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**Y**OU DON'T READ much about snowmobiles these days. They're kind of a dead subject. Or are they? When Outdoors Editor Joe Skorupa suggested a story on snowmobiles, I said what story? As I found out, and as you'll see on page 64, there's a whole new breed of snowmobiles with sleeker styling and more power than ever. And just as importantly, the new machinery is more stable and therefore safer. They're also quieter and more friendly to the environment. You can still have a lot of fun on a snowmobile, so go ahead. But I encourage you to ride them on trails and other areas that are approved for snowmobile usage. . . . **The Yankees and the Red Sox.** The 49ers and Rams. Connors and McEnroe. Ali and Frazier. Great rivalries all. But none is greater than Ford and Chevrolet. It's been raging since Henry Ford and Louis Chevrolet burned rubber together on Woodward Avenue in Detroit in 1911. It continues to rage today, in new-car showrooms, on the high-banked NASCAR tracks all over America and in commercials every night on your TV screen. Now that Chevrolet

has a worthy opponent for Ford's best-selling Taurus, the rivalry rages right here in the pages of this month's issue. Auto Editor Tony Swan and Assistant Mike Allen let you know how they match up on page 57. . . . **When I challenged Home and Shop Editor Steve Willson to come up with a woodworking project that would reward the builder himself, Willson came up with a dream project—a full-sized pool table loaded with professional features like a slate top and real bumpers. It's a fabulous project and one that every reader will want to build—even if only in your dreams. . . . On the surface, high-definition television looks like a winner. Bigger, clearer pictures. Hi-fi sound quality. It's a great idea. The only trouble is, we can't have it. Not yet, anyway. Seems there are a few details yet to be worked out—like what broadcast standards will be used to get the bigger, clearer pictures from the in-studio camera to the HDTV set in your home. Nevertheless, if you spend any time at all in front of a television set, Electronics Editor Steve Booth's article "21st Century TV," will have you salivating in short order. . . . Speaking of salivating, I mentioned to a pilot friend of mine that this month's cover story was about a homebuilt aircraft that not only comes in a kit but, when completed, is capable of Mach 1.4 speeds and altitudes in excess of 20,000 ft. The Bede BD-10J is all that and more—an astounding performer with enough punch to thrill even the most jaded cockpit veteran. By the way, the story was edited by our new Science/Technology Editor, Abe Dane. Dane has been a contributor to PM for over a year. Now he joins us full-time. I'm sure you'll enjoy Dane's work in future issues of POPULAR MECHANICS. Till next time.**



Skorupa tries a new-breed snowmobile.



Abe Dane, new Sci/Tech Editor.

  
Joe Oldham

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# PEOPLE WRITE TO PENNZOIL®

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## Energy Conserving

**Q.** I recently purchased a new automobile, and I noticed that the manufacturer recommends an additional motor oil identification of ENERGY CONSERVING or ENERGY CONSERVING II or FUEL EFFICIENT, etc.

This terminology as applied to motor oil is new to me. Is motor oil identified as ENERGY CONSERVING different than oil not so identified?

F.K., Castro Valley, CA



**A.** The American Petroleum Institute (API) currently defines two classes of energy conserving motor oils. They are designated as ENERGY CONSERVING and ENERGY CONSERVING II.

ENERGY CONSERVING oils produce a 1.5% fuel economy improvement over a standard reference oil, while ENERGY CONSERVING II oils produce a 2.7% fuel economy improvement.

Oils meeting this requirement display ENERGY CONSERVING or ENERGY CONSERVING II in the lower portion of the donut-shaped API Service Symbol on a bottle of motor oil.

## How Long Between Changes?

**Q.** How often should I change my motor oil and oil filter?

R.M., San Diego, CA

**A.** Even though some manufacturers may recommend oil changes at more than 5,000 miles for normal service, Pennzoil recommends oil and filter changes every 3,000 miles or 3 months, whichever comes first, because most motorists actually drive under severe service which contaminates the oil at a faster rate.

It's also very important that you follow recommended preventive maintenance practices, and maintain the proper oil level. Engines that operate with oil levels *lower* than the full level (even by as little as one quart), can dramatically increase severe conditions on the oil remaining in the crankcase. And unfortunately, most drivers don't always remember to check and add oil at every fill-up to maintain a full crankcase.

## Warming Up On A Cold Morning

**Q.** I have trouble getting my car started on icy winter mornings. What's the best way to warm up my car on days like these? Should I let the engine idle?



## By Don Johnson

*Vice President, Product Engineering  
Pennzoil Products Company*

Should I race the engine?

L.C., Memphis, TN

**A.** The most effective way to get going on a cold morning is to start your car, wait until the oil light goes out and the engine is running smoothly, and then, begin driving at a moderate speed. Allowing your car to idle for long periods can cause severe oil contamination, since the engine speed isn't high enough for efficient fuel combustion. Racing your engine adds to contamination and excessive wear by spewing in more fuel than a cold engine can digest.

## Dirty Oil

**Q.** Is dirty oil a sign of problems in my car's engine?

A.C., New Orleans, LA

**A.** Not at all. On the contrary, dirty oil is a sign that your oil is doing its job by picking up contaminants in the engine and keeping them suspended so they can't collect on engine parts. These contaminants are removed when the oil and filter are changed.

## Paraffin Based Oils

**Q.** Will using a paraffin based oil cause engine deposits?

D.S., Katy, TX

**A.** No. Paraffin is a chemists term for relatively non-reactive hydrocarbons which have excellent oxidation stability. It should not be confused with other types of paraffins such as paraffin wax, propane and octane (gasoline). Most major motor oils today are formulated with paraffin based oils.

## The 5&10 Story

**Q.** Now that colder weather is here, which oil is better for protecting my engine: 5W-30 or 10W-30?

R.H., Albion, NY

**A.** For most vehicles, 5W-30 is the *only* grade permitted below 0°F. To select the optimum grade for your vehicle, check your owner's manual for the grades allowed in your climate.

## Editor's Comments:

More and more car manufacturers are now recommending 5W-30 oils because of their superior performance. They help engines start easier in cold weather (especially for 4-cylinder cars), reduce friction, improve fuel economy, flow faster for better cooling of today's hotter running engines, and prevent engine damage during a low-temperature start.

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For more information about motor oils, write Pennzoil for a free copy of our booklet, "The Motor Oil Story."

## We're Open To Questions

about motor oils, lubricants and engines. However, you can tell us a few things, too. Maybe you've discovered something about motor oil or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to:

Don Johnson, Pennzoil Products Company, P.O. Box 2967, Houston, TX 77252-2967.



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# LETTERS

## Imagining The Future

**I** WOULD like to compliment John Berkey and POPULAR MECHANICS on the illustration of the heliport that appears across pages 54 and 55 of your cover story ("Heliport 2000," Sept. '89). I had to look a half-dozen times to be sure I wasn't looking at a photo.

RUSS CHRISTIAN  
MARTINEZ, CA

Your cover story of "Heliport 2000" seems like my worst nightmare coming true. Here in New Jersey our skies are covered with four levels of planes day and night from three international airports, plus numerous business planes flying from smaller airports.

Your magazine's view of the future would add an additional, even louder, menace to our skies, plus the vibrations and pressure waves helicopters create. Also the courts recently barred New York City from further filling in of the river as an environmental hazard. It makes no difference whether the fill



September helicopter story included art by John Berkey, Mike Machat (cover), Ed Vallgursky and Hank Iken.

is for a road, buildings or a heliport.

Our country needs the vision to create a high-speed monorail system similar to the vision that created the federal highway system. It could carry more people and more freight faster and cheaper than helicopters ever could.

CARL H. KOCH, JR.  
LEBANON, NJ

For your view of the future, one that includes high-speed magnetically levitated trains, see "Supertrain," page 78, June '88. The pull-out poster



Granddaughter Amanda Rose takes wheel of "Sidewalk Classic."

("Futurerail") included in this issue shows a sweeping view of a city with a rail transportation system—the concept by John Berkey.

### Fantastic Projects

I was searching for plans to build an electric car for my granddaughter. Your "Sidewalk Classic" that first appeared in November 1963 seemed perfect. With the plans and nothing more than sabre saw, hacksaw, electric drill, pliers and screwdriver I completed my labor of love.

Where else but in POPULAR MECHANICS can you find such fantastic projects!

MICHAEL A.

IRENE SR.

LONG BRANCH, NJ

Your article "Air Power," in June 1989 (page 80), covering hovercraft and ACVs, was of special interest to me. My brother and I just finished building your Tri-Flyer, featured in May, 1986 ("Hot-Rod Hovercraft," page 92). Probably the most unique thing about the hovercraft is that we (my brother and I) began it when I was 14 and he 12. We used a 10-hp Tecumseh lawn-mower engine for the lift, and a 40-hp Xenoah/Chaparral 340 snowmobile engine for thrust. Construction took approximately two and a half years, with somewhere between 1000 and 1500 man-hours involved. All of our "flights" so far have taken place over ice, where we approached top speeds of 40 mph. Overall, it was a great experience, and a learning opportunity. MIKE UNGER

FRANKLIN, MI

Plans for "Sidewalk Classic," still in our Plans And Ideas catalog, are \$6.95. The Tri-Flyer plans including 60-page instruction booklet are \$19.95 from POPULAR MECHANICS, P.O. Box 1014, Radio City Station, New York, NY 10101.

### Winter Gets A Grip

In the comments about Brakes In Winter ("Car Clinic," page 43, Aug. '89), Mike Allen suggests all sorts of remedies for problems attributable to difficulties with freezing temps and drum brakes in the rear of an '87 Maxima.



The Ungers' Tri-Flyer is at home on ice.

Mike must be thinking about a Maxima from a different manufacturer than mine, since one of the major reasons for my purchase was 4-wheel discs.

CHAUNCEY BENEDICT  
SANTA ANA, CA

Nissan Maximas do indeed have disc brakes on all four wheels. Any braking system, disc or drum, can freeze up under the correct conditions, and the remedies suggested are equally applicable to either type—which is why we included references to drums as well as discs in suggesting a solution to the problem. **PM**



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Buckle up—together we can save lives.

**Best-built American cars.**

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

All 1990 Mustangs are equipped with a driver air bag supplemental restraint system.

# Ford Mustang GT

Have you driven a Ford...lately?



# TIME MACHINE

## 75 YEARS AGO: DECEMBER 1914



### Inhumanity Perfected

Perhaps the most fiendish device ever to find its way onto our cover was one developed by northern Mongolians to silence political dissent. Many of the most highly educated Chinese were manacled for life in these coffin-like boxes, with a small, round opening their only communication with the outside world. Without room to sit upright or lie flat, they languished, surviving day after hopeless day on rations given by attendants.

### Easy Diver

The peril and hardship of underwater activity was eased with the introduction of a diving suit that fully protected its wearer from hydrostatic force. Essentially a small, man-shaped diving bell, the suit was made of aluminum alloy, with roller-bearing joints. Features included electrically lit mechanical hands, a pneumatic pump to clear water from small bilges in each foot and a phone line strung along the air hose to the surface. The suit was tested at 212 ft.



## 50 YEARS AGO: DECEMBER 1939



### Mines In The Sky

While the Germans rampaged across Europe, Britain was desperately casting about for ways to counter an impending threat of air raids. One idea, our cover subject, involved lofting 5-ft.-dia. hydrogen balloons attached by 40-ft. trigger wires to small canisters of high explosives. The plan was to deploy them in aerial minefields around cities and other vital objectives. And in fact, a variation on the concept, the barrage balloon, did play a role in the Battle of Britain.

### Glory Days Of Rail

America's infatuation with travel by train was growing ever more ardent. The rail industry was in the midst of explosive growth, fueled by research that brought on breakthroughs in railroad technology. Between 1932 and 1938, the number of miles of track traveled at speeds greater than 60 mph grew from a handful to more than 48,000.

And steam engines, battling to hold off the up-and-coming diesels, took on gorgeously refined shapes, such as that of Santa Fe's *Chief*, below.



## 25 YEARS AGO: DECEMBER 1964



### Sauna Boom

A flush and status-conscious America had seized upon the Swedish sauna as its latest symbol of success. Our cover story introduced readers to the then-alien pleasure of dry-heat-induced sweat, and revealed how a sauna could be built at modest cost. Intended for family use, the 6 x 8-ft. unit could be tucked into unused closet or space and accommodate four. Redwood or red cedar that stays cool to the touch was specified in the plans, which included a shower and dressing room.

### Turbine Truck

Anticipating the completion of our vast Interstate highway network, Ford packed all its ideas for the truck of tomorrow into a 95-ft., twin-trailer monster driven by a 600-hp gas turbine. Made to cruise at 70 mph, the truck incorporated into its design an Allison 5-speed transmission capable of manual or automatic operation, aerodynamic trailer skirts, and an independently suspended cab with 6 ft. of headroom, a refrigerator, a TV and lavatory. Our test driver called

this truck a "driver's dream"—and it's one that still remains to be fulfilled. **PM**



# MAGNA

Good Smoke.  
Great Price.

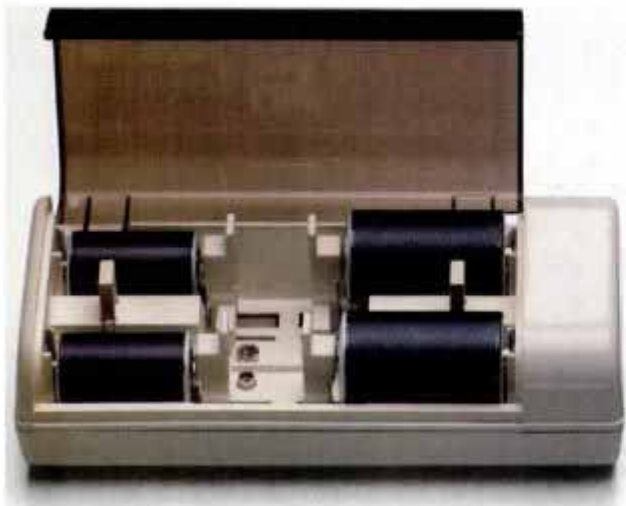


© 1989 R.J. REYNOLDS TOBACCO CO.

**SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.**

LITES BOX: 9 mg. "tar", 0.6 mg. nicotine, FILTER: 14 mg. "tar", 0.9 mg. nicotine, av. per cigarette by FTC method.

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14 Hour charge time



1 Hour charge time

# You'll have to excuse our competition. They're a little slow.

Introducing the Eveready® Generator™ One-Hour Rechargeable Battery System: Eveready Generator one-hour rechargeable batteries and chargers. Just pop AA, C or D size Generator batteries into the Generator charger and the charger lets you know when your batteries are ready to use. You just need one hour!

That makes our Generator One-Hour Rechargeable Battery System up to 14 times faster than the others. So when you compare the Eveready Generator System with the competition, you realize *there isn't any.*



**EVEREADY®**  
**Generator™**

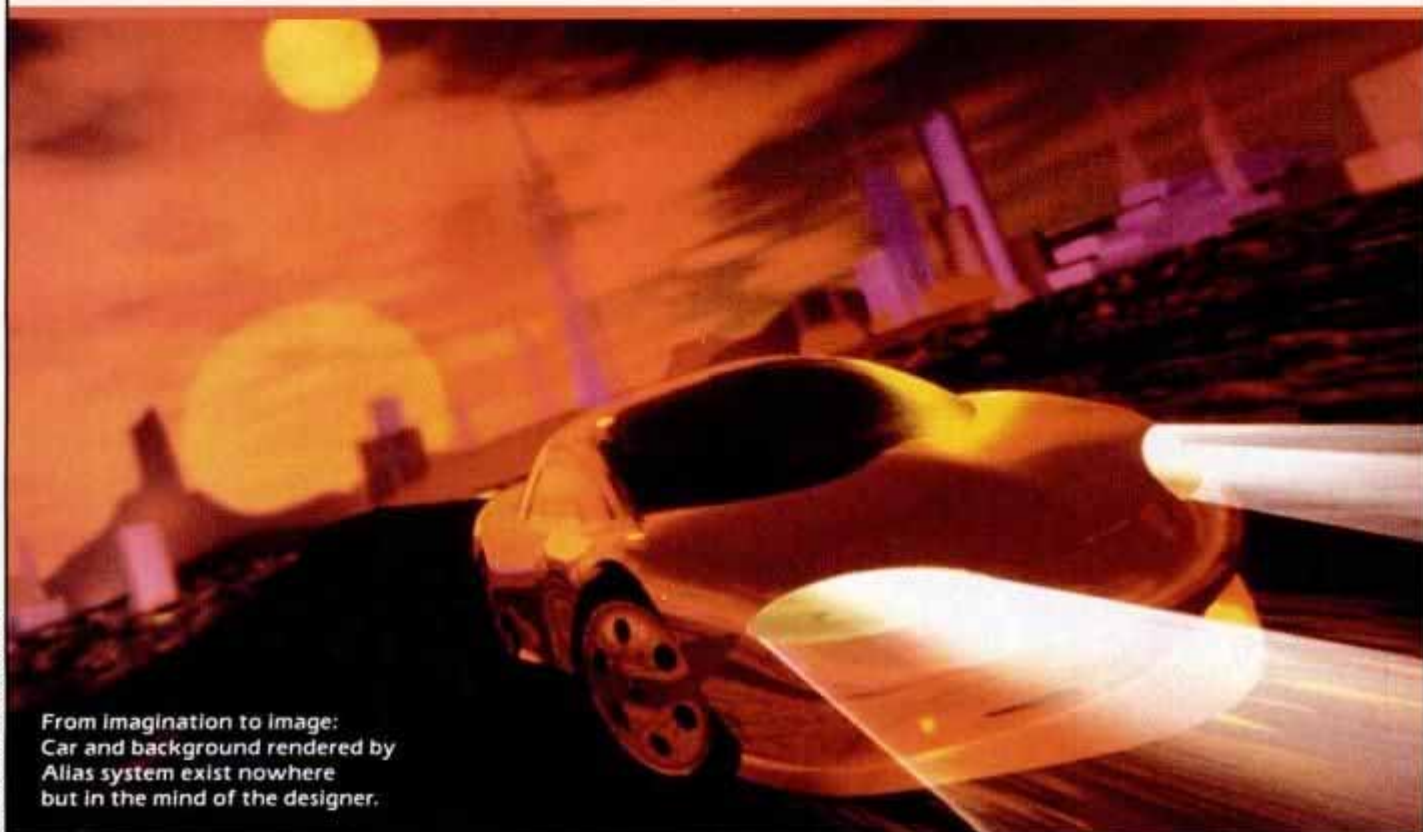
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# TECH UPDATE

News Of Tomorrow's Technology Today



From imagination to image:  
Car and background rendered by  
Alias system exist nowhere  
but in the mind of the designer.

## New Graphics Tools Let Designers See The Future

HIGHLAND PARK, MI—Computer power is finally entering the hitherto primitive arena of product styling. Incorporating recent advances in graphics hardware and software, new machines promise to take much of the perspiration out of design inspiration, and sharply reduce lengthy design cycles that hinder competitiveness.

The newest of these systems, recently installed at Chrysler design studios here, is the Conceptual Design and Rendering System (CDRS) developed by Evans & Sutherland. Like the earlier Alias system now in use at GM, it allows designers to see photorealistic, 3-D images of their ideas, then experiment with variations in shape, color and background. They can even see animated sequences of the cars in mo-

tion. Computer images of selected designs can be dispatched to engineers in the form of mathematical models, which can rapidly be evaluated for structural properties and feasibility of manufacture.

Although there has been much talk of computer-aided design (CAD) equipment in the auto industry, its use has been confined mostly to the engineering of mechanical and structural parts. Until recently, computers could not simulate the complex contours and realistic shadings needed in the creative concept-development phase. Stylists still moved laboriously from sketches to tape drawings to clay models, which often had to be revised

numerous times. Going from concept to production car generally took four to six years, and some designs

were outdated before they were introduced. Chrysler expects the new system to shave a year off the cycle.

### Highlights This Month

- **The Ultimate Test**—Crashing a jet fighter into a wall at 480 mph yields data on how to shield nuclear reactors.
- **Bomb Stoppers**—New technology thwarts airline terrorists.
- **Car Safety**—This seat design reduces injuries in frontal crashes.
- **Advances In Sun Power**—Fresnel concentrator boosts photovoltaic performance.
- **Our Future In Space**—New directions for the post-Voyager era of space exploration.
- **Satellite Navigation**—Pocket receiver gives pinpoint location worldwide.
- **Technology For The Handicapped**—New tools mean a fuller life.

Editor: Abe Dane  
Contributors: Mike Filton,  
Mike Allen, John M. Williams

## Jet Impact Studied

ALBUQUERQUE, NM—Sandia National Labs has sacrificed a surplus, but fully functional, F-4D Phantom to science. The 42,000-pound fighter was rammed into a million-pound block of reinforced concrete at 480 mph to find out, among other things, what would happen if a plane struck a nuclear reactor.

The experiment was carried out on Sandia's 2000-ft. rocket sled track. For the first 230 ft., acceleration came from a pusher sled holding 36 super Zuni rockets. Then five Nike rockets attached to the plane cut in, and the sled separated.



Footage shows Phantom's split-second demise. Plane disintegrated completely, except for small sheared-off sections of tail and wingtip.



SANDIA PHOTOS

To measure the impact, the target was floated on air bearings, which allowed it to

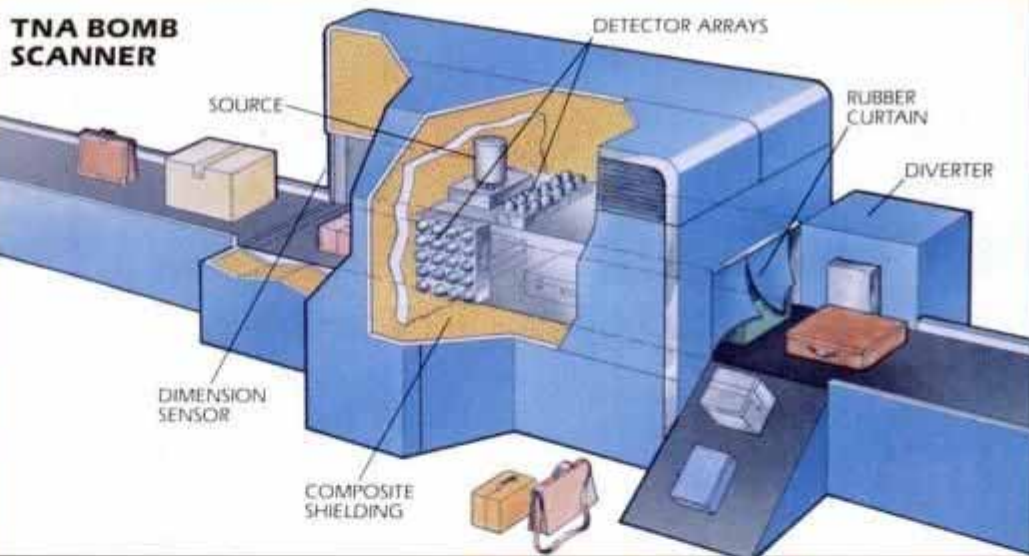
move easily. Sixteen high-speed cameras recorded the collision, and 10 accelerom-

eters transmitted data from the plane through a tail-mounted telemetry package.

## Antiterrorist Bomb Scanners Installed

NEW YORK, NY—An intensive research effort, spurred by the bombing of Pan Am's Flight 103 over Lockerbie, Scotland, one year ago, is now showing its first practical results. The FAA has ordered American carriers to install a device called a thermal neutron analyzer (TNA) in major airports here and abroad.

The device works by beaming neutrons from radioactive Californium 252 at baggage placed on a conveyor. Substances containing nitrogen—a key component of virtually all explosives—respond by radiating gamma rays with a distinctive signature. Sensors arrayed around the baggage pick up the rays,



Shielded TNA scanner bathes baggage in neutrons, then shunts off suspect items for hand-inspection.

PM ILLUSTRATION BY HANK IREN

and computer analysis flags items with suspicious nitrogen densities.

In tests, the procedure caught explosives 95 percent of the time. There is,



Handheld collector (above) sucks up 2 liters of air per second, then is inserted in Thermedics analyzer (left).

however, some concern that extremely small devices might slip by. Originally designed to detect bombs of at least 2.5 pounds, the TNA machine's sensitivity can be adjusted upward—but that also increases false alarms. Potentially more reliable techniques are currently being examined.

Despite heavy shielding around the detection chamber, concerns about radioactivity would probably prevent TNA machines from being used on checked baggage. Another approach, called a

vapor sniffer, may prove more useful in that context.

One sniffer, developed by Thermedics, Inc., gathers air from around baggage into a small, handheld collector. The collector is then plugged into an analyzer which performs gas chromatography, chemiluminescence and other analysis techniques to check for explosives. In a test on 2000 passengers at Boston's Logan Airport last year, the device set off only one false alarm. Similar techniques might also be used to scan for illegal drugs.



THERMEDICS PHOTOS

# TOYS "R" US

OPEN 'TIL  
MIDNIGHT  
MONDAY - SATURDAY  
LATE SUNDAYS  
STARTING  
NOVEMBER 20

## You can only find it here...

# BACK TO THE FUTURE II PART II

Action Products

### BACK TO THE FUTURE II BATTERY-POWERED CAR

Available only at Toys "R" Us!  
Detailed like sportscar in movie!  
Includes 6V battery and charger.  
Ages 4-7.

# 15999



JRL  
**BACK TO THE FUTURE  
II RADIO CONTROL CAR**  
Detailed DeLorean roadster looks just  
like time-traveling movie machine!  
Ages 8-up. (9V, eight AA batteries not included)

# 4999

BACK TO THE FUTURE II™  
TM & © 1989 Universal City Studios,  
Inc. & Amblin.  
Coming soon to a theater near you!

16 PAGES OF EVERYDAY LOW PRICES ON HOLIDAY GIFT IDEAS!

# I don't want to grow up.



**NINTENDO ACTION SET**  
Amazing, lifelike graphics. With control deck, controllers, light gun, game pack.

**9999**

**NINTENDO POWER SET**  
(Not shown) With Power Pad for dynamic foot control on special games, game pack, controllers, control deck.

**14999**



**Nintendo**



**ADVANTAGE JOYSTICK**  
Arcade-style joystick with turbo feature and slow-motion control. 1 or 2 person play.

**3999**



Wow... here's the world's biggest selection of Nintendo games with *more* new titles arriving right now!

# I'm a Toys "R" Us Kid...

## TURBO GRAFX-16

The next generation of home video games! 16-bit graphics processor allows faster sequences, new levels of play, and a broader range of colors and images. Game included.

# 19999



WITH "KEITH COURAGE" GAME!



**COMPACT DISC PLAYER**  
Provides superior sound. Compatible with all CD's. **39999**



# NEC



WE'RE YOUR COMPLETE CENTER FOR TURBO GRAFX-16 GAMES

# SEGA®



WITH "ALTERED BEAST" GAME!

## SEGA GENESIS SYSTEM

The new dimension in video game play! Uses powerful 16-bit arcade technology plus stereo sound for the ultimate home system. Includes Altered Beast game.

# 18999



**POWER BASE CONVERTER**  
Allows you to play more than 80 games originally designed for the Sega Base, Master and SegaScope systems.

# 3499



ALL THE NEW GENESIS GAMES!

# TOYS 'R' US

# There's a million toys



**OUT RUN**  
Electronic LCD video game on an authentic car console! 5 races in all, super sound effects. Ages 8-up. (Two AA, C batteries not included)

**29<sup>99</sup>**



**AFTER BURNER**  
Electronic LCD video game built on authentic F-14 fighter controls. 18 levels of play, amazing sound. Ages 8-up. (Two AA, C batteries not included)

**39<sup>99</sup>**



**TIGER ELECTRONIC TOYS**

## SUGAR RAY LEONARD TALKING BOXING

Electronic LCD video game with super sound effects. Ages 8-up. (Two AA, C batteries not included)

**49<sup>99</sup>**



### A. BATWING

Action features like rocket launcher and scissors device. Ages 4-up.

**19<sup>99</sup>**

### B. BATCAVE

Stairs, radar dish, collapsing bridge, boulders, bottomless pit. Ages 4-up. (Figures sold separately)

**24<sup>99</sup>**

### C. BATMOBILE

Concealed rocket launchers fire soft, safe rockets. Ages 4-up. (Figure sold separately)

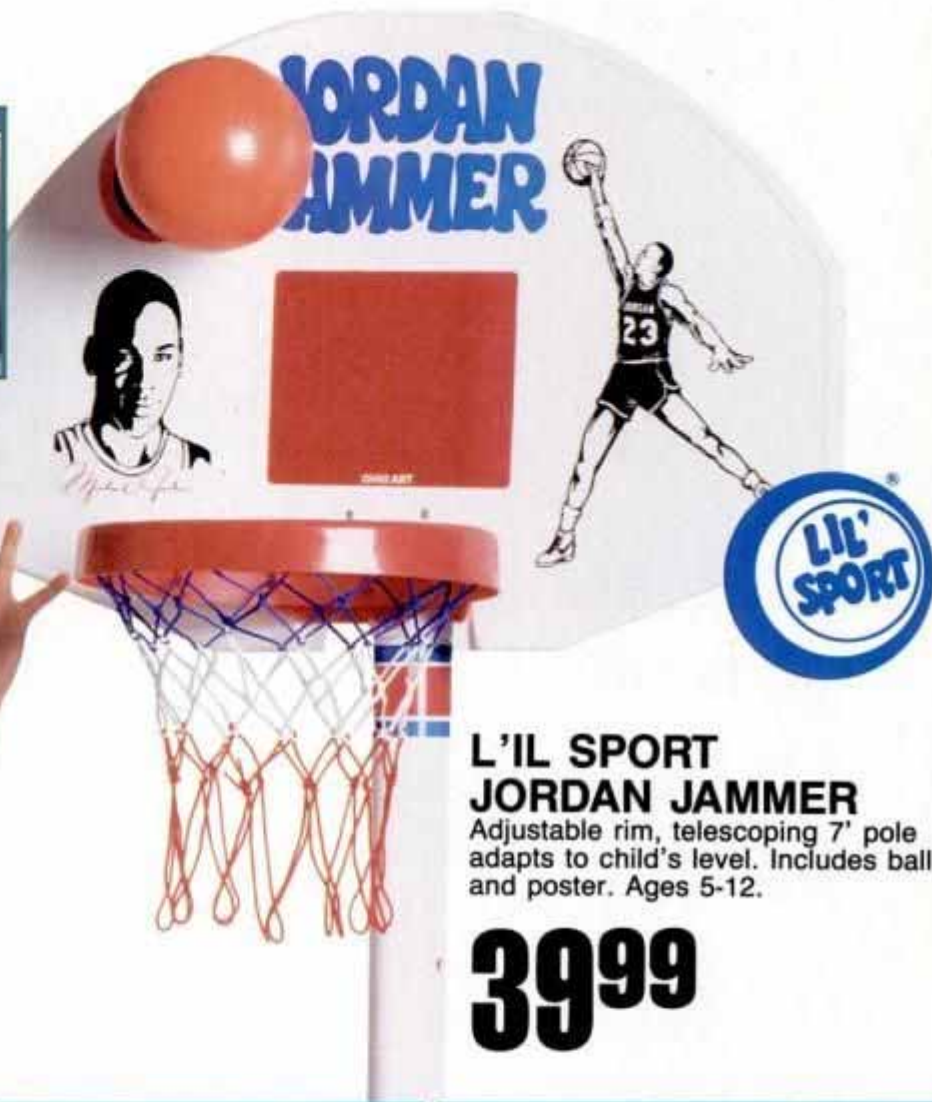
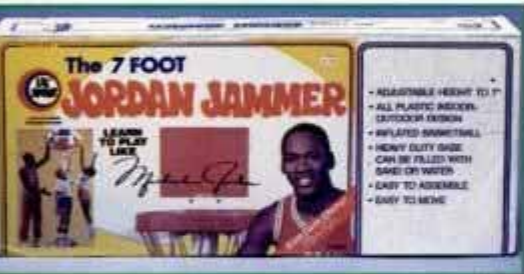
**16<sup>99</sup>**

### D. DC COMICS SUPERHEROES

Assortment of good and bad 4 3/4" figures, many from new Batman movie! Ages 4-up.

**3<sup>99</sup>**  
Each

# at Toys "R" Us...



## L'IL SPORT JORDAN JAMMER

Adjustable rim, telescoping 7' pole adapts to child's level. Includes ball and poster. Ages 5-12.

# 3999



## ETCH-A-SKETCH ANIMATOR

Brings drawings to life! 12-frame memory creates real moving pictures. Ages 6-up. (Four AA batteries not included)

# 4999

## DYNA-MIKE

New electronic musical toy lets you change voice pitch, be a musician, munchkin or monster. Ages 6-up. (Two C batteries not included)

# 3999



# TOYS "R" US

# We've got the best



## SCATTERGORIES

Match different categories with words that begin with the same letter. For example, roll an "R" then name a U.S. city: "Rochester!" Ages 12-up.

**23<sup>99</sup>**



**MB**  
MILTON  
BRADLEY

## CROSSFIRE

Rapid-fire, sharpshooting marble showdown for 2 players. Ages 6-up.

**22<sup>99</sup>**

## TUBA-RUBA

The body action game! For one or more players. Ages 8-up.

**13<sup>99</sup>**

## WIN, LOSE OR DRAW

High speed game of sketching and guessing! For three or more players. Ages 12-up.

**15<sup>99</sup>**

## TRUMP, THE GAME

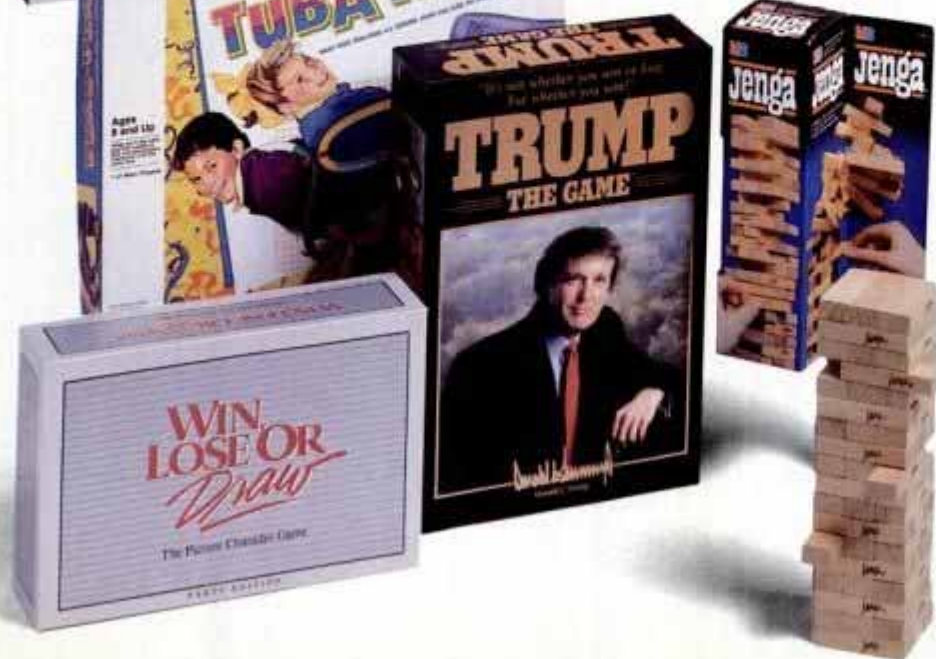
Enter the world of Donald Trump and learn the art of the deal. For two or more players. Ages 12-up.

**19<sup>99</sup>**

## JENGA

Keep the tottering tower from toppling! For two or more players. Ages 6-up.

**14<sup>99</sup>**





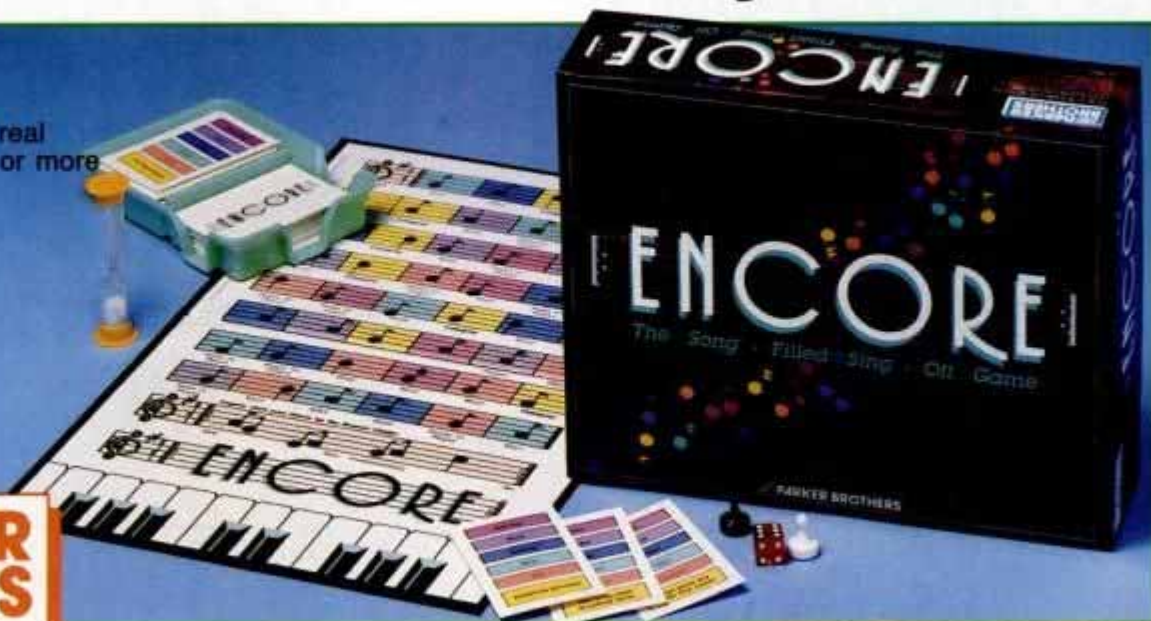
# for so much less,

## ENCORE

Party sing-off game. A real show-stopper. For four or more players. Adults.

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**PARKER BROTHERS**



## NERF BLAST-A-BALL

Shoot foam balls from blaster and try to catch or tag. For two players. Ages 5-up.

# 19<sup>99</sup>

## CLUE MASTER DETECTIVE

Super sleuth version of classic game of detection. For three to ten players. Ages 10-up.

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## TRIVIAL PURSUIT THE 1980'S EDITION

Prove your knowledge of current events since 1980. For two to six players. Ages 12-up.

# 24<sup>99</sup>

## DARE!

Wacky game of true and false questions. For four to eight players. Ages 13-up.

# 19<sup>99</sup>

## NERF FENCING

Learn how to fence in safety! Foils made of foam. For two players. Ages 8-up.

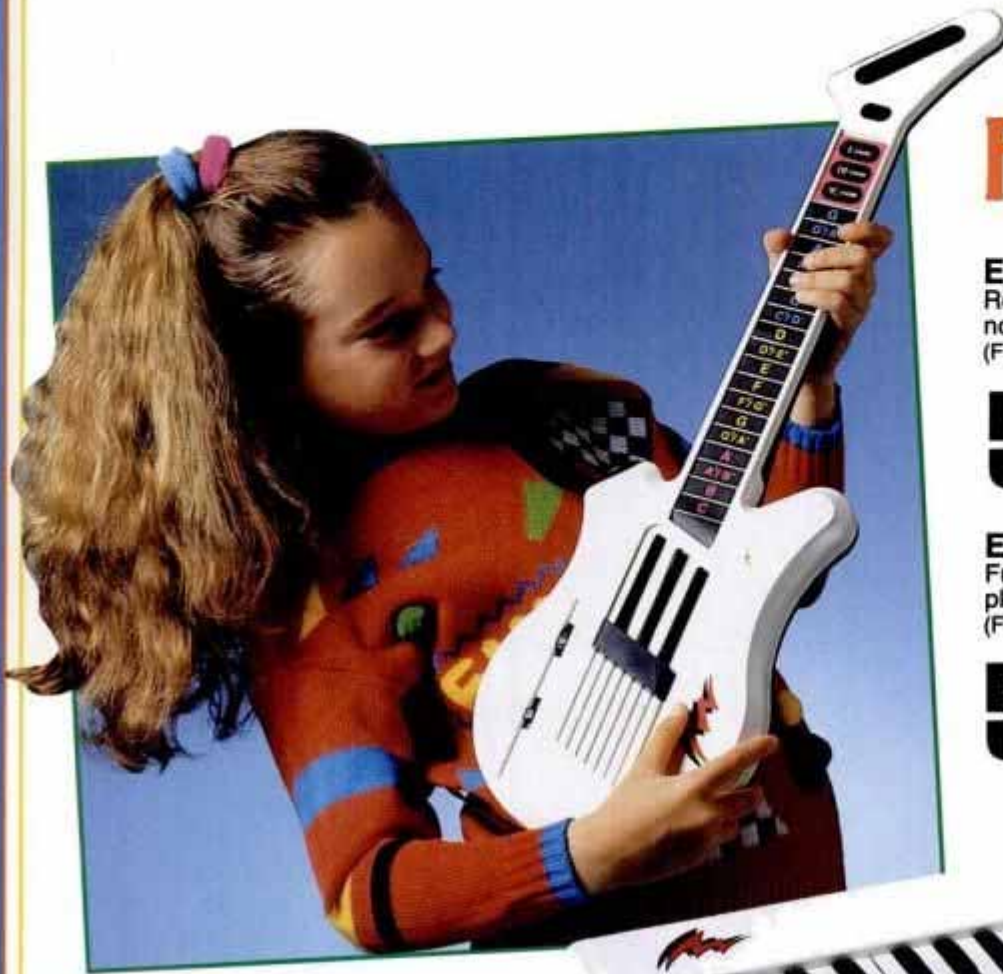
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# TOYS 'R' US

# From bikes to trains

Fisher♥Price



## ELECTRONIC GUITAR

Real guitar sound; play chords or single notes on strum bars. Ages 5-up.  
(Four C batteries not included)

**59<sup>99</sup>**

## ELECTRONIC KEYBOARD

Full size keys, real piano sound, playback, 2 demo songs. Ages 5-up.  
(Four C batteries not included)

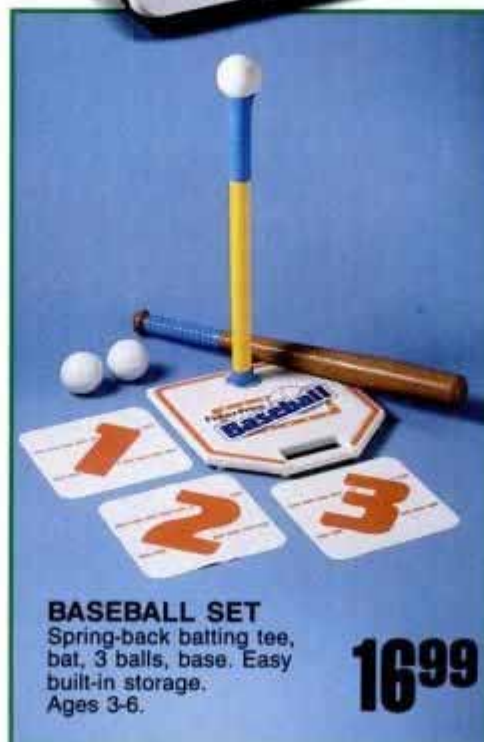
**59<sup>99</sup>**



## BASKETBALL

Wheeled base for easy storage; includes ball. Ages 3-up.

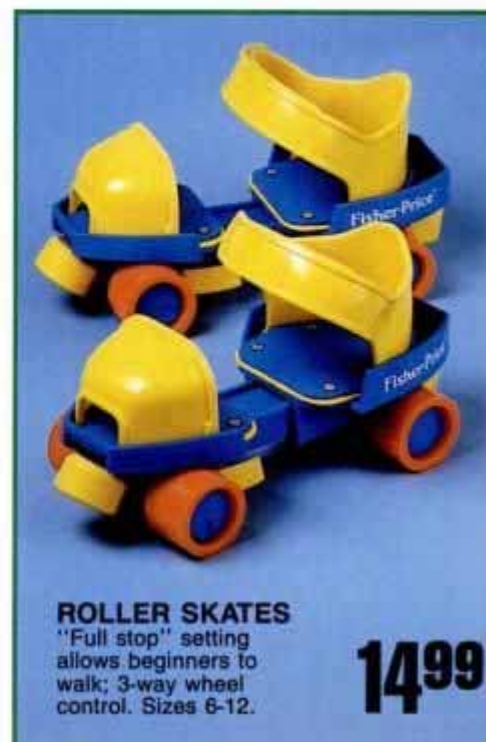
**36<sup>99</sup>**



## BASEBALL SET

Spring-back batting tee, bat, 3 balls, base. Easy built-in storage. Ages 3-6.

**16<sup>99</sup>**



## ROLLER SKATES

"Full stop" setting allows beginners to walk; 3-way wheel control. Sizes 6-12.

**14<sup>99</sup>**

# to video games,



## BOY'S 20" BMX CHALLENGER

Tubular fork, BMX saddle, coaster brake, lifetime frame warranty.

# 59<sup>99</sup>

## BOY'S 24" ENDURO ALL-TERRAIN BIKE

Lifetime frame warranty, dramatic new colors and design.

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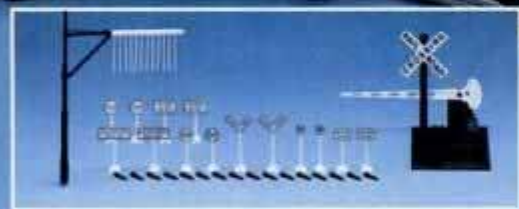
*Troxel*  
CHILD'S HARDSHELL HELMET..... 19.99

ADULT HARDSHELL HELMET.. 24.99

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**WEAR A SAFETY HELMET WHEN YOU RIDE**

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## HEAVY IRON ELECTRIC TRAIN SET WITH GEOFFREY GIRAFFE CAR

Six-unit, .027 gauge set with die-cast locomotive and working crossing gate. Ages 8-up.

