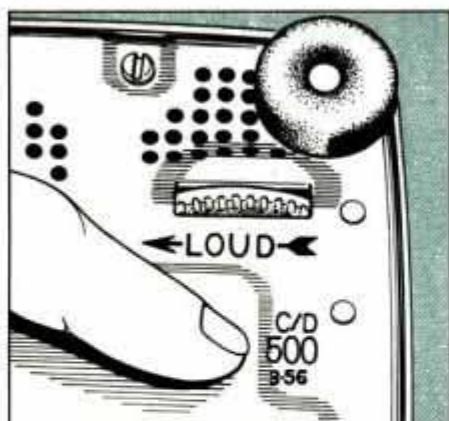
Before you start to fix the phone, be sure that it's the *phone* that needs fixing. The problem could also be caused by the phone wiring inside the house walls, wiring outside of the house, or the equipment that's located at the tele-

phone company's central office.

To check the problem phone, first take it to a neighbor's house and plug it into their wall jack. If the phone works properly, then the trouble is probably with your house wiring.

Next, borrow a phone that you know operates correctly and plug it into the wall jack at your house. Be sure that it's the same jack that the problem phone was connected to. If the borrowed phone works okay, then your phone has a malfunction.

Caution: Disconnect the phone's line cord from the wall jack before starting any repairs. If the cord is plugged in and



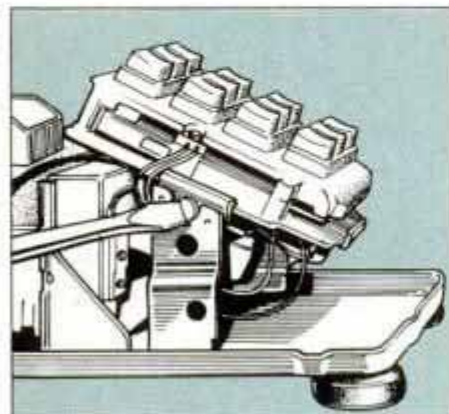
1 Phone's model number and date it was manufactured are printed on its bottom plate. Note ringer's volume control knob.

the phone rings as you're working on it, you can receive a severe electrical shock. The electrical voltage developed when a telephone rings is approximately 60 to 90 volts.

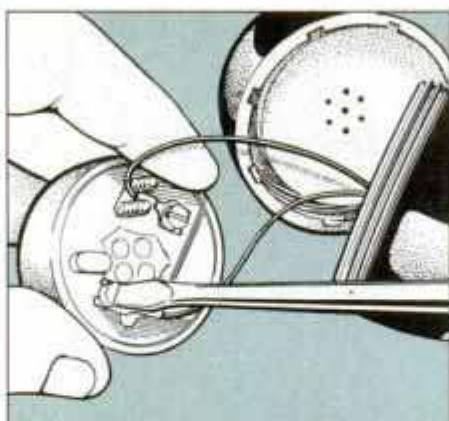
How's that?

One of the most common problems with older phones is reception quality. Voices may sound muffled or distant. First, unscrew the earpiece cover from the handset and lift out the receiver. The receiver is attached to the handset with two wires. Tighten the screws that hold the wires to the receiver (Fig. 2). Loose wires will cause bad reception. If that doesn't help, then loosen the screws to free the two wires from the receiver. Use a piece of very fine emery cloth or sandpaper to clean the Y-shaped wire terminals (Fig. 3) and the contacts on the back of the receiver. Now tap the receiver on a hard surface to loosen the carbon granules that are inside (Fig. 4).

Carbon is used as a medium through which receiving is accomplished. Over



7 In order to get at the contacts, you must remove the Touch-Tone panel, or rotary dial, by loosening the screws on each side.



2 The receiver is located behind the earpiece cover. Be certain that the wires leading to receiver are fastened securely.

the years, the carbon granules may have become compacted. For good reception, the granules must be loose. Hold the receiver near your ear and shake it. You should hear the granules rattling around.

Reattach the wires to the receiver, place the receiver back in the handset and replace the earpiece cover. Now call someone and test the phone. If reception isn't improved, there are two more steps to take: servicing switch-hook contacts and replacing faulty parts.

Checking contacts

The switch-hook contact assembly consists of a series of make-and-break points. The contacts are located inside of the phone and are protected by a transparent plastic dustcover.

To expose the phone's guts, turn it upside down and loosen the two screws that hold the metal base to the plastic phone housing. The screws may be captive, meaning that they can be loosened, but not removed and possibly lost. The switch-hook contacts are located behind the dial, in front of the switch-hook (Fig. 6). To work on the contacts, remove the dial by loosening the screw on each side and pull it to

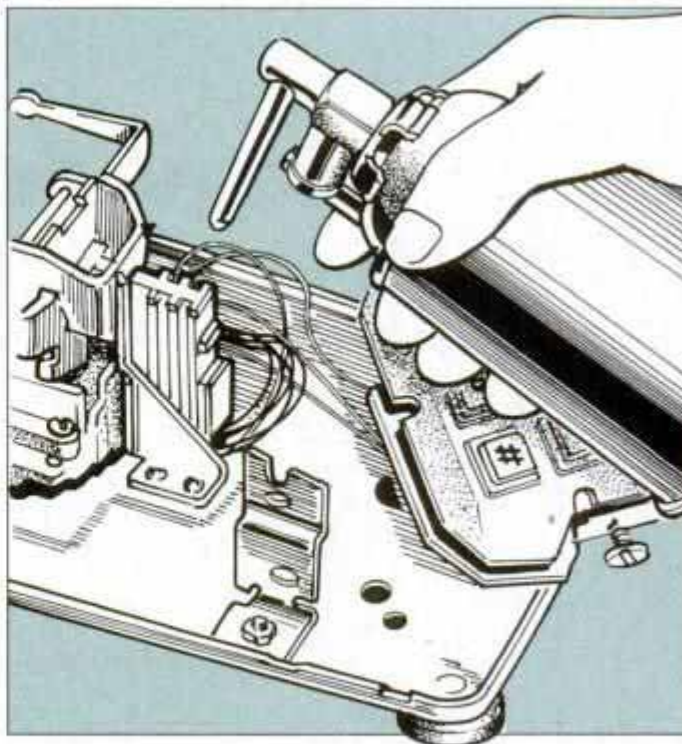


3 Use very fine emery cloth or sandpaper to clean Y-shaped terminals of receiver. Clean back surface of the receiver, too.

one side (Fig. 7). Next, remove the clear plastic dustcover that protects the switch-hook contacts.

Using a screwdriver, press the tab on top of the cover while squeezing its sides. Lift up to free the cover. Then, use an ear syringe or compressed air to blow out dust and dirt from between the contacts (Fig. 8).

Press down the switch-hook and release it slowly to open and close the contacts. If the contacts stick together, then further cleaning is necessary. Remember though, switch-hook contacts can be responsible for problems other than bad reception.



8 After removing the plastic dustcover, clean between the contacts with a can of compressed air. Blow out all dirt and dust to prevent the contacts from sticking together.

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4 If the carbon granules inside of the receiver have become compacted, tap it against a hard surface to loosen them.

Replacement part remedies

Bad reception can also be caused by faulty cords. Modular cords—the kind you can unplug—are easy to test. Simply unplug the cords from the handset, phone and wall jack and connect them to another phone.

If the phone's reception is clear, then the cords are okay. Buy a new receiver for the problem phone, reconnect the cords and test the phone.

Telephone replacement parts are available at Radio Shack and phone stores. Take the old part to the store so that the salesperson can cross-check part numbers to ensure that you get the



5 Unscrew mouthpiece and remove transmitter. Then, bend up the contacts slightly to ensure good contact with transmitter.

right part. Older phones have cords that are wired directly into the phone and handset.

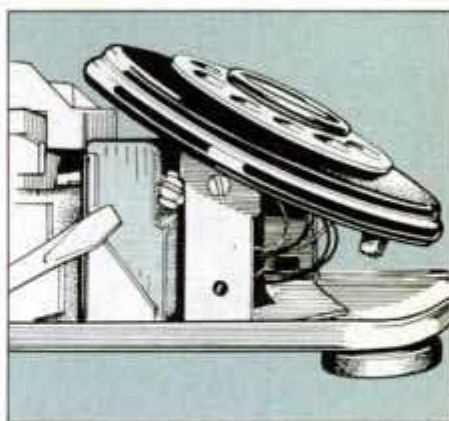
Don't try to remove these cords. Instead, install a new receiver. If this doesn't help, and you've already checked the switch-hook contacts, then the phone is beyond repair.

Weak transmission

Do people have difficulty hearing you over the phone? Then the problem may be with the transmitting end of the handset. Unscrew the mouthpiece cover and remove the transmitter. Unlike the receiver, there are no wires attached to the transmitter.

Inside of the handset are two metal contacts.

Clean the contacts and the metal surface of the transmitter with very fine emery cloth or sandpaper. Then, bend up each contact slightly to ensure that they touch the transmitter (Fig. 5). Now tap the transmitter on a hard surface to loosen the carbon granules inside. Replace the transmitter and mouthpiece and test the phone. If transmission quality isn't improved, then clean the switch-hook contacts, test the cords and, finally, replace the transmitter.



6 Here, we're pointing out the position of the switch-hook contacts. The contacts are protected under a plastic dustcover.

More quick fix-its

In addition to reception and transmission problems, there are other troubles that can strike model 500 and 2500 telephones. The good news is that in most cases you can make the repairs yourself.

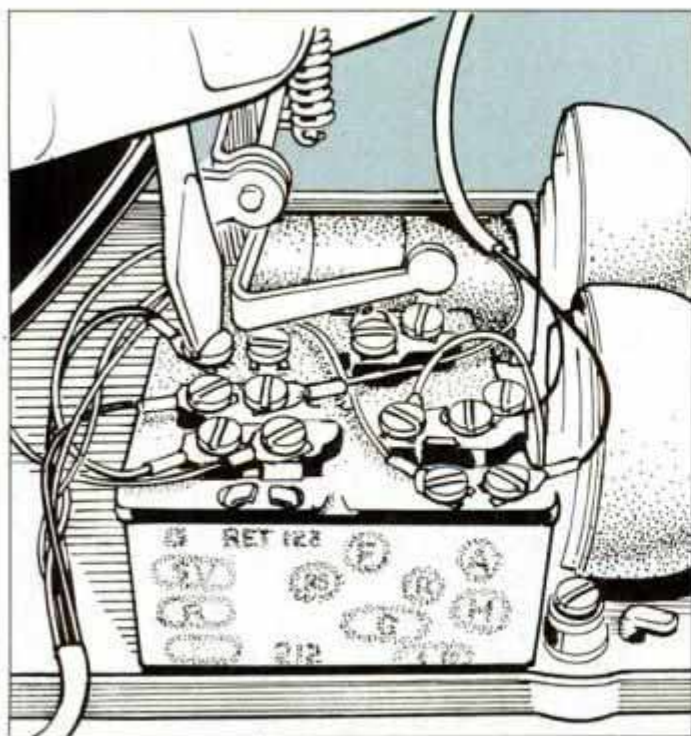
Here's a rundown of some of the most common problems and reliable remedies.

■ **Constant dial tone**—You pick up the handset, dial a number and get only a dial tone. Now what?

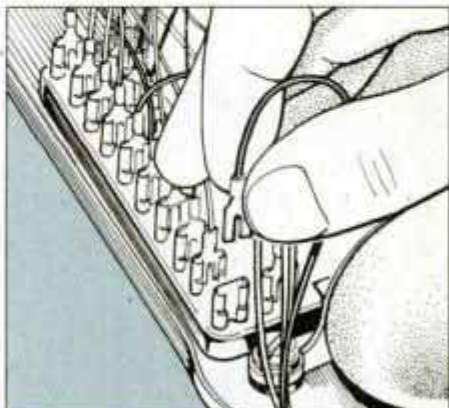
Disconnect the line cord from the wall jack and remove the phone's housing to expose its interior. Next, examine the network—the panel to which the tangle of interior wires are connected. Depending on the phone, the wires will be connected with either push-on/pull-off spade connectors or screws.

To test spade connectors, push down on each wire to make sure that they're attached securely to the network (Fig. 10). If the wires are fastened with screws, simply tighten each screw. Now test the phone.

If you still can't break the dial tone,

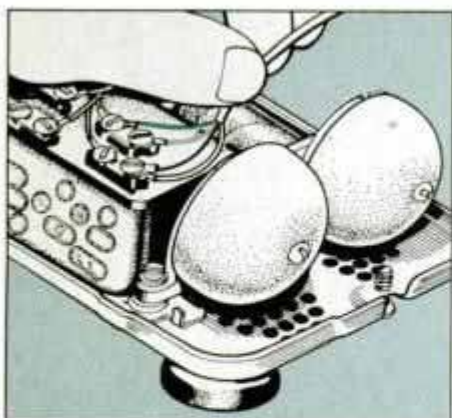


9 Rotary-dial phone uses screws to attach wires to the network. Tighten all screws to prevent trouble caused by loose wires. Also, clean away all dust and dirt that has accumulated.



10 This Touch-Tone phone uses spade connectors to attach wires to the network. Push down on connectors to secure wires.

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11 Four wires connect line cord to network. Reverse positions of red and green wires to help break constant dial tone.

switch positions of the red and green wires on the network. This will reverse the polarity.

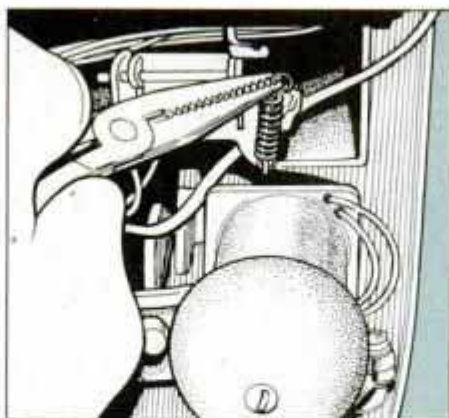
Be sure to switch the red and green wires of the line cord—the cord that connects to the wall jack. If this doesn't help, put the wires back in their original positions and clean the switch-hook contacts.

■ **Irregular dial tone**—Another annoying problem results in an on-again/off-again dial tone. Sometimes the phone works fine. Other times it's dead—no dial tone.

This is usually caused by a defective line cord. Replace the line cord with a cord from a properly operating phone. If the substitute cord solves the problem, then buy a new line cord for your phone. If not, again, service the switch-hook contacts.

■ **No dial tone**—When the phone appears dead—no dial tone at all—check the line cord. Be sure that it's connected securely to the phone and wall jack. Then, substitute another cord.

If the line cord isn't at fault, then check the switch-hook spring. Be cer-



12 Use needle-nose pliers to connect the switch-hook spring to the arms of the switch-hook. This will restore the dial tone.

tain that the spring is connected to the upper and lower arms of the switch-hook (Fig. 12). Also, clean the switch-hook contacts.

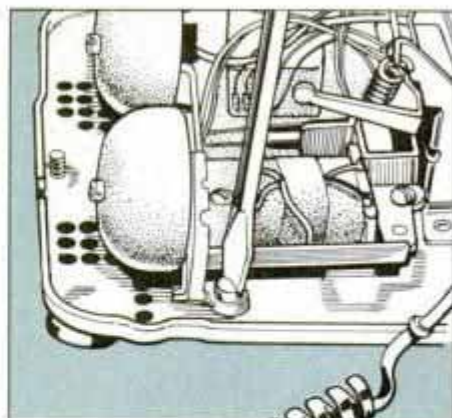
If these repairs don't restore the dial tone, then the problem is probably a defective network. And, since a network can't be replaced, the telephone must be scrapped.

■ **No connection**—Let's say that you dial a number and the phone on the other end rings. But, when the party picks up, no connection is made and you hear a dial tone. As with so many other phone troubles, this one is caused by dirty switch-hook contacts.

However, if cleaning the contacts doesn't help, then check with the telephone company. A fouled circuit at their central office will prevent the connection from being completed.

■ **No incoming calls**—If your phone doesn't ring when someone calls, check the ringer.

First, make sure that the ringer isn't turned off. A ringer volume-control knob protrudes from the underside of the phone's base. Rotate the knob to full



13 If phone doesn't ring, you may need to replace the ringer assembly. Loosen screw on each side of ringer to remove assembly.

volume (counterclockwise) and have someone call you to see if it rings. If not, clean the switch-hook contacts. If the phone still doesn't ring, replace the ringer assembly.

The ringer assembly is fastened near the rear of the phone with two screws. Remove the screws and lift the ringer assembly from the phone (Figs. 13 and 14). The assembly consists of two bells, a coil, clapper and spring.

Note that the ringer has a part number stamped on it (Fig. 15). Use this number when buying a replacement ringer assembly.

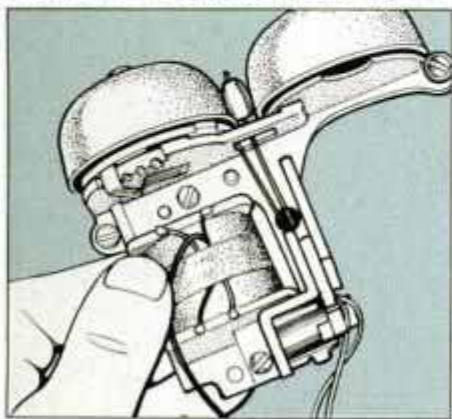
Install the new ringer, place the volume control on its loudest setting and have someone call you. Consider the phone beyond repair if a new ringer assembly doesn't help.

■ **Wrong numbers**—You should suspect a faulty rotary dial or Touch-Tone panel if you dial one number and are connected to another. First, loosen the screws on each side of the faulty dial or panel and lift it from the phone, but *don't* disconnect any wires, yet. Lay the new, replacement dial or panel next to the faulty part.

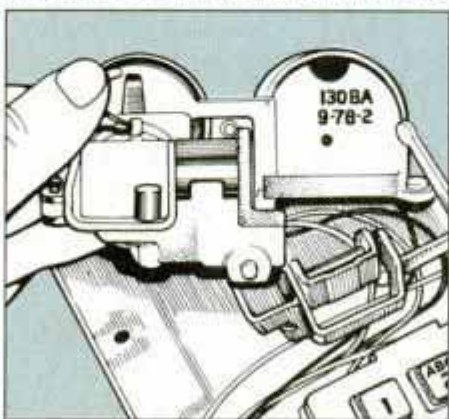
Now disconnect one of the wires of the old dial or panel from the network and replace it with the same colored wire from the new part. Follow this procedure—disconnect an old wire, connect a new wire—until all the wires are attached. This is a foolproof way to avoid getting the wires mixed up.

If you come across two wires of the same color, you have a 50-percent chance of making the correct connection the first time. If the phone doesn't work, then reverse the positions of the same-colored wires.

