

Ford power rocks the pickup world!

Tough Ford Pickups have climbed this brutal boulder mountain before—but now an '86 Ford does it <u>carrying</u> a Chevy and <u>towing</u> a Dodge!

On TV a few years ago you saw a tough Ford Pickup bite and claw its way up a monstrous mountain of boulders with a full-size Chevy on its back.

But now came an even tougher challenge.
Could Ford carry a Chevy and tow a Dodge all the way to the top?

You see the answer on the right, in scenes from an '86 Ford commercial now on television. Ford's big 4x4 with optional 7.5LV-8 engine made it—and with a big competitor on top, and one in tow!

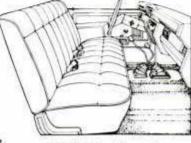
Most Powerful V-8's.

If you want toughness and power in a pickup, you want Ford. This year Ford has the most powerful line of V-8's of any pickup, gas or diesel.

The biggest Six.

too. Plus the
brute strength to
haul up to 5,550
lbs.—or tow up
to 12,500 lbs!*
It's easy to
see why the fullsize Ford Pickup is
America's best-seller.

for eight straight years.**



Built Ford tough.

Big Fords feature
Twin-I-Beam independent front suspension
with 2-wheel drive. TwinTraction Beam on 4x4's
(Mono-Beam front axle
on F-350 4x4's for extraheavy-duty applications).
And they all come Ford
tough—from rugged
ladder-type frame to
double-wall construction.

Choice of cab comfort.

No one equals Ford's choice of cabs: Roomy Regular Cab models. Exclusive Supercab with folding rear bench seat. Plus 4door Crew Cab.

Best-Built American Trucks.

At Ford, Quality is Job 1. A 1985 survey established that Ford makes the best-built American trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1984 models designed and built in the U.S.

Lifetime Service Guarantee.

Participating Ford Dealers stand behind their work, in writing, with a <u>free</u> Lifetime Service Guarantee for as long as you own

your Ford car or light truck. Ask to see this guarantee when you visit your participating Ford Dealer.

- *When properly equipped and with 5th wheel.
- **Based on 1978 through 1985 model year manufacturers reported retail deliveries.

Buckle uptogether we can save lives.



FORD PICKUP

BEST-BUILT AMERICAN TRUCKS









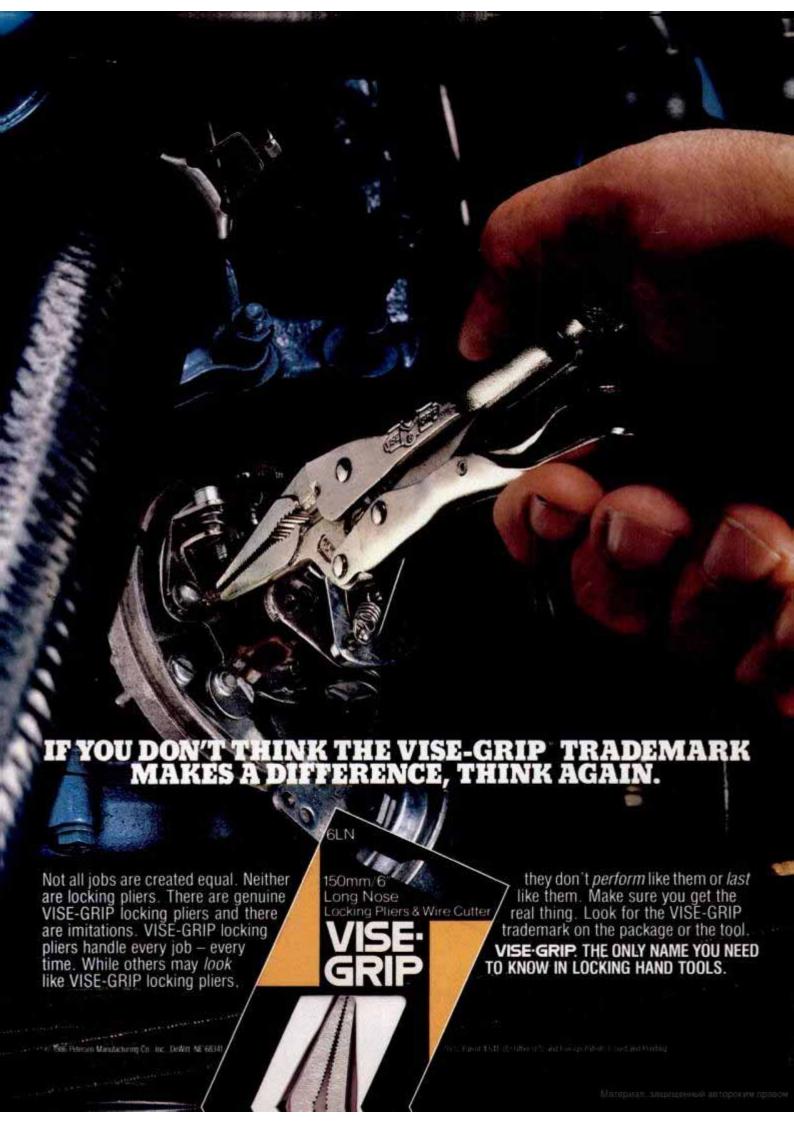




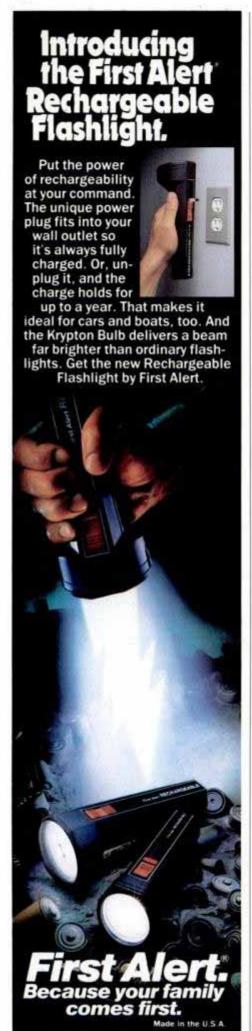












Letters



Best present



Comba built PM's Crayola box desk.

built PM's Ultimate Desk For The Crayon Set (page 118, June '80) for my daughter Leigh's fifth birthday. I eliminated the perforated board areas and used blackboard spray and built it to seat four.

As an industrial arts teacher, I've incorporated many of your projects in my classes throughout the years. Many thanks for serving the home craftsman as well as those of us in technology education.

JOSEPH E. COMBA

NESHANIC STATION, NJ

Photocopies of the 5-page Crayola box desk story, or any stories from back issues of PM, are available for 50¢ per page. For the desk story, which includes plans and materials list, send check or money order for \$2.50 to PM, Box 1014, Radio City Station, New York, NY 10101.

Light Whaler

I enjoyed your boat test (Five Fast Fishermen, page 100, May '86), and noted Boston Whaler's refusal to divulge construction details. If present construction is similar to that of older Whalers, I can understand their reason. I recently observed the disassembly of a 17-ft. Whaler about 12 to 14 years old because it had a leak. We

found a large void, and to me, the boat didn't appear to have adequate structural reinforcement for the outer hull.

If you look at the spec chart for the Outrage 18 in your test, you see the Whaler's weight is 1250 pounds, while the other boats are 1550 to 1900 pounds. You gotta figure something is missing. "TAG" MCPHERSON

PERDIDO BEACH, AL

As we footnoted in our specifications chart, Boston Whaler, as a matter of policy, declines to divulge construction details. It also chose not to respond to our requests for a reply to Mr. McPherson's observations.

Merkur mystery

In one breath you vote the Merkur XR4Ti one of the 10 best cars (PM Editors Pick The 10 Best Cars Of 1986, page 93, Apr. '86) and then say in the same issue in the Long-Term Car Test (page 88) that the car had a "longish list of complaints."

JIM PEYCHAL

WEST ALLIS, WI

We've discovered that the troubleprone Merkur in our long-term test fleet was what is called an "earlybuild" car. While its performance was representative of production line cars, its durability was not.

The right letter

I was the electronics officer with a Navy Torpedo Bomber squadron (VT-17) from 1943-'45, participating in seven major campaigns, so any reference to Torpedo Bombers catches my eye (Editor's Notes, page 4, Apr. '86).

You shouldn't call a TBM a Grumman TBM Avenger. The nomenclature for WWII aircraft specifies TB as torpedo bomber, but the last letter is for the manufacturer: C for Curtis, F for Grumman, M for Martin and so on.

The Avenger originated with Grumman but Martin made them, too. You should have referred to the plane as a Grumman TBF Avenger.

> RICHARD C. REED LCDR USNR (RET.) ACCOKEEK, MD

Trucks, aye and nay

I enjoyed Detroit Editor Jim Dunne's article *Truckin' Into The Future* (page 65, June '86). It helped me to understand how tractor trailers work.

PAUL SEXTON FREDERICK, MD

Great! Just what we need! Bigger trucks! It's already to the point where cars stand about as much chance on the road as a bug in a duck pond. And we need more?

HARRY BADGER

MONTPELIER, VT

Publisher

Daniel J. Coleman

Advertising Director

Floyd Sembler

National Sales Manager

Bud Gilbert

Advertising Offices

New York

224 West 57th St New York, NY 10019 (212) 262-8824

Chicago

1 South Wacker Dr. Chicago, IL 60606 (312) 984-5190

Detroit

377 Fisher Rd. Grosse Pointe, MI 48230 (313) 881-3520

Los Angeles 3000 Ocean Park Blvd. Santa Monica, CA 90405 (213) 450-8881

Business Manager Agnes P. Maillaro

Marketing Director Edward Vaquero

Production Manager

Lori Ellwood

Advertising Production Patricia Woods (212) 262-4800

Classified Sales Manager

Sophie Gronowicz (212) 262-4825

Reader Service Department

Gary Frederick, supervisor 224 West 57th St., New York, NY 10019 (212) 262-4292

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Just answer each question, total your score, then fill out the coupon and send it to Shopsmith.

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Circle A, B or C for each question:

- How much experience have you had in woodworking, home repair and maintenance?
- (A) Little or no experience
- Some experience (C) Quite a bit of experience
- 2 Which phrase best describes your workshop?
- (A) A selection of hand and portable
- power tools (B) A table or radial arm saw, hand and portable power tools
- (C) A good selection of stationary and portable power tools
- How involved do you want to become How involved do you want to become
 with woodworking, home repair and maintenance?
- (A) Not very involved
- (B) Moderately involved
- (C) Heavily involved
- What's the likelihood that you'll buy a woodworking tool within the next vear?
- (A) Not likely (B) Somewhat likely
- (C) Highly likely

Which best describes you?

(A) I do some home repairs and maintenance

(B) I do some woodworking and a variety of home repairs

(C) I'm primarily interested in fine craftsmanship woodworking

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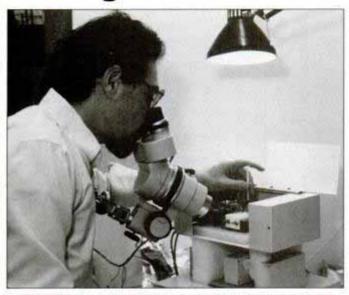
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Dept. 379U

Science

BY DENNIS ESKOW

Looking at scents



Duke researchers are learning to identify smell with the eye's help.

Your eyes see and your nose is the receptor for scents. But what if scientists could distinguish scents with their eyes? A whole new range of analysis could be available. Duke University researcher Sidney A. Simon and his colleagues have begun doing just that. Studying olfactory hairs from human noses, they found receptor molecules that behave like a water-filled tube with a door on one end. When the hair comes in contact with an odor, the door opens and an electric response starts on a journey to the brain.

"We are measuring currents of only a millionth of a millionth of an ampere," Simon explains, so the work is very tricky. The researchers hope the result will be an artificial electrical and chemical scent sensor that can produce a chemical formula for a specific scent. It should revolutionize such industries as wine, perfume and entertainment.

Interferon arrives

After 17 years of research, the Food and Drug Administration has approved the use of Interferon in the treatment of hairy-cell leukemia. Only 1000 Americans get the deadly illness each year, but the licensing of Interferon for this type of leukemia may open the doors for use of the new drug in other cancers.

Roche, which manufactures Roferon-A, one of the first two commercial Interferons to be licensed, says clinical studies indicated a remission rate of 90 percent in patients who have the rare disease. Some optimists believe this will translate to very high remission rates for all types of cancer. But scientists are being cautious in their predictions. It may be years before Interferon is used in the treatment of other major illnesses.

Watch this

The last time we spoke to astronomer Terence Dickinson, he was in a hurry, trying to finish his latest book on stargazing. When the book finally arrived last week, I was surprised. Night-(Camden House, \$19.95) is one of the most thoughtful guides ever published to help newcomers to stargazing. Instead of trying to go around the mathematics of astronomy, Night-Watch spoon-feeds the reader with the most essential math. Then it's on to the adventure of locating stars, galaxies and as-yet unclassified objects with great depth. Illustrations by Victor Costanzo and Adolph Schaller really help you figure out what you're looking at when you look up. The fall is the best time to start stargazing, because there's less haze than in the summer and the weather is not prohibitively cold. So get Night-Watch and start your tour of the universe.

Future boxing?

If you saw our special issue in July, you'll remember Jeff Greenfield's report on the future of boxing (see *The Pur-* suit Of Happiness, page 249). Jeff predicted that the boxer of the future will be wearing Kevlar armor that contains sensors to measure blows. When the computer tied to those sensors registered excessive brain or tissue damage, the boxer would lose his license.

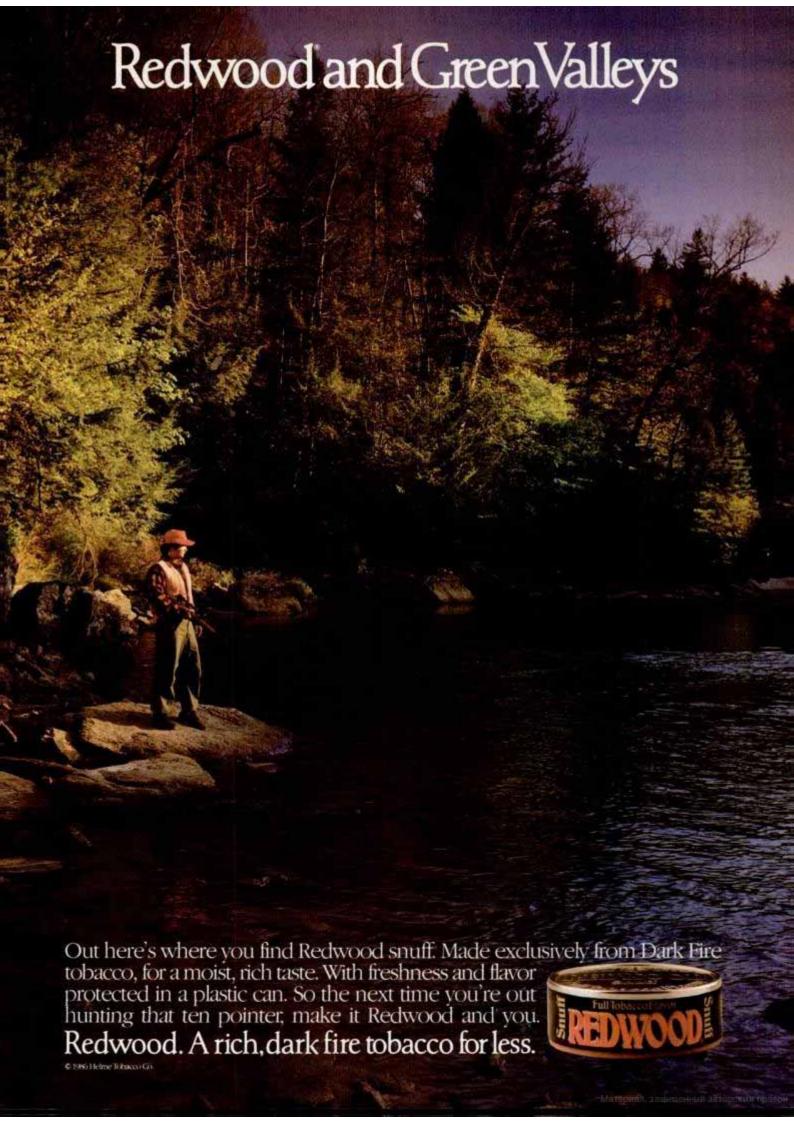
Now, writing in the Journal of the American Medical Assn., Rockefeller University's Robert Glenn Morrison proposes federal regulation of boxing that would, among other things, monitor cumulative damage a boxer takes in the ring. How this would be accomplished is not spelled out to great length. But we know of a technology that could make it possible.

Cloth thermostat

Scientists from the Federal Agricultural Research Service are working on a molecular thermostat that will help clothes keep you warm in winter and cool in summer. Treating rayon, cotton and polypropylene fabrics with two types of alcoholbased chemicals, the re-searchers found that the heat-retaining ability of the fabrics could be stepped up. The alcohol molecules form in a similar way to plastic crystals, storing or releasing heat as they change from solid to liquid. In hot weather, they release heat; in cold weather, they contract and store it. The treatments may go to market within three



Alcohol molecules will form heat-storing nodes to heat cotton.



Imports



BY BILL HARTFORD

High-revving Rovers



Coupe Concept Vehicle (CCV) will be basis for the Sterling coupe.

n a few months, Austin Rover Cars of North America will open the doors of over 100 dealer show-rooms and let fly its high-performance, 4-door sed an—the Sterling. Meanwhile, back in Britain, the Austin Rover Group is showing the CCV, a crowd-pleasing prototype of the 1989 Sterling Coupe.

The Sterling began life as Project XX, a joint venture between Rover and Honda to design and build a luxury grand tourer. Honda's already got its "executiveclass" GT with the Legend, and now Rover is ready with its version. The Sterling goes on sale in Great Britain this month. After production revs into high gear, we'll get our cars in a choice of two V6 models: a flagship, \$25,000 Sterling, and a lower key, \$19,000 version. When we drive the two U.S. models later this month we'll judge the sum of their parts. Some we're familiar with already. The 151-hp, fuel-injected V6 powers the Honda Legend

and it gives that car "a top speed approaching 140 mph" (see Firsthand Drive Report, page 21, June '86). The 5-speed and automatic transmissions, A/C, brakes and some other parts are



Wraparound glass of hardtop hides pillars.



also Honda-developed. Rover did the body, suspension (a firmer setup than the Legend's) and a dohc, 4-valve Four for the European market. It'll be a turbocharged version of this 2-liter Four that may power the CCV when it becomes the '89 Sterling Coupe. Yes, the British Rovers are coming again, starting with a Sterling salvo after the New Year.



Sterling, Rover's version of Honda Legend, arrives in '87.

All the Porsche you need

In 1977, at the wheel of a smooth-bodied, black 924, we slipped south out of Stuttgart and made a blur of Switzerland, The 125-hp Porsche took us on an incredible topographic tour: up, over, down, around-and through-a barrel of mountains. The then-new 924 was likable and capable, but, to Porsche, it was always the runt of the litter. And it wasn't long before we in the U.S. were able to get the front-engine Porsche in its posturing

Today, that's the 944 and

toughest guises only.

944 Turbo. For 1987, though, the 924 is back—with the same basic, non-muscle-bound body and a base price of \$19,900. The bigger engine (2.5 liters, 147 hp) gives better performance (134 mph top speed, 0 to 60 in 8.3 sec.) and there are more standard features.

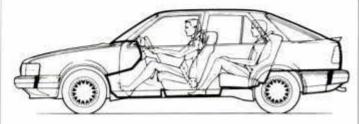


The 924S Four is 2.5 liters, 147 hp. Its top speed: 134 mph.

Saab's Good Book

One of the best "parts" of the Saab 9000 is in the glove box, according to the Swedish Automobile Assn. It's the owner's manual. The color illustrations, detailed index, layout and easy-to-understand explanations of complex systems throughout the car brought Saab top honors from the association.

PM readers especially appreciate the need for a good manual to understand and maintain a machine. Car designers and inventors are often recognized, so, it's nice to hear about proper praise for the technical illustrators and writers who drew the fine lines and chose the right words.



For an inside look at the Saab 9000, check inside the glove box.

TOYOTAITON

PAYLOAD POWER!

Toyota's 1 Ton Truck is built to handle the jobs other compact trucks can't take on. Its payload is the biggest of any truck in its class.



HAULS A LOAD AND TAKES A LOAD OFF YOUR MIND.

HEAVYWEIGHT CHAMP

Being #1 carries more weight behind it ... a whopping 2655 lb. payload, including passengers, equipment, and cargo. Power to move big loads comes from the 1 Ton's 116 hp EFI engine. Toyota's 1 Ton is specially equipped with heavy-duty suspension and axles, double-wall bed with heavy-duty floor, and 8-ply rated steel-belted radial tires, all standard. Toyota Trucks, #1 in compact truck sales, owner satisfaction.** and import model selection.

NUMBER ONE IN COMPACT TRUCKS Trailer Boats
magazine
picked Toyota 1 Ton
as Best Tow Vehicle
of the Year, outperforming all other
trucks tested with a
5000 lb. tow load.

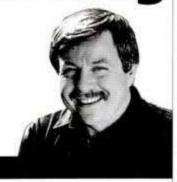
WHO TOYOTA
COULD ASK TOYOTA
FOR ANYTHING
MORE!

Get More From Life ... Buckle Up!

"Manual transmission and optional towing package only, not to exceed GCWR of 8500 lbs. "Ward's Automotive Reports, calendar year 1985 total compact pickups. "1985 J.D. Power & Associates Compact Truck Customer Satisfaction Index (for 1984 vehicles).

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Freewheeling



BY WADE HOYT

Trucks made for haulin'



Ford's fifth-wheel "Texas limo" has Lincoln trim inside (below).

ast month's special section on pickups (page 93) was so popular that I thought I'd use my column this month for some of the exceptional trucks we just didn't have room for in the

August issue, including Ford's SVT.

What's an SVT? You all know about SVO. Ford's Special Vehicle Operations has designed such high-tech goodies as the Mustang Probe GTP race car (see Technology Of Speed, page 91, Mar. '86) and the SVO version of the Mustang road car. SVT is a little in-house joke at Ford's Light Truck Engineering Special Projects Department. It's the nickname for a "Texas limousine" built around a dualwheel Crew Cab F-350 and set up for fifth-wheel trailer towing in style.

Billed as an "employee involvement project," the SVT features a slew of interior amenities from the Lincoln



parts bin, including four plush bucket seats, climate control and stereo systems, door panels with control consoles, and other un-trucklike trim. There's also a refrigerator and a custom rack for cut-glass tumblers.

Outside, there's a muted cream-and-tan paint scheme, plus custom running boards with built-in mud scrapers that carry the SVT logo.

Not to be outdone, the people at Chevrolet have whipped up a couple of special projects of their own. West Coast Editor Steve Parker got a close look at the division's wishful truck thinking during a recent outing in the Arizona desert.

The first truck he sampled was a Twin-Turbo S-10 pick-



Injected Vette V8 (below) looks at home in this Fleetside lowrider.

up. The 2.8-liter 60° V6 has been fitted with two turbochargers to make it one of the faster delivery vehicles around. The Twin Turbo truck also sports a 5-speed transmission, custom leather-trimmed interior, high-level stereo and an outstanding silver-and-charcoal paint job to top it off.

For good measure, Chevy engineers have specified a sport suspension package Goodyear with Eagle P215/65R15 radials, but it still needs help to handle the screaming power this unit produces. Steve drove the truck both on- and off-road and found it difficult to keep the rear end under control even during moderate acceleration. He clocked a 0-50 run in 6.8 seconds and could have done much better with some traction.

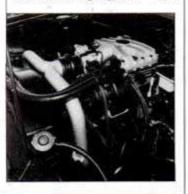
Brute-force fans would appreciate Chevy's second dream truck, a C-10 Fleetside packed full of 5.7-liter Corvette V8, tuned-port fuel injection and all.

The 2-tone black-andwhite truck has the front end lowered 3 in. Alternate mounting points for the rear springs lower the back end some 3½ in. Adding to the lowrider look is a blackout grille, Centerline satin-finish wheels and wraparound Firebird taillamps.



Hardly all show and no go, the Vette V8 coupled to a THM 350 automatic transmission and a 4.11:1 rear end help push this big truck from 0 to 60 mph in under seven seconds.

When will we see turbocharged and Corvettepowered pickups on the road? Don't hold your breath. But as one source at Chevrolet told us: "We don't have the money to make things like this just to fool around. Everything we do must have a purpose."





Chevy's Twin Turbo has a pair of blowers piped into V6 pienum.

typically with 2x4 stock and have many supporting chords in between that eliminate any useful space. To open up a truss roof is possible, but it's very expensive.

An attic under a rafter roof can yield additional bedrooms, a den or a hobby room. However, if there is sufficient headroom only in a narrow strip in the middle of the attic, you can still increase the usable floor area by adding a large shed dormer to one or both sides of the roof. Basically, this involves raising sections of the roof at the outside walls and then adding shorter walls between the raised roof and the top of the outside walls. This increases the headroom throughout the attic and brings it a great deal of light when windows are added to the exterior wall extensions.

The basement

A finished basement can increase a home's living space by as much as 50 percent. With a little imagination and elbow grease, your basement can be converted into an extra bedroom, work room, exercise room, in-home office or rec room for the kids.

Masses of pipes, wires and ducts running through this area can be a thorny problem, but most can be rerouted to fall between the floor joists and then be covered with a suspended ceiling. Remember, too, that basements usually have little window area, so you may have to settle for more artificial light.

Often, you will have to contend with moisture problems. These must be resolved before putting any hard-earned money into the job. This could involve installing a curtain drain around the house foundation or using sump pumps and baseboard drains. Sealing and waterproofing the foundation may also be necessary.

The garage

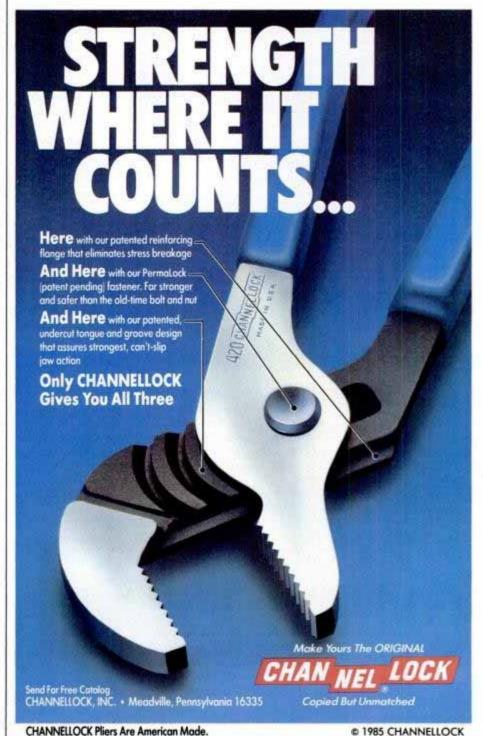
The garage is often adjacent to the kitchen, so it's an ideal spot for a large family room. The fact that it's already framed and attached to the house eliminates much of the difficulties and expense of adding a room. It could also serve as an additional bedroom with even another bathroom. You will have to remove the garage door and build a new wall underneath the garage door header. And, usually, you'll want more windows as well as a new subfloor. But, once this is complete, installing electricity, insulation and drywall will yield a new room for a fraction of what a comparable addition would cost.

Additions

If you have considered all the possibilities of converting your existing space and you still need more room, the only alternative left is to build an addition. Before beginning, check with your local planning and zoning office for laws that effect the size and placement of any additions you would like to build.

As a rule, you should design the addition to supply the type of space you need the most. If your primary desire is for a big, modern kitchen, use the addition for the new kitchen and use the old kitchen as a new dining room, breakfast nook or even a combination utility-laundry room.

Many homeowners find the best way to expand their house is to simply add onto one room or attach a new room on the ends, or back of the house. Others opt for the "satellite" concept. With the latter, the addition is erected as a separate building and connected to the house by a narrow room which often serves as an entry way or mud room. But, in order to retain the original character of your house, both types of additions should conform to your home's existing architecture. You don't want your home to look like it's been "remuddled," instead of remodeled. To help achieve architectural unity, match roof pitches where possible, install windows of the same type, and use consistent siding materials.



Inside Detroit



BY JIM DUNNE

Reatta vs. Corvette



Reatta stack up against the Corvette? Though the cars are aimed at different buyers—Reatta leans toward luxury while Corvette stands for performance—the differences are not as sharp as GM may have intended. The Buick sports car will have a husky 3.8-liter V6 engine and use Riviera's front-drive setup, while Corvette will continue with its V8 and rear drive.

Those are the major differences. But both are 2-seaters, and both will be among the hottest performers on the streets. Don't underestimate the power of the Buick V6. In the Regal Grand National, with turbocharger and intercooler, the engine produces 235 hp to Corvette's 230. Buick's only

problem might be too much power for the Reatta's frontwheel-drive setup. But if an all-out performance Reatta is built, the car could be a Corvette beater.

Riv revision

Within two years, Buick will make a major change in the styling of the Riviera in an attempt to separate the appearance of this \$20,000 model from that of the \$10,000 Somerset. Widely criticized for its look-alike styling, the Riviera will have a new roofline, doors, grille and rear-end shape when the 1989 models are introduced.

A "tapper" door handle will be hidden in the window frame, similar to the design seen on the Chevrolet Baretta. The rear window will be tilted to flow into the



New roofline, grille and doors will distinguish 1989 Riviera.

trunk surface less abruptly. The B-post will slant rearward instead of standing upright. And the grille will have a peak in the center that will wrap up into the hood slightly. Also spotted on a prototype at the GM proving grounds were small vent windows in the doors.

The changes not only make the car look different from the Somerset, but also make it appear bulkier, which is more appropriate to its price level.

Cutlass Supreme

Olds plans a new, front-drive version of the Cutlass Supreme for 1988 that will make its appearance with a revised Grand Prix and Regal. Top engine will be Buick's 3.8-liter V6 which, when equipped with port fuel injection, will be competitive with the Thunderbird V8s. Overall, the new GM G-body cars will be smaller, lighter in weight and still hold five passengers. Styling is completely different from today's models. Olds' version will have a gap-tooth grille and rounded front end like the Toronado. The rear of the greenhouse will bend in sharply along the top of the rear quarter panel. Rooflines will be exclusive to each GM division and that, as much as the grille, will set the cars apart from each other.

Chrysler tap still open

The flow of new models from Chrysler will continue for at least another year. Fresh on the heels of the Sundance/Shadow, LeBaron GTS 2-doors, Dakota and Maserati will come a completely new line of front-drive luxury sedans that will eventually replace the rear-drive Fifth Avenue. Set for introduction next fall, the styling of the new cars will depart slightly from the shapes you see now at Chrysler.

"They will be just as formal in appearance as the Fifth Avenues," according to one Chrysler insider. That means a prominent hood and trunk line, and a boxy roof shape. The new cars are to be built on a 104-in. wheelbase—the longest of any Chrysler front-drive car—and will compete against GM and Ford midsize sedans like Celebrity and Taurus.

Later, perhaps in the 1989 model year, a luxury version to be called the Imperial will make its appearance. Its mission: take a piece of the luxury sedan business away from Continental and De-

(Please turn to page 18)



Front-drive '88 Olds Cutlass Supreme will have its own roofline.

MICHELIN INTRODUCES THE TIRE THAT LETS YOUR PICKUP, VAN AND 4X4 RIDE LIKE A CAR AND WORK LIKE A TRUCK.



Big loads aren't a big deal for the XCH4 radial. It gives you the carrying capacity of a light truck tire. With the comfort of a Michelin passenger tire.



The XCH4 is proof that a light truck tire can work hard for you without being hard on you.



The XCH4 is designed to wear slowly, and just as important, evenly. Which prevents premature wearout. And gives you the kind of mileage Michelin is famous for.



The crisp handling and precise response you expect from a Michelin. Now your vehicle can achieve all the driving excitement and fun it was designed for.





MICHELIN'
BECAUSE SO MUCH IS RIDING

Материал, защищенных авторским при

INSIDE DETROIT

(Continued from page 16)

Ville. Look for the new line to be offered in Chrysler, Plymouth and Dodge versions. They will have the Mitsubishi 3-liter V6 engine as standard power.

What about the Fifth Avenue? That car, which traces its heritage all the way back to the Plymouth Volare, is enjoying strong demand from buyers. So Chrysler hopes to keep it in production somehow, even though company assembly lines are currently choked full of front-drive models. The Fifth Avenue, along with sister models Gran

Fury and Diplomat, is being pushed out of its St. Louis assembly plant by a new Chrysler minivan production line. It's now looking for a place to be built.

Heavy facelift

The Ford and Mercury full-size sedans-the LTD and Grand Marquiswill get a major "freshening" next year as Ford responds to buyer demand by keeping these rear-drive big cars in production. Ford, like the rest of the industry, is strongly committed to front-wheel drive for its sedans, but the older rear-drive models are still mighty popular. So Ford is planning new

grilles, headlights and front bumpers for both the LTD and Marquis. At the rear, taillights and bumpers are also revised. Still, the basic angular shape of the body remains. Prices on these models. like those of the Chevrolet Caprice, remain relatively low. The LTD and Marquis are now among the best values in the new-car market.

Look out, Europe

"The Japanese will come in and take over the market before the Germans know what's happening." That's the scenario painted by J.D. Power, the highly respected auto market analyst, when describing the introduction of higher-priced cars from Japan.

They will bring the same reliability and trouble-free service to the \$20,000 luxury car market that they have in the

small-car field," he says.

According to Power, the Europeans are not really taking the Japanese "that seriously.'

"Word will soon get out that you don't need a mechanic to get around, and that's when the Japanese will take much of the American luxury car market away from the cars from Europe."

Power also points out that the Japanese are beginning to face some difficulty in America.

"U.S. car quality is still only 75 percent of that of the Japanese, according to our surveys, but the higher prices of the imports and improvements in U.S. cars have caused some oversupply of Japanese models."

Power also found that the highest quality cars sold by Chevrolet are Sprint, Spectrum and Nova. All three are Japanese designs. Nova uses a drivetrain imported from Toyota.

What drives car owners crazy, according to Power, is the little thingslike cold startup, hesitation on acceleration, rough idle, squeaky brakes and radio static. Also, new-car owners go up the wall when the service manager says, "The problem can't be fixed. They're all like that.'

Quality and reliability are now the top complaints of new-car owners, replacing fuel economy as No. 1. Power predicts performance will become the chief concern of buyers in a few years, if quality continues to improve.

Chrysler-Maserati

Chrysler will have its 2-door convertible ready for sale "about next June," according to insiders. Two engines will be offered, both versions of Chrysler's 2.2-liter iron Four. The base engine is Chrysler's new Type II turbo with intercooler that will put out power to spare in the small 2-seater. Even more powerful will be a Maserati-tweaked version of the same engine, this one with a special 3-valve head.



NOW WE'VE GOT THE EDGE IN PRICE, TOO!

When you pick up a Husqvarna, you expect to get the best in new technology. The best in durability. The best power-to-weight ratio. Now you can also expect the best deal around at \$289.95. And ask about the protective gear promotion.

Participating Husqvarna dealers are offering valuable premiums at dramatic savings. Like a

woodcutters kit or a safety helmet with hearing protectors or a winter jacket. Stop by for the special offer in your town. But hurry, special pricing and premiums end November 15, 1986.

Get the saw that gives you the edge—in performance and in price. At your full-service Husqvarna dealers.

"Manufacturer's suggested promotional price 9/1-11/15/86. With 16" bar and chain at participating dealers.



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in a 1987 Jeep Wrangler!

Enter The Great Pennzoil Jeep Giveaway-and you might drive away a winner! Just look for the display at your favorite store. Then fill out and mail in the Entry Form you'll find on specially-labeled bottles of Pennzoil Motor Oil, Start stocking up on Pennzoil Motor Oil today! And YOU may be one of the lucky ones who'll drive away a winner!

NO PURCHASE NECESSARY to enter or receive a prize. To enter, you may use the coupon found on quart containers of Pennzoil Motor Oil. You may also enter by hand printing your complete name and address on a 3"×5" piece of paper. Mail to: PENNZOIL "JEEP", P.O. Box 16, NYC, NY. 10046. Enter as often as you like, but each entry must be mailed separately. No mechanically reproduced entries accepted. All entries must be received by March 31, 1987 to be eligible. Not responsible for late, lost, or misdirected mail.

Winners will be selected on or about April 15, 1987 in a random drawing conducted under the supervision of Marden-Kane, an independent judging organization, whose decisions are final. All prizes will be awarded Odds of winning depend on total number of entries received. Winners will be notified by first class mail and will be required to PENNZOIL sign an affidavit of eligibility and release. Winners' names and likenesses may be used for publicity purposes for this or

similar promotions without additional compensation. No substitutions forprizes, nor are prizes transferable. All applicable taxes, if any, are the sole responsibility of winners. By entering this sweepstakes, entrants agree to be bound by the official rules and the decisions of the judges are final in all

TWENTY GRAND PRIZES-New, 1987 JEEP WRANGLERS with all standard equipment. Total estimated retail value of prizes is \$195,000. Winners agree to accept vehicles as delivered. Limit one per household, address or organization. If any prize is won by a minor, it will be awarded in the name of a parent or legal guardian.

Sweepstakes open to licensed drivers in the U.S., its territories, and Canada, except the province of Quebec. Employees of Pennzoil, its distributors, agencies, retailers, Marden-Kane and their immediate families are not eligible. Void at gasoline retailers in ME, MA, MD, NH, NV, and where prohibited by law. Canadian winners are required to correctly answer a skilltesting question before awarding of prize.

For a list of prize winners, send a stamped self-addressed envelope to: PENNZOIL WINNERS LIST, P.O. Box 10614, LIC, NY 11101 (residents of Washington state send self-addressed unstamped envelope).

The Standard of Protection Since 1889.™

CAR CLINIC

(Continued from page 22)

Ref says, 'Break clean'

I say the air conditioner in my '85 Toyota Corolla doesn't cool enough. My dealer says that's the way it is. Instead of coming to blows, we've agreed to let you decide who's right.

The dealer has gone over the system from stem to stern and found no refrigerant leaks. The unit is fully charged, pressure readings are within spec, the drive belt is tight—in fact, he says every possible reason for insufficient cooling has been checked. Still, it's too warm in the car. Is there something he's missing?

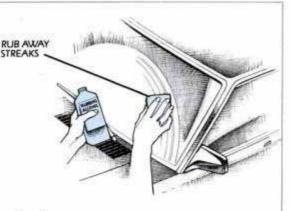
ROGER PERKINS JACKSONVILLE, FL

He could be overlooking the possibility that the heater water valve and cable, which control temperature settings, are not positioned correctly. This could cause warmer air than normal to come from the air-conditioning ducts.