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**SECRET AUTO SUPPLIES  
BATTERY/AIRPORT**  
Real-looking car battery  
transforms into a Micro  
Machines airport playset.  
Ages 5-up. (Cars sold  
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**SECRET AUTO SUPPLIES  
MOTOR OIL/LUBE SHOP**  
Realistic oil can opens into  
action playset. Features  
working lift, 3-level garage.  
Ages 5-up. (Cars sold  
separately)

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CAR WAX/DETAIL SHOP**  
Can transforms into  
custom vehicle care  
shop. Ages 5-up.  
(Cars sold separately)

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**A**



**B**



**B**



**A. MICRO MACHINES SEMI TRUCKS**  
Authentic trucks with tilt-open cabs, detachable trailers  
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**C. MICRO MACHINES CITY SCENES PLAYSETS**  
Each with light-up windows and 2 vehicles. Four styles.  
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Superfast on and off road racers you can customize for optimum performance. Ages 5-up. (Batteries sold separately)

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Quick-change slick racing tires with chrome mag wheels for high speeds.

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With detailed engine cover; for top speeds of 300 MPH (Super Changers Scale).

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Perfect for mastering tough off-road terrain; detailed engine cover.

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Twin turbo boosters propel racers straight uphill and through challenging course. Includes 2 cars. Ages 5-up.

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Includes 2 Micro Color racers. Winner jumps pond at finish, loser doesn't. Ages 5-up.

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Six-pack. Color change spy planes with hand-control flight stick. Ages 5-up.

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Four-pack. Ultra-fast, color-changing mini machines. Highly detailed. Ages 5-up.

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Assortment. 4 highly detailed playsets with working parts, snap-in features. Ages 4-up. (Vehicles sold separately)

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## B. CONVOY TRUCK PLAYSET

Giant, free-wheeling transporter with working crane. Ages 4-up. (Vehicles sold separately)

**21.99**

C. CONNECTABLES, 5-PK . . . . . 4.99



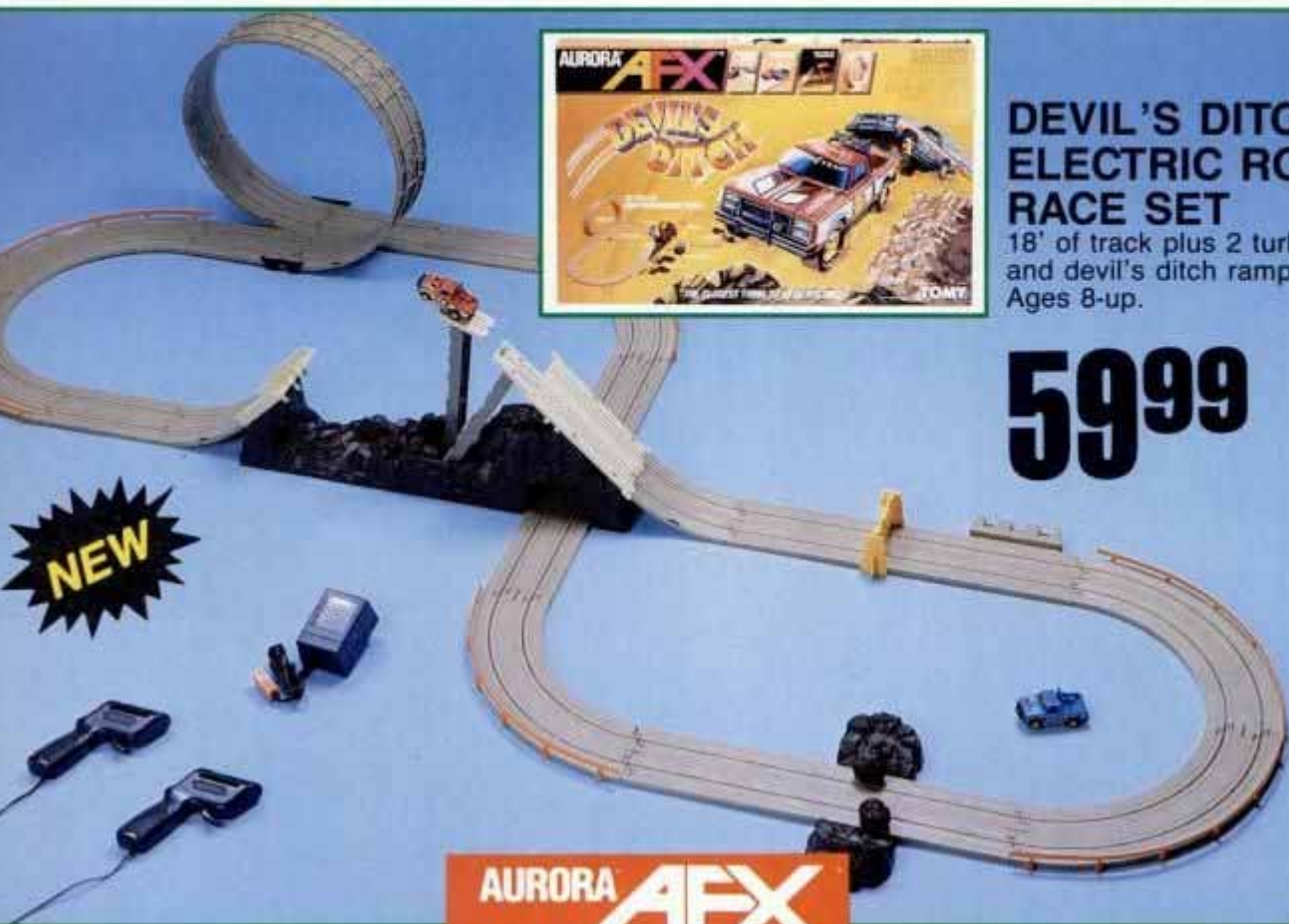
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ELECTRIC ROAD RACE SET**  
Race the 2 Grasshopper cars between mountains, around hairpins, through a tunnel. Ages 7-up.

**49.99**

**Marchon**



# more toys, oh boy!



## DEVIL'S DITCH ELECTRIC ROAD RACE SET

18' of track plus 2 turbo trucks  
and devil's ditch ramp.  
Ages 8-up.

# 5999

AURORA **AFX**



## DOUBLE FIRE ELECTRIC ROAD RACE SET

High performance 13' double-  
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darkness. Ages 8-up.

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# I want to be

## PLAYSKOOL EXPRESS

Complete train set made just for preschoolers. Battery-powered loco with working light, 19' snap-together track. Ages 3-up. (Four C batteries not included)

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**PLAYSKOOL**





# a Toys "R" Us Kid!



A

SOLD ONLY AT TOYS'R'US

## NIKKO



B

### A. RADIO CONTROL DRAGON FIRE

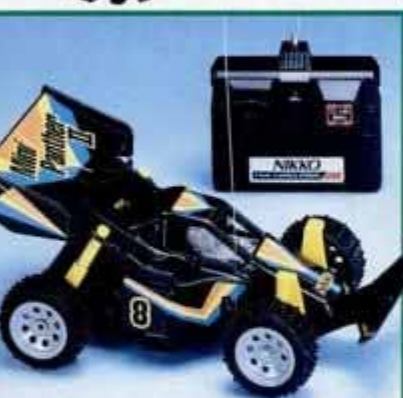
Available only at Toys "R" Us! Full function buggy with impact-resistant bumper, knobby tires. Ages 8-up. (9V, four AA batteries not included)

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### B. RADIO CONTROL BIG BUBBA

1/14 scale off-road monster truck. 4-wheel drive, 2 speeds. Ages 8-up. (9V & rechargeable battery pack sold separately)

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### RADIO CONTROL MINI PANTHER

Independent front suspension. Ages 5-up. (9V, two AA batteries not included)

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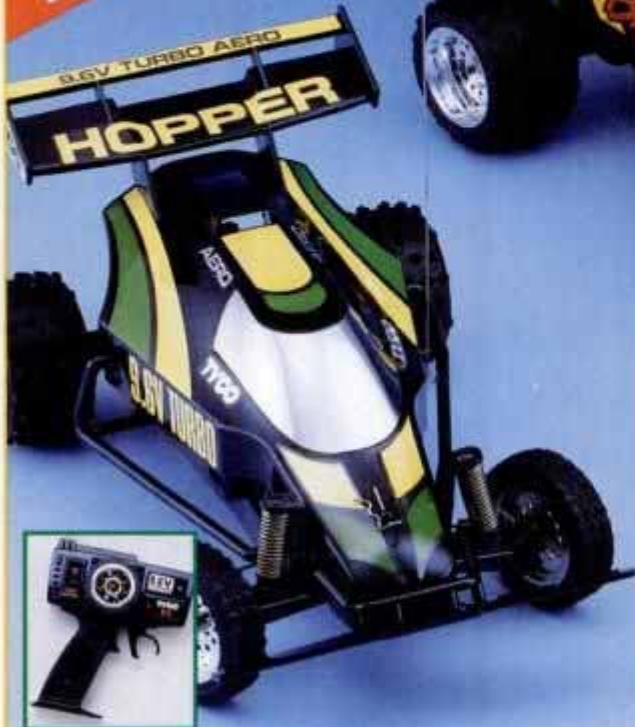
### RADIO CONTROL HAWK/MIDNIGHT CRUSHER

Electronic torque-splitting system. Ages 8-up. (Ten AA batteries not included)

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# TOYS 'R' US

**TYCO R/C RADIO CONTROL**



**RADIO CONTROL TURBO AERO HOPPER**

Aerodynamic design and sleek styling. Ages 8-up. (Battery pack sold separately)

**59<sup>99</sup>**

9.6V BATTERY PACK & CHARGER . 29.99  
9.6V NI-CAD BATTERY PACK . . . . .19.99



**RADIO CONTROL TURBO BANDIT**

9.6V turbo off-roader swing-axle suspension. Ages 8-up. (9.6V battery pack sold separately)

**69<sup>99</sup>**

**RADIO CONTROL TURBO HOPPER**

9.6V turbo off-roader. Ages 8-up. (9.6V battery pack sold separately)

**59<sup>99</sup>**

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Hoover  
Huntsville  
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Montgomery
- ARIZONA  
Paradise Valley  
Phoenix  
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- ARKANSAS  
Fort Smith  
North Little Rock
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Bakersfield  
Chico  
Fairfield  
Fresno  
Lancaster  
Los Angeles  
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San Bernardino  
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San Francisco  
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Tallahassee  
Tampa  
West Palm Beach
- GEORGIA  
Atlanta  
Augusta  
Columbus  
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Monroe  
New Orleans  
Shreveport
- MAINE  
Bangor  
Portland
- MARYLAND  
Baltimore  
Frederick  
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Boston  
Springfield  
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Florissant  
Independence  
Mid Rivers  
Springfield
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Omaha
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Reno
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Nanuet  
Queens  
Rochester  
Syracuse  
Utica  
Yonkers
- NORTH CAROLINA  
Charlotte  
Durham  
Gastonia  
Greensboro  
Raleigh  
Wilmington  
Winston-Salem
- OHIO  
Cincinnati  
Cleveland  
Columbus  
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North Olmstead  
St. Clairsville  
Toledo  
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- OKLAHOMA  
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Eugene  
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Philadelphia  
Pittsburgh  
Washington  
Wilkes-Barre  
York
- RHODE ISLAND  
Providence
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Charleston  
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Chattanooga  
Clarksville  
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Johnson City  
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- TEXAS  
Amarillo  
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**TOYS 'R' US**

## New Angle On Design For Safer Car Seats



Safety seat, demonstrated here in 45-mph crash without seatbelt, leans back to keep driver's head and chest from contacting the wind-screen or the steering column.

ST. LOUIS, MO—A simple sliding seat rack mechanism, combined with airbags or passive restraint seatbelts, may be the key to substantially reducing injuries in frontal automobile crashes.

The patented seat motion device, marketed by Top Sound International of Colorado Springs, has undergone extensive development testing including more than 500 live test crashes, monitored by inventor Randy Beauvais. Technical development now includes computer simulations to refine the parameters that will provide optimum performance.

The mechanism of the seat uses a simple arrangement of

pins sliding in inclined slots to lift the seat as it slides forward. The front of the seat is set to rise more than the rear, effectively keeping the occupant in the seat. A travel of only a few inches seems to have a profound influence on reducing injuries.

"We know the mechanism works. We're going to be using computer simulations to find out why, and what kinds of improvements we can realistically expect. Then we'll work to improve performance, and see what, if any, changes are needed in the seatbelt and seat," said Neil Singer, Ph.D., a consultant and mechanical engineer.

Reductions in injuries



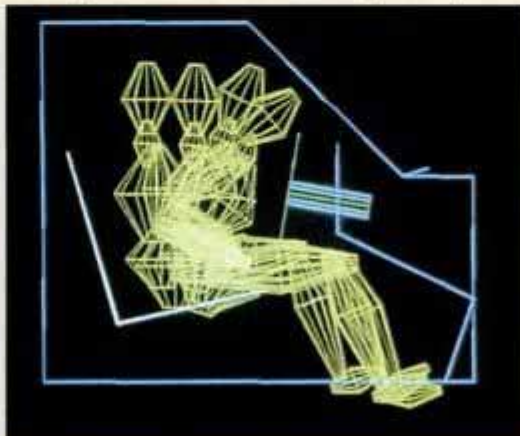
seem to be based on three significant effects. These include the increased linear stopping distance of the passenger, a conversion of some of the stopping energy to rotary motion, and the raising of the seat bottom—which tends to keep the passenger on the seat during the crash. Increasing the stopping distance should lower the peak accelerations by spreading them over a longer time. Friction is necessary to keep the

thighs from sliding off the seat, and raising the seat during the forward motion increases this friction.

One immediate benefit from this last phenomena might be a reduction in pelvic and knee injuries that come from submarining under an airbag or passive shoulder belt. Bulky knee bolsters used for this purpose now might be reduced or eliminated as a result.

Longer-term goals of the program may require reengineering of the present safety systems in the car, including changes in seats, seatbelts and airbags.

The device can be built for an estimated \$20 per seat. Singer's preliminary computer simulations (below, implemented on ADAMS software at Mechanical Dynamics, Inc., of Ann Arbor, Michigan) suggest that the inner seatbelt anchor should be attached to the seat, rather than anchored to the floor, to get the greatest benefit from the system.



Preliminary computer simulation of crash shows lack of forward motion of torso and pelvis of safety-seated driver (left) compared to unbelted driver (right).

## Solar Module Milestone

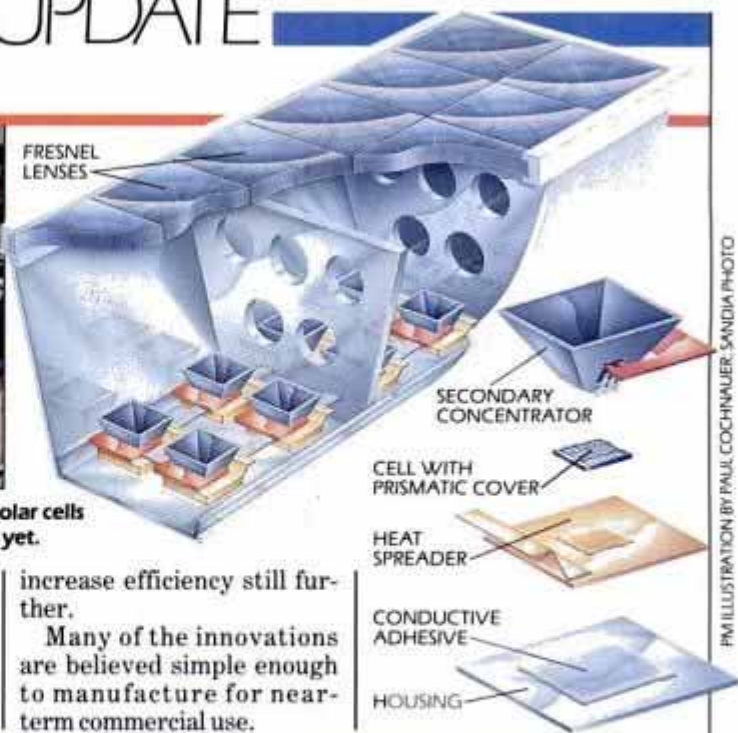
ALBUQUERQUE, NM—By integrating numerous refinements, Sandia Labs has built a module of 12 photovoltaic cells that converts sun to electricity with a record 20.3-percent efficiency.

Key to the achievement is a unique concentrator assembly. Above each cell is a Fresnel lens that focuses light and multiplies it 100-fold. Small, secondary concentrators then funnel it toward the cells. Light that would normally be blocked by metallic grid lines that transmit power away from the cells is in-



Sandia's module gangs 12 silicon solar cells in the most efficient configuration yet.

stead refracted by prismatic cell covers. Direct soldering of the cells to copper heat spreaders, and an antireflective magnesium fluoride coating on the Fresnel lens



increase efficiency still further.

Many of the innovations are believed simple enough to manufacture for near-term commercial use.

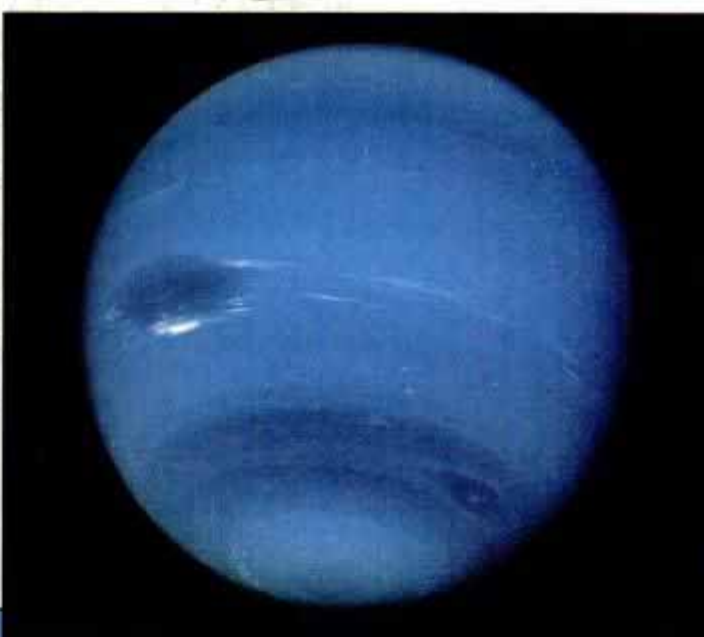
PH ILLUSTRATION BY PAUL COCHNAUER, SANDIA PHOTO

## After Voyager's Triumph

NEW YORK, NY—With the hardy *Voyager 2* off for parts unknown, NASA's Jet Propulsion Laboratory is wrapping up the 12-year vigil it kept over the craft, and attention now turns to the future of our evolving space infrastructure.

One sign of things to come is the recent launch by McDonnell Douglas of the first privately owned rocket to reach orbit. Hughes contracted the history-making flight to loft *Marcopolo 1*, a communications satellite they built for a British television firm.

The rocket used was McDonnell Douglas's Delta II, the newest in a line of vehi-



A new world: *Voyager's* view of Neptune rewrote the textbooks.



MCDONNELL DOUGLAS PHOTO

Delta II bearing *Marcopolo 1* departs Cape Canaveral. Six of nine solid rockets fire for liftoff.

cles it has been selling to NASA since the early 1960s. With three stages, and nine strap-on solid-fuel boosters, it is able to carry payloads of up to 4000 pounds into geosynchronous orbit.

The Department of Transportation's commercial space office expects at least 27 more private launches through 1993.

The Space Shuttle, however, remains our only option for manned operations in space. NASA hopes to demonstrate the importance of this capability

with the *Astro-1* mission—the first since *Challenger* to use the Shuttle's Spacelab facility. Now scheduled for April launch, *Astro-1* will test four instruments that may serve as the basis of future orbiting observatories. Fixed to Spacelab's Instrument Pointing System will be the Wisconsin Ultraviolet Photo-polarimeter, the Hopkins Ultraviolet Telescope, and the Ultraviolet Imaging Telescope. A fourth instrument, the Broad-Band X-Ray Telescope, will be mounted on an independent pointer. It is hoped that correlating UV with X-ray data will help astronomers understand the varying emissions of phenomena such as binary star systems.

### ASTRO-1 PAYLOAD

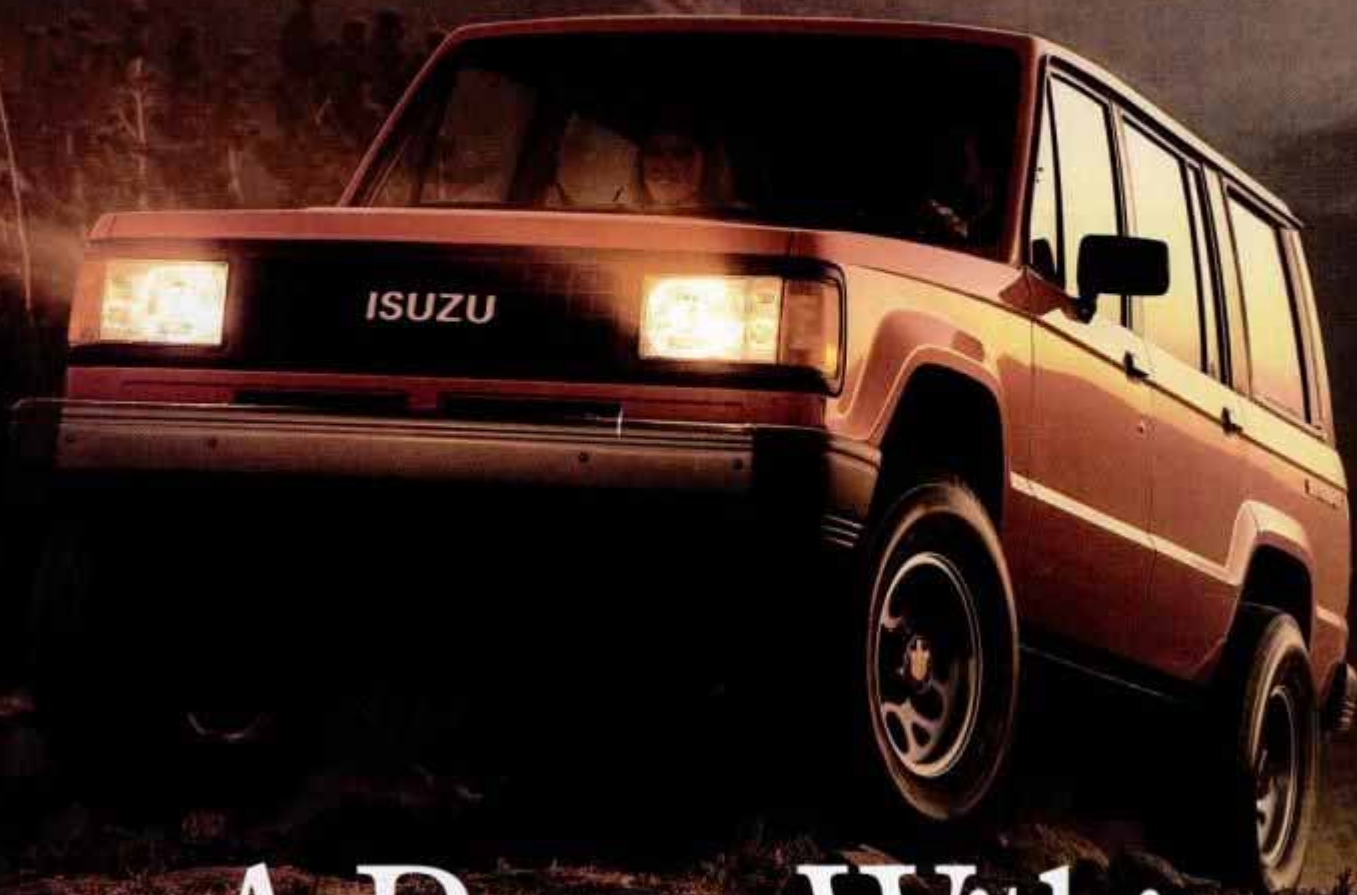
ULTRAVIOLET IMAGING TELESCOPE  
 ULTRAVIOLET PHOTO-POLARIMETER  
 HOPKINS ULTRAVIOLET TELESCOPE

BROAD-BAND X-RAY TELESCOPE



*Astro-1* correlates data from X-ray and ultraviolet instruments.

PH ILLUSTRATION BY ED VALIGURSKY



# A Rover Within Your Range.

If you're contemplating the purchase of a 4x4 utility vehicle, consider your options. You could pay over \$35,000 for a Range Rover and impress all your friends. Or you could spend substantially less for an Isuzu Trooper and impress someone far more important. Yourself.

**\$13,149\***

Like the Range Rover, the Trooper offers high glass areas for excellent visibility and enough interior space to comfortably carry five adults!

Yet unlike the Range Rover, the Trooper offers you a choice of engines. You can get an economical, fuel-injected four-cylinder or opt for a beefier V6.

And while the Range Rover comes with only one type of transmission, the Trooper offers a choice between two: a rugged five-speed manual or an optional four-speed automatic transmission.

Of course, the Range Rover does offer an impressive 70 cubic feet of cargo space with its rear seat folded down. But, once again, the Trooper offers you even more.

For free Isuzu brochures  
call (800) 245-4549.

The way we see it, there's only one thing keeping the Trooper from being the vehicle in vogue. It's affordable. And that's just not chic.

**Isuzu Trooper**



\*M.S.R.P., P.O.E. excluding tax, license and transportation fees as of 11/10/88. Optional equipment shown. †Rear seat optional.

## Mars By Balloon

SAN DIEGO, CA—NASA has awarded a contract to study balloons as a way of transporting instruments over the surface of Mars.

Riding the winds of the planet's thin carbon-dioxide atmosphere, the balloons could travel for miles without the weight and complexity of a wheeled rover.

Initially developed in France, the concept is now being studied by Titan Systems, under the NASA contract, and at other centers here and abroad. The Soviets are perhaps most advanced, with a balloon now being designed for launch in 1994. The U.S. will assist by including data-relay equipment on the 1992 Mars Observer mission.

**In one concept, balloons might be used to drag an instrumented snake over Martian surface.**



PM ILLUSTRATION BY MICHAEL CARROL



## Handheld Locator

CEDAR RAPIDS, IA—Rockwell International has demonstrated a global positioning satellite (GPS) receiver that fits in the palm of your hand. Weighing 8 ounces without batteries, it can determine any location in the world to within 16 meters.

Intended to demonstrate new chip technology, the receiver incorporates the first monolithic microwave integrated circuit, and uses very large-scale integration tech-



**Mockup GPS receiver (above) is same size as working unit (top), shown partly disassembled.**

niques. The chips will go into a variety of tiny aids to military navigation.

ROCKWELL INTERNATIONAL PHOTOS

## Workplace Tech Helps The Handicapped Compete

NEW YORK, NY—Computerized equipment is creating new opportunities for the handicapped by enabling them to read, write and speak more easily. The technology opens up professions such as law, computer programming and engineering that would have been inaccessible only a few years ago.

One of the most successful devices works as an ultralight laptop computer for the blind and visually impaired. Measuring 8 x 4 x 1 in. and weighing about a pound, Braille 'n Speak replaces the display of a normal laptop with a speech synthesizer. The user enters data through a 7-key Braille keyboard, and orders the synthesizer to play it back as necessary. Able to store up to



**Speech trainer shows graphics in response to headgear sensor input.**

300 pages of copy, the device is most commonly used for notetaking and word processing, but can perform other computer functions as well. Ports are provided to

drive printers producing Braille or regular hard copy.

Another laptop synthesizer has been developed for the severely speech impaired. Called Realvoice, it simulates male or female voices, and has an LCD readout and built-in printer.

To help the hearing-impaired learn to speak, Matsushita has developed a system that uses computer graphics to provide visual feed-

back on pronunciation and vocalization. Although the machine is now marketed only in Japan, research now under way in the United States may adapt it to the English language.

The large visually impaired population will benefit from another family of devices that magnify characters up to 45 times. High-resolution closed-circuit TV technology scans reading matter and presents it on 19-in. CRT monitors. Split-screen software provides separate windows for reading and writing simultaneously. People with low vision can also operate IBM PC-compatibles by loading a system called LPDOS which enlarges on-screen characters.



**Communications equipment for the visually impaired includes Braille 'n Speak (above), and electronic magnifiers (left).**



**Realvoice laptop provides speech impaired with voice, print and LCD outputs.**

MATSUSHITA PHOTO

ADAPTIVE COMMUNICATION SYSTEMS PHOTO

OPTILEC PHOTO (RIGHT); BLAZIE ENGINEERING PHOTO

# To help prevent second heart attacks doctors chose Bayer 4 to 1.

## For themselves.

Studies with people who've had a heart attack show a regimen of exercise, the right foods and an aspirin a day could help save lives.

We asked doctors if they'd had a prior heart attack or unstable angina, which aspirin brand they'd take to help prevent a future heart attack. *Doctors chose Bayer 4 to 1 for themselves over any other brand.*

Doctors know no other brand is safer or more effective. Bayer<sup>®</sup> is pure aspirin. No caffeine. No sodium. And only Bayer has the Toleraid<sup>®</sup> micro-coating, so it's easy to swallow.

Doctors chose Bayer. Ask your doctor how Bayer can help you.



The Wonder Drug That Works Wonders.™



# O N L Y O N



*The \$1.5 million Ferrari PPG Pace Car.  
Exclusive tires: Goodyear Eagle "Gatorback" street radials.*



*The \$144,500 Ferrari Testarossa.  
Exclusive tires: Goodyear Eagle "Gatorback" street radials.*



# E A G L E S .



*You are looking at over \$1.5 million worth of Italian art. Exported from Maranello to America on just one make of tires: Goodyear Eagles.*

As the engineers at Ferrari know, there really is a difference in high-performance tires.



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

It is a difference that ultimately shows itself in the

"contact patches" of your tires, where your car meets, grips and responds to the road.

Which may help to explain why every 185 mph Ferrari Testarossa that comes to America does so on Goodyear Eagle street radials. Exclusively.

And why the one-of-a-kind, \$1.5 million Ferrari PPG Pace Car also uses Goodyear Eagle street radials. Exclusively.

Because Goodyear makes better high-performance tires. For the track. For the street. For virtually every performance car.

As Ferrari knows, the finest examples of automotive technology deserve the finest examples of high-performance tire technology.

Which explains why these Ferraris come on Goodyear Eagles. Exclusively.

For a free copy of our 12-page Guide to "Everything you ever wanted to know about performance tires" write The Goodyear Tire & Rubber Company, P.O. Box 9125, Akron, Ohio 44305.

## **GOODYEAR**

BECAUSE THERE REALLY IS A DIFFERENCE.

# DETROIT SPY REPORT

BY JIM DUNNE

## New Camaro, Firebird Revealed

**Y**OU CAN forget all those rumors you've been hearing about GM discontinuing the Camaro/Firebird line. As the spy shots on this page indicate, styling work is virtually complete on replacements for the current F-cars, which have been in production for over eight years now.

The new cars are scheduled to debut in late '92 as 1993 models, and have scored well with consumer clinics.

Chevy boss Jim Perkins says that the Camaro prototype has tested extremely strong.

"People walked out just raving about that car," he said.

One of the reasons Perkins and the rest of Chevy management is so adamant about

Next-generation Camaro reflects evolutionary change.



sell more than 250,000 units a year, but dealers also love the Camaro for its ability to help build showroom traffic.

Although GM had a well-advanced program for a front-drive F-car replacement a few years back, the new Camaro and Firebird will be rear-drivers.

As the photos show, both

bird. Chevy will stick with exposed headlights while the Firebird lights are hidden.

### Mustang Dilemma

With Chevy gearing up to launch what seems to be an obvious winner, Ford is wrestling with the dilemma of how to handle the next generation of its popular Mustang.

The big problem is that Ford would like very much to retire the Mustang's current Fox platform in favor of something more up to date. However, if a rear-drive layout is to be used, that leaves only one option—the Thunderbird/Cougar chassis, which is 12.5 in. longer and substantially heavier.

Developing a new chassis for the Mustang alone is unlikely, since Mustang sales—less than 200,000 in 1989—wouldn't justify the investment.

### New Deal At Olds

In a move that could have far-reaching consequences,

Oldsmobile has added a new wrinkle to its sales policies.

If an Olds buyer is dissatisfied with his or her purchase in the first 30 days or 1500 miles, the car can be returned and the price of the purchase applied to another new Oldsmobile.

Owners who decide that they want to take advantage of the new policy aren't restricted to the same model.

Led by division manager Michael Losh, who previously helped restore Pontiac to good health, the program has already been a strong image-builder for Oldsmobile. And it's also been a good gamble—the number of Oldsmobiles that have been returned is quite small so far.

"Less than one-half of 1 percent used this offer in '89," claims Losh.

Losh says that only half of the buyers who have returned cars stayed with the same model on the reorder phase of the deal.

Olds plans to continue the program at least through the 1990 model year.

*(Please turn to page 27)*



The 1993 Firebird indicates strong influence of Banshee show car.

retaining Camaro is simple. Market study after market study show that Camaro is the best known name in Chevy's lineup. As a result, Chevy has no intention of letting the name go, even though current Camaro sales are only about 125,000 cars, which are down from a 400,000-car peak.

Citing stronger competition, Chevy sales executives don't expect the new car to

prototype cars represent an evolutionary step forward from the current F-bodies, although both also embody some styling themes from recent divisional show cars.

The Firebird, in particular, shows Banshee show car influences in the front-end treatment.

As with the current cars, the nose will be one of the main points of difference between Camaro and Fire-



Next-generation Firebird: steep windshield rake, low hoodline.

# New Steam® Premium.™ Cleans your engine. Outcleans the competition.

**NEW!**  
25% MORE  
THAN THE LEADING  
BRAND

**GUMOUT**

**STEAM  
PREMIUM  
XTRA DUTY. ENGINE  
CLEANER DEGREASER**

Dual action  
micro-emulsion formula

Emulsifies to cut toughest  
grease. Lifts off dirt.

Spray on. Rinse away.

**PENNZOIL**

If your engine degreaser's not cutting it, let off some steam.

From this big can comes the best there is. With an advanced cleaning formula that cuts through engine dirt and grease *better* than anything you've ever used.

With *more* active ingredients than the competition. *Twenty-five per cent more* product than the leading brand, so one can clean your entire engine. And, with a handy spray-any-way valve that cleans hard-to-reach spots with ease.

If your engine degreaser's just not cutting it, maybe it's time you let off some serious steam. With new Steam® Premium™ XTRA DUTY® Engine Cleaner Degreaser.

**GUMOUT**

**PENNZOIL**

Another Quality Product of the  
Pennzoil Products Company.

**Reach new heights.**



## Sounds Of Silence

How do you make a quiet car even more quiet? Engineers on the Lincoln Town car had this problem in designing the new 1990 model.

While the old Town Car was one of the quietest on the road, the development teams found three ways to reduce noise even more.

Wind noise was a definite problem that presented opportunities. They attacked that in the design of the body and flush-fitting window glass that reduced eddies and turbulence.

Adding a layer of acoustical insulation in the floorpan cut down on engine and transmission noise, and a new tread design by Michelin reduced tire hum.

Finally, adding air springs to the rear suspension reduced ride harshness and cut down on suspension noise.

## ZR-1 Ragtop

Anticipated from the beginning of the Corvette ZR-1 supercar program, a convertible version is currently undergoing testing at GM proving grounds in Michigan and Arizona.

Although Chevy produces L-98 Corvette convertibles on regular factory assembly lines, the ZR-1 version will probably be farmed out to a specialty shop for production.

Insiders expect the droptop ZR-1 to show up in 1991 new model introductions next fall. Look for a price even higher than the ZR-1 coupe, probably well over \$60,000.

The current ZR-1's \$58,995, is the highest list price ever posted for an American production car. Nevertheless, Chevy expects to move 3000 of its supercars during the 1990 model year.

## The Storm's Apex

Chevy plans to add a new kammback model to its Geo Storm lineup for the 1991 model year.

Styling will differ from the current sporty look of the other Storm models, principally by a squared-off rear end that lends a miniature station wagon appearance to the car.

Side glass wraps up into the roof a couple inches imparting an open, lightweight appearance.

The Storm family is built for General Motors by Isuzu.

## Luxo Locales

A recent Audi demographic study has pinpointed the areas where you're most likely to see a relatively high percentage of luxury cars—the \$40,000 and up variety—in the traffic mix.

Audi's survey indicates that fully one-third of all luxury car sales are made by dealers in the Los Angeles and New York metropolitan areas.

Add in Miami, San Francisco, Chica-

go, Boston, Philadelphia and the District of Columbia and you account for almost all the country's luxury car sales.

## Chevy Saturn?

Chevrolet insiders confirm that the division has discussed the possibility of a new small Chevy emerging from the new Saturn plant located in Spring Hill, Tennessee.

Saturn management is deferring that possibility for now, preferring to concentrate all its manufacturing expertise on the new Saturn cars that will roll out next fall.

However, once the plant is up and running smoothly, the Chevy request will probably get a rehearing.

## Reatta Ratios

Based on enthusiastic response at auto shows, Buick is optimistic about the future of its new Reatta convertible.

Insiders say the sales ratio could go as high as 50/50 between coupes and convertibles, a ratio the division is ready to meet, thanks to flexible manufacturing techniques.

Buick plans to allow demand to dictate build priorities.

## The Persistence Of Viper

Although rumors persist of its demise, Viper, Chrysler's throwback sports roadster, continues to move toward the possibility of production.

The Cobraesque show car has been making the rounds with a V10 engine, which is definitely part of Chrysler's powertrain program, although the production roadster could wind up with a V8 engine.

The basic plan is to keep the car as simple as possible. Plenty of power, straightforward suspension, no turbos, no electronically controlled shocks and certainly no traction control.

If Viper stays on schedule, look for a late 1992 launch as a '93 model.

## ABS For All

GM engineers are talking about a plan to provide antilock braking systems in all General Motors cars and light trucks in the not-too-distant future.

Delco Morain, the General's brake subsidiary, has developed a low-cost antilock system for use on all GM vehicles. The plan is to put rear-wheel ABS systems on a number of vehicles initially and phase in 4-wheel systems as time goes on.

GM has a couple good reasons for instituting such a program. First, some insurance companies are giving premium breaks to ABS-equipped cars.

Second, and more important, GM expects antilock systems to be federally mandated by the mid-1990s. **PM**

**W**hen it comes to pickups, some buyers set their sights higher. One look at the 1990 Sierra, and you'll see why that suits us at GMC Truck just fine.

Sierra is the full-size pickup born and bred to be nothing less than the best truck we can bring you. Able to go just about anywhere, with shift-on-the-fly four-wheel drive and the unmatched standard muscle and torque of the 4.3-liter Vortec V-6. Then stop just as surely with rear-wheel anti-lock brakes. There's even a new sport handling package available, with special low-profile tires and gas-charged Bilstein shocks.

Of course, Sierra's also big on comfort. And its advanced, aerodynamic styling is so far ahead of its competition, *4-Wheel & Off-Road* magazine said, "it is now the benchmark against which all other products are being measured."

The 1990 Sierra from GMC Truck. It's the one pickup every other truck on the road has to live up to.

For a catalog and the name of your nearest dealer, call 1-800-VALUE90 (1-800-825-8390).

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**GMC TRUCK**

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# Introducing the new ESCORT

New technology makes this radar detector perform unlike any other in the world

In 1978 we introduced the original ESCORT. Its superheterodyne technology changed the science of radar detection forever.

At the time, *Car and Driver* said, "If you can imagine the Turbo Porsche of radar detectors, this is it...it's a brilliantly conceived device. In no test did any of the other detectors even come close." But that was just the beginning.

#### Our strategy

Since then, we've continuously advanced the science of radar warning by encouraging our engineers to spend their time on only one thing: improving performance. Because of this program, ESCORT and PASSPORT have unequalled reputations for performance, winning test after test.

But we've never stopped striving for another quantum leap, a revolution in technology that could redefine radar detection again. And now we've done it. The key is a new technology: DSP.

#### Incredible technology

DSP is Digital Signal Processing, a technology virtually unheard of in personal electronics, but used in many exotic electronic devices.

DSP is used by NASA to create detailed space photos from blurry images. It's used by military radar to distinguish enemy aircraft from friendly aircraft. It's used to deliver sharp images of internal body tissue from medical scanners. And now we're using DSP to find radar signals too weak to be detected by conventional technology.

DSP to find radar signals too weak to be detected by conventional technology.

*The heart of ESCORT's DSP circuitry is this custom 30 MHz 24 bit parallel HCMOS processor, capable of 10.25 million instructions per second.*

#### How it works

Our new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This information is then digitized and continuously analyzed by what is essentially an incredibly fast internal signal recognition computer.

#### Breakthrough performance

The new ESCORT's DSP circuitry was developed using everything we've learned about advanced radar detection. The end result is incredible.

The new ESCORT's advanced signal processing provides an incredible increase in sensitivity on both bands. Quite simply, this means that the new ESCORT picks up radar signals much further away than was ever before possible.

In fact, not since we introduced the first ESCORT has there been a performance improvement like this. But there's more.

#### Complete warning system

The new ESCORT keeps you fully informed with a variable audible warning with adjustable volume, and different tones for X and K bands. And both a Mute and a new Auto-Mute function.

For visual warning, there's an alert lamp and ten-segment signal strength meter, both dimmed to suit ambient lighting. There's also a Dark mode for more discrete operation.

ESCORT is housed in a heat treated aluminum housing, finished in low-glare black, and is incredibly compact, only 3/8" high and 3 1/4" wide. And everything you need is included.



*The new ESCORT is only a fraction of the size of the original.*

#### Everything included

The new ESCORT comes complete with visor clip and adjustable windshield mount, and power cords to suit any installation (both a coiled and a straight cord that plug into your lighter, and a cord for direct wiring into your car's electrical system, if you prefer).

There's also a leather carrying case, and a comprehensive owner's handbook. ESCORT also incorporates our revolutionary Digital Key security system (see sidebar for the full story).

#### Satisfaction guaranteed

We only sell ESCORT direct from our factory to you, and we guarantee your satisfaction. To order, just call us toll-free. After you receive ESCORT, if you're not completely satisfied within 30 days, just return it. We'll refund all of your money and your return shipping costs, no questions asked. There are no hidden charges.

The new ESCORT outperforms any other radar detector in the world. But don't take our word for it. Order today and see for yourself.

## Bad news for thieves:

A new security system in new ESCORT and SOLO makes them of little use to anyone but the rightful owner. Here's how it works:

The system is fully automatic, and easy to use. Included with your new radar detector is a tiny electronic "Digital Key"™ to put on your key ring (see the main photo above and the cutaway at right).

About every two months, your detector's circuitry will prompt you to insert your Digital Key into a small jack on your detector, and turn your detector on. After confirming that you used the right Key, your detector will reset its lock and will be ready for two more months of use. That's all there is to it.

**May we help you?** ESCORT and SOLO bring totally new technologies to radar warning. But there's one thing we didn't change: Our system of selling direct from our factory to you.

Just call us toll-free. One of our radar experts will be glad to answer your questions or take your order. And remember, our 30 day trial lets you try new ESCORT or SOLO at no risk. Call today.

**ESCORT \$295**

Ohio residents add \$17.70 sales tax

Prices slightly higher in Canada

**ESCORT**  
RADAR WARNING RECEIVER



# Introducing self-powered SOLO

## A new kind of radar detector— No power cord

If you're a business traveler, always switching between cars and using rentals in distant cities, you need the most convenient radar detector possible. But radar detectors have always been less than ideal for traveling. Until now.

### First things first

After years of development, we're introducing self-powered SOLO. It has the same long-range warning as our test-winning PASSPORT, and it's even smaller (only  $\frac{3}{8}$ " high and  $2\frac{1}{4}$ " wide). But incredible performance isn't the breakthrough.

However, for someone who doesn't have the right key (and there are thousands of different Digital Keys), the radar detector simply won't work. And there's little economic incentive for a thief to steal your radar detector if he can't sell it. And if a stolen ESCORT or SOLO is ever returned to us for service, we'll immediately contact you (if you have reported the theft to us).

Although nothing is totally "theft-proof," our new Digital Key security system will help keep your new ESCORT or SOLO yours.

Actual size cutaway of Digital Key



Call Toll Free 1-800-543-1608

(24 hours a day, 7 days a week)



Or mail us your order:

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 Dept. 6068D9  
 One Microwave Plaza  
 Cincinnati, Ohio 45249



**SOLO \$345**

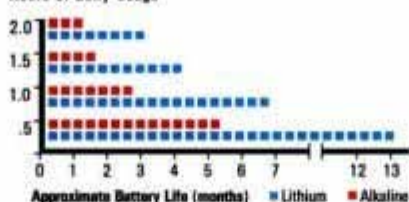
Ohio residents add  
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### Revolutionary convenience

SOLO is the first self-powered superheterodyne radar detector. You just mount it on your visor or windshield and turn it on. It's that simple.

SOLO doesn't need a power cord, recharger, or add-on battery pack. Its remarkable design operates about 200 hours on a single 9 Volt lithium battery (or 80 hours on a standard alkaline). For most drivers, that's several months of use.

Hours of Daily Usage



For most drivers, a single battery will last several months.

### Total performance

Unlike most battery powered devices, SOLO maintains full performance over its full battery life. And when you finally need to replace the battery, SOLO tells you five hours in advance so you have plenty of time to plan ahead.

Needless to say, there was only one way to make self-powered SOLO a reality. Starting with a clean sheet of paper, our engineers have designed the most efficient superheterodyne radar detector in the world. SOLO uses only 2% of the power of a conventional radar detector.

### Incredible technology

The advances that made SOLO possible would fill this page, but here's a brief outline: A varactor-tuned GaAs FET microwave oscillator, four custom CMOS integrated circuits, seven circuit boards, and hundreds of SMD components controlled by a CMOS microprocessor and powered by a digital power supply. All contained in a thin wall magnesium housing for incredible strength and lightness (just  $5\frac{1}{2}$  ounces complete with battery).

### Standard equipment

SOLO has all of the advanced features we pioneered with ESCORT and PASSPORT. Variable rate audio warning, with adjustable volume and different tones for X and K bands. An alert lamp and ten-segment LED signal strength meter, both automatically dimmed to suit ambient lighting. And a Dark mode for even more discrete operation.

In addition, SOLO has both a Mute switch and a new Auto-Mute function that automatically reduces the audio to a lower level after the initial alert. There's even a special battery-saver circuit that turns SOLO off if you forget to.

And our new Digital Key security system means your SOLO will be of little use to anyone but you (see sidebar for the full story).



Instead of a conventional meter, SOLO uses ten Hewlett Packard ALGaAs LEDs bonded directly to a tiny circuit board.

### The complete package

SOLO comes complete with everything you need. An articulated visor clip that opens wide for padded visors, but folds flat for convenient handling. A windshield mount that easily adjusts for different windshield angles. A leather pouch for everyday use, and a travel case for taking SOLO with you on trips. And of course, we include two batteries, both a lithium and an alkaline, to get you started.