After the wiring is completed, screw the dial or panel in place and test the phone. If it still doesn't work, it's time for a new phone. **PM**

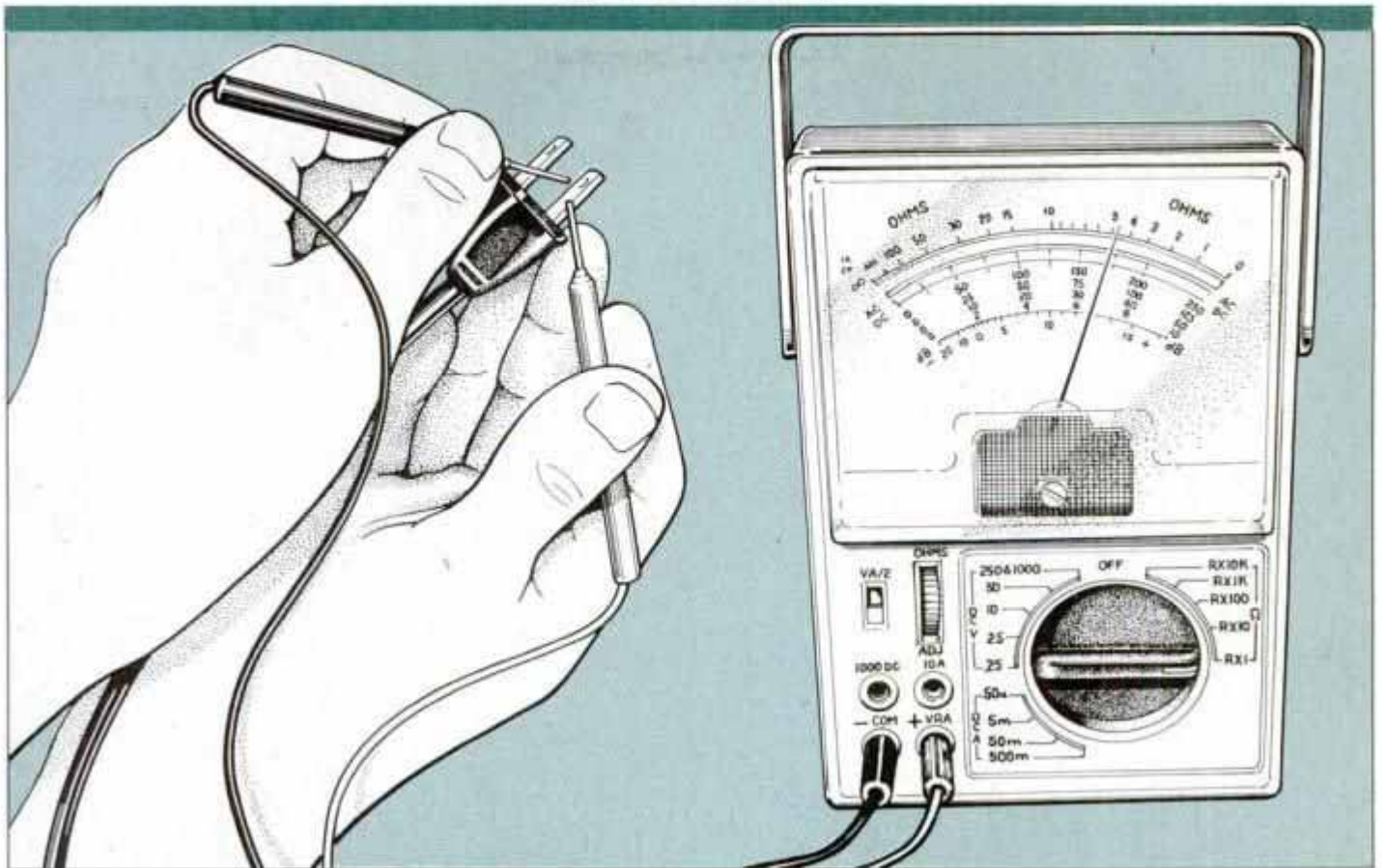


14 Ringer assembly consists of two bells, a clapper, spring and coil. Mark wire positions before disconnecting the assembly.



15 Note that the model number is printed on the back of the ringer assembly. Use this number to buy the correct replacement.

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How To Use An OHMMETER

Here's how you can test and troubleshoot electrical appliances like a pro—safely and easily—using an ohmmeter. An ohmmeter can test virtually every single electrical component in any appliance—small and major. This includes all power cords, switches, solenoids, relays, timers, thermostats and heating elements to name just a few. By simply placing the meter's probes on the component's wires or terminals, you can determine quickly and safely if the part is defective.

Some of the typical tests that you can perform include checking the water-level switch on a clothes washer, testing a thermostat of a refrigerator or freezer, and checking the heating element of a clothes dryer, electric range or oven. The owner's manual that comes with each meter provides more specific examples and instructions. And, if you're concerned about receiving an electrical shock, don't be. When using an ohmmeter, the appli-

BY MORT SCHULTZ
Illustrations by George Retseck

ance must be *unplugged* from the electrical outlet during testing.

An ohmmeter can perform three vital electrical tests. One is for continuity to determine if a continuous, unbroken circuit exists. Another test measures the resistance to the flow of current. Every electrical component has a specified amount of resistance that is measured in ohms. Testing tells you if the component meets the requirements set for it. Ohmmeters can also test for short circuits.

The instrument shown in the drawings is a multimeter known as a volt-ohm-milliammeter (VOM). Most people prefer a VOM over a straight ohmmeter because it expands their testing capabilities. A VOM can test for continuity and measure resistance (ohms), voltage and current (milliamperes). You can buy an adequate VOM for about \$40. Regardless of

whether you use a straight ohmmeter or a VOM, the continuity and resistance tests shown here are performed the same way. Note, however, that the ohm scale on a VOM reads from right to left. At the highest end of the scale is the symbol for infinity (∞).

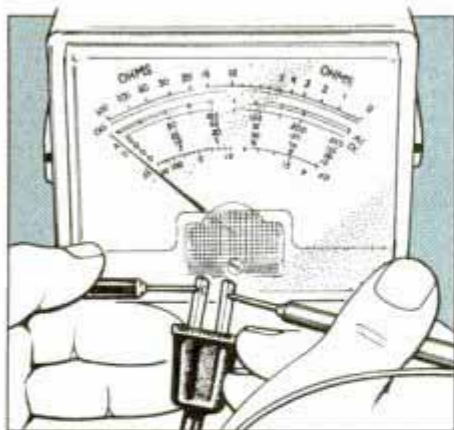
When the needle points to infinity, the meter isn't capable of measuring the resistance of the tested part (Fig. 1). Therefore, an open circuit (lack of continuity) exists and you need a new part. When testing for continuity, you aren't seeking an exact numerical value. A circuit is either open or it isn't. If it's open, the needle will point to infinity. If the circuit isn't open, the needle will point to a number.

Also, a VOM is powered by one or more batteries. Keep the batteries fresh to ensure accurate readings.

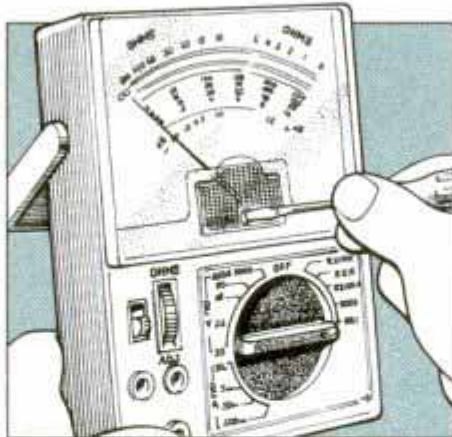
Meter adjustments

The two holes, or jacks, in the face of the meter accept the test leads. Be sure to insert the red lead in the posi-

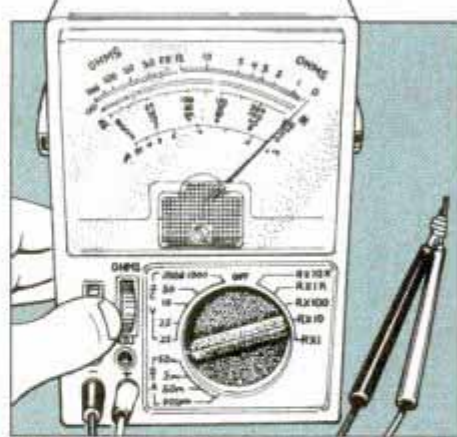
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1 When needle points to infinity symbol, there may be a lack of continuity. Note that the ohm scale reads from right to left.



2 With the leads removed from the jacks, use a small-blade screwdriver or knife to set needle exactly on the infinity symbol.



3 Insert leads and tie together the probes with a rubber band. Adjust the needle exactly to zero with OHMS ADJ knob.

tive (+) jack and the black lead in the negative (-) jack. The ends of the leads have either metal probes, as shown, or alligator clips.

Before using a VOM or ohmmeter, you must adjust it to ensure accurate readings. First, *remove* the leads from the jacks and stand the meter upright on a flat, level surface. Insert a small-blade screwdriver or knife into the pivot point of the needle and turn it slowly until the needle rests exactly on the infinity mark (Fig. 2).

Next, use the ohms adjustment control knob to set the needle to zero. Insert the leads into the jacks and tie together the probes using a rubber band. Rotate the knob until the needle rests on zero (Fig. 3). If you can't get on zero exactly, the batteries may be weak—replace them.

Most meters have a range-selector switch with three RX positions—RX1, RX10 and RX100. Some meters also have RX1000 (often designated RX1K) and RX10,000 (RX10K) settings for reading greater ohm values. To determine the resis-

tance of a circuit or component, simply multiply the RX value by the number that the needle points to. For example, if the range-selector is set on RX1 and the needle points to 50, then the circuit has a resistance of 50 ohms. If the range-selector was set at RX10, the circuit would have a resistance of 500 ohms.

When testing for continuity, start with the range-selector set at RX1. If the needle points to infinity, switch the selector to RX10 and then RX100. If the needle doesn't move off of the infinity mark, an open circuit exists.

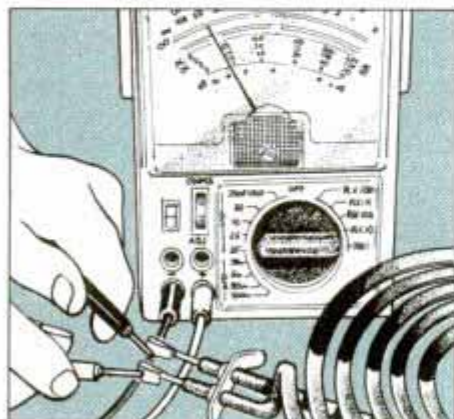
Often when checking the resistance value (ohms) with the meter set at RX1, you'll get a reading on the high end of the scale. Since the high end isn't calibrated very precisely (see illustration on page 103), switch the selector to RX10 and bring the needle into the lower, more precisely calibrated end of the scale.

Exact resistance

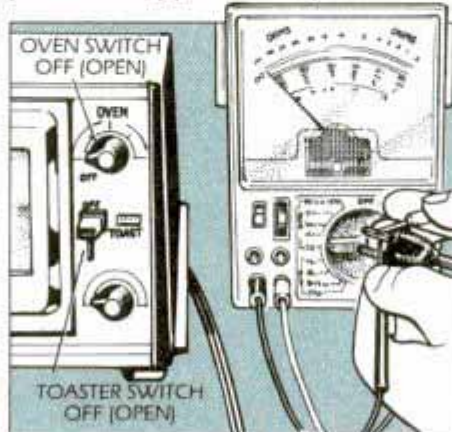
The exact resistance values of the parts of an appliance are printed on a

wiring diagram that is glued to the appliance. Appliance manufacturers can also provide resistance values for specific parts. Another alternative is to check the resistance values listed in appliance repair books. The reading that you get doesn't have to equal exactly what's listed in the book. For example, a repair book lists the resistance value of an electric range cooking element at 50 ohms. If you get a reading of 45 ohms (Fig. 4), that's close enough. A much lower reading of 10 ohms would indicate that a short exists in the element. When a short exists, the meter will display a low value—it won't point to infinity.

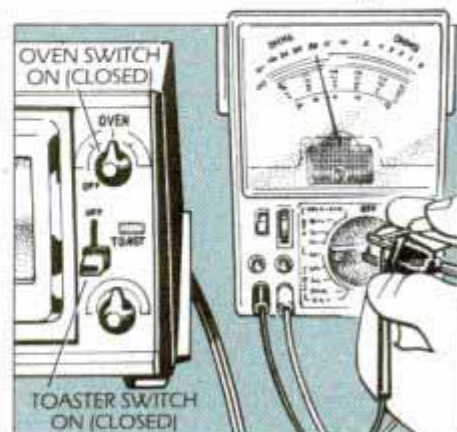
Also, when testing for continuity or resistance, it's important that the appliance's switch be turned on (even though, the appliance is *not* plugged into an electrical outlet). If the switch is left off, it will cause the needle to point to infinity indicating that there's an open circuit (Fig. 5), which may not be the case. If the appliance has two switches, such as a toaster-oven, be sure both switches are on (Fig. 6). **PM**



4 To test the resistance value (ohms) of an electric range cooking element, place one probe on each prong of plug-in element.



5 Here, with both switches off, the meter points to infinity indicating that there's an open circuit: an erroneous reading.



6 For a correct reading, the switches must be on. If an open circuit still exists, then test the internal components of the appliance.

Homeowners' Clinic

BY NORMAN BECKER, P.E.

Ice Dam Woes

Every winter the north slope of my cathedral ceiling leaks when the snow starts melting. It doesn't leak in the rain. My ceiling gets ruined and has to be retaped and painted. Do you have any suggestions other than preventing or removing snow accumulation?

ROBERT OSTROV
MIDDLEBURY, CT

You have a classic case of leakage caused by an ice dam. Ice dams begin when a layer of snow next to the roof melts. When this water freezes, a dam is created which causes further melted snow to accumulate in a pool. Roofs are designed to shed water, not to protect against standing water.

A fairly common practice for avoiding ice dam problems is to have the snow removed from the roof. Although this is a recurring expense, it may be preferable to an annual retaping and painting. Another method is to use electrical heating tapes along the eaves and valleys. This may not solve the problem completely as its effectiveness is limited to the area where the tape is installed. Ice dams can still form farther up the roof.

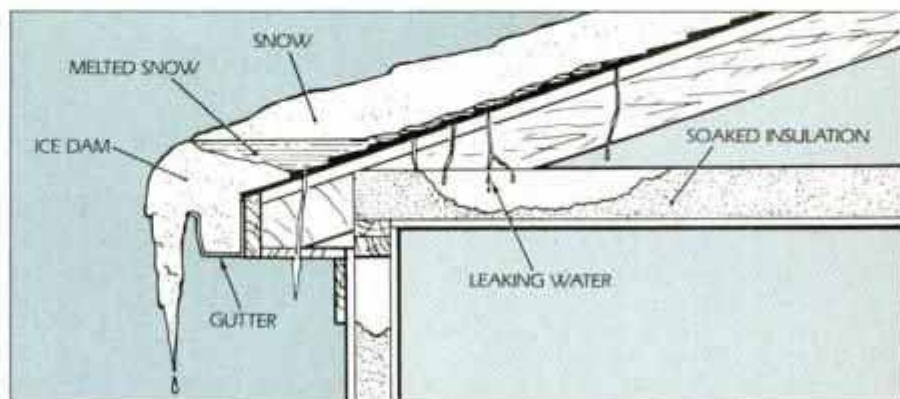
An excellent booklet on the subject is available from the Agricultural Extension Service University of Minnesota. It's called Roof-Snow Behavior and Ice-Dam Prevention in Residential Housing.

For a copy, send \$2 to: Distribution Center, University of Minnesota Publications, 3 Coffey Hall, 1420 Eckles Ave., St. Paul, MN 55108.

According to the booklet, the best method for minimizing an ice-dam problem is to maintain what's called a cold-roof. By over-insulating the ceilings and ventilating the attic profusely, the roof-deck temperature will be lowered to the point where the snow won't melt.

In a house with a cathedral ceiling, you normally cannot add more insulation under the roof deck, and depending on the construction, you may not be able to provide additional ventilation.

In this case, other than having the snow removed, I would try the heating tapes which, although not perfect, may do the job.



Ice dams occur when changes in roof heat cause a layer of snow to melt and then refreeze. Further melted snow collects in a pool and can leak through the roofing.

To Strip Or Not

I'm thinking of putting new shingles on the roof of my home. Would I get as good and long-lasting a job by installing roofing paper and new shingles with longer nails over the old shingles, or is it necessary to strip all the old shingles and start from scratch?

CHARLES F. CAMERON
MORRISTON, FL

The major factor to consider would be the number of layers of shingles already on the roof. Some municipalities allow two layers of shingles and many allow three. Check with your local building department to determine the code requirements for your area. Keep in mind that if the existing shingles are deteriorated, with curled, lifted or eroded sections, you're likely to get a lumpy, uneven surface appearance. The old shingles must be in fairly good condition to provide you with the smooth surface you may be expecting.

When installed properly, there's no appreciable difference between applying a new roof over old shingles and stripping away the old shingles to start fresh. It's not necessary to install roofing paper when installing new shingles over the old roof.

Blistered Plaster

My problem is with the plaster in our house—it seems to be growing. It bubbles, almost like foam, and gets powdery. The problem is most noticeable under the windows.

Our house was plastered in ex-

tremely cold weather. Could the plaster have frozen while setting up or is the problem due to moisture?

DORIS BATEMAN
GOOD THUNDER, MN

The problem is caused by a moisture condition. Constant wetting results in a breakdown of the crystalline structure of the plaster causing it to swell. Your description suggests that the condition is active and must be corrected before repainting. In my experience, blistered and deteriorated plaster is always caused by water leakage.

Check for cracked or open joints around the windows where water can seep in. These should be caulked. Water dripping from the window pane due to condensation may add to the problem as could clogged drain holes at the bottom of storm windows. Once the moisture problem is corrected, scrape away all loose and deteriorated plaster. Then replaster the affected areas, prime and paint.

If the house was plastered when the interior temperature was below freezing, all the walls and ceilings would be soft and crumbly and the situation noticed right away. When plaster freezes before it sets, there's no remedy but to remove it and replaster. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH

Knocking Dryer

The dryer basket in our Westinghouse electric dryer model No. DEH450W2, serial No. G19751 knocks as it turns. Any idea what's making the noise?

JERRY D. WALL
CRESCENT, OK

Your problem could be caused by a lump in the drive belt, worn or loose basket bearing, or a loose plastic-basket vane. To determine exactly where it's coming from, you'll have to remove the drive belt. First, disconnect the power source. Then, pull the unit away from the wall and remove the rear access cover.

You'll see the drive belt passing around the motor pulley and idler pulley. Push down on the idler pulley to free the belt from the motor and idler. Gently pull on the belt and check for imperfections such as lumps, cracks or fraying. If the belt needs to be replaced, get part No. Q63807 from your nearest Westinghouse parts distributor.

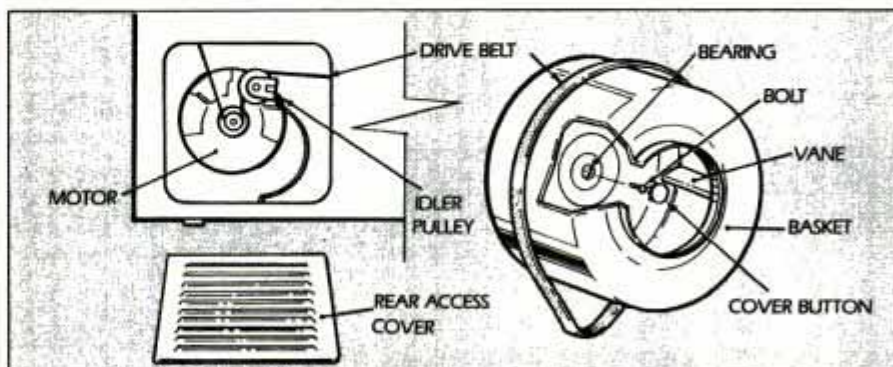
Move to the front of the dryer and insert a putty knife between the top and cabinet about 2 in. in from each corner to release the two spring clips that secure the top. Raise the top and rest it against the wall.

Now, rotate the basket and listen for a knocking noise. Check the screws that hold the vanes to the basket and tighten if necessary. If loose vanes aren't your problem, the next step is to remove the air duct and door assembly.

First, remove the lower service panel and toe plate. Then remove the screws from the bottom of the front panel as well as the single screw that holds the bottom of the air duct to the cabinet. At the top of the panel, remove the two inside and two top screws that hold the front panel to the cabinet. Lift up on the panel and swing it to the right. Label and remove the wires from the door switch and two thermostats.

If a bad drive belt was the problem, install a new one by lifting the basket just enough to remove the old belt and then slip on the new. Be sure to position it where the old one was.

If the bearing is your problem, pry off the cover button at the basket center. Then, remove the bolt and slide the basket forward to remove it from the dryer. Check the bearing mounting screws to



A knocking noise that appears when the dryer basket turns, can be located by first checking the belt for wear. Then, check for a loose basket vane or a bad bearing.

make sure they're tight. If the bearing is bad, install a new bearing replacement kit part No. Q142850. This bearing will be different than the original and the kit will include all necessary parts and instructions.