Here's what should be done:

Set the temperature control lever on the dash to the FULL COOL position and make sure the heater water valve is also at its FULL COOL position by loosening the clamp on the bracket holding the cable to the valve and turning the valve





Sparkle plenty

If scrubbing fails to remove a coating of haze on the inside of your car windshield, spritz the glass with window cleaner, rub lightly with very fine No. 0000 steel wool and use paper towels to dry the surface. Careful, if you rub too hard, you may scratch the glass.

For outside glass that's streaked because of windshield wipers which have seen better days, wiping the windshield with rubbing alcohol will make it sparkle.

Caution: Do not use steel wool on the interiors of windshields that have plastic overlays to protect passengers from glass splinters in case of an accident. This type of windshield is found on some 1986-'87 models and generally has a warning label on the glass. Consult the owner's manual for your car to find out if this caution applies in your case.

clockwise as far as it will go.

Once the valve is in the full OFF position, check to make sure the dash lever is still in the FULL COOL position, then retighten the clamp on the cable.

In areas of high temperature and

humidity, an A/C system may work at its maximum and you still may not feel comfortable in the car. If your dealer has taken a temperature reading at the A/C outlet and found it to be close to 40° F., there's not much else he can do.

Take along a Powermate



for electricity that's just a cord's length away.

Why let your do-it-yourself spirit be confined to the length of an extension cord? With Power-mate's® portable 1500 watt generator, you can take your own power to places electricity's never reached before.

Our popular sized generator is easy to carry and easy to use; capable of running your favorite power tool or small appliance – around the house or on a camping or fishing trip. It comes in handy during power outages, too; delivering enough electricity to keep a deep freeze or sump pump operating for hours.

For information on all six Powermate* generators (ranging from 500 to 4600 watts) contact the Powermate* dealer nearest you.

For the Powermate* dealer nearest you, call 1-800-344-1010 (In Canada, call 1-800-526-8000.)

POWERMATE

Electric Generators

Manufactured by Ag-Tronic, Inc. 125 Airport Road, Kearney, NE 68847

Dishpan hands

The aluminum-alloy wheels on my '82 Mazda RX-7 are stained a corrosive-looking white. I've tried various mag wheel cleaners without success. What do you suggest?

JOHN L. RATCLIFFE OCEAN PARK, ME

I've had success with commercialgrade aluminum pot and pan cleaner, available in hardware and home supply stores, applied with a very fine steel wool pad (No. 000). Don't use a more abrasive pad; even No. 000 may remove the anodizing that makes the wheels shine. But the shine can be restored by spraying on clear lacquer or enamel. Be sure to flush away all traces of the cleaner before applying the spray.

Big for its britches

A few days after I drove my '84 Honda Accord from the showroom it developed an engine knock. After several trips to the dealer, we got a factory representative involved. He said the knock was coming from the No. 1 piston, so it was replaced. The knock remains to this day and it seems no one can do anything about it. Yet, one mechanic told me there are a lot of Accords out there that knock. Do you know anything about this?

JAMES NILES ST. PAUL, MN

SERVICE TIPS

- A low-speed shudder (or chuggle, as dealers call it) from a 1985 Pontiac Firebird equipped with the 5-liter engine and automatic transmission could happen as the torque converter clutch (TCC) engages. Reduce the sensation by installing a different computer PROM chip to raise TCC engagement speed to 41 mph and engine idling speed to 650 rpm. If the car has air conditioning, install the PROM having part No. 1227741. If there's no A/C, get PROM No. 1227742.
- Transmission fluid on the floor under '85 or '86 front-wheel-drive Chrysler cars built in the U.S. may be from a leak at the speedometer pinion adapter. Install a new adapter (part No. 4295857) to stop the leak, says TSB 21-04-86.
- That rattle from the dashboard around the radio in your '86 Toyota Celica can be eliminated. For instructions on increasing retention of the panel in which the radio is encased, ask your dealer to check TSB 001, Reference NVH.
- Speaking about unwanted noise, is there one in the form of a squawk coming from the front suspension of your '84-'86 Cadillac Cimarron? If so, refer your dealer to TSB 85-13A to have new insulators installed
- If you're sitting mighty low as you drive your '86 Ford EXP, have a dealer raise the height of your bucket seat by installing new spacers and bolts, as per TSB 86-6-5.

If the noise is a light tap that disappears a minute or two after the engine is started, Honda classifies it as "normal cold piston noise."

If the noise is there all the time and is louder when the engine is warm and the transmission is in gear, there is probably too much clearance in the No. 1 main bearing.

Ask the service manager to read

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic. Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column. Honda Parts News No. A85072604, or Parts Information Bulletin No. 86-0044, which discuss the availability of tighter main bearings. You can verify if too much No. 1 bearing clearance is causing the noise by starting the engine and pulling the No. 1 plug cable. Does the noise disappear? If so, that's it.

The Honda publications list three special replacement bearings for your engine. The mechanic should check the clearance of the present bearing with a Plastigage. Then, depending on the size of the bearing now in the engine, he should install one of the three that gives a clearance of .025 mm, or .001 in.

THE MOST EFFICIENT FILTER YOU CAN BUY.

In standard laboratory tests for filtering efficiency against other leading brands, the others left as much as 56.8% more dirt in the oil than a Lee Two-Stage Maxifilter.

No surprise here. Lee adds a second filter to effectively trap dirt as small as one-fifth the width of a human hair. Lee Two-Stage. The clean breakthrough in oil filter technology.



NEVER DRIVEN THIS CLEAN.



Homeowners'

BY NORMAN BECKER, P.E.

Water heater safety

As some of you know, in addition to writing this column I do building inspections for prospective buyers. One problem that I periodically run into is that of an improperly protected domestic water heater. I want to call this problem to your attention because it could result in an explosion causing severe damage or injury.

All tank-type water heaters, whether they are electrically heated, gas fired or oil fired, must have a relief valve that is both temperature and pressure sensitive. Unfortunately, many relief valves are pressure sensitive only and this will not provide you with the needed pro-

tection against an explosion.

Should the heater's thermostat malfunction, the water in the tank could become superheated, meaning it's heated beyond its boiling point of 212° at atmospheric pressure. As the boiling point of water increases, its pressure increases and both combined can weaken a tank and cause it to rupture.

If this happens, the water pressure immediately drops to atmospheric pressure. It instantly flashes into steam, increases its volume and liberates an amount of energy that can be greater than a pound of nitroglycerin. If the water had not been heated above 212°, it would not

flash into steam and an explosion would be impossible.

Consequently, pressureand temperature-sensitive relief valves are designed to prevent the water temperature from exceeding 210° F. It does this by discharging the overheated water and allowing cooler water to enter the tank, safely lowering the water temperature.

It's also important that the BTU capacity of the relief valve exceed the BTU input of the water heater. If the capacity is less, the relief valve will not be able to discharge the overheated water at the same rate it's produced, resulting in an unsafe condition or possible explosion. Check the capacity of the relief valve by looking at the nameplate mounted on the valve. Specifically look for the AGA (American Gas Assn.) rating given in BTU/hour. This rating must exceed the BTU input to the water heater listed on the plate on the tank casing.

Also, when the relief valve is installed, its temperaturesensing element should be immersed in the top 6 in. of water in the tank. This is important because there is a temperature difference between the tank and the hot water outlet pipe. For instance, when the relief valve is installed in the hot water outlet pipe 5 in, away from the tank, the water in the tank could be raised to 250° F before the temperature at the valve reaches 210° F.

Deck treatment

I built a wood deck with treated southern pine. Can it be stained now or must I wait a specific length of time? Which stains would be most compatible with it?

> ALPHONSE PLAZA AMHERST, MA

I'll assume the lumber you used was pressure-treated with Chromated Copper Arsenate (CCA). This is the formulation used in Wolmanized wood (a trademark of the Koppers Co. and not a generic term for pressure-treated lumber). These chemicals cause the familiar

green tint in the lumber.

If the lumber's treatment stamp has "dry" included in it, the wood was redried after treatment to a moisture content of 19 percent. Then, as long as weather conditions permit, you can paint or stain immediately.

More often, the lumber has not been redried. In this case, you should let it dry for 12 weeks before applying a semitransparent stain with an alkyd base that has a water repellent in it.

Peeling door

For the last four years, we've had a problem with our energy-efficient foam-core metal door. After some cold weather, its paint peeled down to bare metal. We were advised to sand the door, remove any rust, apply several coats of metal primer and then paint, all of which we have done.

It looks like we'll have to repeat the process, as it's rusting again. Any advice?

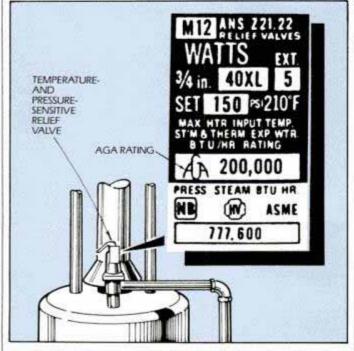
> RYAN SULLIVAN RUSTON, LA

It's possible that either the door wasn't prepared properly prior to priming or the wrong primer was used.

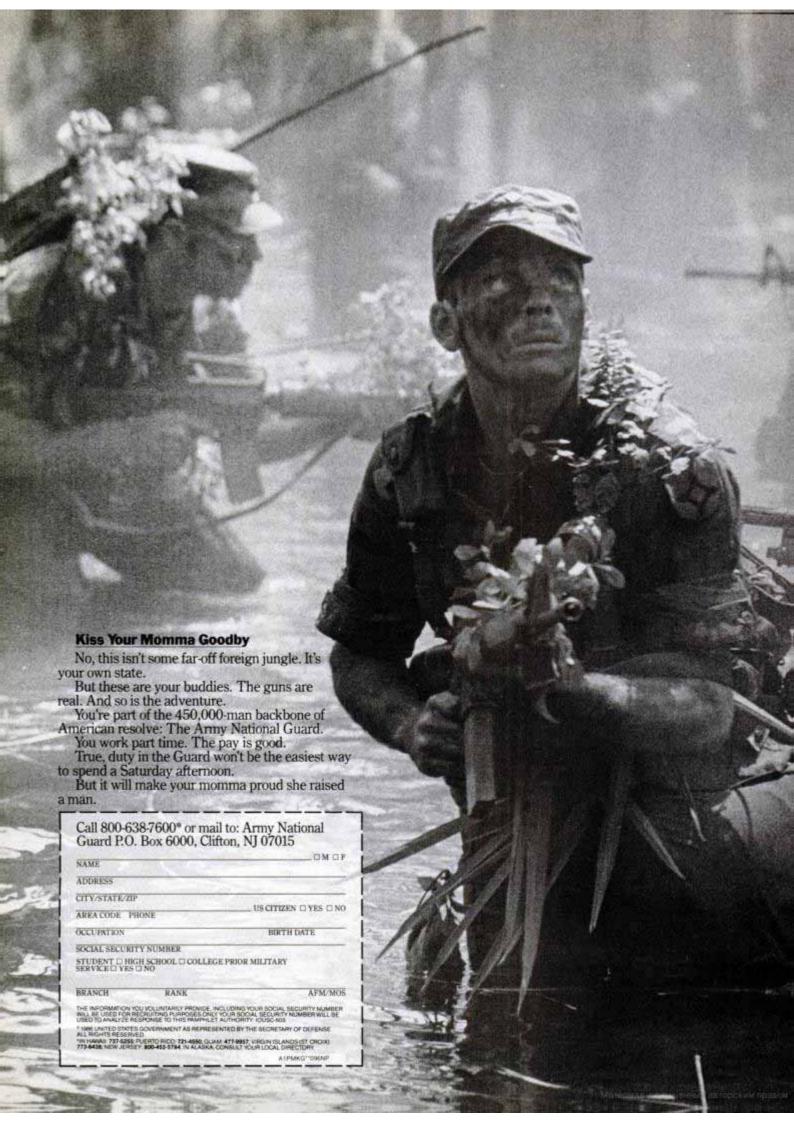
It's important the door be sanded down to bare metal. If you sandblast the door to strip off the paint and rust, then you must clean it afterward with a rag dipped in mineral spirits. The oil from the compressor could pass through the sandblaster's nozzle, leaving a thin film of oil on the door.

After preparing the door, apply a primer coat of zinc chromate. Don't wait a day to apply primer because a thin layer of rust can develop. Let the primer dry for 24 hours, then apply a coat of exterior-grade, marine quality alkyd enamel.

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.



Look for the AGA rating on the plate hanging from the relief valve. The rating must exceed the BTU input to the water heater.





IRRESISTIBLE FORCE

Computers



BY RON SCIBILIA

PC's pigskin challenge

A rmchair quarterbacks, awake! If you've ever wanted to stage a rematch of the Super Bowl, replay one of last season's grudge

matches or prove yourself the equal of John McFadden or Mike Ditka in the strategy department, here's your chance.

With XOR Corp.'s NFL Challenge you can commandeer the Monsters of the Midway—or any other NFL team—at the toss of a floppy. Min-

nesota-based XOR has created a computer football game, officially endorsed by the National Football League, that is both rousing fun and an excellent primer in pigskin education.

You can play this simulation as a football novice, or you can delve deeply into the NFL playbook if you're a more advanced football aficionado. The game's ready for you either way.

It costs \$100, and all you need is an IBM-PC or compatible with 256K-RAM and DOS-2.0 or above.

NFL Challenge draws on the latest year's actual NFL statistics to determine the probabilities of what will occur on your PC gridiron. This means individual plays and game results should closely reflect the true capabilities of NFL pros.

What will strongly influence the outcome of a particular game, though, is coaching, and you'll get a wealth of information in this program SubLogic's Football gives a 3-D overhead of the field plus menus, stats.



to test the extent of your football smarts.

For starters, the package includes a 128-page book, The Illustrated NFL Play-book, which provides a basic grounding in the complex workings of the pro game, complete with diagrams, charts and definitions. Peruse this opus and you'll be ready to do color commentary on Monday night, dazzling your friends with the differences between stacks, stunts, slants, pinches, dogs and blitzes.

NFL Challenge also comes with two playbooks for actual game play, one for offense and one for defense. On offense you can choose—with the help of on-screen menus—from 55 different regular plays, plus extra selections for kickoff, fourth down and 2-minute situations. You'll try to counter those efforts on defense with

score, down,
position of the
selection me
Play results a
bottom of the
If your Po

26 different gambits,
Plays are listed in
order of riskiness.
You get a chance to
change your mind before the clock runs
out—or even undo a
play entirely and replay it some other
way. Your opponent

will be able to see the play group you're picking, and make a strategic judgment just as he would in a real game by seeing your on-field formation. But the opponent won't know your actual play call until you've made it. This feature can be disabled if you choose.

NFL Challenge lets you ease into pigskin expertise at your own pace. There's a useful LEARN mode option that allows you to take your calling plays-and time thereby avoid penalties for exceeding your 30-second play-calling allowance. You can play either against another person or against a computer coach. Or you can let the computer coach both teams. You even get to pick a persona for the computer coach-conservative. anced or aggressive.

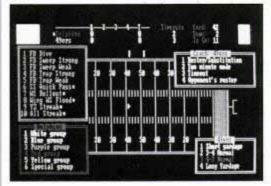
The NFL Challenge screen is loaded with information, even supplying upto-the-moment game statistics if you desire. During actual play selection, you'll see an overhead view of the field gridiron, showing the score, down, yards to go and position of the ball, with play selection menus overlaid. Play results are noted at the bottom of the screen.

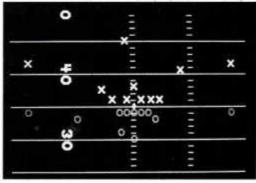
If your PC has graphics capability, NFL Challenge will show off its animation. You'll get a bird's-eye view of the field with offensive players depicted coaching-style as O's and defensive players as X's, all moving in very effective simulation. You even get an optional slow-motion replay.

Another football simulation for pigskin fanciers is SubLogic Corp.'s Football, a \$40 program for the Commodore 64 or 128. You'll need a disk drive and one or two joysticks for this one.

Football—for either one or two players—doesn't replicate actual NFL football, but it does offer an enjoyable simulation. Players have dif-

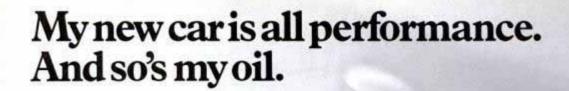
(Please turn to page 32)





NFL Challenge by XOR uses actual league performance statistics to simulate real game probabilities.

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I said this is a performance car.
Tom said Quaker State's a
performance oil. That it's quality.
He said Quaker State 10W-30 or
5W-30 keeps new cars up to speed.
The result? Stable viscosity. The
Big Q keeps flowing, protecting
and performing.
I read my owner's manual—Tom
is right!

Quaker State.
The Big Q stands for quality.
Always has. Always will.



See, procrastination pays! Putting off buying new locksets for the entry doors of your home was really a smart idea.

Because now you not only get the new Bel Air design entry locks you need, you get a free Eveready® flashlight with each one you buy. Perfect for the kids trick-or-treating on Halloween evening.

There's lots more, too. The bonus of an adjustable deadlatch for ease of installation in a variety of doors. And a \$1.00 off rebate coupon for the batteries you'll need.

Most important, though, is dressing up your entry doors with America's largest-selling residential locksets for lasting beauty and dependable, trouble-free performance.

You surely recognize a bargain when you see one, so go directly to wherever you buy hardware and ask for the Kwikset-lock-and-free-flashlight-deal.

You were smart to wait. But don't wait any longer.



HARDWARE GRO

COMPUTERS

(Continued from page 30)

ferent adjustable ability quotients and move individually on each play.

One nice touch that Football offers is a 3-D overhead perspective of the playing field, with the ball carrier always highlighted to make identification easy.

IBM hits the road

One of the primary pastimes of IBM watchers has been wondering when "Big Blue" would introduce a portable, laptop computer. The company has finally put all the speculation to rest with its PC Convertible.

The new battery-powered laptop unit doesn't blow away its portable rivals with mind-boggling new technology. Rather, it's a smartly designed, competitively priced machine. And IBM isn't counting solely on the computer-to-go market. As the name implies, the dual-identity PC Convertible is as happy on a desktop as on the road.

IBM accomplishes this by offering a detachable display that let's you replace the standard issue LCD screen with either of two new CRT (cathode ray tube) displays. One is a 9-in. monochrome screen (\$180); the other is a 13in. color version (\$400). Both are expressly fashioned for the Convertible-

and require an additional \$325 adapter that also lets you connect the Convertible to IBM's PC Color Display, PCjr Color Display, or a standard TV set.

The Convertible's detachable LCD screen also paves the way for upgraded portable displays employing liquidcrystal, electroluminescent or gas-plasma technology.

The PC Convertible sports twin 31/2in. microfloppy drives with 720 kilobytes of capacity each-good for storing about 700 double-spaced pages of text. This will boost the smaller floppydisk format, especially since IBM offers a 31/2-in. external drive for its larger PCs (to facilitate program and data transfer) and an optional, internal 31/2incher for a new version of its PC XT. Several major software publishers now support IBM's 31/2-in. disk format with new versions of their programs.

Other key specs on the 13-pound Convertible include 256 KB of random access memory, expandable up to 512 KB with 128 KB add-in cards (\$195 each). The 25-line x 80-column LCD screen provides 320 x 200 and 640 x 200 pixels of graphics support. The Convertible has six to 10 hours of battery life per NiCad charge, a 78-key fulltravel keyboard, and a clock.

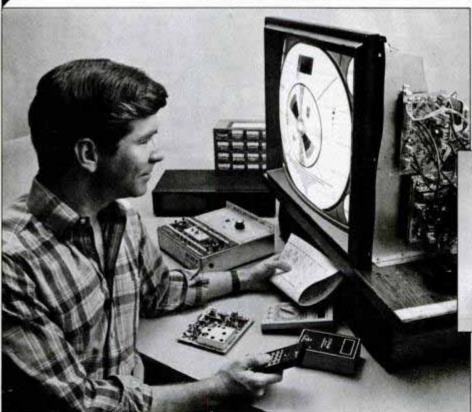
The basic unit costs \$1995 including LCD screen, AC adapter, battery pack and a start-up diskette with menudriven interface for the new DOS 3.2

> (updated for the 31/2in. disk) and several utilities. Besides the larger displays and external display adapter, options include an attachable thermal transfer printer with 24-element printhead (\$295), a 300/1200 bps internal modem (\$450), serial/parallel adapter (\$195), battery charger (\$25), printer cable (\$45) and an automobile power adapter (\$25).



HEW

Only NRI gives you a 27" high-resolution stereo color TV you build to prepare you for today's video servicing careers.



Become one of America's most soughtafter technicians . . . put your talents and spare time to work for you in the "explosive-growth" world of home entertainment electronics.

Train in state-of-the-art video/audio servicing and become a fully qualified service professional the uniquely successful NRI way. It's hands-on training, at home . . . designed around the latest electronic equipment you build and keep as part of your training.

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 markets that are just starting to boom.

Here is your chance to become a fully qualified professional the way tens of thousands have trained with NRI.

Totally Integrated Hands-On Training

Since NRI training is built around "learn by doing," right from the start you conduct important experiments and tests with your professional digital multimeter. You assemble the remarkable NRI Discovery Lab and perform a complete range of demonstrations and experiments in the process.



NRI's commitment to you goes beyond providing you with equipment appropriate to the latest technology. Best of all, we ensure that in the learning process you acquire the very skills that will make you a professional service technician on the job.

You Build a 27" Stereo TV

During the assembly process of your stateof-the-art Heath/Zenith 27" TV, you learn to identify and work with components and circuits as they actually appear in commercial circuitry. Then through tests, adjustments, and experiments you quickly master professional troubleshooting and bench techniques.



Inside Your TV

The Heath/Zenith 27" TV has all the features that allow you to set up *today* your complete home video center of the future. Flat screen, square corners, and a black matrix to produce dark, rich colors . . . even a powerful remote control center that gives you total command of video and audio operating modes.

NRI has purposely designed your training around equipment that has the same high-tech circuitry you'll encounter in commercial equipment. That means your training is real-world training.

Your NRI Training Has Another Special Element

Also built into your NRI training is the enormous experience of our development specialists and instructors. Their long-proven training skills and personal guidance come to you on a one-to-one basis. Always available for consultation and help, these instructors ensure your success both during your training and after graduation.

Step Into the Future Today

The richest reward gained from your NRI Video/Audio training is a firm grip on the future. Now is the time to act. Send the post-paid card to us today. You will receive our 100-page catalog free. It's a fascinating explanation of our training methods and materials. (If someone has used the card, write to us at the address below.)

School of Electronics

McGraw-Hill Continuing Education Center 3939 Wisconsin Avenue, NW Washington, DC 20016

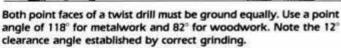




Minicourse

BY ROSARIO **CAPOTOSTO**





12° CLEARANCE POINT CUTTING LIP SLIRFACE ANGLE DEAD CENTER HEEL CORNER

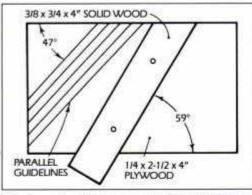
Sharpening drill bits

oring a clean, round hole is relatively easy with a properly sharpened twist drill bit. But using a dull bit can be frustrating. A dull bit cuts slowly and may need to be forced into the workpiece, resulting in a rough, oblong Proper sharpening solves this problem.

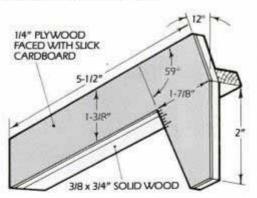
To sharpen a bit, you must grind the angle of its point at 118° for metalwork and 82° for woodwork. Equally important, each face of the point must slope down from the cutting lip. This 12° slope prevents the point's face from rubbing behind the cutting lip and slowing the cutting action. The angle of this slope is the clearance angle.

To grind a bit and then check it, make the sharpening jig and gauge shown at right. Begin grinding the bit by holding it against the jig's fence. The jig must be attached to the toolrest precisely perpendicular to the wheel's circumference. Start at the leading edge of the cutting lip, feeding the bit lightly into the wheel. Turn it clockwise and swing it parallel to the 47° lines on the jig. Which line you stop at will depend on the diameter of the bit. Complete the grinding when the bit is at 47° to form the clearance angle. Repeat the procedure for the second face.

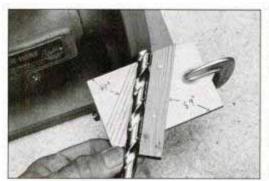
Bits under 1/4 in. dia. are ground at 59° but are not swung out to 47° or rotated clockwise. To create the clearance angle, simply hone the point surfaces on a sharpening stone.



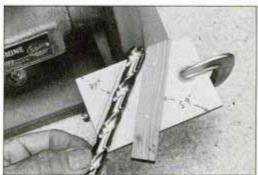
This sharpening jig helps ensure that drill bits are Make this wood and cardboard gauge to check the held at the correct angle while grinding. The parallel guidelines are drawn about 1/2 in. apart.



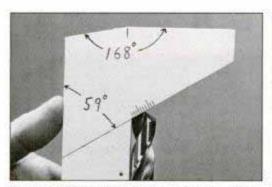
bit's clearance angle and to make sure the point faces are the same length.



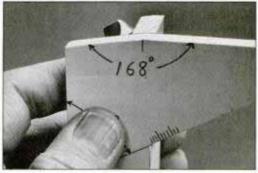
The jig must be clamped to the grinder's toolrest, perpendicular to the wheel's circumference. Start grinding at the leading edge of the cutting lip.



Grind the bit first at 59°, then, while rotating it clockwise, swing it out so it's parallel with the 47° lines. Repeat the procedure on the second face.



Check that both faces of the point have been ground equally before measuring each face with the gauge. Space guidelines 1/16 in. apart.



The bit's clearance angle is checked by holding it along the gauge's fence. The sloping face of the gauge should coincide with the clearance angle.

Photography



Hands-on: Polaroid Spectra



Polaroid Spectra print, reproduced actual size in new rectangular shape, has good detail and vivid color (not shown).

f you've seen Polaroid's recent advertisements for its new Spectra system, you probably know that our June Photography crystal-ball re-

port (Instant Gratification, page 51) was right on the money. Here's a detailed account based on lots of fun instant-shooting.

PM Photo-Tips Album





Adding sparkle to your pictures is as easy as holding a cross-screen filter in front of your lens. The criss-cross patterns etched onto the filter create starburst effects from light sources.

Making your own is simple. Scratch fine parallel lines, about 1-mm apart, on a piece of clear plastic. For 4 points, as seen in our photos, scratch more lines perpendicular to the first.

Star filters soften images slightly, making them useful for portraits with candlelight. Also, try night scenes, reflecting water shots and holiday lights. Keep apertures small and backgrounds dark for best results.

-Armand Ensanian





Clamshell-shaped Spectra opens for easy, binocular-like handling.

Physically, you hold Spectra's nonslip rubberized body like binoculars. This lets your index finger rest comfortably on the shutter release button. A slight amount of pressure makes the sonar autofocus system lock onto your subject-even in the dark-while the lightmetering system calculates shutter speed and f/stop for automatic exposure. If needed, the fast recycling flash (2/10-sec.) is ready by the time you trip the shutter.

One reason for Spectra's speed is its unique Quintic lens system. Conventional lenses focus by rotating their multiple optic elements back and forth. But in Spectra, the kidney-shaped Quintic element shuttles up and down between two fixed lenses. It responds to the sonar readings in the blink of an eye to select one of 10 focus zones, from 2 ft. to infinity.

When you look through the viewfinder, Spectra tells you your distance from the subject and, if all's okay, gives you a green go-ahead light. A yellow light and pleasant chime might caution that you're out of film, too close to the subject or beyond the 15-ft. flash range. It might also mean you've turned off one of the automatic functions.

You'll find these function switches on the back of Spectra, between the viewfinder and the descending (10 to 0) film counter. The defeatable functions include caution chime, autofocus and autoflash. Spectra's flash is always on and fires "fill" at 25 percent illumination if the metering system detects a backlight situation. There's also a 12-sec. self timer and a distance readout you can set for feet or meters.

Also on Spectra's back

panel is a socket for an optional, wireless remote control that operates the camera from 40 ft. away. Then, there's an exposure control switch that lets you underexpose or overexpose by % of a stop.

Exposure control is a useful feature. I photographed the Polynesian couple (left) in harsh midday sun using the % underexposure. This prevented the strong light from overexposing the scene and washing out the colors (the photo is printed here in black-and-white).

Technically. Spectra's shutter speeds range from 1/245th to 2.8 sec. Apertures range from f/10 to f/41.8 (f/10 to f/31.5 with flash) on the 125-mm f/10 lens. If that focal length seems large compared to 35-mm SLR cameras, keep in mind that the Polaroid print is larger than a 35-mm film frame. If equated to a 35-mm camera, Spectra's lens would check in around 46-mm f/3.7-giving a quite natural perspective and moderate speed.

Spectra's instant film gives rectangular prints that measure 2% x 3⁹/₁₆ in. Film speed is around ASA/ISO 600. Each 10-pack costs \$11.75, including a built-in battery that powers the camera.

The film itself is a big improvement on previous Polaroid instant formulations. It has 18 layers, plus cover and base supports. Separate processing layers for reds, greens and blues prevent the tones from becoming muddied. The yellows really benefit from this new chemistry, and compared to earlier Polaroids, the whites are cleaner with less tint. Additionally, the new Spectra film has excellent contrast; you'll see more detail in the shadow areas of the photo.

Now, how do Spectra instant prints compare to 35-mm? After all, Polaroid's bold claim is that Spectra will rival the color quality of conventional prints.

Color-wise, the claim stands. Compared to 31/2 x 5-in. machine-processed prints that I shot on ASA/ISO 400 film (a close equivalent to Spectra), Polaroid's colors are equally vivid. The reds and yellows really pop, skin tones are lifelike and greens seem more natural. You'll have to take my word for it, since there's no color on the facing page. Better yet, try it yourself.

In terms of sharpness, Spectra beats negative films smaller than 35-mm but seems to lack that extra edge you get from a 35-mm ASA-100 or 400 negative. In small print sizes this shouldn't matter much, but it could become a factor in large blowups. Speaking of enlargements, the new Spectra reproductions are surprisingly good, thanks to Polaroid's laser-digital system. You can get reprints in six sizes from 2 x 21/2 in. (75¢) to 11 x 14 in. (\$13.45).

Be prepared for a shock, because the electronic scanner picks up everything in the original Spectra print-including detail you might not have seen because of the original's relatively small size. The digital process enhances this detail before the laser exposes the image on photosensitive paper, which is then developed by conventional wet processing. Polaroid cites a 10-day turnaround for Spectra copies.

In my June column, I noted the availability of accessories for Spectra (\$225). Besides the remote control (\$36), there's a tabletop minitripod (\$25) and a carrying case (\$24). On the creative side, there's a \$26 special-effects filter kit. The five pieces include a starburst filter, a motion filter that imparts movement to stationary subjects, a red-center spot filter that puts a warm halo around portraits, and two multi-image filters that make your subject appear three and five times in the same photo. You'll have lots of fun with these trick effects, as I did.

If I've any criticism of the new Spectra camera, it's about the flash. It's a direct-firing design, so if you're very close to your subject, the illumination can be a bit harsh. Additionally, the camera's design places the flash close to the lens. This can produce "red-eyetis"

in your subjects.

There's a remedy for both problems. You can soften the flash by covering it with tissue paper or thin cloth. And if you pose your subjects so that they don't look directly into the camera, you'll keep those blue eyes blue. Finally, if you have copies or enlargements made, Polaroid's digital enhancement process will restore those zombie-eyes to their natural color.



A TRIP TO THE WAREHOUSE is the quickest part of the slow, slow way we make Jack Daniel's.

With a knowledgeable driver (and some husky barrelmen) we can put this whiskey to rest right quick. But then it will take years and years to reach maturity. And prior to all this, it will have dripped in unhurried fashion through room-high

vats of tightly tamped charcoal. Getting Jack Daniel's to the warehouse is the fastest part of all. But, we assure you, it's the only step where any hurrying is allowed.



Audio



BY FRANK VIZARD

Do-it-all receivers





Versatile SA-590 receiver has multiple audio/video functions.

Audio receivers are striving toward a new level of intelligence. True, they might not be as smart as HAL, the on-board computer featured in 2001. But if you want to watch this science-fiction classic or any other movie at home, these latest receivers are the central brain that will tie audio and video together.

A good example of this new breed of receiver is the Technics model SA-590. It's got more functions than a Swiss Army knife.

Let's say the tape of 2001 you're watching is an old one with lots of hiss on the soundtrack. You can make this 1968 film sound much more pleasurable by engaging the SA-590's "VCR Sound EQ" button—fancy nomenclature for what is essentially a filter that acts on high and low frequencies simultaneously.

Further dickering with the sound can be done by using the built-in, 7-band equalizer to modify specific portions of the audio bandwidth. The SA-590 dispenses with normal slide controls, however. All you have to do is draw the desired equalization curve across the control panel with your fingertip. The internal circuitry responds instantly to your finger's pressure.

The SA-590 has the ability to memorize three equalization curves of your choosing. Another two—one for vocals and the other for jazz—are already preprogrammed into the machine. The equalizer display serves as a spectrum analyzer when the equalizer is not being used.

As you might expect, there are inputs for every audio source. How well the SA-590 handles video may surprise you. The unit has two sets of video inputs: One set, comprised of one video jack and two audio jacks (for stereo), is located on the front panel to simplify any dubbing operation.

Additional flexibility is provided by preamp outlets that let you hook up devices such as surround-sound decoders or dynamic range expanders with a minimum of fuss. The convenience outlets on the back panel are all polarized to facilitate easy connection of other components—yes, someone finally realized that most electronics components sold today have polarized plugs.

Adding to the unit's video versatility is simulcast recording capability. The SA-590 can also tune into FM programming on cable. A stereoplex switch is included to simulate stereo from mono sources.

At 100 watts per channel, the SA-590 should satisfy the power requirements of most users. High-powered amplifiers of this type can sometimes generate much heat and degenerate the unit's performance. Heat sinks usually do an adequate job of dissipating heat, but the SA-590 goes one step further by incorporating a small fan into the chassis. This fan lowers the amplifier section's temperature more than usual. The benefit, says Technics, is that the amp runs with less distortion.

Such engineering care might make the SA-590 worth its \$550 list price just on that basis alone. The SA-590's real value is the convenience and flexibility it offers. Add autoscan tuning and 16-station randomaccess memory to the list of features described already and you have an audio/video brain that can be the heart of any system.

And if that's not enough, the SA-590 comes with a 28-key remote control that operates other Technics hi-fi components—as well as Panasonic-brand VCRs and televisions.

Tale of the tape

Some years ago, I was strolling through the Tokyo Audio Fair when I came upon a blank tape called That's, made by Taiyo Yuden Co. At the time, this audio tape was available only in Japan, but now it is imported here by Harman America under the brand name Triad.

The name change is probably well-deserved, but more noteworthy is the patented formulation that promises the performance of metal tape (Type IV) at prices lower than usual.

Triad offers three types of tape, one for each of the recording positions found on most current cassette decks. The MG-X metal tape (Type IV) lists for \$4.59, the EM-X high bias (Type II) tape lists for \$3.99, and the F-X normal tape (Type I) lists for \$3.39.

Metal tape is in big demand among audiophiles because of its ability to record high signal levels such as those demanded by Compact Discs. To achieve this, metal tape needs its own special recording position on tape decks because of the stronger recording current it requires. While most good tape decks have this switch built-in, metal tape still remains expensive because of the high cost of manufactur-

(Please turn to page 42)





The view from NEC's new 46" projection TV is breathtaking.* Your favorite TV stars have never shone so brightly. Or so clearly. And the sky has never been bluer.

While these improvements are visible even to the untrained eye, the breakthroughs responsible are hidden deep within. That's where NEC's own

high-powered picture tubes create a brighter image. Liquid cooling keeps them at the peak of performance. For crisp, clean colors, we improved the phosphors. And NEC's all-glass, optically-coupled lenses keep things in perfect focus.

lenses keep things in perfect focus.
It shouldn't surprise anyone that the company behind this brighter projection TV is NEC. After all, we've been at the

forefront of high-technology video for years. In fact, NEC's professional theater system is the world's largest projection TV. This pro video expertise is our *real* secret ingredient.



We bring high technology home.

Look for the World Series of Golf, August 17-24, sponsored by NEC.

SELL PART-TIME MAKE FULL-TIME



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When I was working in the oil fields, I used to get depressed about being paid by the hour and constantly struggling to feed my family while others were striking it rich. Not being able to control my own destiny really got to me.

One day I saw a Pace ad about a man who earned \$4,154.46 on just one Seamless Spray order—without investing a penny of his own. I wrote for Free Information. And am I glad I did. Becoming a Pace Dealer was the best move I ever made.

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My first few calls were not big successes—but then it happened! My first sale. It was to renew a school roof that had been leaking for 25 years. Seamless Spray did the job. I made \$7,700 and today my family and I enjoy a life we never thought possible . . . Thanks to Pace!

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Earn big money selling part-time like Tedd Mainwaring! Enjoy the financial security and independence of your own business! Our field-tested sales kit provides all the know how you need. No investment required . . . No training. Start making \$1000 a sale—even up to \$7700 and more. Send for FREE facts. No obligation.

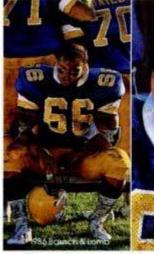
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You owe yourself the highest standards in sight.



THIS CLOSE.

AUDIO

(Continued from page 40)

ing it from pure, unoxidized iron.

Taiyo Yuden, however, has found a way to make metal tape cheaply. Scrap iron is transformed into a fine powder through a patented process then mixed with other materials to form particles called goethite. These goethite particles are near-perfect in uniformity of size and composition. The goethite is then reduced by hydrogen to become magnetite, the basis for all three Triad formulations.

This process not only lets Taiyo Yuden make metal tape inexpensively, it also allows the company to make tapes for the high-bias and normal-bias positions that have metal tape's ability to record higher signal levels.

In making the high-bias tape, the magnetite particles are halved to reduce their coercivity—or resistance to magnetization. This optimizes the tape for the weaker recording current used at the high-bias position. (A similar process adapts the magnetite for the low- or normal-bias recording current.) What does this mean for you? If you've got an older cassette deck that lacks the metal/Type IV position, Triad's EM-X will give you near-metal results in the high-bias position. So, too, will the HX-S cassette from TDK Electronics, which is formulated the same as EM-X.