### Factory direct

We only sell SOLO direct from our factory to you. Just call us toll-free to order, or for more information. And we guarantee your satisfaction. If you're not completely satisfied in 30 days, just return SOLO for a full refund. SOLO is also backed by our one year limited warranty.

Some people will see SOLO as a convenience breakthrough. But also consider the performance advantage of having a radar detector you'll use every time you get in your car.

BY ABE DANE

## New Imax Opens At The Smithsonian

**T**HE remarkable Imax camera continues to go where few can follow, and bring back pictures—stunning 5-story-high moving pictures—that make reality seem drab by comparison. A new double feature which is now showing at the Smithsonian's Air & Space Museum uses the large-format film technology to good advantage.

Leading off the twin-bill is "To The Limit," an exploration of the biological mechanism behind world-class athletic performance. The film intercuts footage of three top athletes in action with endoscopic shots that probe the passages of the cardiovascular system.

One of the best sequences duplicates with alarming fidelity the experience of Swiss Olympic skiing champion Maria Walliser as she runs the downhill. Dizzying speed is a sensation that Imax conveys especially well, and there's plenty of it in the jumps, high-G turns and plummeting schusses of Walliser's 60-mph descent. Three specially designed camera mounts maneuvered by skiers shot the footage.

"To The Limit" is paired with "Speed," an earlier film by the same company, MacGillivray Freeman. Narrated by author James Burke, it follows man's progress from a 27-mph run to the 26,791-mph return of *Apollo X* from the Moon, showing all sorts of good-looking, go-fast gear along the way.

Two gripes: The footage of the SR-71 Blackbird spy-plane is tantalizingly brief. One can never see enough of this elusive 2193-mph craft, in my opinion. Also, in both films, the different subjects sometimes seem loosely connected, and the transitions between them contrived.



Imax camera looks back from belly of Blue Angel in 500-mph delta roll (left), and views tendons supporting the heart's interior (right).



But plot is not the point with these movies. They're more like magnificently illustrated coffee-table books of the film world.

Showing Fridays, Saturdays and Sundays at 7 pm, the feature will continue through the spring.

### A Bigger Pi

In the quiet world of mathematics, something big is brewing. It's pi. The endless number representing the ratio of a circle's circumference to its diameter has now been calculated out to a billion digits by a pair of Columbia University professors. Their feat is just the latest surge forward in a steadily escalat-

ing international pi race.

The previous record of 539 million digits was set in July by a Japanese team using a Hitachi supercomputer. Rather than answer the challenge with the hottest new equipment, new record-holders Gregory and David Chudnovsky used a highly efficient algorithm of their own design to coax world-beating performance from a pair of relatively commonplace IBM 3090 supercomputers.

Why go to such lengths? Because it's difficult, for one thing. Infinite, or transcendental, numbers such as pi provide a uniquely strenuous proving ground for computers and software. A single

error—caused by a stray cosmic particle or power surge—throws off the calculation in ways that show up in the final result.

The Chudnovskys' algorithm has the advantage of checking its own results as it goes. It is also able to tack new numbers on the end of the string, without recalculating all the previous ones.

The Chudnovskys expect the huge number-handling capabilities of the algorithm to be of use in weather prediction, aerodynamic simulations and image processing.

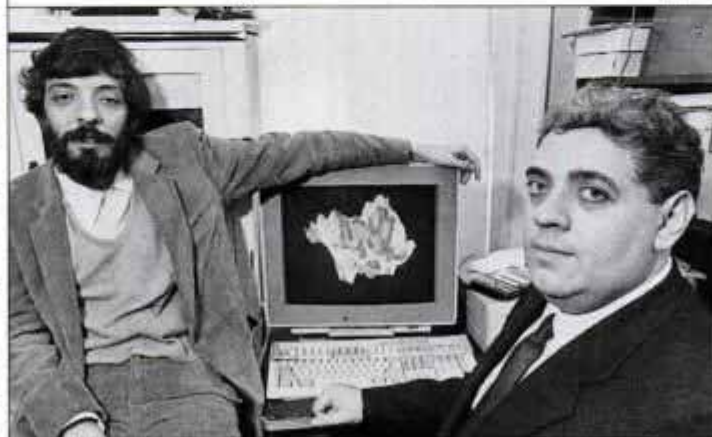
### Superkids

Accomplishments like the new pi record take more than high-priced hardware. If supercomputers are to play the role they should in our future, the next generation of scientists must be trained to use them. That's the point behind SuperQuest, a program that gives a few selected high school students access to these multimillion-dollar machines.

Teams whose proposals were selected from a nationwide pool of applicants spent two weeks at the Cornell National Supercomputing Facility this summer. There, they worked with instructors to refine their experiments and work out programming.

The annual contest almost died this year, because former sponsor ETA systems went out of business. But quick offers of support from the National Science Foundation, Cornell and IBM saved it just in time.

Now back in school, the students continue their work by remote hookup to Cornell, and it's time the next batch of superkids got busy on their applications. For details, contact Ann Redelfs, Cornell Theory Center, 265 Olin Hall, Ithaca, NY 14853. **PM**



Chudnovsky brothers display a graphic of pi's first million digits.



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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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# ELECTRONICS

BY STEPHEN A. BOOTH

## Recharging Santa's Helpers

**D**ECEMBER IS upon us, with its end-of-year holidays. As the number of shopping days diminishes, so does the supply of electronics items that people will give and receive. So many of these are battery powered, it is amazing that any AA, C or D batteries are left on the shelves.

According to Eveready Battery, 25 percent of all the batteries purchased in a year are bought in November and December. This year, holiday shoppers will spend about \$800 million on nearly half-a-billion batteries. It's a good bet that many of those dry cells will go into toys, for kids of all ages, and that they'll run dry before the Earth completes one revolution on its axis.

For the many households that use 100 or more batteries a year, rechargeables make sense. But the 7 to 14 hours they take to recharge has often been a drawback. Now, Eveready has the process down to a single hour with its Generator series of chargers and cells.

The compact charger, for up to four AA cells, costs \$40. The larger model recharges any combination of four AA, C or D cells and costs \$50. Two-packs of Generator batteries range from \$8 to \$10. Though the Generator charger can be used to restore other types of rechargeable

batteries, these require 7 hours. A Generator AA cell has a 2500-hour lifetime, according to Eveready, compared to about 25 hours for an alkaline AA cell.

### Have Sound, Will Travel

One voracious consumer of batteries is the personal stereo—that is, the portable cassette or CD player with headphones. And while they're fine for personal concerts, you need a boombox-type portable system when you want to share music with others on the go.

Bondwell Industrial Co. has a way to get more use from your headphone system. The company's MC-100 portable sound system (\$130) comes with everything except the music source. Just plug your personal CD or cassette player into the MC-100's special compartment and you've got tunes to share.

The compact, 12-pound system has a built-in 50-watts-per-channel amp that powers a pair of detachable speakers with 4.5-in. bass woofers and 1.5-in. treble tweeters. The sound was quite clean on the model we evaluated, and the speaker/amp combo could be driven pretty loudly before any objectionable distortion set in.

Other features of the MC-100 include bass, treble and

volume controls, microphone inputs and a storage compartment for cassettes or CDs. The MC-100 runs off the supplied AC-to-DC adapter, a car battery, or 10 D cells. A companion piece, the MA-100 (\$110) consists solely of the amplified speakers, and runs off AC or car battery only.

### DAT For '90—Maybe

The long-running dispute between the record industry and hi-fi manufacturers over digital audio tape (DAT) recorders appears to be over. But how soon DAT machines will appear on store shelves is an unanswerable question.

Perturbed by DAT's ability to record perfect digital duplicates of a Compact Disc, the record industry lobbied hard against the product's introduction to the U.S. Now, a compromise between the two groups clears the way for DAT sales. But your ability to make DAT copies of your DAT recordings will be severely limited.

According to the agreement, DAT recorders will incorporate an anticopying safeguard called a Serial Copy Management System. This integrated circuit will allow you to make one digital tape copy of a CD or prerecorded DAT cassette. While it does, the SCMS chip records a subcode on the copy. Should you attempt to make a DAT duplicate of the copy, the subcode directs that machine to disregard your instructions.



Eveready's Generator system recharges batteries in just 1 hour.

For nondigital source material, such as live music or analog discs and cassettes, the SCMS chip allows you to make two serial copies.

The SCMS is designed to prevent high-volume digital copying for illegal sale. As such, it shouldn't crimp the style of the average home tapist who might wish to make one or two tape copies of a CD for use in a car or portable DAT system.

Despite the DAT agreement, U.S. introduction remains a ways off. Music companies are in no hurry to issue recordings on DAT, as these would compete with CDs. And given their cautious approach to date, hi-fi manufacturers probably won't offer machines until prerecorded DATs become available. **PM**



Bondwell MC-100: Big sound from personal headphone stereos.

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## The High-Tech Revolution in the Home Is Just Starting

Sweeping changes are taking place in our homes, changes brought about by the phenomenal growth of home entertainment electronics. Already available are high resolution TV, TVs with stereo sound, simultaneous multi-channel viewing, projection TV, Camcorders, 8 mm video cassettes, and compact disc players.

And the revolution has spread to the business sector as tens of thousands of companies are purchasing expensive high-tech video equipment used for employee training, data storage, even video conferencing.

## Join the Future or Be Left Behind

Today the consumer electronics industry represents a whopping \$26 billion opportunity for the new breed of consumer electronics technician.

Today's consumer electronics revolution is creating huge servicing and repair mar-

kets that are just starting to boom.

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# OLD HOUSE RESTORATION

BY BOB VILA

## All About The National Register

**T**HE PRIDE you have as owner and restorer of an old house can sometimes be taken one step further—to a listing on the National Register of Historic Places.

This same sense of pride is probably the main reason most homeowners pursue a listing. Unfortunately, federal tax credits that are available for a listing only apply to income-producing properties. But depending on where you live, pursuing a listing may yield some financial incentives on the state level. In any case, the honorific recognition that comes with having your home listed on the National Register may help increase its value on the market.

Obviously, this is not going to be an appropriate choice for most readers. But there may be a few of you who own properties that qualify for this honor. Understanding what the National Register is, what its qualifications are and how to submit a nomination will help you decide if it's right for you.

### A question of significance

The National Register for Historic Places is the federal government's official list of properties that are significant in our history. Maintained by the Department of the Interior and administered by the National Park Service, it dates to the pass-

*Contributing Editor Bob Vila was host of public television's "This Old House" for 10 years.*



President Woodrow Wilson's home in Washington D.C. is listed on the National Register.

ing of the National Historic Preservation Act of 1966.

In addition to individual buildings, the National Register includes sites, districts, structures and objects. All must have some significance to American culture, history, architecture, archeology and engineering and, in most cases, it should be at least 50 years old.

There are several guidelines or criteria used to evaluate a potential National Register entry. One is that the site, district, structure, building or object should be associated with a significant event in American history. In the case of an old house, for example, perhaps an important document was signed there or the house functioned as a commercial building that was important to the development of local history.

Another guideline used is

whether the potential entry is associated with the life of a person considered significant to our nation's past. This could apply to an old house if a famous historical figure lived there.

The third criterion deals with the question of architectural significance. If a house exhibits distinct characteristics of a certain period or method of construction or is a prime example of an architect's work, it may also be eligible for this listing. A property can qualify if it has potential to impart information important to American history or prehistory. But, this is usually reserved for archeological sites.

Coupled with the above criteria, to be eligible for the National Register, a property must conform with another separate standard. The property must retain the integrity of its historical signif-

icance. That is, it must reflect what it looked like at the time it was claimed to be an important part of history. This is referred to as its *period of significance*.

For example, if you're seeking a nomination to the Register based on the fact that a historically important person lived in your house, the building should look like it did when that person lived there. Or if you're using the building's architectural style or significance as its basis for inclusion, like Greek Revival, it should retain the basic integrity it had at that time period. In this instance, the significance of the exterior

of the building is the important part.

But interiors may also come into play, particularly if your home's period of significance is associated with a historical event. For example, if an important treaty was signed in your house—an event that obviously occurred inside—then to retain its integrity the interior should reflect that time.

It's important to note here that a museum-quality restoration is generally the exception to the rule. The government recognizes that buildings are organic and change over time, reflecting different tastes. Most have had alterations. Therefore, a building's integrity is really a matter of degree. It's the sum of the workmanship that's gone into the building, along with the retention of its original features and spaces. You cannot re-create integrity.

## Historical jigsaw

If you think your old house may qualify for this national recognition, you'll need the backing of your State Historic Preservation Office (SHPO). The folks there should be able to give you the guidance you need to get the registration process started. This involves completing the standard nomination form, which is used to describe the historic property and explain its significance under the National Register criteria described above.

They'll also review drafts and suggest changes. The completed form is then voted on by the state review board. If it passes, it is forwarded to Washington. Although it is possible to complete this form yourself, some homeowners seeking nomination to the National Register hire historic research consultants to secure the documentation needed to justify their entry.

No matter what basis you're using to qualify, the building's historical significance must be well documented. For instance, if the basis of your entry is that someone of historical significance lived in your house, this may involve a complete title search back to the building's origins to document ownership.

The title search will yield all the past owners, which may include people who played a significant part in history—either national or local. This full deed search usually starts at the municipal hall of records and continues on at the local library or historical society. If you're lucky, you'll find printed local histories available to aid you in determining notable owners.

Other materials helpful to the researcher in proving a building's historical significance include insurance maps, photos or illustrations, newspaper clippings, public and business records, and even personal letters and diaries. You are actually putting together a historical jigsaw puzzle, piecing together the past life of your house.

The architectural features of the building must also be documented. You must note when certain parts of the building were added, as well as the construction techniques and materials used throughout.

Most old-house owners can do the title research and discover notable past owners themselves—it's actually kind of fun! But when it comes to architectural significance, you may want to call in a specialist to help you with this part of the form. Some state offices have architects on board who can aid you.

## Historical dollars

Unfortunately, the federally funded grants program of the late '70s, that awarded private homeowners of listed properties grants for their rehab work, were phased out under the past administration. The government does offer a 20-percent tax credit for certified rehabilitations for income-producing properties (commercial or rental). This investment credit applies to expenses within the four walls of the building. It does not apply to the acquisition of property, site improvements or additions.

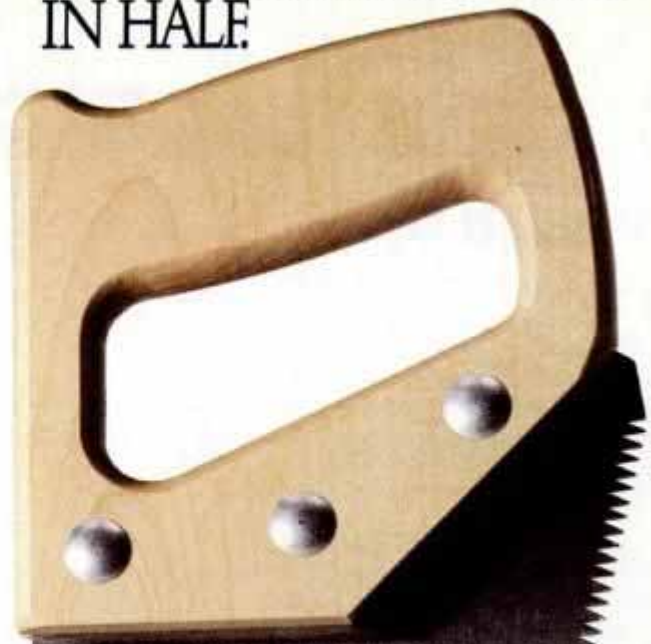
This obviously won't apply to most old-house owners, unless you're rehabbing a building with rental units. To get the credit, the building must either be listed on the National Register or be a contributing part of a historical district. Any rehab work must be reviewed and certified by the National Park Service as being consistent with the historic character of the building.

If you apply for a federal tax credit, your rehab work must follow the guidelines set forth in "The Secretary of the Interior's Standards for Rehabilitation," a booklet that outlines what is appropriate for both exterior and interior restoration work. It's available through the government printing office. Your SHPO should be able to get you a copy.

Fortunately, some states do provide financial incentives for owner-occupied houses listed on the National Register. These may be in the form of grants, special property tax assessments or low-cost loans. Check with your SHPO for more information.

No matter what the financial incentives are, a listing on the National Register of Historic Places is an honor. A source of pride for you and your family, this special recognition from the federal government can only give your old house the prestige it deserves as an important part of our American past. **FM**

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# CAR CLINIC

BY MIKE ALLEN

## Crossed Up

**A** YEAR AGO I had the plugs replaced in my '86 Celebrity. I just tried to remove them to check the gap, but one of the plugs will only turn out about  $\frac{1}{8}$  of a turn. A GM mechanic says it's cross-threaded.

If I do turn it out, is there room to install a Helicoil? There's just barely room to put a thinwall socket over the plug. Or will I have to go to the expense of pulling the head?

HERMAN EISSLEMAN  
HONESDALE, PA

*Look at the rest of the plugs. Is there evidence that they protrude into the combustion chamber and collect carbon on the exposed threads? If you look at several brands of plugs of the same heat range, you'll often find some a little longer than others.*

*If so, turn the plug out your  $\frac{1}{8}$  turn, and douse it with penetrating oil for a day or so. Then turn it out, which may require a lot of effort. The carbon buildup may damage the threads slightly, but you probably will be able to run a thread chaser in and clean them up.*

*And next time use two gaskets to space the plug properly in the threads.*

*If there's no evidence of carbon interfering with the threads, it very probably is crossed—so I'd leave it alone until the misfire starts—which might be a long time.*

*When you finally have to, turn it out. There still might be enough threads left to chase and use. If not, the tool that installs Helicoil thread inserts is turned in by the same plug socket you removed the plug with, so there*

*is enough room. I suggest you get this done by a mechanic or machinist who does it every day—it's one of those things you have to do by the seat of your pants, so the more experience you have, the better the results will be.*

*And if you're very unlucky, you may wind up pulling the head to replace the Helicoil when it comes out with the plug on the next plug change.*

## How Dry Am I?

Now that newer cars have sealed fuel systems is there any reason to add Drygas to the fuel tank to absorb water? Are there any special considerations for fuel-injected systems?

MICHAEL MARTIN  
RICHMOND, VA

*In theory, if the gas station has a vapor-recovery system, as many do nowadays, and your vehicle has a charcoal canister evaporative emissions system, as they all do nowadays, there is no moisture-laden outside air to drop its water inside either tank—and there would never be any need for fuel-line deicer, right?*

*Well, sort of. There is certainly less need, but there's still potentially a certain amount of water in the gas when it's delivered—probably dissolved in the gas rather than liquid on the bottom. That water can settle out of solution when conditions are right. So prophylactic use of gas-line dryer isn't a bad idea.*

*Fuel-injection systems have huge filters compared to the small in-line ones on carburetors. The pleated paper elements in these can store as much as a cup of water, which is good. But when they finally saturate, they can fail, releasing that water and the dirt they've been filtering out all at*

*once—which is bad, very bad. So be sure to replace the filter at regular intervals, especially in cold weather.*

## Vintage Potables

I know antifreeze loses its rust-inhibitive qualities over time. Would it lose this quality if sitting on the shelf, or is mileage driven or type of use the car gets a factor?

If mileage driven and/or use is a factor, then what would be the recommended changing interval?

LINWOOD LEWIS  
ADELPHI, MD

*Antifreeze is more properly called coolant—because it does a lot more than just keep your radiator from freezing. It also raises the boiling point of the system well above that of plain water, which is terribly important when engines run as hot as they do today.*

*The antifreeze and boil-over functions are from the alcohol (ethylene glycol) content. It doesn't really wear out.*

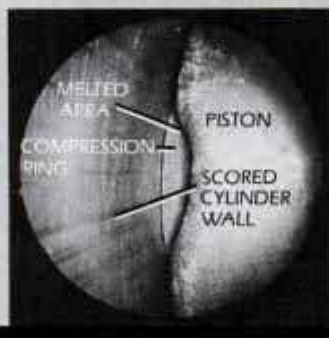
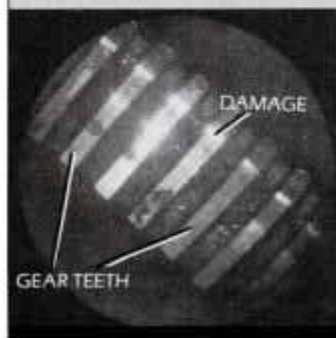
*The third function is provided by the anticorrosion additives, which prevent the dissimilar metals found in your cooling system from digesting each other electrochemically. This additive package does wear out once it's in your engine—but not on the shelf. There's no reason not to use a gallon of antifreeze if you've stored it for a year or two.*

*Don't mix brands—the additive packages differ from manufacturer to manufacturer, and they are not necessarily compatible.*

*Once in the engine, the additives are consumed slowly. (Better the additives being consumed than the solder that holds your radiator together.) The mileage or type of service has little effect on*

## Inside Straight

Ever wonder what it really looks like deep inside the mechanical parts of your car? Borescopes have been around for years, especially in the aviation and medical fields, but at least one manufacturer has gotten the price down to something a mechanic can afford. Using the Autoscope, the two photos below were taken without disassembling anything. The gear on the left is in the final stages of abuse, driven by someone who obviously couldn't handle a manual transmission. The piston on the right, melted right down to the top compression ring, was savaged by a combination of lean jetting and too much compression ratio—an expensive lesson indeed. The \$795 Autoscope is available from Lenox Instruments, 265 Andrews, Scottsville Industrial Park, Trevose, PA 19047, (215) 322-9990.



the speed with which this happens. "Permanent" coolant should be flushed and replaced every two years, or sooner if you see evidence of rust in your coolant.

### Always Thirsty

The gas gauge in my 1964 Comet doesn't show how much gas is in the tank. When I turn on the ignition, it moves about 1/4 in., up to the E mark, regardless of how much gas is in the tank. Is there any way to check to see if it's the instrument panel or the sender in the tank that's bad?

IRVING DIAMOND  
LAS VEGAS, NV

*It's probably a bad connection to the gas gauge sending unit, or a bad sending unit itself.*

*Disconnect the wire leading to the sender, and ground it to any good chassis ground. The gas gauge needle should be pegged on FULL when the key is on. If it is, then the sender is bad, and you'll have to drain the tank and replace it. If it doesn't, run a jumper wire to the gauge itself to ground it. If that pegs the needle, then the wiring between the sender and gauge is bad.*

*If it doesn't peg the needle, then the gauge must be bad. Getting up under the dash to replace it isn't impossible—it just seems that way.*

*Just remember that the hot-wire meter movement will take as long as a minute or two to reach full-scale.*

### Boiled

If your car boils over because of a stuck thermostat will you have to replace the antifreeze? I was told that boiling of the antifreeze will destroy its ability to work as a summer coolant! Is this true, or was I ripped off?

STEVE AMICH  
APPLETON, WI

*The boiling point of ethylene glycol in coolant is 123° C, well above that of the water it's mixed with in your radiator. Assuming the engine boiled over slowly, and the water was boiled out at a faster rate than the glycol, then the concentration of water would be smaller, and the boiling point of the mix would be higher, not lower.*

*If the mechanic was concerned that the radiator was previously filled by someone else with something other than the correct 50/50 mix, and he didn't want to be responsible if your radiator froze during the next cold snap, all he would have had to do was check with a coolant hydrometer for the correct concentration.*

*If you paid for any more antifreeze than was necessary to fill the system after replacing the thermostat, you paid too much—unless, of course, your coolant was approaching the 2-year replacement interval anyway.*

*(Please turn to page 41)*



YOU CAN TELL the holidays are here when our tree trimming committee gets busy in the Visitor's Center.

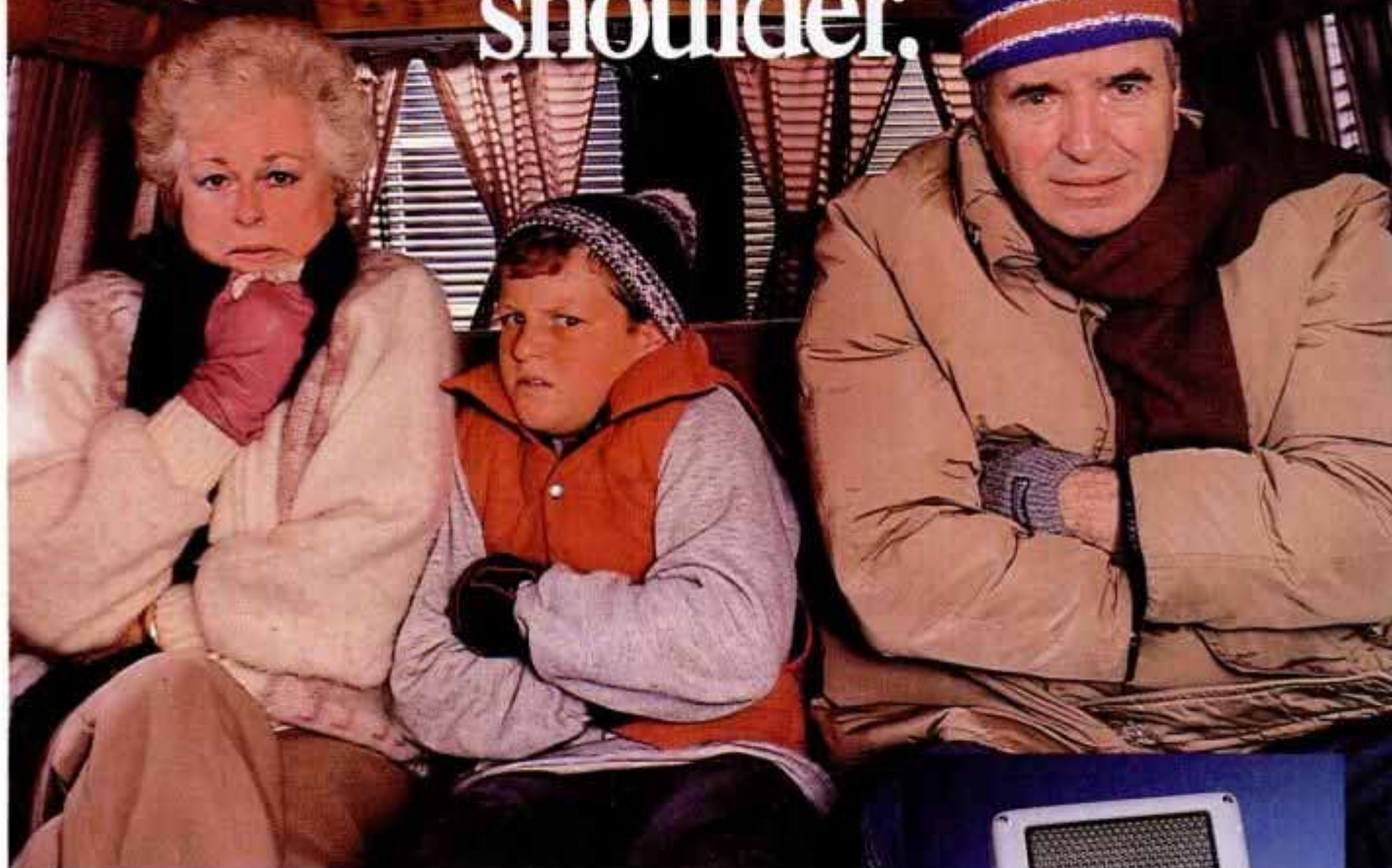
We hope you enjoy the Christmas season this year more than any you can remember. And that Jack Daniel's oldtime Tennessee Whiskey is one of the reasons why. Merry Christmas!

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## Lights Out

My 1985½ Escort is hell on batteries. The battery in the new car went dead at 20 months, and the replacement battery lasted 27 months. Both were maintenance-free batteries carrying 60-month warranties.

Do I need some adjustment of the alternator, a new alternator—or something else?

GLENN COLE  
FAYETTEVILLE, AZ

*With the engine warm, and no electrical load, you should see 13.5 to 14.5 volts measured across the battery terminals. Then turn on every electrical load on the vehicle—the wipers, lights, rear window defroster, all of it. You should still see at least 13 volts at the battery terminals. Any more means a new voltage regulator, and any less calls for troubleshooting the charging system and wiring.*

## Cool-Hand Fluke

There's a lot of hilly territory around here, and when I drive my '87 Caddy uphill for more than a mile or two, the air-conditioning vents start to blow hot air. The air-conditioning shop I've been taking it to can't find anything wrong with the cooling system. They changed to a cooler thermostat, which had no effect.

They have done extensive testing, including blocking off most of the radiator with cardboard until the engine overheats, and now they're trying to talk me into replacing the compressor.

JOHN RIVERS  
KNOXVILLE, TN

*First, have the correct thermostat reinstalled in your Caddy. If the water temp is too low, the injection computer will continually run its overrich warmup program, giving you poor mileage and fuel-diluted oil.*

*There's nothing wrong with your compressor. The controls on your dashboard are vacuum operated. And when you go up a steep hill, the engine manifold vacuum is low, because the throttle is open wider. There's a vacuum reservoir to store enough vacuum for hills, but after awhile, there isn't enough vacuum left to keep the blend-air door under the dash open—and it starts blowing hot air from the heater core instead of cold air from the evaporator.*

*Have the a/c shop look for a vacuum leak, crack in the reservoir, pinched hose, cracked vacuum motor or bad check valve.*

## DO YOU HAVE A CAR PROBLEM?

*Just ask Mike about it. Send your question to 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.*

# COLD REMEDY

Now there's a prescription for helping your car or truck start significantly faster and easier in cold weather: Just add a bottle of Winter Start\* to your motor oil.

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For more information, send for your FREE copy of the booklet, "The Cold Facts About Winter Start." The Shaler Co., Box 471, Dept. P129 Waupun, WI 53963, 1-800-777-9870.

If you can't locate Winter Start in your area, write Shaler for your nearest dealer. Or, call 1-800-777-9870 for direct ordering information.

\*Results of independent laboratory tests, available on request.



## SERVICE TIPS

■ The underhood lamp may be intermittent or constantly on in some 1988 Regals and Cutlasses because of a bad external switch. Buick TSB 88-8-17 and Olds TSB 88-T-76 explain how to replace the lamp with P/N10106508, which has an internal mercury switch.

■ An exhaust leak on '87 or '88 4-cylinder Isuzu trucks may be caused by reusing exhaust pipe nuts. TSB SB88-03-004 specifies that new nuts (P/N8-94156-626-0) always be used to install the exhaust pipe.

■ To improve Conquest's road feel and provide "a more positive steering input," Chrysler TSB 02-03-89 suggests replacing the front and rear lower control-arm bushings with the bushings introduced as a running change for these cars in May 1989.

■ Oil leakage complaints on some 3- and 5-series BMWs may be traced not to any real leak but to oil that pools on the right engine mount when changing the filter. Use a rag to catch any oil spillage, and to wipe up any spilled oil. TSB 11-02-89, 1820

PM



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# OUTDOORS

BY JOE SKORUPA

## Trailblazing Wyoming's White-Open Spaces

**S**NOWMOBILING is as Midwestern as Big-Ten football, dairy farms and waving fields of grain. Of purple mountains' majesties, well, the Rockies are at least 1000 miles to the west and skiing has long been the cold-weather sport of choice there. But extensive networks of groomed trails have recently been blazed along the Great Divide and snowmobiling, developed by flatlanders 30 years ago, is today conquering the big-sky country of the Wild West.

I got my first taste of Rocky Mountain snowmobiling two years ago in West Yellowstone, Montana, which claims to be the snowmobile capital of the country. This was the winter before the infamous fires. Most of the tourist town was closed for the season, but much was open due to the booming snowmobile business.

### Snowmobile heaven

From the first snowfall after November 1 to mid March, Yellowstone National Park roads are dedicated to snowmobile use, creating the most unique 370-mile-trail system in the country. Not surprisingly, other towns on the Park's border are challenging West Yellowstone's prominence as winter gateway to the park, notably



As networks of groomed, high-country trails expand, scenic snowmobile touring booms in the West.

Jackson and Cody, both in Wyoming.

But despite everything magnificent Yellowstone has to offer, there are certain drawbacks: 1. no off-road exploring, 2. 45-mph speed limit, and 3. occasional heavy traffic, even though it's a fraction of summer levels.

While testing 1990 snowmobiles last March for this month's "Snowbusters" story (page 64), I discovered that Yellowstone isn't the only snowmobile paradise in Wyoming. State agencies are finishing up a 400-mile network of trails running along the Continental Divide from Lander (southwest of Jackson) to Flagg Ranch, just outside Yellowstone.

When completed in 1990, the groomed system will run nonstop through the stunning Wind River Range and connect with trails that lead all the way to West Yellow-

stone. This area includes Wyoming's highest mountain, Gannet Peak (13,804 ft.), historic Union Pass and numerous views of the fabulous Grand Teton Range. Most of these pass through land managed by the National Forest Service, which strongly supports responsible snowmobile use.

### Happy trails

Riders on this new network (excluding portions in Yellowstone and Grand Teton National Parks) will be allowed to explore off-trail areas and enjoy throttle speed limited only by safety. Many lodges are located within the system, so overnight expeditions can be planned. For more information, call (307) 332-3892 or (307) 856-4801.

Another Rocky Mountain state, Colorado, also recently opened a network of groomed snowmobile trails (about 400 miles) in the Grand Junction/Glenwood Springs area. For information on this system, call (303) 945-6589 or (303) 963-1890.

Interestingly, the recent

horsepower wars in snowmobiling seem to be giving way to 2-up luxury cruisers and models with extended tracks, both of which are designed to capitalize on the touring boom in the West. (Extended drive tracks stay on top of the West's deep-powder trails, a characteristic called flotation.)

One of the hottest sleds for 1990, which approaches the boom from a different direction, is the Yamaha SnoSport. Many riders on the recently created trails are new to snowmobiling and looking for unintimidating, economically priced, entry-level machines.

To fill this niche, Yamaha created the compact 243-pound SnoSport. Its 125-cc, single-cylinder engine achieves a sporty 35-mph top speed and comes with an affordable \$1999 base price. Currently, Yamaha is the only game in town in this market (it also offers the smaller SnoScoot), but this probably won't last, especially if the trailblazing boom in the Wild West continues. **PM**



Yamaha's new SnoSport is powered by a 125-cc engine.



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# FREEWHEELING

BY TONY SWAN

## Spark Up Your Car Collection

**W**E'VE SEEN and heard of all sorts of car-related collectibles, but when Deane Jordan told us about the Spark Plug Collectors of America we had to admit it was a new one on us. We asked Mr. Jordan to tell us more. His report follows.

—Tony Swan

Searching for that right sparkplug? (PM considers sparkplug as one word.) You're not alone. Over 300 people are looking for a few plugs and all are members of the Spark Plug Collectors of America.

Sparkplug connoisseurs scour old garages, long-stored tool boxes, even dilapidated barns to uncover rare plugs. And even though the world's sparkplug manufacturers have produced literally millions of plugs, there are few enough collectible plugs to be found. Although there have been several thousand different brands made during the past 90 years, few were manufactured for any length of time.

Some sparkplugs that trace their histories back over several decades still sound familiar today—brands such as Champion, AC and Allis Chalmers. But some of the most interesting brand names—Bald Head, Disco, Horseshoe and Raccoon,

for example—came and went quickly.

One reason why collectors are fascinated with plugs is that their design reflects the evolution of automotive technology. Plugs were changed to meet the changing needs of the internal combustion engine. Old engine designs that employed updraft carburetors, for example, had plugs with small, valved priming cups on them, allowing the owner to drop raw gas into cold cylinders to encourage starting on cool mornings or winter days.

one of the most expensive plugs ever made. In 1920, when the average weekly salary was \$10, a set of these plugs cost \$20. It doesn't take a CPA to figure out why they disappeared from the market.

William Bond, the founder and director of Spark Plug Collectors of America, says members meet twice a year to trade stories and, of course, sparkplugs.



Plug at left dates to 1904, features integrated coil. Plug on right was used in Space Shuttle Columbia.



Benford's sparkplugs used 24-karat gold plating. Plug on right was equipped with "shorting bar."



"Visible" plugs had small windows that allowed observers to locate dead cylinders at a glance.

There were also plugs that detached easily for soot cleaning because early gasoline contained a heavy dose of oil. Some plugs had gold or platinum tips to intensify the spark. Coil plugs, for marine use, were what their name implies—each had an integrated ignition, eliminating high-tension wire connections. The manufacturer claimed it would even run underwater and the design is very similar to spark-igniters used in the Space Shuttle.

Some brands had glass viewing ports so the explosion in the cylinders could be seen, telling the viewer quickly and unmistakably whether that plug was functioning properly. The viewing plug is also

"All of us try to track down examples of the 3000-plus brands that have been produced," said Bond, an engineer in Ann Arbor, Michigan.

Bond said no particular sparkplug commands top dollar over all others but, as you'd expect, there are two or three types of plugs that generate high prices and spark interest because of their rarity.

"It's like saying what are the three rarest automobiles. You can't do it. It's a function of buyer and seller. But there are definitely rare types of plugs."

Bond said sparkplugs that command the highest price are coil plugs, quick detachable plugs and primer plugs. They can fetch anywhere from \$30 to \$400, depending upon rarity. That may sound like a

lot of money for something as ordinary as a sparkplug, but it's cheap compared to some other kinds of automotive collectibles.

Plug aficionados also collect tools that were used to install or clean the various plugs, as well as examples of packaging and advertising.

And not all the sought-after plugs are from yesteryear. Bond has a plug from an X-15 rocket plane that set a world's altitude record, and a sparkplug from the Space Shuttle Columbia.

Dues in the organization, founded in 1975, are \$15 a year for residents of Canada and the United States, \$20 elsewhere. For more information, write Bond at P.O. Box 2229, Ann Arbor, MI 48108.

—Deane Jordan



Wellman-Howe plugs had built-in mini-files that let owner clean contact points without removing.

# Save Gas, Save Engine with 'POLY'

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## 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."

TUV, a German testing laboratory with credentials every bit as prestigious as our Underwriters Laboratories, tested Slick 50 in 1986. They found substantial increases in both gas mileage and horsepower. Their tests showed that these gains were due to a reduction in friction.

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

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

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

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



## It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "Poly" between the parts where it is burned 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.

## Works with Most Oils

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)
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# BUICK REATTA

BY MICHAEL LAMM, Contributing Editor



**R**EMEMBER THIS marketing claim? "When better cars are built, Buick will build them." Buick hasn't used that line for awhile, but judging by the result of this survey, it would certainly be appropriate for the Reatta 2-seater—if for no other reason than eye appeal. The owners we queried responded overwhelmingly to Reatta's sassy lines—and the fact that they didn't see themselves coming around every corner. When all the responses were tallied, it was the Reatta's styling that impressed 88.7 percent.

Regrets? A few. But the majority of Reatta buyers were pleased with their purchases.

## Praise for workmanship

Workmanship came in for a lot of positive comment, with no one rating the Reatta below the level of good. That means no fairs or poors, which is unusual for any survey.

Buick must be making some marked improvements here, because when we surveyed Riviera owners back in 1986, 10.3 percent of the group rated workmanship just fair, while another 1.5 percent flatly called it poor. It's also interesting to note that the Reatta's workmanship rating was higher than the Cadillac Allanté (page 74, June '89).

When Reatta owners needed service, which doesn't seem to have been often, the dealers also won points for Buick. Over 85 percent of our Reatta respondents rated dealer service good to excellent. That, too, is better than the rating accorded Cadillac service departments by Allanté owners, which came in at 82.6 percent good to excellent.

More surprisingly, it's also above the 81.3 percent good-to-excellent rating for Mazda dealers in connection with the RX-7 sports car. So who says American dealers can't maintain cars?

When it came to peeves, the most annoying aspect of Reatta ownership was the car's CRT touch-screen computer command center in the middle of the dashboard. This was hardly a surprise, since about half our Riviera owners—especially older owners—hated it too.

Specific complaints centered on image washout in bright sunlight and confusion over which menu was up on the screen.

However, this particular complaint is academic as far as would-be Reatta owners are concerned, since the screen is gone for 1990.

Standard Reatta controls came in for some criticism as well. The control buttons are arranged in two tidy ver-

tical columns on the dashboard, but a number of respondents noted that using the buttons required the driver to glance away from the road. This is the same criticism that dogged the CRT command center through its brief career, although the volume of complaint is much smaller.

## Performance and handling

We got an interesting mix of owners' responses concerning the power of the Reatta's 3.8-liter V6 engine. Just over 10 percent of our respondents complained that the Reatta needed more muscle. On the other hand, 19.7 percent specifically praised its performance and 14.2 percent cited horsepower as one of the things they liked best about the car. Buick is already conscious of this dichotomy, and we expect to see a more potent engine option in future Reattas.

Ride and handling got great marks—stiff enough to provide a sporty feeling without being too hard for comfort consistent with a luxury-class car. The Reatta's antilock braking system, supplied by Teves and standard equipment on all models, also drew praise.

Although we have always regarded the Reatta's interior design as exemplary for a 2-seater, due to its exceptional volume and storage space, the



inner car did draw a little flak from owners. For example, a number of smokers suggested that the Reatta's console-mounted ashtray ought to trade places with the power-window switches on the doors.

A bigger complaint came from bigger drivers—those over 6 ft.—who couldn't get enough headroom without getting into a contortionist routine that involved lowering the

bottom cushion and reclining the seat back, which resulted in an uncomfortable driving position.

Still others wished a convertible Reatta had been available when they bought their cars. But based on our survey results, we have a feeling some of these owners may be back now that a droptop has joined the model lineup for 1990. As a group, Reatta owners seem to be happier

than the average car owner with their experience.

Good-looking, dependable, enjoyable and no hassles at the dealership. That seems to sum up the Reatta owners' experience to date. Two-thirds of our group said they'd buy a Reatta again.

It seems to be a rare kind of 2-seater—the kind you can live with on a full-time basis. **PM**

## SUMMARY OF 1989 BUICK REATTA OWNERS REPORTS\*

Total miles driven	686,378	Handling	43.7	Good	23.3	Good	36.4
Average miles per gallon:		Comfort	33.9	Average	0.0	Average	9.6
With automatic transmission		Riding qualities	32.6	Poor	0.0	Poor	5.3
In town	18.3	Performance	19.7	<b>Comfort opinion:</b>		<b>Number of vehicles owned:</b>	
On the highway	24.6	Power	14.2	Excellent	71.1%	This car only	22.6%
<b>Why did you choose the Reatta?</b>		<b>Specific dislikes:</b>		Good	27.4	Two cars	34.0
Styling	88.7%	No complaints	16.7%	Average	1.5	Three cars	23.8
Comfort	12.8	Computer display screen	13.3	Poor	0.0	Four or more cars	19.7
Price	11.7	Engine power	10.5	<b>Had any mechanical trouble?</b>		<b>Would you buy a Reatta again?</b>	
Handling	10.9	Mpg lower than expected	9.0	No	71.3%	Yes	66.8%
Made in America	10.9	Ashtray location	7.1	Yes	28.7	Maybe	27.0
It's a 2-seater	8.3	Not enough headroom	6.7	<b>What type of trouble?</b>		No	6.2
<b>Major options chosen:</b>		<b>What changes would you like?</b>		Electronic (CRT, etc.)	47.4%	<b>Would you buy a different Buick product next time?</b>	
16-way power seat	59.6%	No changes	13.7%	Electrical system	14.5	Maybe	54.2%
Power sunroof	23.8	More powerful engine	11.6	Air conditioning	10.5	No	27.3
<b>Opinion of antilock braking system:</b>		Change instrumentation	8.7	Transmission	6.6	Yes	18.5
Excellent	40.8%	Add a convertible (Convertible is available for 1990)	8.3	Power steering	5.3	<b>Principal driver:</b>	
Very good	32.9	Delete computer screen	7.1	<b>Did you repair it yourself?</b>		Male	52.5%
Good	24.2	More headroom	7.1	No	96.1%	Female	45.6
Fair	1.7	<b>How much did you pay?</b>		Yes	3.9	Equal	1.9
Poor	0.4	Average	\$24,172	<b>Dealer repairs satisfactory?</b>		<b>Age distribution of owners:</b>	
<b>Specific overall likes:</b>		Range	\$19,000-\$29,400	No	70.6%	Under 29 years	9.6%
Exterior styling	80.7%	<b>Workmanship opinion:</b>		Yes	29.4	30-49 years	45.0
		Excellent	76.7%	<b>Dealer service opinion:</b>		50-plus	45.5
				Excellent	48.8%		

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

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# Play A Disc, Any Disc

BY FRANK VIZARD, Contributing Editor

**I**F YOU like your entertainment wrapped up in a single package, then the new wave of combination disc players is for you.

Offered by several manufacturers, combi players can spin any of the various laser-optical discs available for audio and video entertainment. On the audio-only side, this includes 3- and 5-in. compact discs. From a video standpoint, this includes 5-in. CD-videos as well as 8- and 12-in. laserdiscs.

You are probably not a stranger to compact discs for music, but you might be less aware of laserdiscs as a video medium. CD-videos contain a 5-minute music video with an analog soundtrack, plus 20 minutes of digital music. Larger 8- and 12-in. discs contain more lengthy video programming, such as concerts, movies, documentaries and educational fare. Although laserdiscs have been around for years, the necessary players have been rather pricey. Hardware prices are now coming down, though, and the recent advent of combi players provides a versatility not normally found in single-purpose machines.

## Hi-fi sound

Among the latest low-priced combi players is Sony's MDP-210 (\$700, but actual retail prices will be lower). Like all combi players, the MDP-210 is larger than most audio/video components. It measures 17 x 4 1/4 x 15 1/4 in. and weighs just over 17 pounds.

The MDP-210, as you might suspect, offers the type of au-

dio performance expected of a good CD player, particularly one bearing the Sony brand. The key audio specifications claimed by Sony include impressive frequency response of 4 Hz to 20 KHz, a signal-to-noise ratio exceeding 107 dB and dynamic range exceeding 98 dB, total harmonic distortion of 0.003 percent, and channel separation of 100 dB. Audio performance is aided by 8-times, 18-bit digital oversampling with dual digital-to-analog (D/A) converters.

Listening confirms what the specifications imply: The MDP-210 is a fine-sounding machine. Laserdisc players often have been criticized for using audio technology one or two years behind the times. That's certainly not the case with the MDP-210.

In addition to outstanding audio performance, the MDP-210 offers outstanding video images, displaying up to 425 lines of horizontal resolution. And it offers a range of special features depending on whether Constant Angular Velocity (CAV) or Constant Linear Velocity (CLV) discs are being used.