It's Elemental

The oven-heating element for my Hot-point range model No. 109RC11, serial No. 7108097, is no longer made and I need a replacement. A repairman told me he can rewire the element but is unable to find wire of the correct size.

Do you know where I can get this wire or a new element?

STEVE DUNKLE
TAMPA, FL

South Eastern Electric Range Parts Manufacturing Co., 301 South Linwood Rd., Gastonia, NC 28052 (800) 438-8364, can supply the wire if you advise them of the voltage and wattage of the element (found on the model number plate), and the length and diameter of the old wire.

There's a good chance they can manufacture a new 1-piece replacement to fit your range. Send them the old element along with the voltage and wattage. The approximate cost for the replacement unit is \$20 plus shipping.

Automatic Input

The problem with our Sunbeam model No. T-35 toaster is that the bread no longer goes down automatically.

Is there a repair or adjustment I can make?

MRS. ALICE ROCKWELL
DELTON, IL

Most likely, the tensioning of the platform that the bread sits on is out of adjustment. To correct this, unplug the toaster and lay it upside down on a towel to protect the chrome surface. Open the crumb tray and locate the small adjusting screw in the center of the opening. Turn the adjustment screw counterclockwise one full turn. Then, replace the crumb tray and try the toaster. If the problem isn't corrected, try the procedure again. If after three full counterclockwise turns the problem hasn't been corrected, then you'll have to take your unit to your local Sunbeam authorized service center.

Needs Part

I tried to get a part for my General Electric automatic-drip coffee maker and was told I had to buy a whole new unit.

Is this true?

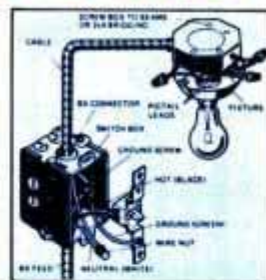
MRS. RUTH HILLS
HEBRON, CT

Black & Decker has taken over the G.E. small appliance division and doesn't supply repair parts to consumers for many products, including your coffee maker. In fact, their current models have tamper-resistant screws to discourage home repairs and warning labels that recommend taking the unit to an authorized service center when problems arise. You can, however, get decorative parts such as knobs and covers.

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

NEEDED IMMEDIATELY: VOLUNTEERS TO FIELD-TEST A GOLDMINE OF DO-IT-YOURSELF PROJECTS

We're giving away a free volume to anyone ready to trade a little sweat for a lot of satisfaction.



We want *Popular Mechanics* readers to spread the word about the newly expanded 27-volume POPULAR MECHANICS DO-IT-YOURSELF ENCYCLOPEDIA by accepting Volume 1 FREE.

It's yours to keep — no cost or obligation. But we want you to use it, not look at it. And we invite you to inspect the remaining volumes on approval, without risking a cent.

Volume 1 alone will save you a bundle

Next time your dishwasher goes on the blink, instead of paying \$25 just to have a serviceman walk in the door, turn to page 103. You'll find 73 possible causes and how to fix them. (Ditto with your washing machine, dryer, stove, hot water heater.)

How much money is your old refrigerator wasting? It may just need a tune-up. So before you blow \$550 for a new one, turn to page 125 and do it yourself. (Same with your air conditioning — see page 38.)

If you're handy, there's not much you can't do yourself with the *Popular Mechanics Encyclopedia's* help. Its 27 volumes are crammed with step-by-step plans, photos, diagrams and articles on everything from auto maintenance to woodworking, bedroom furniture to wallpapering, computers to VCRs.

Let's get one thing straight. If you can't stand dirty fingernails, this offer is not for you.

Whether your objective is to save big bucks, increase your home's value, keep your car out of the shop, or simply enjoy the satisfaction of building things with your own two hands (and maybe teaching your kids the same), send for Volume 1 of the *Popular Mechanics Encyclopedia*.

Use it. Keep it. Prove to yourself what a goldmine of do-it-yourself projects this is.

If you like what you see, we'll ship you the remaining volumes on approval. If you don't, however, you're under no obligation. Volume 1 is yours to keep, absolutely free, whether you decide to buy further volumes or not.

Act promptly to participate in Field Test

The free volumes for this Field Test will be distributed on a first-come, first-serve basis. If you wish to participate, mail the reply card promptly to be sure of receiving Volume 1 without cost or obligation. (If card is missing, please use the coupon.)

Remodel your basement
Caulk your bathtub
Improve your lawn
Service your brakes
Make a home movie theater
Build a rollaway darkroom

Build a barbecue cart
Tune up your child's bike
Learn to use a bench saw
Install kitchen cabinets
Frame your own pictures
Design a workshop

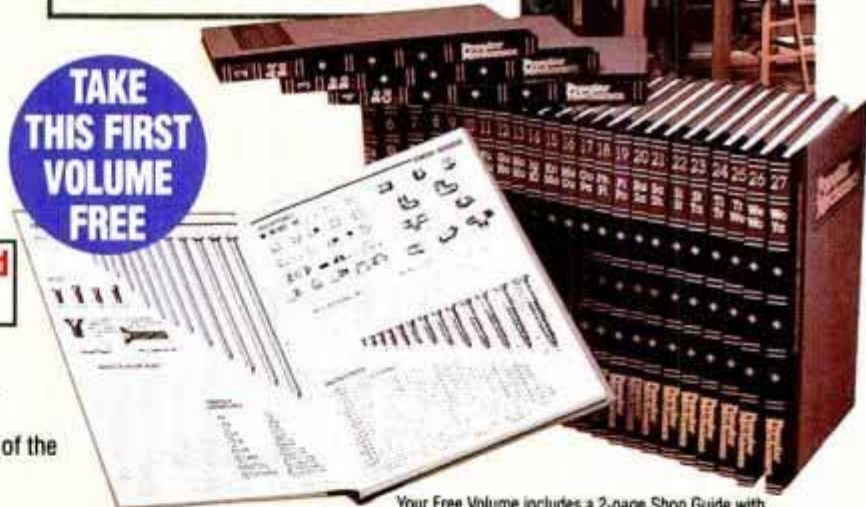
What's the Catch?

If you think there's a catch to this Free Offer, turn the magazine upside down.

There is no catch. We're out to spread the word about the POPULAR MECHANICS DO-IT-YOURSELF ENCYCLOPEDIA — and the best way is to get it to *Popular Mechanics* readers who love working with their hands. Once you've field-tested Volume 1, we think you'll want all 27, but if not, no problem. Volume 1 is yours to keep, with no strings attached — no obligation to buy even a single book ever!



TAKE THIS FIRST VOLUME FREE



Your Free Volume includes a 2-page Shop Guide with penny nail and screw charts, standard lumber sizes, abrasive paper grades, pipe fittings; plus two pages of metric conversion charts (not pictured).

Send no money. Just mail this coupon to:
Popular Mechanics do-it-yourself Encyclopedia, P.O. Box 10204, Des Moines, IA 50336

I VOLUNTEER! Please ship me Volume 1 of the *Popular Mechanics do-it-yourself Encyclopedia* FREE. As part of this Field Test it is mine to keep without risking a cent.

I agree to notify you within 10 days of receipt if I don't wish to field-test further volumes. At 6 week intervals, you will send me Vols. 2 and 3. Then, Vols. 4-27 will be mailed to me if I have not cancelled and you have received my payment for Vols. 2 & 3. All volumes are sent on a 10-day approval basis. For those volumes I wish to keep, I will pay only \$6.98, plus shipping and handling (and sales tax where applicable). Beginning with Vol. 4, I need pay for only two books per month, no matter how many volumes I have received — and there are no finance charges. Also, each year, I will receive both a YEARBOOK to update my series and a handy DO-IT-YOURSELF GUIDEBOOK — again on a 10-day approval basis without obligation. I may cancel AT ANY TIME without further obligation and will return any volumes for which I have not paid. The 128-page Volume 1 is absolutely FREE, no matter how many, or how few, of the later volumes I decide to keep.

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Материал, защищенный авторским правом

"I'm proud he did it on his own..."

MAKING MONEY

Last summer, my son Robert turned 18, and he was looking for a way to make money.

We've had the worst drought here in Oklahoma since the 1930's. A lot of folks are running out of water, and I told Robert he could make good money if he learned how to drill water wells.

I've been in this business for about 12 years. I operate a big truck-mounted drill which I finally got paid off last year. I thought if I could find a good deal on a used drill, I'd get it and teach Robert to run it.

But he had a different idea. He saw an advertisement that got him excited. It claims you can drill water wells with a little \$600 machine.

He asked my opinion. I told him I just didn't believe any little \$600 machine could drill a water well - not around here. It went against everything in my experience. I advised him to forget it. But Robert kept studying it and finally he made up his mind to get one.

When it was delivered by United Parcel Service, you can pretty well imagine what I was thinking.

FIRST DAY ON THE JOB

The day he went out to drill his first well, Robert got a buddy to help him. They were so enthusiastic, I went along to watch even though I figured they were in for a big disappointment. It was July and hot - about 98 degrees. I found a shade tree and settled down to wait.

It was 2 hours later when they came over, both of them grinning. I asked if they were ready to call it quits. They said they sure were because they had finished the well.

I couldn't help being impressed. It was a good well - clean water and plenty of it. What impressed me even more was this: they had drilled that well in about the time it takes me just to set up my big drill.

MAKING MONEY

The next morning, Robert started another well. He said he wanted to do it all by himself. He drilled about 115 feet,



mostly through rock, and hit water that afternoon. I couldn't have set up and drilled the well any faster than that.

In the past, I've lost out on some jobs because people were afraid my truck would tear up their yard. Robert says he can drill anywhere without tearing up anything, and that gets him customers

other well drillers can't get.

He's one happy young man. And why not? The first week he made more money than he paid for his drill. Now every dollar he takes in is nearly all profit. That's really amazing, isn't it?

WHAT I BELIEVE

I admit I was skeptical when Robert bought a HYDRA-DRILL. I didn't believe that someone without any experience could go out and drill water wells, and surely not with that little machine. Also, I thought he'd be calling for help. But he didn't. He just went by the instructions that came with the drill, and it worked!

The best part is that he didn't have to go in debt and struggle to pay it off the way I did. I'm thankful for that, and I don't mind saying I'm proud of how he did it all on his own.

I believe the man who invented the HYDRA-DRILL really knew what he was doing. To invent a machine that does the job, and to keep it simple and inexpensive - that's a wonderful thing, isn't it?

"Easy to Use!"



WATER WELLS FOR EVERYONE!

You can drill water wells for less than \$1 per foot with our easy-to-use drills.

5 low-price models for home, farm, and commercial use.

Check one or both boxes for information and mail today!

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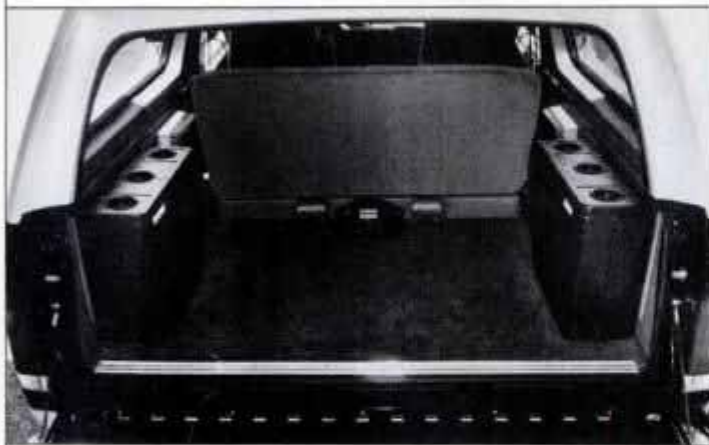
Phone _____

5345



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Nice Bedside Manner



Stow-Away is a toolbox/storage box for the unused space behind your truck's wheel wells. Every 4x4 has a space behind the wheel well and there's a Stow-Away engineered for all of them, as well as for some vans and pickups. They're great for tow ropes, tire chains, fishing or hunting gear, tools or anything you'd like to keep

out of sight and buttoned up in your vehicle. And the boxes won't keep you from using most of the space between the wheel wells for large flat objects, like plywood sheets. Stow-Away comes with lock and key. It costs \$89. Order direct from LIDO, Inc., 13615 Toper Circle No. 2, San Antonio, TX 78233, or phone (800) 533-5436.

Hot Locks

This sensational winter-time lock de-icer melts your car door lock problems in seconds. Two AA batteries are required, and it also includes a light for nighttime use.

Insert the probe into your frozen door lock, and the heated probe will melt the ice from the tumblers in seconds. Not intended for use on locking gasoline caps or anything flammable. Available only in black. Just \$7 (includes postage and handling) from the Davenport Co., P.O. Box 832R, Romeoville, IL 60441, or phone orders at (312) 839-5625.



Super Gasket

Permatex's Ultra Blue No Leak silicone gasket is designed to handle the gasketing problems of today's engines. With three times the oil resistance of other silicones, its low volatility permits use on cars with O₂ sensors that are poisoned by vinegar-smelling sealants. Can be used to replace original factory sealants, or to replace cork or rubber gaskets. Noncorrosive formula is safe for aluminum.

\$5 in auto parts stores.



Tech Tuneup

Souping up your car isn't as easy as it was even a few years back. The computer-controlled ignition and fuel injection just aren't amenable to backyard tinkering anymore. But now there's the Hypertech Power chip, a replacement for the factory's original computer chip. It optimizes fuel/air ratios, full-throttle spark advance and torque converter clutch lockup points for increased performance and driveability. Comes in three stages from stock to modified. Hypertech claims 0.5-second improvements in 0-to-60



times. The chip installs (and un-installs) in 15 minutes. Available for some models of GM cars only. \$150 from Hypertech, 2104 Hilshire Blvd., Memphis, TN 38134, (901) 382-8888.

Streamlined Storage



You can keep your gear out of the weather, and save gas with Aeropac car top carrier. It's a stylish way to keep your skis or other valuables safe, too. Aeropac's aerodynamic shape of-

fers lower drag than the conventional box-shaped carriers and it sheds sidewinds for increased car stability. The lid is opened by gas struts so accessing the 18-cu.-ft. interior of the carrier is effortless. Its fiberglass construction means light weight and sturdiness, and availability in several colors. You can even order a custom match color for your vehicle (\$98). It's \$549 from Amcraft, P.O. Box 3335, Idaho Springs, CO 80542, or call (303) 567-4877.

Pickup Trunk Folds Flat

This pickup truck bed storage add-on is called Truck Trunk. It provides exactly what a pickup truck lacks: An easily accessible place to stow things like groceries and tools so they don't flop around in the bed. You *could* buy an extended-cab pickup, but that's pretty expensive. The aluminum diamond-plate storage box folds down to a height of only 1 in. when not in use, leaving the entire bed free, and locks with its own key. Truck Trunk is available in a variety of models for most full-sized and minipickups. \$150, Superior Industries, 7800 Woodley Ave., Van Nuys, CA (818) 781-4973.



Cocaine can make you blind.

Cocaine fools your brain.

When you first use it, you may feel more alert, more confident, more sociable, more in control of your life.

In reality, of course, nothing has changed. But to your brain, the feeling seems real.

From euphoria...

You want to experience it again. So you do some more coke.

Once more, you like the effects. It's a very clean high. It doesn't really feel like you're drugged. Only this time, you notice you don't feel so good when you come down. You're confused, edgy, anxious, even depressed.

Fortunately, that's easy to fix. At least for the next 20 minutes or so. All it takes is another few lines, or a few more hits on the pipe.

You're discovering one of the things that makes cocaine so dangerous.

It compels you to keep on using it. (Given unlimited access, laboratory monkeys take cocaine until they have seizures and die.)

If you keep experimenting with cocaine, quite soon you may feel you need it just to

function well. To perform better at work, to cope with stress, to escape depression, just to have a good time at a party or a concert.

Like speed, cocaine makes you talk a lot and sleep a little. You can't sit still. You have difficulty concentrating and remembering. You feel aggressive and suspicious towards people. You don't want to eat very much. You become uninterested in sex.

To paranoia...

Compulsion is now definitely addiction. And there's worse to come.

You stop caring how you look or how you feel. You become paranoid. You may feel people are persecuting you, and you may have an intense fear that the police are waiting to arrest you. (Not surprising, since cocaine is illegal.)

You may have hallucinations. Because coke heightens your senses, they may seem terrifyingly real.

As one woman overdosed, she heard laughter nearby and a voice that said, "I've got you now." So many people have been totally convinced that

bugs were crawling on or out of their skin, that the hallucination has a nickname: the coke bugs.

Especially if you've been smoking cocaine, you may become violent, or feel suicidal.

When coke gets you really strung out, you may turn to other drugs to slow down. Particularly downers like alcohol, tranquilizers, marijuana and heroin. (A speedball—heroin and cocaine—is what killed John Belushi.)

If you saw your doctor now and he didn't know you were using coke, he'd probably diagnose you as a manic-depressive.

To psychosis...

Literally, you're crazy.

But you know what's truly frightening? Despite everything that's happening to you, even now, you may still feel totally in control.

That's the drug talking. Cocaine really does make you blind to reality. And with what's known about it today, you probably have to be something else to start using coke in the first place.

Dumb.

Partnership for a Drug-Free America



Get in on the PROFITS in SMALL ENGINE service and repair Start your own money



BEAT INFLATION!

Cash in on the huge demand for small engine repair.

Work part time, full time right at home - we help you every step of the way.

making business!

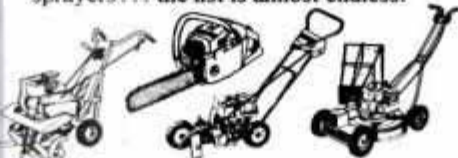
In just a short time, you can be ready to join one of the fastest growing industries in America... an industry where qualified men are making from \$25.00 to \$30.00 per hour... and that's just for labor. Parts, engines and accessories add even more to the profits.



Because the small engine industry has grown so quickly, an acute shortage of qualified Small Engine Professionals exists throughout the country. In fact, it's not unusual for a good small engine man to be three to four weeks behind in the summer and at least a week behind in the winter. When you see how many small engines are in use today, it's easy to understand why qualified men command such high prices — as much as \$49.95 for a simple tune-up that takes less than an hour!

65-million small engines are in service today!

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.



No experience necessary.

You don't need to be a 'born mechanic' or have prior experience. If you can read, you can master this profitable trade right at home, in your sparetime, without missing a single paycheck. Lessons are fully illustrated — so clear you can't go wrong.

You receive trade secrets and business plans.

We guide you every step of the way, including tested and proven instructions on how to get business, what to charge, how to get free advertising, where to get supplies wholesale... all the "tricks of the trade"... all the inside facts you need to assure success right from the start.

Increased Income

"I've had about 8 years experience repairing small engines... but repairs were only minor... until I started the Foley-Belsaw Course."



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With our famous 'learn-by-doing' training method, you get practical 'hands-on' experience with specialized tools and equipment that you'll receive with your training *plus* a brand-new 4 HP engine — *all yours to keep!*

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You risk nothing by accepting this offer to find out how Foley-Belsaw training can give you the skills you need to increase your income in a high-profit, recession-proof business of your own.