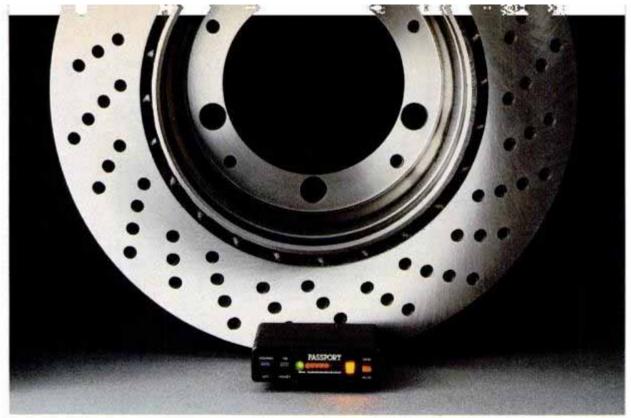
Shifting gears

Auto-reverse is a great convenience feature in car stereo cassette/receivers, but there is a price to pay. Head-to-tape alignment in most autosound decks is accurate in one direction and too often in error when reversed. If you've ever thought Side A of a cassette sounded better than Side B, then you've experienced the problem.

In the past, correct alignment of the tape in both directions was achieved only on the most expensive machines. But now the technology is available in more reasonably priced models.

Leading the way in this regard is Fujitsu Ten. The company includes what it calls a dual azimuth system into its M Series line. This system rotates the tape head up to 180° so that when the tape reverses direction, the head is in perfect alignment. Conventional auto-reverse decks use a stationary head-drum with twin playback heads, one for forward and one for reverse.

List prices on the four Fujitsu models range from \$250 to \$449: All the models have electronically tuned AM/FM radios. The highest-priced model, the QMX-3570, is sized to be a replacement for many General Motors units. And since it is larger than most cassette/receivers, it packs plenty of power—25 watts per channel.



Small Wonder

It's here, pocket-size radar protection.

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slide into a shirt pocket, beautiful enough to win an international design award.

Small means nearly-invisible protection

That could only be PASSPORT. It has exactly what the discerning driver needs, superheterodyne performance in a package the size of a cassette tape.

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedented in radar detectors. It's no surprise that such a superlative design should be greeted by superlatives from the experts.

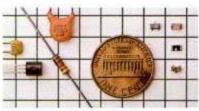
"In a word, the Passport is a winner," said Car and Driver.

The experts report excellent performance. Simply switch PASSPORT on and adjust the volume knob. Upon radar contact, the alert lamp glows and the variable-pulse audio

Small means the size of a cassette tape

begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

As you get closer, the pulse quickens and the bar graph lengthens. Should you want to defeat the audible warning during a long radar encounter, a special switch provides silence, yet leaves PASSPORT fully armed for the next encounter. A photocell adjusts alert lamp brightness to the light level in your car. PASSPORT was designed for your protection and your convenience.



In PASSPORT, 102 SMDs (right) do the work of ordinary transistors, resistors and canacitors.

PASSPORT comes with a leather case and travels like a pro, in your briefcase or in your pocket—to the job for trips in the company car, on airplanes for use in far-away rentals. Just install on dashtop or visor, then plug into the lighter PASSPORT keeps such a low profile. It can be on duty without anyone noticing.

Small means an easy fit in the briefcase

One more PASSPORT convenience—call us direct. It's toll free. We make PASSPORT in our own factory and we'll be happy to answer any questions you may have. If you decide to buy, we'll ship your PASSPORT within 24 hours by UPS, and we'll pay the shipping. For an extra \$6.00, Federal Express guarantees 48-hour delivery.

If you're not satisfied within 30 days, return PASSPORT. We'll refund your purchase and your return shipping costs. There are no hidden charges.

Isn't it time for a PASSPORT of your own?

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Colonial Style Garage/Barn—Huge enough to hold two full-size cars in its two separate bays. The structure measures 24' x 26' with an additional 350 square feet on the second floor. A 4-foot recessed walkway along the side provides excellent space for wood and garden equipment, and a 3-foot overhang in front keeps snow from accumulating against the garage doors. Plans include an 8-page instruction manual and 4 blueprint-size layout sheets with: • Overall perspective • Basic wall building steps • Construction details for framing loft, floor, roof and end gables • Exterior finishing details and suggestions for alternate versions of the barn. Materials list included. (PL-1277—\$30.00. Each additional plan \$20.00 when purchased with first plan.)



Model Steam Tractor—Challenge of a lifetime! The famous J.I. Chase threshing machine steam tractor, 16 separate plans sheets plus instruction booklet. The finest detail work. Stacks firewood but burns alcohol. 9 separate gears in the transmission alone. What a thrill to see it huffing and puffing under its own power. (PL-1272—\$11.95)

Popular Mechanics is a publication of Hearst Magazines, a Division of the Hearst Corporation.



Barn/Garden Shed—Combines roomy storage space for yard equipment with a pleasant area for gardening activities. Measures 12'x 16' and has an upper loft for about 380 square feet. Wide barn doors at one end allow you to roll in bulky equipment, and a sheltered alcove with a potting bench and storage for gardening supplies lets you work while shielded from sun or rain. (PL-1278—\$10.50; 2 plans for \$17.50)



Stowaway Picnic Table—A clever one-piece design made from long-lasting redwood. After the picnic season, just fold it up for convenient indoor storage. Easy to build. (PL-1716—\$5.95)



Portable Ironing Center—Unscrews from the wall to move when you do. Plans feature a receptacle for the iron, a fluorescent light and storage space for all materials. The ironing board folds up behind louvered doors. (PM-1005—\$5.95)



Bookcase Wall—Turn your wall into a great display area for books and other items. Our bookcase goes from floor to ceiling with outof-sight storage space on the bottom. The five cabinets can be adjusted to any width to fit your wall. (PM-1008—\$5.95)



Model SS United States—The glorious, record breaking flagship of the U.S. Merchant Marine. Though now retired at Norfolk, VA, no passenger ship has ever approached her top speed. The professional quality model is described in detail on 3 full size blueprints. Over 2 ft. long of wood and metal. (PL-1200—\$9.95)



Adirondack Lawn Furniture—This traditional Adirondack furniture is as durable as it is attractive. Crafted of hardwood, each piece is carefully sanded, then assembled with water-resistant glue, sealed with wood preservative and painted—all to make them withstand the rigors of outdoor use. Plans and materials list. (PL-1751—\$5.95)



Redwood Patio Furniture—Six durable, lightweight and handsome pieces—barbecue cart, chaise, coffee table, telephone caddy, tray and planter. All are designed to withstand exposure to sun, heat and moisture and to be free of blemishes and warps. Build them for your backyard, patio, deck or sunroom. (PM-1013—\$6.95)



Tool Tests

Airless power nailer

t was my pleasure to test a truly revolutionary tool: the Paslode Impulse 300/75—the only self-contained, portable power nailer. Unlike an electric or pneumatic nailer, it has no power cord or air hose.

The Impulse nailer is powered by a patented linear combustion motor. A rechargeable nickel-cadmium battery powers the tool's ignition system for about 4000 shots. A disposable hydrocarbon fuel cell (about \$4.20 each) provides power

enough to drive up to 1400 nails. The tool drives nails from 2 to 3 in. long at a rate of 3 nails per second. The nails are joined on strips in a variety of styles, including galvanized and screw shank.

To operate the tool, simply grip the handle to depress the fan switch. The fan draws fresh air into the combustion chamber to dissipate exhaust. Then, press the tool's nose firmly against the work surface and squeeze the trigger. The extended nose design permits toenail-



Cordless, airless nailer is powered by a patented linear combustion motor that operates off a disposable fuel cell and a battery.

ing—a valuable feature when house framing. Also, the nose can be adjusted to control the depth that the nails are driven. The 8½-pound tool has a belt clip, a clear magazine with visible nail load and a durable, lightweight nylon housing.

The tool also comes with a

high-impact plastic carrying case, battery cell, AC battery charger, two pairs of safety glasses and instruction booklet. It costs about \$890. Contact Paslode, 2 Marriott Dr., Lincolnshire, IL 60015, or call toll-free 1-800-323-1303.

-Rosario Capotosto



Insert hydrocarbon fuel cell. Cell's valve, acting like a carburetor, injects a precise amount of fuel at start of each cycle.



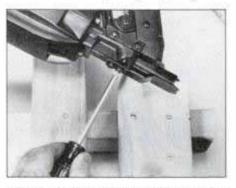
Rechargeable nickel-cadmium battery will drive about 4000 nails. Tool's red light warns when battery charge is getting low.



Loading nail strips into the magazine is quick and easy. A spring-tensioned follower bar advances the nails after each shot.



Closeup view shows fan switch on top of the handle and the trigger located underneath. Note how the nail load is clearly visible.



Nailing depth is adjustable. Nail at left is underdriven; center nail is driven too deep. Nail at right is driven at correct depth.



Portable nailer comes with plastic carrying case, battery charger, battery and two pairs of safety glasses—clear and tinted.

Cycles

BY NORMAN MAYERSOHN



Ahead to the past

Aero is in, let there be no doubt about that. And it has been in for a long time judging by these two aero bicycle designs drafted 40 years apart. Just as today's wind-cheating Taurus and Sable family sedans trace their roots back to the Chrysler Airflow models of the 1930s, the Bottecchia Kronotech (right) owes some of its sleek lines to such future-think cycles as the Bowden Spacelander (below).

The similarities of the two swoopy bicycles goes much deeper, even though the Bowden's profile was more a matter of streamlined styling than the Kronotech's aerodynamic racing advantage. The Spacelander was created for a 1946 design fair in England. The new Kronotech was conceived in Italy and is on display at the Italian Pavilion at Expo '86 in



Bottecchia Kronotech bicycle leads in Aero Age styling.

Vancouver, Canada. Both cycles feature composite fiber construction in which the visible skin acts as the supporting framework—no metal tubing is used, except for the Bowden's front fork. Above all, aero-inspired styling is the leading dra-

increasingly being applied to street and touring cycles. Aero tires, wheel rims and oval-section spokes are fairly common. Oval frame tubes and small fairings for the rider are gaining a foothold, too. Helmets with long, pointed rear sections looked oh-so-Hollywood at the '84 Olympics, but will soon become the rule for serious road riders. Naturally, it's still the rider who makes up the bulk of the frontal area meeting the wind. So until we find a way to breed ovalsection people, all that can be done is to further lower the front and raise the back to place the body at an optimum aerodynamic angle.

matic hallmark of both of

to slick up a vehicle that will

barely reach half the nation-

Why would anyone bother

Just remember that the

use of solid-disc wheels on a

racing bike can give a rider a

full minute advantage over

the course of a 25-mile time

trial. With the rider provid-

ing all the propulsion, every

little bit of energy saved is

The latest racing bicycles

display a top-to-bottom aero-

dynamic cleanup program,

much appreciated.

these sleek bicycles.

al speed limit?

For all its Buck Rogers styling influence, the Bowden Spacelander started life with solid engineering principles behind it. The inventor and designer, B.G. Bowden, was experienced in the automotive and industrial fields. He devised a bonded

fiberglass structure as the actual load-bearing framework of the bicycle and subjected it to standard weathering tests. Mass production of consumer bicycles took until 1960 to work out, when Bombard Industries Grand Haven, Michigan, announced that the Bowden wound choices, inc. would be built in five color including Outer Not good enough? Then special-order it in a luminous pigment for night riding!

Not only were the sprockets and chain enclosed for weather protection and aero considerations, but the kickstand also tucked in out of the wind when folded up. Despite the fiberglass construction, shipping weight was a hefty 50 pounds and retail price listed at \$89.50. Advertising of the day claimed "Nothing like it anywhere!", and that can't be disputed today—only 19 Bowden Spacelanders are known to have survived.

The radical Kronotech is bound to be as rare as the Bowden, with a production run of only seven scheduled and a projected price of nearly \$16,000. And no wonder—the bicycle carries a laundry list of the latest advancements in material technology including carbon fiber, Kevlar, titanium and honeycomb fillers.

The result of a collaboration between a handful of Italy's top bicycle component and accessory makers, the 19-pound Kronotech dispenses entirely with standard tube frame construction. The supporting structure, like the "tub" of a Formula One car, is comprised of a carbon fiber skin. Two shell halves are separated by a honeycomb section and reinforced with carbon wire structural inserts placed according to the axes of stress. The pedal cranks are shaped into lenticular discs, rather than the standard forged arms, to protect the chainring. Even the pedals get aero footstops made of Kevlar, and the rear wheel is removable while the

(Please turn to page 48)



Bowden Spacelander was designed in 1946, built in 1960 in U.S.

Save Gas, Save Engine with "POLY"

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

The Secret is "Poly"

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

Years of Testing and Use Have Proved it True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

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

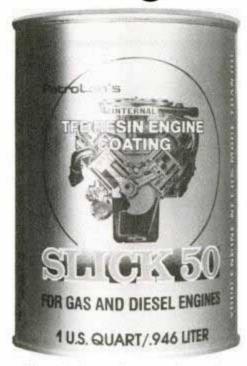
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money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

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #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 decreases fuel consumption in tests done at the university."

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

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



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

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

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleumbased 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:

- Increase mileage
- Increase horsepower (small economy cars and large RV's really need this)

- Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
- Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

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There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

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Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

For purchase or further information call toll-free 1-800-525-8624, ext. 9 (in California 1-800-233-9559) or send to: Progressive Energy Corporation, 255 South Bent Avenue, #B-1, Dept. PM 986, San Marcos, California 92069.

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255 South Bent Avenue, #B-1, Dept. PM986 San Marcos, California 92069 CALL NOW. TOLL FREE 1-800-525-8624. IN CALIFORNIA, TOLL FREE 1-800-233-9559. #1986 Progressive Energy Corp. (Continued from page 46)

chain stays in place inside the frame. The radical pistol-grip handlebar takes on a wind-parting flat form and carries levers for the hydraulic brakes and a digital trip computer. Even the seat gets a stylish bellows to maintain the aero advantage no matter where the adjustment height is set.

It just takes one quick look to know that this sleek machine is no city kid's curb jumper, but we hope to see some of its treatment reach road cycles in the next few years. As signs of bikes to come, the Bowden and the Kronotech are a pair of aero stars without parallel.

Luxury scooters from Honda

In this country, nobody ever took motor scooters seriously. But the message didn't reach the folks at Honda. Those



Honda's Helix steps up in scooter luxury.

whimsical devices of below-basic transportation that clog the streets of Europe's cities came and went in the U.S. market. But nowadays they're making a strong comeback in the Sun Belt.

The popularity of motor scooters in the U.S. will be bolstered, no doubt, by the introduction of vehicles like the Helix, Honda's top-of-the-line unmotorcycle. The Helix is the luxury limo of the scooter world, complete with pushbutton starting, automatic transmission, digital instrumentation and an optional AM/FM stereo with power booster.

The big difference from previous offerings is in the size—over 13 in. longer in wheelbase than the 250 Elite model. A hydraulic front disc brake takes some of the drama out of slowing down, especially useful since this baby will comfortably outpace the 55-mph legal limit. And, of course, it's freeway legal.

Lack of comfort won't limit your trip range, that's for sure. The generous seating area is nearly as spacious as the sofa in your living room. Well-integrated styling provides space for a lockable storage compartment large enough to swallow a briefcase.

Above all, the Helix is most noticeable because of its styling treatment. Grown-up and aero-influenced, we see touches of the Civic CRX all over it. Honda already claims 90 percent of the 125,000 yearly scooter sales in this country, and they expect the market to hit a quarter-million annually in the very near future. So dramatic styling like this will be vital to making scooter converts out of pedestrians.

Most likely, though, first rides will start at a smaller size than the Helix. At \$2598, it is \$400 more elite than the Elite model, and far pricier than the 50cc Spree scooter.

Positively a drag

Serious cyclists who are looking to improve the health benefits of pedal work should take a look at the clever Velo-Equalizer. A simple adjustment device that allows you to dial in a set amount of rear brake drag, this addition to the front cable lever converts level ground into a grueling uphill challenge or a low-speed cruise into an all-out sprint.

The Velo-Equalizer fits on the brake cable between the handbrake and the cable housing, and can be quickly installed with normal maintenance tools. Felt pads replace the standard rearbrake rubber pads to make the action smoother, and the brakes can be used as normal. The screw device portion of the equalizer allows for a very fine adjustment range.

For such a simple device, the Velo-Equalizer has an interesting history. It was invented by a doctor who was alarmed at the increasing amount of mashed faces he saw on young riders. He thought that if he could reduce the speeds required for proper training stress, he could also cut down the risks.

The Velo-Equalizer costs \$11.95 from Bell-Mar, 676 East First Ave., Suite 9A, Chico, CA 95926.



Velo-Equalizer installs on rear brake cable.

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Home Video

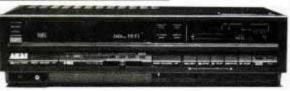


BY JAMES B. MEIGS

Fall video preview



The latest VCRs from Sony (above) and Akai emphasize sound quality with built-in amps to power outboard speakers.



not be the limit. At the show, Mitsubishi unveiled a monstrous 40-in. tube, though company execs wouldn't say whether it would be available to home users.

■ Just when you thought they'd added everything to VCRs but a sunroof, videocassette recorder makers have come up with a few new ideas. One of the most practical innovations comes from Sony and Akai.

Both companies have developed Hi-Fi VCRs that include small, built-in stereo amplifiers. This means you simply hook up a pair of speakers directly to the deck to enjoy Hi-Fi stereo sound from videotapes. And, since both models include built-in (Multichannel Sound) decoders, you'll be able to hear stereo TV broadcasts, too.

The Sony model, dubbed "SuperBeta Theater," includes a 20-watt amp and drawback is that manufacturers continue to be vague about exactly which of the four circuits comprising HQ they're using in their decks. If you want the maximum level of HQ, you still face a

carries a \$699 price tag. Akai's VS-565U-a VHS Hi-

Fi unit-packs a 10-watt am-

plifier and a full load of fea-

VCRs is the use of digital

technology to improve special effects. This is an ad-

vance that's been long prom-

ised. Now it appears digital models will be in stores by

the end of the year. Toshiba

displayed a 4-head VCR (Model DX-7) that uses digi-

tal circuitry to produce rock-

steady freeze-frame and

slow-motion pictures. It, and a less expensive 2-head ver-

sion, should be available this fall. Other companies show-

ing prototype digital VCRs included JVC, Sharp, NEC

■ One welcome develop-ment: Virtually every VHS

VCR and camcorder coming

this fall will feature HQ

boosting circuitry. The only

picture-

Quality)

and Mitsubishi.

(High

tures at a tentative \$880. ■ Another innovation in

Camcorder

What will VCRs be like in 10 years? Manufacturers of 8mm video say that format fading fast.

But so far, the battle to determine the future VCR format is being fought in a different arena: the camcorder. Manufacturers of 8mm gear-especially Sonyare betting that many of the people who buy 8-mm camcorders today will look to buy 8-mm machines again when it comes time to replace their current VHS or Beta table models.

Until recently, many of the largest VHS makers were planning to introduce 8-mm camcorders for home moviemakers. But in an abrupt about-face, virtually every major VHS manufacturer has dropped-or at least suspended—its 8-mm plans. In fact, the VHS group has launched a powerful counter-attack against the smaller 8-mm format by deciding to sell the new VHS-C VideoMovie camcorder instead.

The charge is led by JVC, the company that invented VHS. Matsushita (the Japanese parent of Panasonic and Quasar), Akai, Hitachi, Minolta, Mitsubishi, Sharp, Toshiba and Zenith have also announced they'll sell their own versions of JVC's mini-VHS VideoMovie as soon as possible. The VHS-C camcorder is not only as small and light as most 8-mm models, but uses 1/2-in. tape in a special mini-VHS cassette that can play back in any VHS VCR (see Home Video, page 83, May '86).

The decision to back VHS-C is a clear blow to the fledgling 8-mm format. The major VHS manufacturers have apparently decided to keep the future safe for VHS camcorders by keeping the 8-mm format pretty much on the sidelines.

This doesn't mean the 8mm format is finished-it's still an attractive choice for camcorder buyers. In fact, at June's CES, Olympus unveiled an impressive new 8mm camcorder dubbed Movie 8. It's the lightest, smallest, full-featured 8-mm camcorder yet, and shows off the format's potential. But if anyone tells you 8-mm makes your VHS machine obsolete, tell them some of the world's bigger video companies disagree.

(Please turn to page 53)

Материал защишенных авторокогу правои

every June, the world's top electronics manufacturers gather on the shores of Lake Michigan for a massive convention dubbed the Summer Consumer Electronics Show. During this Chicago powwow, they show off their latest inventions, everything from products they'll ship immediately to protofresh-from-the-lab types that won't reach your local stores for years.

Combing the show is the best way I know to discover what's new in video. Here are a few highlights from the latest CES:

 Look for more big-screen TV sets to start hitting stores soon. Sets using the new 35-in. direct-view picture tube developed by Mitsubishi (see Home Video, page 12, July '86) are on the way from other manufacturers including Fisher, Sanyo, JVC and NEC. But even the astounding 35-in, set may guessing game.

conflicts

will gradually replace VHS and Beta as the single world format. But advocates of VHS point out that there are close to 100 million VHS machines in homes around the world (over 20 million in the United States alone). With such a huge following, they say VHS will be difficult to budge. Beta, sad to say, is

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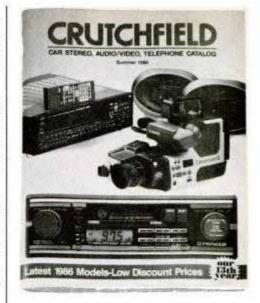
HOME VIDEO

(Continued from page 50)

New fall products

- One of the most stunning-looking video products at the Consumer Electronics Show is actually two products in one. The unique wedge shape of the Marantz VS65VCR (\$2000) houses a 26-in. monitor receiver and a VHS Hi-Fi VCR with picture-boosting HQ circuitry. To take advantage of the videorecorder's super-stereo sound, the cabinet also incorporates side-firing 3-way loudspeakers with 12-in. bass woofers. Those speakers will also do justice to the TV's MTS stereo reception.
- HQ circuitry is also part and parcel of Canon's new VR-HF720 VHS Hi-Fi VCR. So is MTS stereo reception in the tuner section. The 99-channel VCR has some other interesting twists as well. For example, you can program the deck for up to eight events in a single month. The VCR confirms your timer settings

- and channel selections by displaying them on your TV. You can even program the VCR through its wireless remote control. The Canon VR-HF720 costs \$1050.
- Memorex has a better mousetrap when it comes to cleaning VCRs. The company's Safeguard system is a wet cleaner whose tape material traps dirt permanently, so it can't be redeposited on the heads. The Memorex Safeguard costs \$16.
- The Olympus Movie 8, referred to earlier, is the smallest 8-mm camcorder on the market that can play back tapes as well as record them. The 3.3-pound handful also features an f/1.2 autofocus 6X power zoom. The ¾-in. CCD pickup captures low-light images down to 10 lux. Price isn't available.
- You can get Dolby Surround-Sound from your videotapes and discs with the SS-One processor from AudioSource (\$290). In fact, the unit will even impart surround-like effects to non-Dolby soundtracks. Built into the bargain is a 30-watt stereo amp to power your backchannel loudspeakers.



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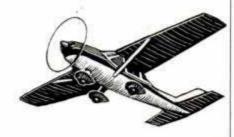
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Her Majesty's rotary craft were the show's hit.

when we first heard about a new airshow scheduled for Freeport, Bahamas, we couldn't wait to get Aztec N87A preflighted. After all, New York in February isn't exactly Xanadu.

Our own airshow started with the flight out of Caldwell Airport in New Jersey. We requested 10,000, right between layers. At 12,000, we were hearing reports of severe icing. While 87A is certified for known ice, we'd rather keep the boots, hot props and windshield in reserve than test them against the real thing.

Below us it was soup all the way down to 300 ft. With a stiff quartering wind off the nose and the Aztec's turbocharged Lycomings sipping 28 gph at 55 percent Cheapskate Cruise, we booked 135 knots over the ground and 160 true. At our first refueling stop at Grand Strand, South Carolina, we had 3000 broken and plenty of visibility.

Out of Grand Strand, it

was eyes on the green glare of our trusty old RCA AVQ47 radar to pick our way through some convective activity. We decided to call it a night in Jacksonville when it began to snow!

Next day in Freeport, gusts were going to 30 mph and above. Despite the warm company of the Freeport Rotary Club and the opulence of the Freeport Xanadu, the show suffered. The weather worked against it. But the Royal Navy came to the rescue in the form of four Westlands choppers hastily assembled: Two old Wessex MK V's, a Wasp and a Lynx put on a show that would make the Blue Angels blush. Flying to the show was half the fun. And the finale made it all worth the

Magic boxes

We were in the avant garde when we installed an Apollo 612B Loran in the old Cessna 182 two years ago. And now that same unit is still providing yeoman service in the Aztec.

However, time is flying nowhere faster than in the world of aircraft Lorans. A friend recently installed a new Loran in his Seneca III N4327N that he describes as unbelievable.

The Northstar M1 Loran has all of the normal features of the older units. It tells you where you are and gives distance, bearing, course, track, ground speed, ETA and so on. And, like the Apollo, it has a database.

However, the Northstar database is huge! It has all 6500 U.S. public airports, plus 1150 VORs, 1600 NDBs and 4800 low-altitude en route intersections. Let's just say this data base knows where every American landing strip is located and how each of them is equipped.

The real mindblower is the airport information. It lists them by city, state, name and provides frequencies for approach control, tower, ground and other linkups. About the only thing it doesn't tell you is the quality of food at the airport restaurant. Our friend's unit cost \$3100 installed plus \$300 for a control panel interface.

Star-Lite

They may have to invent a new word for ultralights. The Star-Lite has recently weighed in at 250 pounds. So, with only a 40-hp engine that sips 2.5 gph in automotive gasoline, you get a kit plane that takes off in 300 ft. and cruises at 120 mph. The price is also lightweight, \$8495 minus prop and instruments. Star-Lite sells the kit in three parts under a payas-you-go plan.

Construction time is advertised as 400 hours. The premolded composite structure is relatively easy to put together. Intricate sections have been prefabricated to speed up assembly.

The only internal structure in the Star-Lite are the bulkheads to support the landing gear, wings and pilot. All bulkheads are cut from a flat sheet of sandwich composite supplied in the kit. Full-size patterns are provided.

The Star-Lite has a conventional aeronautical configuration. Thus, while thrills and chills are promised because of its low weight, there should be no surprises in handling the craft in flight. The Star-Lite can be built either with a tail wheel or tricycle-type landing gear. The tail wheel is for particularly rugged landing strips—something to consider with an ultra ultralight.

-Fred Mackerodt



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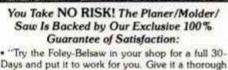
Pays For Itself: • R.S. Clark, Springfield, Ohio: "I bought a batch of walnut in the rough, and after planing it on the Foley-Belsaw I figured up the money I saved. It was enough to pay for two-thirds the cost of the Planer. It really does a good job."

More Than Expected • Stephen Schultz, Orangeville, Penna.: "This machine pays for itself by making money out of scrap boards. It is a very well built machine and I confess it is more than I really expected for the price. It does everything you say it will."

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"I recommend Foley-Belsaw Planer-Molder-Saw as the most useful shop tool any craftsman could own. We use one every day in the Workbench model shop, and couldn't get along without it."

JAY HEDDEN - Editor WORKBENCH Magazine



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Electronics



BY STEPHEN A. BOOTH

Electronic camera arrives

Canon RC-701 makes 50

photos on magnetic disc.

The era of filmless photography has begun.

And the reason there's a camera on this page is because the picture-taking and printmaking are done electronically.

As reported earlier (*Photography*, page 54, July '86), the new system hails from Canon, which also makes conven-

a film camera, it

tional film cameras, video cameras and recorders. Technologically, the new system is a cross between the two types.

In fact, Canon calls the new product a Still Video System (SVS). Like captures still images. And like a video product, it stores the image on magnetic material and displays it on a TV. Because there's no film, there's nothing to develop. Instead, a desktop-size de-



Electronic image is printed conventionally in Konica system (above). Sony Mavigraph (right) uses thermal printing.

Before you run out to buy Canon's SVS, I ought to point out that it's intended for commercial use at this time, by newspapers, wire services and the like. You could buy an SVS, but it would set you back about \$14,000 just to take and print pictures on your own. A transceiver to send the pictures costs another \$20,000. The person on the other end of the phone would also need a transceiver and a printer (\$7750) to make copies. Now the good news: Canon plans to introduce an electronic camera for us amateurs in about two years.

Today, the business end of Canon's Still Video System is the RC-701 Still Video Camera (\$2600). Physically, it resembles a large 35-mm SLR and weighs in around 4½ pounds with the SV 11- to 66-mm f/1.2 zoom lens (\$800) and battery.

Most of the RC-701's controls will be familiar to 35-mm camera owners. But instead of loading film, you load a 2-in, video floppy disc capable of recording up to 50 images. The RC-701 can fire up to 10 frames per second.

That's not all that's unconventional about the RC-701. When the shutter opens, the light doesn't hit a frame of film or even the video floppy. Instead, the image registers on a %-in. charge-coupled device (CCD) capable of reading 390,000 pixels, or picture elements. These convert light (and color values) to electrical signals that are recorded on the magnetic disc.

If the focal length (11 to 66 mm) of the RC-701's zoom lens seems unconventional, it's because the imaging area of the \(^2\alpha\)-in. CCD is only a fourth the size of a 35-mm

film frame. Consequently, the 11- to 66-mm zoom is really a 44- to 264-mm lens. But, there's no loss in light transmission. Lens speed remains a fast f/1.2.

Besides the 11- to 66-mm zoom, for \$795 Canon also sells a 50- to 150-mm f/2.8 zoom (really 200- to 600-mm) and will offer a 6-mm f/1.8 wide-angle lens (effectively 24-mm). Additionally, you can fit 60 regular Canon FD lenses to the RC-701 by using an adapter. Following our CCD-to-35-mm conversion, this means the company's FD 800-mm f/5.6 supertelephoto lens becomes an amazing 3200-mm f/5.6 optic!

You'll notice another peculiarity about the RC-701 and its lenses: There's no aperture ring or f/stop markings. The RC-701 is a highly-computerized program camera with automatic exposure control for shutter speed and aperture. Though there's no aperture ring, you do get a shutter speed dial (1/4th to 1/2000th sec.) for occasions when you want to control exposure time. Otherwise, the RC-701 picks a matching f/stop automatically.

What about film-speed settings in a filmless system? In an electronic camera, this is determined by the CCD pickup, not the floppy disc. The RC-701's sensitivity is equal to an ASA/ISO rating of 200. Under low light, this is increased automatically to about ASA/ISO 600.

Once you've taken pictures with the RC-701, you'll view the images on the disc—instantly—with a TV



Floppy (left) is larger than slide.

monitor. To do this, you must insert the disc in an RR-551 still video recorder and player (\$2700). It hooks up to a TV just the way a videocassette recorder would, but operates somewhat like a slide projector. You can program the order and the amount of time each photo is displayed.

The pictures you'll see on the TV screen are field images. As you probably know, each TV frame is composed of two interlaced fields, each containing some 262 scanning lines (you actually see only about 244 of these).

(Please turn to page 60)

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ELECTRONICS

(Continued from page 56)

If your TV is capable of showing 488 scan lines, why does the SVS camera give you only half the image resolution? By sticking to a field image, which is faster to record, the RC-701 avoids the possibility of jittery, blurry images

caused by moving subjects.

Though the RC-701 takes only field images on the disc, the RR-551 recorder/player can make pictures in either the field mode or frame mode (25 images per disc). Those pictures can come from a videodisc, videotape, videocamera or TV broadcast. Ideally, you'd use the frame mode to record images you've frozen on the videodisc or VCR. You might want to print the better snapshots and erase the rejects. That's where Canon's RP-601 ink-jet printer comes in (\$7750).

When hooked up to the RR-551 (or RT-971 telephone transceiver, \$19,990) it produces color copies in 3 to 41/2 minutes, depending on size $(2^{11}/_{16} \times 3^{9}/_{16})$ in. or $3^{5/8} \times 4^{13}/_{16}$ in.) To produce the continuous tone colors, the printer squirts dots of yellow, cyan, magenta and black ink in varying combinations. In all, it deposits 167 dots per inch, horizontally and vertically. By comparison, the color photos inside this magazine are composed of 110 dots per inch. After the RP-601 makes your prints, they're laminated to sharpen the clarity and preserve the dyes.

How do the electronic photographs look? At today's stage of progress, they're acceptable for their intended purpose-namely newspaper and magazine publication, business presentations and other uses where high image resolution is not demanded.

The electronic snapshots have a grainy look compared to pictures taken on film and developed conventionally. This has to do with both the CCD pickup and the printing process.

Canon's CCD has 390,000 pixels. By comparison, a Kodachrome transparency boasts around a million. But the comparison's unfair. The electronic photo's resolution of 167 dots per inch is suitable for most publications. And the speed and convenience the SVS affords for fast-breaking stories can't be matched by conventional photography.

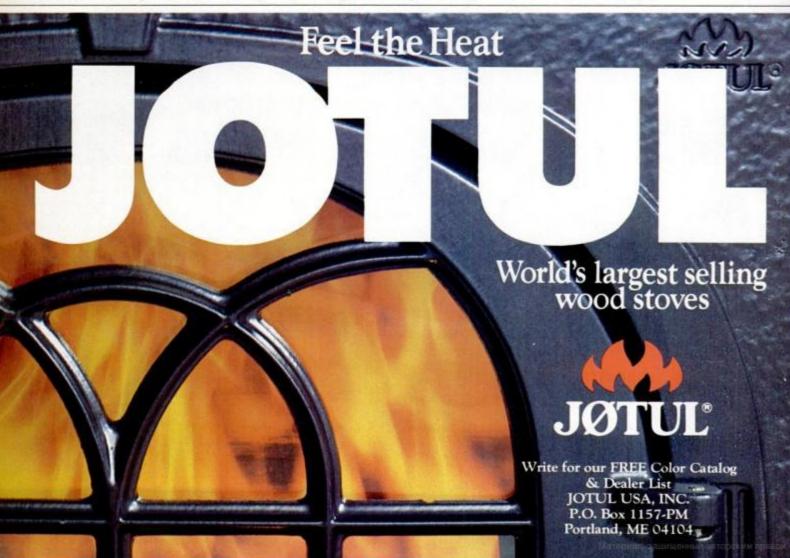
The day will come when your wedding album holds electronic photos. For one thing, CCD pickups will improve. Kodak's already unveiled a 1.4-million pixel model. Secondly, print-making equipment will yield copies with better color and finer grain.

Canon's ink-jet is only one way of producing electronic prints. Sony's Mavigraph print uses a thermal transfer process in which ink dots are melted onto paper. Konica's system prints an electronic image on conventional wetprocessed photosensitive paper. Additionally, it digitally interpolates picture information between the adjacent TV fields to eliminate the telltale scan lines. Eventually, astounding electronic prints will be made by a digital laser developing the image on photosensitive paper (see Photography, page 38). The future will find these printing systems in the same shop that processes your film today. Konica's system ships to commercial photo processors this year.

By the time Canon and others introduce amateur electronic cameras, all you'll need at home is a playback device for the disc (such as Fuji's TV/Photo System, about \$200 in Japan) and a TV to display your pictures. You'll select the ones you want printed and bring the

disc to your photo dealer.

That's all in the future. Right now, I'm still waiting for prints taken with Canon's RC-701. The sample electronic prints that accompany this column weren't made with a still video camera. The Konica shot comes from a videodisc freeze-frame. The Sony Mavigraph was taken with a video movie camera. Tune in next month to see actual photographs from Canon's RC-701.



The Royal Road o Riches

Dear Friend,

Dear Friend,

My name is John Wright. Not too long ago I was flat broke. I was \$31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

Things have changed now. I own four homes in Southern California. The one I'm living in now in Beverly Hills is worth more than one million dollars. I own several cars, among them a brand new Mercedes and a brand new Cadillac. Right now, I have a \$1 million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

tificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing — shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from — Maui, Hawaii.

Hawaii.

I'm not really trying to impress you with my wealth.

All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or may be even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me family and me.

wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all — peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest legal way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where

need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in inst 3 vears.

New England who used this secret and made \$2 million in just 3 years.
You can use this secret to make money no matter how old or how young you may be. There is no physical labor involved and everything is so easy it can be done whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times: The Royal Road to Riches is paved with golden tips.

Los Angeles Herald Examiner:

We've all got to start somewhere... The Royal Road to Riches is the first step in the right direction!

National Examiner: John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities: The Royal Road to Riches is an invaluable guide for finding success in your own back yard.

News Tribune:

Wright's material is a MUST for anyone who con-templates making it as an independent entrepreneur.

Success!

John Wright believes in success, pure and simple,

Money Making Opportunities: John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

Hollywood Trade Press:
We have never heard of an advertiser offering to pay readers \$20 to try its program. Wright's willingness to do this convinces us that his money secret must really work.

California Political Week:
...The politics of high finance made easy.

Hollywood Citizen News: He does more than give general ideas. He gives peo-ple a detailed A to Z plan to make big money.

The Desert Sun:

Wright's Royal Road to Riches lives up to its title in offering an uncomplicated path to financial success.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves per-

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have got-ten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in

"More Money Than I Ever Dreamed"
"All I can say — your plan is great! In just 8 weeks, I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year."

A. F. Providence, P. I.

A. F., Providence, R.I.

\$9,800 In 24 Hours!

"I didn't believe it when you said the secret could produce money the next morning. Boy, was I wrong, and you were right! I purchased your Royal Road to Riches. On the basis of your advice, \$9,800 poured in, in less than 24 hours! John, your secret is incredible!"

J. K., Laguna Hills, CA

"Made \$15,000 In 2 Months At 22"

"I was able to earn over \$15,000 with your plan — in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money, as fast as I've been able to do. I really do wish to thank you, with all of my heart."

Ms. E. L., Los Angeles, CA

'Made \$126,000 In 3 Months'

"For years, I passed up all the plans that promised to make me rich. Probably I am lucky I did — but I am even more lucky that I took the time to send for your

material. It changed my whole life. Thanks to you, I made \$126,000 in 3 months."

S. W., Plainfield, IN

Made \$203,000 In 8 Months' "I never believed those success stories... never believed I would be one of them... using your techniques, in just 8 months, I made over \$203,000... made over \$20,000 more in the last 22 days! Not just well prepared, but simple, easy, fast... John, thank you for your Royal Road to Riches!"