## Special effects

CAV discs offer 30 minutes of playback per side, and generally include a host of special-effects possibilities. "FX" like freeze-frame, frame-by-frame playback and fast playback are sacrificed on CLV discs in favor of getting 60 minutes of audio/video information per side. Still, special effects can be obtained on CLV discs when they are played in expensive combi players that have additional digital memory capacity.

CLV discs are becoming the predominant form of videodisc due to their space-saving characteristics. Despite its low price, the MDP-210 does sport a variety of indexing and accessing features appropriate for CLV discs.

## Fun with films

In the CLV release of Brian DePalma's "The Untouchables," for example, goofs-and-gaff fans might want to access the 50-second scene in which the top button of Sean Connery's shirt seems to open and close of its own spooky volition. More serious film fans may want to directly access

the scene involving a baby carriage on the train-station steps, which pays homage to a similar scene in the classic silent movie "Potemkin" directed by Russia's Sergei Eisenstein. Fans of Alfred Hitchcock will notice that there's more than a nod and wink in his direction as well. Either way, each scene can be bracketed by the MDP-210 for repeated viewing. CAV discs, of course, can be played on the MDP-210 with all the special effects that are available on such discs.

When the movie is over, just turn up the lights and pop in a CD for audio-only playback. Versatility like this is generally found only among utility players on baseball teams.

## Late News

A compromise between hi-fi manufacturers and the recorded music industry has cleared the way for the sale of digital audio tape recorders (DAT) in the U.S. and elsewhere. For details on the redesigned DAT decks, see the "Electronics" column on page 32 in this issue. **PM**



Sony's MDP-210 plays digital audio CDs or laser videodiscs of any size, with many video special effects.

# Cocaine lies.

After nearly a decade of being America's glamour drug, researchers are starting to uncover the truth about cocaine.

It's emerging as a very dangerous substance.

No one thinks the things described here will ever happen to them. But you can never be certain. Whenever and however you use cocaine, you're playing Russian roulette.

## **You can't get addicted to cocaine.**

Cocaine was once thought to be non-addictive, because users don't have the severe *physical* withdrawal symptoms of heroin—delirium, muscle-cramps, and convulsions.

However, cocaine is intensely addicting *psychologically*.

In animal studies, monkeys with unlimited access to cocaine self-administer until they die. One monkey pressed a bar 12,800 times to obtain a single dose of cocaine. Rhesus monkeys won't smoke tobacco or marijuana, but 100% will smoke cocaine, preferring it to sex and to food—even when starving.

Like monkey, like man.

If you take cocaine, you run a 10% chance of addiction. The

risk is higher the younger you are, and may be as high as 50% for those who smoke cocaine. (Some crack users say they felt addicted from the *first time* they smoked.)

When you're addicted, all you think about is getting and using cocaine. Family, friends, job, home, possessions, and health become unimportant.

Because cocaine is expensive, you end up doing what all addicts do. You steal, cheat, lie, deal, sell anything and everything, including yourself. All the while you risk imprisonment. Because, never forget, cocaine is illegal.

There's no way to tell who'll become addicted. But one thing is certain.

No one who is an addict, set out to become one.

## **C'mon, just once can't hurt you.**

Cocaine hits your heart before it hits your head. Your pulse rate rockets and your blood pressure soars. Even if you're only 15, you become a prime candidate for a heart attack, a stroke, or an epileptic-type fit.

In the brain, cocaine mainly affects a primitive part where the emotions are seated. Unfortunately, this part of the brain also controls your heart and lungs.

A big hit or a cumulative overdose may interrupt the electrical signal to your heart and lungs. They simply stop.

That's how basketball player Len Bias died.

If you're unlucky the first time you do coke, your body will lack a chemical that breaks down the drug. In which case, you'll be a first time O.D. Two lines will kill you.

## **Sex with coke is amazing.**

Cocaine's powers as a sexual stimulant have never been proved or disproved. However, the evidence seems to suggest that the drug's reputation alone serves to heighten sexual feelings. (The same thing happens in Africa, where natives swear by powdered rhinoceros horn as an aphrodisiac.)

What is certain is that continued use of cocaine leads to impotence and finally complete loss of interest in sex.

## **It'll make you feel great.**

Cocaine makes you feel like a new man, the joke goes. The only trouble is, the first thing the new man wants is more cocaine.

It's true. After the high wears off, you may feel a little anxious, irritable, or depressed. You've got the coke blues. But fortunately, they're easy to fix, with a few more lines or another hit on the pipe.

Of course, sooner or later you have to stop. Then—for days at a time—you may feel lethargic, depressed, even suicidal.

Says Dr. Arnold Washton, one of the country's leading cocaine experts: "It's impossible for the nonuser to imagine the deep, vicious depression that a cocaine addict suffers from."

**Partnership for a Drug-Free America**

# High-Speed Hauler

BY LEN FRANK



Driving a modified GMC S-15 Jimmy Club Coupe, Don Stringfellow broke a Bonneville speed record previously held by a Porsche 928S 4.

**O**N AUGUST 7, 1986, the late Al Holbert drove a new Porsche 928S 4 complete with stereo cassette deck and catalytic converter from Porsche's headquarters in Reno, Nevada, to the Bonneville Salt Flats just east of Wendover, Utah.

There he drove 171.926 mph through the kilometer, 176.110 through the mile, a 2-way average that established new world FIA-sanctioned records for Category A, Group II, Class 9 vehicles.

If we are to believe the TV commercials, Holbert did it while listening to classical music on the cassette player—Wagner's "Ride of the Valkyries" would have been appropriate. Then, the story goes, he drove back to Reno.

On the afternoon of July 20, 1989, a GMC S-15 Club Coupe (GMC's version of the extend-

ed cab pickup), driven by Don Stringfellow, went down the salt and back at 194.843 mph for the kilometer, 194.770 for the mile and took the record.

Since straight-line speed is a function of horsepower trying to force a vehicle through the air and drag it over the ground, increasing horsepower, decreasing the vehicle's frontal area, reducing coefficient of drag ( $C_d$ ), and/or reducing rolling resistance and chassis friction, makes the vehicle go faster.

The most successful efforts, of course, include all of the above, and it was all of them that GMC's Advanced Vehicle Engineering group (AVE) applied to the S-15.

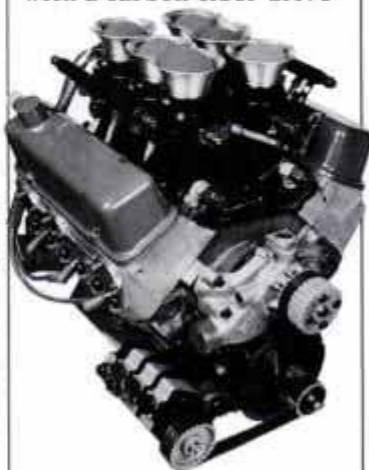
Air drag is the hard one—power requirement goes up as a square of the speed. The stock S-15 has a top speed of about 100, so to get it to go almost 200 takes four times the

power. But if you reduce air drag, requirements drop off by that same square. The rules require a stock body. The Club Coupe has less drag than short cab trucks and that small advantage was aided by some of the S/T package trim pieces—primarily the front spoiler. Major reductions in drag came from lowering and changes in rake—slightly nose down (achieved by Bell Tech dropped spindles)—and in taking care of the air that spills over and around the cab.

A tonneau box at the rear of the bed helps take care of that spilled air. It reduces drag more than a full tonneau cover, or running with the tailgate down, and it hides some interesting hardware. The result, determined in GM's own wind tunnel, reduces drag nearly 40 percent from stock.  $C_d$  is now 0.31, down from 0.49, and frontal area is slight-

ly reduced by the lowering.

Rolling resistance was cut by removing the front brakes entirely, replacing the transmission with a Weissman racing 5-speed, the rear axle with one from Strange Engineering, and connecting the two with a carbon-fiber drive-



Stock 4.3-liter V6 was expanded to 5.0 and 523 horsepower.

shaft. The trans has an almost infinite number of quick-change ratio combinations—both trans and axle have less internal drag (and more noise) than stock. Driveshaft U-joint angles were kept as straight as possible and front toe is at the minimum for rolling drag.

The stock GMC 4.3-liter V6 (160 hp at 4000 rpm) has been replaced by a racing version of same built by Katech, best known for its GM-based road racing engines. The engine was developed by AVE and Katech, and begins with the cast-iron "Bowtie" heavy-duty block. Unlike the even-fire production engine, the Bonneville version uses a Moldex odd-fire crank, with Oliver steel billet rods connected to Diamond Racing Product pistons. Heads are Brodix aluminum—compression is up to 12.6:1 (stock 9.3:1). Both bore and stroke have been increased and displacement is up from 262 cu. in./4300 cc to 301/4939.

A steel billet roller cam setup by Competition Cams is combined with Iskenderian lifters, Falconer needle bearing rockers, a Katech rev-kit and titanium valves—all standard hot-rod stuff.

Intake is by a road race-based Kinsler fuel-injection manifold and throttle assembly, combined with AC Rochester injectors, fuel pump and fuel regulator. Ignition is a Delco CD unit, and engine management is by a Delco Generation II ECM, monitoring throttle position, intake plenum, air temp, coolant temp, crank position and engine speed—somewhat simpler than its passenger car application. It sets ignition timing, injection timing and injection volume.

Bonneville is over 4000 ft. elevation, ambient temperatures are high and both conditions are the death of horsepower. Some of it is recovered by a system that starts with an ice chest hidden under the tonneau box in the rear—a pair of electric bait pumps circulate ice water through a pair of converted Harrison a/c evaporators mounted behind the grille. Intake air is drawn through them, cooled and made more dense, fooling the engine into thinking it's running at lower altitude.

On the record run, underhood air temp was 116° F, while intake air was lowered to 86° F. Cooling water temp went from a chilly 42° to a tepid 64°—the system works. The result of this combination of standard hot-rod hardware and sophisticated electronic control and induction is a reliable 523 hp at 6800 rpm, and 414 lb.-ft. of torque at 6400.

A second engine has been built to tackle SCTA national truck records, similar in most respects to the 5-liter but displacing 4.26/260 to fit the class. The smaller engine is rated at 470 hp at 7800 rpm.

Skinny (23x5x15) Goodyear Drag Front Runners are teamed with Stock Car Specials in the rear, Cragar wheels on the front, Weld wheels rear, covered by Moon discs to lower drag.



Club Coupe had room for electronics behind seat, lower drag coefficient than short cab.

All factors that control state of tune, engine condition, wheelspin, speed, weather conditions, aerodynamic lift, are monitored and relayed back to a special telemetry van so that corrections can be made, information gathered and analyzed, and disasters averted. Ironically, the system failed to work on the record runs. A magnetic field generated by the salt itself was suspect, and AVE/Delco

will look into better shielding for the future. A similar system was developed by Delco/Powell Motorsports and has worked successfully for some years.

Although pleased with the record, GMC still has its eyes on the 200-mph mark for the truck. But even if that goal is never achieved, this is one Jimmy that can legitimately claim membership in the supercar club. **PM**

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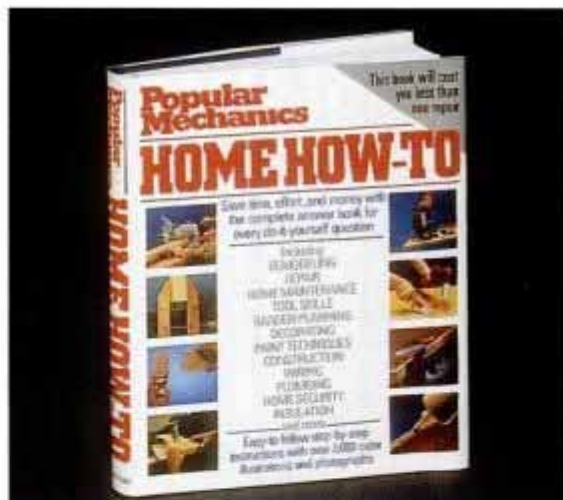
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AUTOMOBILES

# CIVIL WAR

Ford Taurus and Chevy's new Lumina battle for All-American sedan supremacy.

BY TONY SWAN, Automotive Editor; PM Photos by Bill Ashe

**T**HE COMBATANTS are new, but the basic conflict goes back generations. Taurus versus Lumina. Ford versus Chevy. Although other brand names have figured in this ongoing struggle for the center of the U.S. marketplace, these two makes have pretty much defined the character of the mainstream American sedan for more than 75 years. And they continue to do so today.

Although the contest has been unrelenting, this road test recognizes a resurgence on the Chevrolet side of the field—a rather tardy counteroffensive. When the Taurus swept triumphantly onto the scene in late 1985, Chevy's Celebrity sedan became an instant also-ran.

It's taken this long for the Celebrity's more contemporary successor to get into the fray.

Naturally, we were anxious to see how effectively Chevrolet had employed those four years.

Chevy has had new 1990 Luminas motoring around since last summer, since it's GM's policy to dedicate the early part of a new-car build to rent-a-car and other fleet sales. The timing of our late-summer test wasn't ideal for Ford, however. Our request for a Taurus tester caught Ford right between model years, and even though there's very little change between Taurus '89 and Taurus '90, our friends in Dearborn were anxious to have us test the new car. A few weeks' wait and



## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE: LIST/ AS TESTED	ENGINE/ DISPLACEMENT (cu. in./cc)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in./mm)	LENGTH OVERALL (in./mm)	WIDTH OVERALL (in./mm)	TRACK FRONT/REAR (in./mm)
<b>Chevrolet Lumina Euro Sedan</b>	\$14,240/ \$16,261	V6, pushrod OHV 191.0/3130	front/ front	4-speed automatic	107.5/ 2731	197.6/ 5019	71.0/ 1803	F: 59.5/1511 R: 58.0/1473
<b>Ford Taurus LX</b>	\$16,180/ \$17,115	V6, pushrod OHV 182.0/2982	front/ front	4-speed automatic	106.0/ 2692	188.4/ 4785	70.8/ 1798	F: 61.6/1565 R: 60.5/1537

\* ABS system optional equipment.

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

we were in business. The two test cars were as evenly matched as we could make them. Powertrains were virtually identical and both cars had a goodly array of comfort and convenience features.

Although both Taurus and Lumina are available with 4-cylinder engines, we chose V6 editions, and opted for upscale models. In Lumina this means the Euro model, with 3.1-liter V6 and 4-speed overdrive automatic.

The upscale Taurus is the LX model, and our test car had the 3.0-liter V6 engine and 4-speed automatic.

### Lumina Euro Sedan

The real Lumina news for this fall is the coupe, but since Ford refuses to produce a Taurus coupe, we matched up two 4-doors.

The Euro sedan carries some exterior trim differences—blackout grille, body-colored moldings, mirrors and rear deck spoiler—but there are functional distinctions as well. Included are stiffer suspension components, and fatter 195/70R15 tires. Euro-model buyers can opt for 215/60R16 tires on handsome 16-in. alloy wheels, which were part of our test car's equipment list.

Inside we found nicely contoured bucket seats, a leather-wrapped sport steering wheel with tilt feature, central locking, power windows, an AM/FM/cassette sound system and air conditioning—all Euro standards.

As an engineering package, this car holds few surprises. It's the GM-10 platform—Buick Regal, Pontiac Grand Prix and Oldsmobile Cutlass Supreme. Front suspension is independent struts and at the rear there's a single transverse composite leaf spring, à la Corvette. All models get 4-wheel disc brakes—a plus versus the basic Taurus.

### Ford Taurus LX

The car that once caused Ford to hold its corporate breath has become a familiar sight, but still manages to look new, without any styling changes.

The chassis is also carryover—independent struts at all four corners. Unlike Chevy, Ford offers only one level of suspension tuning, save for the 220-hp SHO model.

However, there are a couple of significant changes for Taurus in the safety area. Foremost on this list is ABS braking, standard for the SHO, optional on models with 4-wheel disc

brakes, including our LX test car. There's also a driver's airbag and a knee bolster to go with it.

Ford has also extended the front seat tracks and revised the instrument panel. A tilt-adjustable wheel is now standard and speed-sensitive power steering is available.

### On the road

Neither of these cars, as tested, is particularly quick. However, the Lumina did have a decided edge in our acceleration runs, a statistic that pays dividends in reduced passing expo-



GM-10 platform and Euro suspension make Lumina an agile slalom performer. Dashboard seems borrowed from another era. Port-injected 3.1 V6 gives good jump off the line.



## TEST RESULTS

CURB WEIGHT (lbs.)	STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (EPA city/PM test)	ACCELERATION 0-60 MPH (sec.) ¼-MILE (sec @ mph)	BRAKING 60-0 MPH (ft.)	700-FT. <sup>1</sup> SLALOM (mph)	SKIDPAD <sup>2</sup> 200-FT. CIRCLE (G)	EPA <sup>3</sup> INTERIOR VOLUME (cu. ft.)
3122	Power R&P/2.9	F: 10.47-in. vented disc/ R: 9.99-in. disc	19/ 24	10.5 17.7 @ 76.9	136	54	.79	97
3095	Power R&P/2.5	F: 10.0-in. vented disc/ R: 10.0-in. vented disc, ABS*	21/ 25	11.8 18.6 @ 75.1	149	52.4	.76	100.1

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

sure times. Taurus has a couple of cures for the slows, though, in the form of additional engine options—the torquey 3.8-liter V6 or the hot-rod SHO model. Additional engine options are still a year away for Lumina.

On the skidpad and handling course, things were much closer. There is no optional suspension package for the Taurus while our test Chevy had the optional Euro Sedan suspension. The higher spring and shock rates, fatter stabilizer bars and wider 16-in. wheels and tires made a marginal difference here in the Lumina's favor.

Our braking tests put the Chevy way ahead of the Ford with stops from 60 mph averaging 13 ft. shorter.

Numbers aside, though, the most interesting thing that came across for our testers was how different these two cars feel.

Part of this has to do with interior appointments and ergonomics. Our reaction to the Lumina's interior could be characterized as indifferent. We liked the seating, but we weren't impressed with the quality.

Similarly, the styling of the instrument panel, compressed into a narrow

horizontal strip, would be more at home in a '70s-era car. Control location is average—the power window controls in particular, set into the forward surface of the armrests, came in for criticism.

The Taurus has had good marks in these same areas since its introduction, and compares well versus the Lumina, though the Lumina seating provides better lateral support.

Both cars measure up well in front seat roominess, but rear seat passengers may feel a trifle cramped. The dimensions are very similar, and trunk space is generous in both cars.

The Taurus is quieter than the Lumina, partly because of the Lumina's sporty induction noise, partly because it generates more wind noise. The Taurus also gets our nod for ride quality. "Substantial" and "solid" were two words that kept recurring among our testers in this regard.

These cars aren't especially handy in tight places. Though their steering is quick—only 2.5 turns lock-to-lock for the Taurus—turning circles are sizable. The Lumina gets slightly better grades for visibility, thanks to its more generous greenhouse, but neither car has any real blind spots.

### Testers' choice

Because of its substance, overall design and the availability of optional engines, we give our nod to the Taurus. You don't have as much flexibility when ordering a Lumina, although more engine options are coming.

If you value sporty feel and superior road handling more, then the Lumina could be your choice.

There's no question that both are thoroughly competent cars. But right now, in the ongoing battle for All-American sedan honors, Ford still holds the high ground. **PM**



Taurus handling conveyed sense of solidity to test crew. Instrumentation is new for 1990, as is driver's airbag and knee bolster. Vulcan 3.0 V6 gave Taurus acceleration honors.

# 21st CENTURY TV

High-Definition Television is coming. And with it, widescreen viewing, film-quality pictures and digital surround sound.

BY STEPHEN A. BOOTH, *Electronics Editor*

**T**HE QUARTERBACK is gasping for breath—and so are you. You're on the edge of your seat, but the seat of his pants is on the turf. What you've got in common is surprise: Part of the sack's violence is its shocking suddenness. One moment, the passer is looking for daylight to find his receiver. The next moment, some blitzing defenseman emerges from nowhere and knocks the daylights out of him.

The quarterback doesn't see the hit coming and usually, if you're watching on TV, neither do you. Someday you will—and it won't be hindsight. You'll be able to see the entire play unfold in the widescreen perspective of High-Definition Television.

Experimental transmissions of High-Definition Television (HDTV) are well underway, and the screens for displaying it are in the works.

Last year, Japan's public TV system, NHK, used satellites to convey HDTV coverage from the Olympics in Seoul. This summer, visitors at the Berlin Audio/Video Fair got a glimpse of the pan-European Eureka project—supersharper TV images delivered by satellite to widescreen tubes and projection monitors. In the U.S., various forms of HDTV have been demonstrated privately and publicly. Clearvision, the first stage of Japan's Hi-Vision system, hits the airwaves next year, and the 1992 Barcelona Olympics is the goal for Europe's HDTV kickoff. But as for the U.S. gameplan, the players are still in the huddle.

## Many points of view

Though the very words suggest precision and clear-sightedness, the trouble with HDTV is defining it. Like the parable of the blind men and the elephant, there are different conceptions of what HDTV should be. This makes it hard to determine *when* it will be.

To strategic planners at NASA or

the Pentagon, HDTV connotes enhanced electronic images from outer space, or flat-panel video displays for the constricted space of aircraft cockpits. To futurists in the nation's think tanks, HDTV means all manner of interactive computer environments for industry, education and the home.

These viewpoints and others are primarily concerned with the image resolution and physical makeup of the actual video display—not the transmission of prime-time programs. As such, their area of concern ought to be labeled high-definition or high-resolu-

what High-Definition TV will be.

These include broadcasters, cable operators, telecommunications companies, electronics manufacturers—and the Departments of Commerce and Defense. Congress and the Administration have convened ongoing studies. Meanwhile, the Federal Communications Commission has begun evaluating several proposed HDTV systems, with the goal of setting standards for the nation.

## Home cinema

In terms of what the TV viewer will see, there is some consensus as to what HDTV should be. What differs is the technical means by which it will be transmitted and displayed.

Almost every proposed HDTV system—seven to 20 at last count—widens the screen display. Today's boob-tube has width-to-height proportions of 4-to-3. This ratio was established in 1941 by the National Television System Committee (NTSC).

HDTV would expand the aspect ratio to 5.33-to-3, usually expressed as 16-to-9. This is about the width-to-height proportions of a Cinemascope-type movie screen. It means home viewers will see the same film as theatergoers—instead of a TV version that's been cropped off at the sides. It also means wide-aspect HDTV cameras will capture more of the action at live events—like that linebacker's approach to the quarterback for the sack.

## Improved resolution

While HDTV aspires to cinematic grandeur, it also promises film-like image quality. Every proposed system calls for increasing the number of vertical scanning lines that make up a TV picture. Instead of the flicker inherent in today's picture, televised images would appear seamless.

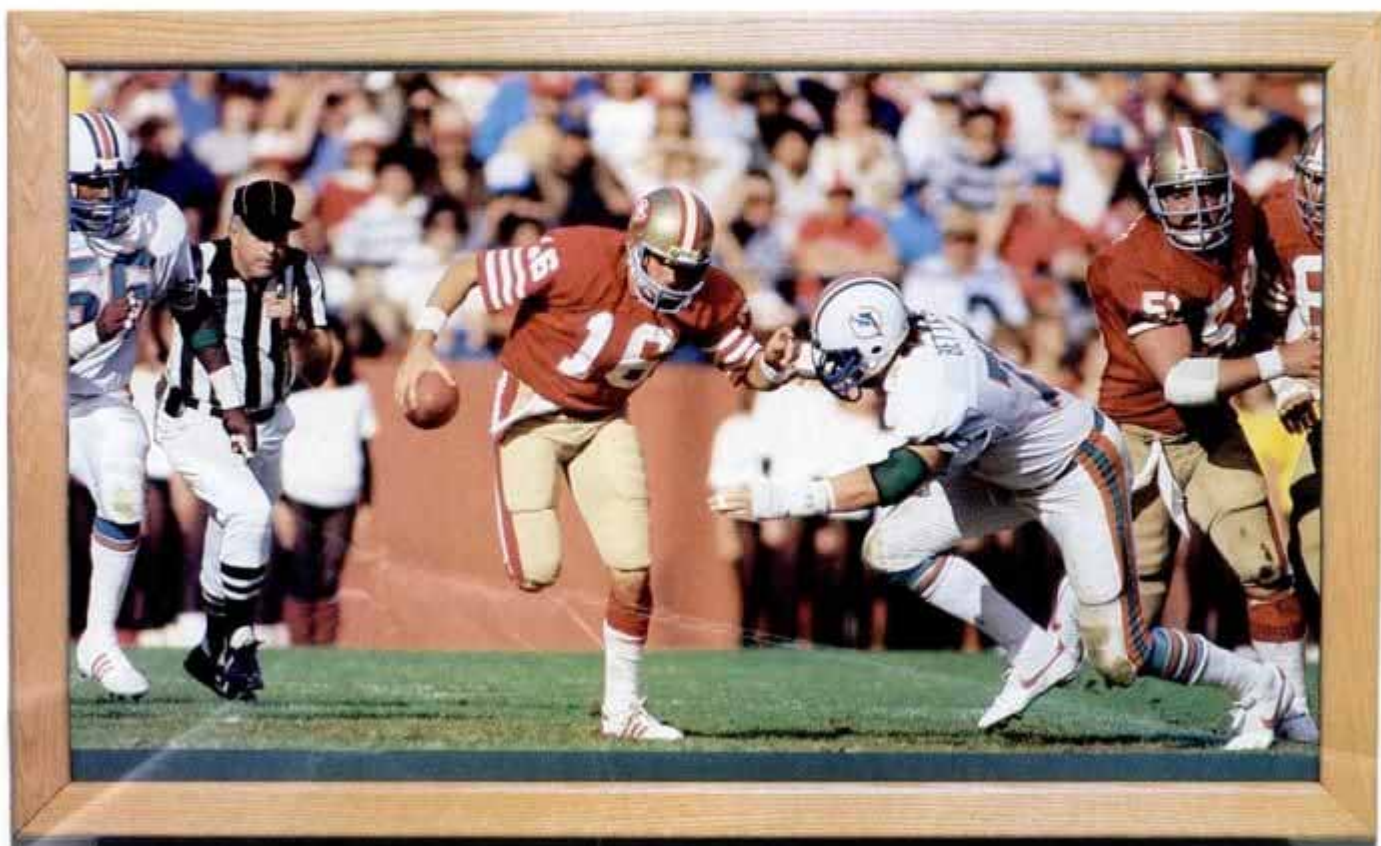
Under the current NTSC system, each TV frame is composed of two interlaced fields of 262.5 lines, for a to-



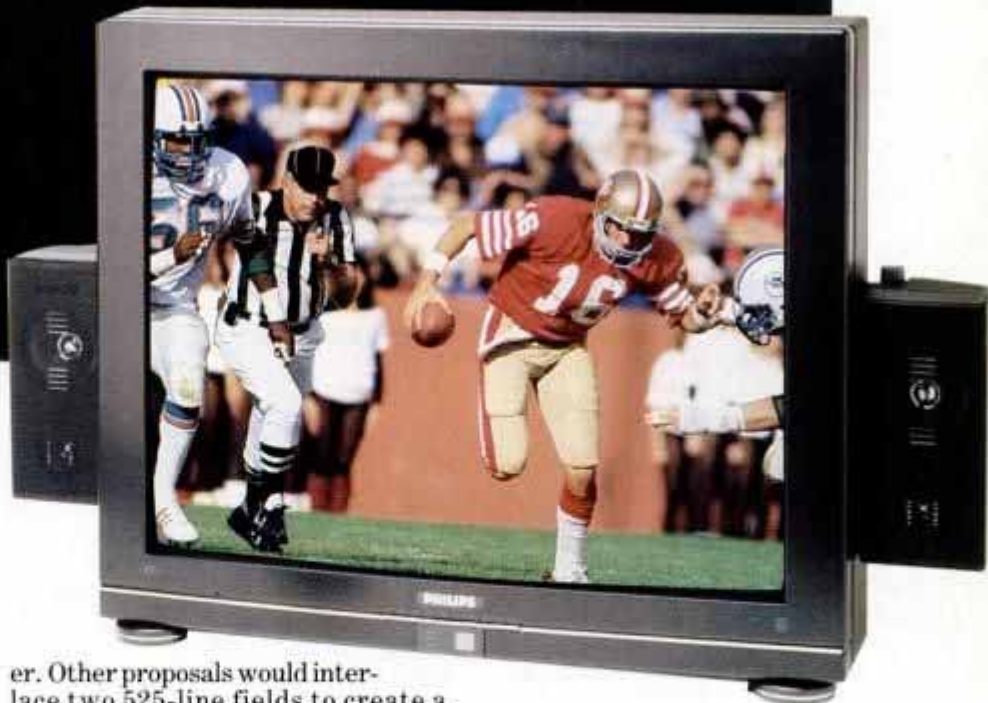
Ready for HDTV: Thomson's 16-to-9 format TV with 34-in. widescreen tube debuts in Europe next fall. It also can display four regular TV shows, as above.

tion *video*, to avoid confusion with the issue of an advanced broadcast format for "Monday Night Football."

Trouble is, HDTV has become a *political* football in the U.S. It encompasses a bewildering variety of issues, everything from the nation's military preparedness to its economic competitiveness abroad. As such, many interested parties want a say in



PHILIPS



The quarterback didn't see the sack coming, but home viewers will when widescreen, High-Definition TV arrives. Prototype HDTV projection set by Philips (above) measures 62 in. diagonally. But its width-to-height ratio is 16-to-9, proportionately one-third wider than the 4-to-3 ratio of today's TVs (illustrated at right by Philips' current 31-in. tube set). HDTV sets will yield movie-film sharpness too, by improving the structure of TV's vertical scanning lines.

tal of 525 lines. To convey motion, the fields are alternately updated every  $\frac{1}{60}$  of a second, creating a new frame every  $\frac{1}{30}$  of a second.

The proposed HDTV systems would upgrade vertical resolution in different ways. Some call for the progressive scanning of the 525 lines every  $\frac{1}{60}$  second, thereby eliminating the interlacing and its resulting flick-

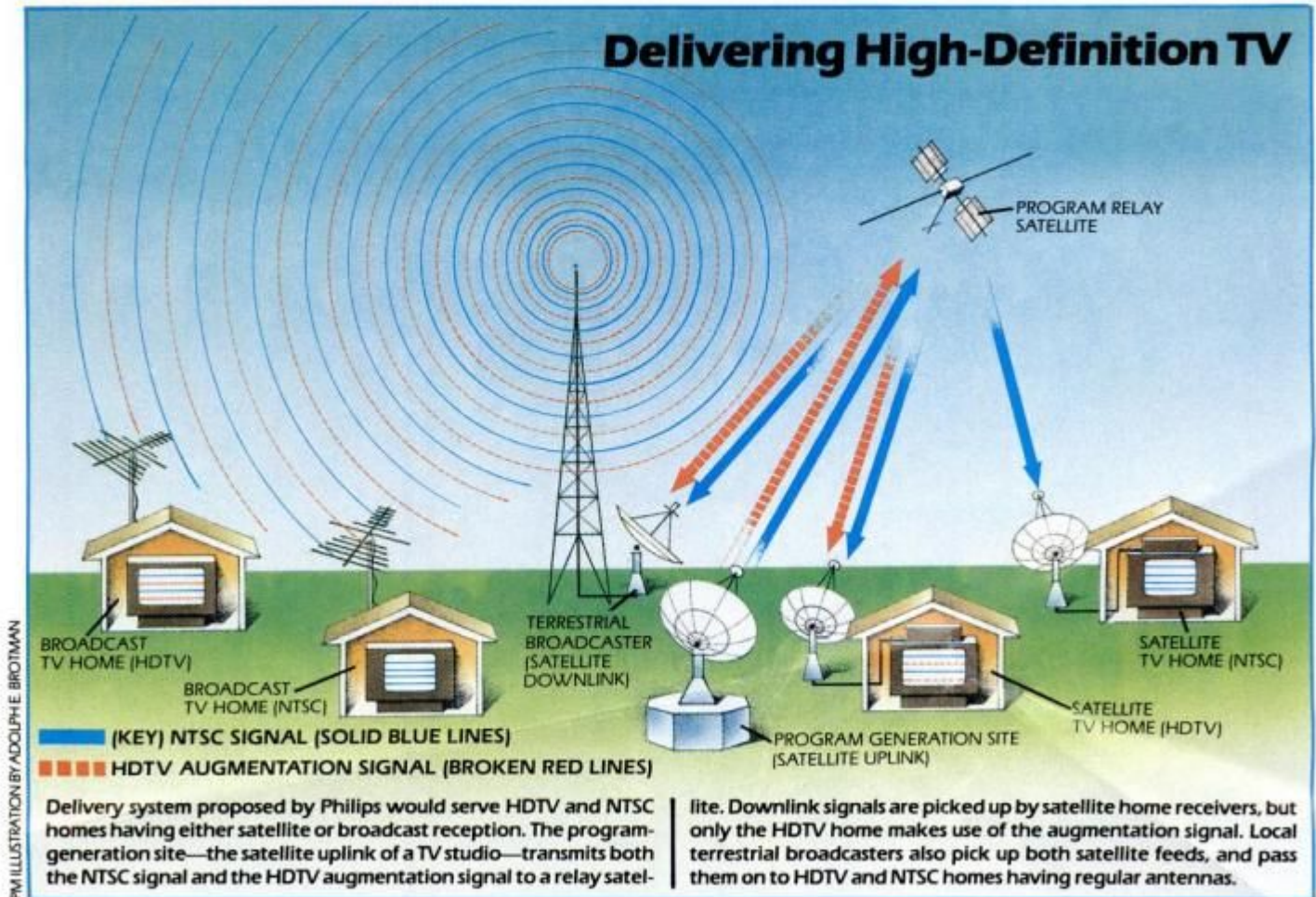
er. Other proposals would interlace two 525-line fields to create a 1050-line frame. These so-called line-doubling schemes also deliver finer resolution, and use signal processing to eliminate any flicker.

#### Better color, CD sound

While they improve vertical resolution by increasing the scan rate,

HDTV systems also promise enhanced horizontal resolution. Although the HDTV screen is one-third wider than NTSC (5.33-to-3 versus 4-to-3), all HDTV proposals would deliver more picture elements, proportionately, from left to right on each scanning line. This would be

## Delivering High-Definition TV



FM ILLUSTRATION BY ADOLPHE BROTMAN

achieved by packing the pixels more densely than is done today.

Brighter pictures, more intense color and a lack of color bleeding are also among HDTV's attributes. These feats would be accomplished by transmitting and processing the different signals separately, instead of multiplexing them as NTSC does.

Finally, because research has established that the perception of sound enhances human vision, all HDTV proposals call for digital audio with compact-disc quality—four channels of it. This would permit the addition of surround-sound effects to supplement a 2-channel stereo image emerging from the screen area.

### The challenge

All that HDTV promises is within the grasp of technology. The mathematical formulas and the physical hardware are doable. The problem, at least for over-the-air HDTV, is limited space in the broadcast spectrum.

All the various forms of communications place a great demand on airspace, which is in finite supply. Conveying all the extra video and audio information that HDTV would carry requires more frequency bandwidth than the current NTSC signal.

In fact, one reason why Japan and Europe are close to implementing

HDTV is because neither system uses over-the-air terrestrial broadcasting. Instead, the HDTV signals will be delivered exclusively via direct-broadcast satellites to small home-receiving dishes. In essence, this means Japan and Europe each will have two incompatible TV systems: conventional, terrestrial broadcast TV, and a satellite-delivered HDTV signal accessible only to those homes equipped to receive it.

### Compatibility

In the U.S., there already exists an extensive, and privately owned, terrestrial broadcast system. Besides over-the-air telecasting, an extensive cable TV system serves U.S. homes. Also in place are an estimated 160 million TV sets, capable of receiving only NTSC signals. Currently, there is no private, commercial direct-broadcast satellite system in the U.S. Accordingly, terrestrial broadcast is the most likely avenue for future HDTV transmissions.

The Federal Communications Commission makes the rules for all forms of broadcast communication, and is the authority that allocates space in that finite supply of broadcast frequencies. Last September, the FCC laid the ground rules for HDTV broadcasts.

Although it did not rule out alternate means of HDTV delivery (such as satellite and fiberoptic cable), the FCC did move to protect the nation's investment in broadcast equipment and home TVs by ruling that any over-the-air HDTV delivery must be compatible with the current NTSC system. In practice, this applies to cable TV too, since CATV systems depend on terrestrial broadcasters for much of their programming.

What compatibility means is that any HDTV signal from a transmitter must be receivable by conventional NTSC sets—though in conventional format, not HDTV quality. Theoretically, broadcasters would be free to transmit one NTSC signal (for existing receivers) and, on another channel, simulcast an HDTV program for advanced sets—but not really. This is because the FCC "urged" HDTV developers to stay within the bandwidth of two NTSC channels.

### Tight fit

Currently, each NTSC channel occupies 6 megahertz (MHz) of bandwidth. Apparently, then, because an HDTV signal needs more than 6 MHz, a broadcaster could not simulcast NTSC and HDTV channels.

That is, not unless the HDTV system somehow compressed the extra

video and audio information within 6 MHz, and used this channel to supplement the basic information already being transmitted on the NTSC broadcast. This is precisely how the various HDTV developers propose to deliver the big picture through the constricted pipeline.

The HDTV delivery systems proposed by North American Philips, Zenith and ACTV are representative of the clever compression schemes the FCC soon will evaluate. For the record, ACTV stands for Advanced Compatible Television, a consortium that includes Thomson Consumer Electronics (RCA and General Electric), NBC and the David Sarnoff Research Center. North American Philips (NAP) comprises the Magnavox, Philips and Sylvania brands.

### No more taboos

Although each of the three proposed systems achieves different degrees of high definition and delivers it in different ways, all use the so-called taboo channels for the HDTV component of the broadcast.

Taboo channels are the unused ones between two active channels in any city. In New York, for example, the FCC does not allocate the frequencies between Channels 2 and 4. What would be Channel 3 is left unoccupied, to prevent the possibility of interference between adjacent channels. Here's how the three HDTV proposals would break the taboo.

■ NAP's High-Definition System for North America (HDS/NA) would send a regular NTSC broadcast on one 6 MHz channel. All the extra information that makes up the HDTV signal (additional screenwidth and vertical resolution, and digital audio) is compressed to 3 MHz and transmitted in the 6 MHz taboo band. This means two TV stations, say Channels 2 and 4, could share the taboo channel between them to send HDTV. Conventional NTSC sets pick up the NTSC signal and ignore the compressed HDTV information. New HDTV sets would combine the NTSC channel information with the extra information in the taboo or augmentation channel.

■ Zenith's Spectrum-Compatible HDTV system uses digital compression to alter the way a TV signal is broadcast. Normally, the low-frequency portion of the video signal (below 200 kilohertz) requires most of the power needed to broadcast. The remainder of the broadcast—frequencies above 200 KHz—uses only 1 percent of the transmission power. Zenith compresses the low frequencies digitally, so that the entire broad-

## Seeing The Whole Picture

ISSUES OF FINER resolution aside, the most tangible benefit people will first perceive in HDTV is the wider onscreen image.

Conventional TVs have width-to-height proportions of 4-to-3. Theatrical movies, though, are filmed with a wider aspect ratio—as much as 2-to-1. Accordingly, movies shown on TV must be cropped to fit the narrower screen, and home viewers miss some of the scene. The alternative, called letterboxing, keeps the movie's width but puts a smaller picture on the screen, with black bars above and below.

When cropping for TV (or prerecorded video) is done indifferently, an equal area on each side of the scene is simply lopped off. This is most evident in the title frames, where the beginnings of words on the left and ends of those on the right are missing.

A more thoughtful, conscientious form of cropping is called pan-and-scan. Here, a technician using a joystick-like controller follows the action on the original widescreen version, and frames the "de-scoped" 4-to-3 scene for the best possible presentation.

The Philips HDS/NA system provides for pan-and-scan techniques, so that owners of older 4-to-3 sets do not receive merely a cropped-off version of the wider HDTV signal. This applies to live TV as well as canned movies. For example, when a wide-aspect HDTV camera is used at a football game, a technician would pan-and-scan the live image to make sure that key actions can be viewed in the 4-to-3 format.

—S.A.B.



Proposed HDTV screen (below) is one-third wider than a conventional NTSC set (above), but is the same height. Because the wider HDTV display has proportions similar to Cinemascope-type movie-theater screens, the HDTV side panels will accommodate the parts of scenes that are cropped away to fit today's 4-to-3 television screens.



cast requires only 10 percent of the power normally used to transmit an NTSC signal to the same geographic area. This drastic reduction in radiated power, according to Zenith, virtually eliminates the possibility of interference between adjacent TV channels. Accordingly, broadcasters can use the taboo band to simulcast HDTV information. Circuitry within the new receivers would add the extra HDTV information to the regularly transmitted NTSC program.

■ The ACTV consortium's proposal for HDTV takes an evolutionary approach, in two acts. In the second stage, two 6 MHz channels are used to elevate the system to true high definition. But while the world waits for ACTV-II, the consortium's ACTV-I system would offer widescreen viewing with somewhat enhanced definition of NTSC. Basically, the extra screenwidth and some picture improvements are compressed and transmitted along with the conventional 6 MHz NTSC signal. New, widescreen ACTV-I sets pick up and display the extra information. Conventional NTSC sets ignore it—though ACTV claims even older sets will benefit from the sharper ACTV-I signal. The intriguing aspect of ACTV-I is the possibility of widescreen TV today—without waiting

for HDTV standards to be set. Coincidentally, the Thomson part of the consortium already has demonstrated working, 34-in., 16-to-9 aspect widescreen tube sets. The company plans to sell them in Europe next fall, priced at about \$5000. Philips plans to begin European sales at the same time.

### What's playing?

Until true widescreen programming becomes available—in Europe or elsewhere—the widescreen set Thomson demonstrated in Berlin uses digital magic to make the most of what's available.

For example, programs broadcast or recorded on videotapes and discs in the 16-to-9 letterbox format can be displayed full-screen—without the usual black bars above and below the picture. Conversely, standard 4-to-3 aspect pictures can be cropped top and bottom to fill the widescreen. Or, the screen space not used by a 4-to-3 picture can be filled with three smaller pictures stacked on one side of the main image.

If the prospect of watching four football games at once doesn't thrill you, consider the alternative: More than one TV engineer has half-jokingly described a "woodgrain" computer chip to fill in the sides of the wide screen until true HDTV arrives. **PM**

OUTDOORS

# SNOWBUSTERS

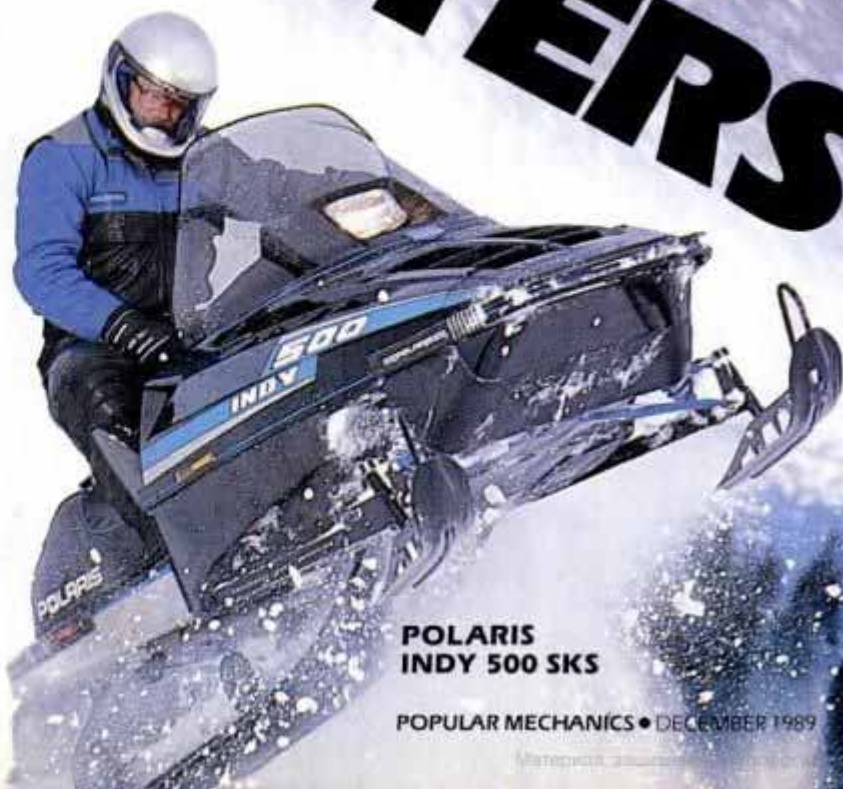
White-knuckle performance and high-tech cruising converge as we attack winter's high country on four slick new sleds.

BY CHARLES PLUEDDEMAN  
PM Photos by Rich Cox

**B**LASTING THROUGH deep-powder drifts and carving graceful arcs on snow-covered meadows was the dream of every frost-belt teenager in the 1960s. My first sled was a 1966 Ski-Doo Olympic powered by an unshrouded single-cylinder, air-cooled, 14-hp engine with a heavy steel chassis and steering skis suspended by leaf springs. It was noisy, fumey and the sparkplug fouled constantly. But its top speed was about 40 mph and it seemed to me the best way ever invented to beat winter-induced cabin fever.

Not surprisingly, snowmobiles have advanced light years since then. During a 1990 preview last March, on 10,000-ft.-high trails near Wyoming's Grand Teton Range, the PM test team discovered that even modest sleds have liquid-cooled engines, sculpted lines, aluminum chassis and independent front suspensions. Cutting-edge models feature extended drive tracks, sculpted fairings, option-filled comfort and 100-mph speeds.

Clearly, it was time for a closer look at the new generation of high-tech sleds. The PM test



**POLARIS  
INDY 500 SKS**





**ARCTIC CAT PROWLER**

# SNOWBUSTERS

team joined Arctic Cat, Polaris, Ski-Doo and Yamaha during their annual new-product showcase hosted by *Snowmobile* magazine. We wrung out a dozen machines over three hard-riding days, but found four sleds leading the fleet in high-tech advancement. Although we didn't rank the snowbusters, since they range from agile speedsters to extended-track cruisers, each sled was subjected to a rigorous battery of tests.

## Arctic Cat Prowler

The basic design of the snowmobile hasn't changed much in 25 years—2-cycle engine, cleated rubber track, torque-sensing transmission, steering skis. But improvements are vast and Arctic Cat's futuristic new Prowler, a midsize sport sled, is a perfect example.