Just fill in and mail coupon below (or send postcard) to receive full information and details by return mail. **DO IT TODAY!**

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BOSCH

Item # 1581VS
TOP HANDLE
JIG SAW



122

1582VS	BARREL GRIP JIG SAW	116
3230	JIG SAW	48
3238VS	ORBITAL JIG SAW	80
1272D	3X24 DUSTLESS BELT SANDER	159
1273D	4X24 DUSTLESS BELT SANDER	168
3270D	3X21 BELT SANDER	103
3258	3 1/4 PLANER	98
1901	1 HP ROUTER	88
1604	1 3/4 HP ROUTER	115
1608	TRIM ROUTER	74
1908L	LAMINATE TRIMMER	76
1608T	TILT BASE LAMINATE TRIMMER	88
1609	OFFSET BASE LAM TRIMMER	112
1609K	TRIMMER INSTALLERS KIT	156
1920RK	3/8 CORDLESS DRILL	78
1158VSR	3/8 VAR SPEED REV. DRILL	54
11212VSR	3/4 SDS ROTARY HAMMER	174
11202B	1 1/2 ROTARY HAMMER	339
1198VSR	1/2 VSR HAMMER DRILL	114

Makita

Item # 8093DW
3/8 CORDLESS DRILL
VARIABLE SPEED
REVERSIBLE



122

BO4550	DUSTLESS FINISHING SANDER	44
DA3000R	3/8 ANGLE DRILL REVERSIBLE	119
9503BHKIT	4 1/2 SANDER GRINDER KIT WITH CASE	74
410	DUST COLLECTION UNIT	238
832007-4	9.6VDC BATTERY	27
832002-4	7.2VDC BATTERY	25

HITACHI

Item # C10FA
DELUXE
10" MITER SAW



264

TR12	3HP ROUTER WITH ALL ACCES.	184
C6DA	6 1/4 CORDLESS CIRC. SAW	99
C15FB	DELUXE 15" MITER SAW	364

Item # PSG7
PROFESSIONAL
SPRAY
GUN



29

Item # PTUG
TOUCH
UP
GUN



27

CHICAGO PNEUMATIC AIR TOOLS



Item # CP734
1/2" IMPACT

49

CP711	HAMMER 3500 BLOWS/MIN	32
CP715	HAMMER 2100 BLOWS/MIN	36
CP720	3/8" BUTTERFLY	56
CP744	1/2" HEAVY DUTY IMPACT	75
CP766	ORBITAL SANDER	54
CP767	STRAIGHT LINE SANDER	74
CP768	D.P. STRAIGHT LINE SANDER	94
CP772	3/8" IMPACT	188
CP777	ORBITAL SANDER	62
CP778	HI-SPEED SANDER	32
CP787	3/8" DRILL 1800 RPM	58
CP788	3/8" DRILL 2750 RPM	96
CP788H	1/2" DRILL 500 RPM	124
CP789	3/8" DRILL REVERSIBLE 2200 RPM	104
CP797-6	1" IMPACT W/8" SHANK	320
CP825	1/4" RATCHET	49
CP828	3/8" RATCHET	44
CP835	NIBBLER	78
CP860	DIE GRINDER	54
CP861	HI-SPEED CUTTER	48
CP864	ORBITAL SANDER	49
CP865P	VERTICAL POLISHER	124
CP865S	VERTICAL SANDER	124
CP869P	ANGLE POLISHER	128
CP869S	ANGLE SANDER	128

Item # 8511



2 SPEED SAWZALL



118

0228-1	3/8" DRILL 3.3A 0-1000RPM	84
0234-1	1/2" DRILL 4.5A MAGNUM	99
0244-1	1/2" DRILL 4.5A MAGNUM	96
1876-1	H. DUTY HOLE HAWG W/CASE	225
3002-1	ELECTRICIANS RT ANGLE KIT	105
3102-1	PLUMBERS RT ANGLE DRILL KIT	172
0450	7 7/8" POLISHER 1750 RPM	118
5535	7" POLISHER 2800 RPM	125
8012	1/3 SHEET ORBITAL SANDER	99
8014	1/2 SHEET ORBITAL SANDER	106
8085	7 7/8" SANDER GRINDER	114
8226	2 SPEED BANDSAW W/CASE	249
8396	7 1/4" CIRCULAR SAW WITH ACCESSORIES	104
8606	VARIABLE SPEED SAWZALL W/CASE	122
8750-1	DRYWALL DRIVER 0-4000	83
8753-1	DRYWALL DRIVER 3.5A	72
8975	HEAT GUN	49

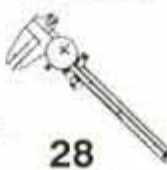
Item # BPD

BRAD
POINT DRILL
SET



9

Item # 06DC
6" DIAL
CALIPER
IN WOODEN CASE



28

12DC	12" DIAL CALIPER 0-12"X0.001"	78
06VC	6" VENIER CALIPER STAINLESS STEEL .001	18
12VC	12" VENIER CALIPER 0-12"X0.001	48

Item # 2QSO
2 QT.
SPRAY
OUTFIT



43

Item # 8SND
8 PC
SILVER &
DEMING
9/16"-1"



45

Item # 15SC
15"
SCROLL
SAW



124

WITH 12 BLADES

Item # CP 99
HOPPER
GUN



34

Emglo

TWIN TANK
HAND-CARRY
COMPRESSOR



AM39HC4	3/4" HORSE POWER	265
AM77HC4	1 1/2 HORSE POWER	275

COMBINATION
WRENCHES
"SUPERKROME"



Lifetime Warranty



86012	11 PC FRACTIONAL 1/4"-7/8"	43
86013	13 PC FRACTIONAL 1/4"-1"	54
86022	13 PC 7MM-19MM	43
86023	15 PC 7MM-22MM	54

PORTER-CABLE

Item # 330
SPEED BLOCK
FINISHING SANDER



51

352	3X21 DUSTLESS BELT SANDER	118
360	3X24 DUSTLESS BELT SANDER	178
362	4X24 DUSTLESS BELT SANDER	189
555	PLATE JOINER	165

HIGH SPEED STEEL

HEAVY DUTY
DRILL
BITS



29RS	29 PC. REDUCED SHANK 1/16" TO 1/2"	18
19MB	19 PC. METRIC 1MM-10MM	22

SANDBLASTER
KIT

Item # SK00
12



124

WITH 12 BLADES

RIFFLER
FILE SET

12

SET OF 10



Husky.

1/2" DR BREAKER
BAR



Item # OH88
9

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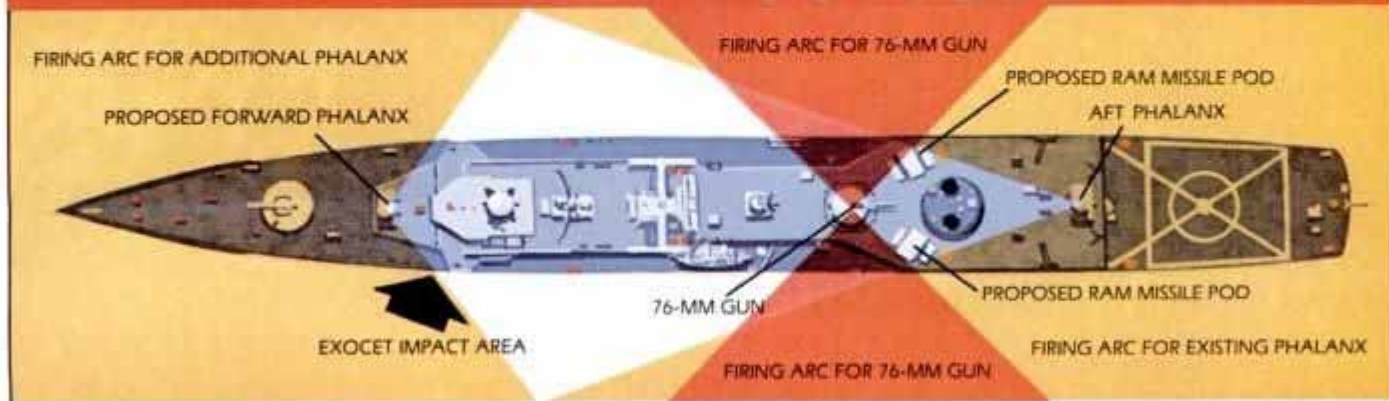
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P M TECH UPDATE

OCTOBER 1987



Guided-missile frigate Stark patrolling the Persian Gulf. Could weapons upgrade (top) have avoided disaster?

PM ILLUSTRATION BY ED VALIGURSKY

Upgrading Stark: Will It Prevent A Tragedy?

Iraq's May 17 attack on the U.S. guided-missile frigate has raised some questions about the vulnerability of the Oliver Hazard Perry-class ship to air-to-surface weapons. The Perry-class frigate represents the low end of the Navy's 600-ship fleet, with moderate cost and moderate performance compensated for by large numbers. Its specific job is to escort convoys and carrier battle groups. Designed to ward off airborne and surface threats, plus conduct anti-

submarine warfare "over the horizon," the Perry class has been drawn thin in onboard defensive weapons.

As a result, *Stark* and her sister ships are equipped with single, automated fire control systems. There are no backups. The Navy suggests that these limitations are acceptable since Perry-class ships are designed to operate under the "security blanket" of a heavily muscled carrier fleet. Consequently, the ship is undergunned in a patrol frigate role—exactly

the job *Stark* was performing when attacked.

Some analysts believe one way to improve the defensive performance for ships like *Stark* is to add a second Phalanx antimissile system forward and two 24-cell RAM (Rolling Airframe Missile) pods on each side amidships. The firing arc for a single Phalanx on the stern can't cover the bow (illustration). By simply remounting the Standard/Harpoon missile launcher farther forward, a stepped-deck could be ex-

tended from the front of the bridge to accommodate the additional Phalanx—and the added security from missiles coming from the bow area. *Stark* was struck on the port side forward (illustration). Adequate missile protection like this could extend the usefulness of the Perry-class frigate to inshore patrol duty—in places like the Persian Gulf.

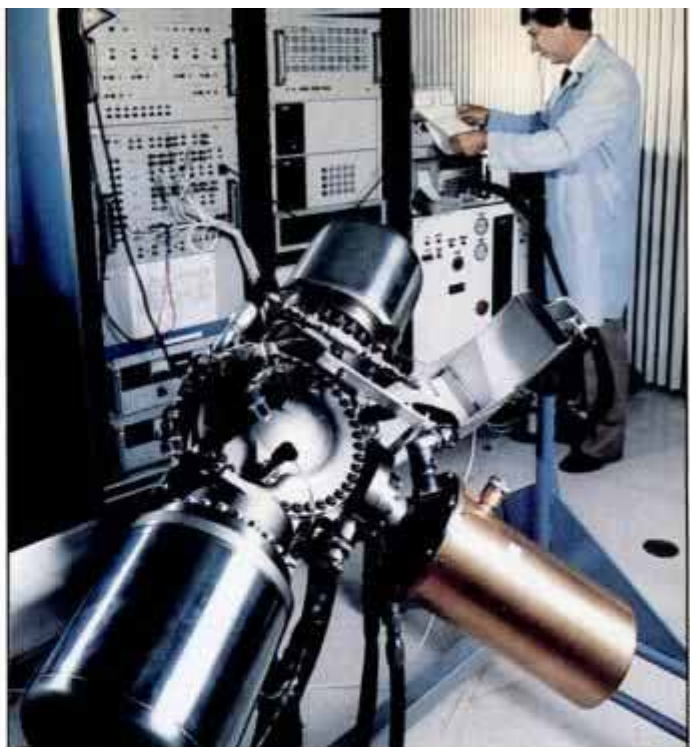
Editor: Tim Cole
Contributors: Nick Nichols,
Mont Schultz, Ed Valigursky,
Josh Eppinger, Chris Davis,
Jim Peterson, Mike Fillon

SDI's "Fridge"

The ability to detect incoming missiles and discriminate between real warheads and decoys is vital to the Strategic Defense Initiative. Scientists at GM's Hughes Electronics Corp. are helping meet this important SDI objective with the Vuilleumier-cycle cryogenic refrigerator. The satellite-borne unit will be placed aboard larger orbiting systems and will cool infrared sensors to near ab-

solute zero to increase their sensitivity to thermal radiation. It recently completed an accelerated 5-year test. Dr. Manos Vourgourakis, program manager, says it's the only device of its type to perform that long at such low temperatures.

Vuilleumier-cycle refrigerators are ideal for use in space because the unit operates with low internal forces, reducing wear on bearings and seals. The result is a long, maintenance-free life. In space, satellites will be equipped with two coolers in tandem to increase reliability. Hughes Electro-Optical and Data Systems Group developed a thermal switch which activates the second cooler if a problem occurs.



A Hughes engineer and the Vuilleumier-cycle cryogenic cooler.

HUGHES PHOTO

New Energy Technologies

To develop a commercial-size solar-power generating plant of the future, engineers will have to rely on thousands of expensive mirrors called heliostats to focus the Sun's energy on a central collecting tower.

Now, scientists at Sandia National Laboratory have figured out a way to save up to 25 percent over conventional heliostats by using a stretched membrane mirror to accomplish the same task. A silver polymer film is glued to the side that reflects sunlight. The material is then stretched over a steel hoop. In other energy news, researchers at Oak Ridge National Laboratory are getting closer to practical fusion energy with a new "machinegun" refueling device. The repeating pneumatic injector fires pellets of frozen hydrogen at speeds up to 4000 ft. per second into a fusion reactor's 100,000,000° F plasma. Both developments promise a clean, inexhaustible source of energy for the next century.



Sandia's solar heliostat.

SANDIA PHOTO



The Oak Ridge hydrogen-fuel pellet injector.

OAK RIDGE PHOTO

Arms For The Army

The Advanced Combat Rifle (ACR) will replace the latest version of the M16, known as the M16A2. The procurement, scheduled for the 1990s, calls for a 100 percent increase in accuracy, increased hit probability through controlled burst-fire, a reduction in weight, use of an advanced optical-sighting system and an advanced type of ammunition. Caseless ammunition has been discussed in context with the ACR, but several alternative solutions, including a flechette-type round using a dart-shaped projectile are also being investigated by Army planners.

Composites are expected to play a major role in weight reduction. Six major contractors are producing technology demonstrators: AAI Corp., Heckler & Koch, Colt Industries, McDonnell Douglas Helicopter Co., and Steyr-Daimler-Puch.

Whatever the selection, the battlefield of tomorrow is destined to be a far more lethal environment.



Army's rifle of tomorrow?

AAI PHOTO

Space Station Takes Shape

The full-scale module structure, identical to the one NASA will place in low Earth orbit in the 1990s, is being constructed at Boeing



Welding the Space Station.

Aerospace's facility in Huntsville, Alabama. The 45-ft., flight-quality platform uses a diamond-grid reinforcement design and is being assembled using robotic welding techniques. The mock-up will validate design and assembly procedures, and automated manufacturing is expected to reduce cost over the life of the Space Station project.

BOEING PHOTO

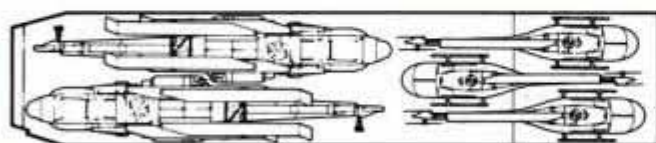


The C-17 Abuilding

Lockheed-California is currently crafting a full-scale wing section mock-up for America's next airlifter. The structure will help C-17 designers properly position spars, stringers, pylons and other wing components when the C-17 enters final development leading to a first flight in 1990. Lockheed was awarded the wing subcontract from McDonnell-Douglas, C-17's prime contractor.

The intricate wing, incorporating a winglet for the first time on any military aircraft,

C-17's intricate wing structure (top), load configuration (left) and all-up profile (below).



will also include the largest pieces of aluminum ever produced for an airplane, stretching from the center of the aircraft to the wingtip at a length of 88 ft. All up, the wing components will weigh around 45,000 pounds on each aircraft. C-17 will replace the Military Airlift Command's aging fleet of 4-engine turboprop C-130s, MAC's principal workhorse for the past 30 years. Main features of the C-17 include a 2-pilot cockpit operation with a full array of CRT and heads-up displays, refueling capability, one loadmaster operation, four Pratt & Whitney PW2037 engines, and advanced composites structures. The aircraft was designed to accommodate a full complement of battle equipment, able to carry on separate flights, four UH-60 Blackhawk helicopters, a combination of two Bradley Fighting Vehicles and other assorted trucks and trailers or two AH-64 attack and three OH-58 observation helicopters. C-17 can deliver a total of 172,200 pounds of cargo consuming 20,900 cu. ft. of space in a cargo hold 18 ft. wide, 88 ft. long and up to 13.5 ft. high. Wingspan is 165 ft. Externally blown flaps and high maneuverability at low speeds make C-17 suitable for short-field landings in remote trouble spots.

Hemoglobin Made Anew

The procedure involves the use of a centrifuge to separate red blood cells from whole blood, washing the cells in a salt solution and re-

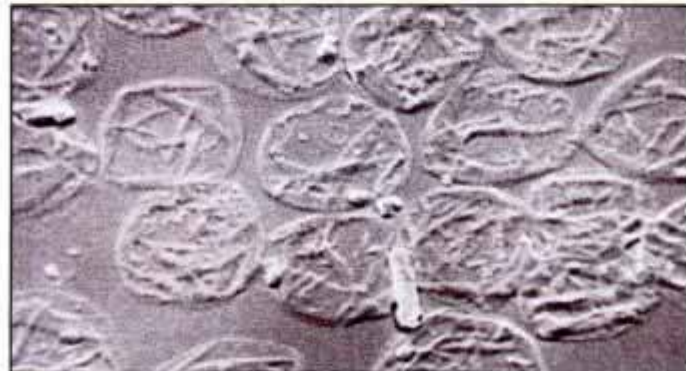
moving the salt with a kidney dialysis machine. Dialysis lowers the salt concentration and makes the cells swell, opening minute pores that release the hemoglobin in quantity. Current methods

of hemoglobin extraction break up red blood cells, which can contaminate the hemoglobin with antigens or impurities from cell membranes. Scientists at the U.S. Department of Agricul-

ture developed the procedure to produce large amounts of pure hemoglobin, a protein in red blood cells that carries oxygen to the body and removes carbon dioxide. The hemoglobin is used to feed research insects. According to the USDA's Dr. John DeLoach, "tests showed commercially available hemoglobin was not pure enough, and, at \$8 per gram, was prohibitively expensive." The new method is 10 times faster to produce and costs one-eighth as much. Researchers may one day be able to use the technique to get ultrapure hemoglobin for transfusions.



Hemoglobin production (top) via centrifuge and red blood cells with hemoglobin removed.



Computerized Quality Control

"Kiwivision," developed at the University of Wales, creates a digitized version of a defect-free item on a production line. A computerized camera eye then scans up to 10 items at a time, comparing the items with the perfect image installed in memory. It's estimated that the sys-



Spotting flaws via computer.

tem spots faults five times faster than the human eye. Kiwivision can "see" anything from insects in a packet of flour, to cracks in metal components, to imperfections in molten steel. More complex objects can be scanned by adding boards to its central processing unit.

Tamper-Proof Packaging

PA Technology of Princeton, New Jersey, uses optical variable film (OVF) to show consumers whether or not a product has been opened. The film, which changes color or according to the way you shift the package to the light, becomes transparent if the package has been tampered with. Two pieces of different color film oriented in different directions increase package security. OVF, transparent to start with, is loaded into a vacuum-deposition machine, which hot-stamps the colors on the film as it passes



Packages get more colorful.

through. The material is then cut and inserted into a package on an assembly line. The system—designed for a variety of consumer products—could be in stores in a year.

The Army's New Air Defense

The operative acronym is FAAD, which stands for Forward Area Air Defense—and Army planners see a bright future for the concept in the face of an evolving Soviet air threat. Army planners went back into the huddle following the demise of the Sgt. York Division Air Defense gun, and came back with a 5-part interrelated suite of guns and missiles connected by a stand-alone command, control and intelligence unit. Part one is a non-line-of-sight, fiberoptically controlled missile that surveys the battlefield and strikes helicopters hiding behind terrain or foliage. Part two, dubbed line-of-sight forward heavy, consists of a tracked vehicle (probably either a Bradley APC or Abrams tank hull) bearing a gun/missile hybrid. Contenders for the contract include the Roland II, the Rapier, the ADATS and the Shahine—all missile systems bearing guns for close-in work. Testing of all four systems is taking place at White Sands Missile Range in New Mexico, and the

winner will be announced next month. In part three, line-of-sight rear security will be achieved by a Pedestal Mounted Stinger in the bed of a Hummer light utility vehicle. Combined arms rounds for the existing guns on the Bradley and the M1A1 Abrams constitute part four of the system. Among the technologies being analyzed are proximity-fused high-explosive rounds for the Bradley's 25-mm automatic cannon and guided projectiles for the M1A1's 120-mm smooth-bore. Part five binds this interdependent network of ground and aerial surveillance sensors (both active and passive). The ground sensor combines targeting devices with an IFF (identification, friend or foe) system. Each component is designed to work in concert with all of FAAD's other components. Fielding is expected in the early 1990s, and Defense Department experts envision a system that can expand to meet a growing Soviet potential to attack and defeat ground forces.