C. M., Los Apoeles, CA C. M., Los Angeles, CA

'\$500,000 In Six Months'

"\$500,000 In Six Months"
"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright."

R. S., Mclean, VI

amazing miracle! Thank you, John Wright."

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember — I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course, you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this — so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, instead postdate your check for a month and a half from today. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.

satisfied with my material.

\$20.00 FREE!

There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back plus \$20.00 in cash FREE!

Do you realize what this means? You can put my simple secret into use. Be able to solve all your money problems. And if for any reason whatsoever you are not 100% satisfied after using the secret for 30 days, you your original UNCASHED CHECK, but I will also send you an extra \$20.00 cashiers check just for giving the secret an honest try according to the simple instructions.

I GUARANTEE IT! With my unconditional guar-tee, there is absolutely NO RISK ON YOUR PART.

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Since the material I'll be sending you is heavy, please add \$1 to cover portion of shipping costs.

But the supply of my material is limited. So send in your order now while the supply lasts.

If you wish to charge it to your Visa or MasterCard— be sure to include your account number and expiration date. That's all there is to it. I'll send you my material right away by return mail, along with our unconditional

SWORN STATEMENT:

"As Mr. John Wright's accountant, I certify that his assets exceed one million dollars.

Mark Davis

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Outdoors



BY TIM COLE

Popeye's offshore revolt



Al Copeland and Bill Sirois take the checkered flag at Treasure Cay.

Go fast. Then go faster. In the world of offshore powerboat racing, those simple words embody not just the ultimate goal, but now the ultimate reality.

Al Copeland, of Popeye's Fried Chicken fame, and his racing director, Bill Sirois, have developed a unique powertrain in their 2-place Open Class I cat capable of speeds approaching 150 mph. The machine copped first place in the first race of the offshore season, averaging an astonishing 103 mph in a field where 80- to 90-mph speeds are considered the limit. It's estimated the new Popeyes hit a top end of 140 mph on the Treasure Cay,

Bahamas, race course.

The boat is a basic twinhulled Cougar cat made of spruce for lightness and strength. But here's where it gets interesting. It accepts an innovative 8-engine powertrain—four Mercury Marine V6 2.0 Liter EFI outboard powerheads laid down on their sides in each hull, port and starboard.

Each engine is independently geared and linked to a common shaft in each hull via an 8-mm Uniroyal toothed drive belt. Each shaft powers a MerCruiser No. 4 surfacing drive on each transom.

Not only is the boat fast with this configuration—

POPEVES CAMOUS FAIR CHICKEN A BISCUIT

Eight outboard powerheads power the Popeyes Cougar Cat.

1000 more horsepower in a boat that weighs 3000 pounds less—but it's cheap! The bill to replace an outboard powerhead is less than one to replace a conventional inboard block.

Budget bass boat

PM subscriber Joe Papasso of Margate, Florida, read The Battle Of The Bass Boats in the January issue (page 79) and decided to fashion a bass boat with a budget of \$1500.

The result is as charming as it is innovative. He started with a secondhand \$60 aluminum jon boat hull and a \$250, 50-hp Mercury.

Joe is a "catch-and-release" fanatic, and to make an aerator-equipped livewell, he cobbled together a fiberglass tank, PVC pipe, Tupperware food container and bilge-pump water circulator. Total cost? Under \$30.

After hand-crafting the livewell, Joe set out on a scavenger hunt for used equipment. His materials list reads like a nautical flea market. Batteries, \$150; steering system, \$150; fuel tank, \$3; wood for platforms, stowage and trim, \$75; fasteners, glue and miscellany,





Joe Papasso's converted jon boat serves nicely as a bass fishing platform. Note the \$30 PVC and fiberglass livewell.

\$55; folding seats, \$60; pedestals, \$2; brass box hinges, \$30; built-in cooler, \$1.

This functional and seaworthy amalgamation rests in Joe's driveway on a \$250 trailer—when he's not out fishing. Total price? \$1451. Share your budget bass boat ideas with Joe by writing him at 6751 Northwest 23rd St., Margate, FL 33063.

Lead substitutes



Twelve ounces of Valv-Tect lead additive treats 40 gal. of fuel.

The EPA-mandated reduction in lead content for motor fuel has caused boat owners plenty of concern, particularly those with engines built prior to 1975. The absence of lubricating lead results in excessive valve seat wear, causing valve seats to recede into the cylinder head. Loss of compression and reduced power under load soon result as the seats recede.

Naturally, the need to protect older powerplants, particularly 4-cvcle boards, roused some entrepreneurial instincts, and two lead-substitute gas additives are currently on the market. Valv-Tect is made by Bell Fuels Inc., 4116 West Peterson Ave., Chicago, IL 60646; and ReLead comes from Marine Development & Research Corp., 116 Church St., Freeport, NY 11520. Both products reportedly provide a protective coating to valve and valve seats and prevent metal-to-metal contact under high rpm.

(Please turn to page 64)



WINa Ford Eddie Bauer Bronco

OR ONE OF HUNDREDS OF OTHER GREAT OUTDOORS PRIZES.

You've got a great opportunity to win a set of hard-working, race-winning Grabber light truck radials with a Ford Eddie Bauer Bronco attached. It's got electronic fuel injection, air conditioning, tilt steering, stereo... the works.

All you have to do to enter is register with your participating General Tire retailer between August 15 and September 30, 1986.*

5 FIRST PRIZES

\$500 Eddie Bauer gift certificates

25 SECOND PRIZES

Ford Bed Liner with built-in tailgate protector



100 THIRD PRIZES

Ford Brush and Grille guards to protect grille and radiator.

250 FOURTH PRIZES

Pair of Ford fog lights designed to penetrate rain, fog, snow.

*No purchase necessary. Sweepstakes open to residents of the Continental U.S. 18 years of age or older as of August 15, 1986. Void where prohibited or restricted. Entry forms and complete rules are available at participating General Tire retailers or by writing to General Tire Great Outdoors Entry Form Request, P.O. Box 1356, Medina, Ohio 44258. Sweepstakes ends September 30, 1986.

Save \$30. Daiwa Executive Travel Pack rod and reel combo only \$49.95 with the purchase of two Grabber light truck radials. Your General Motorsports dealer has a complete line of Grabber AP,* AT* and MT* all-terrain, all-weather light truck radials to fit your "great outdoors" needs.



Generals.

Independence!

New Rascal Front Runner



Gives You Instant Electric Mobility!

Our 14th Year Modernize your fireplace HEARTH AID II America's Javorite Jireplace heat exchanger COLD AIR HOT AIR Increases Heat Output by 500%

'Custom Fit to any Fireplace.

Easy to install. *Thermostatically controlled, works automatically.

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And best of all you can enjoy your fireplace while saving on your heating bills because with Hearth-Aid II * you don't need to sacrifice your fireplace's appearance or the delight of an open fire to be energy efficient.

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OUTDOORS

(Continued from page 62)



Fishing function topside on a performance hull mark the new Stratos 200 CC.

Performance salt-water boat

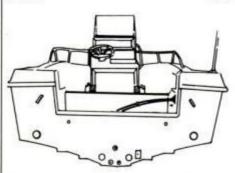
Earl Bentz of Stratos Boats is an accomplished ex-race boat driver for Mercury Marine. So it's not surprising that Earl injects a performance note in the fishing designs produced at his Tennessee boat-building company.

The Stratos 80-mph tunnel-vee is making waves on the bass-fishing trail. And Earl has transferred his considerable talents in high-performance hull design to the salt-water center-console field in the new 200 CC. Stratos engineer Roark Summerford has designed the same kind of lifting strakes and running pads you'd find on a performance bass boat.

The result, as I discovered during a run in Florida, is extreme stability at high speeds in rough water. The boat mounts the pads with authority and cleaves through the chop, resulting in a top-end speed increase of between 3 and 6 mph.

The 200 CC has all the accouterments you'd expect from a functional centerconsole design, including rod stowage port and starboard and a large locker forward. Overall, it's an interesting example of design crossbreed in a competitive marine field.

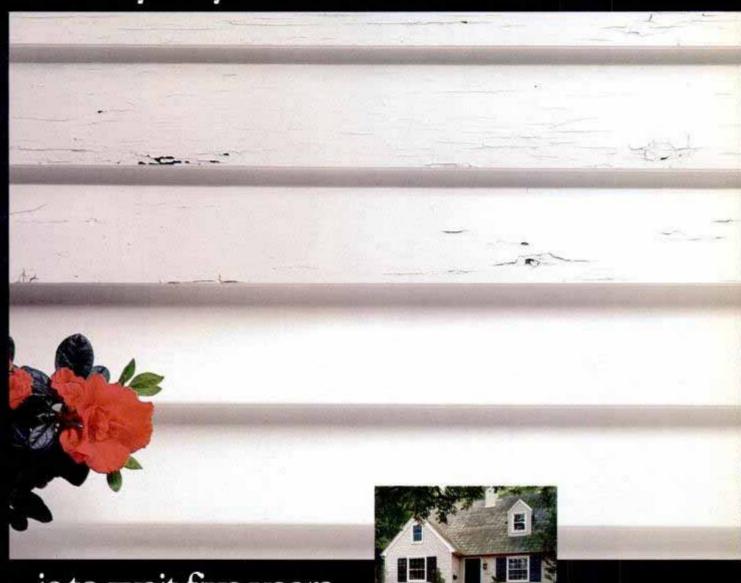
For more information about his techniques, contact Earl at Stratos Boats. 931 Industrial Rd., Old Hickory, TN 37138.



Series of running pads and lifting strakes characterize the 200 CC transom.

POPULAR MECHANICS . SEPTEMBER 1986

Half of this ad is painted wood. Half is Restoration Vinyl Siding. The only way to tell the difference...



...is to wait five years.

Introducing Restoration* Vinyl Siding from Wolverine.

Our apologies to Mother Nature, but, as you can see, our new Restoration solid vinyl siding not only looks like real wood, it's actually better. It lasts longer. It never needs painting. And it costs substantially less.

Restoration solid vinyl siding comes in seven beautiful colors. The color is actually part of the vinyl, so Restoration

will never peel or blister. Never. That's one of the reasons we guarantee it for life.*



For more information on the entire Restoration Collection, a family of

solid vinyl accessories designed to accent and beautify your home, call Wolverine Technologies at 1-800-356-8722 (in Michigan, call 313-386-0800) for a free color brochure. But don't tell Mother Nature.

*A copy of the warranty is available by writing Wolverine Technologies Inc. 1650 Howard Street, Lincoln Park, Michigan 48146. @1986 Wolverine Technologies Inc.

New Winston Lights Box. Kings and 100's.



Discover smooth, rich flavor in a Lights Box.

SURGEON GENERAL'S WARNING: Cigarette Smoke Contains Carbon Monoxide. Not available in some areas.

LIGHTS 100's BOX: 9 mg. "tar", 0.7 mg. nicotine, LIGHTS BOX: 11 mg. "tar", 0.7 mg. nicotine, av. per cigarette by FTC method.

Popular Hechanics

ENGLAND'S EPTER FRENCH CONNECTION

English Channel digging machines will bore through chalk, remove it by conveyor and install the tunnel waits.

The equipment is ready and digging starts soon on the tunnel that will connect England and France.

BY FRANK P. DAVIDSON

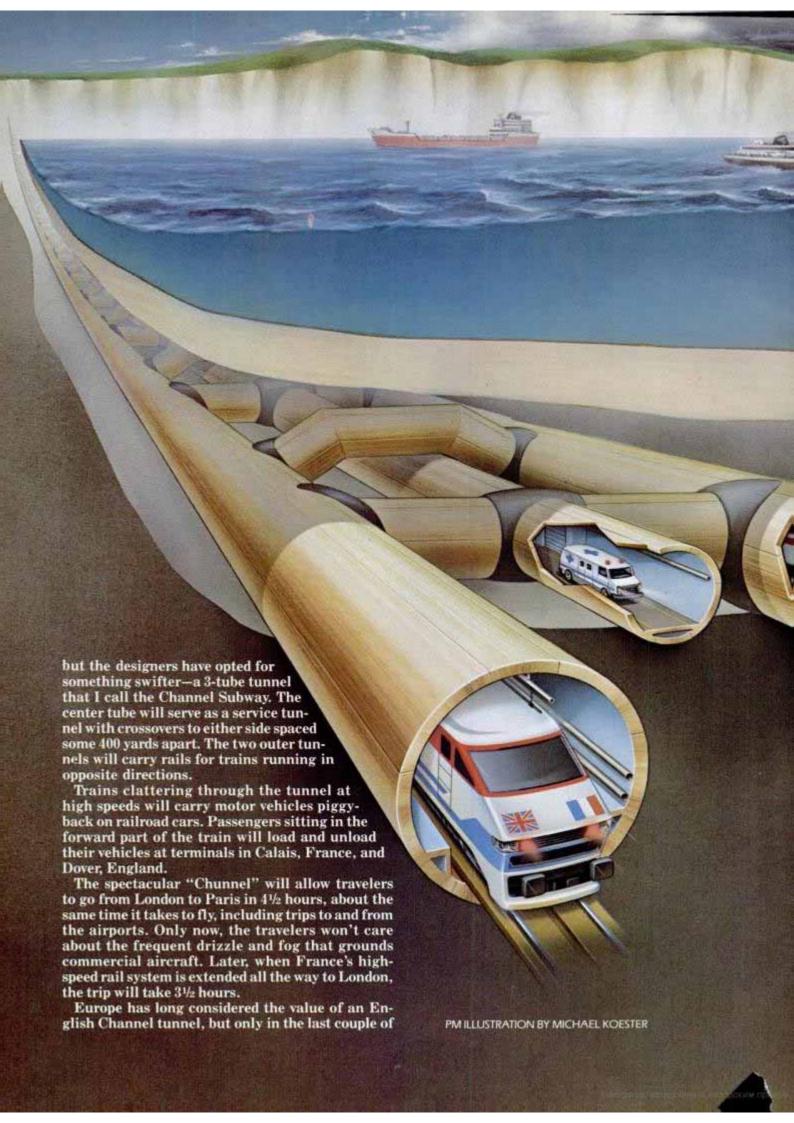
he juggernaut moves along ponderously, chewing out the inside of the White Cliffs of Dover and spitting chunks of rock into a conveyor behind it. The machine is huge, but the most impressive part is a simple device in the nose end, a 15-yard-dia. hydraulic razor with dozens of modular ceramic teeth that nibble at the chalk beneath the English Channel. Some 40 years ago, this scene was a dream shared by myself and a handful of men interested in macro engineering—the creation of huge public works projects. But now that dream is a reality. The long-awaited English Channel Tunnel will soon be under construction. The 30-mile tunnel, slated for completion within nine years, has a projected price tag of \$3 billion or more, depending on inflation.

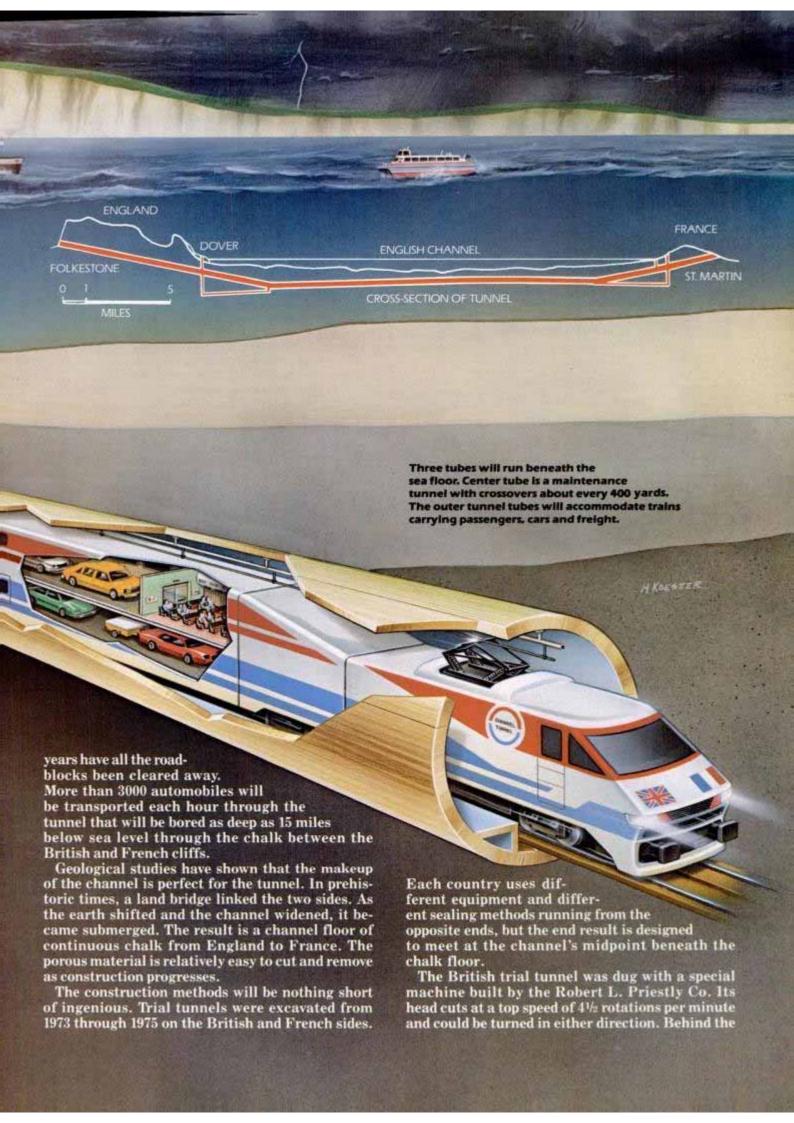
You may have in your mind's eye the image of a tunnel filled with autos, buses and trucks,

Tou may have in your minus eye the image of a turner fined with autos, buses and trucks

Frank P. Davidson is program coordinator of the Macro Engineering Research Group at the Massachusetts Institute of Technology and author of MACRO, A Clear Vision Of How Science And Technology Will Shape Our Future.

PM ILLUSTRATION BY JIM DINEEN





FRENCH CONNECTION

head of the locomotive-like machine is a system of conveyors and erectors. The pieces of cut chalk fall to the ground as the hydraulic-driven cutterhead turns. They are then scooped up in buckets behind the head. These buckets dump the chalk into conveyors that carry the waste to small boxcars on rails.

Also behind the head is the erector system, which uses hydraulic jacks to place preformed, reinforced concrete segments against the cement-grouted wall of the tunnel. At a few points on the British side, engineers expect to find weak chalk formations or water leaks. Instead of reinforced concrete, the tunnel linings at these points will be made with preformed cast iron, ready to set in place against a grouting. These cast-iron linings would later be bolted and coated for reinforcement.

The trial tunnel finished on the French side in 1974 encountered a slight variation on the geology. There was a great deal of water seepage in parts of that tunnel. The French will line their side entirely with spheroidal cast-iron plates. The special iron is highly ductile, so it has a little give. It also is extremely strong. Bolts and a special adhesive will hold the French wall coverings in place.

The French machine used in the trial tunnel phase was built by Robbins Engineering of Seattle, Washington. It works in almost the same way as the British model, but the cutting head is slightly more convoluted in anticipation of harder rock formations.

When construction begins by the middle of next year, the Channel Tunnel's dimensions may be inches different from that of the trial tunnel. Also, since the original work was completed in the 1970s, equipment advances have changed some of the construction methods. Thus, the Channel Tunnel agency is letting out bids for new contracts, and companies other than Priestly and Robbins may bring in new equipment.



The cutter head on the Robbins machine features replaceable ceramic "teeth."



Workmen drag cables out of the French trial tunnel that was completed in 1974.

Prior to the current Channel Tunnel agreement, England and France signed a tunnel treaty in 1973. On the eve of the third and final reading of the treaty in the British Parliament, Prime Minister Harold Wilson became worried about his nation's financial liability for railroad and other improvements. So the plan went on the back burner. The trial tunnels were sealed pending further developments. The Britons even sprayed the dusty construction roads leading to the site with a cement mixture to preserve the contour of the roads. The revived plan largely leaves the two governments out of the system's financing. The governments are guaranteeing construction bonds, but the money is to be raised by the private sector and the tunnel is to be run by a private international company.

A forthcoming proceedings book from a Massachusetts Institute of Technology and Macro-Engineering Research Group symposium suggests several interesting construction methods that will be considered before next year. Among them is a method suggested by J. Vincent Harrington and myself to submerge caissons to permit digging from the middle of the channel outward in both directions. This could cut construction time by a year or more.

Speed and safety

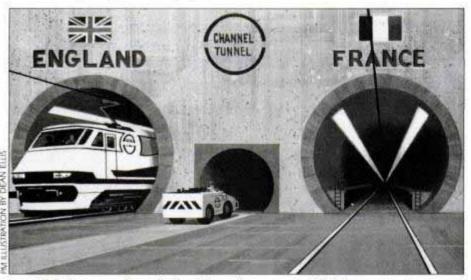
However construction takes place, the final result will be a 3-tube tunnel. Inside the tunnel, trains will move at a steady rate five minutes apart. No reservations will be needed. Passengers in a hurry will be able to take advantage of a drive-on, drive-off system behind the lead cars of each train. Those who have extra travel time will be able to leave their cars and go forward to air-conditioned refreshment parlors in the front. The train's cars will be soundproofed and comfortable.

Between the terminal at Cheriton on the Dover side and Frethun on the Calais side, the trip will take about a half hour, traveling at speeds up to 80 mph. Freight will also move through the tunnel in special cars that open at the rear, allowing a tractor-trailer to drive in, and close again for the trip.

A publication of the Channel Tunnel Group promises that "special measures will be introduced to forestall or deal with terrorism or sabotage." Since the tunnels are bored through the rock, rather than constructed atop the sea floor, they are considered less subject to sabotage than traditional tunnels.

Will the tunnel pay for itself? The answer is yes, and almost immediately. Employment generated by the tunnel construction is expected to have a significant impact on the British and French economies. But once the tunnel opens, revenue is expected to be even more impressive. One study suggests that the tunnel will generate upwards of \$1 billion a year in revenue from passenger and freight. That is based on a 1-way ticket tariff of \$50 per passen-

(Please turn to page 116)



Artist's concept shows design of tunnel entrances and lighting arrangements.



Choosing and using athletic shoes begins with an understanding of foot mechanics.

BY DR. JOE HAMILL

s a racing car is to the family automobile, the high-tech athletic shoe is to the old-time "sneaker." Just a short time ago, a running shoe was anything you wore while running. A basketball shoe was a shoe that you wore when you played basketball. Tennis shoe? Likewise. It really didn't matter. Whatever you had on your feet for a particular activity could be deemed appropriate.

But all that's changed. Sports medicine clinicians and researchers have found that the type of shoe you wear during certain highly specific forms of exercise can prove critical in preventing injury. But what about Zola Budd, the young South African sensation who runs barefoot in the 3000-and 10,000-meter track

events? Or Abebe Bikila, the Ethiopian who ran barefoot through the streets of Rome to win the 1960 Olympic marathon? They're the exception rather than the rule. For most people, it would be hard to imagine competing in any kind of sport without proper footwear. Paved roads, concrete sidewalks, synthetic tracks and artificial surfaces compound the problem of finding and using the right kind of athletic footgear.



Converse Odessa (top) is for running. Bottom, from left: Converse AeroKick for aerobics, New Balance high-top for basketball, Adidas Lendl for tennis, KangaRoos Dynacoil for running and general fitness.

What is it about the human body that makes it necessary to wear shoes? Why do we have different shoes for different activities? These are questions that have been answered, for the most part, using the study of biomechanics.

Each time the foot makes contact with the ground, the body must absorb a "load." This load is generally the athlete's own body weight. For example, in running I mile, the average foot

must endure between 500 to 600 surface collisions at 2 to 4 times his or her own body weight. This loading places strenuous demands upon the foot and leg. If athletic shoes can reduce these stresses, then the shoe has functioned properly and potential injury can be avoided.

The second question deals with special shoe de-

INS AND OUTS OF FOOT MECHANICS



Prior to contact with the ground, a runner's foot is supinated, or angled in at ankle.

signs for a given activity. Biomechanists evaluate the demands of a particular sport in achieving proper footwear design. Each activity has its own unique movements, and these movements place different stresses on the lower extremities. For example, basketball players run. Runners run. Why can't they use the same shoe? Well, basketball players also cut, pivot, jump, stop quickly and slide.

Let's explore proper footwear for the three primary athletic activities:

Running shoes

A vast quantity of research on running has been translated into high-technology running shoes. Generally, running shoes have exceeded other types of shoes in design and performance.

Most research revolves around a simple question that has a complex answer:

The axis of the foot and ankle straighten on initial contact with the ground.

What happens to your foot when you run, and how can a shoe help your foot absorb and support loading? Regardless of a runner's footfall pattern, the foot is angled slightly inward from the vertical, or "supinated" in biomechanical terms, at touchdown, causing an initial landing on the outside portion, or lateral aspect, of the heel. Impact results in the foot being rapidly forced on the running surface, causing a bending, or flexion, phase in the knee and hip. Further loading upon initial impact causes the bottom of the foot to be turned away from the body's midlinea phase biomechanists call pronation. The ankle is rolled toward the midline and the whole foot is turned out from the body's midline. This causes the ankle to appear to move in toward the center of the body as the foot lands flat on the ground (see diagrams). After reaching maximum pronation, a propulsion phase begins and all the foregoing

The foot and ankle are angled out, or

pronated, during maximum impact.

actions are reversed. Pronation has often been described as abnormal. However, pronation during walking or running allows the impact forces to be absorbed over a greater time period, thus reducing the effective magnitude of the forces. Without pronation, excessive stress would exist on the supporting structures. Excessive pronation, on the other hand, may be injurious to the runner, and is generally associated with complications of the knee and ankle. The culprit in "overuse" running injuries (as opposed to "traumatic" injuries) is the relationship between the knee flexion/extension and ankle pronation/supination. These actions must be synchronous, with maximum pronation at the ankle and maximum knee flexion occurring at









Testers from the Biomechanics Lab at Southern Illinois University (left) evaluate mediolateral control and shock absorption in one athletic shoe design. The science of designing athletic footwear is controlling, but not inhibiting, natural foot function as shown in diagrams on facing page. A Converse shoe (right) is mechanically tested for wear and flex.

the same time. If they don't occur at the same time, the joints will be functionally antagonistic, resulting in a low-grade but prolonged irritation of the knee.

Based on knowledge of foot function during running, it is generally thought that running shoes should serve two functions. Dr. Barry Bates, director of the Biomechanic/Sports Medicine Lab at the University of Oregon, says these functions are "to protect the foot and body from excessive forces and to provide adequate stability and control in the mediolateral, or sideways, direction." As we'll see, they are often contradictory objectives.

Initially, athletic shoe designers felt that shock absorption was the most important function, since it seemed logical to protect the foot from excessive impact forces. The two areas of the foot that required the most protection were the heel and the forefoot. In the past several years, however, the second function, generally called mediolateral or rearfoot control, has come to be recognized as equally important. Bates and his associates have concluded that these functions are inversely related. That is, a good shock absorbing shoe is generally a poor rearfoot controller and a good rearfoot controller is a poor shock-absorbing shoe.

For example, manufacturers use soft midsole materials to act as a shock absorber. However, this softer material will cause the foot to be less stable during pronation because the heel rolls on it too easily. Conversely, a hard midsole material absorbs little shock, but controls the side-to-side actions of the foot during pronation. A manufacturer of high-tech athletic shoes must compromise these inverse functions.

It's no easy task. Shoe companies have begun to label shoes as good "motion control shoes" (that is, rearfoot controllers), good "cushioning shoes" (shock absorbing) or good "combination shoes." There are several excellent shoes currently on the market that accomplish both functions very well, but with different technologies.

The Nike Epic has an air wedge that runs the full length of the shoe. The wedge provides shock absorption in the heel and forefoot areas. For rearfoot control, Nike researchers filled in the instep for greater arch support. The Tiger Epirus and the Reebok BB 6600 (diagram) both use a dual-density midsole, an attempt to give the athlete both a good shock-absorbing and rearfootcontrol shoe. The medial portion of the midsole is a denser (harder) material which, ideally, does not allow the foot to move to a severely pronated position, nor does it allow the foot to move as quickly into a pronated position.

KangaRoos USA has turned to a new midsole material called dynacoil, which uses a 3-dimensional woven coil fabric in the midsole. This coil contains two different fibers integrated along the

(Please turn to page 105)





PM COMPARISON TEST:

OFF-ROAD WARRIORS

We take eight compact 4x4 utility vehicles from downtown to desert to check out their utility and durability.

ixty miles east of Palm Springs, California, 20 miles from the nearest outpost, the Orocopia Mountains shrivel in the desert sun. This is a place of unnerving silence and dreamlike clarity, but also of enervating heat and frightening emptiness. Get yourself too far off the beaten path, and the only travelers' aid comes from iguanas, the only shelter from the prickly shade of a Joshua Tree. We ventured into the Orocopia wasteland to find out who builds the best 4-wheel-drive utility vehicle. For two solid days, we jumped, slid and climbed our eight "utes," at a cost of six flat tires, one temporarily defunct clutch, and a variety of small ills ranging from an adrift shifter to a shredded serpentine belt. After two trips through a car wash, however, there were no permanent scars.

It's well documented that nine out of 10 4-wheel-drive vehicles never get farther off-road than the supermarket parking lot. So we spent another two days on the unique combination of freeways, surface streets and canyon roads that makes up Los Angeles. In its own way, this is a driving environment as challenging as anything the Orocopia Mountains have to offer.

The best utes are as versatile as any vehicles on the road. They make safe suburban station wagons, spacious light-duty vans, comfortable commuter cars, powerful tow trucks and nimble off-roaders. They're surprisingly fun to drive, and have a brawny image that seems to be equally attractive to drivers of both sexes. Our testers came away thinking that one could do worse than have a utility vehicle as your second—or even only—car.

GMC S-15 Jimmy

GMC S-15 JIMMY

Our testers' unanimous favorite is General Motors' GMC S-15 Jimmy, also sold by Chevrolet dealers as the S-10 Blazer. Essentially, this is the S-10/S-15 pickup with the wheelbase shortened 8 in. and a 3-door wagon body applied in place of the pickup's separate cab and bed. The S-10/S-15 is our favorite 4x4 pickup (see *Torture Test*, page 84, Sept. '85), so it's only logical that we'd like the Jimmy/Blazer.

The exterior styling is the most sophisticated in this group, managing to be both pretty and tough-looking at the same time. The Jimmy has been around for four years, but it still looks fresh and contemporary. Unlike some of the competition, its basic good looks haven't been gooked up







with bolt-on macho accessories of little functional or aesthetic value. The Jimmy looks right just as it is.

On the inside, GM's top-line interior offers excellent accommodations for two, with reasonable seating space for two more. The typical GM bucket seats aren't as comfortable or supportive as those in the Japanese utes, and the new "high-tech" instruments shared with the Astro van are a step backward from last year's round gauges. Otherwise, our testers thought this was the most appealing interior in this group, both functional and attractive.

The optional Bilstein gas shock absorber suspension and oversize tires on sleek 5-spoke alloy wheels provide equal competence on-road and off-road. No matter what the surface, the Jimmy has excellent handling, perfect balance and a remarkably comfortable ride. The tried-and-true 2.8-liter V6 feels stronger than larger and, theoretically, more powerful engines in other utes; and despite long throws and an inconveniently located 4wd shifter, the 5-speed gearbox is among the best.

The Jimmy exudes a marvelous feeling of confidence—this is the ute we always turned to for the most demanding trail blazing. It handled every situation with grace and style, whether it was hauling a boatload of sailing gear to Newport Harbor or getting airborne off the side of a mountain for the benefit of the photographer.

Toyota 4Runner

Almost every mini utility vehicle is built off a pickup-truck base. Toyota's oddly named 4Runner goes one further—this is a Toyota pickup with a 1-piece cab/bed, two seats in the back, and a removable cap. The result, happily enough, is more than the sum of its parts. Our testers voted it into a solid second place, put off only by a breathtaking \$18,000-plus price tag.

The best part of the 4Runner is its turbocharged 2.4-liter engine. This gives great highway performance, plus a surprising amount of low-speed oomph for off-road slogging. Our Toyota came with an excellent 4-speed overdrive automatic that was perfectly matched to both the turbo engine and off-road conditions. The only hesitation we have is the nightmarish underhood view of the EFI turbo engine. Few home mechanics will want to deal with even normal maintenance chores.

Unlike Toyota's previous rigid-axle chassis, the new independent front suspension provides a nice mix of comfort, handling and long travel. It's not as well controlled as the Jimmy's in really rough beatings and the relatively narrow tires bog down in desert sand, but our testers ranked the 4Runner second in both on-road and off-road performance. Our only complaint is the use of

Produced by the PM Auto Dept. Text by Rich Taylor Photos by Rich Cox old-fashioned get-out-and-get-dirty manual locking hubs.

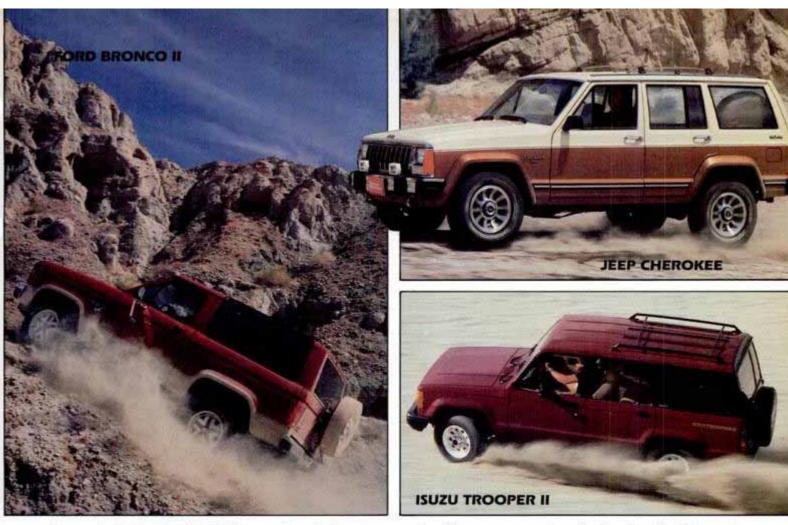
The 4Runner's interior got mixed reviews. The driver's seat was described as "the best I've ever tried, infinitely adjustable and comfortable." Things we didn't appreciate, however, are the overstyled digital dashboard and overabundance of electronic gizmos. We'd rather have seen Toyota put its money into automatic hubs and better tires than fragile gadgets.

Overall, we like the 4Runner. Its proper place is profiling on the San Diego freeway, not cutting cross-country through an Orocopia dry wash, but that's the way most people will use it, too. It's more of a truck than most of the others, but, paradoxically, more luxuriously outfitted, too. And like all Toyota products, the quality is fabulous.

Jeep Cherokee

Our testers like the Cherokee, calling it the land yacht of the desert and a luxury wagon with 4-wheel-drive. This is the most car-like vehicle in this group, closer to being a 4x4 station wagon rather than a pickup truck with seats in the cargo bed.

Most of the Cherokee's visual clues inside and out—are intended to project the image that this is a refined transportation choice for conservative, upscale folks. Indeed, the 4-wheel-drive Cherokee has become the In thing to have among affluent suburbanites in



the snowbelt. The Cherokee's biggest selling point is its 5-door convenience. General Motors will offer a 5-door Blazer/Jimmy starting next year, but the only other 5-door in this class is Isuzu's Trooper.

Our testers like the Cherokee for other reasons, too. The chassis is shared with the Comanche pickup, including the 2.8-liter V6 AMC buys from General Motors. This will soon be replaced with Jeep's own 4.2-liter Inline-Six. Both engines are smooth and torquey, though neither has enough horsepower. Every one of our testers complained about the Cherokee's weighty feel and lack of get-up-and-go.

Otherwise, the chassis works well both on- and off-road. The steering is too light, the ride too soft to be truly comfortable off-road, but driveability is acceptable under most conditions. This is not a wagon that's fun to drive in the normal sense of the term. As one tester put it, "This is a smooth highway cruiser on-road and a Sherman tank off-road. You'll go slow both places, but you'll get there."

There are three areas our testers think AMC needs to attack. One is interior styling. As one tester put it, "This is a ute in which grandma and grandpa will feel comfortable. But do they buy these vehicles?" Just about every AMC vehicle is trimmed like something from the late '60s, and we think it's time to update seats, dash-

boards, instruments and upholstery.

Second is price. At nearly \$19,000, our test Cherokee was judged to be \$3000 to \$4000 overpriced compared to the competition. Judged just against the other 5-door in this test-Isuzu's Trooper-we prefer the Cherokee. But a \$6000 premium seems like an awful lot to pay. Finally, AMC has to do something about quality control. More things broke or went wrong on the two Jeeps in our test than on the rest of the group put together. When you get to this price bracket, buyers expect high quality. Cherokee buyers are also not the DIY sort, so every failure means a trip to the dealer.

Mitsubishi Montero

"What a neat little vehicle" and "A very pleasant surprise" were among our testers' enthusiastic comments after driving the Montero. The Montero is one of those happy designs that works. It's an absolute blast to drive, it can go just about anywhere, it's festooned with more gadgets than the starship Enterprise and while it's certainly not pretty, it's devilishly cute. Even the price is right. The Montero has the lowest price tag in this test, except for the Samurai.

Like other manufacturers, Mitsubishi builds its ute from primarily pickup components, though in this case with a different, more Jeep-like body. There's not enough noticeable styling, but our testers called the boxy Montero cute, tough and utilitarian. The Montero is actually about the same size and weight as the S-15 Jimmy or Bronco II, but it feels smaller and handier. We had a narrow pass to get through in order to see a rock formation called The Devil's Punchbowl. Of course we used the Montero. We knew it would fit where the others wouldn't.

Mitsubishi's tried-and-true 2.6-liter Four is under the hood, along with torsion bar independent suspension and an excellent 5-speed. Equipped with balance shafts, this is one of the smoothest, quietest big 4-cylinders on the market, whether it's fitted to a Montero, a Starion or a Chrysler van. It seems perky and more than powerful enough to suit the Montero. Indeed, our testers gave the Montero a very high rating for driveability, both on-and off-road.

The Montero is set up for serious offroading—witness its unique independently sprung driver's seat, dashmounted tilt-o-meter, well-located controls and simple, well-protected mechanicals. "Excellent access to all normal maintenance spots, a piece of cake for the do-it-yourselfer" wrote one of our impressed testers.