The Prowler features a front suspension that looks like it was lifted from an Indy car, with aluminum ski spindles, a pair of steel A-arms and coil springs wrapped around adjustable shocks.

The lightweight hood and sidepods, made of Metton plastic, replace the hood-and-bellypan arrangement used on other sleds, and the sculpted windshield, similar to a motorcycle fairing, pivots with the handlebars.

Power is provided by a liquid-cooled, 62-hp, 440-cc Suzuki Twin, which weighs just 52 pounds. The lightweight powerplant features a unique system of magnetic sensors on the carburetors that stops the engine if the throttle linkage freezes.

## SKI-DOO FORMULA MX LT



On the trail, the Prowler soaks up bumps as well as heavier cruisers, yet at 425 pounds it's agile enough to whip through corners with ease. Tach and speedo are on the handlebars, close to the eyes and easy to read. Handlebar warmers are standard, too.

The small fairing-and-windshield design offers minimal protection, but facemask or goggles provide comfort enough for most. A minor nit to pick is lack of storage space.

In an impromptu 15-mile race on steep, twisty trails along the Continental Divide, the superb handling Prowler was one of the first to reach the lodge. And with its radical contours, it's as good looking as it is quick.

## Polaris Indy 500 SKS

New to the Indy 500 line this year, the SKS model features one of the hottest design trends of the '90s—an extended track. The SKS track is 133.5 in.

long, 12.5 in. longer than previous Indy 500 models. Originally developed to increase flotation (stay on top) in deep powder, long-track sleds have other advantages: smoothing out bumps and allowing 2-up riding.

The Indy SKS is powered by a liquid-cooled, 488-cc Fuji Twin, with engine cooling handled by heat exchangers located under the chassis. New for 1990 is a 200-watt alternator that provides power for a halogen headlight and handwarmers.

While most modern snowmobiles have adjustable suspensions, the SKS features a new Dial-Adjust system in the rear, which allows riders to alter spring preload (making it firm or soft) by simply turning a knob.

On the trail, the extended track keeps the ride flat and stable, especially on washboard trails, although shifting body weight on tight corners doesn't seem to have much effect. You

### TEST PARAMETERS

Each sled prototype was tuned by factory technicians, who appear in some photos doing stunt driving, but all data in story and chart was collected by the PM test team. While flat-out runs were measured, top-speed figures are only estimates based on performance at sea level. Testing took place at 10,000 ft. For every 1000 ft. of elevation, engines lose about 3 percent of power.



MAKE/MODEL	ARCTIC CAT PROWLER	POLARIS INDY 500 SKS
Engine/Displacement/Hp	Suzuki/440 cc/62 hp	Fuji/488 cc/NA*
Length/Width/Weight/Fuel	108.5"/42"/425 lbs./7.2 gal.	113"/41.6"/442 lbs./7.3 gal.
Track Length/Track Width/Ski Stance	121"/15"/37"	133.5"/15"/36.5"
Suspension Travel Front/Rear	7"/8.5", enormous amount of travel	6"/7.8", handy Dial-Adjust system for rear
Top Speed, Handling	80-85 mph, superb handling increases trail speed	85-90 mph, brisk top-end performer
Trail Riding, Cornering	Agile and responsive to body English	Less responsive than sport sled, but smooth
Fit And Finish	Radical front-end styling, easy-to-read instruments	Best instrument display and storage, tasteful styling
Price	\$4799	\$5199
Manufacturer/Address	Arco, Inc., Box 810, Thief River Falls, MN 56701, (218) 681-8558	Polaris Industries, 1225 Hwy. 169 N., Minneapolis, MN 55441, (612) 542-0500
Track length—circumference of cleated rubber drive track. Ski stance—distance between centerlines of steering skis. Slide-rail suspension—inside drive track, maintains track contact with snow.	Excellent access to clutch and drive belt. Note small, ultralight cylinder heads. Engine is lightest in fleet.	Large and high-mounted instruments are easy to read. Trip meter, warning lights standard.

\*Manufacturer does not publish horsepower rating.

learn to let the skis do the work.

We thought the Indy had the best instrument display, with well-placed large, easy-to-read tach and speedo. Other noteworthy features are a toolbox over the right footwell and small storage compartment behind the soft seat.

Despite the feel of a big sled, the Indy 500's Fuji engine is powerful and responsive, and, at sea level, top speed should be about 90 mph.

### Ski-Doo Formula MX LT

The Ski-Doo Formula MX LT is another long-track sled, although at 138 in. *extralong* would be more accurate. Naturally, the Formula MX LT has superb flotation, but it surprised the test team with unexpected agility in tight corners.

In keeping with Ski-Doo's performance heritage, the Formula MX LT has a ground-hugging, sporty profile. Power is supplied by a torquey, 463-cc Rotax Twin with rotary valve induction and liquid cooling.

Front suspension features the independent P.S.R. (Progressive Reaction Suspension) system, with adjustable inboard coil-over shocks, torsion bar for flat cornering, and long trailing link attached to the chassis. The slide-rail track suspension has a monoshock and rising-rate springs.

Instruments include a speedo, tach and temperature gauge, located some distance from the driver, which feature somewhat hard-to-read blue numbers on a black background. A welcome detail is the cam-action

### YAMAHA PHAZER II



throttle lever that helps reduce thumb fatigue.

The Formula MX LT uses the same chassis as the standard model, but covers the extended track with a short plastic fender and large taillight housing. A storage compartment would probably be more useful here.

Bury a snowmobile in chest-deep snow and you'll quickly learn to appreciate the extended track of the Formula MX LT, an ideal sled for those willing to trade a few mph for a smoother, less demanding ride.

### Yamaha Phazer II

With its radical telescopic front suspension and handlebar-mounted fairing, the Yamaha Phazer has become the best seller of the '80s. But since its introduction five years ago, the competition is catching up and even creating copycat models. Yamaha rises to the challenge in 1990 with a new-gen-

eration sport sled, the Phazer II.

It's probably no accident that so many of the Phazer's design details have a motorcycle flavor. Take the fairing, for instance. Attached to the steering head, it turns with the handlebars to aim the headlight in the direction the sled is headed.

The T.S.S. (Telescoping Strut Suspension) is similar in concept to a motorcycle fork. The strut encases a long, progressive-rate coil spring and a double-tube shock absorber. And finally, capitalizing on the sled's racy, low-slung profile, the standard 1990 Phazer II features a bold red-and-white color scheme (similar to Yamaha's factory-team motorcycles).

The Phazer II is powered by a 485-cc Yamaha Twin rated at 53 hp. The engine is air cooled, which is lighter and less complicated than liquid-cooled engines, although not as powerful per cubic inch. But don't let this fool you—Phazers have won three consecutive world championships.

At only 406 pounds the Phazer is light and nimble, especially easy to control in deep powder where you change direction by shifting body weight. The suspension is among the softest on the market and soaks up bumps you've already braced for.

Riders either love or hate the Phazer's wild styling, but once you take it out, you'll understand why it was the hot sled of the '80s and why the Phazer II is even hotter.

On the final dawn-to-dusk day of pounding high-altitude trails, the test team found a virgin, mountain-top meadow and couldn't resist the temptation to explore. We soared over the deep powder for a mile or so and came to a knoll facing the Grand Tetons. As the craggy peaks were beginning to blaze with the rich colors of sunset, we sat on our high-tech sleds marveling at the amazing advancements made in the sport of our youth and became convinced all over again that snowmobiles are the best way ever invented to beat cabin fever.

FM



#### SKI-DOO FORMULA MX LT

ROTAX/463 cc/NA\*

109"/41"/504 lbs./10.8 gal.

138"/16"/36.3"

5.2"/5.8", monoshock suspension on rear

85-90 mph, sporty power for a large sled

Surprisingly agile due to taut suspension

Cam-action throttle, wide handlebars nice touches

\$4799

Bombardier, Inc., Valcourt, Quebec, Canada J0E 2L0, (514) 532-2211

Track is huge—17 in. longer than standard model, with monoshock slide-rail suspension.



#### YAMAHA PHAZER II

Yamaha/485 cc/53 hp

103.5"/32"/406 lbs./8.2 gal.

121"/15"/36.2"

6"/6", Telescoping Strut Suspension on front

80-85 mph, soft ride with throttle wide open

Light and nimble, responsive to body positioning

Trendsetting motorcycle styling, racing colors

\$4549

Yamaha Motor Corp. USA, 6555 Katella Ave., Cypress, CA 90630, (714) 761-7457

Enclosed T.S.S. strut suspension shows motorcycle influence. Its clean profile creates minimal drag.





# HOMEBUILT MACHBUSTER

Maverick kitplane designer James Bede is on the verge of realizing his dream—a Mach 1.4 jet for everyman.

BY WILLIAM GARVEY

**C**ANOPY UP, YOU SLIDE INTO the snug, well-equipped cockpit. Battery switch on, and the engine begins to crank. As the turbine speed reaches N1, advance the power lever and light the fire. Once the engine spools up to idle, go to internal power. You're ready. It's time to go flying, fighter-pilot style.

To know the thrill of piloting a superhigh-performance jet fighter, you first have to sign up for someone's air force—since only a government can afford to operate such exotic machinery. At least that's the way it's been ever since the Messerschmitt Me 262, the first jet fighter, took to the air in World War II. But now someone is challenging that tradition.

Jim Bede, the one-time guru of the homebuilt aircraft set, is back. This time with a dream machine even more outrageous, more revolutionary than his single seat BD-5 of the 1970s. He calls his latest creation the BD-10J, and if he can really bring it to life, the airplane could literally change the course of aviation forever. This is Everyman's Fighter.

With an empty weight less than a VW Beetle and dimensions similar to the Yankee, the light trainer that Bede created at the start of his career, the 2-place BD-10J promises to be a Mighty Mouse indeed. The secret is what's packed in the compact fuselage—a General Electric CJ 610 turbojet pumping out 2950 pounds of thrust.

Since the engine's power rating exceeds the normal gross weight of the aircraft by 200 pounds, the resulting performance—30,000-ft.-per-minute vertical climb and a cruise of 1.4 Mach—is extraordinary. Astonishing, actually, when you realize that the BD-10J is designed as a build-it-yourself airplane.

Ever the optimist, despite his near financial ruin brought about by the BD-5 debacle in 1979 (see "BD-5: The First Do-It-Yourself Jet," page 70), the bearded and ample girthed Bede poses the self-confident ques-

tion: "What if I could build a jet like this for everyman?"



Cavorting among the clouds, BD-10J has the power to stand on its tail and streak to 20,000 ft.

tion: "Who's going to design and build a supersonic home-built, if I don't?"

### **A gleam in Bede's eye**

When the BD-10J project began 5½ years ago, Bede was simply exploring ways to improve the performance of the jet-powered version of his BD-5 to enhance its appeal at air shows. But the tiny dimensions of the 1000-pound minijet would not permit the installation of any powerplant other than the craft's original French-made TRS-18 Microturbo.

There were several problems with that engine. First, it put out only 210 pounds of thrust (the latest version has been upped to 300 pounds). Second, it had to be overhauled every 750 hours. Third, the TRS-18 Microturbo engine cost about \$70,000. So, Bede decided to abandon the whole idea of upgrading the BD-5J and start over from scratch. His only guideline at that point was to design something that pleased him. "I just said,

"Gee, what would I like?" The answer to that question tells a lot about the man.

### **Power hungry**

Since it was primarily the lack of a proper engine that brought the celebrated BD-5 project to a bitter end, Bede began his latest project by selecting the powerplant and then designed the airplane around it. He picked the CJ 610 because of its record of reliability in years of service powering Model 20 series Learjets and Jet Commander business jets. Additionally, the J-85, the military version of the CJ 610, had been well proven over decades of service as the power behind the supersonic T-38 trainer and the F-5 fighter.

Moreover, his research indicated that used engines were in plentiful supply at prices beginning at about \$40,000. Because the CJ 610 puts out so much power,

# HOMEBUILT MACHBUSTER

Bede wasn't particularly constrained in airframe size. As a result, the BD-10J is designed to carry two people in tandem seats and its internal main and auxiliary tanks hold approximately 299 gallons (2020 pounds) of Jet A, enough fuel to travel 2788 miles at 600 mph (.91 Mach) at 45,000 ft.

## Supersonic roots

Since the aircraft was originally intended to fly high-speed aerobatics at air shows, it should come as no surprise that the twin-tailed Bede looks very much like a combat fighter, which is after all the ultimate aerobatic aircraft. However, the Bede jet is only about one-third the size of an F-16 and has none of the system complexity or redundancy found on a real military aircraft.

While the jet's concept may be revolutionary, many of its design elements and construction methods are familiar. For example, Bede admits he's relying heavily on data from jet testing that occurred in the 1970s and earlier, before the advent of boosted or fly-by-wire controls.

The BD-10J pilot uses a sidestick for low-speed handling and shifts to a

standard center stick for high-speed control. These are linked to the control surfaces through a series of heavy-duty push-pull rods. To accommodate pressure shifts on the wing which occur at transonic speeds, the BD-10J features an electrically operated stabilizer trim system with which the pilot adjusts the horizontal tail. The system, similar to the mechanical controls used by Chuck Yeager back in 1947 on the original Mach-busting Bell X-1, is much simpler, lighter and more affordable than the powered controls and stability augmentation systems found on most supersonic aircraft. The aircraft's structure is approximately 60-percent 2024-T3 aluminum and only about 35-percent composites with the pressurized cockpit accounting for most of the latter.

Bede expects he can deliver a full BD-10J kit, less engine and instrumentation, for \$160,000. A high price for a do-it-yourself airplane, but small change for a high-performance, fighter-like aircraft capable of 12G maneuvering, direct climb to 20,000 ft. in less than a minute from takeoff, and a 1.4 Mach (923 mph) cruise at 45,000 ft.

## Evolution of a pocket rocket

Design of the BD-10J has been a continuous process, with Bede adding minor adjustments on his Cimline computer right up until actual building began. Now, with the first preproduction planes being fabricated, every detail is at last locked up, and final performance projections have been formulated.

The aircraft has a high midwing with a 28.5° leading-edge sweep. The wing has a 20-ft., 7-in. span and is fitted with full-span, leading-edge slats and slotted flaps. Its F-14-like twin vertical fins total almost 20 sq. ft. of area, giving the aircraft excellent directional control.

The BD-10J has an overall length of 28 ft., 10 in. The cabin's 9-psi pressurization system will take the aircraft up to 50,000 ft. Because of the aircraft's extraordinary thrust-to-weight ratio, the BD-10J will get going in a hurry. Bede anticipates that after brake release the aircraft will need only 10 seconds and 600 ft. of runway to start flying. And once airborne, the aircraft has the power to climb straight up to altitude.

## BD-5: The First Do-It-Yourself Jet

**T**HE BD-5 KIT has been available since 1972. Needless to say, most people don't go out and build their own jet plane from a kit. In fact, since the first BD-5 kit was sold for \$1800 in '72, only 50 to 60 have been completed out of approximately 3000 kits sold. Of the 50 or 60 completed kits (mostly propeller models powered by Honda turbocharged engines), about 30 are still flying. Of the BD-5J jet kits sold, seven are now flyable and four are actively flown as air-show performers.

If you're contemplating building your own jet plane, be forewarned. Flying a jet plane, any jet plane, and especially one you've built yourself, can be hazardous to your health.

According to the newsletter *The Aviation Consumer*, 14 of the first 25 completed BD-5 homebuilts crashed. One special shortwing version, for which a couple hundred kits were sold, had a particularly inauspicious beginning. Of the first four completed, three crashed on the first takeoff and one lasted just long enough to crash on its first landing.

National Transportation

Safety Board statistics show 25 accidents for BD-5s in total, nine of which were fatal. *The Aviation Consumer* knows of three more, for a total of 12 in all. Two of the fatalities were in early BD-5J jet models.



Modified planes of the Silver Bullets aerobatics team are one shining exception to the unfortunate safety record of the BD-5J.

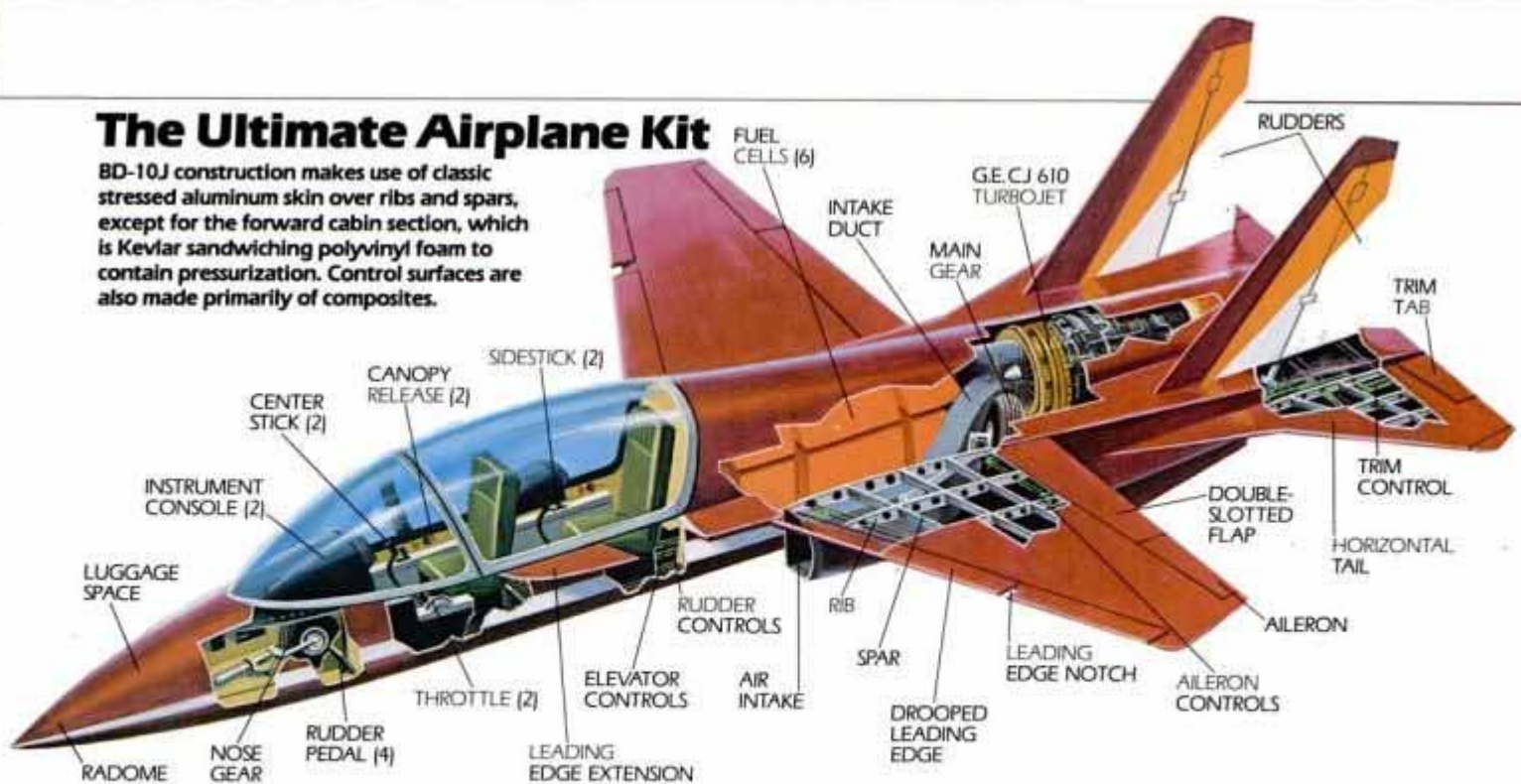
The air-show BD-5Js now being flown are a different story. Bobby Bishop, one of the original Bede test pilots, and the head of the Coors Light Silver Bullets team, points to a near-perfect safety record with the planes he currently flies and has flown for the past 13 years. He attributes this to the Acrojet modifications he has made to the original design. The major change is that the Acrojet is 100 pounds lighter and is an all-around better-balanced machine.

While most BD-5s are tail-heavy, requiring up to 50 pounds of ballast in the nose, the Acrojet version requires no ballast. It also has a much lower stall speed—58 knots compared to 71 knots, along with other important refinements.

What does all this say for the BD-10J? It is unfair to even begin to characterize the performance of an airplane that has yet to be flown by that of its completely different predecessor. But one thing's for certain: When it does fly, like all Bede projects, it's going to be one heck of an exciting flying machine. —Fred Mackerodt

# The Ultimate Airplane Kit

BD-10J construction makes use of classic stressed aluminum skin over ribs and spars, except for the forward cabin section, which is Kevlar sandwiching polyvinyl foam to contain pressurization. Control surfaces are also made primarily of composites.



The BD-10J's 35-pounds-per-sq.-ft. wing loading drops to 18 pounds per sq. ft. with low fuel loads typical just prior to landing. That gives the aircraft a 70-mph stall, which results in an approach speed of about 90 mph. Landing distances of 1500 to 2000 ft. are anticipated, however, since the CJ 610 will continue to produce about 140 pounds of thrust when pulled back to idle.

There is no pilot ejection system. But if customer interest is strong enough, Bede might offer a powered parachute that would pull the pilot out, if the need arose. The aircraft is equipped with a fuel dump system, thus minimizing the risk of fire in a dead stick, emergency landing.

## Building underway

Construction of the first four preproduction versions of the plane is now taking place at Bede's Oklahoma City shop. Original plans to build a prototype were scrapped, because it was felt that only a plane built on production tooling would represent the final version's characteristics accurately enough for certification trials.

Bede expects the first BD-10J to be finished sometime in February, after which flight testing will begin in Mojave. National Airshows Group, operator of the Holiday Inn Aerobatic team will do the flying, and will also be among Bede's first customers.

Bidding for that privilege has apparently been brisk. Bede says he already has 18 firm orders, which may take him nearly a year to fill. He won't even begin accepting new orders until this summer. As for the four preproduction planes now under construction, Bede won't say who's getting

them, except that serial No. 1 is reserved for himself.

National Airshows Group will also handle customer training. Bede says that in the beginning all prospective customers will be expected to come to the manufacturing site and fly with a factory instructor in a BD-10J and demonstrate enough proficiency to handle the aircraft safely. The BD-10J, says Bede, "is just too much aircraft to simply turn over to someone who happens to have a lot of money and the ability to buy it."

The BD-10J will probably be sold only as a complete kit, minus engine and avionics. Initially, Bede had intended to sell plans for the plane to anyone interested. However, as the project took shape, he decided that that idea was unrealistic. "The airplane is too complicated for a guy to even try building it from scratch," Bede says. Instead, the factory will produce all composite components in vacuum ovens and will be responsible for all complicated formed or machined parts.

The aircraft fall into FAA's home-built Experimental certification category. Bede does not intend to manufacture complete BD-10Js, at least not for the civil market.

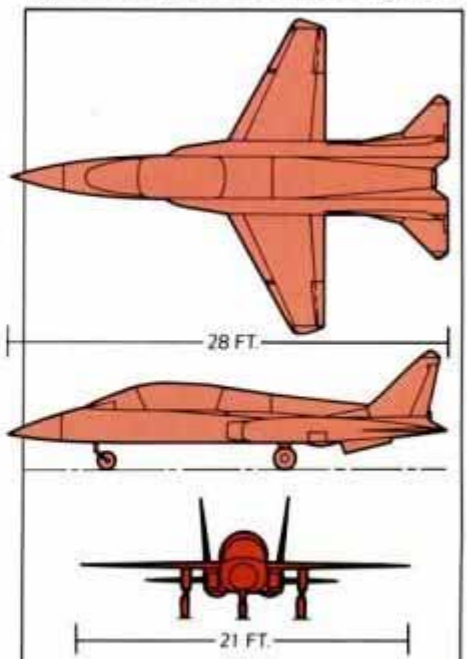
## Waiting in the wings

When Bede began his jet project, his intent was to produce the hottest airplane ever to hit the air-show circuit. The market wasn't a big one. He estimated 15 airplanes would do it. However, as word of the BD-10J spread, letters and calls began to overwhelm the little Advanced Aircraft office. Bede says he has received some 1100 inquiries about his minifighter.

And what about the air-show performers for whom it was originally targeted?

Bob Bishop is a one-time Bede Aircraft test pilot who now makes his living in a BD-5 as the leader of the Coors Light Silver Bullets aerobatic team. He thinks the BD-10J concept is a bold one and, supersonic practicalities aside, that the aircraft "will be neat no matter what it does."

But beyond that, if the BD-10J delivers all that Bede promises, Bishop believes the aircraft "could change the face of aviation." That is an observation that may be echoed again and again once the BD-10J takes flight. **PM**



Twin vertical, and fully movable horizontal tails betray BD-10Js' fighter heritage, but light wing loading allows for manageable landing speeds.

STOP  
STOP  
STOP  
STOP





## ***Chevy Astro introduces 4-wheel anti-lock braking you can't get on Ford or Chrysler minivans.***

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Ford Aerostar doesn't control braking like Chevy Astro.



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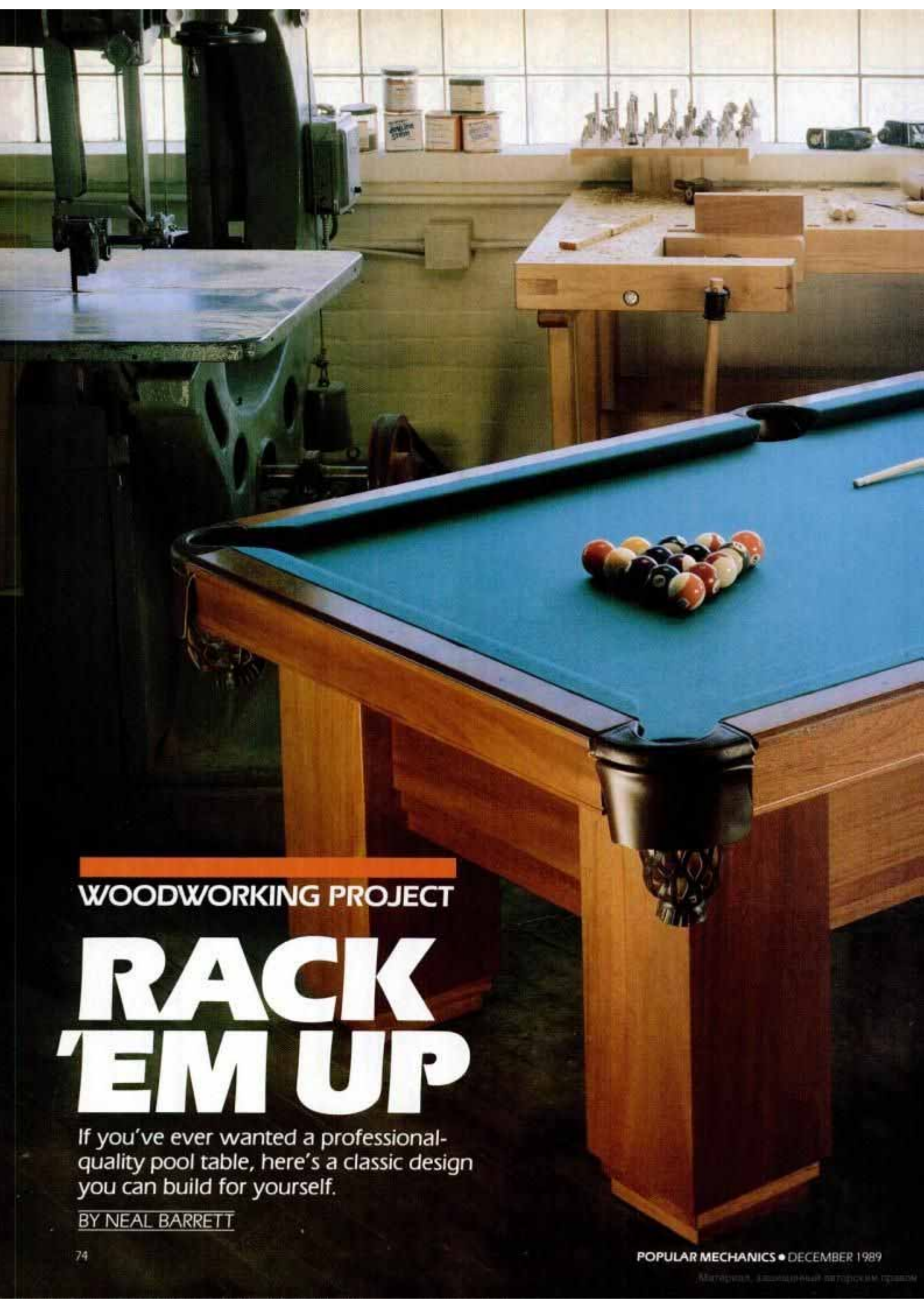


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**OF AMERICA IS WINNING**  
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WOODWORKING PROJECT

# RACK 'EM UP

If you've ever wanted a professional-quality pool table, here's a classic design you can build for yourself.

BY NEAL BARRETT



**P**OOE IS BACK and it's hotter than ever. It seems like everyone—from the investment banker on Wall Street to the iron worker in Washington State—is rediscovering this great game. For the real enthusiasts, it seems to be endlessly challenging. The rigid geometry that defines the game requires steady nerves, a very smooth stroke and a real appreciation of just how feckless simple spheres can be. And the romance of the game is equally appealing with the touch of smooth green felt and the chorus of collisions as the balls career around the table being unmatched by any other pursuit.

Mastering the game, however, takes time, patience and—in the

best of all possible worlds—a table of your own. That's why we decided to build the 4 × 8-ft. slate table shown here. Once you've finished it, it may take awhile before you can play like Jackie Gleason, Paul Newman or even Tom Cruise but at least you'll have a great place to start.

The inspiration for our design comes from tables built in the Art Deco style of the 1920s and '30s. It is constructed of solid mahogany and poplar and features a 3-piece Italian slate bed and professional cushions, pockets and felt. It is also designed to be as easy-to-build and inexpensive as possible while still maintaining the standards of the best professional tables. Depending on where you get your materials, the project should cost about \$1200 and

certainly be the equal of tables costing three or four times as much.

You should purchase your slates before you do anything else. The slates do come in matched sets but can vary somewhat in overall size and other features. Because of this, you may have to make slight changes in our plans to accommodate the slates you buy. If at all possible, locate a pool table supplier in your area and purchase the slates from them to avoid some costly freight charges. If you can't find one nearby, we've included the addresses of the mail-order suppliers we used in the Materials List on the following page.

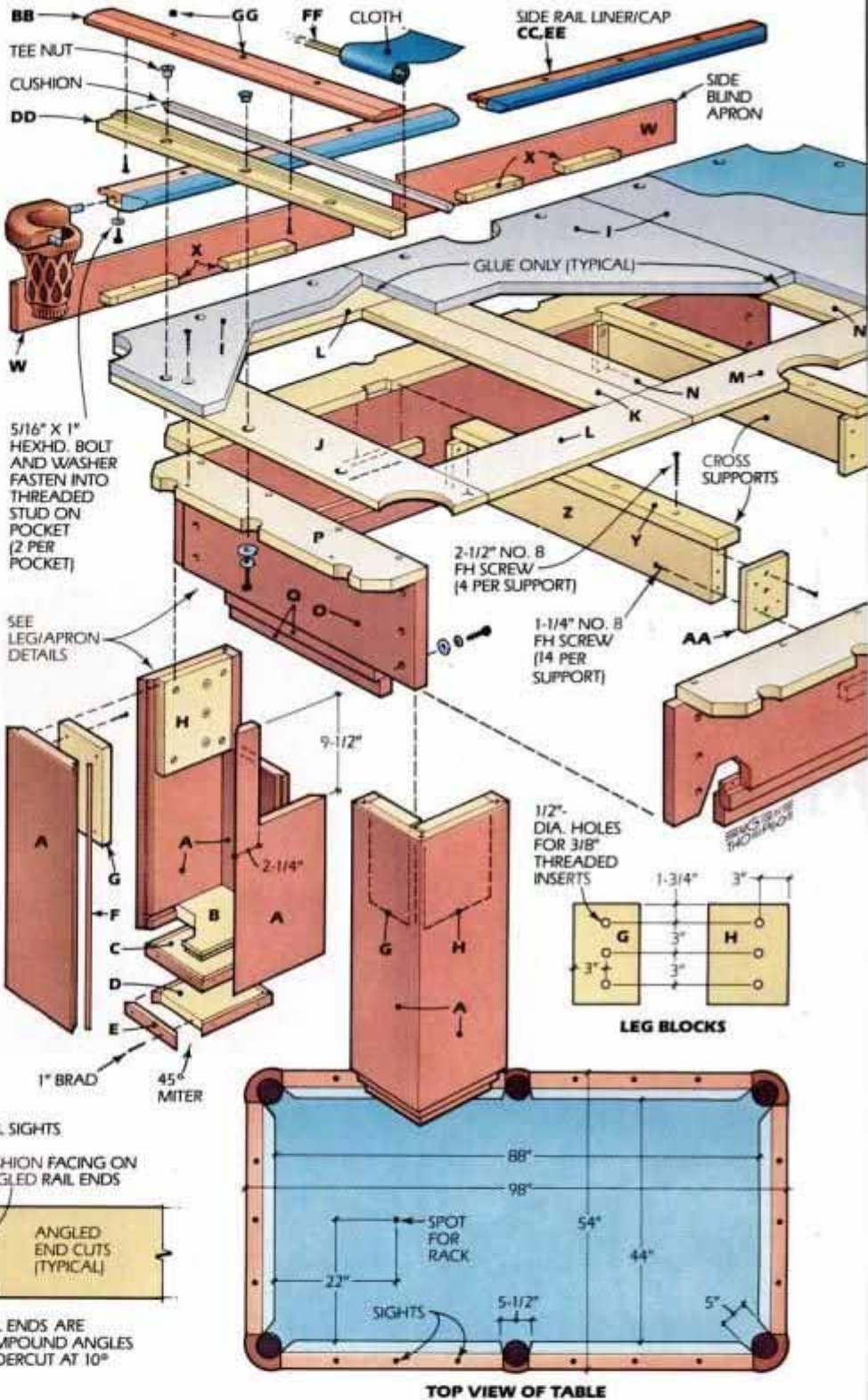
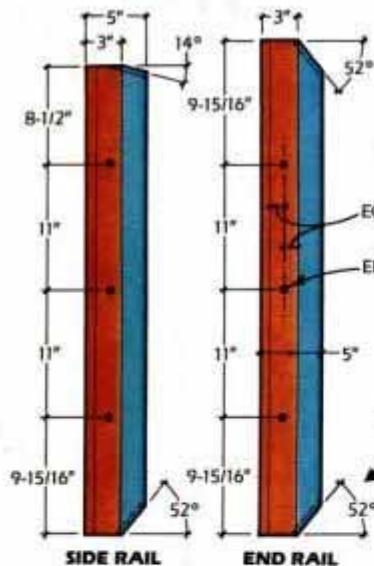
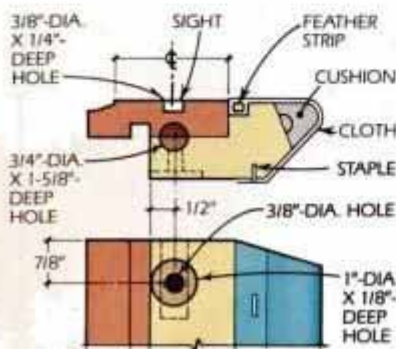
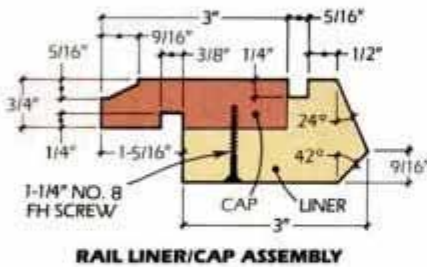
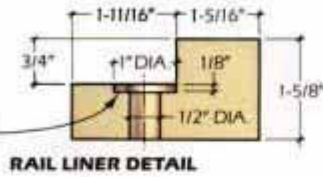
**Color photo:** John Griebisch  
**Black-and-white photos:** Neal Barrett  
**Technical art:** Eugene Thompson

# WOODWORKING GUIDE

## POOL TABLE

31" HIGH X 54" WIDE X 98" LONG

LOCATE HOLES FROM SLATE. INSTALL 3/8"-16" TEE NUTS



## Slate Preparation

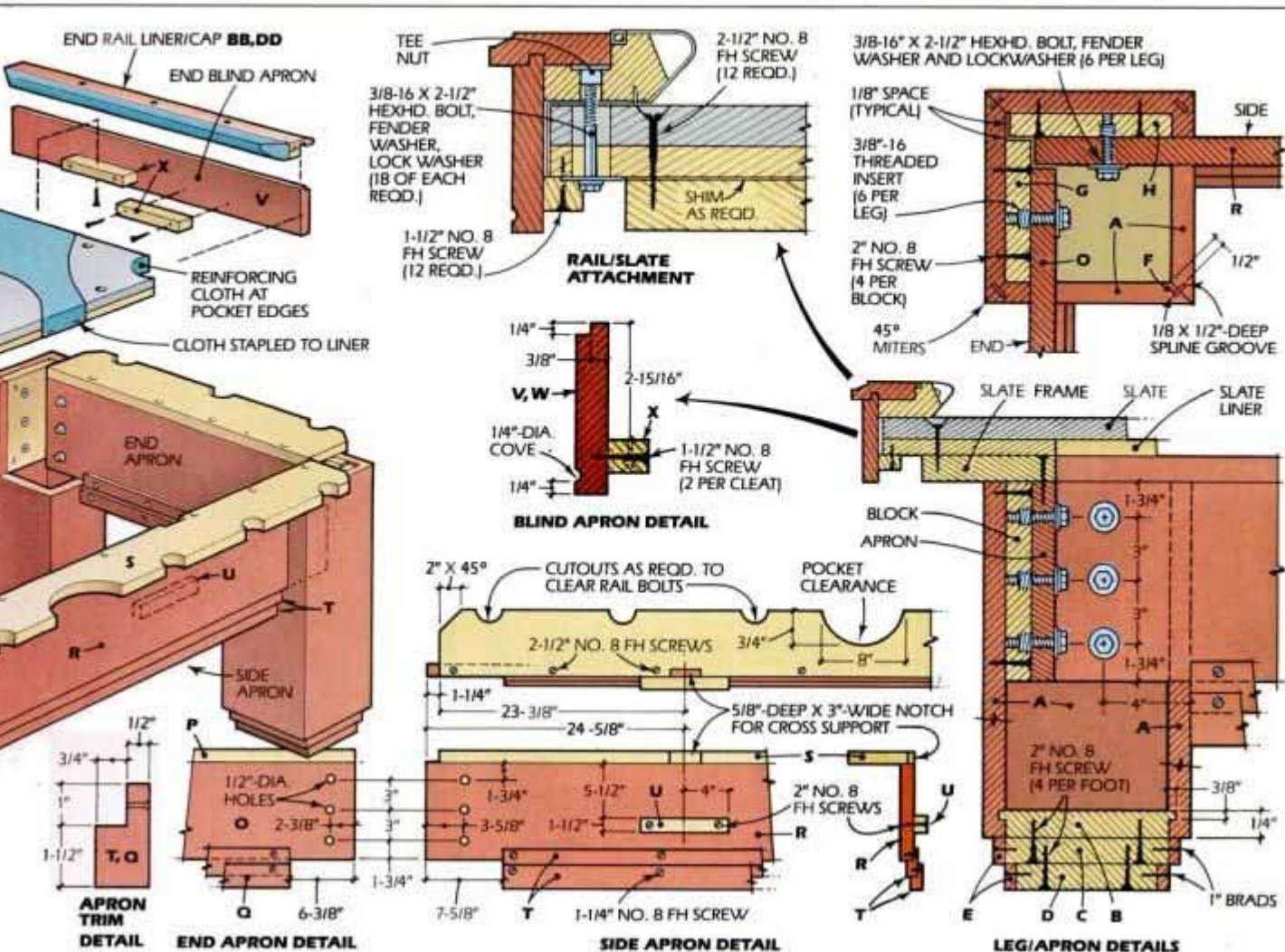
**B**EGIN BY preparing slate liners from 3/4-in.-thick poplar. Spread yellow glue on the liners and slates, and clamp the liners to the slates (Photo 1). When the glue has dried, use a router and flush cutting bit to trim the liners to the slate in each pocket opening (Photo 2). Bore through liners—using the predrilled holes in the slate for the rail bolts and screws (Photo 3).



**1** Glue and clamp slate liners to slate. Use blocks under clamps on slate side to prevent damage to playing surface.



**2** Cut away liner at corner and side pockets. Use either a sabre saw or a straight bit and ball-bearing pilot in router.



### MATERIALS LIST—POOL TABLE

Key	No.	Size and description (use)
A	16	1 x 10 x 2 5/8" mahogany (leg side)
B	4	1 1/4 x 8 1/2 x 8 1/2" poplar (block)
C	4	1 1/4 x 8 x 8" poplar (foot)
D	4	1 1/4 x 7 x 7" poplar (foot)
E	25	1/2 x 1 1/4" mahogany (band)
F	32	1/2 x 1/2" hardboard (spline)
G	4	1 1/4 x 6 1/2 x 9 1/2" (block)
H	4	1 1/4 x 7 1/2 x 9 1/2" poplar (block)
I	1	1 x 51 x 95" slate (3-pc. top)
J	2	3/4 x 8 x 51" poplar (slate liner)
K	2	3/4 x 4 x 35" poplar (slate liner)
L	4	3/4 x 8 x 23 1/2" poplar (slate liner)
M	2	3/4 x 8 x 31 1/2" poplar (slate liner)
N	2	3/4 x 4 x 35" poplar (slate liner)
O	2	1 1/4 x 9 1/2 x 34 1/2" mahogany (apron)
P	2	1 1/2 x 6 1/4 x 34 1/2" poplar (frame)
Q	4	1 1/4 x 2 1/2 x 22" mahogany (trim)

R	2	1 1/4 x 9 1/2 x 81 1/2" mahogany (apron)
S	2	1 1/4 x 6 1/4 x 78 1/2" poplar (frame)
T	4	1 1/4 x 2 1/2 x 66" mahogany (trim)
U	4	1 1/4 x 1 1/2 x 8" poplar (cleat)
V	2	3/4 x 4 1/4 x 41 1/2" mahogany (blind apron)
W	4	3/4 x 4 1/4 x 40 1/2" mahogany (blind apron)
X	12	3/4 x 1 x 8" poplar (cleat)
Y	2	1 1/4 x 3 x 36 1/2" poplar (top band)
Z	2	1 1/2 x 5 1/2 x 35" poplar (beam)
AA	4	1/2 x 5 x 5 1/2" poplar (block)
BB	2	3/4 x 3 x 41 1/2" mahogany (rail cap)
CC	4	3/4 x 3 x 40 1/2" mahogany (apron)
DD	2	1 1/4 x 3 x 41 1/2" poplar (rail liner)
EE	4	1 1/4 x 3 x 40 1/2" poplar (rail liner)
FF	6	3/16 x 1/2 x 43" poplar (feather strip)
GG	18	3/8" dia. x 3/8" ebony (sight)

**Misc.:** 1 1/2" No. 8 fh screws (44 reqd.), 1 1/2" No. 8 fh screws (36 reqd.), 2" No. 8 fh screws (72 reqd.), 2 1/2" No. 8 fh screws (32 reqd.), 3/8-16 x 2 1/2" hexhead bolt (42 reqd.), 3/8" fender washer (42 reqd.), 3/8" split-ring lock washer (42 reqd.), 3/8-16 threaded insert, 3/16 Teentut (18 reqd.), 3/16 x 1" hexhead bolts (12 reqd.), 3/16 I.D. washers (12 reqd.), 1" brads (as reqd.), Bosch router bits No. 85480M (rail cap), 85444M (blind apron), staples, yellow glue.

**Specialized supplies:** 1 set rubber cushions, cushion facings, pool table cloth, 1 set pockets, available from NYRA, Inc., 1780 Monroe Ave., Rochester, NY 14618. NYRA will not ship slate, but the following companies will: Century Billiards, 2091 Jericho Tpke., E. Northport, NY 11731; Blatt Billiards, 809 Broadway, New York, NY 10003.



**3** Bore rail bolt holes through the liner (slates come predrilled). Block ensures a clean hole where the bit exits liner.

## Legs

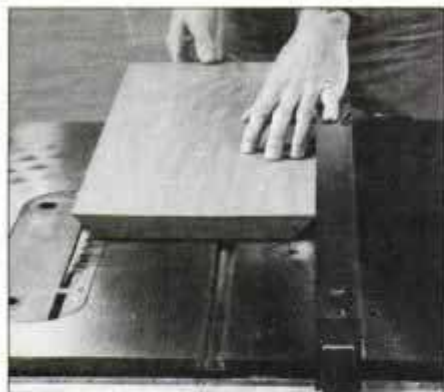
**E**ACH LEG consists of four pieces with mitered and splined edges assembled around a base block. Rip, crosscut and dado each leg piece. Cut the spline groove in each mitered edge (Photo 4). Cut notches at the top of each leg piece that receives an apron (Photo 5). Rip and crosscut the base blocks, foot and filler blocks for the top of each leg assembly.

Glue and clamp two leg pieces at a

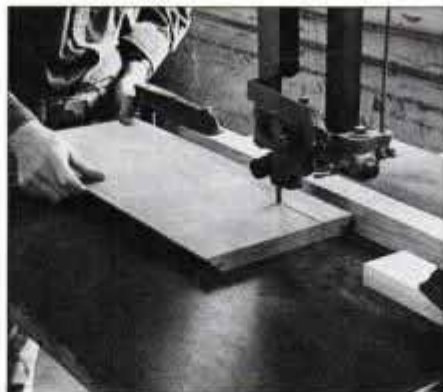
time, slide in the filler block, but don't glue it, and clamp the remaining two sides (Photo 6). Miter, glue and nail the trim strips around the foot blocks. Screw on the foot blocks (Photo 7) after the assembly has dried. Then, screw in the filler blocks.

Rip and crosscut the aprons. Clamp the aprons to the filler blocks and bore the 1/2-in. holes into the filler blocks for threaded fasteners (Photo 8). Remove aprons, and screw in the 3/8-in. threaded fasteners (Photo 9).