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MAZDA 626/MX-6

Steering is by all fours on the third-generation 626.

BY MIKE ALLEN, Assistant Auto Editor

At 100 mph on Mazda's test track, the 626 just didn't feel right. If we didn't know that the car was equipped with 4-wheel steering, we would have backed off. But we kept our foot in because we were on the high-speed banking to get used to the new steering system, and find out how the third-generation 626 compared with the model that is being replaced.

Last year's 626 design dates to 1983—old by Mazda's standards. So, the company conceived a new-from-the-ground-up 626, sporting a new 2.2-liter ohc engine and a host of high-tech refinements. And, in a brilliantly downplayed show of technical one-upmanship, a 4-wheel-steering system that is considerably more complex than the only other system in production: Honda's.

The bodywork is all new, but anyone who knew the older 626 will not have any trouble identifying this car.

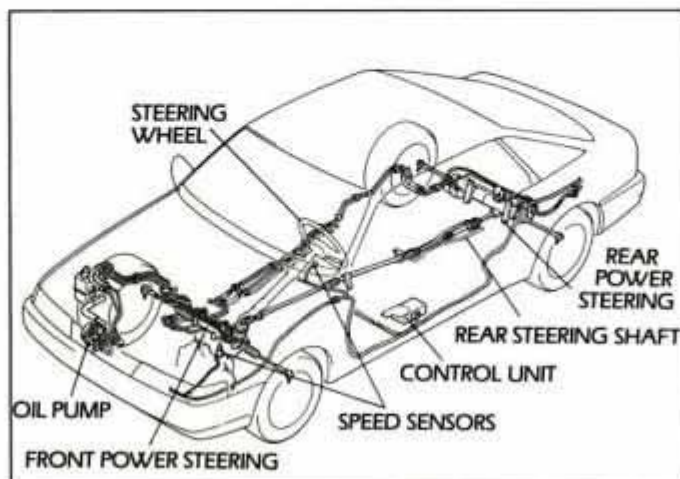
There's a 4-door sedan and a hatchback, as well as a coupe variant labeled the MX-6. The MX-6 label is to distinguish the "sporty" version, which might otherwise be perceived as a stripe-and-sticker pseudo performance car.

All three versions are front-wheel drive, have flush glass, conservative

use of brightwork trim, and a C_d between 0.34 and 0.32. Lifter height in the rear of all three is only as high as the rear bumper, if you happen to travel with suitcases full of rocks often. Mazda's rear seats are usually available in a 60/40 split version that lets you carry your skis inside and still have one passenger in the back seat, and the 626 is no different.

The new 2.2-liter 12-valve powerplant produces 110 hp and 130 ft.-lbs. of torque, while the intercooled turbo version puts out 145 hp and 190 ft.-lbs. With two intake valves and a single exhaust valve, the tremendous valve area permits relatively mild camshaft timing for good mid-range torque, while permitting a free-breathing top end. Mazda claims that the no-turbo version has 80 percent of its torque available from idle to near the redline, and driving the car seems to bear that out.

(Please turn to page 122)



When Mazda 626 speed is less than 22 mph, rear wheels steer in opposite direction of front, more than 22 mph they steer with fronts.

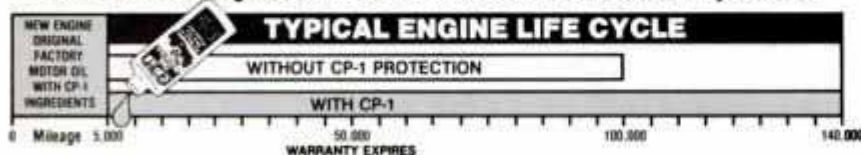
"When You See Smoke At Indy... It's Too Late!"



By Howard A. Smith
President, Curb Products

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- **Loss of Power During Acceleration.**

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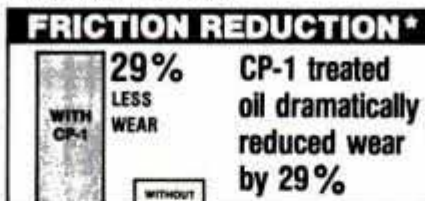
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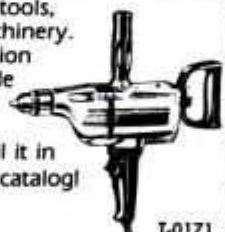
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MAZDA 626/MX-6

(Continued from page 120)



Steering wheel turns the front wheels, rears are turned automatically, 5" maximum.

Besides port injection, there's also a "smart" wastegate for the turbo that increases boost from 5.8 psi to 7.3 momentarily at low rpm for a quick burst of power. The 5-speed transmission has been revised for easier, smoother shifting, and the automatic has a button on the shifter that will hold the transmission in a higher gear for those snowy days when low gear might be a little too much for the available traction.

If you've never driven a car with ABS on a slippery road, wait for a rainy day and try a 626. The ability to steer around obstacles with the brake pedal mashed to the floor is nothing short of uncanny, and it's good to see ABS offered on a moderately priced car.

A displacement of 2.2 liters is pretty big for a Four, and some examples buzz pretty badly. But the 626's powerplant is as smooth as any other inline Four we can remember, and that's without the use of balancing shafts. Fluid-filled engine mounts (and suspension bushings) make for a smooth ride. It feels like there might be a Six under the hood.

The fascinating feature of the 626, though, is its 4ws system. Modestly, Mazda refers to it as "simply another benefit to our customers." It's engineered to make the rear wheels think for themselves: At low speeds, below 22 mph, they steer in the opposite direction from the fronts, for a smaller turning radius. As speed increases, the rear wheels turn less, and at speeds more than 22, the rear wheels steer in the same direction. This means that in high-speed lane changes, the body of the car doesn't have to yaw to the left or the right for the rear wheels to begin cornering. The speed sensor and computer know how fast the car is traveling, and adjust accordingly.

If that sounds like it might be disconcerting, it is. Transitions into and out of medium-aspect turns are noticeable as the rear wheels steer. Instinctively, there's little difference in what the car

(Please turn to page 124)

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MAZDA 626/MX-6

(Continued from page 122)

does—turn right for right, and left for left. The advantage is supposed to be that the car will do what you intend it to do, but better than you could. In a lane change on a snowy road, for example, you'll change lanes with less likelihood of spinning out.

The steering system is hydraulic. A pressure line from the power steering pump, as well as steering shaft, run back to what Mazda calls a phase control unit. With input from the computer, this unit (filled with an impressive array of stepper motors, bevel gears and control rods) calls the shots for a hydraulic cylinder that steers the rear wheels.

The system is available only as part of a \$2400 package that includes alloy wheels and an *automatic transmission*. This marketing approach means that the turbo 5-speed MX-6, a potential rival for the Audi/BMW/SAAB/Volvo market won't be available with 4ws.

Mazda plans to sell only about 3500 4ws in the '88 model year, touting 4ws as a safety/convenience item, rather than a handling enhancement.

Mazda hadn't set a base price structure for the car as of press time. With the dismal shape the yen is in compared to the dollar, it's no wonder that that decision is being left until just days before the cars actually go on sale, which should be right around the time you're reading this. **PM**

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MAZDA 626	GRADE	COMMENTS
Acceleration	B	Good bottom-end torque, turbo version really moves
Handling (2ws)	B-	Uninspiring but competent
Handling (4ws)	B+	Good, with less driver effort needed
Steering (2ws)	C	Power boost lags behind in slalom
Steering (4ws)	B+	Feels spooky, but works way it's supposed to
Transmission	B+	5-speed especially nice to shift
Ride	A-	Quiet and smooth
Fuel Economy	NA	Even preliminary EPA numbers not available
Seating	B-	60/40 back seat is nifty, but uncomfortable for third passenger
Vision	B	Good
Gauges/Controls	B-	Avoid the Ginza-by-night electronic dashboard
Ventilation	B+	Good demisting
Noise @ 55 mph	B	Average
Cargo Capacity	A-	Fold down seats allow long parcels
Engine Serviceability	C	Usual bundle of snakes
Fit And Finish	B	Educated guess until regular production begins

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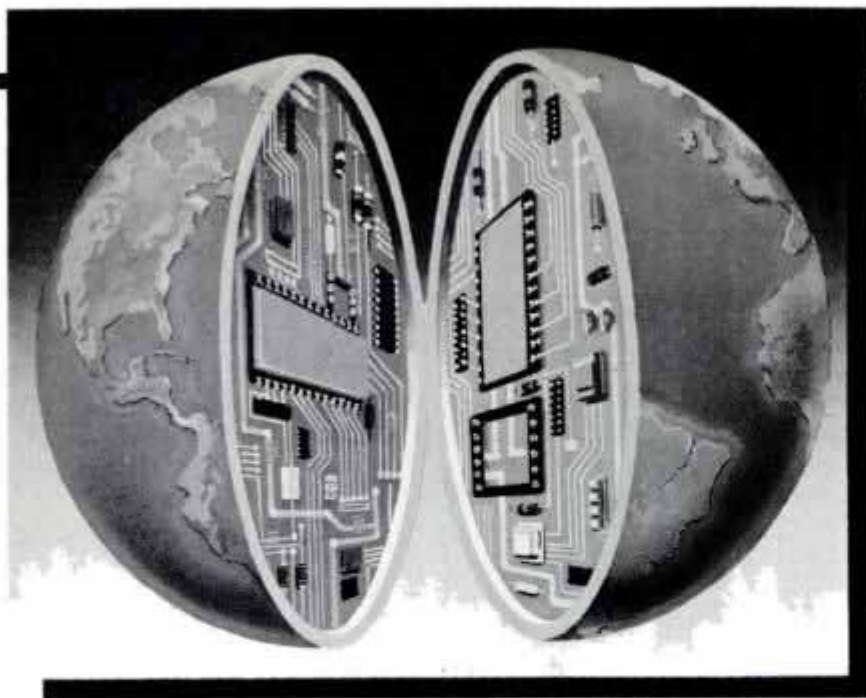
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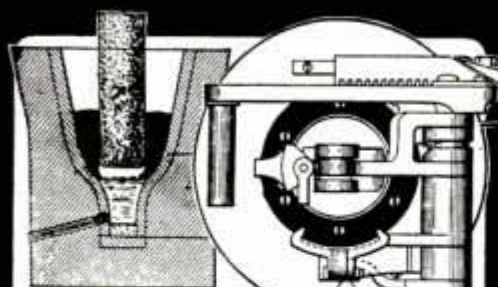
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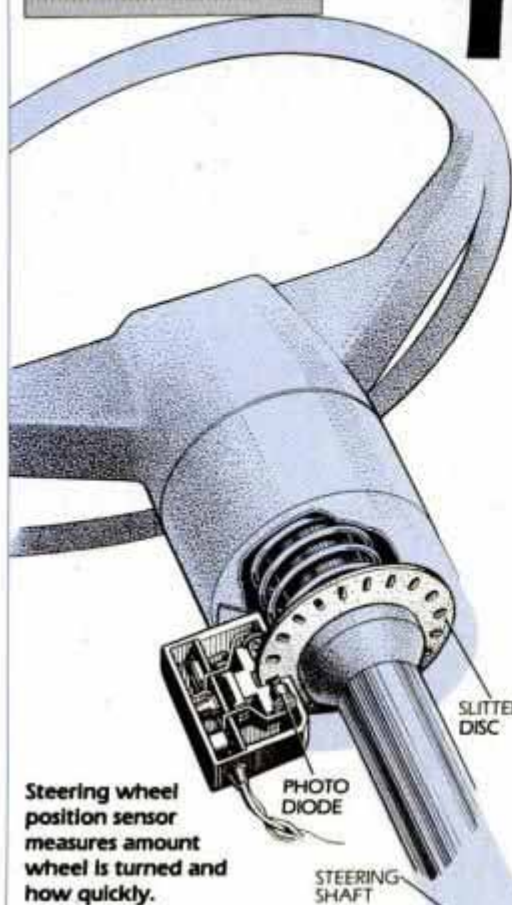
MAKING COMPUTERS AFFORDABLE

ENGINEERING THE NEW CARS

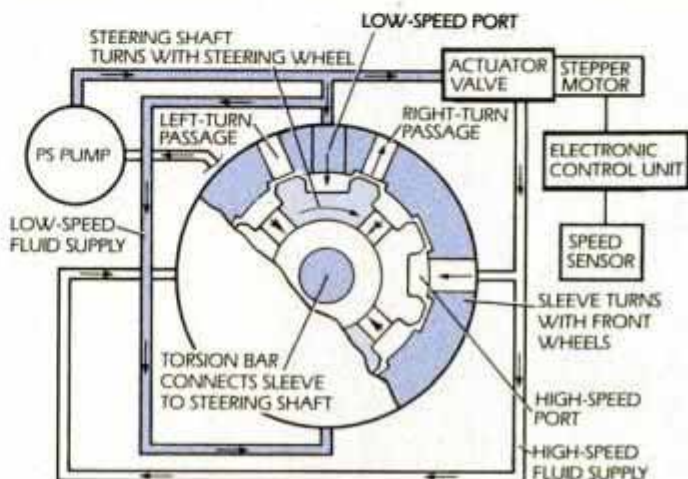
Purists may scoff, but the '88 Lincoln Continental is the first U.S. production car that can be said to have active suspension and steering. The chassis provides an impressive array of responses, using new air spring MacPherson struts, advanced sensor technology, antilock brakes and an additional on-board

computer to control a variable-assist power steering system.

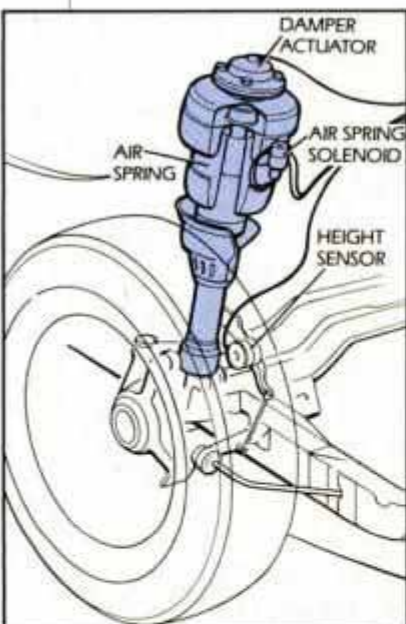
The air spring struts, at all four wheels, are the latest design in modern air springs for the transverse-engine, front-drive car, replacing the separate "air bags" used with separate struts and shock absorbers on the previous Continental, a conventional



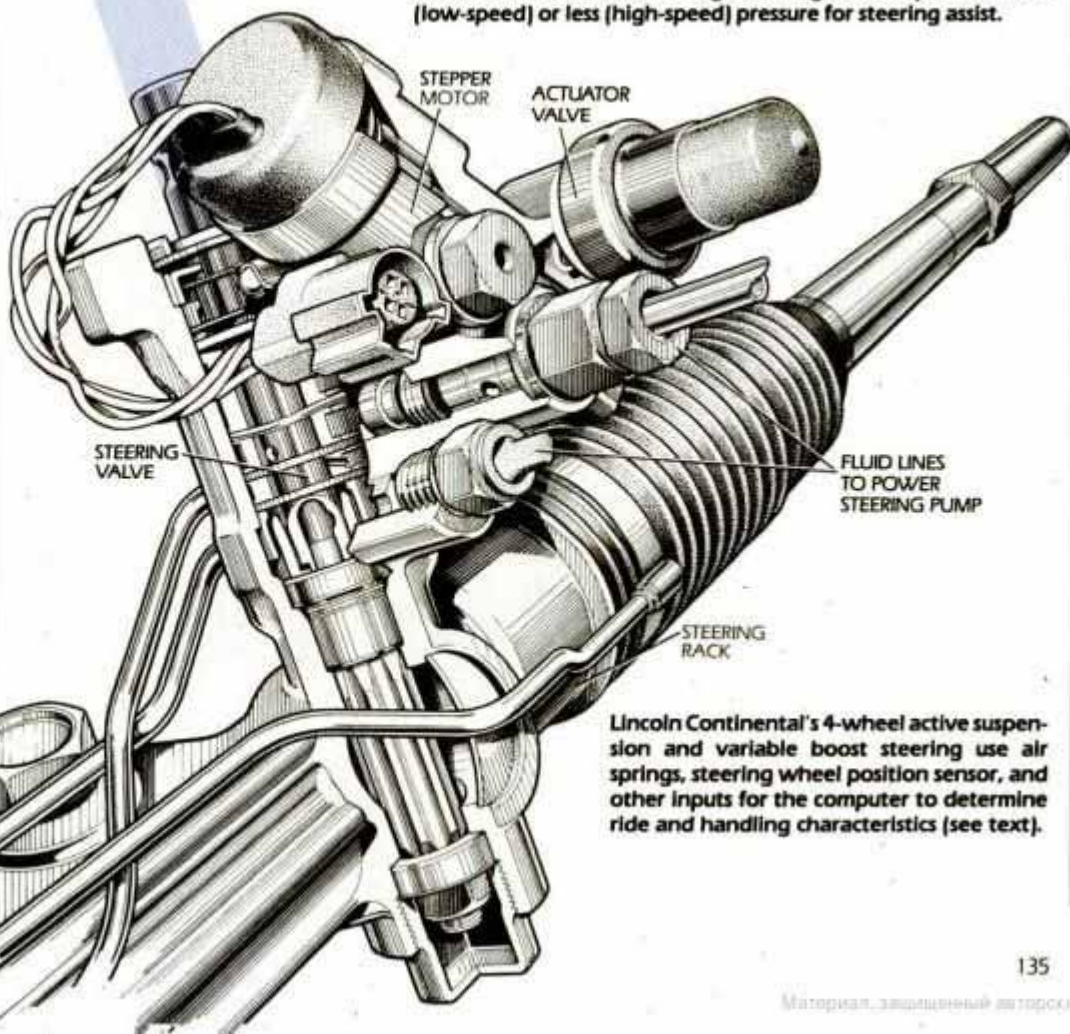
Steering wheel position sensor measures amount wheel is turned and how quickly.



Steering valve cross-section shows fluid flow during right turns. As steering wheel is turned, fluid is metered, depending on position of actuator valve, through steering valve to provide more (low-speed) or less (high-speed) pressure for steering assist.



Active suspension also includes: air compressor, speed sensor, acceleration sensor, brake pressure sensor, electronic control unit and other components.



Lincoln Continental's 4-wheel active suspension and variable boost steering use air springs, steering wheel position sensor, and other inputs for the computer to determine ride and handling characteristics (see text).

ENGINEERING THE NEW CARS

rear-drive car. Like the previous system, this one also is computer-controlled.

The air springs are inflated and deflated automatically by a computer that controls air solenoid valves at the struts and an electric compressor. Previously, the air spring suspension was supposed to simply keep the car level in response to changes in vehicle load. On the '88 Continental, it also contributes to the active system.

It now can recognize a cloverleaf intersection where there are long, deep turns and cancel any attempt by the computer to level the car, which is not desirable under these conditions.

An optical steering wheel position sensor contributes to the computer input. A slitted disc between a light and a photo-diode on the wheel signals the computer so it can tell how far the wheel has been turned, and how fast. It takes some sophisticated thinking by the computer to first determine the wheel's straight-ahead position, but once it does that, it's ready to go.

The system also can detect a snowbank (or a similar type of obstruction), thanks to new height-position sensors that can signal many different points, rather than just too high or too low. The computer then will level the car as soon as it stops, so it doesn't get hung up on the snowbank. The '88 Continental has one sensor at each front wheel and a third for the rear suspension.