The Montero is more like a Jeep CJ than a Cherokee, more rough-andready than country club casual. It will comfortably hold four adults, however. It comes with a full complement of useful features and is obviously well-

OFF-ROAD WARRIORS

built. Off-road, the Montero is as capable as the Jimmy, 4Runner and Cherokee—the others are more at home on the street. But the Montero holds a terrific price advantage, and it's also more pure fun to drive.

In 1987, for the first time, Dodge dealers will sell a version of the Montero called the Raider.

Isuzu Trooper II

The Trooper's big selling point for many people is the availability of a 5-door version. This makes it superficially similar to the 5-door Cherokee, but that's where the resemblance ends. The Cherokee is redolent of manicured lawns and badminton players in green and pink; the Trooper carries a whiff of sub-Saharan transveldt. It seems to cry out for camouflage paint, homemade brush guards and gun mounts.

Like its competitors, the Trooper is built from pickup-truck mechanicals, in this case Isuzu's 2.3-liter gasoline Four with 5-speed, 4wd and independent front suspension. Like every Isuzu, except the Impulse Turbo, the Trooper needs more power. On-road or off-road, 96 hp is not enough for a vehicle, especially when you load it up and hitch on a trailer. Surely, the Impulse's 135-hp turbo engine could be fitted under the Trooper's boxy hood.

Even loaded up with high-zoot LS decor, the Trooper is still pretty spartan. It's not as fancy as the less expensive Montero, and not even in the same universe as Toyota's plush 4Runner. This is not to say that it isn't perfectly pleasant for what it is meant to be: a functional hauler of life's detritus. It's the kind of interior that looks like it was designed for golden retriever hair to be vacuumed up easily. There are times when that's exactly what you need.

Our biggest disappointment with the Isuzu is the chassis. Despite its macho aura, the Trooper II is a wimp when the going gets tough. The handling is very sloppy, the body/chassis shakes and rattles and the brakes quickly fade with hard use. As one of our test crew put it, "Cushy on the highway, but you'd better not try anything more strenuous than a well-packed fire road if you want to be sure of getting home."

Jeep Wrangler

Like Harley-Davidson and Levi Strauss, Jeep supplies a market that won't accept improvements, even if they were offered.

The "all-new" Wrangler looks like every Jeep since 1946, but with rectangular headlights. The front suspension is still a rigid axle on leaf springs, the engine is still AMC's 4.2-liter Six, the windshield still folds down, and the doors still come off. Heck, it still even has running boards.

The thing about a Jeep—or a Harley-Davidson, for that matter—is that it doesn't do the job for which it was designed as well as some other vehicles can do it; vehicles which can do other things, too. Every other vehicle in this group is more comfortable and stable to drive on the highway than the Wrangler, but most of them are better offroaders, too.

Interestingly enough, our female testers liked the Wrangler much more than the men did. They called it classic, pretty and really cute. There was a time when calling a man's Jeep "really cute" would get you into a tussle in just about any bar in America, but that's just what the Wrangler is—cute.

Driving it is like driving, well, a Jeep. The Wrangler is undoubtedly a better Jeep than the CJ, but Jeep enthusiasts will be reassured to know it's a Jeep through and through. The ride is bouncy, the steering is quick, there's lots of road, engine and wind noise: As one long-time off-roader put it: "It has that classic Jeep feeling."

Ford Bronco II

The Bronco is to a Ranger pickup as the GMC Jimmy is to an S-15. We prefer the S-15 to the Ranger, and we prefer the Jimmy to the Bronco for many of the same reasons.

Most of our complaints center on the chassis. In off-road driving, even on relatively smooth packed sand, the Bronco just didn't handle as well as other vehicles in the test.

Despite its big 2.9-liter V6, the Bronco constantly feels short of breath. Acceleration is lackadaisical, the steering is too light, the shifter is balky, and the electronic pushbutton for the 4wd shifter is hard to operate, seems likely to give trouble in heavy off-road use, and only completes the shift about half the time. We'd rather have a nice, positive mechanical shifter.

The Bronco's styling is extremely sporty, with eye-catching 2-tone paint schemes and stylish rear-quarter windows that wrap into the roof. Ford also offers some of the most beautiful paint colors on the market: deep maroon, blue and green as rich as the finish on a Lincoln. Add a set of 5-spoke alloy wheels, and the Bronco will out-dazzle just about anything.

You can order your Bronco with equally spiffy interiors, especially in the popular Eddie Bauer versions. Our testers found the driving position poor, with a large steering wheel at the wrong angle and uncomfortable seats. They also complained about the lack of

(Please turn to page 114)

4×4 UTILITY VEHICLE TEST SPECIFICATIONS

AEHICTE.	GAS MILEAGE (EPA city/ PM test)	MAX. CARGO VOLUME (cu. ft.) (rear seat tolded down)	MAX. PAYLOAD (lb.)	MAX. TRAILER TOWING CAPACITY	BASE PRICE	PRICE AS TESTED	ENGINE	WHEEL- BASE (in.)	LENGTH (in.)	WEIGHT (lb.)	OVERALI RATING
Ford Bronco II	17/15.04	64.9	750	5000	\$12,146	\$15,926	140-hp OHV 2.9-liter V6	94.0	158.4	3200	7
GMC S-15 Jimmy	16/15.00	67.2	1000	4000	\$10,745	\$16,252	120-hp OHV 2.8-litter V6	100.5	170.3	3150.	1
Isuzu Trooper II	18/19.40	71.3	1054	2000	\$10,809	\$12,444	96-hp SOHC 2.3-liter Inline-4	104.3	175.2	3150	5
Jeep Cherokee	17/13.63	71.8	1150	4200	\$11,474	\$18,750	115-hp OHV 2.8-liter V6	101.4	165.3	3450	3
Jeep Wrangler	17/12.40	53.4	800	2000	\$9899	\$12,379	112-hp OHV 4.2-liter Inline-6	93.4	153.1	3022	6
Mitsubishi Montero	17/13.81	62.9	1050	2000	\$9369	\$11,638	109-hp SOHC 2.6-liter Inline-4	92.5	157.3	3250	4
Suzuki Samurai	28/25.42	31.9	800	1000	\$6695	\$8275	63-hp SOHC 1.3-liter Inline-4	79.9	135.0	2127	8
Toyota 4Runner	17/14.50	80.9	1400	3500	\$11,898	\$16,683	135-hp SOHC 2.4-liter Inline-4 turbocharged	103.0	174.6	3410	2

*All are 4-passenger, 3-door, except Isuzu Trooper II and Jeep Cherokee, which are 4-passenger, 5-door

ROAD VIBES

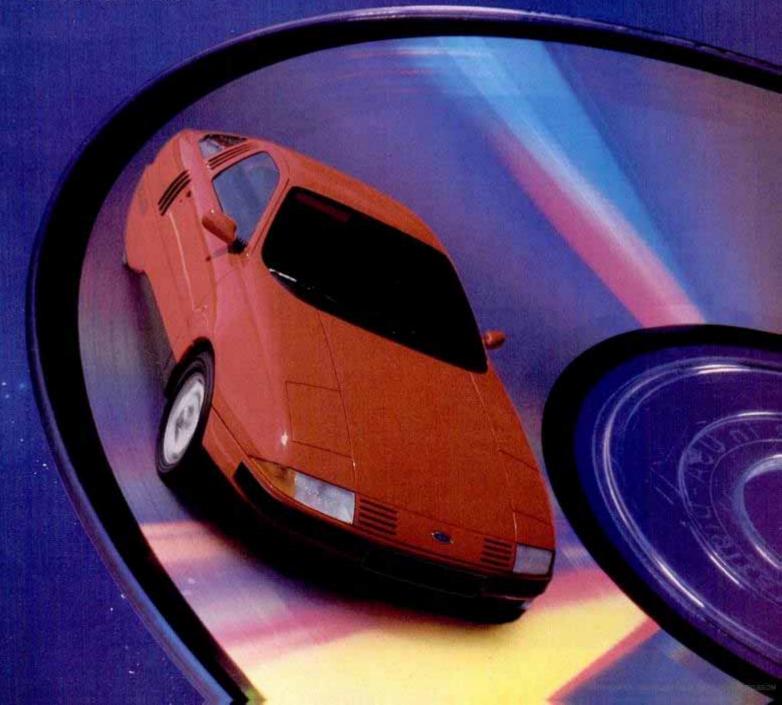
The digital audio Compact Disc is hitting the road in force and redefining highway hi-fi. Here's what to look for in CD performance, features and related gear when you digitize your dash.

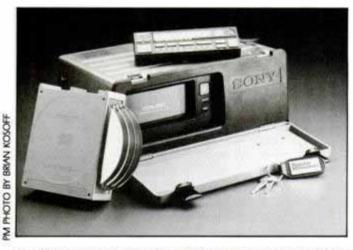
BY FRANK VIZARD

PHOTO COMPOSITION BY MICHEL TCHEREVKOFF: CAR PHOTO BY HUMPHREY SUTTON t revs at considerably fewer rpm than your engine, burns watts instead of gasoline, and pumps out decibels in place of horsepower. It's the digital audio Compact Disc and it's the highest octane music maker you can put in a car. Yet, the CD player you install in your dashboard is quite different from the one in your living room.

Most home CD players look alike and function much the same. They're about the size of a cassette deck, connect to your hi-fi system the same way, and their job is simply to play discs and nothing more. Presumably, the home CD player can expect to remain in one place, enjoy stable indoor temperatures, and suffer a minimum of bumps and jolts.

Not so with car CD players: They're no bigger than a typical car radio, and occupy the same space in the dash. Though





Sony's DiscJockey, the first automotive CD changer, plays up to 10 discs stowed in a magazine (left). Except for the remote control (atop the unit), the system stows away in the trunk.



Yamaha's YCD-1000 eliminates the hazard of fumbling with CD album boxes while driving. You store CDs in the protective cartridge (right), which slides into the player.

some play discs only, many include an AM/FM radio tuner. Others slide out of your dash for safe stowing elsewhere. Among these, you'll find models that run on AC power to hook up with your home hi-fi. Some even run on batteries for listening with headphones.

Besides these physical differences, a car CD player also differs mechanically and sonically from its homebound cousin. Let's deal with the sonic aspect first.

Dynamic range

One thing you'll notice when you read a car CD's technical specifications is that they don't measure up to those of the CD player in your home. Even so, the CD remains superior to any other automotive sound source.

The mobile CD's shortcoming is particularly evident in the specification that most critics agree in digital audio's strong suit: dynamic range. For the record, dynamic range is the spread between the softest and the loudest sounds a player will reproduce. It's measured in decibels (dB)—the more the better.

Even the least expensive home CD player offers 90dB of dynamic range, and some boast more. By comparison, car CD players clock in between 79dB and 89dB. You can blame the size restrictions imposed by the automobile for this slight inferiority in car CD reproduction.

In home machines, there's enough room in the chassis to separate and isolate the player's analog circuitry, digital circuitry, power supply, preamplifier and transport controls. But for car installation, all these components must be shoe-horned into a cigar box-size chassis in order to fit into the dashboard. Even with isolation, the proximity of all these components generates electrical noise—enough to mask some of the musical signal. This noise cramps the player's dynamic range in that it covers up the softest music.

Does this handicap of car CD players mean you should avoid them? Not at all. The digital Compact Disc format still outshines analog cassettes or LP records. For instance, the most expensive car cassette units top out at 75dB of dynamic range when playing recordings made on metal tape with Dolby-C noise reduction. That's excellent dynamic range, but the only way you'll get

it is if you've recorded from a Compact Disc. The very best LP records have no more than 60dB of dynamic range.

Besides dynamic range, the CD format offers other benefits. Compared to tape or LP, distortion is nonexistent. And physically, the CD is immune from normal wear and tear. Finally, though the car CD suffers a slight dynamic range handicap compared to a home player, it's really no handicap in a car. That's because the ambient road noise-wind and tire hiss, motor hum and transmission whine-would probably overpower those soft passages anyway. Sure, you could raise the overall volume to boost the soft passages, but you'd be risking a rude shock when the cymbals crash in.

Musical mechanics

Just as the size limitations imposed by the automobile contribute to the sonic differences between home and car CD players, so too do the rigors of the road demand special mechanical construction in automotive units. For the most part, these differences in construction don't affect the sound, but might make one player operate under more adverse





It's three players in one: Philips' CD-10 slides out of your dashboard for toting as a headphone portable, or for living-room listening with your hi-fi system.

conditions than another can handle. For example, temperature extremes pose one of the most serious hazards to car CD players. The laser pickup system, which reads the digital code on the disc, won't work in severe cold or heat.

Freezing temperatures won't harm the laser, but most car CD players remain in a standby mode until the mercury rises above 0° Celsius (32°F). Heat, though, can permanently damage the laser. Accordingly, some car CD players are designed to shut down automatically at 50°C (122°F) in an effort at self-preservation. Other lasers might have greater tolerance, shutting down at 70°C (158°F) or even 100°C (212°F). These temperatures can be reached inside any parked car on a hot summer day.

Another enemy of the car CD player is vibration and the up, down, forward, reverse and sideways motion of a car. Routine movement is handled quite well by shock-absorbing isolators made of resilient materials such as rubber and ceramic. Additionally, the actual laser pickup assembly might be suspended independently from the transport arms that guide it across the disc.

Road handling

As a backup for the isolation and suspension systems, the player's computer memory continually records the position of the laser in relation to the disc. When a bump is severe enough to cause skipping or mistracking, the laser returns to its position at the time of impact-with little delay.

Audible problems aren't always the fault of the machine. A damaged discone with scratches or messy fingerprints-can cause a loss of information. If the loss is not serious, the CD player will compensate for the lost data. For example, if the musical passage was on a downward swing into the lower frequencies, the CD player will continue along that musical path. This process is called interpolation.





How often a CD player must resort to interpolation might depend on the type of laser the machine employs. There are two types: triple-beam and single-beam. A triple-beam laser uses two beams for tracking and the third for information retrieval. A singlebeam laser accomplishes both the data retrieval and tracking in one shot.

The single-beam laser represents savings to a manufacturer because there are less moving parts in the machine. Sonically, however, there is no difference between a single-beam and triple-beam laser. But proponents of single-beam systems point out that single-beam lasers are slightly more powerful than their triple-beam counterparts. Since a single beam is more concentrated, they say, it is better able to "read" through surface smudges on the disc caused by dirt and fingerprints. Consequently, there is less need for interpolation, resulting in truer playback. This point may be particularly relevant in the automobile since cars are often less than hospital clean.

Noise suppression

Do all car CD players sound the same? No-there are subtle sonic differences. If you do notice any difference in sound quality among car CD players, the difference probably has its cause in the type of noise filtration employed.

Manufacturers use filters to eliminate some undesirable high-frequency (Please turn to page 110)

COMPARISON—CAR CD PLAYERS

MANUFACTURER	MODEL	PRICE	TUNER	SINGLE (1) OR TRIPLE (3) BEAM	FILTRATION Analog/Digital	COMMENTS
ALPINE	5900	\$600		3	Α	1
BLAUPUNKT	7900	800	X	3	A	
	CDP05	550		3	A	2
CLARION	CD005	800		3	A	2
DENON	DCD-C1	900	X	3	D	3
FUJITSU TEN	SD-1110	550		3	D	
HITACHI	CD-D4	600		3	D	1
KENWOOD	KDC-9	659		3	D	1
MITSUBISHI	CD-100	N/A		3	D	4
PANASONIC	CQ-E800CD	700	х	1	D	
PHILIPS	DCO-85	600		1	D	1
	CD-10	400		1	D	1,5
PIONEER	CDX-P1	600		3	D	1
	CDX-1	550		3	D	
	DEX-77	N/A	X	3	D	6,7
SANSUI	CD-X500	600		3	D	
SANYO	FTEC-1	600	×	3	A	1,8
	FTEC-2	700	×	3	A	1,6,8
SONY	CDX-5	600		3	A	
	CDX-R7	700	X	3	Α	
	CDX-A10	1000	х	3	A	9
TECHNICS	CQ-DP5	700	×	1	A	
YAMAHA	YCD-1000	550		3	D	1,2

AUX input; 2. Cartridge-loading system; 3. Removable; 4. Available only with full stereo system; Removable for home/portable use; 6. Built-in security system; 7. Wired remote control; 8. Cassette input; Mounts in trunk, has magazine loading system for 10 discs, optional radio tuner (\$130).

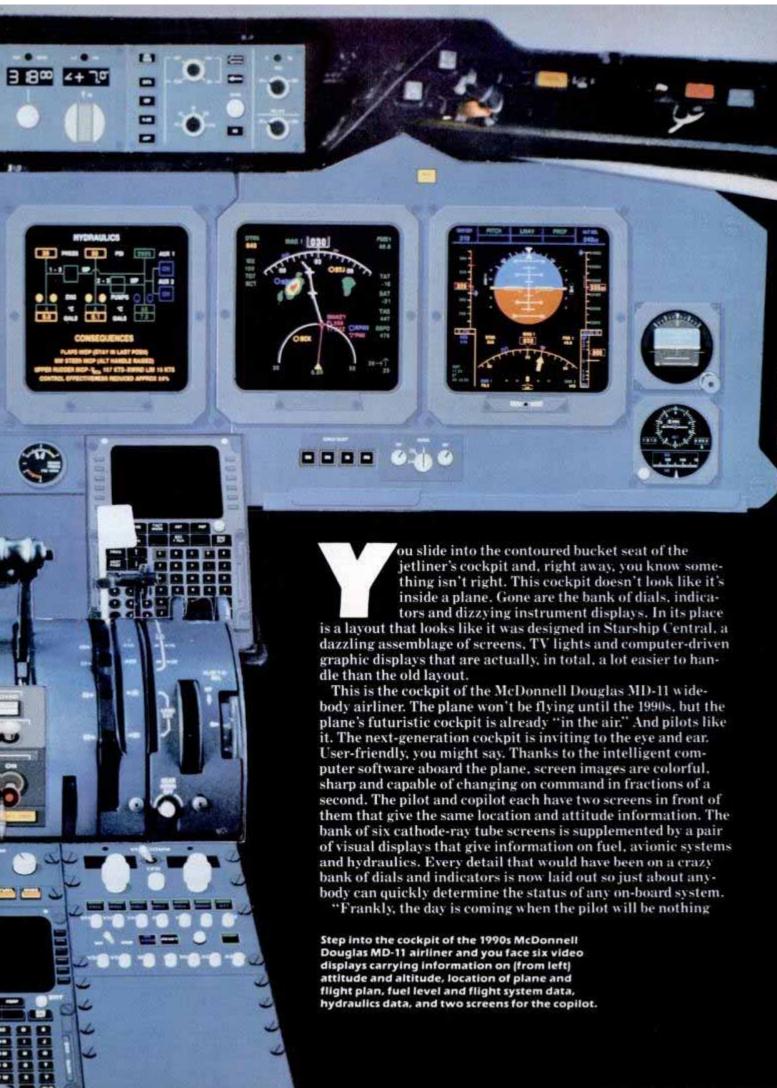


FLIGHT DECK FURE THIR

The next generation of civilian aircraft will have a 'Star Trek' cockpit that makes the pilot an information manager instead of a manual laborer.

BY DENNIS ESKOW, Science/Technology Editor, AND JIM CAMPBELL

1401



FLIGHT DECK FUTURE THINK

The cockpit for the 1990s Airbus A320 airliner places control sticks to the side and gives 2-man flight crew full visibility of 6-screen instrument readings. In current Airbus planes, video displays are stacked. The future model places them side by side for easy scanning. The A320 has a fly-by-wire computer that allows the plane to virtually fly itself in bad weather.

An artist's concept of the MD-11 shows advanced flight controls, including hydraulic winglets at the tips of each wing for superior handling.



more than information manager," says Dr. Thomas Furness, whose work at the Air Force Aeronautical Systems
Division in Ohio is leading toward a 21st century "virtual"
cockpit—for the crews of planes that virtually fly themselves. His project envisions putting a pilot into a cockpit with no indicators of any kind. The pilot would wear a hood containing tiny CRTs that display a stereoscopic view of the outside of the aircraft and of all the control displays. The

advantage of the system is that the pilot can have any

view-of the outside or of the displays-at any time. The

outside view would be provided by hundreds of cameras and sensors placed around the aircraft. The inside view would be generated by an artificial intelligence computer. "That's still a long way off for commercial planes," Furness says. "But the pilot's role is already being changed by the cockpits of the near future."

Like the MD-11 cockpit, another one scheduled for the 1990s is designed to make almost everything electronic. The control stick of this other futuristic craft—the Airbus A320—has been removed from the middle of the dashboard to the pilot's side. The idea is to fly and watch at the same time. While comfortably handling the stick to his side, the pilot or copilot can scan a bank of six CRTs, constantly monitoring the jet's performance.

The A320 sidestick will have no physical connection with any of the plane's control surfaces. Instead, it will sense the pilot's hand movements and send an electronic message to

In Simulators, You Can Crash Twice

DPM

efore manufacturers put a new cockpit in an airplane, they "fly" it for hundreds of hours in a simulator. Flight simulator technology has gotten so hot in recent years that more and more pilots are required to spend long and serious hours in what may seem, to an outsider, to be a very sophisticated computer game. True, when flying a simulator you can crash twice and live, but pilots know that the work they do in the fantasy world develops habits for the real one.

The newest and most advanced simulators (like the one used in the 1990s MD-11 program) are used not only to train pilots, but also to fix engineering problems not anticipated on the drawing board.

When Grumman was building the X-

29, for example, test pilot Chuck Sewell put in hundreds of hours flying the simulated forward-swept-wing craft. On the day he flew the real thing, he said the flight seemed almost anticlimactic. Many glitches had been worked out of the system during the hours of makebelieve flight.

The two main components of the leading-edge simulator are the electronics and the hydraulics. The electronics are the same as those used in the real thing, with extra computer capacity used to generate realistic flying images.

Simuflite is one of the new leaders in the field. Its Gulfstream G-III outfit gives you visual images out the window that make you feel like you're really flying. Every detail is realistic.



The Simuflite simulator is used to train pilots who will fly the Gulfstream III.

Using a very large computer system, Flightsafety has a simulator for the Saab-Fairchild-340 that can duplicate day and night approaches to runways all over the world.







Gulfstream's future cockpit (left) integrates information on large screens. A smaller individual screen (top) tracks plane's position. Large screen (above) shows air speed, heading and other important flight data.

the appropriate servomechanisms to operate the flaps, rudder and other flight controls. That's "fly by wire," the way military jets and the Space Shuttle are flown.

The electronic cockpit—or "glass cockpit," as the industry calls it—began evolving a few years ago with the Boeing 757 and 767 systems. These jets dedicate an entire set of displays to engine and systems management. Designed by the Collins division of Rockwell, the displays provide a somewhat scaled-up representation of normal engine gauges. High temperature, low pressure, overspeed or other problems pop up on the screen with backup alert signals, including a flashing light and a warning tone. This system can be connected with ground computers to provide information on the health of the plane and its engines.

"The most important element in modern cockpit design is redundancy," says Grumman test pilot Chuck Sewell, who flew the X-29 forward-swept-wing prototype last year (see "I Flew The World's Hottest Fighter," page 75, Apr. '85). With the new flight display system, when one display goes out, the computer redirects the signal to another screen.

Under this system, if a flight plan display is lost, the computer might patch it into one of the management displays, alternating the two distinctly different readings at a pace quick enough to give the pilot any reading he needs, but slow enough to keep him from going insane trying to follow the on-and-off patterns. The redundancy is called "reversionary mode" because a single screen will show one set of data, then revert back to an original mode.

If reversionary mode goes out, the 1990s cockpits are equipped with small electromechanical instruments and the basic needles and balls placed in every cockpit since World War II. It wouldn't provide enough information to conduct a transcontinental flight, but the backup is good enough to get a plane with problems to a safe haven.



Pilots make a night runway approach on a Flightsafety approach simulator.

Besides the electronics, the hydraulics in the simulator are most important. Simulators generally stand atop a system of hydraulic legs that rotate the cabin and move it up and down to give the pilot a realistic feeling of pitching, rolling and speeding along in the aircraft. Flightsafety's Bell 222 helicopter simulator gives the pilot all the swing and whip of a real chopper thanks to the large number of movements allowed by its hydraulics.

The world's leading flight simulator company is Singer-Link, which produces systems for NASA and all branches of the military, among other customers. Some of the Singer-Link simulators carry so much computing equipment that they have to be kept in areas far removed from the flying machines themselves. Such was the case with the Space Shuttle simulator I flew. It roared off the launch pad and glided smoothly through space. I took off and landed with it four times, and I only crashed twice. That happens only in a simulator.—D.E.



Flightsafety's Bell 222 helicopter simulator sits on top of a system of hydraulic jacks. The hydraulic system gives the cabin pitch, roll, yaw and lift that feels like flying to the student inside.

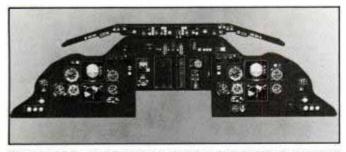
FLIGHT DECK



The A320 airliner of the 1990s will have servocontrols run in a fly-by-wire scheme. The cockpit will be able to fly the plane, with the pilot just keeping an eye on the video displays.



Artist's conception of a future cockpit shows the pilot looking through a HUD, a see-through holographic instrument panel.



An older McDonnell Douglas cockpit has limited CRT displays, but still uses conventional dials and needles for indicators.

While glass cockpits are making their way into the next generation of airliners, they also are catching on in corporate jets. Sperry is developing a lavish and well-equipped 6-CRT system for the Gulfstream IV. High-resolution 8-in.-sq. screens will consolidate the areas that demand attention. The jet's primary flight display, for instance, will also convey navigation information, air speed, altitude and energy trends. Information on critical systems and operating procedures will be available on command.

The corporate jet of the future will also have a wind-

shear detector. Wind shear, the sudden shift in local winds to unexpectedly high velocities, has brought down many jets in recent years. Aircraft can take more chances with the weather than they could a generation ago, but when wind shear happens, no current plane can handle it.

Sperry already has certified a wind-shear detector for commercial and private aircraft. In the cockpit of the future, the Sperry device will be integrated by computer into the video display system. McDonnell Douglas's newest twin jetliner—the MD-88—will have a wind-shear device designed by McDonnell Douglas itself when it takes to the air next year. "While the best course of action is avoidance, we now have the tools to develop better on-board methods of flying through shears that are inadvertently encountered," says John D. McDonnell, director of flight control for Douglas Aircraft.

The glass cockpit is also the future of propeller-driven private aircraft. The Beech Starship has 14 dedicated CRTs of varying orientation and size. Most pilots will admit that the switch from dials and needles to video screens is an advancement, despite the number of screens. The video displays are sharper and more graphic than traditional displays. They keep a pilot alert.

Two new developments are rapidly coming onto the stage. The first is in Head-Up Display (HUD)—the holographic projection of flight displays on a transparent screen placed on the windshield in front of the pilot. He can look right through the displays to the outside of the aircraft, and still read the important data he needs to fly the plane. In bad weather, such HUDs have proven their worth in military jets. Now Pacific Southwest Airlines is using HUDs in some of its MD-80s. Flying in smoggy, foggy or rainy weather along the coast is easier. Other airlines are expected to follow that lead.

In the far future, Artificial Intelligence computers will be used in aircraft. The Air Force is already experimenting with supercomputers in the cockpit of simulators to develop a system that takes over for an unconscious pilot. For commercial airliners, AI may be used to give the crew information for emergency takeoffs, landings and changes in flight plans. One scenario envisions the crew getting a series of possible solutions to a flight problem on the screen. It would be up to the pilot to choose the right move.

"Commercial airliners probably won't make much use of AI until well into the next century," Furness says. "It'll take that long to convince airline passengers that a machine can do most of the work."

BY JOSEPH TRUINI Shop And Tools Editor PM photos by Brian Kosoff

'Measure a thousand times and cut once.'—Ancient proverb

f the numerous tools employed during a typical do-it-yourself project, none is more vital to its successful completion than the various measuring and marking tools used. All craftsmen, regardless of their skill level, must rely heavily on these tools for accuracy throughout each step of the building process.

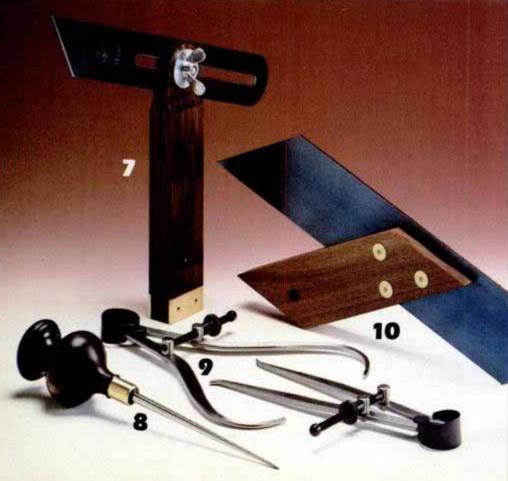
The diverse tool collection shown here includes traditional, time-honored tools as well as the latest, state-of-the-art measuring and marking devices such as an electronic caliper and a handheld computer that reads distances instantaneously. Note that some of the tools are designed for precision shopwork while others are used primarily by the building trades. Many of the tools, however, overlap and can be used for nearly all types of do-it-yourself work.

The variety of measuring and marking tools you need depends largely on the type of work and materials you're involved with. A typical home workshop, though, should be equipped with a 16-ft. tape measure, 6-ft. folding rule, marking gauge, scratch awl, steel straightedge rules of various lengths, and several squares, including a combination, try, framing and sliding bevel square. Then, add tools to this basic starter group as you need them.

The importance of measuring and marking tools is obvious—without them it would be nearly impossible to build even the simplest project. Fortunately, most of these tools are relatively inexpensive. Here's a detailed look at each of the tools shown.

From rules and gauges to calipers and squares, here's a collection of the requisite measuring and marking tools.





1. Bevel protractor-Read, transfer and mark angles quickly and accurately with this bevel protractor (\$52). The tool-shown on the previous page set at 55°-features a rotating head that has a double 180° scale, spirit level and knurled lock bolts. The head is fitted with a 12-in.-long steel rule calibrated in 8ths, 16ths, 32nds and 64ths. Eighteen- and 24-in.-long rules are also available. Contact Starrett Tools, Athol, MA 01331.

2. Bevel-edge square-When extreme accuracy is required to determine 90° angles, try this hardened-steel try square. The 6-in.-long, nongraduated blade is beveled on both edges of each side to provide precise line contact with the tool. The 45/16-in.-long beam (handle) is grooved at the inside corner, where it meets the blade, to provide clearance for burrs and dirt. It's available at hardware stores for about \$95. For more information, contact Starrett Tools, Athol, MA 01331.

3. Japanese miter square-Designed unlike any Western square I've seen, this versatile Japanese tool can mark 90° and 45° angles. The lightweight, all-steel tool measures 4 × 6% in. Features include a %16-in.-wide base and a convenient inch scale that measures the depth of a meter, not the length along the 45° line. It's \$11.50 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

4. Speed square-This simple square is arguably the most versatile carpenter's layout tool available. The Big 12 Speed Square combines the best features of a framing, try and miter square with the angle-finding capability of a protractor. Use the 12×12 -in. aluminum-alloy square for all framing layout work including wall and roof construction and stairway building. It comes with a comprehensive 40-page instructions booklet and a bolt-on layout bar that adjusts to fit out-of-square corners. The tool is sold at hardware stores and lumberyards for about \$18. Contact Swanson Tool, 1010 Lambrecht Dr., Frankfort, IL 60423.

5. Graduated straightedge-A quality steel straightedge is indispensable for scribing perfectly straight lines and checking the flatness of a surface. This precision-ground 113/32-in.-wide × 12-in.-long tool (\$40) is graduated in 32nds of an inch and beveled on one edge. Graduated straightedges are

available up to 48 in. long. Nongraduated and nonbeveled models come in lengths up to 72 in. For details, contact Starrett Tools, Athol, MA 01331.

6. Lighted plumb bob-Here's a fine example of how a simple, yet clever, idea can vastly improve the accuracy of one of the world's oldest toolsthe plumb bob. The Laser plumb bob shines a ½16-in.-dia. spot of light that indicates exactly where to mark—no guesswork is involved. This tool is especially useful in low-light areas. The ¾-in.-dia. × 7¾-in. bob operates on two AA-size batteries. It's available for \$32 from Port Austin Tools, 130 Arthur St., Port Austin, MI 48467.

7. Sliding bevel square—Use this essential shop tool to lay out various odd angles and dovetail joints. Simply adjust the 9%-in.-long steel blade to the desired angle and tighten the wingnut. The 7%-in.-long rosewood handle is reinforced with brass end plates. This German-made tool is available for \$19.95 from Woodcraft Supply, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

8. Scratch awl—A quality awl is necessary for all types of precision layout work and general scribing. This fine-crafted tool has a 4½-in.-long hardened toolsteel blade fitted in an attractive, hand-turned rosewood handle. The blade tip is ground to a very fine, sharp point. It's available for \$31 from Bridge City Tool Works, 1104 Northeast 28th Ave., Portland, OR 97232.

9. Outside and inside calipers-These two tools are designed for transferring and measuring outside and inside dimensions. Calipers are invaluable, particularly to woodturners. The bowlegged caliper is used to measure outside dimensions up to 6 in. The straight-legged caliper has two small feet that flair outward for measuring inside dimensions up to about 61/2 in. Each tool has forged steel legs, tempered steel bow spring and a quickadjust screw. These outside and inside calipers are available for \$14.70 each from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

10. Miter square—Designed exclusively for laying out and marking precise 45° angles, this handsome tool features a blue-steel blade and a rosewood handle. The oversized blade measures 2½ × 10-in.-long for accommodating large workpieces. It's available for \$20.50 from Constantine's, 2050 East-chester Rd., Bronx, NY 10461.

11. Try square—Lay out and mark 90° angles with this exceptionally made, superprecise try square. Featuring a ½-in.-thick × 1½ × 8-in.-long brass blade and rosewood handle, the square is guaranteed accurate to within .002 in. of 90°. The handle's edges are faced with brass wear plates and the sides have brass inlay rivet seats. The try square costs \$52 from Bridge City Tool Works, 1104 Northeast 28th Ave., Portland, OR 97232. In fact, all five tools shown in the above photo (No. 11 through No. 15) are made by Bridge City Tool Works.





MEASURING UP

12. Miter square -Known as a jointmaker's square, this tool is slightly smaller than most miter squares (see No. 10). Use it to lay out 45° miters on smallscale, highly precise work. The 1-in.-wide × 61/2-in. brass blade is riveted to a rosewood handle that is accented with brass wear plates and inlay brass rivet seats. This tool is especially

helpful to furniture builders and modelmakers. It costs \$43. (See No. 11 for the manufacturer's address)

13. Adjustable bevel square-Here's another scaled-down tool from Bridge City Tool Works. Use this brass and rosewood bevel square to lay out and transfer any angle. The 1/4 × 5-in.long blade rotates 360°. Brass wear plates protect a 31/2-in.-long rosewood handle. Tighten the knurled brass knob to lock the blade at the desired angle. It costs \$59.

14. Double square—Sized to fit easily into a work apron pocket, this unique tool is designed for checking a board's edge for squareness after planing and jointing. The 1 × 5-in.-long brass blade protrudes 1% in. from each edge of the rosewood handle. Brass wear plates and brass inlay rivet seats help protect the handle to ensure longlasting accuracy. The double square is available for \$39.

15. Dovetail square—Lay out and mark dovetail joints with consistent accuracy using this novel dovetail square. The 5-in.-long brass blade has a tapered end for marking the angled lines of the pins and tails, and a square end for scribing the vertical joint lines. The square shown (\$41) marks dovetails at a 6:1 ratio. An 8:1 ratio dovetail square is also available.

Fiberglass long-tape—To measure extended distances accurately, try this 150-ft.-long tape from Stanley Tools, 600 Myrtle St., New Britain, CT 06050. The 1/2-in.-wide tape is made of tough, yet flexible, fiberglass that resists stretching. The tape has a protective PVC coating that resists abrasions and numerous solvents and chemical agents. Unlike a metal tape, a fiberglass tape won't rust, kink, conduct electricity or be adversely affected by extreme weather conditions. The tape comes in a 91/2-in.-dia. plastic reel with a rapid rewind crank. It's available at hardware stores for about \$47.

17. Automatic center punch—Using a hammer and punch to strike center points is an adequate, but often imprecise, technique. This automatic



center punch features 1-handed operation-simply press down on the tool and a spring-loaded mechanism strikes a blow. To regulate the force of the blow, adjust the tool's knurled cap. Turn down the cap to strike the strongest blow. Unscrew the cap slightly for lighter blows. The 11/16-in.-dia. × 51/s-in. punch has a hardened steel point that can be removed for sharpening or replacement. It's available at hardware stores for about \$15. Contact Starrett Tools, Athol, MA 01331.

18. Marking gauge—Use a marking gauge to lay out wood joint lines-of-cut. Designed for marking with the wood grain, the gauge scribes a very fine, precise line that is more accurate than a pencil line. This rosewood and brass marking gauge (\$45.50) has a single spur and an adjustable double spur for scribing two lines simultaneously. It can mark up to 5% in. from a board's edge. The gauge features a unique guide for marking curved workpieces accurately. Available from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

19. Combination square—This smaller version of a standard 12-in. combination square is a valuable shop tool. The steel head is equipped with a 6-in.-long steel rule for marking 90° and 45° angles. The rule is graduated in 8ths, 16ths and 32nds. The head has a spirit level vial and a removable scriber. It costs \$11.90 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

20. Trammel points-To scribe a large diameter circle, arc or to transfer measurements that are too great for dividers, use trammel points. Each diecast metal head has a 3-in.-long leg that is equipped with a replaceable point. Slide the heads on a 3/8 × 3/4-in.-wide wood beam of virtually any length. One of the heads has a fine-adjustment mechanism for precise point placement. The trammel points (\$23.95) come with a pencil holder that replaces one leg and a dozen extra points. For more information, contact Constantine's, 2050 Eastchester Rd., Bronx, NY 10461.

21. Measurement computer-Measure distances from 1 to 50 ft. instantly with the DMC-100 handheld computer. Simply push a button and the unit sends out inaudible sound waves that bounce off the facing wall and return as echoes. The unit receives the echoes, calculates the distance and displays it in feet and inches, yards or meters. Use

the DMC-100 to calculate volume and area and to perform various arithmetic functions. It will even read ambient temperature in Fahrenheit or Celsius degrees. The 11/4 × 31/4 × 6-in. unit weighs 71/2 ounces and comes with a 6volt battery. It's available for \$250 from Exact Technologies, Box 620, New York, NY 10028.