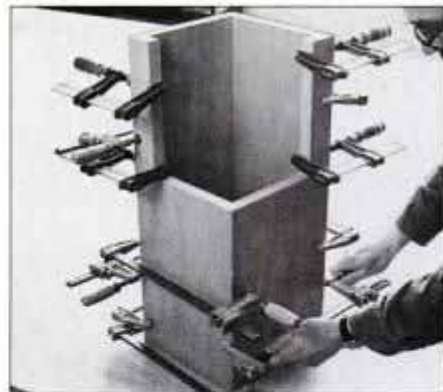
## WOODWORKING GUIDE



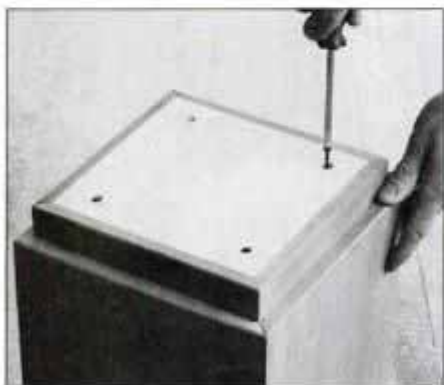
**4** Cut mitered edges on the leg pieces. Reset saw then cut groove on each mitered edge for spline at corner joint.



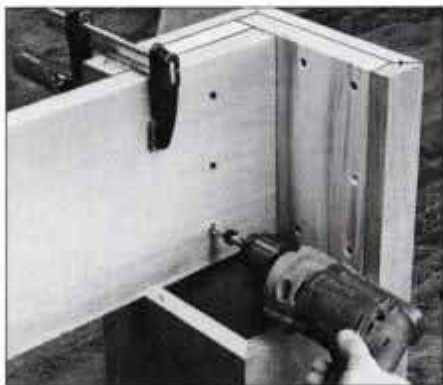
**5** Notch two leg pieces on every leg assembly to receive the apron. Scrap fence and stop block make for accurate cuts.



**6** Apply glue to mitered edges and spline groove. Clamp up two sides and base block. Clamp up the other two sides.



**7** After glue has dried on leg assembly, miter, glue and nail banding to foot block. Then screw foot block onto leg.



**8** Clamp apron to top of leg, in notch, and bore bolt holes using stop collar on drill bit. Note filler block at top of leg.



**9** Screw in threaded fasteners for apron bolts. Drop of varnish lubricates fastener, and when varnish dries, it locks it in place.

## Base Assembly/Framework

**N**EXT, BOLT together the legs and aprons using fender and lock washers (Photo 10). Rip and rabbet the stepped apron trim. Crosscut the trim for a snug fit between the legs. Glue and clamp a trimpiece to an apron and bore pilot holes. Screw the trim to the apron. Repeat the procedure on the next trimpiece, attaching it to the one already fastened to the apron (Photo 11).

Next, rip and crosscut the poplar for the slate frame. The frame rims the base assembly and is spanned by a pair of cross supports to add support

where the slate pieces butt together. Fasten the outside frame members to the aprons with countersunk screws. Mark the locations of the cross supports on the frame and cut the notches for the top band on the frames.

Glue and screw a plywood block to the end of each cross support (Photo 12). Each cross support is comprised of two parts, a beam and a top band. Next, glue and screw the top band so it overhangs the ends of the support to fit into the notches in the frame.

Fit the cross support in place and screw through the end block into the

apron (Photo 13). Rip and crosscut the four poplar support blocks and screw these in place below the cross supports.

Place the slates on the table so the overhang on each end matches and so the overhang on the sides match. Trace the locations of the side and corner pockets and the holes for the rail bolts (Photo 14). Lift off the slates and mark a line back  $\frac{3}{4}$  in. from each traced line.

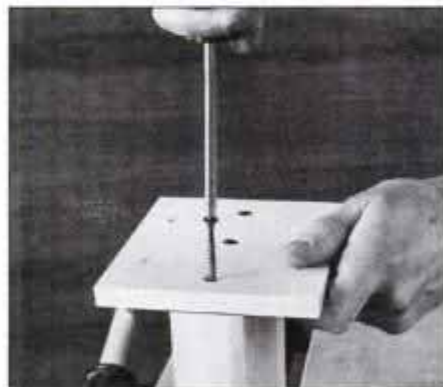
Next, cut on this line to allow extra room around the pockets and so that rail bolt heads are countersunk in the frame when the table is assembled (Photo 15).



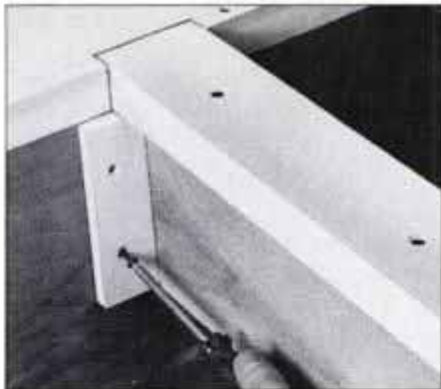
**10** Bolt aprons to legs. Use fender washer against wood and lock washer under bolt head. Do not overtorque.



**11** Cut stepped apron trim for snug fit between legs. Glue and screw trim to apron. Cut and attach second trimpiece.



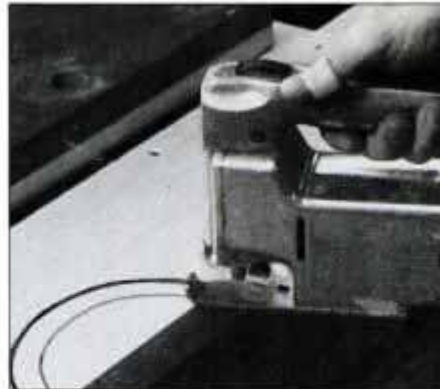
**12** Glue and screw end block to cross supports. Prebore countersunk screw holes through block where it attaches to apron.



**13** Notch top band of cross support into slate frame. Top band lies under joint where slates meet. Screw in end block.



**14** Lay slates on frame and trace pocket cutouts and rail bolt holes. Remove slates and mark setback cutting line.



**15** Cut on setback line with sabre saw. Setback allows extra space for pocket and hardware that attaches here.

## Rails

**T**HE LEFTHAND corner of the drawing on pages 76 and 77 shows the rail assembly. At top is the basic rail liner. Next is the liner and cap, then comes the final assembly with cushion and cloth. Begin by ripping and rabbeting rail liner blanks. Then rip and crosscut the rail caps.

Crosscut the rail liners and clamp them in place with 5 in. between them at side pockets (Photo 16). Center the end rails on the slate. Trace the rail bolt holes on the liners. Then, bore a 1/2-in.-dia. hole on each mark. On top of each liner, centered on each hole,

bore a 1-in.-dia., 1/8-in.-deep hole. Hammer a Teenut into each hole (Photo 17).

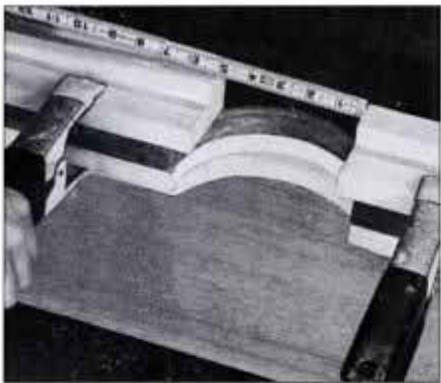
Glue and screw the rail cap to the rail liner. Then cut a 1/4-in.-deep groove in the liner for the feather strip that fastens the rail cloth.

At each rail end, mark for a 3/4-in.-dia. hole, 1 1/8 in. deep for the metal studs (also called pocket ears) on each leather pocket (Photo 18). Bore the holes for the bolts that fasten into the studs.

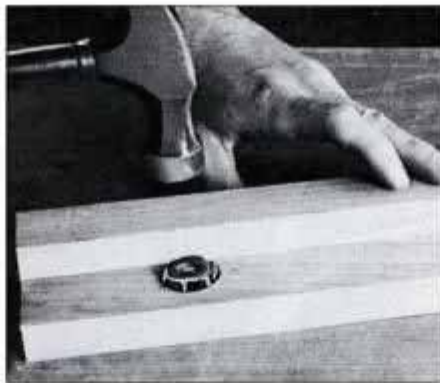
Next, rip the cushion angles on each rail's edge (Photo 19). The top and bottom angles are different. Cut the compound angles at the rail ends

for the side pocket openings. Swing the radial-arm saw to 14° and tip the blade to 10°. Cut one liner with the rail cap up and against the fence. Cut the other liner with the rail cap down and forward. Cut the corner pocket openings with the saw arm set to 52°. Cut from the groove's back edge to the rail's front (Photo 20).

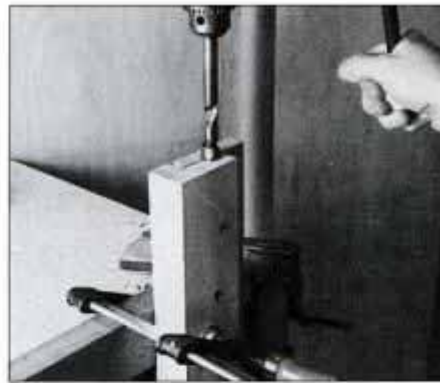
Cut the groove in the rail cap for the blind apron. Rip, crosscut and rabbet the blind apron and cut the decorative groove on its face. Mark each rail cap for three sights. Bore on the marks, and glue in the sights. When the glue has dried, sand the sights flush. Cut the molding on the rail cap (Photo 21).



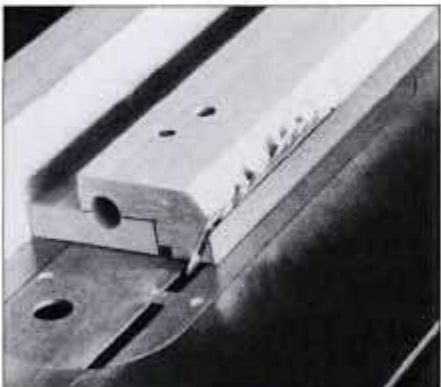
**16** To trace rail bolt holes, clamp rail liners to slates. Position liners for 5-in. space between ends at side pocket openings.



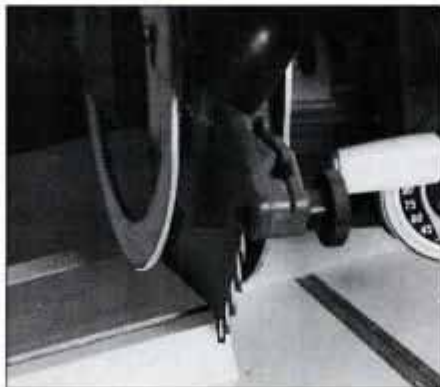
**17** Hammer Teenuts into holes bored in rail liners. To lock down rails, thread bolts from under slates into Teenuts.



**18** Bore holes in rail's end for pocket studs that attach pocket to liners. Mahogany rail cap is glued into rabbet in liner.



**19** Tip tablesaw blade over to rip cushion angles on rail liner. Cut the bottom angle first, then cut the top angle.



**20** Cut compound angles on rail liner ends using radial-arm saw. Readjust saw arm angle to make side pocket cuts.



**21** Clamp rail liner to bench top. Cut shape on edge of rail cap. Ebony rail sights have been glued in and sanded flush.

## WOODWORKING GUIDE

### Cushions

**D**ISASSEMBLE the table—numbering the parts for reference as you go—and sand smooth all mahogany parts using 120- and 220-grit sandpaper. Apply several coats of a durable varnish or polyurethane, rubbing out each layer of finish.

There's plenty you can do while waiting for various coats of finish to dry. Spread yellow glue on each rail's top edge. Place a cushion's canvas face flush with each rail top. Tape the cushions down so they overhang the rail ends, spacing each piece of tape about 1 in. apart (Photo 22). Cut off the overhang, after glue has dried, with a sharp knife lubricated with a little water (Photo 23). Apply cushion facings to the rail ends using contact cement. Trim these flush with a knife and relieve their sharp edges with fine sandpaper mounted on a hand sanding block (Photo 24).

Order a piece of cloth 57 × 101 in. for the table and a piece 6 × 60 in. for each rail and cover the side rails first. To begin the rails, rip a batch of poplar feather strips. Lay a feather strip in its groove, mark it and crosscut it to length.

Next, mark a pencil line across it and the rail 8 in. from the rail end. Remove the strip. Lay the rail so the

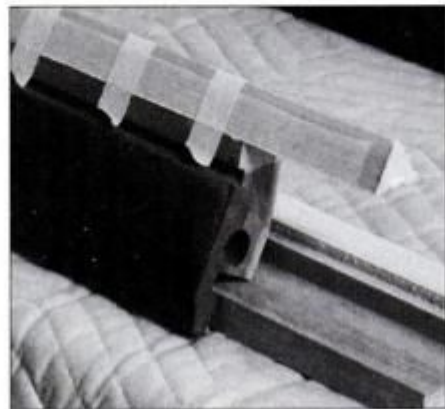
cushion faces away from you. Cover the rail with cloth, face down, so the overhang at each end matches and ½ in. of cloth extends past the groove on the cushion side.

Place the strip in its groove and align the marks. Start at the rail's center, and press the strip down to a side pocket. Then, press the strip toward the corner pocket, but stop 3 in. from the end. Pull the cloth toward the cushion so 1 in. extends past the strip.

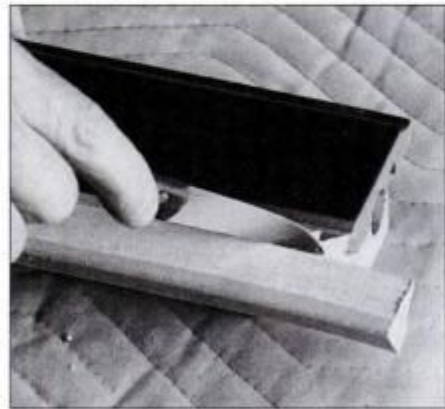
Finish tapping the feather strip in place with a hammer and a wood block (Photo 25). With a knife, trim away cloth on waste side of the strip (Photo

26). Repeat the process on the end rails.

Turn the rail over, and pull the cloth firmly over the cushion. Starting at the center, staple into the rail bottom moving toward the ends (Photo 27). Do not distort the cushion shape. At the corner pockets, stretch the cloth over the cushion facing and drive two staples just beyond the facing (Photo 28). At the side pockets, fold the cloth over and staple as shown. Trim excess cloth with a knife, leaving ¼ in. beyond the staples (Photo 29). Avoid denting the rail cap—support the assembly in a small cradle with a padded surface.



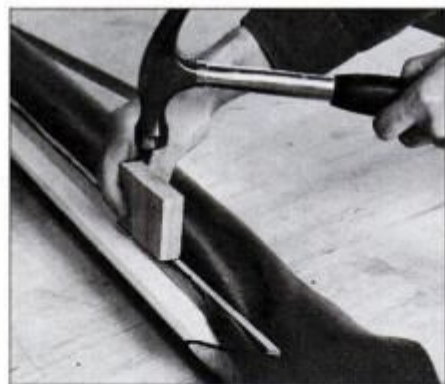
**22** Spread glue on the rail liner edge and back of rail cushion. Hold cushion in place with masking tape while glue dries.



**23** Trim the cushion flush with the rail liner's angled end. Use a sharp knife lubricated with water to ease the cut.



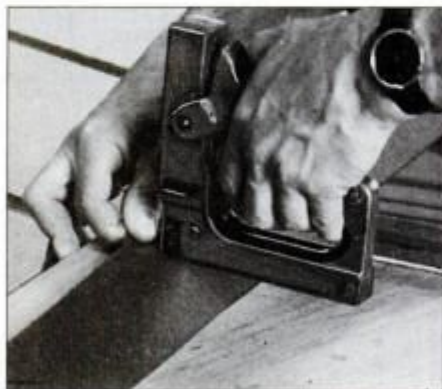
**24** Glue cushion facings to ends of cushions with contact cement. Trim off the excess with a knife, then sand it flush.



**25** Make alignment marks on the strip and rail liner/cap. Then, tap in the feather strip with a wood block and hammer.



**26** Trim off cloth that extends beyond feather strip using a sharp knife. Trim on cushion side (waste side) of strip.



**27** Support rail on padded surface. Wrap cloth over feather strip, tuck under cushion and drive staples on bottom of rail.



**28** At corner pockets, finish stapling cloth over the rail by driving two staples, just beyond cushion facing, into rail end.



**29** At the side pockets, fold cloth over rail end and staple under rail. Trim cloth with knife, leaving ¼ in. beyond staples.



## Slate Installation

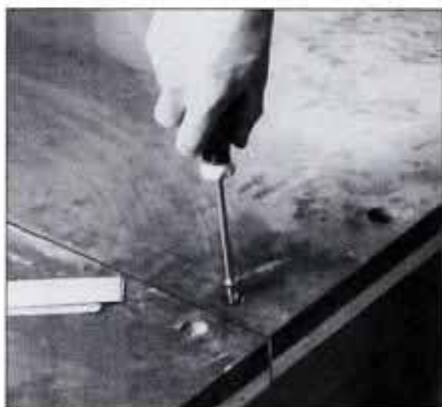
**A**SSEMBLE THE base frame. Check across its width and length for level. If necessary, shim under the legs to level it. Butt the slates together on the frame and shim them flush to each other along their edges, if necessary. Screw them to the frame (Photo 30). Fill blemishes in the slate, screw holes and along joints with plaster of Paris (Photo 31). Once the plaster is dry, sand it smooth with 120-grit sandpaper. Dust off and wipe the slate with a damp cloth. Apply 1½-in.-wide cloth strips to the pockets with contact cement set ⅛ in. be-

low the playing surface (Photo 32).

Lay the cloth over the slate with equal overhang all around. Drive a pair of staples 3 in. apart into the slate liner, near a corner on the table's long side (Photo 33). Pull the cloth tight near the other corner on the same side and staple it. Stretch the cloth tightly across the table and repeat this on the opposite long side. At an end rail, drive staples into the liner 3 in. apart moving from the center to the corners. Move to a long side and staple outward from the center. Staple the other two sides. At the pockets, cut a series of slits within 1½ in. of the slate edge, radiating from the pocket's cen-

ter (Photo 34). Pull each triangle tight and staple it. When the stapling is done, trim excess cloth under the slate and cut open the rail bolt holes by poking a razor knife through the cloth (Photo 35).

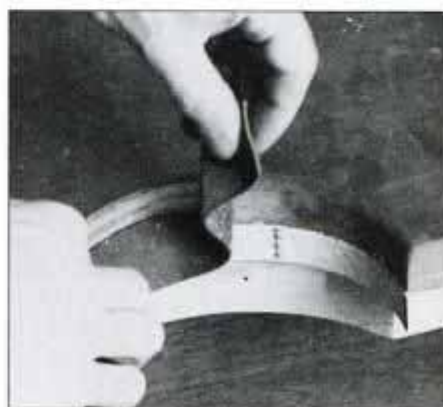
Slip the pocket studs into the holes bored in the rail ends. Then, bolt through the rail bottom into the stud (Photo 36). Place the rails on the table and straighten them by sighting along their edges with a straightedge. Bolt the rails in place (Photo 37). Finally, attach cleat blocks to the blind aprons' backs, and screw through the cleats to fasten the blind aprons to the slate liner (Photo 38). **PM**



**30** Use thin wood shims under slates to bring them even along joints and level. Then screw slates into the frames.



**31** Spread plaster of Paris over joints and scrape joints smooth with 6-in. flat knife. Fill the screwholes with plaster.



**32** Cut six small cloth strips and apply to pockets with contact cement. Place strips ⅛ in. down from the playing surface.



**33** Staple cloth to the frame near corner on table's long side. Staple far corner on same side. Repeat this on opposite side.



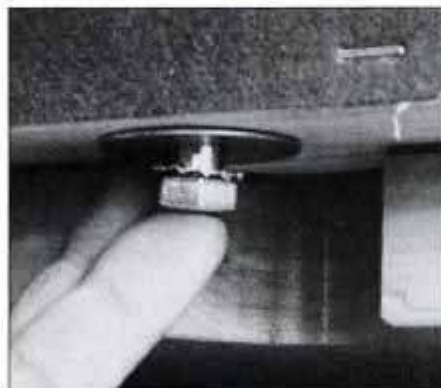
**34** Make radius cuts at corner pockets. Stop cuts 1½ in. from slate edge. Pull each triangle tight and staple to frame.



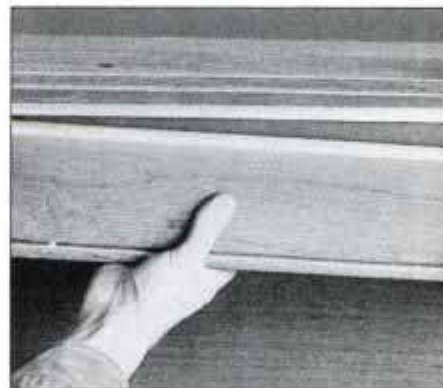
**35** Cut away cloth over holes for the rail bolts. Completely remove the cloth to ensure maximum rail bolt adjustment.



**36** Turn the rails over on pool table, slide pocket studs into rail ends. Fasten pocket to rails with hexbolts and washers.



**37** Position the rails and thread bolts from below. Straighten rails and tighten bolts. Use fender and lock washers.



**38** Last step is to slide blind aprons in place. Push tongue at apron's top into groove in underside of the rail cap.

## HOW IT WORKS

# ELECTRIC SERVICE PANEL

BY MERLE HENKENIUS  
PM Illustrations  
by George Retseck

**T**HE HEART OF every home's electrical system is its service panel, yet few of us understand how these devices work, how they feed and protect the appliances we count on to make our lives easier. To many of us, that gray metal box on the basement or garage wall harbors an ominous mystery, and one, we are told, that is better left alone.

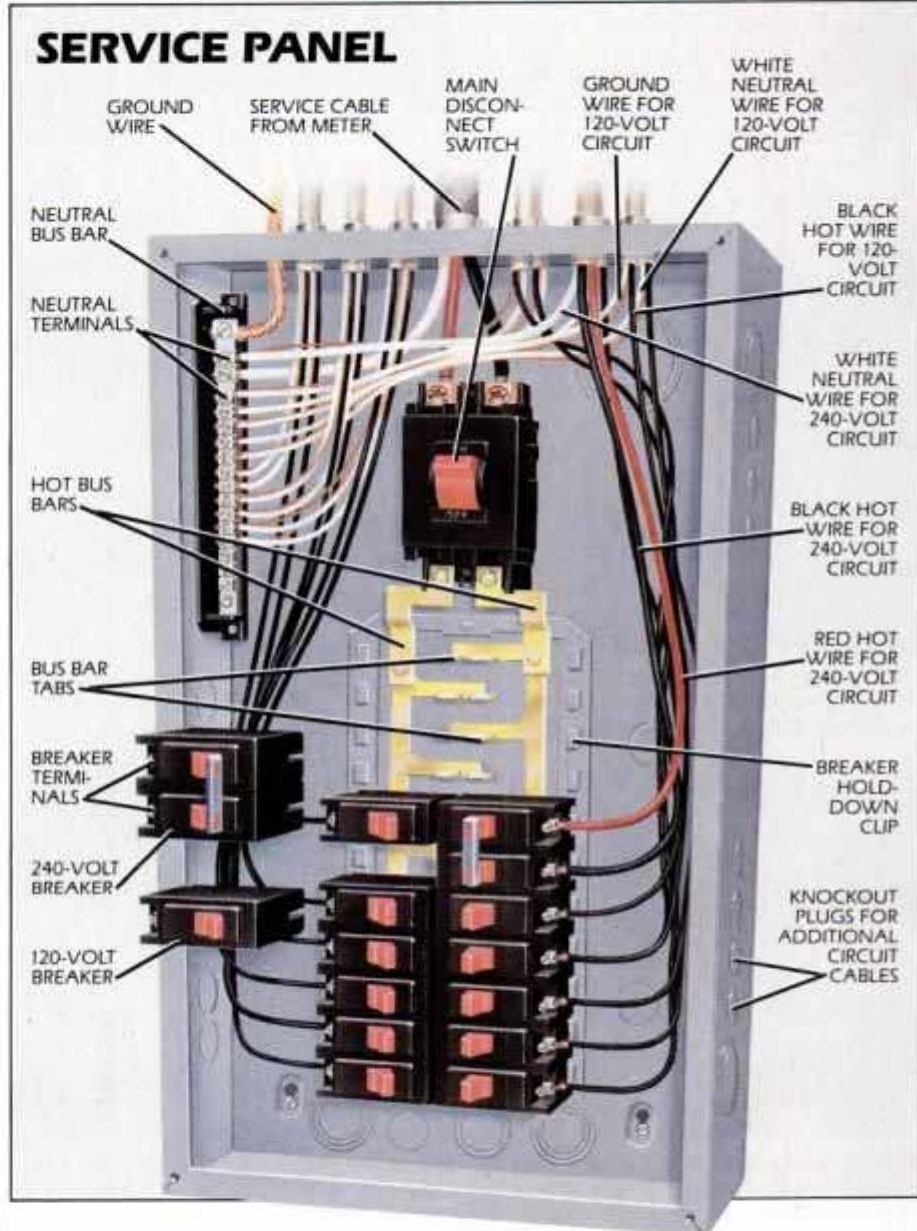
While there is life-threatening voltage present in every service panel, it flows in a precise, logical pattern. In fact, a service panel is little more than a distribution box with built-in safety features. It routes current from a power source and sends it through the household circuitry.

### From transformer to panel

Before the power reaches your home, a transformer, usually located on a nearby power pole, reduces the high voltage carried in service lines to three electrical phases, each consisting of roughly 120 volts.

Now, imagine that each phase has a hot terminal to which we might fasten circuit wires, and that midway between two of those phases is a neutral terminal. If we tap only one terminal, plus the neutral, we'll have a 120-volt, single-phase system. If we tap two terminals, plus the neutral, we'll have a 240-volt, 2-phase system which is considered standard these days. The sizes of the wires and the ratings of the service panel components will then dictate the amperage capacity available to you; typically 100, 150 or 200 amps.

All electrical pathways must complete a circle in order to carry electricity. In the case of 120-volt circuitry, the originating wire is designated *hot* and the return wire is designated



*neutral*. Newer circuits will also contain a bare ground wire that provides an alternate pathway for any stray surge of current, like that which occurs in a short circuit.

Because two phases in the transformer are tapped for a 240-volt circuit, two hot wires are needed, along with a neutral wire. Keep in mind that a 240-volt system is not merely two combined 120-volt circuits, but two 120-volt circuits that are out of phase with each other.

### Life in a service panel

At the top of the panel, the two hot wires are connected to the two termi-

nals of a main-disconnect switch. This switch is in turn fastened to two hot bus bars. By turning the switch on, the two hot conductors extend the circuit into the bus bars and provide connecting points for the house circuits.

In order to facilitate breakers, each bus is equipped with tabs. These are positioned alternately, in two vertical rows. When counting down each row, tabs 1, 3, 5 and so on are from one phase and 2, 4, 6 and so on are from the other. This configuration allows a double, 240-volt breaker to tap both phases at any position on the bus.

The neutral service wire is fastened to a neutral bus bar that's bonded to

the panel cabinet. (Some panels also contain a separate grounding bus, which is connected to the neutral bus by means of a jumper.) In most cases, a single ground wire extends between the neutral bus and the metal water pipes inside the home. In this way, any ground-fault current, from lightning or short circuits for example, would be bled through the water service pipe, leading to the city water main, and would be diffused in the soil outside the home.

Grounding to earth and to metal plumbing pipes provides a critical measure of safety. Although many older homes do not have individually grounded circuits, a grounded panel is an absolute must.

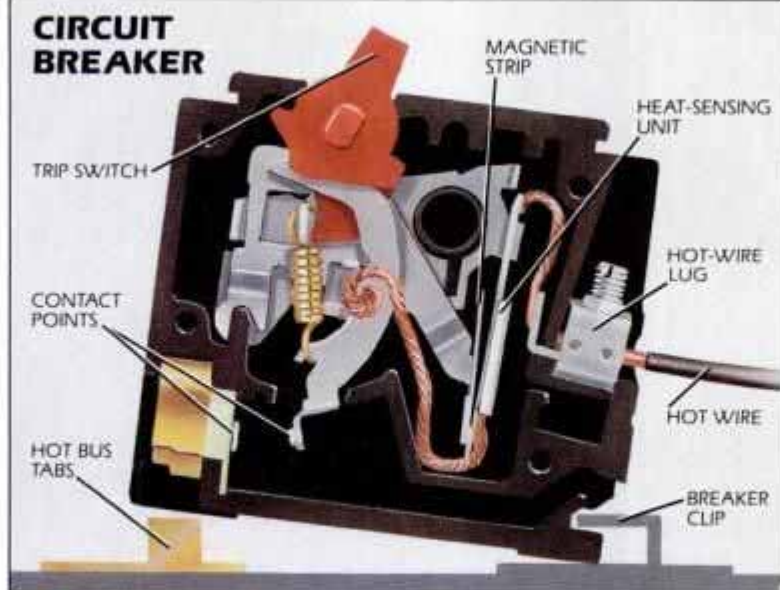
### How circuit breakers work

Breakers are automatic switches, designed to sense dangerous, heat-producing problems elsewhere in the system. Each breaker is calibrated to withstand a given passage of current or amperage. The operating mechanism of a circuit breaker is a small heating element connected to a magnetic strip. In a 20-amp breaker, for example, the element produces an amount of heat consistent with 20 amps of current. If more current passes through the breaker, as happens with a short or an overload, additional heat is produced by the element and the breaker trips.

### How fuses work

Older panels have fuses instead of breakers. The primary difference is that a fuse is not renewable.

An Edison-base fuse is the oldest and simplest type. Here, current flows from a contact point on its base, through a narrow metal strip, and into its brass threads. The metal strip is narrowed at one point. When an



When too much heat is generated by current overload, sensor will trip magnetic strip attached to switch and contact points will open, shutting off current.

overload creates more heat than the reduced portion of the strip can withstand, it burns through, interrupting the flow of current.

The problem with a standard Edison-base fuse is that it cannot withstand a temporary overload. Because most electric motors require up to five times more amperage to start than to run, temporary overloads are common, even though they pose little direct threat to a circuit. To circumvent this problem, fuse manufacturers offer time-delay units which are designed to withstand brief overloads.

A common time-delay fuse treats short circuits and overloads separately. In these dual-element fuses, a fuse strip will burn through instantly

when a short circuit occurs, but a separate, spring-loaded filament guards against overloads. One end of the spring is anchored in lead at the base of the filament. In the event of a prolonged overload, the lead melts, releasing the spring and opening the circuit.

### Connection in the panel

On the user's end, appliances and lights will join the two sides of the circuit through receptacles and switches. The panel connections, however, must be made individually. The white neutral wires

from each circuit are fastened to a series of terminals on the neutral bus bar. All circuit ground wires are also connected to the neutral bus, unless the panel contains a dedicated grounding bus. Each circuit hot wire is fastened to the binding terminal of its own breaker. The breaker is then pressed over a copper tab on the hot bus bar.

When a 240-volt circuit is installed, a double breaker with a 240-volt rating is used. Each hot wire (one red, one black) is fastened to a separate terminal on the double breaker and the breaker is pressed over two adjacent bus bar tabs. In this way, the double breaker taps both phases from the transformer. The neutral and

ground wires are then fastened to the neutral bus. If the panel contains a separate grounding bus, all circuit ground wires will be connected to it.

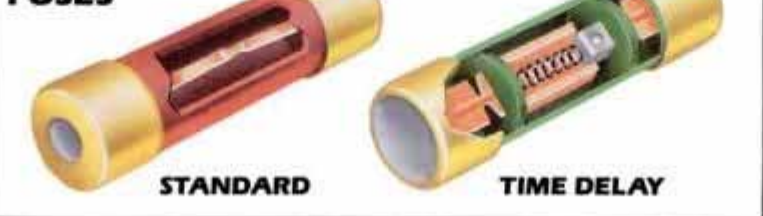
As you can see, the design of a modern service panel provides some protection against electrocution, in that the neutral and hot bus bars are positioned several inches apart. Even so, its primary function is to protect the rest of the system. With that in mind, any work within a panel should be done with the main-disconnect switch in the OFF position. **PM**

### EDISON-BASE FUSES



Fuses have Edison-base or cartridge shape. Both are available with single element or double time-delay elements for temporary overloads.

### CARTRIDGE FUSES



**WOODWORKING  
PROJECT**

**HOW TO  
MAKE  
WOOD  
SPOONS**

TEXT AND PHOTOS  
BY ROSARIO CAPOTOSTO,  
Contributing Editor

**M**ANY WOODWORKERS are content to build furniture in their spare time and leave it at that. They ignore projects such as carving wood spoons, which not only sharpen their woodworking skills, but also result in useful household items.

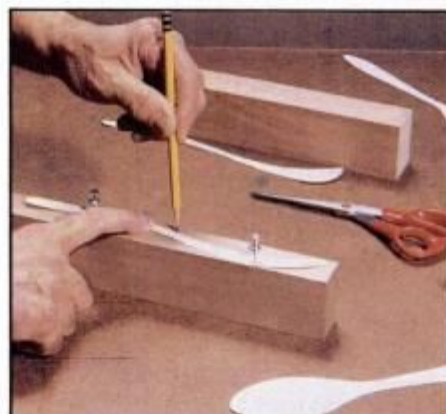
The nice thing about these small projects is that they require minimal tools and materials. I used a carving gouge, coping saw, rasp and an electric drill with sanding attachments and a rotary file. You could get by with a gouge, some sandpaper and a rasp or even a stout pocket knife.

I used maple and cherry for this set, but birch will work, too. You might also try carving a piece of firewood. Species such as dogwood or apple make good and durable spoons.

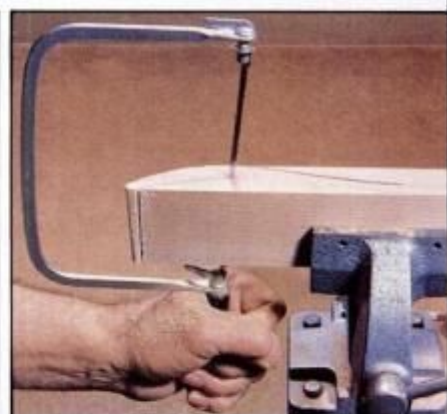
**Patterns and shaping**

Begin by sketching the outlines of each piece in side and plan view on a piece of heavy paper. Use our drawing as a guide. Cut out the patterns and set aside. Rip and crosscut the blanks for each workpiece slightly larger than the finished size.

Tack the side pattern of each spoon



**1** Make patterns using drawing as guide. Then pin pattern on blanks and trace side outline first using sharp pencil.



**2** Clamp spoon blank in vise and cut on profile line with coping saw equipped with coarse-cutting, 10-pt. blade.



**3** After cutting the side profile, trace plan view on spoon blank. Keep pattern tight against curve as you trace.



**4** Hollow the spoon bowl using a fishtail (shallow curve) gouge. Push gouge from bowl's rim to its center.



**5** Smooth away carving marks with sanding drum in electric drill. Move drum over bowl from front to back.

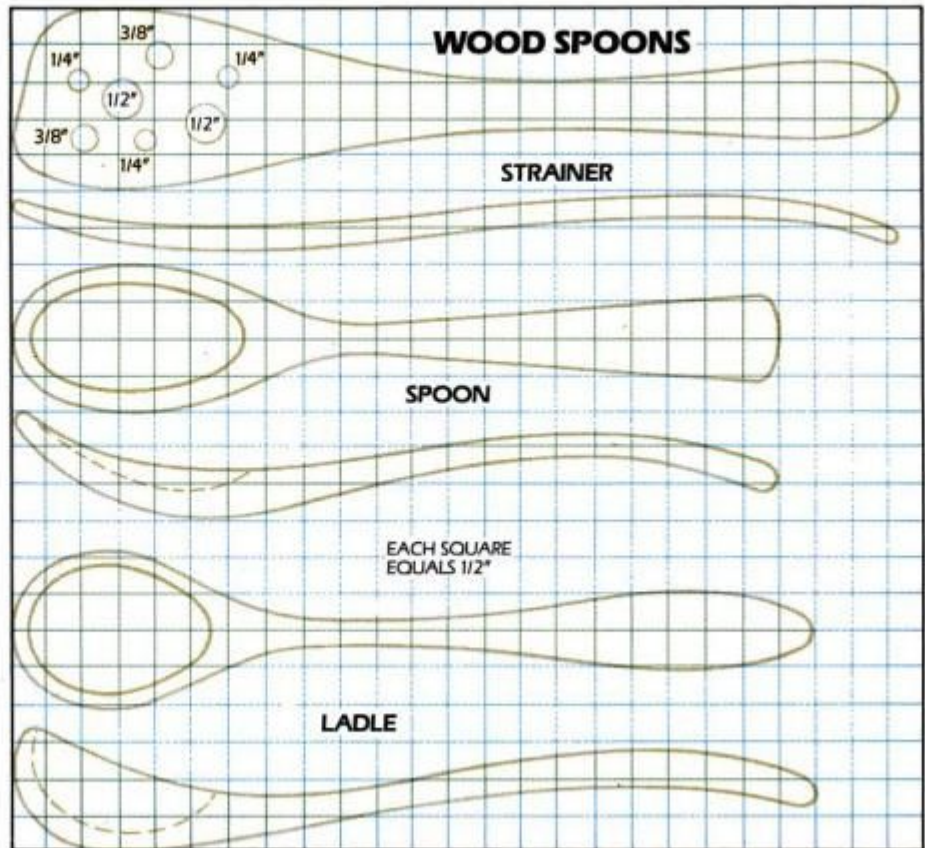
to its blank and trace along it with a sharp pencil (Photo 1). Then lay out and bore the holes in the strainer spoon. When this is done, clamp each workpiece in a vise and cut along the lines using a coping saw fitted with a coarse 10-pt. blade (Photo 2).

Next, tack the plan-view pattern to each workpiece and trace around it (Photo 3). Then begin shaping the spoon by clamping its blank in a vise, and carving out the bowl with a gouge. Pare down from the bowl's rim to its center (Photo 4). To remove gouge marks, smooth the bowl using a 1½-in. or 2-in.-dia. sanding drum in an electric drill. Use 120-grit then 220-grit sandpaper. Keep the drum moving front to back (Photo 5).

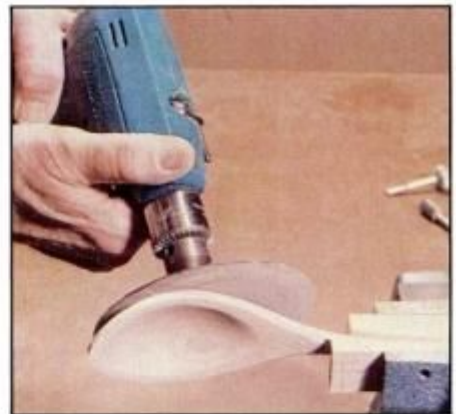
Next, saw out the spoon's plan-view profile (Photo 6), and rough shape its outside with a wood rasp. Then, use the curved scrap pieces from cutting the side profile to hold the spoon in the vise, and smooth out rasp marks with a sanding disc and drum using 120-grit and 220-grit paper (Photo 7). Finish sand the spoon with 220-grit paper worked by hand.

Shape the ladle's bowl with a rotary file (Photo 8). Move the file in an arc, right to left. Apply firm pressure to counteract the file's tendency to climb out of the bowl. Use lighter cuts as you finish, then sand by hand with 120-grit and 220-grit paper. Saw out the ladle's profile, rasp it to shape and disc sand it as you did with the spoon (Photo 9). The ladle's handle is curved in sections and this prevents using scrap pieces to hold it in the vise, so wrap foam or a rag around the handle.

The strainer is the simplest of all. Just cut both profiles with the coping saw, then round the edges with a rasp and sandpaper. Finish the spoons by rubbing in a couple coats of olive or vegetable oil (Photo 10). **PM**



**6** Cut spoon's plan profile by sawing toward blank's center. Switch the blank end for end in vise to finish cut.



**7** Clamp spoon in vise with cutoffs as cushions. Shape outside of bowl with sanding disc and drum in electric drill.



**8** Use a rotary file in electric drill to hollow ladle bowl. Make arcing passes, moving file right to left to counter file's spin.



**9** As with spoon, shape back of ladle with sanding disc. Cushion ladle handle in vise with foam or piece of cloth.



**10** To finish spoons, apply olive or vegetable oil with soft cloth. Reapply oil when finish starts to wear.

## TOOL TEST

# NEW BELT SANDER

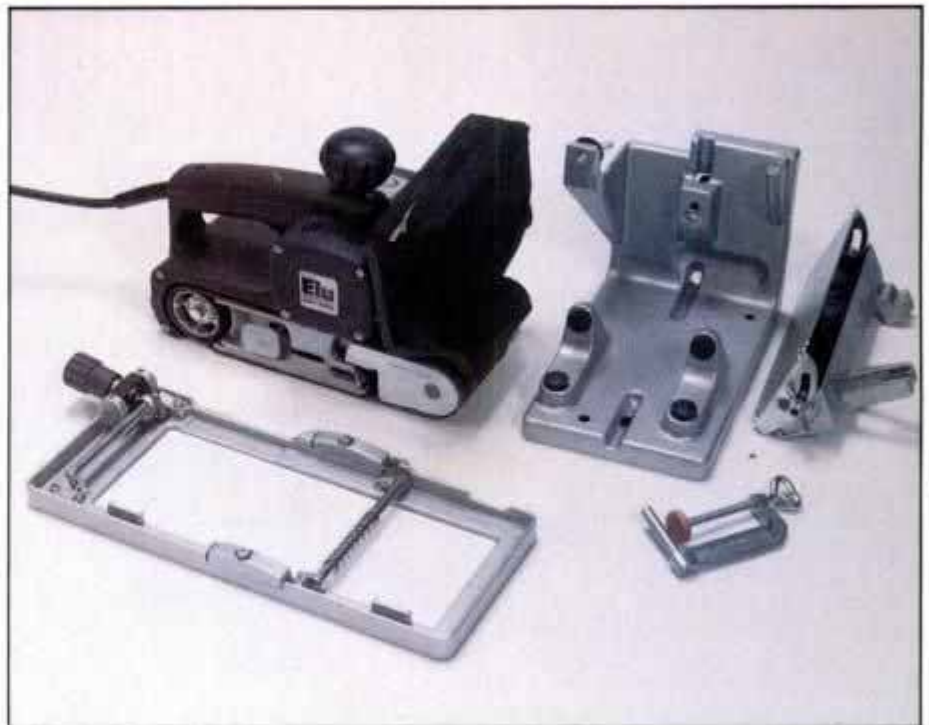
TEXT AND PHOTOS BY  
ROSARIO CAPOTOSTO,  
Contributing Editor

**T**HE ELU MODEL 4024, 3 × 21-in. belt sander is compact, nicely balanced and easy to handle. At 6.2 pounds, it's light enough to use with one hand, an advantage in shaping curved surfaces. My only complaint about the sander is a minor one. The front grip is a little too close to the dust bag to make for comfortable two-handed use (Photo 1).

By sliding a switch on the handle's side, the sander's speed is easily adjusted from 475 to 1100 sfpm (surface feet per minute). At top speed, with an 80-grit belt, the sander hogs off material. Slowed to 475 sfpm, the same belt stays cool enough to remove paint without gumming up. Belt changing is a snap. Flip the lever on the sander's side to release roller tension (Photo 2).

The stand (\$85) converts the Elu into a bench-top stationary sander, and is a handy accessory for shaping small parts. It's easier to move small parts over the sander than vice versa (Photos 3 and 4). The sanding frame (\$42) is used on broad, level surfaces to prevent gouging or to span two edges (Photo 5).

The Elu Model 4024 is available at Black & Decker tool dealers for about \$290. For more information, write to Black & Decker, 10 North Park Dr., Hunt Valley, MD 21030. **PM**



Elu's 3 × 21-in. belt sander can be converted to stationary use with the stand and fence, right. Sanding frame, foreground, keeps sander level to prevent gouging.



**1** At 6.2 pounds, Elu is light enough to use with one hand. Two-handed use is somewhat awkward due to dust bag position.



**2** To change belts, lift lever on sander's side to retract front roller and release tension on belt. Then slide belt off.



**3** Unscrew front handle and bolt sander to cast-aluminum stand to convert it to benchtop sander. Table tilts to 45°.



**4** Sander and stand can be tipped over and clamped to bench. Sander table is repositioned to serve as tilting fence.



**5** Sanding frame keeps sander level to prevent gouging on broad surfaces or spans two edges, as with drawer top.

## NEW EQUIPMENT

# SNOW MACHINES

BY STEVEN WILLSON,  
Home and Shop Editor

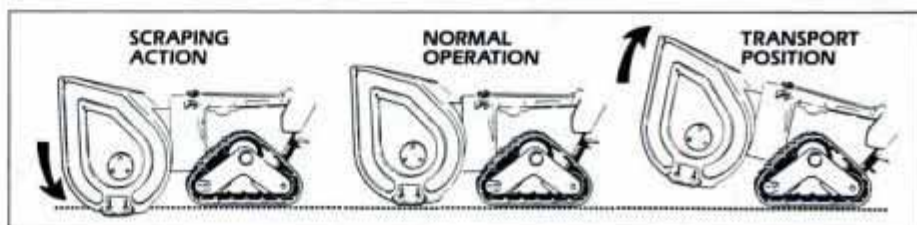
**S**OME FOLKS try to make the best out of cold, snowy weather. They ski, skate, play hockey, build snowmen and snow women and basically carry on as if winter was a wonderful time. Even if you share these enthusiasms you probably don't pursue them in your driveway, where a foot of snow can keep you home no matter what your plans.

Here are two new machines that can take much of the drudgery out of snow removal. One's a big gas-powered model with a track drive. The other is a smaller electric unit.

### Gas Power

Simplicity's 870 ST snowthrower is a big, rugged machine. It weighs in at 284 pounds and stands 37 in. high to the top of the handle. The 2-stage machine is driven by an 8-hp Tecumseh engine and cuts a 28-in.-wide path. But *big* is not always *better*. This machine boasts several notable features besides its size. The first is its distinctive triangular track drive. Generally speaking, a track design is preferred for slippery, steep or uneven terrain because of the added grip provided by the tracks. The tracks also tend to guide the machine in a straight path, thus requiring little steering effort. Simplicity improved on the basic 2-sprocket track design by adding a third—which is the drive sprocket—located higher on the machine. This position exposes the drive sprocket to less dirt and moisture. It also prolongs the track life because it turns only 130° around each sprocket instead of the normal 180°.