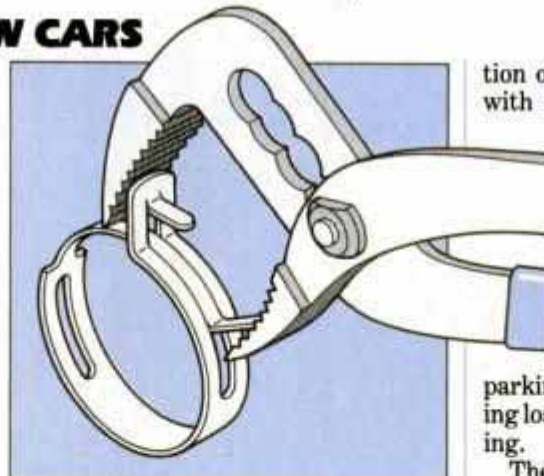
Key to the Continental system are electric motors to change the strut's shock valving on command from the computer, at speeds above 18 mph. With the steering wheel sensor, this is similar to what was introduced last year on the Thunderbird turbo coupe, but with much greater range and a more complex operating program for the computer.

The Bird, for example, has a range of about 3-to-1 from firm to soft. The Continental has a range of 12-to-1, which sounds as though it would upset the tender sensibilities of the luxury-minded, but thanks to the new sensors and computer program, the system goes to firm only when necessary and it switches to marshmallow the instant (within milliseconds) that it's possible.

The new height sensors can detect a road surface problem, such as a railroad crossing, with the first movement of the road wheel, and tell the computer to firm the suspension.

The car rides better and is more controllable. Actual road testing on a wide variety of surfaces was used to develop the shock valving program, and on all the surfaces PM tried, the computer-operated valving was invariably right, even when it chose to keep the struts in the soft mode.

The system goes to firm shocks when-



FORD: New clamp used on all '88 Ford vehicles has more even clamping pressure.

ever the gas pedal is mashed (thanks to a signal from the throttle-position sensor) or when the driver hits the brakes moderately (which triggers a 250-psi switch in the brake system).

The shocks also go firm during quick steering maneuvers at road speed, such as a lane change. In this case, the amount of turn may be too small to keep the struts at firm valving, but because the wheel is yanked quickly, the computer uses the turning rate to hold the stiff valving until the steering emergency maneuver is complete.

In slow steering maneuvers, it may take a substantial amount of steering wheel angle for the suspension to go firm (120° at 20 mph, for example). It takes a much smaller angle, just 52° to trigger the suspension at 55 mph, as the system responds to road speed increases.

The combination of computer calcula-

tion of rate and actual steering angle, with road speed factored in, reduces body roll in cornering situations.

New variable-assist power steering

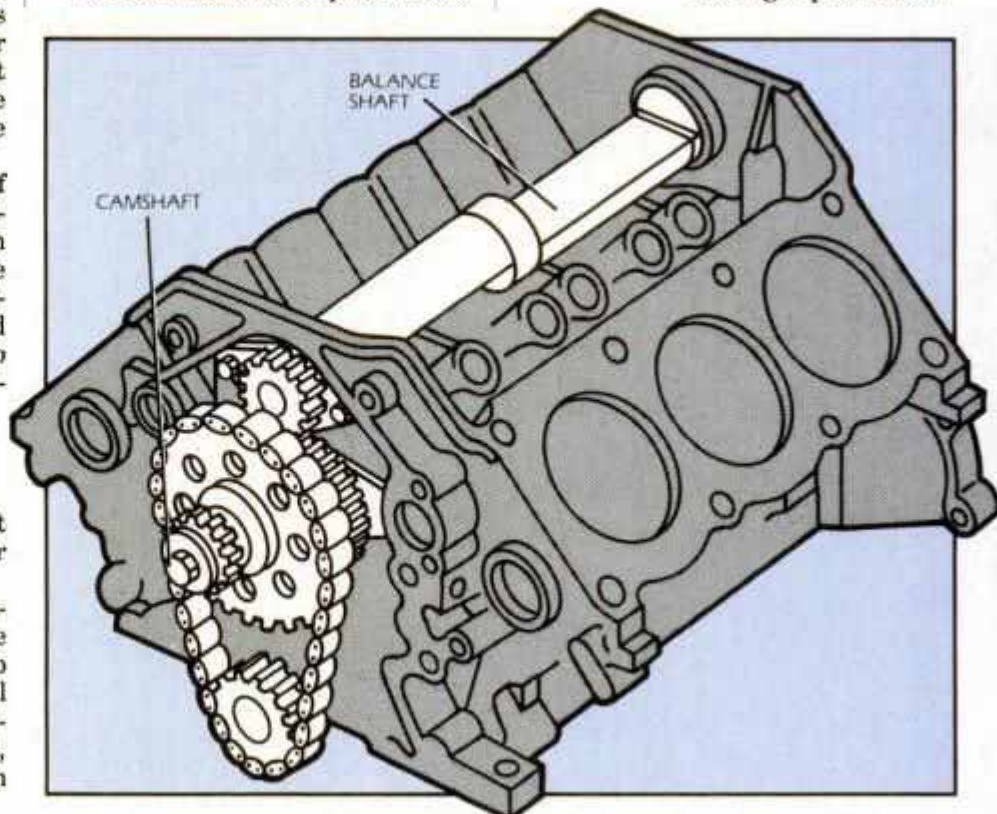
The variable-assist power steering is the answer to the old complaint about the system: To get adequate assist for parking, there is too much assist, causing loss of road feel when the car is moving.

The '88 Continental steering valve assembly has two double-valves, one pair for parking maneuvers (called the low-speed section), a second pair for reduced assist (high-speed).

A conventional power steering pump feeds pressurized fluid into two ports. At parking or low speed, the fluid flows only into the maximum-assist port and into a double-section of the valve assembly. As the wheel is turned to the left or right, a fluid return is closed off, which allows fluid pressure to build up through the valve and out to the appropriate piston on the steering rack.

As road speed builds up, the vehicle speed sensor signals the steering computer (also the suspension and engine computers). The steering computer operates a motorized valve on the steering valve assembly, opening up a second fluid port to the high-speed section. Now the fluid flow from the pump starts to divide, and the higher the speed the greater the flow through the high-speed port, and therefore less power assist.

The high-speed section



FORD: Balance shaft between heads damps shake inherent in the 3.8's 90° V6 layout.

is basically identical to the low-speed, except that it takes much greater steering effort (more fluid bleed-back for less assist and more road feel). The motorized valve has 87 positions, so the computer can provide a progressive reduction in assist with increasing road speed.

Ford engines

The '88 Ford passenger car engine lineup becomes the first in the domestic industry to get multipoint fuel injection across the board. The 2.3-liter Four in Tempo-Topaz and the 3.8-liter in T-bird and Cougar are the last to go to multipoint, after an interim changeover from carburetors to throttle-body fuel injection (although the competition has few carburetors, it still has many models at the throttle body level).

In fact, it's hard to find a carburetor on anything Ford makes in the U.S. The 5.8-liter (351-cube) and 7.5-liter (460-cube) V8s on light utility vehicles also get multipoint fuel injection for '88. The base Ranger 2.0-liter Four, an import, comes with a 2-barrel carb.

Reworked 3.8 V6

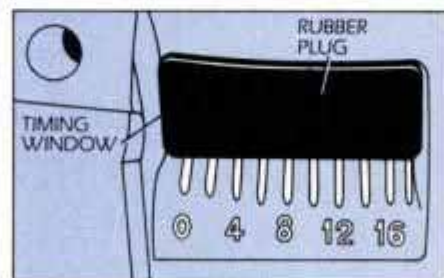
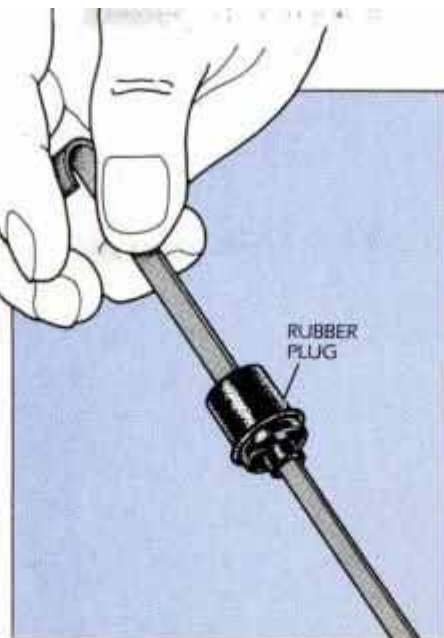
The 3.8 V6 is a key engine for '88 Fords because it goes into the Continental and is an option for Taurus-Sable. The '88 version was extensively reworked, not only for the transverse installations, but to provide the greater smoothness necessary to please the Continental buyer. It seemed reasonably smooth, and it is an even-firing engine.

However, as a Ford engineer put it, "Even firing helps, good mounts help, but you're kidding yourself if you think the engine ends up smooth enough for the luxury market."

The only answer, he said, is a balance shaft, and that's what Ford installed, in the valley between the banks. All 90° V6s suffer from both horizontal and vertical unbalancing shakes from the movement of the reciprocating parts, and a front-drive is more sensitive to these than a north-south. The problem increases in line with engine speed, so the balance shaft counter-rotates at engine speed to cancel out the vertical forces. The engine mounts are tuned to handle the horizontal forces.

The words were little different at General Motors, and the response was exactly the same on the 3.8 V6 offered by the General.

A new coolant hose clamp is one of the tremendous trifles that will appear on the 1988 Escort, then on other models, to help prevent coolant leaks. It's a no-adjust band clamp (so the assembly line boys can't make a mistake), but unlike spring wire clamps, it provides close to 360° even clamping. A horizontal projection from one of the tangs prevents overexpanding the clamp when it's re-



CHRYSLER: Rubber plugs on dipstick, transmission bellhousing of 2.2- and 2.5-liter Fours, keep some noise inside engine.

moved for service. This clamp has been used successfully in Europe and will also be appearing on the AMC Premier.

Chrysler

"Four valves per cylinder mean nothing to the average customer. What he wants is a quiet, smooth-running engine." This statement by a Chrysler engineer may be sour grapes, as the only Chrysler 4-valve is a limited-production engine for the upcoming Chrysler-Maserati. However, much of the '88 engineering of the standard 2.2/2.5-liter Four reflects that philosophy he expressed, which finds some agreement in Ford and GM '88 developments.

Rubber plugs go in the end of the dipstick and the bellhousing's ignition timing window to keep some noise from getting out. Four holes in the concave section of the crankshaft pulley keep it from acting as a loudspeaker for front-end noise that escapes.

The camshaft timing belt teeth have been deepened (from 1.85 to 3.44 mm) and reshaped, so they fit better in the cam and crank sprockets.

This permits a reduction in tension of the timing belt, so it no longer "hums" like a violin string.

And the engine has been fitted with roller bearings in the cam followers. This widely used modification reduces engine friction, but it also cuts the torque needed to turn the engine at idle, so there's less torsional vibration, con-

tributing to smoothness.

To insure the camshaft would hold up, it is made of a premium iron given a final, special hardening treatment. Chrysler also reduced camshaft valve overlap, costing some high-speed power, but improving idle quality.

There's a lot more of "fix what you've got before you try something new."

The Omni/Horizon, which goes back into production, is the last Chrysler front-drive to drop the carb. It gets throttle-body fuel injection.

Most Chrysler turbocharged models get a new Japanese turbo, replacing the long-used Garrett AiResearch, which remains only on the intercooled version. The Japanese turbo is 2.6 pounds lighter and a bit smaller. It has a smaller, lighter turbo wheel that reduces the infamous turbo lag, so a car is significantly quicker 0 to 30 mph.

Chrysler sells more than 100,000 turbos because of limited availability of the 3.0-liter V6s it imports from Mitsubishi. The smaller '88 turbo also produces 1987's 146 hp, because it spins faster and the intake manifold was retuned.

The last of Chrysler's carbureted car engines, the 318 (5.2-liter) V8 used on rear-drives, gets a long-awaited change: a water-cooled intake manifold. This is designed to reduce the coking of exhaust gases in the manifold's exhaust crossover passage, a problem that causes driveability headaches until the engine warms up in cool weather. Customers have been complaining for more than 20 years, but better late than never. Of course, Chrysler expected to bury the rear-drives years ago, and so was reluctant to spend on them.

The 3.9 V6 and 318 V8 on trucks gets throttle-body fuel injection, changes made because the truck versions figure to be around for a while.

And quietly, Chrysler discontinued U.S. production of the 225 slant Six, the rugged gasoline engine introduced in 1959. It had recently only been available on the Ram pickup, which for '88 gets the 3.9-liter V6 instead. Whisper goodbye to a durability legend.

The rear-drive trucks have needed a 4-speed overdrive automatic for competitive reasons, and most get one in mid-'88. Chrysler took its venerable 900 series TorqueFlite (remember the team of Slant-Six and TorqueFlite?) and re-



CHRYSLER: 2.2 and 2.5 cam timing belt teeth have been reprofiled to reduce noise.

ENGINEERING THE NEW CARS

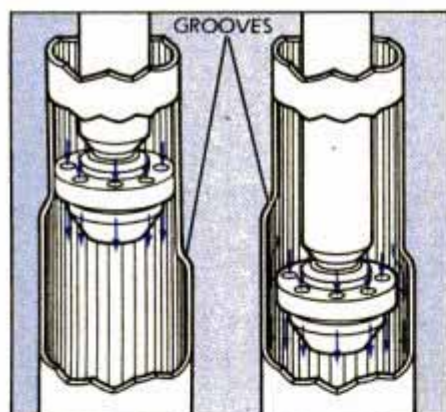
worked the extension housing to take a planetary gearset.

This does permit an easy lockout of overdrive for pulling heavy loads. However, the gearbox now has three planetary gearsets to get four forward gears, rather excessive as this also can be done with a single compound gearset for a more compact design.

Chrysler's New Process division, which makes most domestic 4-wheel-drive transfer cases, offers what should be a very popular modification to the one in the 4wd Dakota pickup: addition of an oil pump to the output shaft. When the vehicle is towed, the rear wheels turn the output shaft and operate the oil pump so the case is lubricated. There's no need to disconnect a propeller shaft and the vehicle can be towed at highway speeds. The oil pump is a super-compact "gerotor" type, becoming increasingly popular because of its size and simplicity. The name is a combination of gear and rotor, for that's what it resembles. There's an inner rotor with one less tooth than the outer rotor, so the space for the "missing tooth" accommodates the oil as it is pulled in, compressed and moved out to lube the case.

Suspensions

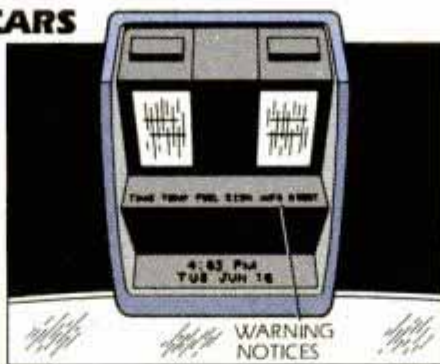
While everyone else is putting electronically controlled valves in the struts and



CHRYSLER: Dynasty/New Yorker struts have progressively higher damping as piston passes beyond grooves in strut.

shocks, the 1988 Dodge Dynasty and Chrysler New Yorker MacPherson struts have something much simpler, providing three stages of spring dampening in a totally mechanical design.

The piston chambers have two longitudinal grooves of different lengths, and when the car hits average bumps, these grooves permit additional oil to bleed between piston and the upper and lower parts of the chamber for normal dampening. When the car hits a more severe rut, the piston moves past the end of the first groove, so oil bleeds through only the holes in the piston and one groove for firmer dampening. When a wheel goes into a real pothole, the piston



CHRYSLER: Overhead console warns about fluid levels in Dynasty/New Yorker.

moves past the ends of both grooves, so the oil bleed is only through the holes in the piston. This design is combined with optional automatically controlled air shocks in the rear. It isn't exactly active suspension, but it does a job.

Electronics

Chrysler's '88 package isn't all rework. Dynasty and New Yorker have the industry's first truly mass production version of extensive multiplexing, an advanced wiring system introduced last year on Cadillac's low-volume Allante to control the car lighting system.

Multiplexing uses microprocessors in key locations, connected only by one or two wires, rather than running thick harnesses throughout the car. Individual components (including sensors and switches) are conventionally wired to a nearby microprocessor, which transmits multiple signals over the one or two thin wires to other microprocessors that need the information, including passenger compartment warning displays. Multiplexing not only saves wire and improves electrical reliability, but permits wider use of electronic controls.

Under the hood, Chrysler has an Engine Compartment Node, a computer containing ambient temperature and compass direction sensors and wired to a host of other underhood sensors, plus the engine control computer and the sensors, solenoids and motors wired to it. Both of these are wired to a "body computer," which also is wired to an overhead console.

The console displays warning notices (such as low fluid levels) received from the body computer, as Chrysler's first multiplexing foray is largely informational. However, the active potential is demonstrated.

The body computer can take the vehicle-speed, throttle-position and gear-shift-position signals from the engine computer and lock the car doors when the car is being driven at 15 mph. That way the car won't be locked if it just popped out of gear and started rolling.

The system also includes a plug for a new diagnostic tester to help the dealer pinpoint troubles in the electric-electronic system.

AMC/Renault

The Premier—final offspring of the AMC-Renault marriage—comes to its adoptive parent well-endowed in just about every department. It has the most powerful conventional engines in its field, state-of-the-art electronics with a first-ever feature, and is made in the newest assembly plant in the world.

Engines

The base engine is the 2.5-liter Four Jeep engine, modestly modified for the front-drive passenger car. Unlike the typical transverse front-drives, the Premier has the engine and transaxle north-south.

The camshaft was completely re-engineered to get maximum torque at a pace-setting 2500 rpm. And by reworking the spark advance curve (thanks to a knock sensor), the torque actually is up, from 141 to 142 lbs.-ft.

There was a modest loss in horsepower, from 117 to 111, but it's developed at 4750 rpm, compared with five grand on the Jeep. Result: the 2862-pound Premier goes 0 to 60 in about 12 seconds. Very respectable.

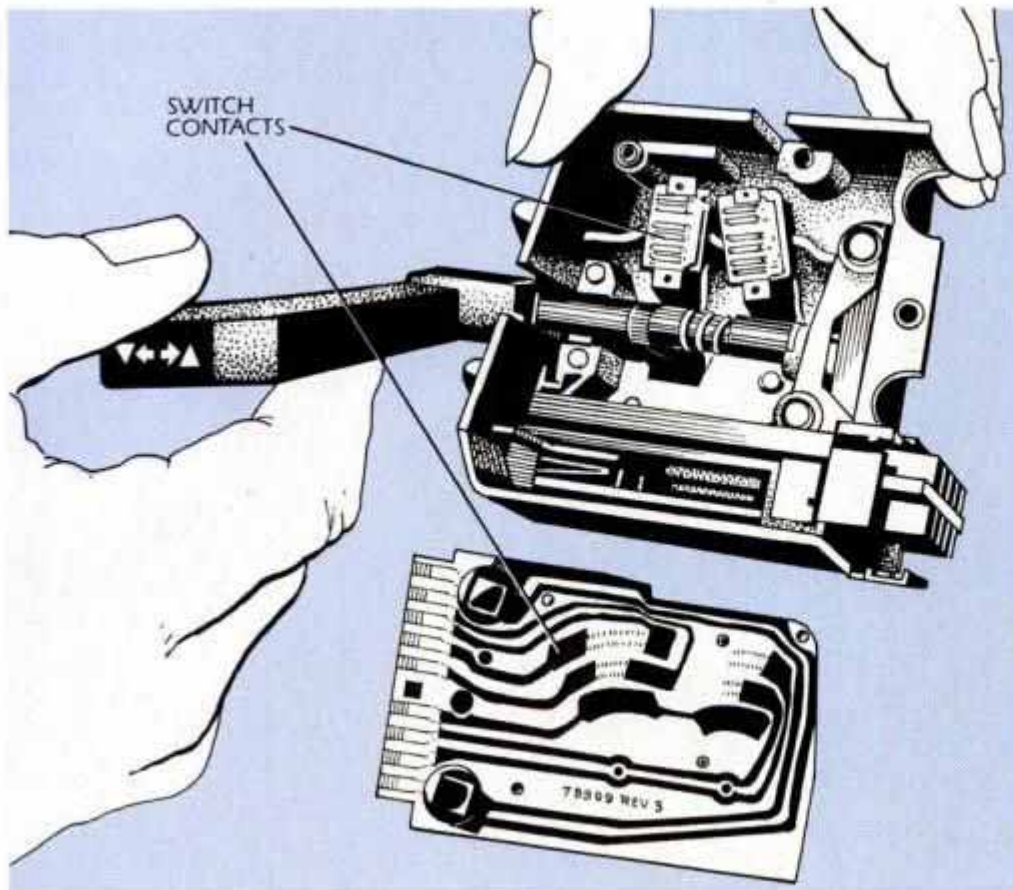
Most buyers undoubtedly will choose the optional 3.0-liter Renault V6, which will be imported from France. The 90° V6, which has overhead cams and multi-point fuel injection, produces 150 hp at 5000 rpm, 171 lbs.-ft. torque at 3750, both the top numbers in the field. The original engine was developed by a Renault-Volvo-Peugeot group, and a 2.65-liter version was used in the De Lorean.