22. Electronic caliper—For superprecise measurements, try this Swissmade digital caliper. Made of hardened stainless steel, the tool utilizes a microprocessor chip to display English and metric measurements up to 6 in. Use it to make accurate inside and outside measurements to 1/1000 in. The caliper comes with two 1.5-volt batteries and a molded plastic case. It costs \$169.50 from Garrett Wade, 161 Avenue of the Americas, New York, NY 10013.

23. Tape rule with angle gauge-Use this versatile tool as a tape measure, level, plumb and angle finder. The A-200 multifunction tape rule (\$16.45) combines a 1/2-in. × 10-ft. steel tape graduated in inches and millimeters with an adjustable angle gauge. Rotate the double-graduated scale to read and transfer angles from 0 to 120°. The high-impact plastic case has a tape lock switch and a belt clip. It's available from Horizon Marketing, Box 758, Niles, MI 49120.

24. Digital measuring devices— Biesemeyer introduces the Blade Finders-instant digital readout measuring devices for a table saw. The Blade Height model measures blade elevation up to 3 in. and to within $\frac{1}{100}$ in. The Blade Angle device reads the angle of the saw blade from 0 to 65° and to within $\frac{1}{10}$ of a degree. Each $2 \times 3\frac{1}{2} \times 5$ in. model operates on a standard 9-volt battery. Follow the step-by-step instructions booklet and install one or both devices on your saw. Blade Finders can also be installed on a radial-arm saw, planer, drill press and jointer. The units cost about \$120 each. For further details and information, call toll-free 1-800-782-1831 or write to Biesemeyer, 216 South Alma School Rd., Suite 3, Mesa, AR 85202.

Although based on modern design concepts, all of these shop projects are clean-lined classics that will be at home in rooms of contemporary or traditional styling. Each item was designed to serve its function efficiently and be pleasing to the eye.

There is a project for nearly every room in the house. For the living room or family room, select from two handsome tables and a plant stand. A clothes hamper and a magazine rack are offered for the bathroom. And, if you keep an exercise bike in your bedroom or workout room, you'll be interested in the

book rack that attaches to the bike. Finally, the small mustard pot lamp can be useful in any room.

You can build most of the projects in very little time. Make the exercise bike book rack, mustard pot lamp, plant stand, magazine rack and clothes hamper in a weekend, with time to spare. The tile-top and herringbone-top tables will take longer, but can be completed in a couple of weekends.

These prototypes were made of oak and pine. However, the classic designs should be compatible with any wood species.

Tile-Top Coffee Table

leek and sumptuous, this coffee table can fit well in the living room or family room.

Ours was built of oak, but you can use any hardwood.

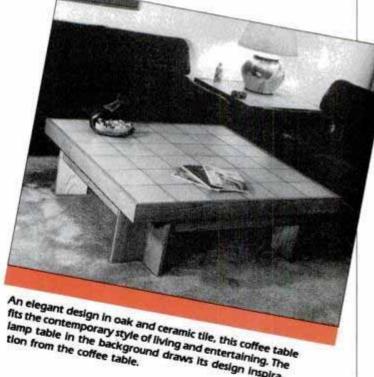
While the dimensions in our plans are based on nominal 8 × 8-in. tiles, it will be best if you first make a dry layout with your own tiles to establish the actual size. The lengths for the aprons (A), stretchers (B) and cleats (E) should be derived from the dimensions of the underlayment. Since the top is designed to be detachable to make moving the table more convenient, stretchers should be cut to allow 1/2-in. play in the fit.

After establishing the size of the top underlayment, cut it to size from %-in. plywood. Using a mastic recommended by the tile manufacturer, glue the tiles to the plywood. Allow the mastic to dry for 24 hours.

In the meantime, cut and assemble the apron boards, legs and other components of the base. Once the apron members (A) have been cut, glue and clamp them together, then check the assembly for squareness. Also, glue and clamp the cleats (E) to the inside of the apron.

It's easiest to cut the miters and spline grooves for the leg pieces (C) on a table saw. First, cut the edge miters with the arbor tilted to 45°. Then, maintaining the 45° arbor tilt, adjust the blade depth, reposition the fence and run the mitered stock past it with the angle facing in the opposite direction. Once the joints and splines (J) have been cut for the leg pieces, glue and clamp the mating pairs.

After cutting the triangular corner brace blocks (F), bore pilot holes for the No.



lamp table in the background draws its design inspira-

10 wood screws. It is critical to bore the holes off the horizontal center of the blocks so that the screw shanks can pass one another.

Glue the top into the apron and let the glue set. Cover the top edges of the apron with masking tape and grout the tiles. Once the grout is dry, position the tabletop on the base and mark the locations for the positioner blocks (D). Glue the blocks in place.

Finally, fine-sand all the wood surfaces and finish as desired. The table pictured here was treated with tung oil and satin finish wax.

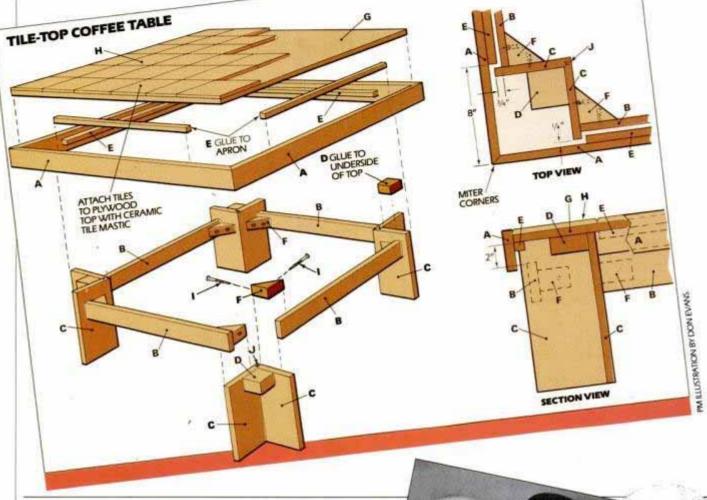
> -Leonard Heiferling

G

MATERIALS LIST-TILE-TOP TABLE

- Size & description (use) 1/4 × 31/2 × 49" hardwood
- (apron) $\frac{1}{4} \times 3\frac{1}{2} \times 32^{\circ}$ hardwood (stretcher)
- $\frac{1}{4} \times 7\frac{1}{2} \times 14$ " hardwood (leg member)
- 1½ × 3 × 3" hardwood (positioner block) D
- × 1 × 311/f hardwood (cleat)
- 11/2 × 3 × 3 × 41/4" hardwood (corner brace block)
- 1/4 × 48 × 48" plywood (top underlayment)
- 8 × 8" ceramic tile (top) 1½" No. 10 fh wood screws ½ × ½ × 7½ hardwood 16
- (spline)

Misc.: Carpenter's glue, ceramic tile mastic, grout, tung oil or other finish, satin finish wax, mediumand fine-grit sandpaper.



Mustard Pot Lamp

ecause of its classic shape and appealing glaze, a French Pom-

mustard pot can easily be converted into an attractive lamp base once the condiment has been consumed. All you need is a few basic wiring supplies and a couple hours of free time.

After soaking off the labels, use a variable-speed drill fitted with a 3/16-in. masonry bit to make a small hole near the base of the jar. Drill at low speed and bear down hard, but be sure that you release pressure just as the bit tip emerges through the inner wall to prevent breakage.

Working with a length of lamp cord, cut into one of the leads about 10 in. away from the stripped end and splice in a switch. Then feed the stripped end of the cord



into the drilled hole and up through the mouth. Connect the wires to the socket terminals, then screw in the

bulb and pull back gently on the cord to seat it in the mouth of the jar.

-Leonard Heiferling

Hinged-Top Table

arquetry—
the art of
creating
patterned
surfaces
with
wood
strips—is
a venera-

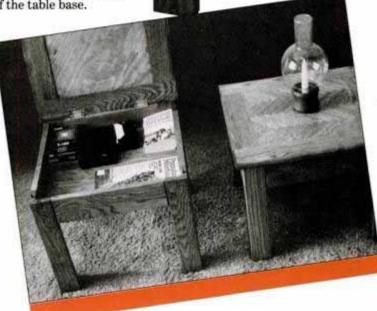
ble craft that many weekend woodworkers think is beyond their skills. However, the procedure is not really that difficult, and with some basic tools and the proper adhesives, all that's needed to reproduce the simpler patterns is a bit of patience.

The herringbone patterned tables pictured here can provide just the occasion to try your hand at parquetry. Fashioned from oak, these small tables are both handsome and functional. They can be used in tandem to serve as a coffee table or separately as occasional tables. Their tops are hinged and the design incorporates built-in storage compartments concealed by the tables' aprons-handy for books, games or cocktail accessories.

Start by cutting solid oak to size for the leg members (A and B) and the apron (C). Where the edges and ends of these members must be eased to create softer corners and the slightly open joint detail, shape the pieces with a router fitted with a ¼-in.-rad. rounding-over bit. To cut dadoes and grooves in the leg and apron members, you must use a router equipped with a guide and ¼-in.-dia. straight cutter.

Next, bore %-in.-dia. × %-in.-deep holes in the leg members and apron ends for the dowels that will be used to join them. For the necessary precision and control, it is best to use a drill press or a doweling jig with a portable drill. It is important to bore the dowel holes \(^1/_{16}\) in. offcenter toward the unrounded edges of the stock to ensure the strongest possible joints.

Give all the components for the base a final sanding. Begin assembling the base by gluing together the leg members. Once the legs are made up, join each pair to an apron piece to make up opposite ends of the table base.



Beautiful herringbone top on this occasional table opens to give access to a storage compartment built within the apron.

Next, cut the compartment bottom (H) from a sheet of ¼-in. oak plywood. Glue, dowel and join the two remaining apron members to one of the base end assemblies. Then slip the compartment bottom into position. To complete the base, glue, dowel and join the remaining base end to the assembly and clamp until the glue sets. Be sure the base is square after tightening the clamps.

Cut a 15-×-15-in. square of ½-in. oak plywood to

serve as the underlayment (G) for the pattern pieces. Next, rip 70 1/4-in.-thick strips from \(\frac{1}{4} \times 5 - in. \) blocks of solid oak to serve as the pattern pieces (F). Draw a centerline on the top underlayment and trim lines 3/4 in. inside each edge. Apply two thin coats of contact cement to the underlayment and to the backs of the pattern pieces. Using a carpenter's square as an aid, begin laying strips in the position and order indicated in the drawing. Once the pattern has

been established, laminate the remaining strips to the underlayment and apply pressure to the entire surface with a hard rubber roller or a softwood block and mallet to ensure adhesion. Smooth and flatten the patterned surface with a belt sander fitted with a 50-grit abrasive belt. Then, trim the patterned inset to its finished size, which is $13\frac{1}{2} \times 13\frac{1}{2}$ in.

Cut the top border pieces (D and E) and bore holes for the dowels that will be used

to join them. Glue and join the shorter border pieces to the patterned inset first, then join the longer border pieces to them. Clamp the assembled top until dry. Sand the top with a belt sander, using first an 80-grit then a 120-grit belt. Roundover the tabletop edges with a ½-in.-rad. router bit, and then finish with an orbital sander fitted with 150-grit abrasive.

MATERIALS LIST— HINGED-TOP TABLE

Key No. Size & description (use)
A 4 ¼4 × 2 × 15" oak (leg)
B 4 ¼4 × 2½4 × 15" oak (leg)
C 4 ¼4 × 3½ × 13½" oak (apron)
D 2 ¼4 × 3¼ × 13½" oak

(border) E 2 34 × 334 × 20" oak (border)

G 1 ½×15×15 oak plywoo (underlayment) H 1 ¼×17½×17½″ oak

plywood (bottom)

1 2 1½ × 2" cabinet hinges
with screws

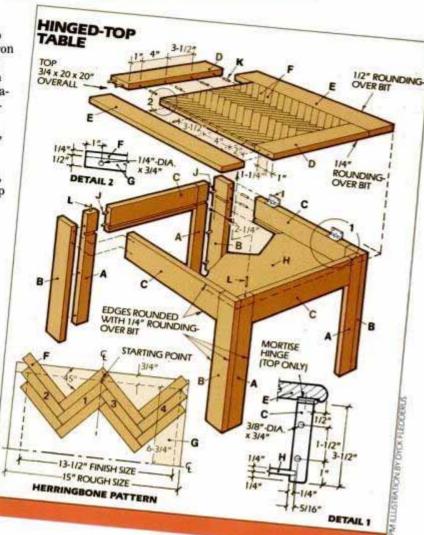
J 28 %"-dia. × 1½" hardwood dowels K 24 ¼"-dia. × 1½" hardwood

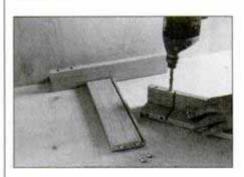
dowels
L 2 %"-dia. × 1" hardwood dowels

Misc.: Carpenter's glue, contact cement, 80-, 150-, 220- and 600-grit sandpaper sheets, 50-, 80-, 120-grit sanding belts, Watco Medium Danish Oil finish.

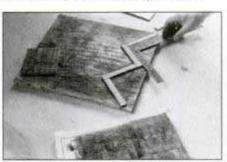
Attach hinges (I) to the top edge of an apron piece, then invert the base, positioning it on the underside of the tabletop. Mark the locations of the hinges on the tabletop and then, using a router with a straight cutter and a chisel to square them, cut mortises in the top to accommodate the hinge. Fasten the hinges to the top with 1/2-in. screws of the appropriate shank diameter.

To finish the tables, apply two coats of Watco Medium Walnut Danish Oil. For added luster, wait 24 hours, then wet-sand with 600-grit abrasive using a few drops of the oil finish as a lubricant. After sanding, wipe the surface dry and polish with a soft, lint-free cloth. -William Bennett

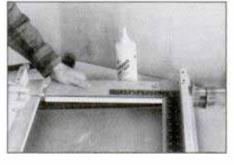




After the leg pieces have been dadoed and the aprons grooved, bore holes for the dowels that will be used to join them.



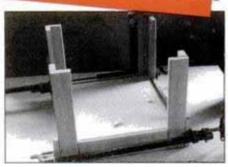
Begin patterned top by gluing full strips to underlayment using square as guide. Then glue remaining strips in place.



Once the two pieces used to make up each leg have been joined, glue each pair to an apron to create end assemblies.



After all strips have been laminated to the underlayment, surface with a belt sander. Then trim the panel to its finished size.



Carefully fit the compartment bottom in place, then join the end assemblies to remaining aprons. Glue and clamp until dry.



Lay out position of holes for the dowels that will be used to join the patterned inset to the top border pieces.

Laundry Hamper

lean and compact, exuding the warmth of pine, this hamper can serve

its utilitarian purpose handsomely anywhere in your home. Cut all wood members and sand them before beginning construction, then assemble. Begin with the frames for the lid (parts E, F and J), the top structural support (G, H and K) and the bottom (G, I and L). Join members of the lid frame with glue and screws. For the top and bottom frames, screws may be driven through the faces of the frame members and into the blocks. Prebore pilot

holes in the corner blocks of the top and bottom frames for lagscrews used to join them to the legs (D).

Nail lattice strips (C) to the bottom frame and then join the top and bottom frames to the legs. Set and fill all nailheads. Finally, fasten the glides (N), hinge (M) and leather pull tab (O).—Leonard Heiferling

MATERIALS LIST-CLOTHES HAMPER

- Size & description (use) $\frac{1}{12} \times \frac{1}{12} \times \frac{1}{12} \times \frac{1}{12} = \frac{1}{12} \times \frac{1}{1$ sides, back)
- ½ × 1½ × 25½" pine (lid) ¼ × 1½ × 25½" pine
- (bottom)

 1 × 1 × 29" pine (legs)

 1 × 1 × 26½" pine
 (front/back, lid frame)

 ½ × 1½ × 12½" pine (ends,
- lid frame) ¾ × 1½ × 24¼" pine (front/back, top and bottom
- frames) H 1/4 × 11/2 × 121/4" pine (ends, top frame)



1½ × 2 × 2" pine (top frame corner blocks) L

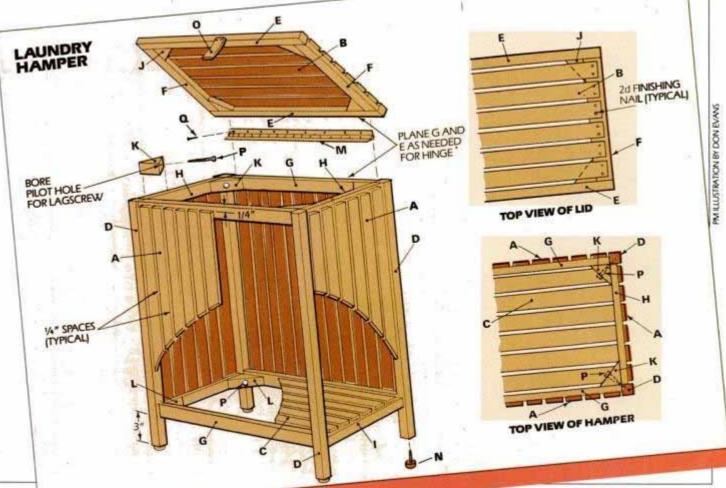
1½ × 2 × 2" pine (bottom frame corner blocks) 1½" × 24" brass-plated

continuous hinge ½"-dia, plastic glides 1¼ × 3" leather pull tab; 2 brass upholstery tacks

1/4 × 21/4" lagscrews (leg

fasteners) %" No. 10 flathead screws 18

(hinge fasteners)
Misc.: 2d finishing nails, carpenter's glue, wood filler, oil stain.



Exercise Bike Book Rack

rack that

iding a stationary bike is one of the best forms of exercise, and a book

mounts on the handlebars of an exercise bike can help make stationary pedaling more enjoyable. Our rack is built from Clear All Heart redwood, chosen for its workability and good looks.

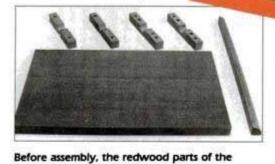
Cut pieces for the book rest, stop and two ¾ × 2 × 5½-in. strips from which you'll make up the handlebar clamps. Join the stop to the bookrest with glue and screws.

Bore holes through the edges of the clamp strips for bolts and counterbore recesses at both ends of each hole. Also bore a %-in. centered hole through the face of each strip. Then, rip each strip lengthwise into two equal parts. Bore and counterbore holes in the top member of each clamp for

Bore holes for the clamp bolts and screws with a portable drill guide.

screws to secure them to the bottom of the book rest. Sand all parts, then decide on the best clamp placement based on your handlebar design. Fasten the top member of each clamp to the book rest with glue and screws. Before mounting the rack, apply a clear finish of choice to the wood.

-Doug Loth



book rack include top and bottom clamp

For a sound body and mind, build and mount book rack to stationary bike's handlebars.

members, book rest and quarter-round stop. BOOK REST EXERCISE BIKE BOOK RACK 3/4 × 10 × LOCATION OF CLAMPS TO SUIT BIKE HANDLEBARS BOOK STOP 3/4 x 15" QUARTER-ROUND MOLDING 1" NO. 6 FH SCREW 13 REOD. 1/4"-DIA X 2" HEXHEAD BOLT, WASHER AND WINGNUT CLAMP 3/4 x 2 x 5-1/2" (2 REOD.) COUNTERBORE FROM BOTTOM FOR 1-1/4 NO. 7 FH SCREW 4 REOD +718 PM ILLISTRATION BY DYCK PLEDDERUS OUNTERBORE NOTE: RIP CLAMP INTO TWO EQUAL PARTS AFTER BORING CENTER AND BOLT HOLES FOR BOLT HEAD 1-13/16 CLAMP DETAIL

Bathroom **Magazine Rack**

his simple wall caddy for the bathroom or powder room is designed to hold magazines and has a dis-

penser compartment tailored to the dimensions of a 175count box of facial tissues. Building the rack is a simple weekend project that doesn't require much material. In fact, you may have all that's needed right in your scrap pile.

Begin construction by cutting the sides (B) and bottom (C). Cut %-in.-deep × %-in.wide dadoes near the bottom of both side pieces. Use a coping saw or portable saber saw to shape the side piece ends. Join the bottom to the sides with glue and drive 10d finishing nails through each side and into the ends of the bottom.

Cut the shelf (D) and supports (E) from hardboard. Position the supports and secure them to the sides with 3/4-in. brads. Bore a 3/4-in.dia, hole centered on the shelf to serve as a convenient finger pull when it's time to refill the tissue dispenser. The shelf simply rests on top of the supports.

Cut the lattice strips (A) for the front and cut the edges of the two pieces to form an oval cutout for dis-

MATERIALS LIST-BATH RACK

Size & description (use) $\frac{1}{4} \times 1^{11}/_{16} \times 11 \frac{1}{4}$ pine (lattice)

34 × 256 × 211/2" clear pine R 2 (sides)

34 × 25/s × 105/2" clear pine (bottom) D $14 \times 25 \times 95$ hardboard

E 9 $\frac{1}{4} \times 2\frac{1}{4} \times 5$ " hardboard

(supports) 1½ No. 12 wood screws G 4 %'-dia. tapered wood plugs Misc.: 10d finishing nails, carpenter's glue, ¾-in. brads, 2d finishing nails, wood filler, 4 wall anchors (see text), polyurethane satin finish. pensing tissues. To achieve an even nailing pattern when the lattice is fastened to the sides, lay out and punch the nail positions of each strip with an awl. Make sure the rack remains square as you attach the lattice, then set and fill all nail heads.

Bore and counterbore holes through the edges of each side piece, top and bottom for the fasteners that will be used to mount the rack on the wall. For installation on drywall, plan to use hollow-wall fasteners. For plaster walls, 11/2-in. No. 12 screws and plastic anchors will be best. After boring the mounting holes, finish-sand the piece,

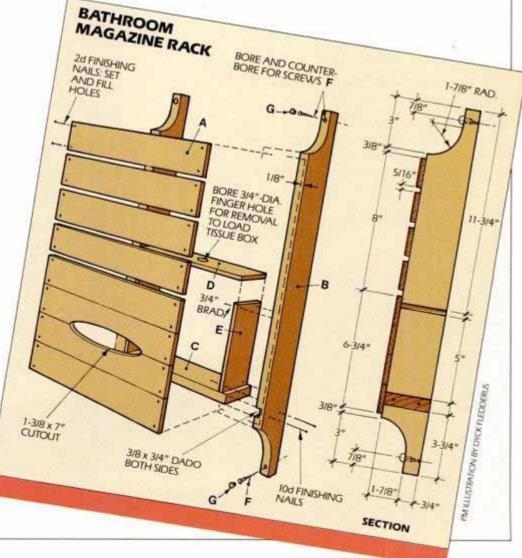
then wipe with a tack cloth. Finish the wood with clear satin polyurethane varnish.

Hold the finished rack in place on the wall and use a sharp pencil to mark the locations for the fasteners. Use a drill fitted with a carbidetipped masonry bit to make holes in the wall for the fasteners or anchors. After the rack has been attached to the wall, conceal the fastener heads by forcefitting stained wood plugs in the counterbored recesses.

-Leonard Heiferling



rack/tissue dispenser is designed to be mounted on a bathroom wall.



Plant Stand

his plant stand uses its structural members-the rails. stretchers and legsto cradle a plant con-

tainer. Because there is no solid top or shelf, the look is light, open and airy-a complement to the natural grace of plants themselves.

The plans presented here are for a stand designed to hold a 12-in.-dia. plant container. To adapt the design for containers of other sizes, you'll get the most stable results if you follow a simple formula to calculate the correct length for the rails and stretchers. To calculate the dimension, first measure the plant container's diameter, then compute the square root of half the square of the diameter (length=√(dia. × dia.) ÷2). Round the result up to the nearest quarterinch to find the length of the rails and stiles. For example, for a 13-in.-dia. pot, find the square of the diameter $(13 \times 13 = 169)$, divide it in half $(169 \div 2 = 84.5)$, then find the square root $(\sqrt{84.5} = 9.192)$. Rounding the result up to the nearest quarter-inch sets the length of stretchers and rails at 91/4 in. Legs can be any length, but for stands taller than 30 in. or so, use 1-in. rather than 34-in. stock to maintain proportion and balance.

Before cutting parts to size, sand your stock first with 80- then with 120-grit abrasive. Ease the edges, then cut lengths for the various members.

You can use a dowel center and a doweling jig to spot locations and bore holes for dowels used to join the parts. First lay out and bore holes in the legs for the dowels that join the legs to the stretchers. Then use a dowel center to mark the positions for holes in the mating rails. Join the legs and rails with glue and clamp the work until the glue sets. Allow the glue that squeezes out of the joints to harden a bit, then remove the excess with a sharp chisel. After the leg-to-stretcher joints have dried, bore holes for the dowels that join the rails to the stretchers. Repeat the same clamping and cleaning procedures.

When the stand is completely assembled, sand all parts with 220-grit abrasive. Stain and finish with a clear satin polyurethane varnish.-Leonard Heiferling

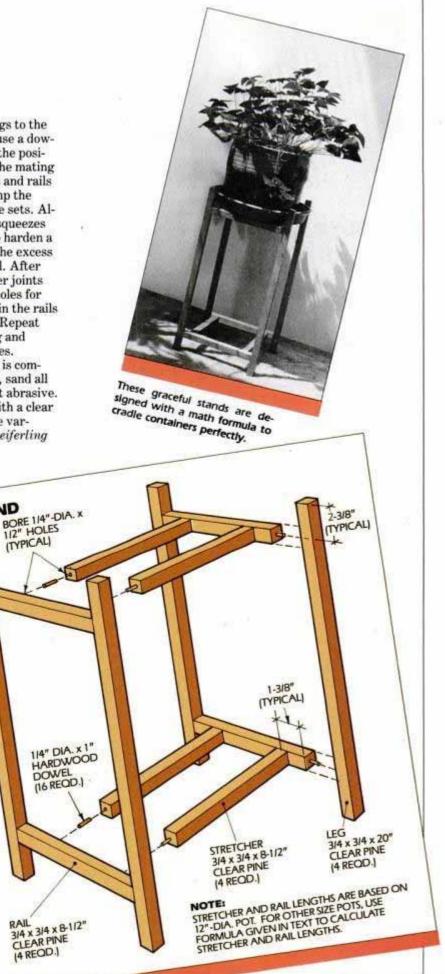
PLANT STAND

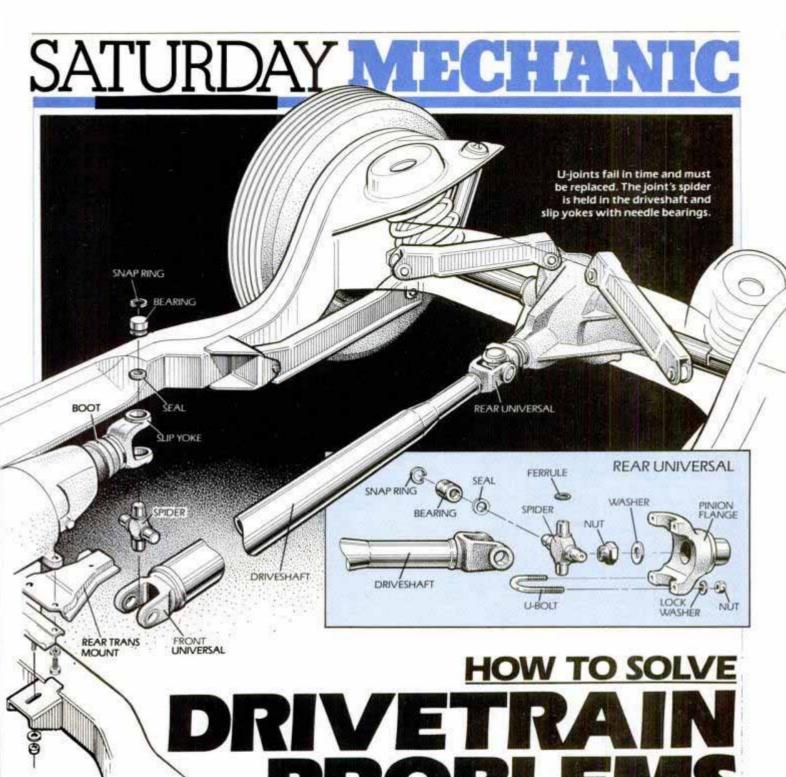
PAN ILLUSTRATION BY DYCK HEDDERUS

(TYPICAL)

CLEAR PINE

14 REOD.





BY PAUL STENQUIST

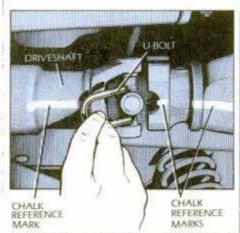
o things go bump in the night when you're traveling on a smooth highway? Does something bang against the floorboards when you tromp on the accelerator? Does slimy goo ooze out from under the rear of your car when it's parked? Do you hear a loud clunk every time you move your foot on and off the throttle?

Ignoring the strange things that happen under your car won't make them go away. In the following sections we'll explain the symptoms and cures for three common drivetrain problems: worn universal joints, broken transmission and engine mounts, and leaking pinion seals.

All of these jobs involve raising either the front or rear of the car for access. When doing so use a hydraulic floor jack, properly positioned under recommended jacking points. On most rear-drive cars these would be the center of the differential and the center of

the front crossmember. Most frontdrive cars have floor-jack support pads mounted front and rear center. If you're not sure where to jack your car, consult the manufacturer's service manual. Before lifting either the front or rear of the car, position large chocks—concrete blocks or railroad ties—behind the opposite wheels.

Once the car has been lifted, locate jackstands in the recommended positions under the frame, rear-end housing or chassis structural members.



 Mark differential, flange, driveshaft for reassembly before removing U-bolts.

Then lower the car onto the stands. If you prefer, you can support the car with ramps. Use only ramps designed for this purpose. Shake the car aggressively to make sure it's secure before sliding underneath.

Universal joint R&R

A seriously worn universal joint on a rear-drive car might clunk and bang as you drive, or it might cause vibration. But the most common symptom of U-joint wear is a distinct clunk that is heard if you press and release the accelerator at about 30 mph. To confirm a bad joint, grasp the driveshaft and attempt to move it both sideways and up and down. Watch the shaft and joint for any sign of looseness. If something moves, the joint is worn.

To repair a bad joint on a car with a single-cross joint on each end of a 1-piece driveshaft, lift the rear of the car and place a drain pan under the transmission's rear seal. Then mark the differential housing and the driveshaft so that the shaft can be reinstalled in the same position (see Fig. 1). Use a box wrench and remove the two U-bolts, four nuts or four bolts that secure the shaft to the rear end's pinion flange.

On some cars, the nuts are locked in place with metal tabs that have to be pryed away from each nut before a wrench can be placed over them. Shift the transmission to NEUTRAL and rotate the shaft to reach all of the bolts or nuts. On cars with U-bolts, pull the bolts from the pinion flange once the nuts have been removed.

Once the U-joint has been disengaged from the pinion flange, pry it away from the flange with a screwdriver or pry bar.

Once the rear joint is clear of the rear end, pull the driveshaft to the rear until the slip yoke disengages from the transmission's output shaft.

Removing the front joint

To remove the front joint, clamp the slip yoke in a vise and support the other end of the driveshaft. (Don't clamp the driveshaft tubing in a vise! You could distort it and throw the shaft out of balance.) Remove the lock rings next to the bearing caps that hold the U-joint spider, or cross, in the yoke and driveshaft ears. These could be located either on the outside or inside of the bearing caps.

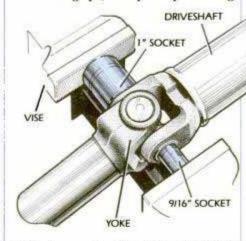
Leave plastic retainers in place; they will break when you press the bearing caps out of the shaft and yoke.

Remove the driveshaft from the vise, and choose two sockets to press the bearing caps out of the joint. You'll need one socket that's big enough for a cap to slide into—1-in. for most cars—and another socket that can slide into the shaft's bearing cup hole—a \$\frac{9}{16}\$-in. socket will usually do.

Clamp the shaft and two sockets in the vise as illustrated (Fig. 2), taking care that the large socket is positioned around one bearing cap and the small socket is located in the center of the other cap. Tighten the vise. This will press the bearing cap socket out of the driveshaft and into the 1-in. socket. If the cap cannot be pressed all the way out of the shaft, grasp the protruding cap with vise grips and pull it out.

Turn the shaft over in the vise. Using a drift that has a smaller diameter than the spider, drive the spider and the remaining bearing down through the flange until it protrudes. Use vise grips to pull it out.

If you have trouble pulling either cap with vise grips, clamp the protruding

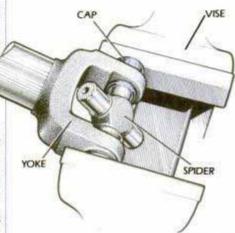


2 Use large and small sockets and a vise to press bearing caps out of the driveshaft.

away from the cap with a soft-faced brass hammer.

Inspect the old U-joint. If it was the cause of your problem, one or more of the caps is probably loose or galling on the cross due to failure of the needle bearings within.

The rear joint is removed in the same way except that, on most cars, the U-joint spider is bolted directly to the pinion flange. If this is the case, all you have to do is press the joint out of the driveshaft. On Fords, you must remove the driveshaft companion flange—the part that bolts to the pinion flange. This is virtually the same as disassembling the front U-joint.



3 Press caps back onto new spider. Be careful not to disturb the needle bearings.

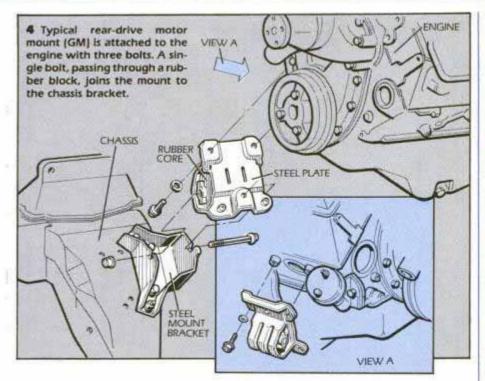
Installing the new joint

Clean any debris from the yoke and driveshaft ears. Then carefully remove the bearing caps from the new U-joint. If you knock over the needle bearings inside the caps, you won't be able to install the new joint.

Place the new spider inside the yoke. Push it all the way to one side and start one cap into the yoke's ear, placing it over the spider's trunnion. Carefully place the assembly in a vise. Drive the cap partway through the ear (Fig. 3).

Remove the yoke from the vise, push the spider so it protrudes from the other side of the yoke, and install a bearing cap over the protruding trunnion. Clamp the yoke in the vise and tighten the jaws so that the caps are pressed into the yoke. As you tighten, turn the spider to make sure the trunnions move freely in the bearings. If you encounter any resistance, stop pressing and check the needle rollers to make sure they haven't been tipped

SATURDAY MECHANIC



under the end of the trunnion.

Install the lock rings that came with your new U-joint. If the caps are not pressed in far enough to allow insertion of the retainers, place a \$\frac{9}{16}\$-in. socket on each cap and press some more. As soon as one bearing retainer groove clears the inside of the yoke or appears above the bearing cap (depending on the type of retainers used), install it and continue to press, using one socket, until the opposite retainer can be snapped into place.

With both caps installed in the yoke, insert the trunnions into the driveshaft ears and repeat the procedure.

Replacing broken engine or transmission mounts

Broken engine mounts can make themselves known in a number of ways. In some cases, the throttle might open or close when the engine twists under load. Occasionally, the engine movement can cause a short circuit, resulting in a stall. If your car is equipped with a floor shift, the shift lever may move excessively when you accelerate.

Damage to engine mounts occurs in the rubber core. This cushion is sandwiched between the steel parts of the mount that connect to the chassis and engine (see Fig. 4). To determine if a mount is damaged, raise the engine with a floor jack and block of wood placed under the oil pan or transaxle while observing the mounts. The mounts are shot if: (1) The rubber surface is covered with heat check cracks; (2) The rubber has separated from the metal; (3) The rubber has split.

To replace a bad mount, disconnect the battery's negative cable. Then remove the mount-to-engine block bolts. Raise the engine and remove the mount-to-mount bracket bolt and nut. Install the new mount on the engine block, then lower the engine and install the chassis mount bolt or bolts.

On some front-drive cars, you may have to remove an inner fender shield to gain access to the engine mount. On GM J-Cars with manual trans, you'll have to remove the oil filter to reach the rear-engine mount bolts and nuts.

On front-drive Chryslers, the right engine mount position must be adjusted to provide correct positioning of the driveshafts when the mount is replaced. See a dealer or service manual for this lengthy procedure.

Most rear-drive cars have a third mount located at the rear of the transmission's tailshaft. If this mount breaks, the trans tailshaft may bang against the floorboards when you accelerate. Locate the floor jack and block of wood under the rear of the trans oil pan to check and replace this mount.

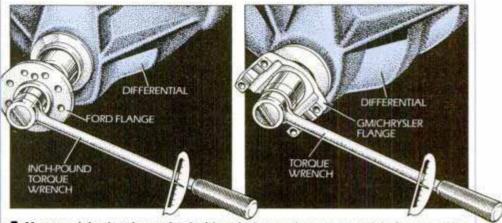
Pinion seal service

The pinion seal of a rear-drive car surrounds the pinion shaft. If the seal leaks, gear lube will drip from the front of the differential.

This is a good job for the do-ityourself mechanic. A lot of professional
mechanics prefer not to get involved,
because there's a chance that replacing
the seal could leave you with a howling
ring and pinion if proper pinion location
can't be maintained. If that happens,
the differential must be disassembled
and adjusted—a job few general mechanics are prepared to perform. If you
realize going in that there's a chance
you won't end up with a perfect job and
might have to take the car to a gear
shop, you've got nothing to lose by
trying to replace the leaking seal.

To replace a pinion seal, support the car so that the rear wheels are off the ground, then mark the driveshaft, the pinion flange and the end of the pinion stem (the splined shaft to which the pinion flange is attached), so the flange and driveshaft can be reinstalled in the same position. Place a drain pan under the transmission slip yoke seal and disconnect the driveshaft from the rear-axle pinion flange. Then tie the driveshaft to the exhaust pipe or chassis. Wrap some tape around the U-joint spider so the bearing caps won't fall off.

Before you remove the pinion flange nut, you have to determine how much the pinion bearing is preloaded, so you



5 Measure pinion bearing preload with an inch-pound torque wrench before removing the pinion nut. Remove the rear brake drums or calipers first to eliminate any drag.

SATURDAY MECHANIC

can reassemble the unit correctly. To do this, remove the wheels and brake drums and turn the pinion shaft nut with an inch-pound torque wrench (Fig. 5). Note how much force is required through several complete rotations and write down the number for reference.