Another notable feature is something the manufacturer calls its Power Boost System. This senses snow depth and density and changes the rpm of the second-stage impeller to accommodate heavier loads. The unit has five forward and two reverse speeds for different snow conditions. It costs \$1529; an optional electric-start kit costs \$127. The same machine with wheel drive, model 870S, costs \$1399. Contact Simplicity Manufacturing, Inc., 500 North Spring St., Port Washington, WI 53704.



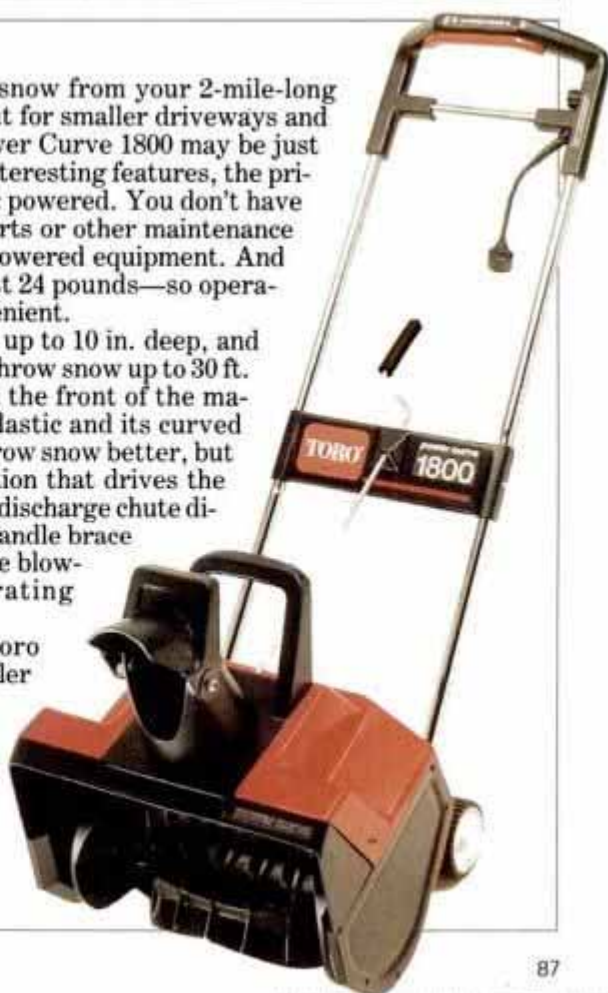
Track-driven blower was designed for rough, uneven terrain. Auger can be adjusted to three different heights—depending on surface conditions—by simply stepping on lift pedal.

### Electric Power

You may not want to remove snow from your 2-mile-long driveway with this machine, but for smaller driveways and sidewalk work, Toro's new Power Curve 1800 may be just what you need. It has several interesting features, the primary one being that it's electric powered. You don't have to worry about hard winter starts or other maintenance problems that can plague gas-powered equipment. And the machine is lightweight, just 24 pounds—so operation and storage are more convenient.

The 1800 cuts an 18-in. path, up to 10 in. deep, and the manufacturer claims it can throw snow up to 30 ft. away. The distinctive rotor on the front of the machine is made of high-impact plastic and its curved shape is supposed to not only throw snow better, but also create a self-propelling action that drives the machine forward. A convenient discharge chute direction crank is located on the handle brace so you can change the path of the blowing snow while you are operating the machine.

The 1800 sells for \$299 at Toro dealers. A similar, though smaller machine, the Toro Power Curve 1200 is available for \$229. For more information and details about these snowthrowers, contact The Toro Co., Home Improvement Div., 5300 Shoreline Blvd., Mound, MN 55364.

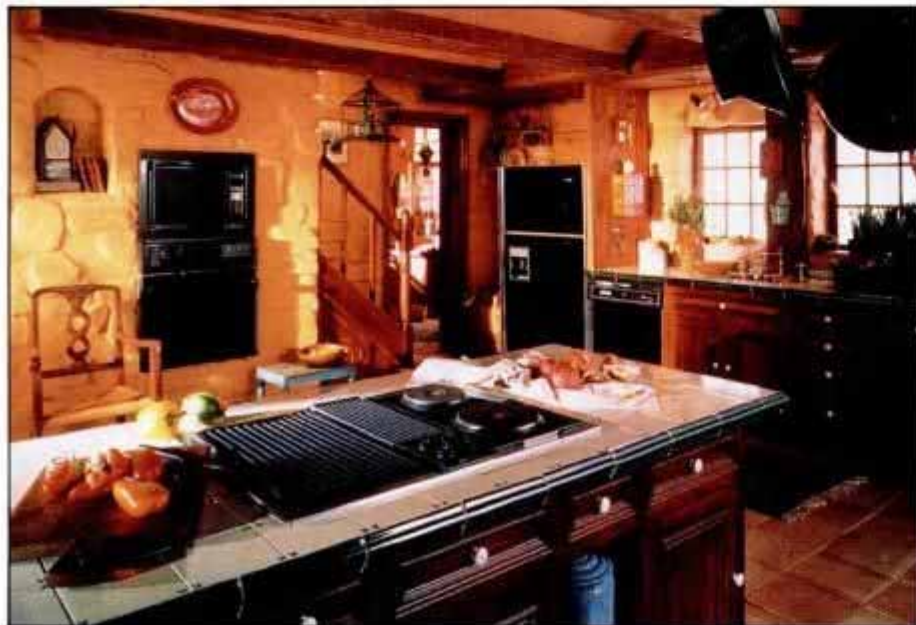


NEW PRODUCTS

# HOUSEHOLD HELP

Twelve home appliances that make life easier.

BY ROY BERENDSOHN, Assistant Home and Shop Editor



## Long-Range Range

You can position the cooktop (above) or range (right) practically anywhere, because both can exhaust cooking fumes farther than previous models. Both units feature a down-draft venting system with powerful blowers that can exhaust fumes about 50 ft. to an outside wall. Each comes with a grill, and you can choose from among four plug-in cartridges (which cost extra) to complement or replace the grill. Both models shown have a black glass top and solid Eurostyle elements.

The cooktop costs about \$700-\$750 and the range about \$1650-\$1800 (cartridge included) at appliance dealers. For more information, write Jenn-Air Co., 3035 Shadeland, Indianapolis, IN 46226-0901.



## Water Wick

Sears' new humidifier replaces belts and water wheels with a removable wicking system for quiet operation. The system is treated to reduce odor-causing bacteria. Honeycomb construction retains the minerals suspended in the water to reduce mineral dust residue that can accumulate on furnishings near the humidifier. A dry-out feature eliminates having to empty the tank before refilling, and an indicator light signals when the UL listed unit is nearing empty. It's sold in four sizes: 8, 10, 12 and 14 gallons. Prices are \$89, \$107, \$127 and \$159. Write Sears, Dept. 703 PM, BSC 40-16, Sears Tower, Chicago, IL 60684.



## Cordless Wonder

Eureka's 12-volt Freedom is the first full-sized cordless vacuum cleaner on the market. Fully charged, the 14-pound upright runs 30 minutes on a lead-acid battery and recharges overnight (about 4 or 5 hours). It features a low profile, 4-in.-high head for cleaning under couches and it has a 3-position handle and headlight. It sells for about \$300 at appliance retailers. For more information on the Freedom cordless vacuum cleaner, write The Eureka Co., A Division of Union Electric Corp., Bloomington, IL 61701-6902.



## Cleanup Crew

For more thorough cleaning, Black & Decker's car vacuum has a detachable front beater brush assembly, powered by a separate motor. The beater brush digs out dirt while the vacuum has extra power to pull it away. Accessories are available to enable it to clean crevices, upholstery and instrument panels. It also has built-in cord storage for when the vacuum is not in use. The UL approved Car Vac plugs into your car's 12-volt cigaret lighter, comes with a 2-year home-use warranty, and costs about \$39 at department and discount stores. For more information, write to Black & Decker, U.S. Power Tools Group, 10 N. Park Dr., Box 798, Hunt Valley, MD 21030-0748.







## L-Shaped Air

The clever L-shaped chassis of this air conditioner places the compressor outside, below the window sill. This yields quieter cooling and allows the vent panel to take up just 6.5 in. of window space height. It's sold at appliance dealers in 6000- and 8000-BTU sizes, \$489 and \$599, respectively. For more information, contact Panasonic Co., Consumer Affairs Dept., 1 Panasonic Way, Secaucus, NJ 07094.



## Hot And Cold

Advanced electronics characterize this refrigerator and cooktop. You can change the temperature on the 25-cu.-ft. refrigerator (top) by simply pressing a touch-control panel on its door. It also has a setting for quick-freezing large amounts of food and audible/visual signals to alert you to mechanical malfunctions or if a door is left open. The smooth, black glass cooktop (above) features a quick-heating 8-in. quartz-halogen heating element. The other three elements are electrical resistance coils. The refrigerator costs about \$1900-\$2100 and the cooktop \$600-\$800 at Amana dealers. For more information on this refrigerator and electronic cooktop, write Amana Refrigeration, Inc., Amana, IA 52204.

## Slide Out, Pop Up

You can reduce the clutter on your kitchen counter with this 4-slice, slide-away toaster. It fits into the wall cavity between standard-spaced (16 in. on center) studs. It features a slide-out crumb tray and a safety disconnect switch that prevents the toaster from being activated inside the wall cavity. Each 2-slice side of the toaster has its own knob-controlled browning setting. The Model TO-1000 is UL approved and costs about \$190 at kitchen and bath outlets and appliance dealers. For more information, contact Iron-A-Way, 220 W. Jackson, Morton, IL 61550.



## Wide Range

Modern Maid introduces the industry's first gas downdraft range. It features a generous 3.7-cu.-ft. self-cleaning oven and a full-width storage drawer below. The built-in exhaust blower is designed to make the unit easier to install without sacrificing oven space. The range is offered in all black with chrome trim and you can choose among four plug-in cartridges (rotisserie, grill, griddle and gas burner). It costs about \$1000 at Modern Maid Appliance dealers.

For more information, write Modern Maid Co., 403 N. Main St., Tipton, PA 19562-1499.



## Hands-Off Can Opener

Set Black & Decker's cordless electric opener on a can and switch it on. Its power punch automatically punctures the lid. The opener then slices its way around the lid. When it's finished opening the can, it shuts itself off. Lift it off the can and the opener's magnet pulls off the lid. Just slide the opener back into its base, which plugs into a wall outlet. The Handyopener costs about \$30 at hardware stores and homecenters. Write Black & Decker, U.S. Household Products Group, 6 Armstrong Rd., Shelton, CT 06484.



## Hot Dish

Designed to focus heat like a satellite dish focuses TV signals, this parabolic-shaped 1000-watt heater costs a third less to operate than forced-air heaters, according to folks at Presto. Its top-mounted thermostat control permits a wide range of settings. Other features include an automatic shutoff switch and loud buzzer if the unit tips over. The UL listed Heat Dish costs about \$60 at hardware and department stores. For more information, write to Presto, Box 1212, Eau Claire, WI 54702-1212. **PM**

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Torque? You'll be lucky if it doesn't pull you into next week when you put it in gear.

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Dodge Cummins Turbo Diesel gets the best mileage of any diesel pickup.\* And, it accelerates fastest and handles high altitudes best.

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*The tough new spirit of Dodge.*



\*These outlandish claims are based on independent acceleration tests (with equal loads) and dynamometer fuel efficiency tests of an '89 Dodge D250 versus comparably equipped '88 Chevy C3500 and '88 Ford F250 (w/loopt. auto, trans. and a.c.). Buckle up for safety. Nice magnifying glass.



*Dodge Cummins Turbo Diesel*

# How To Repair FROZEN PIPES

BY MERLE HENKENIUS; PM Illustrations by George Retseck

**W**INTER IS the season of frozen pipes. While there are a few things you can do to keep pipes from freezing, once a freeze occurs, you'll need to fix it immediately to avoid water damage.

Most freezes occur in crawl spaces, in floors cantilevered over the foundation or areas where cold air enters through cracks in walls, roof or foundation. The room temperature is often well above freezing, but exposure to a thin stream of cold air is all that's required to freeze a pipe.

When freezes occur within interior walls, look to the upper reaches of your home for an air leak. It's quite common, for example, for an entire bath group to freeze when cold air is driven down a flue or chimney chase, especially when the chase is framed in wood instead of built with masonry. Be sure to check the flashing at the top of the chimney chase for a leak. Caulk gaps in flashing or nail it down if it's loose.

If a freeze occurs within a plumbing wall that joins an exterior wall, look for a poorly nailed lap in vertical siding. Also, check for a broken putty seal around gas pipes or air-conditioning lines that pass through the exterior wall.

Insulation is the best prevention. Spaces between sills and block walls should be packed with batt insulation. Pipes in a crawl space or cantilevered floor joists should be insulated, too. Foundation cracks should be pointed with mortar or caulked.

Contrary to popular belief, hot water pipes will freeze. All things being equal, hot water pipes freeze before cold water pipes. A likely reason for this seemingly illogical occurrence is that heated water contains fewer dissolved mineral salts. These salts are cooked out and remain as scale in heaters and boilers. Just as salt added to water produces a higher boiling temperature and lower freezing temperature, salt removed has the reverse effect. When temperatures are at the freezing margin, the hot side will freeze while the cold side may



Sometimes the water inside a pipe will freeze and not break the pipe. If this happens, the fix is easy: Just heat the frozen section with a heat gun or soldering torch.

not. The lesson here is that both cold and hot water pipes should be insulated in questionable areas.

Another common freeze point is the drainage chamber of a frost-proof sillcock. These outside faucets rupture in cold weather when hoses are left attached and air lock prevents the water in them from draining. Their water flow is stopped ahead of their drainage chamber, so a leak won't be detected until the sillcock is used in the spring.

## Making repairs

Begin by shutting off the water supply at the meter or where it enters the house from the well. Then open all faucets.

To get at a ruptured pipe, you may

need to cut away some drywall or plaster. But make any holes as small as possible to minimize repair work later.

Next, thaw the frozen pipe with a heat gun or torch. If using the latter, put a doubled-up piece of sheetmetal behind the pipe to prevent burning adjacent framing members. Keep a fire extinguisher handy just in case.

The repair approach you'll take will depend on the type of piping material you have. Splits in copper piping are better removed (Fig. 1) and a new section of copper pipe spliced in place (Fig. 2).

Freezes in steel piping (commonly called iron piping) occur along the pipe's rolled seam. Quite often, if you can get at the seam, you'll be able to

tap it closed with a ball-peen hammer and install a repair clamp over the split (Fig. 3). Of course, removing the split section (Fig. 4) and replacing it with a threaded union and new length of pipe is a better alternative (Figs. 5 and 6).

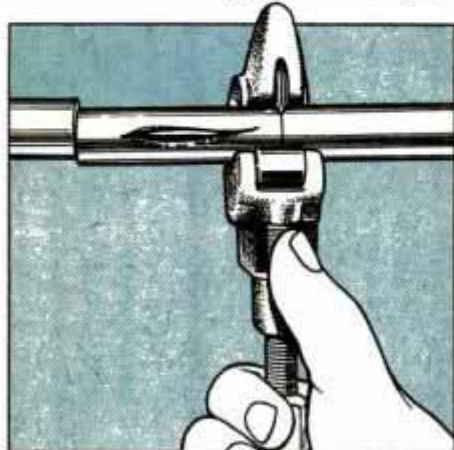
As plastic water pipes will nearly always split with a freeze, you'll have to cut out the damaged section (Fig. 7)

and replace it. In most cases, you'll simply splice a new section in place using solvent-cement couplings. All you'll need is a tubing cutter or hacksaw, couplings, cement and a stub of pipe.

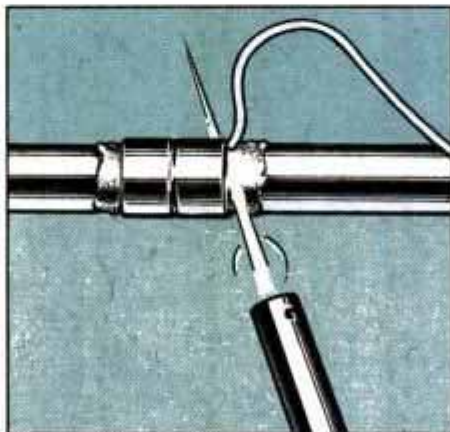
If the split is small, however, you may be able to cut out only an inch or so and join the two ends with a push-fit plastic coupling. Lubricate the pipe

with dishwashing detergent, push on the fitting and tighten (Fig. 8). Its O-ring seals are virtually leak-proof.

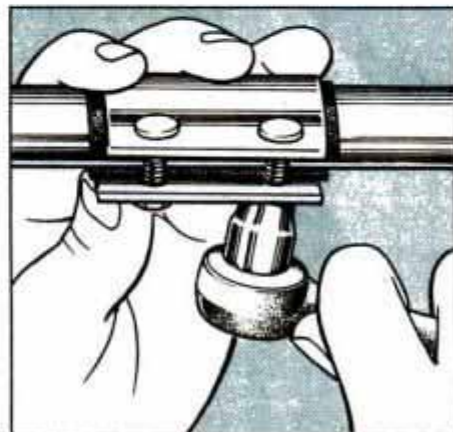
Frozen frost-proof sillcocks are better replaced with models having built-in vacuum breakers. They're called freeze-proof sillcocks. (For more information on this project, see our story: "How To Install A Freeze-Proof Sillcock," page 87, Sept. '89.)



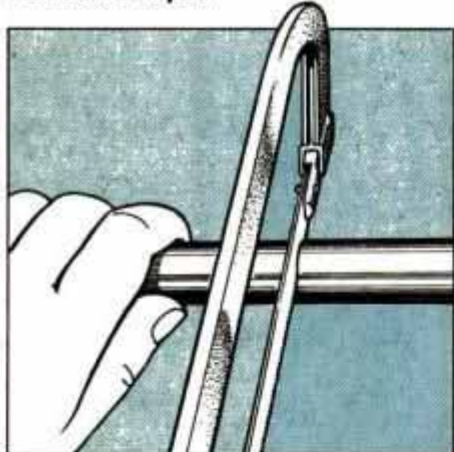
**1** Cut out ruptured section of copper pipe using tubing cutter. Make the cuts at least 1/2 in. from the split.



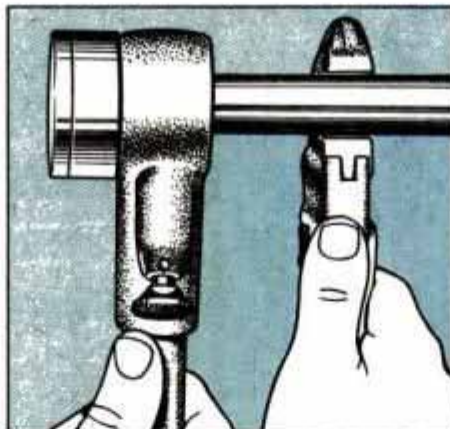
**2** Apply flux to new section of pipe and install with sweat couplings. Hold solder above and heat from below.



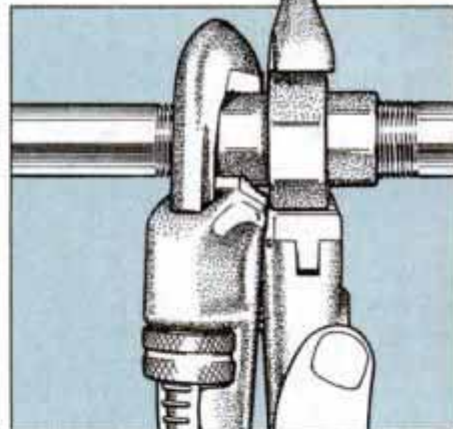
**3** Steel pipe often ruptures along its seam. Often you can tap seam shut with ball-peen hammer, then install repair clamp.



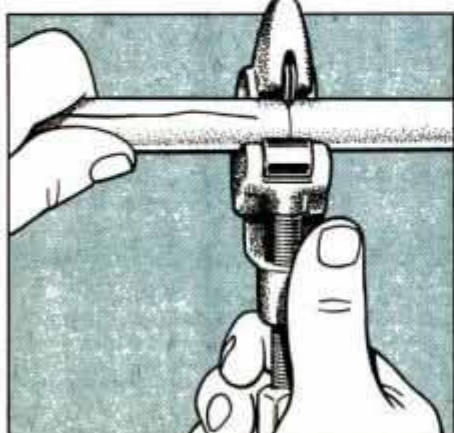
**4** Cut iron pipe with hacksaw a few inches beyond split. Use wrench to unthread damaged pipe from nearest fitting.



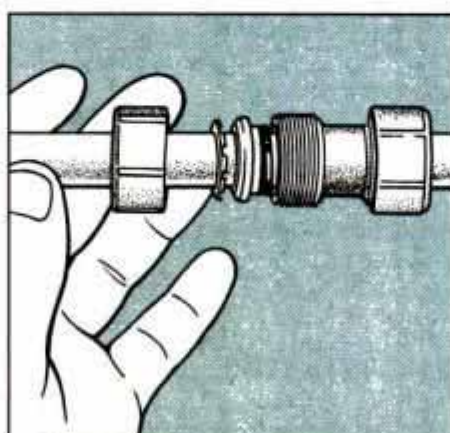
**5** Cut threads on end of remaining pipe with a die. Hold pipe securely with pipe wrench while cutting new threads.



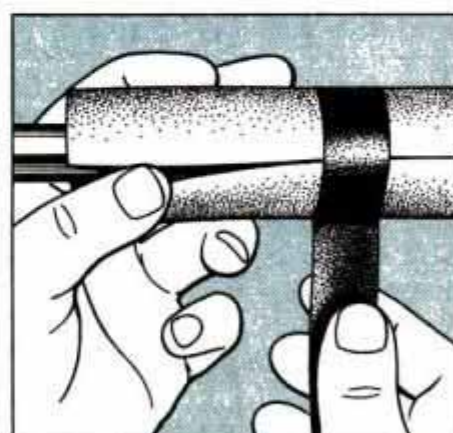
**6** Cut, thread and install new replacement pipe. Join pipe ends with pipe joint compound and union fitting.



**7** Cut out ruptured plastic pipe with tubing cutter. Make sure to remove all damage. Splits can be hard to detect.



**8** Join new pipe to existing pipe with couplings and cement. Or, for small splits, use push-fit coupling (above).



**9** Cover pipes exposed to cold air with foam-rubber insulation, split to wrap over pipe. Tape insulation every 12 in.

# Homeowners' Clinic

BY NORMAN BECKER, P.E., Contributing Editor

## Relief Valve Piping

My home's water heater is in the basement just several feet from my library. If the heater's relief valve lets go, many books, along with furniture, would be damaged or destroyed by the hot water. A pipe runs from the relief valve down the outside of the heater and ends about 4 in. above the floor. There is a floor drain about 4 ft. from the heater.

Is there a recommended (and easy) way to modify this system so the hot water could be contained, piped outside or piped down the drain? Any suggestions for containing an overflow should one occur?

ROY C. DAW  
CHUGIAK, AK

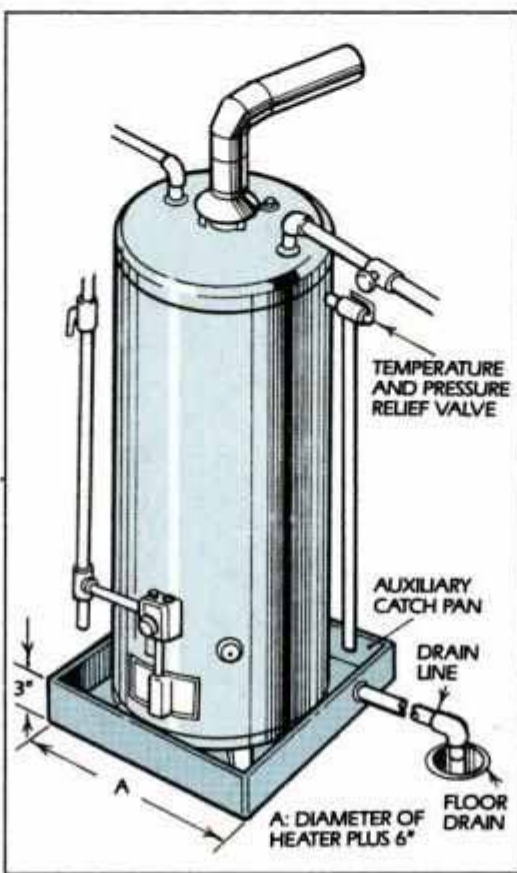
*Discharge from the relief valve indicates a problem such as excessively high temperature, pressure inside the water heater, or even a faulty relief valve. Regardless of the cause, it's important that you know it exists, so you can correct it. If you piped the discharge directly into a drain or outside, you wouldn't know when a problem occurred.*

*When there is a problem, water will not flow continuously from the relief valve like a faucet. It flows in spurts, because as hot water is released from the tank, cold water enters, lowering the temperature and pressure in the tank.*

*One solution is to put a pan under the discharge pipe. Normally, the pan will be dry. If you find water in it, you'll know there's a problem.*

*If you're concerned the pan will fill and overflow, you can run a drain line from the pan to the floor drain. Install the drain line about 1/2 in. above the pan's bottom. If you don't want the drain line to run on top of the floor, because it's a tripping hazard, and you don't want to chip out the floor to conceal it, then install a small pump in the pan, similar to an air-conditioner condensate pump. Run a discharge tube from the pump to any convenient drain or to the outside. Even after the pump has drained the pan, the residual water left will indicate there's a problem.*

*Of greater concern is whether an older water heater leaks. Water heat-*



To contain leakage from water heater's relief valve, place the entire heater on an auxiliary catch pan or direct leakage into smaller pan under relief valve.

*ers generally last from seven to 10 years, but can last 20 years. If your water heater is that old, you might consider setting it on a collecting pan. This will solve the problem of containing water discharged from the relief valve. Inspect the pan periodically and drain it as discussed.*

## Heat Pump Problem

After eight trouble-free years, my Trane heat pump suddenly stopped defrosting. I've had two different technicians check it out only to have them tell me that it's okay. I'm currently defrosting it manually by disconnecting one of the thermistor wires for 3 minutes every so often.

BURKE BRUSH, P.E.  
HARRISON, OH

*Obviously your pump is not okay. Technology has become so complex that it's increasingly difficult for many technicians to stay abreast of*

*the changes and repair all models by every manufacturer. Often repairs are best made by a specialist.*

*I suggest, therefore, that you contact the Trane dealer in Cincinnati and explain your problem. The dealer may know what the problem is or refer you to a Trane service technician in your area.*

*The problem may be a faulty thermistor (a temperature-sensitive resistor). If the heat pump isn't defrosting, then the thermistors may not be sensing the temperature difference between the evaporator coil and the outside air. There is usually a series of thermistors which are tuned to each other, all of which may need to be replaced.*

## Two-Zone Banging

Our raised ranch is heated with hot-water baseboard radiators. We recently had a new gas-fired boiler installed and switched from single to two-zone heating. With both zone valves working, we get banging sounds in various places in the house. I ran the system on the downstairs valve alone and then on the upstairs valve alone. In each case, there was no banging in the pipes.

ROBERT SABO  
WHARTON, NJ

*The problem may be caused by a zone valve closing while the circulating pump is still operating. Depending on how your heating system is wired, the thermostat for one zone may be calling for heat when the thermostat in the other zone is satisfied, and the valve for that zone has closed. The circulating pump may still be pulling water through the system. When that water, moving at 4 gallons per minute, hits the closed valve, it could make the rattling noise. If the zone valves cannot be repaired, you may have to replace them.*

## DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

*Just ask Norman about it. Send your question to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.*

# Appliance Clinic

BY STEVE TOTH, Contributing Editor

## Adjust By Wire

Our Frigidaire Elite Electri-Clean wall oven model REG74BC\*O, serial No. 51CLO485 seems to be hotter than the dial setting. I can't find how its thermostat is adjusted. Can it be adjusted or must it be replaced?

JOSEPH ROBBINS  
CLARESVILLE, GA

*Your oven's thermostat is adjustable. To make the adjustment tool yourself, take a piece of steel wire,  $\frac{3}{32}$  in. dia., or a piece of heavy clothes hanger wire and bend it as shown in the drawing.*

*Place a mercury oven thermometer on the center rack and turn the dial to 400° F. After letting the oven warm up, check the thermometer for the actual temperature. Note how many degrees there is between the setting and actual temperature.*

*Leave the oven set at 400° F but disconnect the power. Pull the oven knob off its stem. Push the adjustment tool into the hole in the thermostat housing. Keep the tool in the hole, and replace the thermostat knob. Slowly rotate the knob until the end of the rod enters a slot on the adjustment insert at the base of the shaft.*

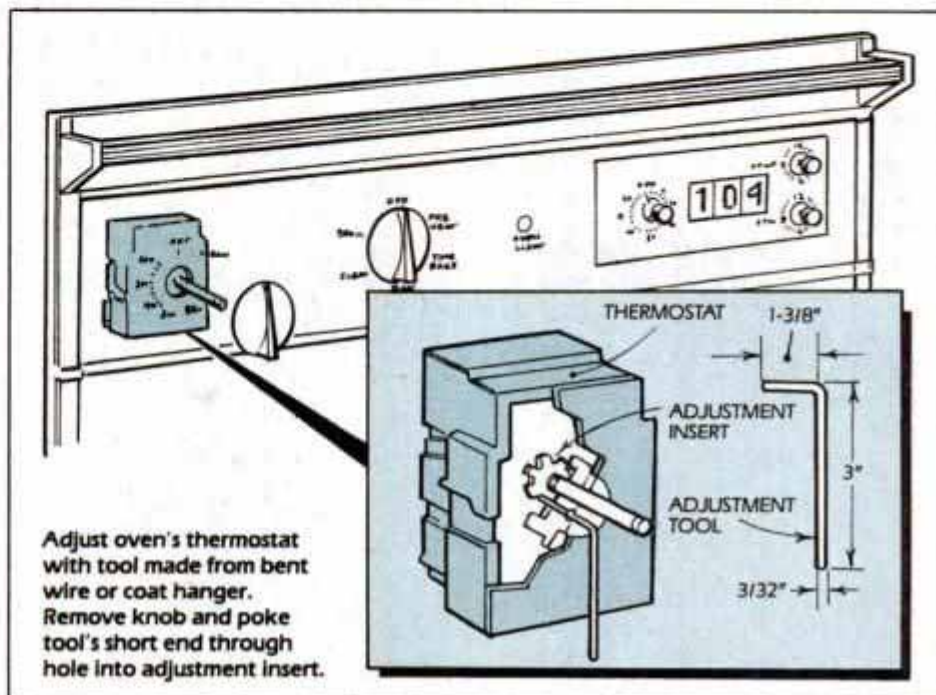
*Holding the tool firmly, turn the knob counterclockwise if the oven temperature was over the dial setting, and clockwise if it was below the setting. Either way, move the knob the number of degrees which the thermometer indicated that the dial setting was in error. Recheck the oven temperature. If the discrepancy persists, replace the thermostat.*

## Timer Or What?

I have a Maytag LDE 412 Auto Dry Control electric dryer. I have a problem with the auto dry, regular fabric cycle. There are times when the dryer runs too long and has to be shut off manually. The Maytag dealer told me the problem is the timer motor (\$50). Is the dealer right, or could something else be wrong?

BOBBY ESCHETE  
THIBIDAUX, LA

*First, disconnect the exhaust vent from the back of the dryer. Turn the dryer on with a load of clothes for 20*



Adjust oven's thermostat with tool made from bent wire or coat hanger. Remove knob and poke tool's short end through hole into adjustment insert.

*to 30 minutes. If the dial advances to the OFF position, there's a good chance the timer motor is okay.*

*Next, set the timer dial to the automatic dry, regular fabric cycle and start the dryer. If the dial advances through the cycle and the dryer shuts off by itself, the problem may be a lint buildup in the exhaust vent. This restricts the airflow through the dryer. In turn, this interferes with the temperature sensing mechanism in the automatic cycle that applies power to the timer and shuts it off.*

*If the dial doesn't move, or if it moves then stops, I suspect the problem is with the timer mechanism and not the timer motor. Mechanically, something inside the timer mechanism is preventing it from moving and you'll need to replace it. It's part No. 3-5448.*

## Radio Interference

We have a Kenmore Electric Range model No. 73316Y/103988787, serial No. 8J19837. I've noticed when using the oven, that the oven-indicator light seems to cause interference on a radio I keep in the kitchen. The radio interference continues as long as the light is flickering. It stops when the light shuts off.

ALVIN GRAF  
MEDINA, ND

*I suspect that the oven's thermostat is making and breaking contact a little too rapidly. With the contacts closed, the oven goes on and closes a circuit to the indicator light. When the oven reaches temperature, the contacts, which are welded to a flat metal spring, open. The space between the contacts may be only the thickness of a hair even though they should be farther apart.*

*A weak contact spring is causing the contacts to flutter. This vibration produces a radio frequency which is generated back through the range to the outlet that the radio is plugged into, causing the static.*

*Replacing the thermostat would be one solution to the problem. A less expensive solution would be to move the radio to another outlet, one that is not on the same circuit as the range. Or if your radio has a universal polarity plug (both of its prongs the same size) remove the plug from the outlet, turn it 180° and plug it back into the outlet. If neither of these steps help, replace the oven's thermostat.*

## DO YOU HAVE AN APPLIANCE PROBLEM?

*Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.*

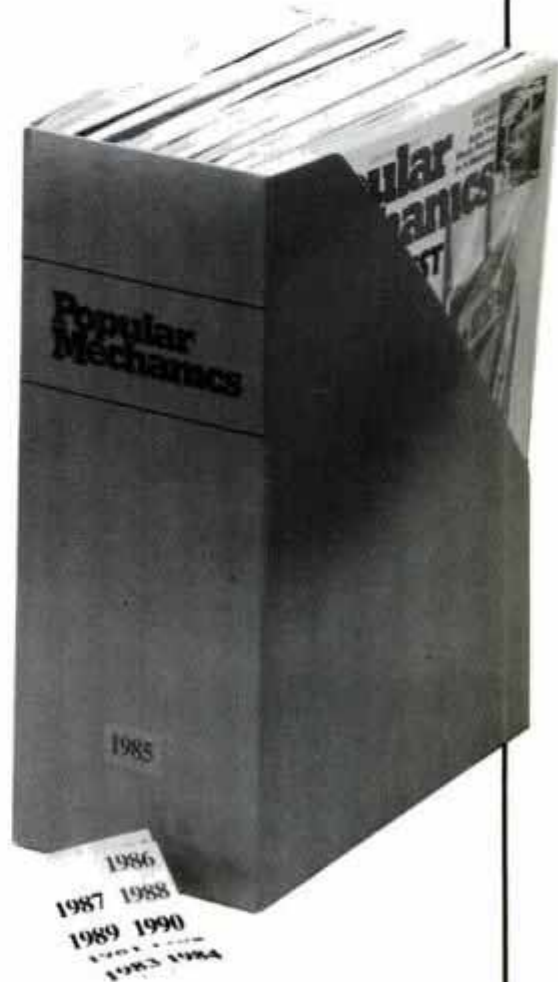
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# IMPORTS '90

## FOREIGN INTRIGUE



GEO STORM GSi

One of the most captivating import car crops on record.

BY RICH TAYLOR, *Contributing Editor*

**T**EN YEARS AGO, who would have believed that Toyota and Nissan would be going head-to-head with Mercedes-Benz and BMW for "Best Sedan In The World" honors? Or that Mazda would create one of the hottest new models by copying a 25-year-old Lotus? Or that Chevrolet would be selling a tiny, high-performance sports coupe made in Japan? Probably not many. But that's precisely the situation we face as the world's car manufacturers head into the '90s.

Not long ago, Japanese companies sold only economy cars. American companies offered primarily middle-class cars, and the Europeans built nearly all the luxury and sports cars. Not anymore. In the '90s, European, American and Japanese companies will wrangle over every point of market share in every category of automobile.

### 1990's All-New Models

One of the most significant new Japanese cars is the Geo Storm, available at Chevrolet dealers. The Storm is a curvaceous Isuzu-built sports coupe with a

## IMPORTS '90

high-output, small-displacement engine and front-wheel drive. In concept, it's the very opposite of Chevrolet's traditional V8 Camaro and Corvette. At around \$10,000, it's also one of the best performance bargains on the road—almost precisely the same size, price and sizzle as Honda's best-selling CRX Si.

The hot-rod Storm GSi is the model to have. It delivers 0-60 under 8 seconds and a top speed over 120 mph thanks to 125 hp from a 1.6-liter Four with 16 valves and double-overhead cams. It also comes with a raft of comfort, convenience and performance items, and still won't strain your pocketbook.

The Storm GSi is not exactly "pretty," but it does have a sprightly, youthful look that's quite appealing. The interior is very cleverly integrated, with excellent ergonomics. The car is a ball to drive, with gentle understeer and a power peak at 6800 rpm that virtually demands you keep it constantly on the boil. In many



NISSAN 300ZX TURBO



PORSCHE 944 CABRIOLET

PHOTOS BY JOHN LAMM

## THE CHANGES IN SHORTHAND

### ACURA

**Integra** is all new for 1990. Engine is now a 1.8-liter, 16-valve Four. Suspension all-independent double wishbones. ABS brakes available. Styling is fuller, more rounded. **Legend Sedan** and **Coupe** are basically carryover models, save for minor cosmetic changes.

### ALFA ROMEO

Alfa Milano sedans have been discontinued in favor of the all-new 3.0-liter **164** sedan now planned for introduction in spring, 1990. **Spider** models remain unchanged since Dustin Hoffman was a boy.

### ASTON MARTIN

The Aston Martin line has been revised. The new **Virage Coupe**, a 200-mph exotic powered by a 32-valve, 5.4-liter V8, will be launched at the Detroit Auto Show. It's already sold out in Europe through 1993. The all-new **Volante** convertible and **Lagonda** sedan will be '91 models.

### AUDI

**80/90**: Only minor changes across the line. Velour upholstery now standard, leather an option. New 4-cylinder head for 2.3-liter 5-cylinder. **100/200**: Has driver's-side airbag, height-

adjustable driver's seat, automatic transmission only, standard leather seats in 200. **Coupe Quattro**: All-new performance car has 135-mph top speed from 164-hp 5-cylinder, ABS, 4-wheel drive and a \$30,000 sticker. **V8**: Big sedan is Audi's first \$50,000+ luxury entry, essentially a 200 with revised styling, 247-hp 3.6-liter.

### BENTLEY

All models have new driver's-side airbag, computerized automatic ride control. **Turbo R** is 155-mph sports sedan with turbocharged 6.7-liter V8.

### BMW

New **850i** sports model will replace 635CSi, features 5.0-liter V12, 6-speed manual gearbox, computerized suspension, price tag approaching six figures; will be here next spring. New **M5** version of 5-series sedan boasts 315 hp from 3.6-liter 6-cylinder. All models come with driver's-side airbag. Computerized traction control is standard on **750iL**, optional on **535i** and **735i**. The 535i has upgraded interior trim, leather and wood.

### CHEVROLET

**Geo Storm** is Chevrolet's all-new sports coupe, built by Isuzu

in Japan. **GSI** version delivers up to 130 hp from a 16-valve, 1.6-liter Four. Inexpensive 2+2 competes with CRX, Eclipse, etc. **Geo Metro** and **Prizm** sedans receive only minor changes. Geo Spectrum has been dropped.

### CHRYSLER

New this year are **Eagle Talon** versions of Mitsubishi Eclipse/Plymouth Laser, with emphasis on the 4wd Talon TSi. Turbo **Colt** dropped in favor of normally aspirated 16-valve, 1.6-liter Four. Minor trim changes on existing models, including the **TC by Maserati**.

### DAIHATSU

**Charade SE** and **SX** are only models in 1990 lineup.

### FERRARI

Mid-engined cars have 3.4-liter V8, are now called **348 GTB/348 GTS**, **Mondial 3.4/3.4 Cabriolet**. 348 series has new bodywork. **Testarossa** deliveries continue, **F40** deliveries begin.

### FORD

**Festiva**, **Mercury Tracer** and **Scorpio** essentially unchanged. Ill-fated XR4Ti has been dropped.

### HONDA

**Civics** have redesigned taillights and bumpers, motorized passive seatbelts. New **EX** model has 108-hp, 1.6-liter engine,

LX trim. **CRX** has 4-wheel disc brakes. **Accord** is all new for 1990, with new 2.2-liter, 130-hp 16-valve Four. Interior expanded, styling rounded.

### HYUNDAI

**Sonata** adds 3.0-liter V6, revamped **Excel** is on the way.

### INFINITI

All-new division of Nissan offers three models. **Q45** is most important, a \$38,000 luxury sedan aimed at Jaguar/Mercedes/BMW. Features 4.5-liter 270-hp V8, ABS brake system, 4-wheel steering. **M30** is Maxima-based, available as coupe or convertible.

### ISUZU

Entire line being restyled for late 1990/1991. New **Stylus** model will replace I-Mark, coupe is similar to Geo Storm. **Impulse** also being redone.

### JAGUAR

In order to compete with Lexus/Infiniti, Jaguar has reduced price of base **XJ6** under \$40,000. More expensive models are now up to \$50,000+. All sedans have analog instruments, added horsepower, dual-range transmission. **XJ-S** is unchanged.

### LAMBORGHINI

Thanks to infusion of Chrysler money, new **Diablo** model—essentially a restyled Countach



**VOLKSWAGEN CORRADO**



**TOYOTA CELICA GT-5**

ways, the Storm GSi is a blueprint for the small sports car of the future.

For about the same price, you can order an old-fashioned roadster that's already sparked a craze they're calling "yestertech." Roughly patterned after the old Lotus Elan, the Mazda Miata MX-5 is meant to combine the delightful open-air fun of a British roadster with the reliability of a Japanese econobox. Under the rounded bodywork is a conventional rear-drive chassis, holding Mazda's 1.6-liter dohc Four as used in the 323. With only 116 hp on tap, the Miata is not the

5000S—is on its way with claimed 200-mph performance.

**LEXUS**

New division of Toyota offers two models. **LS 400** is Mercedes look-alike, offers 150-mph performance from 250-hp, 4.0-liter 32-valve V8 at \$35,000. **ES 250** is Camry-based 2.5-liter coupe.

**LOTUS**

**Esprit Turbo** remains basically the same. New \$30,000, Isuzu-based **Lotus Elan** will arrive next year.

**MASERATI**

All three models—**Spyder**, **228** and **430**—essentially unchanged except for passive belts in coupe and sedan.

**MAZDA**

New **Miata** roadster looks like mid-'60s Lotus Elan, uses 116-hp engine from **323**, rear-drive chassis. Coupe version is on the way. Upscale **929 S** has more power from 4-valve heads on V6, sportier suspension and appearance. Excellent **MPV** van now available with 4-wheel drive. Hot **323 GT turbo** is dropped. **323 sedan** has been restyled and renamed **Protege**. Rest of Mazda line remains basically the same.

**MERCEDES-BENZ**

Only model in low-priced range is 6-cylinder **190E 2.6**, basically unchanged from 1989. Midsize

cars now have lower body cladding, come with 2.5-liter turbo diesel (250D Turbo), 2.6 or 3.0-liter gas **Six (260E/300E)**. **300TE** station wagon is unchanged. **300CE** coupe now has 24-valve head for 3.0-liter Six, 5.0-liter V8 is in the future. Midsize cars are now available with patented 4Matic automatic 4-wheel-drive system. Full-size S-class—**300SE**, **300SEL**, **420SEL**, **560SEL**—is essentially unchanged except for addition of new 3.5-liter diesel, called **350SDL**. **560SEC** unchanged. Famous 560 SL dropped from production after 18 years, replaced by new state-of-the-art 2-seater. With 3.0-liter Six, called **300SL** (Europe only); with 5.0-liter V8, called **500SL**.

**MITSUBISHI**

New **Galant GSX** and **Eclipse GSX** have 4-wheel drive, all-independent computerized suspension, 195 hp. Luxury **Sigma** gets driver's-side airbag. Hyundai-built **Precis** economy car is all new, features fuel injection, rounded aerodynamic styling.

**NISSAN**

**Stanza** is all new, restyled along the same aerodynamic lines as **Maxima**. **Sentra** will be similarly improved for 1990½. The

**300ZX Turbo** gets twin turbos and 300 hp. Remainder of line basically unchanged.

**PEUGEOT**

The **405** wagon is the most recent introduction. All models have passive restraints, otherwise only minor changes.

**PONTIAC**

**LeMans Aerocoupe** and **LeMans Sedan** get minor changes.

**PORSCHE**

The **944 S2 Cabriolet** is new, built by ASC. The **911 Carrera 2** is a 2-wheel-drive version of the all-wheel-drive **Carrera 4**. The **928** remains the same, though deleting "S4" name. All Porsches have standard ABS, driver and passenger airbags.

**ROLLS ROYCE**

**Silver Spirit**, **Silver Spur** and **Corniche II** convertible now have computer-controlled suspension, driver's-side airbag.

**SAAB**

All Saabs have ABS brakes, driver's-side airbag. Otherwise unchanged.

**STERLING**

Unchanged since addition of 2.7-liter engine, 5-door model.

**SUBARU**

New **Legacy** sedan and wagon at top of line have 2.2-liter engine, price tag nearing \$20,000 when fully loaded. DL, GL, GL-10 are now called **Loyale**, otherwise only minor changes. **Justy** has 5-door version, **XT** and **XT/6** are unchanged.

**SUZUKI**

**Swift** basically unchanged, **Samurai** gets fuel injection, 66 horsepower.

**TOYOTA**

**Celica** is completely new for 1990. Body very aerodynamic, top engine is 2.0-liter, 16-valve turbo. Fujitsu sound system is state-of-the-art. All-new **MR2** will debut in spring as 1991 model. **Cressida**, **Camry** and **Supra** get airbags, **Corolla** has more power.

**VOLKSWAGEN**

New **Corrado** replaces **Scirocco**, features 158 hp from supercharged 1.8-liter Four, \$18,000 price tag. New **Passat**, similar to Audi 80/90, replaces **Quantum**. Few changes in **Fox**, **Golf**, **Jetta** lines.

**VOLVO**

All Volvos have driver's airbags, otherwise only detail changes.



**MAZDA MX-5 MIATA**

PHOTO BY JOHN LAMM

# IMPORTS '90

fastest car in the world, but with a basic price of \$14,000 it just might be the most fun.

One notch up from the new Geo Storm and Mazda Miata is Toyota's Celica, which is all new inside and out. Besides the usual better-than-ever sound system upgrades, interior changes include a driver's-side airbag. The line's new bodywork earns a C<sub>d</sub> rating of 0.31.