Electronics

The electronic feature that should have universal appeal is the turn signal system, which automatically cancels if the driver forgets. There have been egg timer-type turn signals that automatically cancelled mechanically, but this setup has a lot more going for it.

The turn signal lever is mounted on the outer end of a pod attached to the steering column jacket, so it can't operate the customary switch and canceling pawl in the column. What AMC did was install an electric switch in the column, and when the wheel is turned it flicks the switch, which transmits a signal to the computer in the turn signal pod. With this signal, the computer cancels the turn indication electronically. It also cancels the signal if the turn is very shallow and the driver forgets (or doesn't hear it going). In a future design, the turn signal computer could receive a signal from the vehicle speed sensor and cancel after a specified distance.

In addition, the Premier has up to seven additional computers. The most important are two for the engine to control fuel, ignition timing and emissions and, on 4-cylinder automatics, a Renault transaxle that uses a computer to



AMC/RENAULT: Electronic turn signals on Premier have a simple switch, self-cancel electronically.

control hydraulic pressure and shift points. AMC has built on-board diagnostics into the engine, transaxle and heat-vent-a/c computers, but unlike Cadillac with its high-capacity microprocessors, it will take a special tester to do the interrogation. Although automotive computers have primarily ROM (Read-Only Memory built-in instructions), they also have some Random-Access Memory and Electrically Erasable Memory, so with the right software they can be temporarily and even permanently reprogrammed instead of replaced. AMC intends to offer its dealers packaged software for different types of problems so the dealer can put a problem car through a factory-designed exercise to isolate the cause. Eventually, minor reprogramming may be used to correct some problems without replacement of the computer ROM.

Suspension

The Premier suspension is a Renault design adapted from the French-built Medallion introduced a few months ago, and although the front is a conventional MacPherson strut type with a linkless sway bar, the rear looks as if there were a sale on torsion bars. It's a semi-independent design with a V-shaped torsion beam between the wheels. Nestled inside the V are four additional torsion bars, two that are suspension springs, and a second pair that serves as a sway bar. The absence of coil springs and

sharp angling of the gas shocks creates a large space at the rear, so the trunk is a generous 16.3 cu. ft.

Both front and rear suspension are completely assembled as modular units and checked at supplier factories, and bolted in place at the Premier plant.

Both front discs and rear drums are cast iron with steel hub inserts for light

weight. At the front discs, the steel is used with damped iron discs to reduce brake noise, as on some GM cars.

General Motors

GM's long-awaited, 4-valve engine, the Quad-4, finally debuts in 1988. Significant improvements to the 2.5-liter Four and 3.8-liter V6, along with many suspension and drivetrain changes also make '88 models very different under the skin.

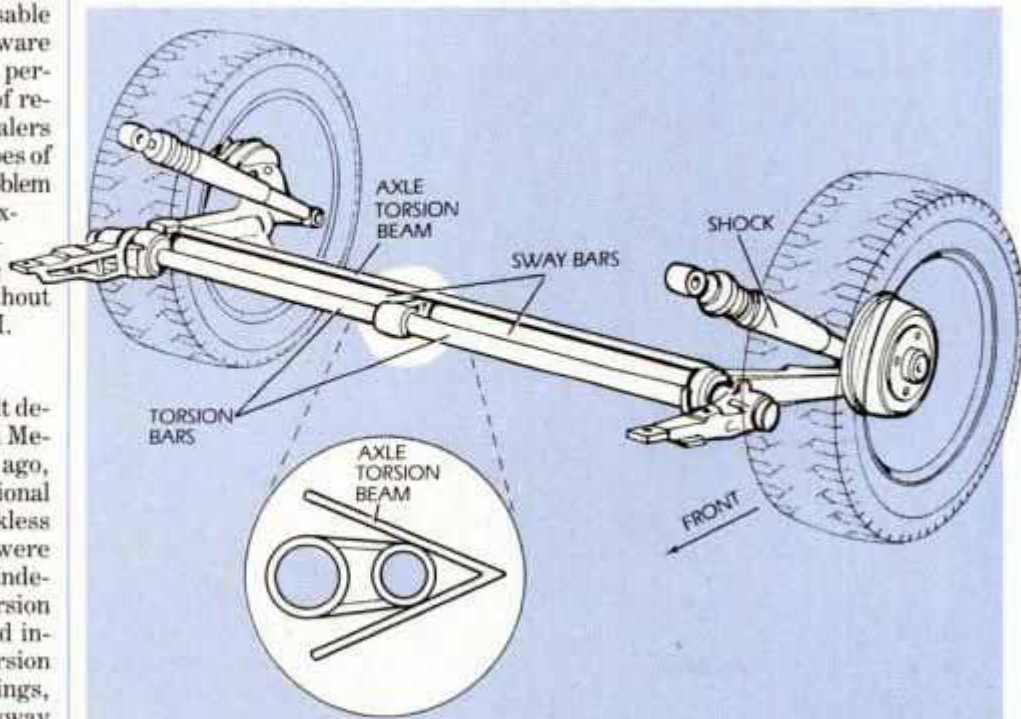
Multivalve Quad-4

The Quad-4, a 2.3-liter Four with multipoint injection and four valves per cylinder, develops 150 hp in stock trim, a very creditable 65 horses per liter (or about 1.1 horses per cu. in. for those who haven't made the metric conversion). It has twin overhead camshafts driven by a double-roller chain.

However, what it doesn't have also is significant: no exhaust-gas recirculation, no cold-start injector, no air pump, no distributor, no sparkplug wires, and no core

holes (therefore no freezeout plugs) in the cast-iron block. The 3-way catalytic converter, however, is a "richer" design (more noble metals) to help the powerplant meet emissions standards.

The engine is not a "free-wheeling" engine, which means that if the chain snaps, the pistons will go crashing into the valves. That's expensive, as Ford



AMC/RENAULT: Premier rear suspension is semi-independent. It eliminates coil springs.

ENGINEERING THE NEW CARS

found out on early Escorts when camshaft belts snapped at an unacceptable rate at low mileage. "That's why we have the double-roller chain," a GM engineer explained. "We've never failed this chain in our testing."

Why not just make it free-wheeling? Power, emissions and fuel economy numbers are just too tempting with the compact combustion chamber. Ford was similarly seduced with the '81 Escort, and it backed off with the 1983 model. However, GM is certainly not being reckless. Most other 4-valve engines also are "crashers," including the Mercedes-Benz, which has only a single roller chain and has not suffered a noticeable failure rate.

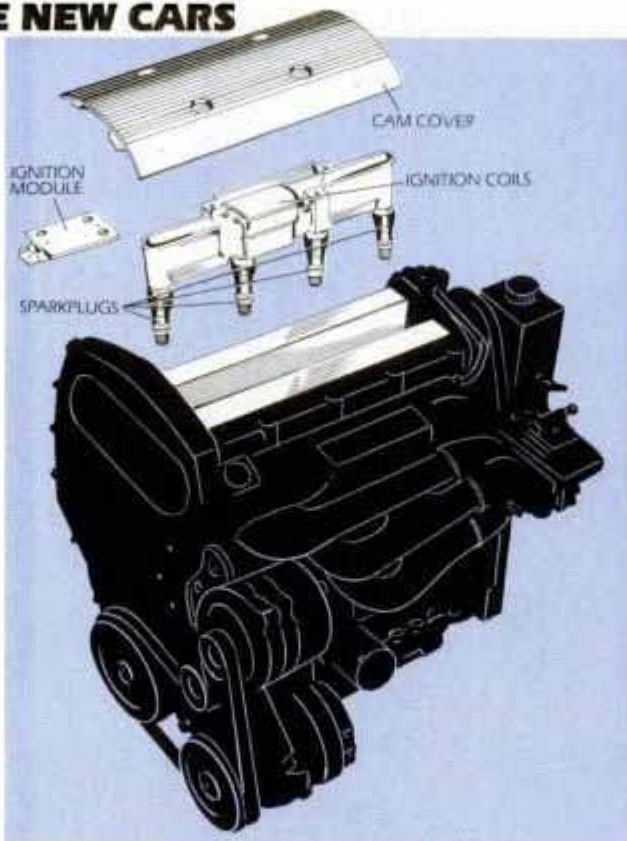
New 3.8 V6

The new 1988 3.8-liter V6 has the same displacement as the old, but it's really new, with new assembly line tooling. Originally built off a 90° V8, the engine was uneven firing (and rough-running) until a split journal crankshaft came in 1978. Splitting the journals forced use of an offset connecting rod. A full-skirt piston was used so the piston and rod wouldn't cock excessively from the rod offset, and high-tension rings were needed for good sealing because the piston wasn't always square to the cylinder bore.

The new engine block is slightly longer, and the cylinder bores are centered over the crankshaft journals, which sounds minor but is very expensive. Now, the engine has lightweight, cut-away slipper-skirt pistons and lighter rods for less reciprocating mass, so throttle response is better, and the pistons have low-tension rings to cut friction. A single balance shaft installed in the engine valley (as on the Ford 3.8 V6) cancels primary vertical shake forces, and the engine mounts are tuned to better handle horizontal shake.

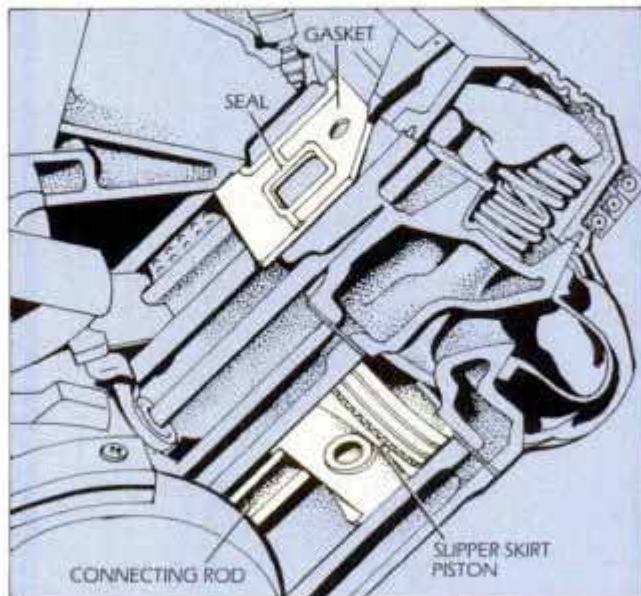
The longer block allows better exhaust and intake port shape for better performance, including improved cold-fuel atomization. Look at the performance numbers: horsepower is up from 150-to-165 and torque is up from 200 to 210 lbs.-ft. The old 3.8 V6 continues on some '88 models until new 3.8 production capacity is adequate.

The new 3.8 engine elec-



GM: Quad-4 has no distributor or plug wires. Twin ignition coils and ignition module nestle under cam cover.

tronics incorporates a pair of interesting ideas. Formerly, GM calibrated automatic transmission powertrains at sea level and tolerated "flaring" shifts at altitude. On the new 3.8 V6, the calibration is at altitude and a control scheme called Torque Management kills the flare at sea level. The computer has inputs from the sensors for vehicle speed, barometric and manifold pressures, throttle position and engine rpm, so if it realizes the engine is starting to flare (because the transmission is ready to shift), it chops spark advance (reducing torque and rpm), which kills the flare.



GM: 3800 V6 doesn't need offset rods. Low-torque intake gasket has rubber sealing material printed directly onto gasket.

Torque Management also protects the transmission from abuse during snow-mud rocking by "reading" the Park-Neutral switch.

If it senses engine flares from rocking, it reduces torque even more by cutting out fuel injectors, one at a time, as many as necessary.

The new 3.8 V6 also has an exhaust-gas recirculation valve with three pulsating solenoid valves, each controlling a different size orifice. The computer can pulse none, one, any two or all three for precise EGR control. Now the camshaft needs less valve overlap (a method used for internal engine mixing of intake and exhaust gases, to lower emissions), and the engine idles smoother.

The Iron Duke

The 2.5-liter Four (Iron Duke), GM's highest-volume engine, now has across-the-board a pair of balance shafts introduced on a limited basis in 1987. However, many more

changes have been (and continue to be) made to smooth out this bread-and-butter powerplant.

The number of balance shaft gear-drive teeth was reduced, the remainder were beefed up and redesigned, to get rid of whine. The exhaust valve guides are 4 mm (0.16-in.) longer at the bottom to hold the valves better, reducing side-to-side rock.

The engine mounts have been retuned for low-speed shake (because the balance shafts take care of the high-speed shake). The piston pin diameter tolerance has been reduced, so the pin moves more smoothly.

This eliminates a piston rock noise that may occur if the pin binds momentarily, then lets go, as the piston reaches the bottom of the stroke.

The 2.5 is the only GM engine without a timing chain or belt—the cam and crank gears mesh directly, and timing gear noise has been a long-term headache. There have been many experiments to reduce the problem and two steps were taken as a result.

Size of the keyways on the shafts was increased, so the keys always lie flat rather than possibly tilt upward at the front, when the gears go on.

If they tilt up, the plastic cam gear teeth distort slightly, do not mesh as smoothly and are noisy.

Another step was to insure that all gears are an interference fit on the shafts, which means they have to be pressed on rather than slid on. Slide-on gears may rock slightly, creating noise.

Cadillac 4.5-Liter V8

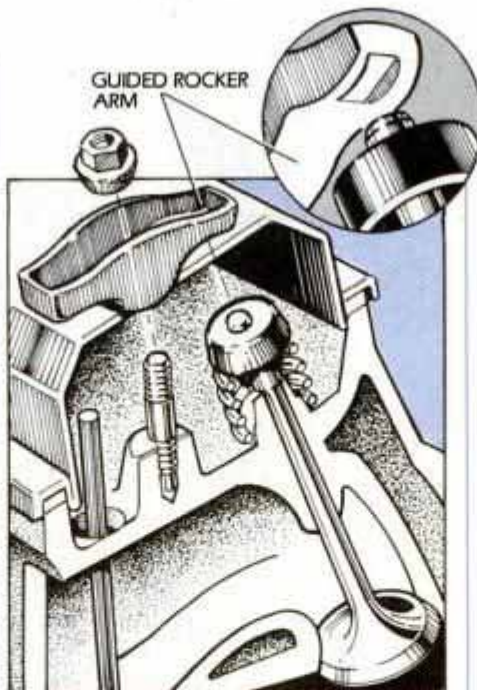
Cadillac has done a classic soup-up on its 1988 transverse V8—"bore it out and let it breathe." And finally it has the under-10-seconds 0-to-60 it has long needed to shed the so-so performance image of its front-drive de Ville-Fleetwood, Eldorado and Seville. The official 0-to-60 time just makes it—9.9 seconds, but that's about 3 seconds faster than '87.

Cylinder bore was increased from 88 to 92 mm, raising displacement from 4.1 to 4.5 liters. With a roughly 10-percent increase in displacement, Cadillac has a 20-percent increase in horsepower (up from 130 to 155) and torque (up from 200 to 240 lbs.-ft.).

Much was done to improve engine breathing. There's a bilevel tuned intake manifold with two groups of four runners, fed through a low-restriction air cleaner and a throttle body with 57 percent more flow area. Cadillac also found it could drop the throttle body's grid heater without suffering a cold-starting problem. Eliminating that heater contributes to greater flow of the air-fuel mixture.

Not only does more air-fuel mixture get in, but the burned gases get out faster thanks to a low-back-pressure catalytic converter and wider-diameter exhaust piping (up from 2¼ to 2½ in.), which increases exhaust gas flow area by more than 23 percent.

To subtly talk per-



GM: Simple groove on rocker replaces pushrod guide plate, guide bore on V8 and V6.

formance, Cadillac has "let it be known" that the 4.5-liter-equipped models are "limited" to 115 mph top speed by the engine computer only to maintain an adequate safety margin for the original equipment tires.

Unlike most soup-ups, this one hasn't badly cut into fuel economy (important when you're trying to avoid a gas-guzzler tax). City fuel economy is still 17 mpg, and the highway number is down only from 25 to 24 mpg.

Helping maintain the fuel economy numbers were some modifications to reduce engine friction, including roller valve lifters, barrel-shaped pistons that

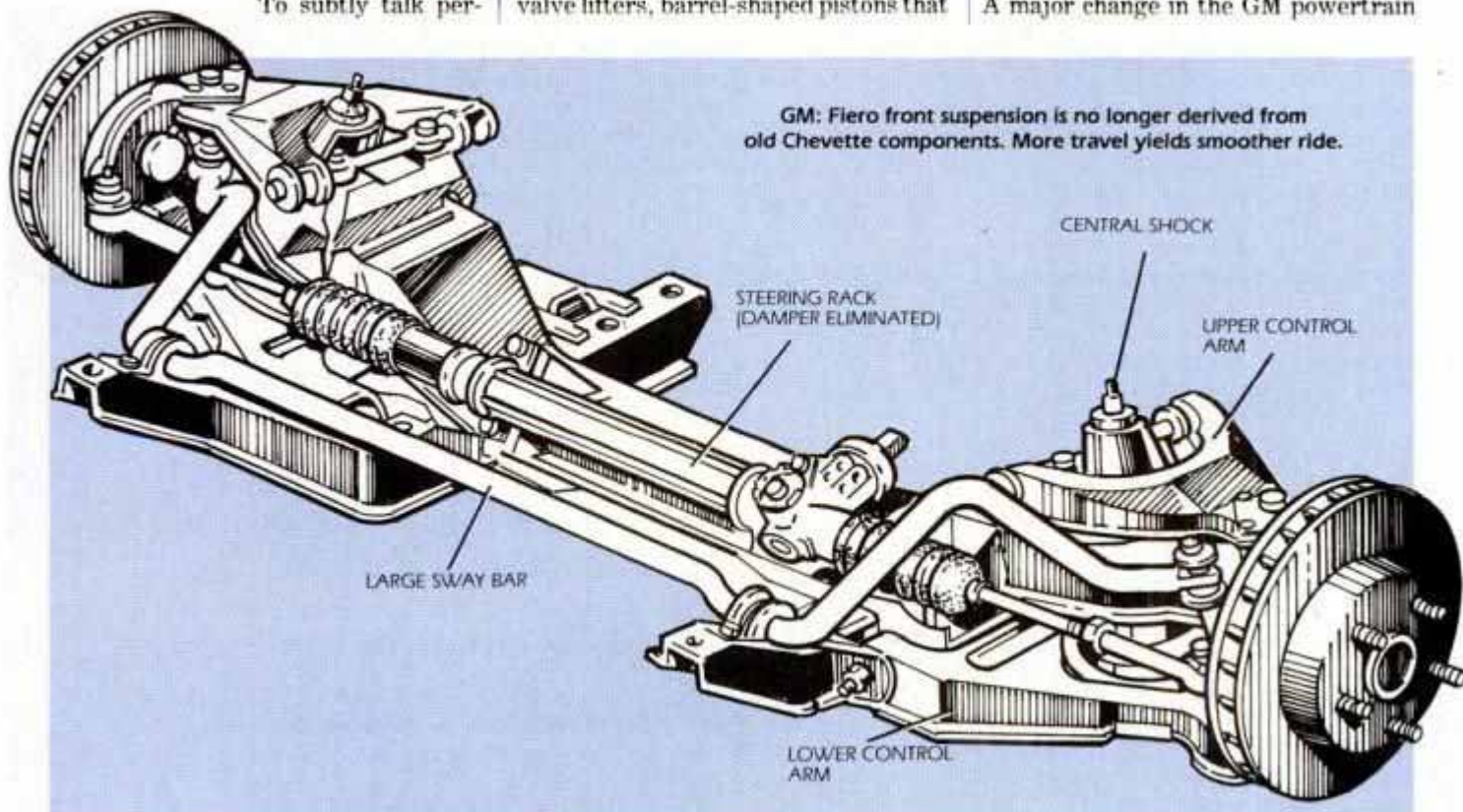
minimize contact with the cylinders and much thinner piston rings (compression rings down from 2.0 mm to 1.5 mm, and oil rings from 4.0 to 3.0 mm).