On GM cars, mark the position of the pinion nut, relative to the pinion shaft and flange. If the pinion flange isn't damaged, you won't have to measure preload for reassembly. However, you must measure it prior to disassembly, so that you'll be able to replace the pinion flange if you have to. Serious pinion flange wear is common on cars with leaking pinion seals. Ford and Chrysler recommend that you check preload with the torque wrench upon reassembly, even if you reuse the old pinion flange.

Before you can remove the pinion flange nut, you have to grasp the pinion flange so it won't turn. To hold the square pinion flange found on Chryslers, GM cars and most others, use a large pipe wrench. On Fords, just screw a couple of bolts into the companion flange and wedge a pry bar between them. The home mechanic with a big bankroll might want to purchase one of the special pinion flange holder tools that are available from the various carmakers. For GM cars, you need part number J-8614-1, for Chryslers C-3281, for Fords T78P-4851-A.

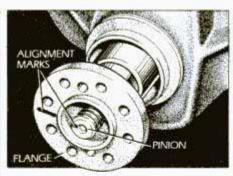
After removing the nut, clean the area around the pinion flange and seal and place a drain pan under the flange.

Removing the pinion flange is next, but make sure it's marked in relation to the pinion shaft before you yank it off (Fig. 6). You'll need a 2-jaw gear puller for most cars. On Fords with the big round companion flange, you can use a 3-jaw puller. Again, special tools are available that make the job easier. For GM, the tool is J8614-3 (used in conjunction with the above-mentioned J-

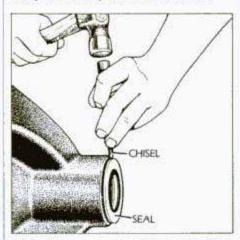
8614-1), for Chrysler it's C-452, for Ford it's T65L-4851-B.

Once the pinion flange has been removed, check it for a seal groove, nicks or other marks. If its seal surface is damaged, it must be replaced or the new seal will leak.

Remove the seal from the carrier using a small pry bar or a blunt chisel (Fig. 7). Do not damage the carrier. Examine the carrier bore and remove any burrs that might cause leaks around the seal.



6 Mark position of pinion shaft, flange and (on GM cars) nut before removal.



7 Carefully remove the pinion seal with a blunt chisel or with a small pry bar.

Installing the new seal

Install the new seal using a driver that fits exactly around the outer edge of the seal. In most cases, a smooth piece of pipe backed by a piece of wood, an old disc brake piston (positioned upside down), or something similar can be used. If you wedge the seal or distort it, buy a new one and try again.

Special tools are available for installing seals as well. Fig. 8 shows how a special pinion seal tool is used to drive the seal into place. For GM cars with 8½-in. or 8¾-in. ring gear, it's J-22388. For GM cars with 7½-in. ring gear, it's

J-23911. For Fords, the seal installation tool is part number T83T-4676-A. For Chryslers with 71/4-in. ring gear, it's C-4004 or C-3719.

For Chryslers with 8¼-in. ring gear, it's C-4076. You can spend a fortune buying special tools for pinion-seal replacement, but most independent mechanics do the job without them.

With the new seal installed, apply a small amount of rear-end lube to the pinion-flange seal area and splines. Note the alignment marks on the pinion shaft and flange, and install the flange in its previous position.

Install a new nut on the pinion shaft—it's important that you don't attempt to reuse the old one—and tighten it while holding the pinion flange. If you're working on a GM car and you didn't replace the pinion flange, tighten the nut to the position that you marked previously, rotating the pinion occasionally. Then tighten it ½ in. beyond the alignment mark.

On GM cars where you've replaced the pinion flange, or on Ford and Chrysler cars, rotate the pinion occasionally as you tighten the nut, and take frequent pinion-bearing preload readings by turning the pinion nut and shaft with your inch-pound torque wrench.

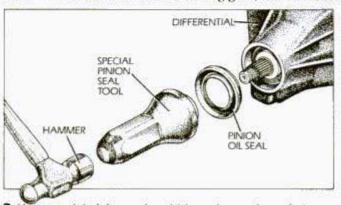
If the torque readings aren't uniform during a complete revolution, something is binding and the condition has to be corrected. You should continue tightening the nut and taking readings until the original recorded preload reading is obtained.

On GM cars the preload should be 3 to 5 in.-lb. more than your initial reading. On Chryslers, the pinion nut must be tightened to at least 210 ft.-lb. and preload should be no more than 10 in.-lb. over the previous figure.

On Fords, tighten the pinion nut until preload reaches the specification for your car or the figure you measured, whichever is greater.

Warning: You cannot back off the pinion nut to reduce preload. If the desired preload is exceeded, the center section must be removed from the car and disassembled. A new collapsible spacer must be installed on the pinion shaft. This is a job for a specialist.

Once the seal installation job is complete, reinstall the driveshaft. Then top off the differential lubricant level and, if necessary, the transmission fluid level as well.



8 Use a special pinion seal tool (shown) or a piece of pipe to install oil seal. Diameter of tool must match that of the seal.



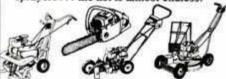
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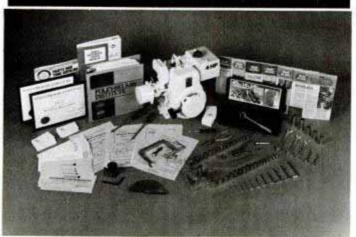
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FANCY FOOTWORK

(Continued from page 73)

width and breadth of the weave. The coil is encapsulated within polyure-thane and surrounded by a firm stability rim. The dynacoil is an excellent shock absorber in both the rear and forefoot areas and maintains its cushioning effect through repeated impacts. The lattice structure of the coil also provides rearfoot control.

As mentioned, the inverse functions of cushioning and stability are difficult to reconcile. The shoes just mentioned attempt in different ways to compromise these functions, although there are other brands that are just as technically innovative.

Basketball/tennis shoes

Shoes intended for racquet sports are included in this category because many of the movements found on the basket-ball court can be found on the tennis court—jumping, pivoting, cutting, running forward, backward and laterally, and so on. Each of these activities places different stresses on the foot. If the shoe is to be effective, it must minimize these stresses without imposing on the other movements.

For example, to minimize the stresses of landing from a jump, the shoe manufacturer may use a very soft midsole material to cushion the foot. However, this obviously would lead to lateral instability in the shoe and cause

(Please turn to page 108)

Every Little Byte Helps

n a world where microchips infest just about every household convenience-from vacuum cleaners to coffeemakers-it's little wonder that the computerized athletic shoe has finally hit the pavement. Designed by Dr. Peter Cavanaugh of the University of Pennsylvania, the Puma RS-Computer Shoe (\$200) is intended to assist the serious runner in keeping tabs on training progress. Along with a state-of-theart pair of athletic shoes, you get software compatible with various Apple or Commodore PCs to help runners establish goal graphs. Its circuit board fits in a special heel housing on the right shoe and includes several computer chips, an inertia sensor that counts footfalls, a battery, and a speaker that beeps when you've run a preset distance. After a run, you plug your shoes into your computer's game port, load the software from the Puma-supplied floppy disk, and learn if the distance you've run matches your goal for the day. Puma says the computer shoe is far more accurate than a simple pedometer because it's calibrated based on your personal running style. With a potential for keeping running records over six years, you wind up with a complete performance analysis. It even lets you know how many calories you've burned, so pass the dessert. Contact Puma, P.O. Box 1369, Framingham, MA 01701.-T.C.



The Puma RS-Computer Shoe feeds distance run into your Apple or Commodore PC. You compare actual performance vs. preset goals to get the most out of your run.









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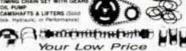


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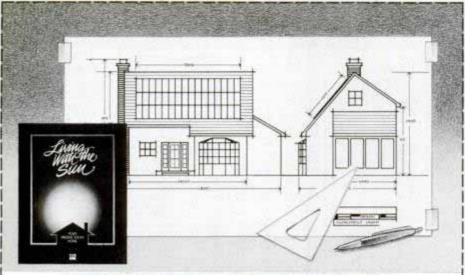
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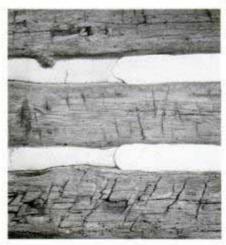
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FANCY FOOTWORK

(Continued from page 105)

severe problems to the player in a number of other movements. Thus, developing, for instance, a good basketball shoe is inherently more difficult than developing a good running shoe. The nature of foot movements during a basketball game must be taken into consideration and evaluated.

Basketball players spend a great deal of time landing from jumps. While rebounding, shooting or simply stopping, this is a primary movement of the game and a significant cause of a large number of injuries. Absorbing shock from jumps should, therefore, be a primary goal for athletic shoe manufacturers.

In a lab test conducted in the Biomechanics Laboratory at Southern Illinois University, landing from a height of 15 in, achieved an average vertical force measuring 3.5 times body weight. In a study carried out by the Biomechanics Laboratory at Pennsylvania State University, vertical forces of 4.1 to 6 times body weight were measured when landing from a rebound. They also identified two types of landings. In one type, the player touched down initially on the forefoot and then onto the rearfoot. In the other, the player landed flat-footed. The data shows that a basketball shoe must absorb a significant amount of shock in both the rearfoot and forefoot areas of the shoe.

Shoe manufacturers have been using various midsole materials and designs from similar research to develop a good shock-absorbing shoe. For example, KangaRoos uses a dynacoil midsole similar to, but thicker than, its dynacoil running shoe. Another shoe manufacturer, Avia, uses a trampoline-type outsole to help absorb heavy loads.

Rapid and forceful lateral movements are also required of basketball players. The possibilities of injuries from twisted ankles, ligament tears or broken ankles come from cutting movements or guarding opposing players. The cause of injuries during these actions is generally due to excessive supination of the foot. In contrast, running injuries generally result from excessive pronation.

Naturally, high-topped or high-cut shoes—with high-tech cushioning and support—have been developed by manufacturers to achieve this all-important lateral control.

Racquet sports shoes have many of the same restrictions and requirements as basketball shoes. Dr. Jack Groppel from the University of Illinois Biomechanics Lab has carried out several studies on tennis shoes. His research has shown that, although tennis players are instructed to stay on the balls of their feet, many of the actions in tennis result in heel impact. Thus, a tennis shoe should have the same shock absorbing qualities in the rearfoot and in the forefoot as a basketball shoe. Additionally, the lateral movements are also quite similar, which suggests that tennis players with ankle problems should consider wearing high-cut, if not high-top, athletic shoes.

Aerobic shoes

Many of the same considerations in racquet sports shoes and basketball shoes affect aerobic shoes. During aerobic exercise routines, the participants jump up and down and from side to side, run in place, hop and perform variations on these basic movements. The aerobic shoe must act like a running shoe and protect like a racquet or basketball shoe. In addition, the shoe must be very light, flexible and comfortable. Again, as with basketball and racquet sports shoes, design doesn't come easy.

The biomechanics research that has been completed on aerobic exercise shoes shows that the vertical forces on the forefoot and rearfoot are quite high during aerobic exercise, rivaling the vertical forces in running. This is not surprising, since some of the movements in aerobic exercise contain running-like footfall patterns. The jumps in

aerobic exercise are on the magnitude of 2 times body weight. Generally, the landings from these jumps are on the forefoot. While running shoes have some forefoot cushioning, this cushioning is generally not adequate for the forefoot landings. Running shoes are just not designed for most types of aerobic activities.

Aerobic exercise shoes must also take into consideration the lateral nature of the exercise movements. Several very good aerobic exercise shoes have taken into consideration the medial and lateral stresses of movements like the pony step or jumping jacks. Forefoot lateral stability is essential in many aerobic exercise movements. The manufacturers of these shoes have responded by making higher-cut shoes that give appropriate ankle support. Extra padding on the higher top at the ankle is also very good. However, maintaining support and making the shoe flexible to deal with a multitude of different movements is a difficult task.

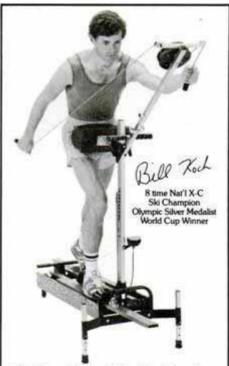
While aerobic exercise is gaining in popularity and high-tech aerobic shoes are improving, there is still a significant way to go before these shoes reach the technology level of other types of athletic footwear. Still, you should look for good cushioning in the forefoot and rearfoot areas. Secondly, buy a highercut shoe that cushions well and has a good lace-up system.

The perfect shoe?

What can we conclude about contemporary athletic shoe design? Well, there's no perfect shoe for everyone. Different brands attempt to solve the same problems of foot mechanics in different ways. While the all-purpose athletic shoe for all-around sports activities must accomplish a somewhat precarious balancing act, a lot of manufacturers are coming out with fitness or workout shoes that attempt to cover a lot of athletic needs. The Reebok entry in this growing field, for instance, has a 44-height ankle support and special lacing for improved lateral support.

So what shoe is right for you? It boils down to the age-old process of determining your needs. The budding Earl the Pearl should go with a high-top basketball shoe. All you Ivan Lendls have plenty to choose from in the tennis area. The Jane Fondas out there can enjoy new horizons in aerobic footwear. The Bill Rodgers and Joan Benoits have a plethora of possibilities in running shoes. Finding the right shoe takes a simple understanding of how your feet work and an awareness of how modern athletic shoes solve biomechanical problems. PM





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ROAD VIBES

(Continued from page 81)

noise generated by the digital code itself. In some players, an analog filter abruptly cuts out all frequencies above 20,000 Hertz-theoretically, the highest pitch humans are capable of hearing. Though this trick eliminates the noise, some critics complain that sharp analog filters impart a certain harshness to the sound.

For this reason, some manufacturers use digital filters to eliminate noise while it's still in code form. With most of the noise eliminated before it becomes sound, the remaining noise is handled by a gentler analog filter.

Still another way of eliminating noise is by a method called oversampling. In this method, the digital signal is boosted two or four times so that any unwanted frequencies remain way beyond the audible range. Some manufacturers use oversampling in addition to digital and analog filters. Others rely simply on oversampling and an analog filter.

Fancy or plain

Factors such as filtering, lasers and suspensions aren't evident from glancing at a car CD player. But other differences are more obvious.

For example, the Blaupunkt, Clarion and Yamaha models use a cartridge system to load the disc. Instead of sliding a naked CD into the machine, you first load it into a flat cartridge. Presumably, you'll load before you enter your car. You'll quickly see the advantage to this method if you ever try to open a CD album box with one hand while the other's occupied with steering. The cartridge tray also keeps dirt and fingerprints off the disc.

Car CD players not only load discs differently, but they eject them differently, too. Some let the disc slide out far enough so you can grasp it by the edges. But others give you only a sliver of the disc to handle. This forces you to leave fingerprints on the disc surface. If left uncleaned, dust could adhere to the prints and prevent the laser from reading the disc's digital code.

Another difference you'll notice among car CD players is that some come with an AM/FM radio tuner, and none play cassettes. Accordingly, choosing between a disc-only and a tuner/disc model depends on how committed you are to cassette tapes.

Many disc-only models feature an auxiliary input for connecting an older, already-installed cassette receiver. When this connection is made, source selection is done automatically within the CD player—and as soon as the CD ends, the cassette receiver is activated. If there is no auxiliary input, then switching between CD and cassette

POPULAR MECHANICS . SEPTEMBER 1986

receiver must be done manually. The latest cassette receivers do feature CD inputs, facilitating source selection by the cassette receiver.

Unfortunately, choosing a tuner/disc combination for your car commits you to the Compact Disc format, and virtually eliminates your option of listening to cassettes. That's because separate cassette players for the car are nearly extinct today.

But you can have your cake and eat it, too, with two tuner/disc units from Sanyo. Each has a front-panel input jack that lets you plug in a portable, battery-powered cassette player.

Other features

There are other variations among car CD players that have more to do with convenience than with sound. For example, the extent to which you can program selections on the disc (and the stations on the radio) varies from player to player. Another variation is the theft-prevention circuitry in the Sanyo FTEC-2 and Pioneer DEX-77 models.

Yet another theft-preventing option is to simply walk away with the unit tucked under your arm. Denon's DCD-C1 allows you to do exactly that because it's mounted in-dash in a removable chassis. The Philips CD-10 model is also removable, but in a more versatile sense. In addition to serving as a car player, the CD-10 can be adapted for home or portable use.

Finally, in the most elaborate option of all CD systems, the hardware is virtually invisible. The player section of Sony's CDX-A10 DiscJockey system is hidden in the trunk along with the 10 discs it can play. A cable connects the player to a handheld remote control in the passenger compartment. The 10-disc changer can also be had with an optional AM/FM tuner module.

Back it up

A Compact Disc player will definitely improve the sound of any car stereo system, but how much improvement you'll get depends on the quality of the other components in the chain.

All car CD players need separate amplifiers to power your loudspeakers. Ideally, those amplifiers should have a minimum signal to noise (S/N) ratio of 90dB to 100dB. Anything less is likely to mask part of the CD signal.

Similarly, speakers characterized by poor frequency response and low sensitivity will only serve to muffle a CD-based autosound system. Look for speakers with high-power handling and the ability to reproduce deep bass accurately. Compact Disc can deliver truly awesome, speaker-busting bass. So much so that if the automotive makers hadn't already developed shatterproof windshields, they'd have to.

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The "Number One" problem in this country today is MONEY. Once you have all the Money you can spend in your lifetime, for the darndest reason, you don't have any fresh ideas. When you are young, and full of fresh ideas you don't have any Money.

That's where this system lets you get started fast. It will allow you to start the system with Credit. (I am NOT talking about borrowing money from a Bank or any other lending institution.) I am talking about a different kind of credit, a cash credit that very few people know

It's Credit that doesn't even require you to submit any information about yourself. Only about the system. No personal (Credit Checks) whatsoever.

(But more about the credit part of the system later.)

Now it's URGENT that you learn why the system will only work for three years.

Wait! Don't get the wrong idea. Let me assure you, right now, the system will work for you for three years, starting today. It just won't work for me any longer.

Here's Why:

If I could make another three million dollars like I did over the past thirty six months, I would do it. And I wouldn't be telling you one solitary thing about this "strike-it-rich system." I wouldn't be writing you this letter. Nor would I be revealing my inside secrets. I would be just working the system I have found and be making all the money I could spend.

But that's not the case. The system is only good for three years. And there's no sense cry-ing about it. It's designed that way and there is no way to change it!

That brings me to this very important point. understand that not everyone wants to start out with a system that can make up to \$1,000,000 American Dollars in twelve months. Maybe you don't want the headaches of handling all that money at this time. Maybe you're looking for something "short-term" and not long term. That's okay. Give me a few more seconds of your time, and I can show you how to do it.

make up to \$10,000, \$50,000, or even \$370,000 dollars. And let's further assume that you want to work part-time only. That's okay. You can do it. You can operate the system part-time, weekends only or evenings if you like, and for the next seven months put up to \$370,000 dollars in the bank. Leave the system in the closet or under your bed for the next four months. Then when you want perhaps another ten or fifty thousand just pull the system out from under your bed and put it into operation again. (It all fits into a single briefcase.)

Listen Closely! What I am offering you here is an opportunity for you to get in on something Brand New, so maybe you can live your life a little differently for a change. Not having to worry about money all the time. Stop worrying about the daily job you have to go to every morning, and once and for all be free from having to get up on days when you don't want to.

Instead, with my system you can sit at home all day if you like or go shopping at your local "Shopping Mail" tinker around the yard like you do on the weekends, or catch a jet for the Virgin Islands or Mexico. Never having to worry about how you are going to pay the mortgage or car payments while you are on vacation. Never having to worry about someone firing you if you are missing a few days from work.

You and I both know that is no way to live worrying all the time. We have both worked for someone who doesn't like us very much, and would probably enjoy firing us the first chance he got. Let's don't make the same mistakes twice. Take my advice, and don't pass up this "once-in-a lifetime" opportunity to perhaps "once-in-a lifetime" opportunity to perhaps become America's Newest Millionaire. Order my system now, today, before you forget about it. If for any reason you don't like it, send it back, and I'll send your money back the same day you re-quest it. "No Questions Asked!" "No delays!"

Let me level with you. Life isn't always fair. Some of us will become millionaires before we are forty years of age, others will die broke. And some of us, whether we like it or not, will spend the rest of our lives living off Social Security, that may or may not be in existence five years from now. What we do with our lives now, today, is what counts. Darn, I would hate for my friends to see me living out the rest of my days in some

nursing home without a penny to my name.

Listen, you've got a "Second Chance" here.

Take it. Let's don't let any of those depressing things happen to you and me. Let's "live-it-up" have some fun for a change. Let's do some of the things we have always wanted to do and let's do them Now.

I could go on and on with all the advantages of this system, and how much money you could make with it. But I know you don't want to hear that. I know you want to find out, first-hand, for yourself the secret behind the system. I know you would like to start making money Now. So I'll keep the rest of the story short and to the point.

But first, let me tell you I know what it's like to start a business from scratch and to watch it fail. I've been there several times. From the time I was a teen-ager, I have always dreamed of own-ing my own business and for the chance to make a lot of money. I always wanted the freedom it would give me to run my life, just the way I wanted I wanted to be able to create and build a fortune on my own, so I could measure it against the rest of the world. But it didn't work

out that way.
I used to be a sucker for all the new "Money Making and Success Seminar Promoters", in the country. I'd get a tip from a friend, and I would drive to a distant city just to attend a new money making seminar. I would get some advice from a fellow office employee and I would buy a four hundred dollar money making program. You name it and I've either bought it or attended it. I have probably bought, or attended every money making promotion on the market today and then some. I even went into debt, to the tune of \$1,200 dollars, to start some dumb 'Loan Broker Business' at the youthful age of twenty one. "What did I know about being a

Nothing worked for me. On the average, I never made any money. I always seemed to lose money. But, don't misunderstand me. As I look back today, I enjoyed each and every minute of it. (I just chalked it all up, as a learning ex-perience.) But now I understand. The problem I faced each and every time, was when it came right down to putting the program or business into operation, there was one thing and one thing only that always stopped me. I was lost.

There just wasn't enough good information for me to follow. Oh, I know they intended to do a good job in the beginning, but their speaking skills and instructions were not enough. Every time I started to do some serious investigating about a particular system or put the plan, I had learned, into operation I came up empty handed.

PLEASE Read the following paragraph carefully. My money making system is complete, well writ-ten, precise, detailed and perfectly understandable. There are no if's or but's to it. My new, closely guarded, powerful money making secret can help you to perhaps start immediately enjoying a large monthly income.

I Promise You Won't Be Disappointed! My Money Making System is very Creative and Very

Starting next month. The "Three Year Clock" is running. If you decide to join in, you could be on your way to "Success and Fortune." This is an opportunity that only comes along once in a person's lifetime. Sometimes never! I urge you to order "America's Fastest Way To Become A Millionaire!" on a Free Trial Basis, Today. Next week or next month may be too late. Because
week or next month may be too late. Because
if you need help "Right Now" this very
minute, then this system will help you. But you
must order now. There are only 36 months
systems available and there are only 36 months in three years. Do you get the point I'm trying to make?

Please Don't Spend the rest of your life living from paycheck to paycheck! Have several thousand dollars left over every month to spend on vacations, a new home, new furniture, or perhaps a new sports car?

Don't get me wrong. I am not trying to get you to purchase something you don't want, nor do I want you to quit your job if you are happy with it. All I am trying to do is to get you to take a look at it. You just might be surprised at what you find. Listen, every day, brings new changes. Some good and some bad. Things may get better for you next week, without my system, then again they may not.
But, if you decide to give my system a try,

promise to show you an exciting and different way to make money that you have never dreamed of before. It's an "Entirely Different Approach" to making big money that will be proach" to making big money, that will be available for the next three years only.

Besides, it's a "Marvelous" way to make money the "Smart" way, that I think will take this country by storm in the next 36 months.

Take a chance, and see if I am right or wrong. If I am wrong you have wasted a postage stamp. But if I am right, you may be able to walk into the showroom of a "Porche" automobile dealership and hand the salesman \$95,000 dollars in cash and drive away in the sports car of your choice. A two-door 928 S would be nice.

Once you read the "inside secrets" of my new system that I have prepared for you, you will see that this hypothetical situation may become a reality for you-not just a dream.

Don't let someone, six months, or a year from now tell you, "I told you so. I told you that you should get in on Mark's money making system while it was hot." Find out for yourself who is right, me or the failures of this world.

Listen Closely! I know I don't know you per-sonally, but for the sake of all that money that might be lost, over Three Million Dollars, I am going to reveal to you powerful inside secrets that most people don't even know exist.

I will give you names and addresses of American and overseas corporations that have been kept hidden from the American public for years. I will also give you the "key to your new found credit." "Confidential Sources," that are

o Become A wealth like you never thought possible.

I will show you how to start the "System" for yourself and perhaps amass a "Small Fortune in less time than this year's "Fall Football Season.

Here's What You Are Going To Receive: You are going to receive a "SUPER CHARGED MONEY MAKER," a complete set of my ideas and systems written exactly as I use them on a daily basis. The same ones I used, last year, to amass over one million dollars.

It is handsomely designed and printed by a First Class printing organization. There are 150 pages altogether, about 130 pages of text and about 20 pages of exhibits, pictures and illustrations. (It all fits into a briefcase.) There are the insider secrets to the system. How to start on a shoe-string budget. Or how to access (you notice I didn't use the words; apply for) the credit. The credit is available to anyone who owns a system. You may access as much as you need. When you need it. \$500, \$1,000, \$5,000, \$10,000, \$25,000, or even \$50,000. (Some people never use any, It's all up to you.) In addition, there are Start-up instructions. Hard-to-find business contacts, and my own special powerful "Magic Nine Steps." This publication is both brand new and the creative system you will find in it is being offered for a limited time and a limited time only.

Don't Let Someone Else Control Your Life. Do something about it Today.

Order "America's Fastest Way To Become A Millionaire!" and Start A New Life Before the time runs out

You could start, right now, and be on your way to your fortune by the end of next month. If you order today, not next week, or next year. But Now! Order my program this very minute, and let me prove to you how enjoyable my new money making system will make your life. Send \$14.95 for your personal copy of "America's Fastest Way To Become A Millionaire!" Today!

Before I go any further. Let me clear up any possible misunderstanding you may have.

I didn't write this money making system and then expect to make my fortune. I made my fortune before I wrote the first word in "America's Fastest Way To Become A Millionaire!" In fact, while we're on the subject, the year before I wrote "America's Fastest Way To Become A Millionaire!" I made \$1,190,000 dollars. The year before that I made \$1,000,000 dollars and two years before that, I made \$755,000 dollars. It's all Documented!

The amount of money I made using my system is documented and can be backed up with bank records and financial statements from my Certified Public Accountants.

I don't wish to brag, but I must make you understand that you too can perhaps do as well as I did for the past three years. You may even

Here Is An Example Of What My Plans Can Do! My Bank Deposits For The Past 12 months:

April	6 05 007 00
April renerrousementonocommunication	\$ 95,297.00
May	\$ 82,816.00
June	\$ 88,592.00
July	\$102,620.00
August	\$131,948.00
September	\$150,067.00
October	\$142,910.00
November	\$115,107.00
December	\$ 77,148.00
January	\$ 56,802.00
February	\$ 85,056.00
March	\$ 77,590.00

These are the facts. You can believe them or not. It's your choice. But I'll tell you this, I didn't have a lot of money when I first started with the "Magic Nine", and that's why I designed the system with you in mind. I wanted anyone who was interested in bettering themselves, to be able to start producing Big money immediately. Don't Delay! Don't miss out on this opportunity!

To miss out on this opportunity without at least taking a FREE look would be a shame. If you put this publication down without ordering, the opportunity will not be available to you again. You may never know how Great It Feels Having \$50,000 dollars in the bank any time you need it for emergencies. You may never know what it's like owning luxury automobiles. You

may always wonder what it's like owning several homes worth over One Million dollars in perhaps the best neighborhoods in the country. Why don't you place your order today for your copy of "America's Fastest Way To Become A

I promise you will be overjoyed ith your copy of "America's with your copy of "America's Fastest Way To Become A Millionaire!" and I guarantee that this "first-time-offered" Money-Making System, will not be found in any other book, TV Show, newspaper, manual, or anything. It is my exclusive "Magic Nine Money Making System." It is all original and it is waiting right here in my office, waiting to be shipped to you.

If you want to become Rich, Powerful and Successful, in a relatively short time, then you owe it to yourself and your loved ones to have "America's Fastest Way To Become A Millionaire!" in your hands next week. It's a "oneof-a-kind" money making system that you will soon find an invaluable aid in seeking your fortune in the coming weeks and months ahead.

P.S. I've told you who I am, and something of the system I have created. Now let me tell you the real reason I wrote this advertisement. Obviously, the odds were against me, from the beginning, for ever amassing a fortune of my own. I just kept doing dumb things over and over again, floundering around, like a fish out of water. Never understanding, what I was doing, or how I was going to achieve my goals. I am telling you this so you will completely understand that I am not much different than most young entrepreneurs in this country. I had to struggle to survive in the beginning, and more than once in my life I found myself financially trapped at the end of the month. With no way to pay my bills. And No way out. But I kept plugging away, determined to beat those loser odds almost everyone is born with. Now after three glorious years of success. It's over with. I'm going to retire. I am going to travel around the world, perhaps buy myself a new \$200,000 yacht and enjoy my life. But before I do all these things. I wanted just a few people, like yourself, in this country to enjoy what I have enjoyed. The freedom to work when I wanted to, the ability to create and build a nest egg for the future, and the thrill of being able to stretch myself to the limit.

Now, I know this may all sound a bit corny --but that's how I feel, and I can't change that. An Opportunity like this only comes along once, maybe never, in a person's lifetime, and I guess I just happened to be in the right place at the right time. But you, you too, are lucky also. You are in the right time. But you, you too, are lucky also. You are in the right place, at the right right time, to make the same things happen for you. Please don't let this opportunity slip through your hands, without at least letting it touch you. Believe me when I say, you are taking no risk. Because you're not. Take my word for it, the system is really worth seeing.

whatever you decide, I want to take this last oppor-tunity to thank you for the time you have spent reading my story. And to also, offer a cheerful congratulations on your decision. I respect you for it, I sincerely mean

"What if I don't like it?" — You Can Return it!
I'll Give You A Full 90 Day Money-Back
Guarantee. If at any time after receiving
"America's Fastest Way To Become A
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reason, do so. I will immediately refund your \$14.95 along with my congratulations to you, for at least having given it a try. There will be No questions asked! No delays! Just a cheerful and prompt refund.

In fact, if you still feel a little uncertain about mailing a check to someone you don't know. You can: Postdate Your Check For 30 Days From Now. I won't deposit your \$14.95 check or money order for 30 days after you get my materials. Use the new system in "America's Fastest Way To Become A Millionaire!" during that time. Then, if you don't think it's for you, just send the materials back and I'll return The



Same Check You Sent Me Uncashed

Take the time "Right Now". Pick up your pen. Fill out the Express "Order Form", and mail it in Today! In a few days time you will have "America's Fastest Way To Become A Millionaire!" in your hands. Use the information and start making big money with my "Magic Nine System." I think you'll see very quickly that it's everything I say it is and just by following the step-by-step guidance it offers, you'll begin to realize your dreams of success as soon as next week. Or you can call Toll Free:

1-800-528-6050 Ext. 370

Charge your order to: American Express — Mastercard — Visa. 24 hours a day. 7 days a week. "Operators on duty Sundays too." Note: Operators can only take orders, Thank You.

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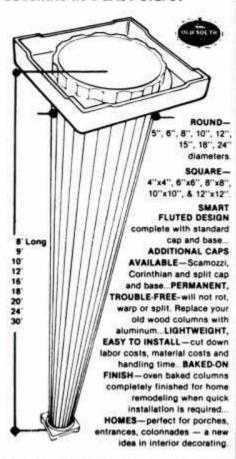




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OFF-ROAD WARRIORS

(Continued from page 78)

real, useful instruments in the dash. Think of the Bronco II as the Lincoln Town Car of utility vehicles. It has a smooth ride and adequate handling, but it's obvious that most of the effort has been spent on styling and fabrics, at the expense of engineering and performance. We think the arch-rival Blazer/Jimmy is significantly better in every way, at a comparable price.

Suzuki Samurai

People absolutely flip over the Samurai. It's the smallest 4-wheeler on the market, inches shorter than a Yugo and a foot shorter than a Honda CRX. Into this 1-ton package, Suzuki packs a 1.3-liter 4-cylinder, 5-speed and two rigid axles on leaf springs.

Two adults fit in the front seats, two kids in back. There's even a little bit of

luggage space.

Remarkably enough, the Samurai could go anywhere the big 4x4s could venture. It took a little longer, but it got there. We got to thinking of it as a 4-year-old following around a group of 10-year-olds—always bringing up the rear, but always there at the end of the day. And, in a couple of narrow spots in the mountains, the Samurai could clamber where the big boys couldn't.

The Samurai can run 70-plus mph on the freeway, but it's not comfortable doing it. It can pound off-road, but you're always a little apprehensive about it. It would be best to take to college, or to run around town, or to have permanently at your cottage up at the lake, ready to head over the hill to that secret fishing hole.

The Samurai costs half as much as most of these vehicles, and it gets twice the gas mileage. As long as you understand the limits of what it can do, this is a great little 4x4—emphasis on the little—that should be easy and cheap to own. Probably the best reason to buy one, though, is that it's hard to take yourself too seriously when you're driving a nutty little tin can painted fluorescent blue. The Samurai is just overall fun. For the price, that's a lot.

Conclusion

The 4-wheel-drive utility vehicle market splits into three groups. In the sporty group, we like the Jimmy/Blazer, followed by the 4Runner and, at a long distance, the Bronco II. As a station-wagon substitute, we like the Cherokee over the Trooper. For serious off-roading, the Montero out-Jeeps the Wrangler, and both are more practical than Suzuki's mini-Jeep. If we had to choose one vehicle, it would be the Jimmy—surely the most versatile all-arounder on the market. It does everything well.

POPULAR MECHANICS • SEPTEMBER 1986

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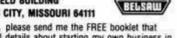
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THE FRENCH CONNECTION

(Continued from page 70)

ger and about \$20 per ton of freight.

More importantly, the English Channel Tunnel is expected to generate billions of dollars a year in new trade and tourism. The economic and strategic value of the tunnel has never been seriously questioned. Only international politics have stood in the way of completing this great project.

The French proposed channel tunnels in 1802 and 1804, the latter being Napoleon's idea for the conquest of England. In 1880, British engineer John Beaumont dug an exploratory tunnel on the Dover side with a machine he invented called the mole. The tunnel was never completed, but it was dug hundreds of feet beyond the English shore. Beaumont's tunnel was used in 1973 to monitor ground shifting and other problems that might have arisen during the digging of the new trial tunnel. His mole machine became a major tool of mining and tunneling.

Ready, set, go

The current tunnel design is so wellformulated that everything is ready to go once the funding is in place. Since the trains will use electric overhead lines and pantographs, they will actually become an environmental asset. To complete the London-to-Paris run, no new tracks will have to be placed except inside the tunnel itself.

In my book MACRO, A Clear Vision Of How Science And Technology Will Shape Our Future (William Morrow, 1983), I proposed the use of a tunnel for ultrahigh-speed magnetic levitation train lines. These could travel safely at record-breaking speeds once air was evacuated from the tunnel. An air supply inside the train would be needed for passengers. The advantage of an evacuated tunnel is that there would be almost no friction produced by the movement of the magley train.

The proposal has been given some serious discussion, but maglev developments are still something for the future. For the present, 80 mph seems to be fast enough for most travelers.

Earlier proposals for the Channel Tunnel called for motor vehicles to move through it as in any other tunnel. This idea was discarded for environmental, efficiency and safety reasons.

It has been about 40 years since an article in POPULAR MECHANICS and a trip across the English Channel gave me the inspiration to work for the building of this project. Now that the dream is about to become realized, I look forward to a time when tunneling methods are so far advanced that even a transcontinental tunnel would be feasible for America.

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And I'll Tell You How You Can Do The Same!

"Life was absolutely miserable until I discovered a method that changed my life around in only 2 days. Before my discovery I owned nothing and was \$14,000 in debt, after my discovery everything changed. Within 2 days I became financially independent. Since then, I have acquired everything that I've desired! Listed below are a few of them:

- Just about every luxury and exotic car you can think of. I'm currently driving a Ferrari.
- An authentic Tudor home worth over half-million dollars.
- A high performance racing boat.
- Net worth of well over One Million Dollars.
- Freedom to go anywhere and do anything!"

LIFE BEFORE MY DISCOVERY

There was a time when I was so broke I could not put diapers on my baby or feed my family. Maybe you are living like I was - I pray that you

Today, my life is incredible, but it wasn't always that way, in fact a few months ago, I lost literally that way; in fact a few months ago, I lost literally everything I had, through a bad business deal. I didn't have money for the car payment, phone bill, gas or light bill. We were living rent free in a friend's home. It was sad that I was hurting, but what was really killing me was that my family was suffering with me! Despite the disappointment of being in debt and unemployed, we kept hanging in there — looking and searching for something — anything.

something — anything.

I know that this sounds like a familiar song, but in my situation, the results were absolutely

In one miraculous day, everything changed. That particular day, I woke up very early. I went into the kitchen, sat down and dropped my head into the kitchen, sat down and dropped my head to the table. I was so miserable and full of hurt and grief watching the hours pass by. All of a sudden I was overcome by an incredible idea: an idea that was so strong I instantly picked up the phone. I made that one certain phone call. Just one phone call and 2 days later we were making \$8,000 a month! All I made was one phone call and in 2 days our miseries were gone

LIFE AFTER MY DISCOVERY

In the next few days, we paid off all of our debts and began buying things that even people who have worked and saved all their lives can't afford. As a symbol of my victory over defeat, I went out and bought myself a \$50,000 sports car. A few days after that I went and bought another \$40,000 sports car.

In a few months after my discovery, I asked myself where would I like to live if given the freedom and the choice. "California." So we packed up everything and moved into our dream home right by the ocean. Yes, we were doing and acting totally as we pleased. Life is incredi-ble and it's all because of one very simple phone call

I'm completely financially independent and have been since I began implementing my method. I have written my method in a short and simple book that takes no longer than an hour to read. I don't believe in sending you a book with a lot of PMA and hype. My book is direct and to the point. I want you, as the reader of my book, to quickly read it and then begin implementing my method so that you can end your financial prob-lems once and for all within 2 days. That's right, in 2 days from the time you receive my book. I

guarantee it. I'm asking \$10 for the book. Not because the material of the book is worth \$10 (it's only paper and ink), but because I want you to be serious in your intent. I feel that if you send me \$10 then I'm going to have your interest to the point where you'll seriously read my method. If after reading it and trying my method, it doesn't end your financial worries in 2 days, simply send the book back for a refund. Once again, I guarantee

Below are my deposits for my first 5 months of operation. This can happen to you if you will follow my simple method.