The Celica's powertrain offerings have been expanded and now include a new 130-hp normally aspirated 16-valve dohc 2.2-liter Four to go with the established 1.6-liter 16-valve twin cam and 200-hp 2.0-liter 16-valve dohc Four that powers the flagship All-Trac Turbo. Its styling is sleeker than before, with fender bulges to cover the fat tires and 5-spoke alloy wheels. The greenhouse is especially graceful, while a rear spoiler and hideaway headlights add to the sporty appeal. Toyota's stylists have also put more visual distance between the potent



All-Trac Turbo and the tamer Celicas with a functional hood scoop and different grillwork.

Archival Nissan has all the big news in the midsize sports-car ranks, with its superb 300ZX. We wrote about it in our March 1989 issue ("The Rites Of Spring," page 61).

But the zinger—literally—for '90 is an optional 3.0-liter V6 that comes with not one, but *two* turbochargers. With a rating of 300 hp, this should bring Z-car performance up into Corvette/Porsche territory, though of course, the price is getting up there.

The Germans aren't sitting still when it comes to new sports cars.

Volkswagen's Corrado, which was expected for 1989, is finally here. Riding on a modified GTI platform, the \$17,900 coupe replaces the Scirocco. The Karmann coachwork is distinctive and the supercharged 1.8-liter Four makes 158 hp, enough to hustle the Corrado up to 140 mph.

A unique feature is an active rear spoiler that automatically retracts at low speeds for better visibility, pops up on the highway to reduce rear-end lift and enhance high-speed stability.

Overall, the Corrado is probably the best car Volkswagen dealers have had to offer in many years, and VW hopes it can spark the turnaround the

## 1990 IMPORT CAR PRICES\*

ACURA	
Integra RS	\$11,950
Legend Sedan	22,600
Legend Coupe	24,760
ALFA ROMEO	
Spider Graduate	\$16,950
Spider Quadrifoglio	23,950
164	27,000**
ASTON MARTIN	
Virage Coupe	\$175,000**
AUDI	
80	\$18,900
80 Quattro	22,800
90	23,990
90 Quattro	27,500
100	26,900
100 Quattro	29,470
200	33,405
200 Quattro Wagon	36,930
200 Quattro	35,805
Coupe Quattro	29,750
V8	47,450
BENTLEY	
Eight	\$114,100
Mulsanne S	133,200
Turbo R	167,400
Continental	215,000
BMW	
318is	\$22,000**

325i	24,900
325is	29,000**
325i Convertible	34,000**
325iX	30,100**
M3	35,000**
525i	37,400**
535i	41,500
M5	60,000**
735i	49,000
735iL	60,000**
750iL	72,000**
850i	75,000**

CHEVROLET	
Geo Metro	\$5995
Geo Prizm	9660
Geo Storm	10,390

CHRYSLER	
Colt	\$6851**
Colt GT	9121**
Colt Vista	11,941**
Colt Vista 4wd	13,167**
Eagle Talon	12,995**
Eagle Summit	8895**
TC by Maserati	33,000**

DAIHATSU	
Charade	\$6297

FERRARI	
348 GTB	\$80,000**
348 GTS	90,000**

Mondial T	\$84,080
Mondial Cabriolet	92,380
Testarossa	145,580
FORD	
Festiva	\$6319
Mercury Tracer	9457**
Merkur Scorpio	26,709
HONDA	
Civic	\$6635
Civic Si	10,245
Civic Wagon	10,325
CRX	9145
CRX Si	11,130
Prelude	14,225**
Prelude Si 4ws	18,800**
Accord	12,145

HYUNDAI	
Excel	\$5899
Sonata	9999

INFINITI	
M30 Coupe	\$23,500
M30 Convertible	25,000
Q45	38,000

ISUZU	
Stylus	\$8995**
Impulse	10,390**

JAGUAR	
XJ6	\$39,700
Sovereign	43,000
Vanden Plas	48,000
Vanden Plas Majestic	53,000

XJ-S	48,000
XJ-S Convertible	57,000

LAMBORGHINI	
Countach	\$145,000

LEXUS	
ES 250	\$21,500
LS 400	35,000

LOTUS	
Esprit Turbo	\$67,500
Esprit Turbo SE	79,500

MASERATI	
Spyder	\$45,000**
228	54,000**
430	44,000**

MAZDA	
323	\$6599
Protegé	9339

626	12,459
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626 GT Turbo	15,699
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MX-5 Miata	13,800
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MX-6	12,279
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MX-6 GT 4ws	16,029
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RX-7 GTU	17,880
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RX-7 Convertible	26,530
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RX-7 Turbo	26,530
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929	19,339
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MPV	11,699
-----	--------

MPV 4wd	18,894
---------	--------

MERCEDES-BENZ	
190E 2.6	\$31,600
300D 2.5 Turbo	40,000**

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It's hard to find a game that everyone in the whole family can play. Well, Basket-Brawl fills the ticket.

Press the start button and hear stadium sound effects. When the music stops, the clock starts and the pressure is on. For the first 20 seconds each basket made scores 2 points, in the last 10 seconds each basket scores 3 points. At the end of 30 second regulation time, if you have scored 30 points or more a buzzer will sound and you are in a 15 second bonus period where

every basket scores 3 points. At the end of the bonus period your total score is displayed on the LED readout mounted in the backboard, right below the electronic time clock.

Play one-on-one, teams, or against yourself. Once you start playing basketbrawl you'll find it hard to stop.

The frame is constructed of sturdy powder coated steel tubing with spring-loaded pins that allow you to assemble or disassemble it quickly and easily. The side and bottom netting keep the ball in play and stop it from bouncing out

of the playing area. It comes with three 7" balls and a safe, low voltage power supply that plugs into a standard outlet.

If the unit is left on for more than 3 minutes without use it will automatically shut off.

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PM



**NISSAN SENTRA GXE**



**MAZDA 323 PROTEGÉ**

company badly needs in its North American sales operations.

To compete in the \$30,000 sport-coupe class, Audi now offers a Coupe Quattro based on the 80/90 body and running gear. With full-time 4-wheel drive, ABS disc brakes and a claimed 135-mph top speed from a 2.3-liter 5-cylinder engine rated at 164 hp, the Coupe Quattro gives about the same performance as the competition, with the advantage of all four wheels sending power to the pavement.

After years of testing public reaction at car shows, Porsche has finally put the convertible version of the 944 on sale. Called the 944 S2 Cabriolet, it

looks much like an RX-7 convertible, and at almost \$50,000, it costs twice as much as the equivalent Mazda.

This pricing policy is deliberate, however. Porsche expects to sell fewer than 9000 cars in the United States during 1990, down from 30,000 two years ago. The idea is for Porsche to be an exclusive purveyor of boutique sports cars, not a mass-market company. And that means they're charging a premium for exclusivity.

At the very top of the sports-car market, Mercedes-Benz and BMW are going head-to-head in Europe with new models, although BMW's new entry, the gorgeous 850i coupe,

won't be in the U.S. until spring.

The Mercedes newcomer is the first new SL in 18 years. We drove it and reported our findings in the September '89 issue ("Fall Firsts," page 51).

BMW's new 850i supercoupe replaces the old 6-series line, and figures to be a strong rival for the Benz SL. Sleek and classically styled, the 850i uses the same V12 that propels the 750iL sedan. Other tech highlights include a new traction control system, a new integral rear axle providing passive rear steering at high speed—like its rivals from Stuttgart, the 850i will be capable of a top speed

*(Please turn to page 107)*

300E 2.6	39,950	300ZX Turbo	33,000	900S	20,995	Celica GT-S	15,495**
300E	45,950	<b>PEUGEOT</b>		900 Turbo	25,495	Camry	11,588
300E 4Matic	52,250	405 DL	\$15,390	900 Turbo Convertible	32,995	Camry Wagon	13,078
300CE	55,700	405 S	17,700	9000S	25,495	Cressida	21,498
300TE Wagon	49,650	405 Mi 16	21,990	9000 Turbo	32,495	Supra	22,860
300TE 4Matic	56,250	405 DL Wagon	15,990	9000 Turbo CD	32,995	Supra Turbo	25,245**
300SE	52,950	405 S Wagon	18,495	<b>STERLING</b>		<b>VOLKSWAGEN</b>	
300SEL	56,800	505 DL	18,590	827 S	\$23,350	Fox	\$7225
350SDL	57,000**	505 S 2.2	19,945	827 Si	26,550**	Golf	8695
420SEL	62,500	505 S V6	22,485	827 SL	29,975	GTI	13,825**
560SEL	73,800	505 DL Wagon	18,590	<b>SUBARU</b>		Jetta	10,295
560SEC	81,500	505 Turbo Wagon	25,940	Justy	\$5866	Jetta GLI	14,950
300SL	72,500	<b>PONTIAC</b>		Justy GL 4wd	7951	Cabriolet	15,485
500SL	83,000	LeMans Aerocoupe	\$6599	Justy ECVT	7791	Corrado	17,900
<b>MITSUBISHI</b>		LeMans Sedan	8349	Loyale	9759	Passat	18,500**
Eclipse	\$10,819	<b>PORSCHE</b>		Legacy	12,499	Vanagon	16,490
Eclipse Turbo 4wd	16,449	944 S2	41,900	XT	13,071	Vanagon Syncro	20,750**
Precis	5595	944 S2 Cabriolet	48,600	XT/6	17,111	<b>VOLVO</b>	
Mirage	6929	911 Carrera 2	58,500	<b>SUZUKI</b>		240DL	\$18,450
Galant	10,989	911 Carrera 4	69,500	Swift GA	\$6399	740	20,685
Sigma	17,879	911 Cabriolet	66,800	Swift Sedan	7399	740GLE 16-Valve	25,440
Wagon	14,929	911 Targa	59,900	Swift GT	9399	740 Turbo	25,775
<b>NISSAN</b>		911 Carrera 4 Targa	70,900	Samurai	7999	740GL Wagon	21,365
Sentra	\$7299	911 Carrera 4 Cabriolet	77,800	<b>TOYOTA</b>		740 Turbo Wagon	26,455
Stanza	11,450	928	74,545	Tercel	\$6488	760GLE	33,185
Pulsar	11,999	<b>ROLLS ROYCE</b>		Corolla	8748	760GLE Turbo	33,965
Axxess	13,949	Silver Spirit II	\$140,200	Corolla SR5	10,895**	780 Coupe	38,735
Axxess 4wd	15,749	Silver Spur II	154,700	Corolla GT-S	13,045**		
240SX	13,249	Corniche III	215,800	Corolla All-Trac Wagon	11,785**		
Maxima	17,699	<b>SAAB</b>		Celica	12,095**		
300ZX	27,300	900	\$16,995	Celica GT Convertible	18,990**		

\* Prices in effect Oct. 6, 1989  
\*\* Estimated price

# THE ENGINEERING STORY

**T**OYOTA has reinvented the wheel—well, actually the tilt-telescope steering wheel with an airbag, but the work represents solid engineering.

The Lexus LS 400 has an optional system that automatically moves the wheel back and up, out of the way for an easy exit, when you remove the ignition key. Put it in, and the wheel moves down and out to one of two pre-selected positions. A computer controls two motors with worm-drive, one to tilt the wheel up to 15°, the other to telescope it as much as 1¼ in. Variable resistors are position sensors to tell the computer the preset positions and when the wheel is in the right location.

The fully automatic tilt-telescope

wheel is part of a memory system with his-and-hers presets for the driver's seat and both outside rearview mirrors. Both systems have separate computers and use Hall-effect switches as position sensors. If you order the full memory option, the tilt-telescope computer also gives you a choice of two positions for the seatbelt anchor.

Even the standard setup gets tilt and telescoping, a first for an airbag car. However, there's no memory feature and power is only used for tilt.

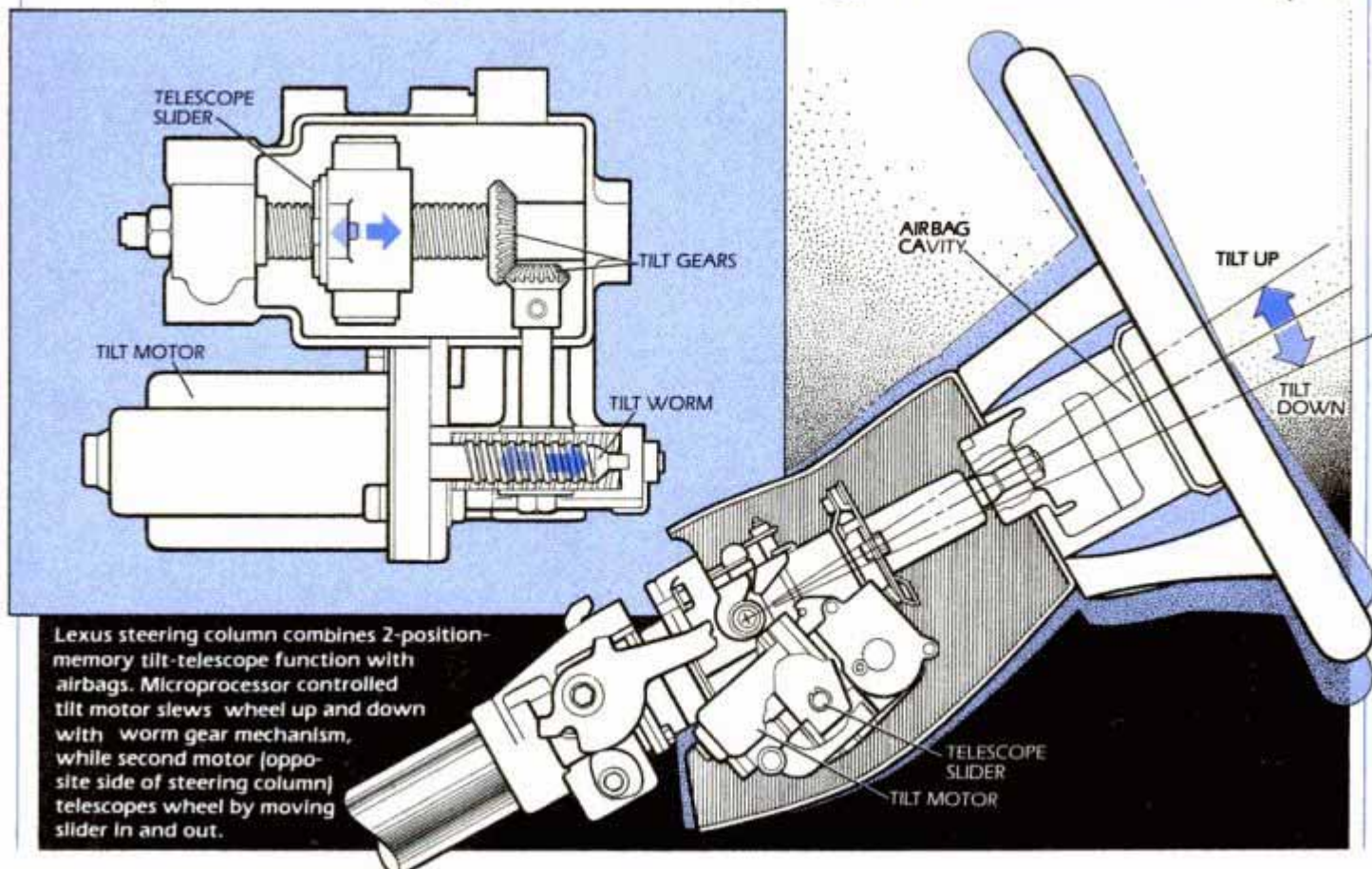
Although much attention on Lexus 400 has been given to its traction control and the basics of its 250-hp 32-valve V8, there's much more in the powertrain department.

The bottom end of the 4.0-liter aluminum V8 is race-engine rugged.

Each main bearing cap has six fasteners, four studs and nuts from underneath and one bolt through each side of the exterior of the block. A structural aluminum lower crankcase bolts to the block for rigidity, and a conventional steel oil pan attaches to the front end of the lower crankcase.

The fuel-injection airflow sensor operates on a novel principle—the Karman-Vortex—still in development at other car companies. Other airflow sensors (flap with variable resistor, hot wire or film) are prone to accuracy or reliability problems. This one should be accurate and reliable.

A disc in the air intake creates air pattern swirls (called vortices) at a frequency proportional to the airflow. The vortices hit a thin metal mirror,



which vibrates in the same proportion. The vibrating mirror, aimed at a lighted diode, causes changes in the light pattern, which is detected by a photo transistor. The transistor sends a signal to the engine computer.

Toyota also has a low-cost automatic memory tilt wheel with airbag, for the 1990 Celica All-Trac (4wd) Turbo. When the driver removes the ignition key, a motor ejects a plunger that trips the tilt wheel lever and the wheel springs upward out of the way, where it locks in position. When the key is back in, the upper latch is released and the driver can pull the wheel down to a preset position.

## Mazda

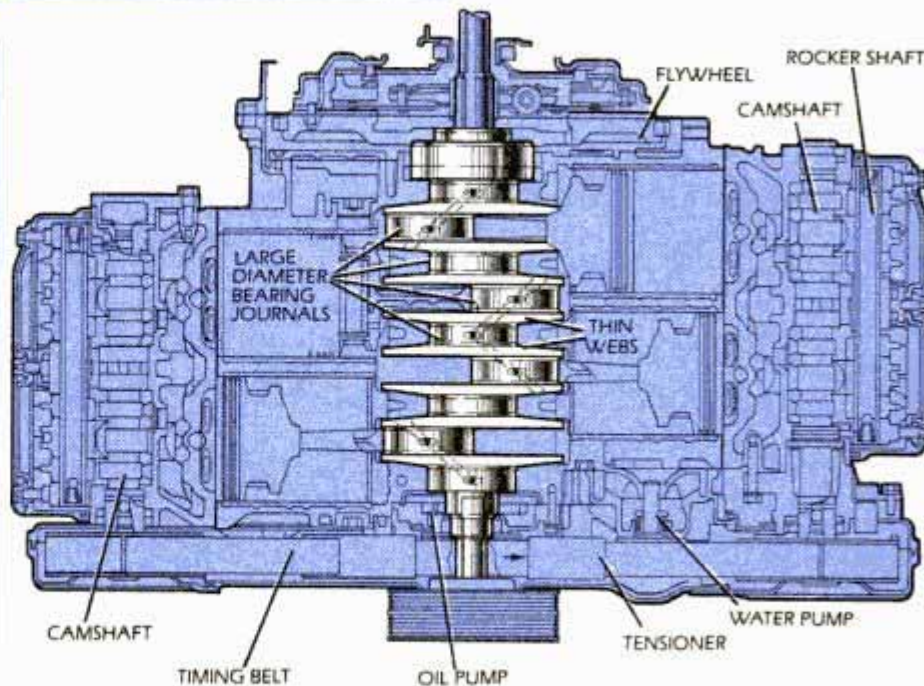
The new Miata is designed to evoke memories of 1960s British sports cars, but it also has a Power Plant Frame, a feature reminiscent of torque tube drive from the 1930s. The frame is a lightweight rectangular truss rather than a tube. It bolts solidly to the transmission and rear axle and has a solid propeller shaft for straight-line power transfer. That means smoothness from the 1.6-liter, 16-valve 116-hp 4-cylinder.

Mazda has an interesting approach to multivalve engines in the Protegé, the premium 323. Standard is a single-overhead-cam 1.8-liter 16-valve 4-cylinder that develops 103 hp at 5500 rpm and 111 lb.-ft. of torque at 4000. Optional is the same 1.8-liter, almost the same compression ratio (9.0 vs. 8.9), but a different cylinder head with dual-overhead-cams directly acting on bucket tappets, instead of a rocker arm setup. The twin-cam head is a freer-breathing design that produces 125 hp at 6500 and 114 lb.-ft. of torque at 4500.

## Subaru

The new Subaru Legacy competes against the Camry, 626, Stanza and Accord, so naturally it has a 16-valve 4-cylinder engine as standard equipment, and with 130 hp is a performance match for the Accord.

However, Fuji likes horizontally opposed water-cooled overhead-cam



Generous diameter bearing journals allow overlap between narrow crankshaft webs, making Subaru Legacy flat Four crank only 12½ in. long.

engines, so the 2.2-liter 4-cylinder in the new Subaru Legacy is this design. The engine is extremely compact—the crank is just 12½ in. long, despite five main and four rod bearings. Counterweights are thin, but are a larger arc so there's mass for balance. Thick counterweights would add mid-section strength, but the Legacy has large diameter main and rod journals (60 and 52 mm), and much overlap between them (18.5 mm).

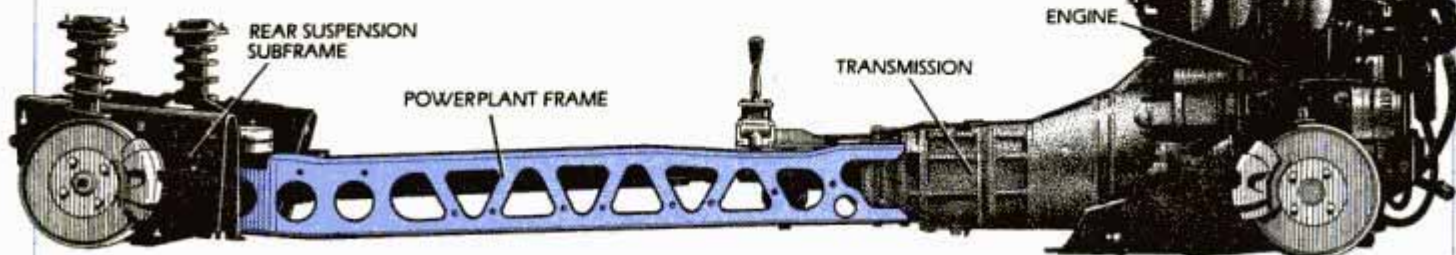
The valve train has a single camshaft at each bank, and rocker arms with mini hydraulic lifters pushed into the arm tips, designs you've seen before. However, the hollow rocker shaft (through which oil is fed to the lifters) has a spring-loaded valve in one end that blows open when the engine is cold and oil pressure is very high. This prevents the lifters from locking up and increasing the valve opening and overlap, which would roughen the idle until the engine warms.

The two exhaust valves use a double rocker that operates against a single cam, a feature that contributes to weight reduction and space saving.

The rear differential in a 4wd Legacy forces use of a saddlebag-shaped gas tank, posing the problem of getting fuel out of both sides simultaneously. You could pull fuel from each side with a separate pump, but that's expensive. Instead, the pump is in one side with the fuel return line. The return line has a venturi and a line that taps off it and goes to the other side. When the fuel return flow goes through the venturi, it creates a vacuum (like the airflow through a carburetor venturi), which siphons fuel from the opposite side.

## Nissan/Infiniti

The 300ZX is the performance flagship at Nissan and the 300 horses you can order as a factory option is more than anything available in 1989 except a ZR-1, Testarossa or a Countach, and a lot more than any 3.0-liter V6 you're likely to find in 1990. The standard 24-valve, 4-cam V6 produces a healthy 222 hp at 6400, but Nissan has a Garrett AiResearch



Miata sports car uses aluminum truss-bridge type framework to tie engine to rear suspension.



twin-turbo setup that kicks it up to 280 with an automatic, 300 with a manual. Each turbo has its own intercooler and has hoses to the engine's cooling system. Two turbos don't add to the peak, but provide better low- and midrange performance than one.

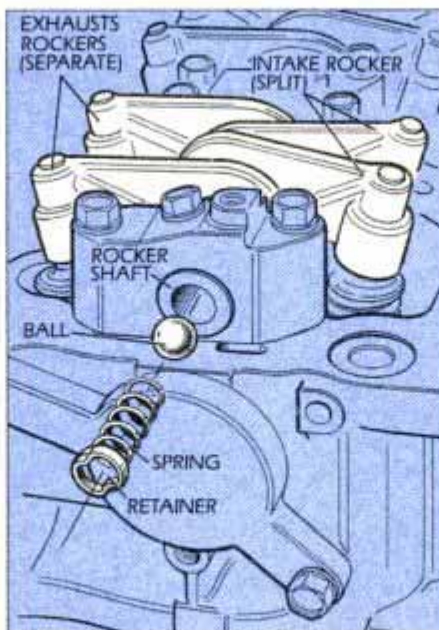
Even when the engine is shut off, the natural pattern of heat flow keeps the cooling process going (a design idea called thermosyphon cooling, used in the days before water pumps).

The Z engine, and the V6 and V8 engines in the upscale Infiniti line, have variable intake valve timing, a dual-mode arrangement that uses a spring-loaded piston with helical gear teeth in a hub inside the intake camshaft sprocket, which has meshing helical gear teeth. The area between piston and sprocket hub is pressurized with engine oil fed through a hollow camshaft, but the pressure is allowed to bleed through an opening at the rear end of the camshaft at both idle and high engine speed, and valve timing is retarded. That opening, however, holds a control valve wired to the engine computer. When the engine is warm and running above idle to medium speed (when advanced valve timing would improve performance), the computer activates the solenoid, closing the valve. The pressure can no longer bleed off, so it applies the piston, which moves inside the hub against spring pressure. This forces the sprocket to turn relative to the camshaft, advancing the valve timing, increasing valve overlap.

The new Stanza comes to market with a 138-hp version of the 240SX-Axxess 2.4-liter 12-valve 4-cylinder, making it (for the moment) the power leader against the Accord, Camry, 626 and Legacy. The Stanza picks up the viscous coupling from 4wd transfer case technology, but uses it as a limited-slip differential for improved front-drive traction.

## Honda/Acura

You can never get too much smoothness in a 4-cylinder engine, and Honda, already a leader in this area, has come up with something new for the 1990 Accord with automatic transmission—a rear engine mount indirectly controlled by the engine computer. The mount is a fluid-filled design, but with two chambers separated by a valve plumbed to a vacuum diaphragm unit. At idle (under 850 rpm), the two chambers are filled, fluid circulates from both through passages and the valve, so the mount provides a maximum amount of damp-



The 16-valve Legacy uses split intake rockers riding on single-cam lobe and ball-type oil pressure relief valve inside rocker shaft.

ing. This reduces idle shake under high load (such as with a/c on). Off idle, the computer closes a solenoid vacuum valve. Result: the vacuum diaphragm turns the valve and closes off the upper chamber. Circulation is only between the passages and lower chamber, so the mount stiffens.

The engine itself, a 2.2-liter 16-valve 4-cylinder, gets a pair of balance shafts. The shafts are above the crankshaft centerline but aren't offset, as in the Mitsubishi. Their effect is on medium- to high-speed vibration, much like the shafts in the oil pan used by Chrysler and GM.

Honda also redesigned its automatic transaxle, and both the Accord and the new Acura Integra get versions of it. The automatic is like a constant mesh manual transmission but with hydraulic clutches to make the gear changes. Normally, this is not as space efficient as a planetary gearset, but Honda manages to fit a 4-speed into a 15-in. box.

## Audi

Audi's entry in the super V8 wars develops 240 hp from only 3.4 liters of displacement. To meet the needs of the new Quattro Sports Sedan's front-drive engine compartment, it has been engineered into a 16-in.-long package, shortest in the car business.

Like several other V8 supermotors, it is cast of silicon-impregnated aluminum with pistons running directly in the aluminum/silicon bores.

At the business end of things you'll find 4-valve combustion chambers

and nicely packaged long intake runners. You'll also find a high 10.6:1 compression ratio, made possible by selective knock control.

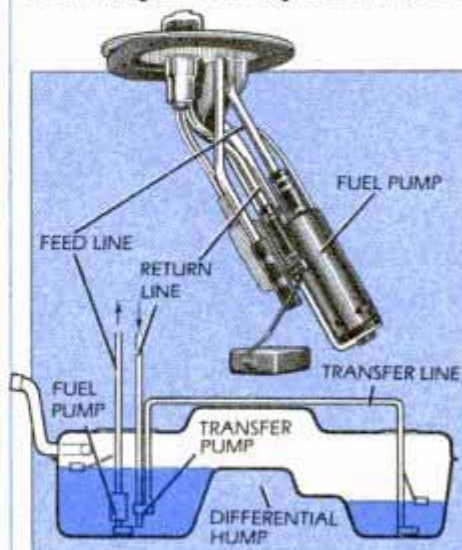
A single computerized management system handles the engine's fuel injection, transmission shift programming, decel fuel cutoff, idle speed and knock control.

The electronically controlled transmission allows for driver selection of a shift mode: efficiency, high performance or manual. The high-performance mode delays upshifts, the manual mode mimics a shift-kit-style valve body. Mode changes are accomplished by means of solenoid-actuated hydraulic-system valves.

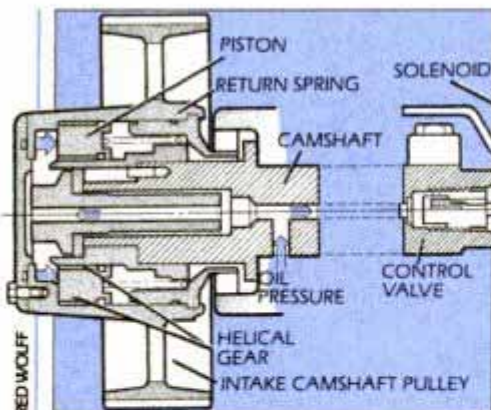
The transmission management system retards ignition timing when necessary to soften gear changes, so luxury car buyers get all that buttery smoothness they're looking for.

The new Audi V8 sedan boasts a more advanced incarnation of the famous Quattro 4-wheel-drive system. Under normal conditions, the Audi system splits front-to-rear torque delivery 50/50. A center planetary gear unit compensates for differences between front and rear axle speed with conventional differential action. If wheel speed sensors detect large differences between front and rear axle speed due to loss of traction, the differential is locked by means of a multiplate wet clutch.

Rear-wheel speed is differentiated by means of a Torsen gearset that mechanically senses torque and can vary power distribution ratios up to 20/80. (See last year's "Imports '89" section ["Tech Review," page 100, Dec. '88] for a complete description of Torsen



Venturi-type jet pump, activated by fuel return flow, transfers fuel across differential hump in Legacy fuel tank.



PM ILLUSTRATION BY FRED WOLFF

Nissan/Infiniti DOHC engines use computer-controlled, hydraulic-actuated variable cam timing for smooth idle, high performance.

differential action.) The center differential's clutch is deactivated upon braking so that wheel-drive systems don't prevent ABS action.

## Mercedes-Benz

The big story from Stuttgart is, of course, the long-awaited SL Coupe/Roadster. And if technical sophistication is your forte, the wait was worth it. The car is packed with innovative new technology. A few examples: The two 4-valve engines—a 322-hp V8 and a 228-hp inline Six—are fitted with a variable valve timing system that boosts mid-range torque and smooths idle, similar to the Nissan system.

A pop-up rollbar of micro-alloy steel is automatically deployed if the car is at least 27° inclined and one wheel is lifted to the point where its spring is fully extended. In other words, it pops up if you're about to go on your head. It also will deploy in an impact severe enough to exceed a programmed deceleration threshold. If you want to look sporting, you can

raise the rollbar by means of a dashboard switch.

The roadster's soft top utilizes 17 microswitches and 15 hydraulic cylinders to achieve fully automatic operation. When you hit the switch that raises the roof, windows descend, the soft top cover swings up, the top emerges, moves forward to the latch points, the rear cover closes, the trailing edge of the top drops to the rear deck, the front edge latches, the rear edge latches and the windows go up.

Other SL techy delights include a magnesium-frame seat that incorporates the upper seatbelt mount, dual airbags, a cabin air-filtration system, advanced ABS and a highly refined multilink rear suspension system.

Also new to the U.S. market from Mercedes-Benz is the 4MATIC all-wheel-drive system. Available in Europe for several years, 4MATIC utilizes the ABS wheel and pinion speed sensors—along with a steering angle sensor—to determine when a loss of traction occurs. Based on this information, the computer causes the drivetrain to shift to one of four modes: rear-drive only, 35/65 front-rear split, 50/50 front-rear split or 50/50 front-rear split with locked rear.

No driver input is required and the system is reportedly almost "invisible." Thus, Mercedes-Benz engineers have included a dashboard light that lets you know when 4MATIC has saved you from the abyss.

If the brakes are applied while the vehicle is in a 4-wheel-drive mode, it

reverts to rear-wheel drive so that ABS capability is fully retained.

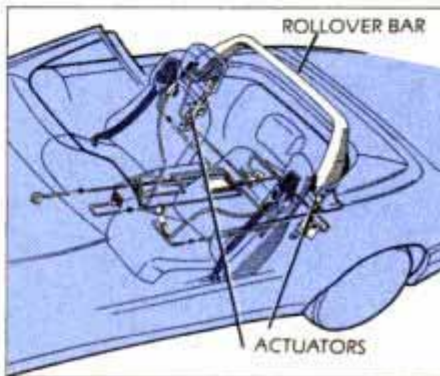
## Saab

The Saab Direct Ignition system has been shown at auto shows since 1985. Now it's available on a U.S. model for the first time.

This capacitive system has no distributor, moving parts or ignition cables. Instead, each sparkplug is fitted with its own small, high-output coil. Thus, the current leaks that plague some high-voltage capacitive systems are reportedly eliminated.

A metal cassette above the coils contains the circuits that cause 40,000-volt firing of the individual coils in a sequence determined by a crankshaft position sensor.

For best starting, the Saab system is programmed to supply approxi-



PM ILLUSTRATION BY RONALD CARBON

Mercedes SL roadster has rollover bar that automatically extends when car tips over.

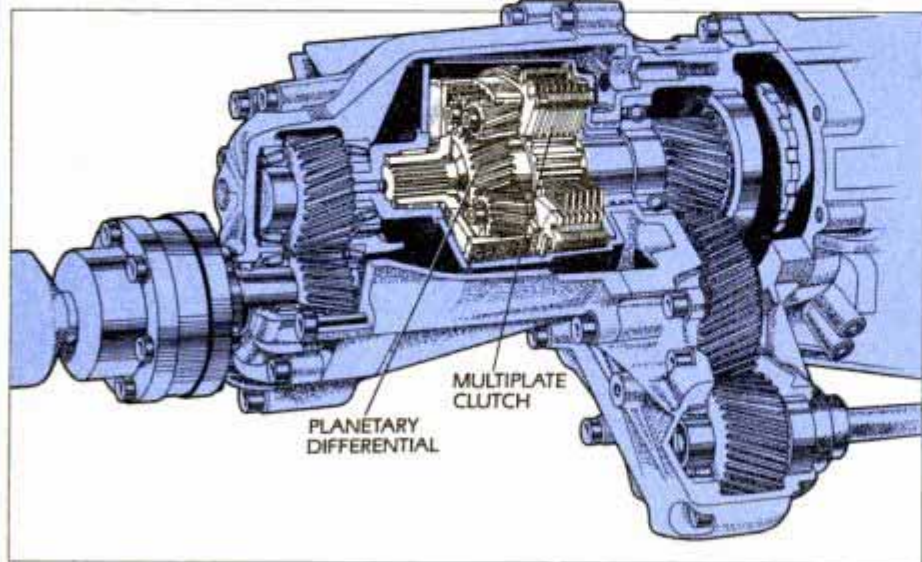
mately 50 40,000-volt sparks to each plug. This can help burn away moisture and other gook that might prevent good spark in a cold engine. When engine speed reaches 600 rpm, the multiple spark function is switched off.

If the engine should fail to start, the direct ignition system barrages all four spark plugs with approximately 1000 40,000-volt sparks when the key is released. That should be enough to make any sparkplug get its act together for the next starting attempt.

## Emphasis On Engines

Look for new engine calibrations and, in some cases, increased power from Jaguar and Volvo. As engineers learn more about electronic controls, spark mapping and other variables, output and driveability continue to improve.

We can at least hope to see the 6.0-liter version of the Jaguar XJ-S V12 engine on these shores, perhaps even before the year is over. This hotter grand touring luxu cruiser reaches 60 in about 7 seconds in Euro trim. **PM**



PM ILLUSTRATION BY RONALD CARBON

Audi V8 center differential uses computer controlled, multiplate clutch for torque split.

# IMPORTS '90

(Continued from page 102)

of 155 mph—and a new 6-speed manual transmission.

When it comes to sedans, by far the most significant new imported cars are Toyota's Lexus LS 400 and Nissan's Infiniti Q45. These \$35,000-plus sedans are the first true luxury cars to be produced in the Far East, and they're possibly going to upset the whole balance of the luxury-car market now dominated by Cadillac, Lincoln and German imports.

Lexus and Infiniti plan to sell 250,000 cars a year between them, which is fully 25 percent of the current luxury-sedan market, although the segment is expected to expand in the next few years. Our complete report on these two new lines was in September's "Fall Firsts" story.

Watch for a Lexus ES 250 convertible to appear sometime midway through the model year.

There are several new Asian entries that will merit attention from shoppers checking the subcompact and midsize sedan ranks. Tops on this list is the Honda Accord, the perennial leader in an intensely competitive class. The new Accord is more powerful, bigger on the outside, roomier on the inside, and will continue to give fits to American manufacturers in the intermediate-size class.

The second generation Hyundai Excel (known in Mitsubishi showrooms as the Precis) has been updated and Mazda has just added the compact 323-based Protégé sedan to its lineup. Nissan's midsize Stanza and Sentra have also been updated, as has Honda's Acura Integra.

All are more aerodynamic than before, with more horsepower, more features and fancier interiors. None are stunning breakthroughs or progenitors of a new market segment. But all represent the kind of solid, durable transportation at a good price such as we've come to expect from Asian manufacturers.

Indeed, Asian manufacturers—and to a lesser extent, European companies—are producing an almost unimaginable range of cars this year, from the updated \$6000 Hyundai Excel to the posh and powerful \$80,000 Mercedes-Benz 500SL. Typically, these new models are stylish, well-built, well-equipped and perfectly suited for their intended tasks.

This is a particularly special year, as Lexus, Infiniti and Mazda have created new market segments that didn't exist before. A great range of new models, whole new types of cars—yes, 1990 is definitely a vintage year for imported cars.

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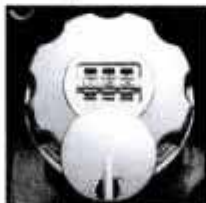
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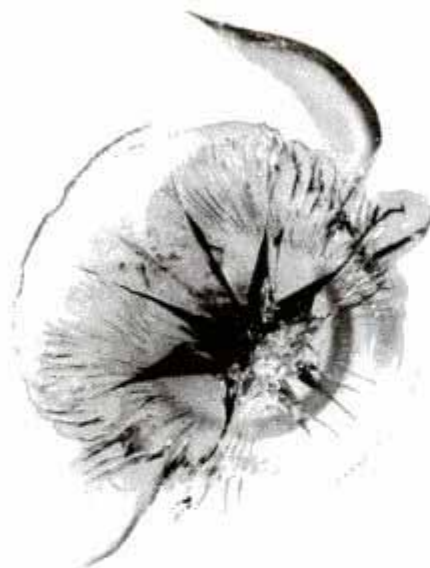


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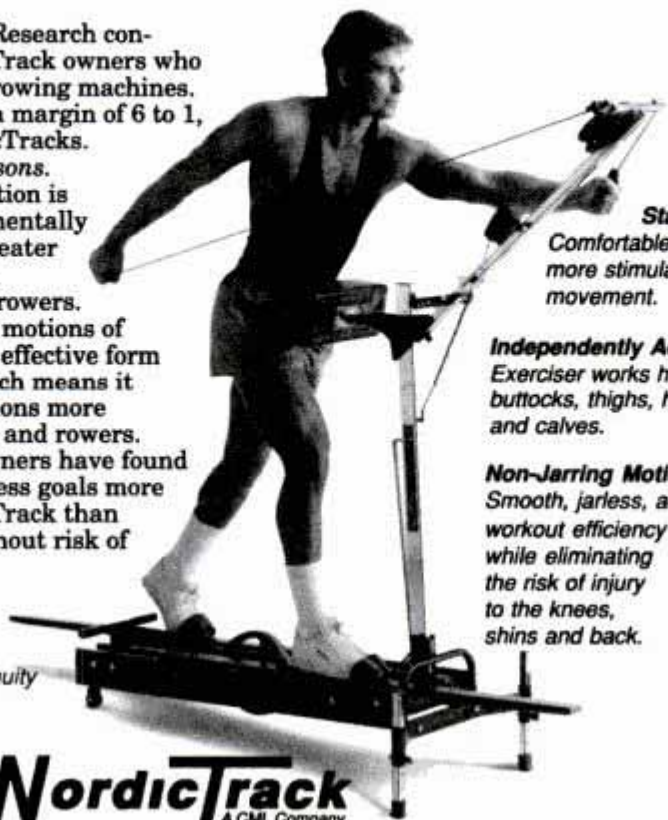
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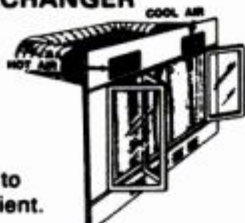
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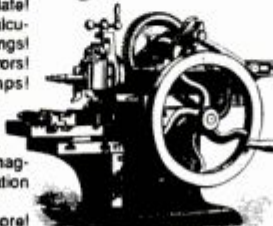
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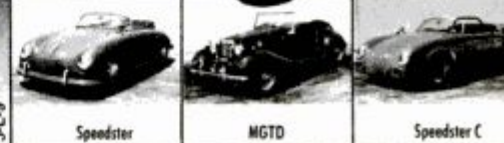
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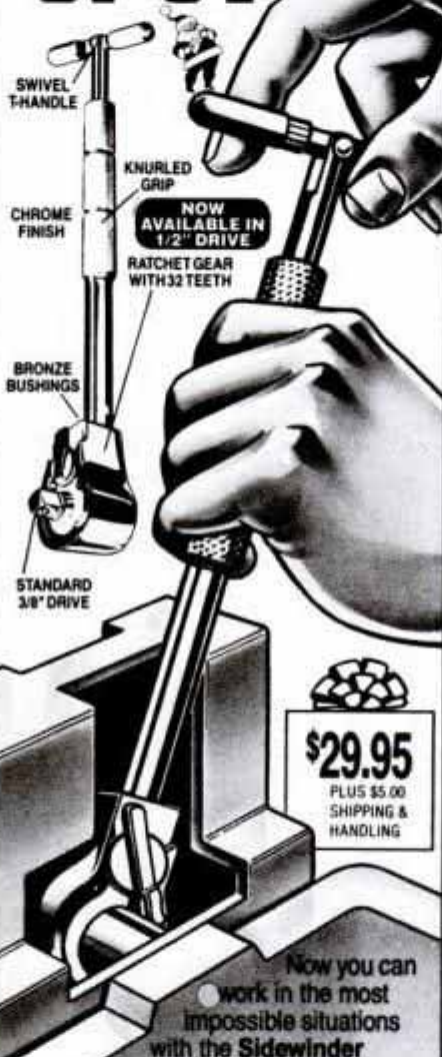
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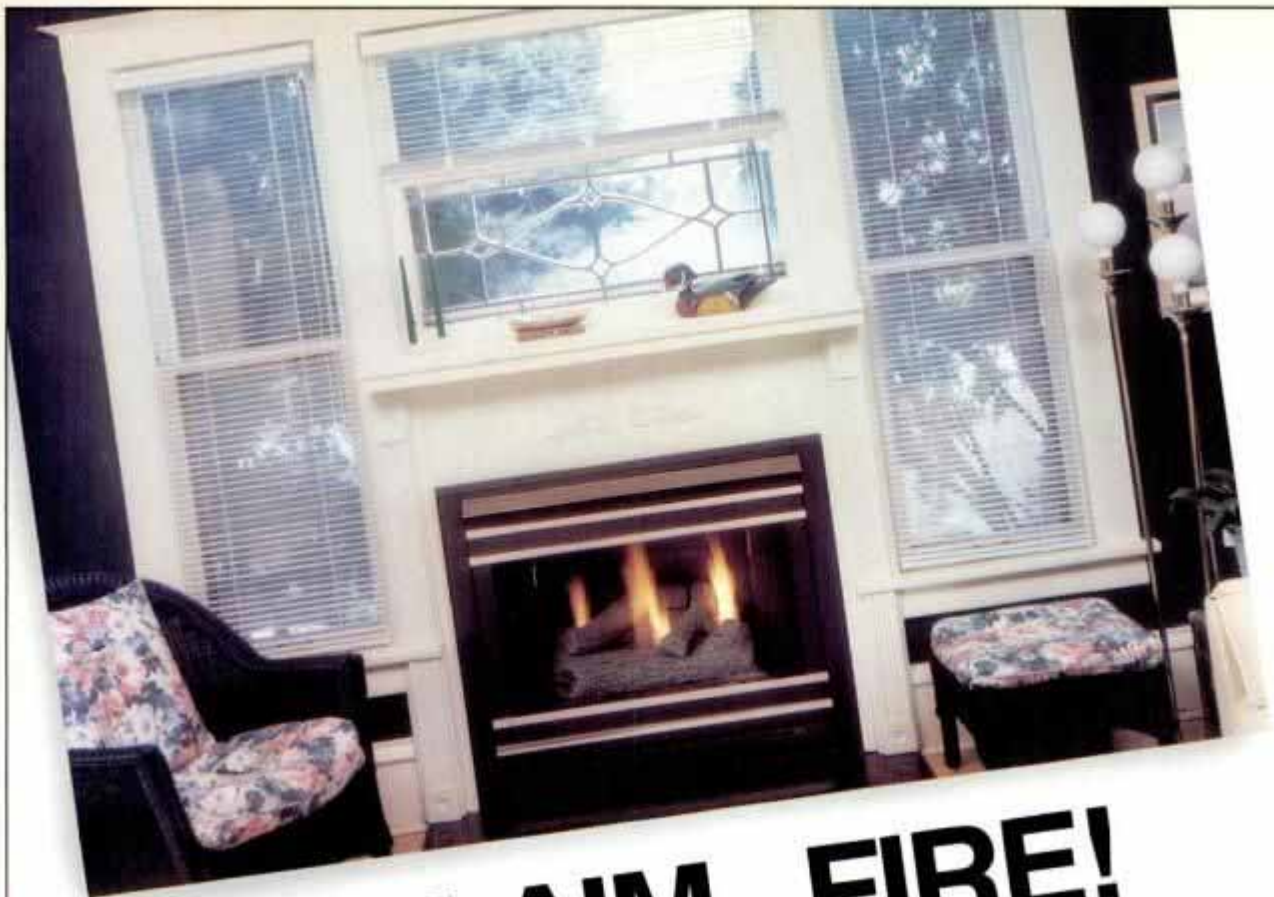
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