The 4.5-liter V8 computer is programmed with a Torque Management strategy similar to that in the 3800 V6, to reduce torque during certain types of shifts, for transmission protection. Cadillac retains the twin-injector throttle body on the de Ville-Fleetwood, Eldorado and Seville models. The '88 Allante continues to have the 4.1-liter version of the V8, but this one has individual port fuel injection and free-breathing intake and exhaust, producing 170 horsepower and 235 lbs.-ft. of torque. Will Cadillac combine the individual port fuel injection with the greater displacement? Will Cadillac install higher-speed tires and "unleash" the computer? When will the long-awaited V12 engine be ready? Stay tuned.

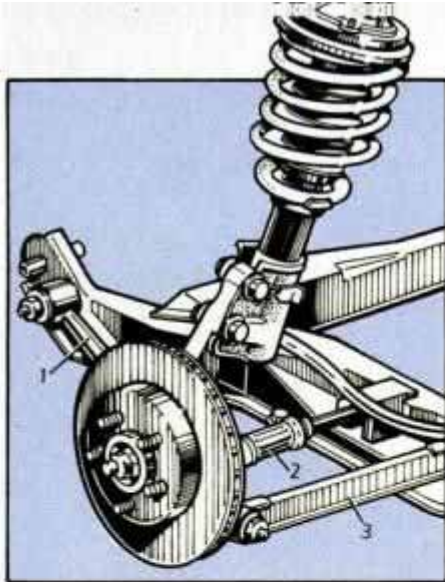
A new guided rocker arm system should improve durability and reduce valvetrain noise on Chevrolet's two small-block V8s, the 5.0-liter (305-cube) and 5.7-liter (350-cube), and the 4.3-liter (262-cube) V6 spinoff. It's just a shaped recess in the underside of the rocker, but it holds it in alignment with the valve stem, without the need for a close-tolerance pushrod bore or a pushrod positioning bracket, either of which can generate noise with the pushrod. Because the rocker is aligned with the valve stem, there should be less side-to-side movement, which causes wear.

No Buick V6 Turbo

A major change in the GM powertrain



GM: Fiero front suspension is no longer derived from old Chevette components. More travel yields smoother ride.



GM: Fiero rear strut: 1 trailing arm, 2 toe-link, 3 lower control (track) arm.

lineup for '88 is a deletion. For the first time in a decade, there isn't a Buick turbo V6. All Buicks have been converted to front-drive and the 245-horse turbo produces more torque (355 lbs.-ft.) than any GM front-drive transaxle can handle. Rear-drives of other GM divisions have optional V8s, so no other GM market was available. However, a suitable transaxle for the turbo is in the works, but there's no firm date on availability.

4-wheel drive

GM gets into 4-wheel-drive cars in '88, adapting a system to the front-drive Pontiac 6000 STE.

It's full-time, that is it's always in 4wd, and a 3.1-liter version of the 2.8-liter V6 (with a stroker crankshaft) is the power source, providing 180 lbs.-ft. torque, 20 more than the 2.8.

It has a planetary-gear transfer case with a bevel gear that drives another gear on an output shaft. The output shaft splines into a propeller shaft that goes to the rear differential. The propeller shaft has a constant-velocity joint at the front and center, and a conventional universal joint at the rear.

A modified 4wd truck front axle serves as a rear axle. The rear suspension is independent, with a fiberglass transverse leaf spring as in other General Motors cars, including the new front-drive Pontiac Grand Prix, Olds Cutlass and Buick Regal.

The normal torque split is 60 percent to the front wheels, 40 percent to the rear. In a traction emergency, flip a dashboard switch to operate linkage for a dog clutch that locks the planetary gearset so the front and rear wheels are locked together. Antilock brakes are standard, making the STE GM's traction leader.

Sport Fiero

The Pontiac Fiero also gets major underbody modifications for 1988. Now

that it's clearly a sporty car, it gets new front and rear suspension.

The front suspension also is an upper-lower control arm design but the arms are much longer. The shock absorbers are centrally located in the control arms and the sway bar is a full quarter-inch thicker in diameter. The turn circle diameter has been reduced from 37.4 to 33.5 ft. This new design does not require a damper for the steering rack.

The rear suspension, which had lower control arms, MacPherson struts and links for adjusting toe, gets a new tri-link design. The lower control A-frame is gone in favor of a narrow arm at the rear. The toelink is mounted ahead of it and the two are tuned to work together, along with the third member, a trailing arm. The trailing arm permits the use of bushings that allow more movement of the rear wheel on bad roads, so less harshness is transmitted to the body for a smoother ride.

A rear sway bar is standard on Formula and GT models. Pontiac has also figured out how to add power steering to the Fiero. A normal power steering system, with an engine-driven hydraulic pump, would require power steering lines more than 10 ft. long. The Fiero already has coolant pipes and air-conditioning lines that long and doesn't need more for power steering, considering the safety implications if the supply line is damaged.

Hybrid power steering

Electric steering got a look, but still is too expensive, so Pontiac is considering a hybrid system. No introduction date is set, but Pontiac hopes to offer it sometime in '88.

The hybrid system would be self-contained in the front, with a hydraulic pump driven by a variable electric motor, so a variable assist similar in performance to the '88 Continental would be possible. The motor is controlled by a computer with an input from the vehicle speed sensor, so the higher the road speed, the lower the voltage allowed by the computer, and the slower the pump turns, for reduced assist and therefore more road feel.

Composite brakes

A composite rotor (steel hub with cast-iron braking surface) makes its GM debut on the newest front-drives, Pontiac Grand Prix, Olds Cutlass and Buick Regal. This combination design, also used on the '88 AMC Premier, permits use of heavily "damped" iron, a type that dissipates brake noise very effectively. Damped-iron discs have been installed to quiet very noisy brakes before, but added too much weight for widespread use. The steel, much stronger per pound than damped iron, provides needed hub strength and brings overall weight down. Steel-insert hubs also are on

some cast-iron rear drums, purely as a weight saver.

Service intervals

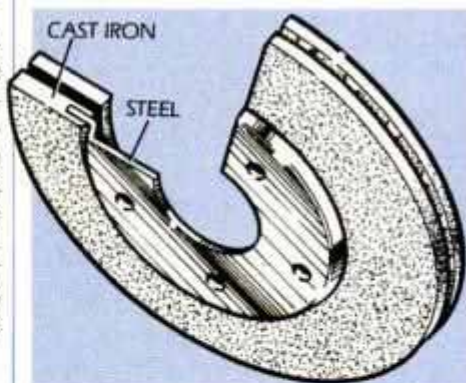
Years ago GM and other manufacturers featured lubed-for-life suspension and steering. Most backed off when joints failed long before the cars were near retirement, and recently GM has set 7500-mile grease intervals. GM has some improved joints and is testing the waters again by eliminating grease fittings on the '88 Grand Prix, Cutlass and Regal.

GM is continuing with its 7500-mile oil change, but on most '88 Oldsmobiles is beginning an electronic evaluation system that could extend oil changes to over 11,000 miles in very favorable conditions or reduce them to as low as 2000 in severe use. The system combines coolant temperature, engine rpm, vehicle speed and time, and uses that information in a computer program that can predict effective oil life almost as well as a laboratory analysis.

Corvette

The '88 Corvette has the U.S. industry's first 17-in. wheel, with a Z-rated (150-mph) Goodyear tire that has an open-tread design for good wet traction. The tire has an incredibly low aspect ratio of 40, which means the height of the cross-section is only 40 percent of the width. Only a few years ago, a 60-percent ratio was heavy stuff.

Making a short, wide-tread tire permits use of a big wheel, which has handling and road speed advantages, but it's also a challenge to the tire makers. The 17-incher is an option, but a stan-



GM: Composite hub has damped cast-iron rotor for low noise, steel hub for strength.

dard, Z-rated 16-incher also is no slouch. A recent Corvette feature introduced for improved handling, the deflected-disc shock absorber, also appears on the big '88 Olds and Buick sedans to improve ride. Stacks of discs replace a spring-loaded valve. The discs deflect to provide a progressive limitation on hydraulic fluid flow when the car goes over road bumps. The number of discs, their thickness and diameter determine the ride characteristic, so it can be very precisely tuned. **PM**

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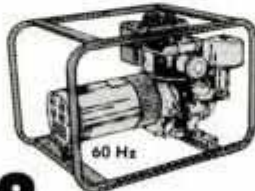
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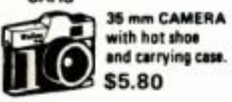
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Win On Sunday, Sell On Monday



Road racing in traffic is easier when you can see over the tops of all the other competitors!

Halfway down the back-straight the '89 Corvette prototype passed me on the inside, easily gaining six car lengths since the right hand corner only a few hundred feet behind us. Just before the kink in the straight, at easily 110 mph, the prototype aluminum-bodied Bertone X1/9 edged past. The right-hand corner at the end of the straight loomed rapidly as I tried to gain a draft on the Capri I had been following for three laps. By simply not lifting my foot off the accelerator anywhere before or during the corner, I gained enough ground to outbrake him at the next left-hander.

It was practice for this year's running of the 24 Hours of Nelson Ledges, an endurance race (like the Daytona 24 hours or Le Mans) that spans an entire two revolutions of the clock. Unlike Daytona and Le Mans, Nelson is for Showroom Stock cars, cars largely unchanged from the way they were driven off the dealer's lot. Punishing on the vehicles and the teams of drivers, endurance racing has become a hot marketing tool for the auto companies, with exotic iron like the Corvette and \$250,000 X1/9 prototypes run this season. Win on Sunday, sell on Monday, as

the adage goes. I'd raced at Nelson a few years ago, so I was invited to drive this year by Roger Marble, part-time racer and full-time engineer at Firestone. Firestone was looking for a way to get involved in a new venue for their performance tires, and a lightbulb suddenly went on over Roger's head.

Last fall the Sports Car

Back to Nelson Ledges. Ford had donated the two trucks from the Manufacturer's Challenge to the effort, and Firestone made sure there were plenty of tires to last for several thousand miles of racing. Also invited to join the team were *Motor Trend's* Editor Mike Anson, and *SportsCar's* Mac DeMere.

Endurance racing is a dif-



Ranger had few modifications except safety equipment. Pit crew changed tires, brakes, added fuel all night. Drivers could at least sleep between shifts.

Club of America sanctioned an invitational race at Lime Rock, Connecticut, called the Manufacturer's Challenge. And Ford had showed up with two V6 Ranger pickups. The SCCA thought this was so neat that there's a racing series for mini-pickup trucks this season. Sponsored by Coors, the races are run as Saturday afternoon teasers for Trans-Am races, where Big Detroit Iron races on road courses.



ferent kind of beast. The emphasis is on going as quickly as possible and still being in the race the next afternoon. Pit stops for fuel, tires and brakes must be planned with the precision of a moon shot. Drivers suffer from exhaustion, heat and the glare from high-powered driving lamps only a few feet from the rear bumper.

But the real test is that of the machine. Few purpose-built racing machines can complete a full 24-hour race, and to expect an unmodified street vehicle to put up with this foolishness could be thought of as, well, foolish. Racing is so important to some manufacturers that they have been known to make changes in the design of production vehicles within only a few weeks, insuring the legality of those changes on the race cars.

During qualifying, I managed to turn lap times faster than I had in a Volkswagen Rabbit a couple of years ago, times that had been under the official track record in the VW Rabbit's class then.

In fact, the truck was considerably faster, at least on some parts of the track, than many of the cars. The 100-plus mph sweeper at

the end of the backstraight was my favorite place to put the moves on other vehicles, as the truck's excellent handling allowed it to corner flat-out. Braking, with

brakes biased as a compromise between full and unladen, was mediocre and took a delicate touch on the pedal. Frankly, I had expected problems with handling. There's no weight back there, and with rear-wheel drive, oversteer would seem to be a problem. But with proper high-performance, low-profile tires, the handling turned out to be a real strength.

The race?

With only four entries in the Prototype class—the Vette, the aluminum X1/9, and the two pickups—one of the pickups finished second in class after spending nearly two hours third overall. And, yes, the Corvette won. **PM**

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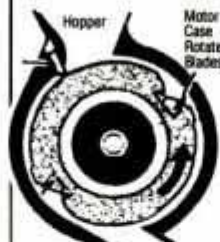
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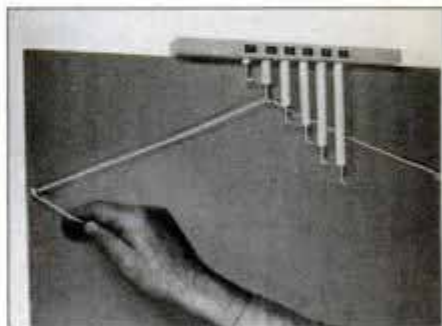
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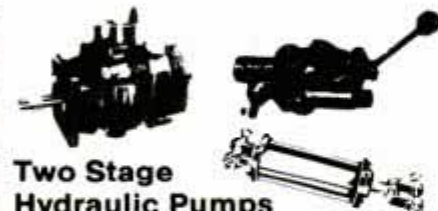
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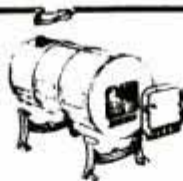


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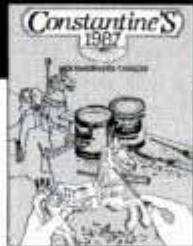
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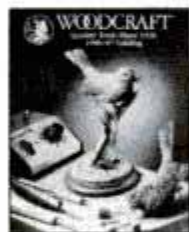
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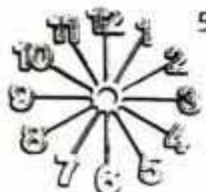
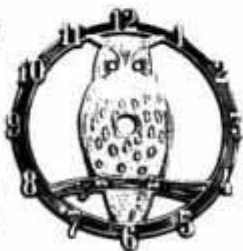
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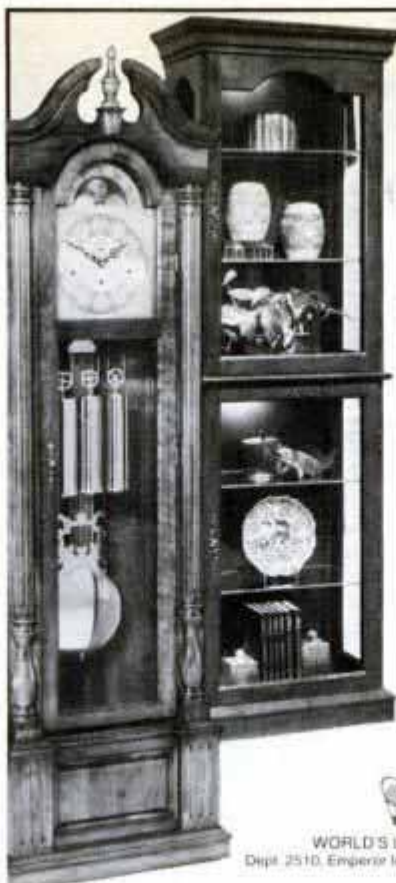
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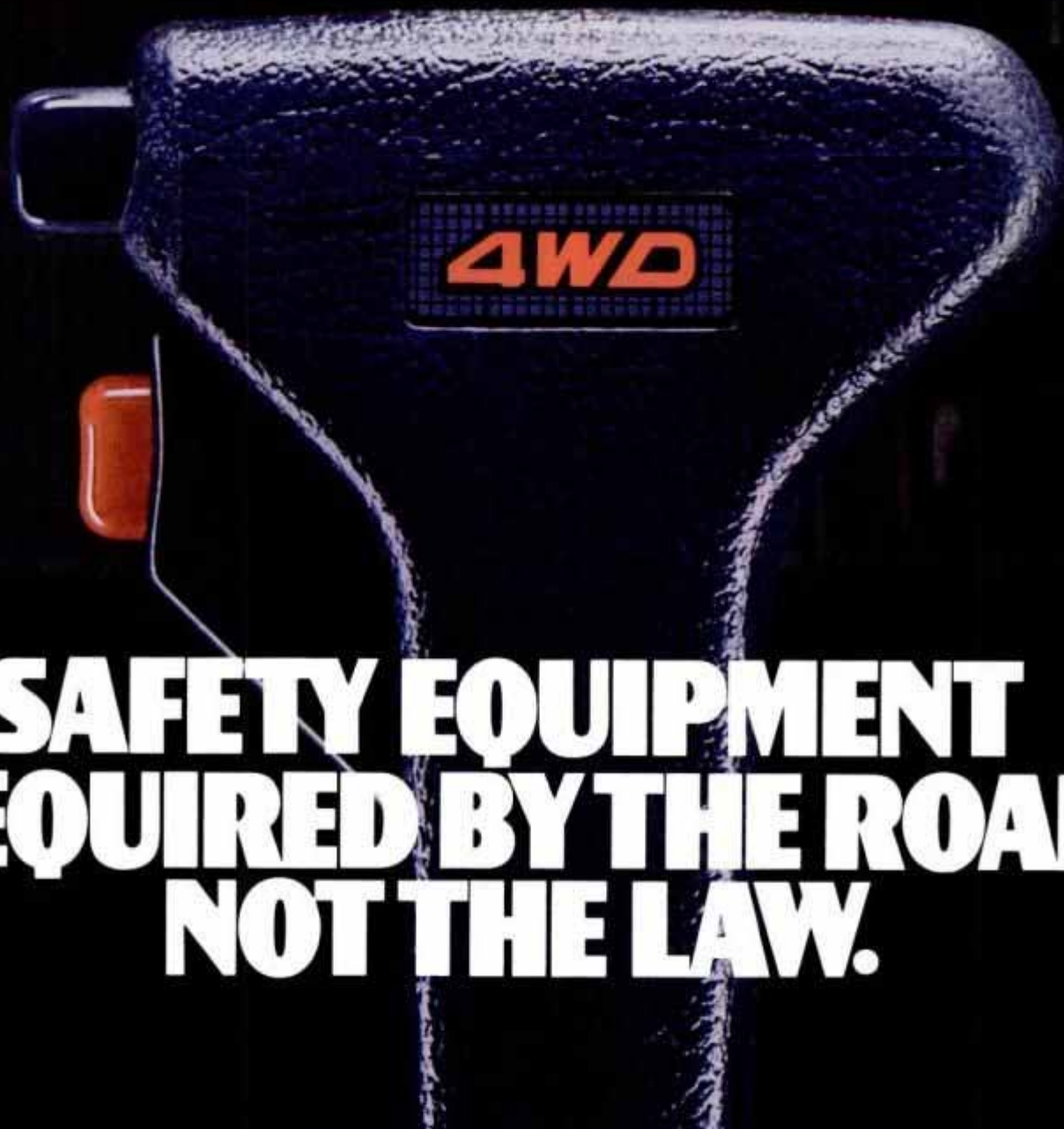
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