September													a			\$ 92,481.65
October .			200								٠.				15.	134,383.25
November							į,					٠,		,		116,462.18
December																101,258.00
January .																190,482.61
And still	C	H	m	b	in	g		8	Ţ	0	T,	A	L			\$635,067.69

My method is an easy-to-follow formula that works as follows: A 3-minute phone call can make you up to \$8,000 per month income, and more, for as long as you implement the method. Below are just a few of the many, many testimonials that we have from everyday people that

ordered my book. Notice the time in which it took them to change their lives.

SOLID PROOF

Mike Kohler, Texas

Mike was a professional organist, living off of a very small salary. He did, however, have a desire to get ahead. He ordered my book. As a result, he claims to have been able to secure an income for himself of \$12,000 per month. The time in which it took him to do this was 2 days. In his own words: "After receiving your book, it took me 2 days to secure an income of \$12,000 per month for as long as I wanted it."

Karen Skelly, Illinois Karen is a 32 year old single woman. With only a high school education, she was pinching pen-nies to make ends meet. She told me that she has ordered and tried just about every money making idea on the market. She claims that our method was the only one that worked for her. She also claims to have made enough money to be financially independent. It took her 1 week to start making big money, in her own words; "I'm 32 years old with a high school education." Once receiving your book, within a few days I secured enough income to be financially

Ken Smith, Saskatchewan, Canada

Ken was a construction worker. He became Ken was a construction worker. He became extremely irritated with working in the hot sun and the idea of working for someone else. As a last resort, he ordered my book. He claims to have been able to lock in an income for himself of \$12,000 per month. He did this in 18 hours. In his own words; "Within 18 hours of reading your book, I locked in an income of \$12,000 per month."

Dan Cockrell, Texas

Dan was a preacher for christianity. He left that job in hopes of finding a new job doing some-thing where he would be his own boss. Apparently, Dan sent us his last \$10 in hopes that this would answer his prayers. It did indeed. He told us that in **3 days** he had secured an income for himself of \$7,600 per month. In his own words, "I was flat broke when I received your book. After 2 days of applying your method, I locked in an income of \$7,600 per month."



FEATURED ON NATIONAL TV

My method has been featured on national television. Because of the popularity of the program, it was aired 3 times a week for 4 straight months. It has been seen by 18 million people all across the United States and Canada.

Financial Independence Guarantee!

If you are not making an absolute min-imum of \$8,000 per month after applying my simple method, simply send my book back and I will refund your original \$10. At any-time you can send the book back for a

Before you do anything, call the phone number the space below. It's an individual that has been able to witness first hand the \$8,000-in-2-days miracle. It is another testimonial that you'll be able to hear for yourself.

AN INCREDIBLE MESSAGE 805-964-8246

Make \$24,000 in 30 days or \$16,000 in 14 days. If you have any doubts simply order the book. With my guarantee you will be trying my program absolutely free. You have nothing to lose and \$8,000 in 2 days to gain!

Important notice: Due to the high demand for my book, please order within 7 days to insure prompt delivery. Orders are filled on a first come, first serve basis.

Exclusiv	a Ord	or E	orm
EXCIDEIA	e oro	et L	orm

Douglas G. Holmes (805) 964-4366 5290 Overpass Rd., Suite 215 Dept. 307 Santa Barbara, CA 93111

I am willing to send you \$10 on the condition that if I'm not absolutely satisfied or am not making \$8,000 in 2 days after trying your method, I can send it back at anytime for a full refund.

NOTE: Please enclose an additional \$1 (cash) to cover the cost of shipping and

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Space Shuttle Contest Winners

When the winners of PM's Space Shuttle Contest put their experiments in orbit, a new frontier will be crossed.

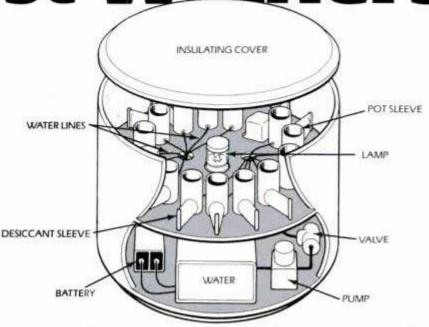
BY DENNIS ESKOW Science/Technology Editor Illustrations by George Retseck

hen the seven Challenger members were snatched from our midst in a fiery accident earlier this year, there were widespread fears that the entire space program could go up in smoke. But America recovered from the shock and, determined to continue exploring space, set out to determine the cause and prevent future Shuttle disasters. The Space Shuttle is expected to start operating again sometime in 1987, and POPULAR MECHAN-ICS will be among the first civilian institutions to put an experiment aboard. We have selected the winners of our Space Shuttle Contest (see Launch Your Experiment On The Space Shuttle, page 68, June '84).

Certain to go into orbit is an ingenious experiment by researcher John Joseph Chiment of Cornell University's Boyce Thompson Institute in New York. Chiment's experiment could pave the way for future Space Station life-support activities. He has designed a way to test the viability of growing plants in orbit. Chiment's experiment seeks to measure the content of a chemical called glutathione as an indication of how soybeans might grow under the stresses of space flight.

For his effort, Chiment has won a Bausch & Lomb Criterion 4000 telescope and an all-expense-paid trip to the launch facility when the Shuttle flies with the experiment.

The experiment envisions a group of enclosed "jiffy pots," each containing a soybean seed, placed on one level of our NASA container. On the next level, a water supply would keep each pot precisely moistened through a computerized pumping system. Each container holding a jiffy pot would have a sleeve

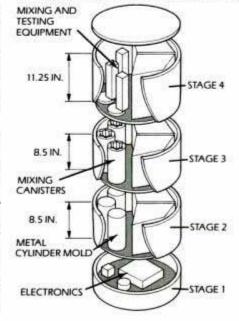


The winning experiment will measure the ability of plants to take the stresses of space.

filled with a desiccant silica gel, designed to absorb moisture. When the flight ends, the water will be turned off and the growing soybean seeds will be dehydrated for chemical analysis. The levels of glutathione in each plant will indicate how well the budding seed took gravitational changes and environmental shifts as the cargo bay turned to face the sun or Earth.

If there is room in our Space Shuttle canister, we will also run a modified version of the second-prize winner de-

Second-prize winner envisions forming concrete cylinders in stages in Shuttle canister.



signed by graduate student Kevin F. Hanlon of Tempe, Arizona. Hanlon's experiment calls for a 4-stage mixing of metalized concrete. The results will be of importance to NASA, which will have to use a form of cement to protect manned areas of the Space Station from gamma rays. The experiment, divided into stages, would mix the ingredients and cast cylinders in orbit. Hanlon is the winner of an Astroscan telescope provided by Edmund Scientific.

Third prize, a Celestron C-90 telescope, goes to James J. Secosky of Shortsville, New York. There will not be enough room in the canister to fly his experiment, but it proved to be a close third. He proposed a means of growing blue-green and green algae in orbit.

In addition to the winners, we selected four runners-up because their experiments were so closely related to the winners. Robert Edward Arnold of Alexandria, Virginia, and John F. Legendre of Glendale, Arizona, proposed experiments on concrete manufacture. Timothy Shankland of Indianapolis proposed an experiment on "dispersion dynamics," basically on how gases mix in a micro-gravity environment. Another honorable mention went to Mary Ann Dodson of Akron, Ohio, for her proposal to grow gallium-arsenide crystals in orbit.

In all, 400 readers entered our contest and 31 finalists were selected. We'll report on our building of the Shuttle experiment in a future issue.

ARMY RESERVE OFFICERS' TRAINING CORPS



For a few hours a week, Army ROTC gives Joaquin Martinez a chance to apply classroom theories to the real world.

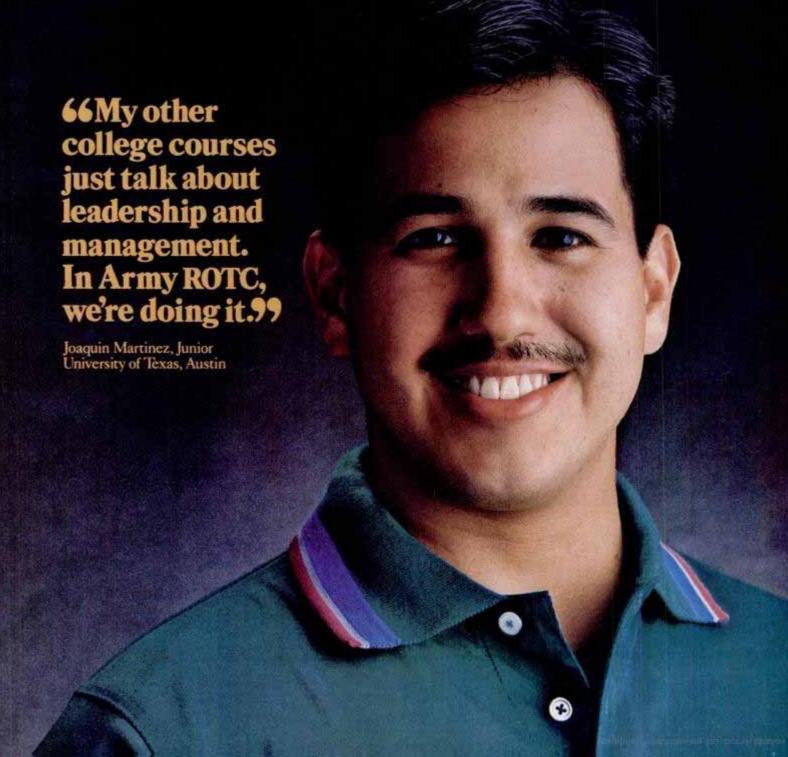
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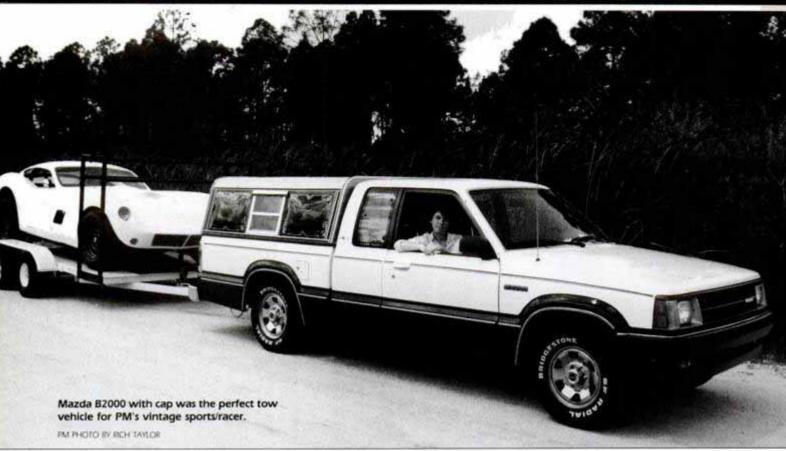
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- -PM LONG-TERM CAR TESTS-



MAZDA B2000 CAB PLUS

Willing workhorse

"car" tests, this month our truck count is up to 50 percent with the acquisition of a Mazda B2000 Cab Plus pickup and the continuing saga of our domestic Jeep Comanche XLS. On the car front, we've added a Subaru 3-Door Turbo coupe and sent our Buick Riviera T Type off to an early retirement.

Mazda B2000 pickup

With less than 800 miles on the odometer, I beefed up our Mazda pickup's rear bumper, added a pair of helper springs, borrowed a temporary cap and towed my Kellison J-4R vintage race car from New York to Florida. Loaded down with a half-ton of tools and equipment, towing 3500 pounds of race car and trailer, the B2000 cruised at 70 mph, never missed a beat, and averaged just over 20 mpg for 3000 miles. I was impressed.

Back home, the B2000 has just as competently eased into service as an everyday runabout. This particular

JEEP COMANCHE

Keeps on truckin'

truck is the very top of Mazda's pickup line, the B2000 LX Convenience Package Cab Plus. Base price is \$8545, though the window sticker on our optioned-up model reads just over \$10,000. I think that's pretty reasonable for a vehicle which is as truly multipurpose as this one.

The best thing about the B2000 is the Cab Plus. Unlike the side-mounted jump seats in other extended cab pickups, the Cab Plus has two surprisingly large seats that fold down from the rear



Jeep Comanche has been a civilized workhorse with very few complaints.

SUBARU 3-DOOR TURBO

Inscrutible engineering

bulkhead. Two forward-facing adults can sit back there as comfortably as in most small sedans. And, of course, the Cab Plus provides the secure storage space that's lacking in a conventional pickup truck.

The B2000 is extremely car-like throughout. The engine is a singleoverhead-cam 2-liter adopted from the 626 sedan, as is the overdrive 5-speed gearbox. The torsion bar front suspension, coupled with the long 117.5-in.

(Please turn to page 128)



Subaru 3-Door Turbo presented a number of engineering conumdrums.

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Item#	Size	Ply	Cap	Sale	tire only
1211	480×8	4	590 lbs.	\$19.95	\$15.95
1212	570×8	4	715 lbs.	\$29.95	\$24.95
1216	480x12	4	780 lbs	\$32.95	\$24.95

Trailer springs, 134" wide w/eye center of 25%"

Item#	Capacity	Springs	Leafs	Sale
1250	1000 lbs.	2	2	\$20.00/pr.
1251	2000 lbs	2	3	\$22.00/pr.
1252	3000 lbs.	2	3	\$25.00/pr.
Single S	pring Set Sh	ackle, Iten	n# 1255	89.50/pr.
		a Application		

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\$474.95

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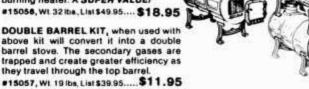
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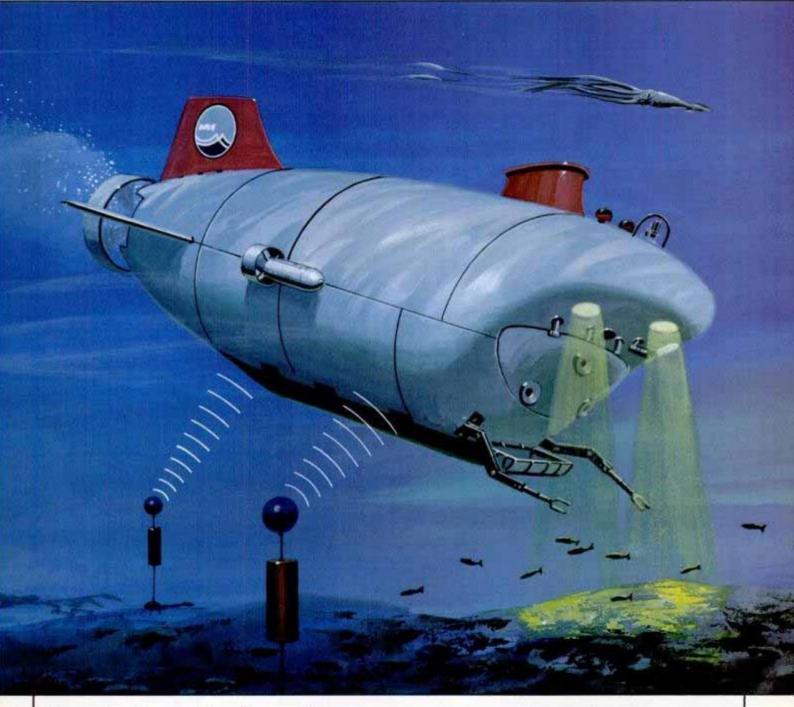


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TECHNOLOGY UPDATE 9/86



Secrets of the deep

For over 25 years the French-built research sub *Trieste* has held the world record for the deepest dive—35,820 ft. Now, Japan is mounting a project to beat the record and do some prospecting work as well.

A free-swimming craft will observe the sea bottom in Japan's territorial waters, looking for sources of minerals and clues for earthquake prediction.

The crew of two will ride in a 3-in.-thick steel sphere tucked inside the streamlined hull. With outside sea pressure reaching 10,000 psi, the total force bearing on the sphere, just inches from the crew, will be over 100,000 tons.

Already in construction, this new submarine—with its sonar, remote sensors, video cameras and other scientific probers—will be able to tell us much more about the secrets of the deep, and thus find real treasure.

Editor Dennis Eskow Assistant Editor. Tim Snider Contributors: Ken Sanders, Jack Hammond, Steve Eskow, Wade Hoyt

TECHNOLOGY UPDATE 9/86

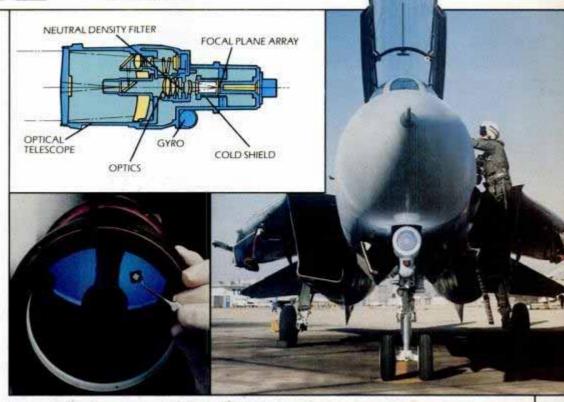
ELECTRONICS

Night vision

What has 16,384 eyes and sees in the dark? It may be flying overhead right now in the form of a Northropequipped Navy F-14 Tomcat. If the Defense Department gives the go-ahead, jets equipped with a special under-the-nose TV camera (far right) will soon be able to fly at night and in bad weather with pilots seeing daylight on a screen. A tiny chip with more than 16,000 sensors (right) picks up heat from the image received by the camera (illustration). The heat is translated into a daylight picture with the help of a computer on board.

Private TV goes global

Lots of big companies use satellites to connect various plants for major television business conferences. But Wang Laboratories has taken it a step further. With the help of the Private Satellite Network, Wang has set up a full-time worldwide television network for its own use 24 hours a day. The network taps into the transponders of







six satellites and uses main receiving stations like the one shown at the right to process the signals. Wang officials can call a conference of employees at 17 locations around the globe in an instant. Several other major companies are following suit.

Helper won't do windows

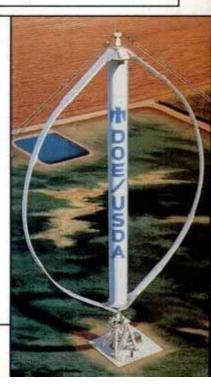
Need help with the housework? Toshiba is testing a new robot that dusts, vacuums, scrubs and waxes floors, and serves as a night watchman. But, it won't do windows, or anything else that requires arms or hands. The robot won't be available here until 1987. Toshiba is reported to be working on an advanced version, but windows are still out.

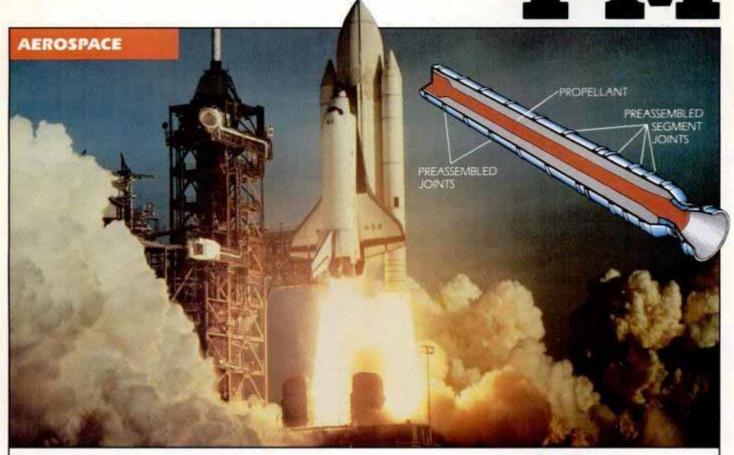


ENERGY

Catching the wind

Sandia National Laboratories later this year will begin operating the largest vertical turbine, or eggbeater, windmill in the world. The 500-kw., 164-ft. turbine is located on the Texas high plains near Amarillo. The Sandia turbine is twice as large as the next biggest eggbeater. New design, lightweight plastics and other technologies promise to make it the most efficient wind machine.





New Shuttle booster design

While NASA works on getting the Space Shuttle program back in orbit, subcontractors are offering ideas for improvement of the ship's safety. Aerojet General, a major rocket contractor, has proposed a new design for the Shuttle's solid rocket boosters, source of the explosion that downed the *Challenger* earlier this year. The booster would be cast in one piece rather than four, eliminating field joints where a rupture could occur. The interior would be rubber-insulated. Aerojet envisions using existing motor casings. It could have the first model ready next year.

AVIATION

A snap-on rescue vehicle

The Air Force Aeronautical Systems Division at Wright-Patterson Air Force Base in Ohio is building a new aircushion rescue vehicle that could be attached to the wing of a C-130 aircraft. The 50-ft. vehicle will carry firefighting and rescue equipment and can be flown to a site and snapped off the aircraft for hurry-up work. It will be tested in 1987,

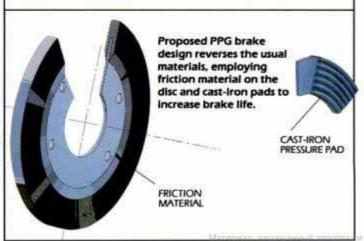




AUTOMOTIVE

Lifetime disc brakes

Reed Grundy and a team at PPG Industries have designed an all-composite car to demonstrate the capabilities of new materials. One proposal is an "inside-out" brake, where the high-temperature composite disc is coated with racing-car friction material. The brake pad is made of cast iron with cooling fins and holes. By making the disc the friction source instead of the pad, the friction area is increased a dozen fold and the discs could conceivably last more than 100,000 miles. Some racing cars now use carbon-fiber discs, but with conventional friction pads.



TECHNOLOGY UPDATE 9/86

MILITARY

Realistic war games

To be safe in real war, soldiers and machines must be trained and tested with realism in peacetime. Unfortunately, most war games are just that, games-especially when the combat involves expensive tanks. But now accurate marksmanship can be achieved, military tactics can be practiced and real scores posted-without dead or wounded, or destroyed tanks. The Talissi shot simulator being developed for the U.S. Army seems like war, but is just smoke, lasers, firecrackers, lights and little computers. While the gunner aims, the lasers track a shot. The strap-on system scores hits or misses for both gunner and his instructor/ commander, and adds a flash for the shot, and bang with red smoke for the hit.



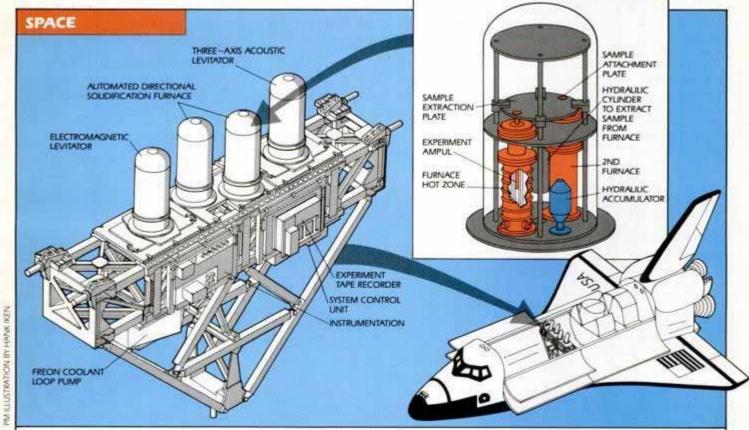
Little tank, big shot

Teledyne has developed a new idea for the U.S. Army's light tank prototype. Called the AGS (Armored Gun System), it has a 105-mm autoloaded cannon that can fire more than 10 shots per minute. The AGS can speed up to 50 mph.

Mechanic in a box

Finding and fixing an electronic fault in the complex maze of wires and black boxes of a high-tech fighter could keep a plane on the ground for days, even weeks. But a new electronic repair brain, the prototype AIMES, will fix and diagnose electronic problems as they occur in flight. This suitcase-sized computer figures out the problem and tells the mechanic.





Made in space

Scientists have discovered that some high-tech computer crystals grow better in the microgravity environment of space. To capitalize on this discovery and to test space manufacturing techniques, the International Space Corp, is planning to put a special furnace on the next available Space Shuttle. The furnace will heat then freeze materials to produce several varieties of infrared and semiconductor crystals. The fully automatic furnace will fly in the Shuttle's cargo bay. While the Shuttle is in orbit, the furnace will make crystals unassisted. Crystals produced in the weightless space environment are expected to have fewer flaws and a more regular structure than crystals that are made on Earth. And the hypercleanliness of space will produce flawless semiconductor surfaces.



Computerized repair manual

When you're 300 miles up in space, you can't just run to the hardware store to replace a part. The job has to be done right the first time. To look over the space technician's shoulder, Boeing Aerospace has developed a voice-actuated computerized repair manual/supervisor. The astronaut talks into his helmet for advice and is reminded what to do and what tools to use. The system is being tested under water, where conditions resemble the feel of space.

RAIL

New rail car for commuters

The Advanced Light Rapid Transit rail car by UTDC of Canada could be the new wave for commuters. With composite construction and linear induction motors, the ALRT is strong, light, very energy efficient and quiet. The first units appeared in Vancouver at Expo '86, Detroit will have them next year and Japan wants to import them to ease traffic.



LONG-TERM CAR TESTS

(Continued from page 120)

Cab Plus wheelbase, gives a ride softer than that in our long-term Subaru 3-Door. Handling with the Bridgestone SF Radial tires is adequate by automotive standards, terrific measured against other light trucks.

Add power steering, power disc brakes, cruise control, cloth bucket seats, a decent stereo plus lots of sound-deadening insulation, and this truck turns out as easy to drive as most small passenger cars. The only common convenience Mazda doesn't offer are power windows and power door locks.

Our truck is painted 2-tone white/wine red with a red tweed interior. At first glance, it seems almost too pretty and car-like, not macho enough for many truck buyers. But we've now completed 4600 miles, most of them either towing a trailer or heavily loaded, and the B2000 is as fresh as the day we picked it up.

Not one thing has gone wrong. Fuel economy, when not loaded down, approaches 30 mpg—and my wife is just as happy driving the B2000 instead of her usual 626 sedan. This is the first time that has happened in the 15 years I've been using a pickup as a second car. So far, the B2000 has been a resounding success. We'd hop in it and tow a race car to California without a moment's hesitation—or we'd run down to the neighborhood post office. The B2000 is equally capable of either chore.—R.T.

Subaru 3-Door Turbo

The new 3-Door is identical to Subaru's familiar sedan and wagon models, except for the body, which has been turned into a sleek hatchback. Fold down the rear seat and there's an excellent amount of luggage room. Drivetrain consists of the time-honored Subaru 1.8-liter, 111-hp turbocharged flat-Four, with 5-speed transmission and 4-wheel drive.

In everyday use, this Subaru presents an odd set of engineering compromises. The 3-Door Turbo has been given the same stiff suspension, "European" interior and Bridgestone Potenza tires as the limited-edition RX Turbo sports sedan. As a result, the ride is jiggly enough to crack your fillings, yet dry road cornering is a wobbly affair. There's lots of engine noise and torque steer under acceleration, yet the 3-Door really isn't very fast in a straight line. The Bridgestone Potenza tires stick wonderfully on dry roads in 2wheel drive. But in rain or snow, when you shift into 4-wheel drive, these highperformance tires don't have enough traction to take advantage of Subaru's proven 4x4 system. We think the 3-Door is an excellent candidate for Goodyear's new Eagle GT+4 all-season performance tire.

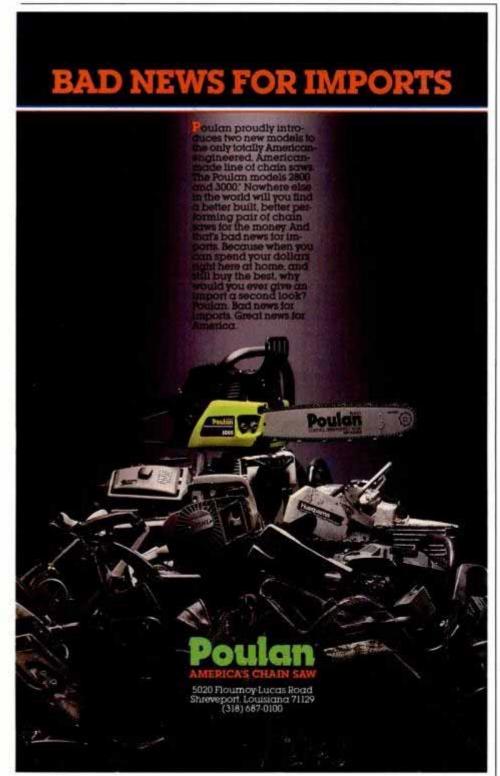
In 3000 miles of driving, we averaged 22.5 mpg. That's not as good as we had hoped for. On the plus side, the 3-Door has been dead reliable, nothing has broken or gone wrong, and with the exception of the too-stiff suspension, it's been quite comfortable even on long trips. It's also beautifully put together.

The best part of the 3-Door is the interior. The neatly trimmed cloth bucket seats are comfortable, the controls are all easy to find and use, the analog instruments are great, and Subaru's one-touch power window switch ought to be standard equipment on every car.

Our next step is to try a set of Eagle GT+4 tires. Perhaps they'll help tame the ride and handling of what otherwise is an enjoyable combination of style and practicality.—R.T.

Jeep Comanche

Our Jeep pickup has been truckin' right along after a trip to the dealer to have a leaking rear transmission seal replaced. Our only complaint has been fuel economy of 13/16 mpg in normal commuting. But considering the mas-



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LONG-TERM CAR TESTS

(Continued from page 128)

sive face that this "compact" truck presents to the wind, the drag generated by an open pickup bed, and the automatic transmission with V6 engine, that's really not much of a surprise. Its EPA city/highway ratings are only 17/19 mpg. (With the 2.5-liter Four and manual transmission, the ratings are 23/27 mpg.)

We've only ventured off-road a few times in the Comanche, but it always got us back with no sweat. The real surprise is its comfort in everyday driving. Although a bench seat might have been more practical, the deeply contoured buckets we chose gave plenty of side support in cornering. The knobby Goodyear Wrangler radials are about one-third worn in 9000 miles, which is about par for chunky off-road tires used mainly on the street. We'd do better by giving up the macho look in favor of a good all-season passenger tire.

There are a few plastic buzzes starting to develop in the dash, and the truck really sounds strained and unhappy at anything over 65 mph, but then it was designed to be an everyday workhorse, not a high-speed GT car. We're real happy with this Comanche, and the 170-hp in-line Six rumored for '87 models can only make it better.—W.H.

Buick Riviera

When we turned our star-crossed Riviera T Type back to the Buick dealer to fix a number of electronic gremlins (see Long-Term Car Tests, page 130, June '86), he was surprised to find that there were no parts listed for the keyless entry system. In fact, he couldn't find a keyless entry system available for the Riviera in his order books. And that's when a fascinating behind-the-scenes story began to unwind.

It seems that this particular Riv was

a so-called "preproduction car" that was pretty much hand-built before the normal assembly lines started up. It didn't even have a Vehicle Identification Number. It was intended for use in press previews, auto shows and airport displays, but was never meant to undergo normal day-in, day-out service. That's why it had been given to us for use as a project car. When we're done re-engineering it, the Riv will be returned to Buick and dismantled, as preproduction cars always are-they are never sold to the public, simply because many of their parts are fragile, handmade prototypes. Because of this, we are withdrawing it from our Long-Term Test

fleet. Buick is replacing the fragile,

handmade pieces with production

parts. When this is done, look for it as

a future PM Project.-W.H.

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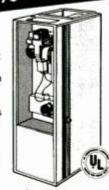
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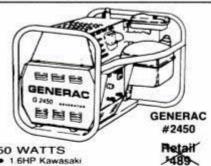
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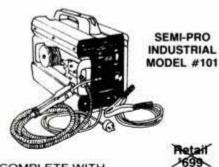
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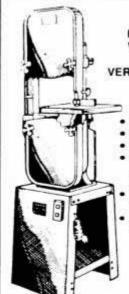
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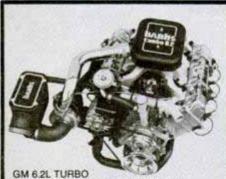
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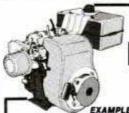
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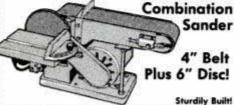
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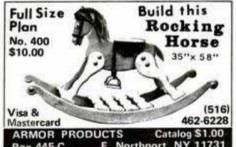
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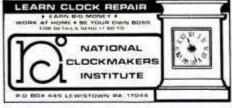
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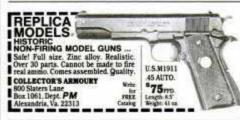


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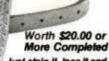








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TIME MACHINE

75 YEARS AGO: September 1911



Auto racing labeled unsafe.

Auto racing's end

"The racing game, in fact, has outlived its usefulness. The science of speed has reached a point where any manufacturer can produce a car which will satisfy any sane driver." These words were written by auto racing pioneer Barney Oldfield, who observed that racing were approaching speeds of 60 mph and better. Dirt tracks were killing race car drivers. Today's drivers do 55 on their way to the track and over 200 mph in competition that's safer than it was in 1911.

Pandora's Box

The yawl Pandora (right) was halfway on her trip around the world. It took one year, 46 days. During the voyage, the 37-ft. vessel hit rough seas and almost turned over at one point. On two occasions, Pandora's masts were washed overboard. The crew was composed of well-heeled adventurers who weren't trying to break any record in particular. Still, as she neared the 22,000-mile mark of her journey, PM observed that Pandora may have been the smallest global vawl ever.



Capital gain

Designs were approved for new buildings for the justice, commerce, labor and state departments. The total cost of the project was \$11 million, which was considered a bargain even in the days before the Gramm-Rudman act spending limits.

50 YEARS AGO: September 1936

Sleek ferry

Aerodynamics was coming into fashion in 1936, when Raymond F. Loewy introduced a new ferry for Chesapeake Bay. Designed in a wind tunnel, the 260-ft.-long ferry was made to transport up to 80 cars and 300 passengers. The craft was made to ply the bay's waters at 18 mph, but it never got up to top speed and was never commissioned because of safety problems with doors in her bow. She was refitted and used as a part-time ferry and military supply ship in World War II.

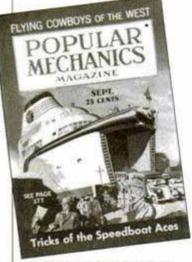


Hello, dolly

Hollywood introduced the new camera dolly. The rubber-tired camera platform kept camera crews at a steady 1 foot from the subject during a scene involving motion. The dolly has become commonplace.

Suited for space

In 1936, the closest man expected to get to outer space was the stratosphere-a bit higher than 50,000 ft. above Earth. Spanish flier Emilio Herrera was to make the first manned attempt the following year. To get that high up in an aircraft, he needed a pressurized suit with an oxygen supply. The rig (left) looked like a deep-sea diver's suit with flexible arm sockets, valves and vest. Herrera's flight was canceled for lack of funds. We were in the stratosphere by the 1940s.



Aerodynamic ferry launched.

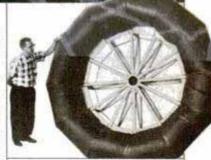
25 YEARS AGO: September 1961

High-tech house

The term "modular" for new home designs seems to have come into usage in the past decade. But PM beat the bandwagon when it offered plans for a modular house in 1961. It could be built with two different style roofs and had "zoned" rooms where you could cut off heat or air conditioning when not needed. And it had a variety of floor plans for different-sized families with differing requirements. "The House of Imagination" proved to be the forerunner of today's high-tech homes.

Lunar tube

When a landing module set down on the moon, how would it handle the shock? No problem, said the researchers at Goodyear Aircraft Corp. You install an inflatable donut-shaped wheel with collapsible spokes on the bottom of the lander. As it approaches the lunar surface, the wheel inflates (right) to full size. The craft sets down softly. NASA eventually springed legs on the bottom of lunar landers. But the inflatible-wheel idea was considered for a long time.



Bull's eye

The Air Force announced that a Falcon air-to-air missile hit a 36-in. target a mile away. That's about half as accurate as current air-to-air missiles.



Futuristic modular housing.

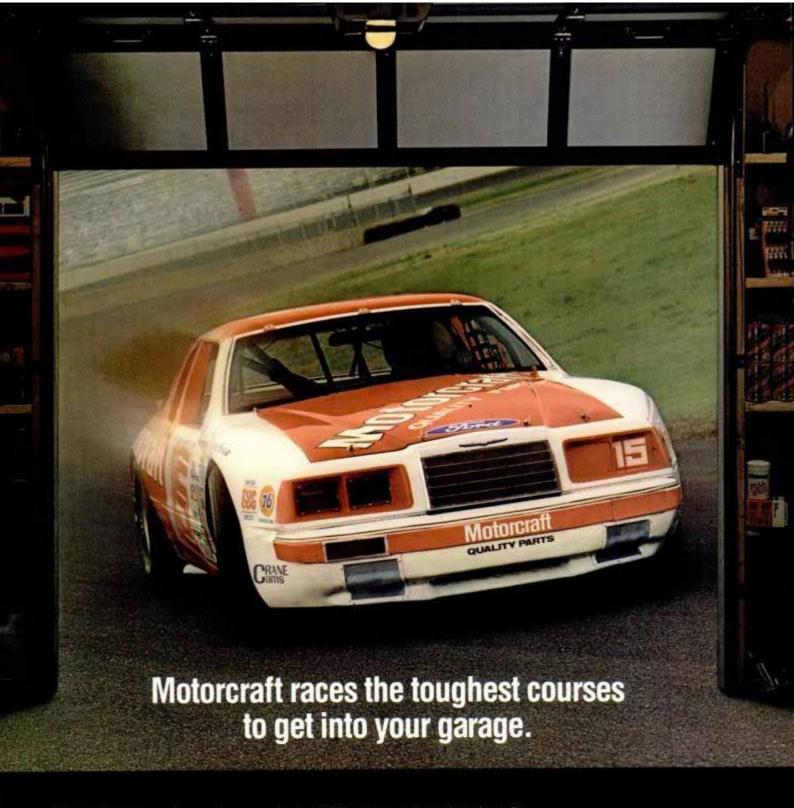
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