

Popular Mechanics

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FLYING WING

You Build And Fly It Yourself

FAMILIES IN THE FAST LANE

We Test 8 New Sport Sedans

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Silent Pellet Guns Score Highest In Accuracy

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SPECIAL REPORT

Photography • CAMERAS • Video

- Newest Equipment
- How To Take Better Photos, Make Better Videos
- How To Maintain Your Gear

PLUS—

Enter Our New PHOTO CONTEST And Win A State-Of-The-Art Camera



Taurus will often carry rear seat passengers, so they figure equally in the overall design: With wide, comfortable places for their feet; rear seat heat ducts; and if the rear seat passengers happen to be children, Taurus' child-proof rear door locks offer some peace of mind.

▶ **THOROUGH DESIGN.** To carry a lot of cargo, the trunk is deep and commodious. To carry two bags of groceries, most models include an elasticized net to keep them upright. When it rains, Taurus has 20" wipers to clear the windshield. And for bright days, a secondary driver's visor, on most models, provides simultaneous front and side protection from the sun.

▶ **ONLY FROM FORD: 3-YEAR UNLIMITED MILEAGE POWERTRAIN WARRANTY.** Ford's powertrain warranty covers you for three years with unlimited mileage. It's a combination unmatched by any other American manufacturer. Ford's warranty covers major powertrain components on all 1987 Ford cars. Limited warranty and certain deductibles apply. Also, participating Ford Dealers stand behind their customer paid work with a free Lifetime Service Guarantee. It's good for as long as you own your Ford car. Ask to see the Powertrain Warranty and the Service Guarantee when you visit your Ford Dealer.

▶ **FORD. BEST-BUILT AMERICAN CARS... SIX YEARS RUNNING.** "Quality is Job 1!" In fact, for the past six consecutive years, Ford quality has led all other American car companies. This is based on an average of owner-reported problems in the first three months of service on '86 models, and in a six month period on '81-'85 models designed and built in North America.

AND WHY IT PAYS OFF SO HANDSOMELY. FORD TAURUS.

Successful design anticipates the needs of the user. And the vision pays off in Taurus. Buy or lease one at your local Ford Dealer.

Have you driven a Ford...lately?



**FORD TAURUS
SEDAN AND WAGON**



Powertrain:

2.5L 4-cylinder EFI
Front-wheel drive
Transaxles: Auto CLC or
5-Speed Manual
3.0L V-6 Multiple Port Fuel
Injection
Front-wheel drive
Transaxle: Auto Overdrive

Facts and Figures:

Passenger Capacity:
Sedan—Up to Six
Wagon—Up to Eight
with optional third seat
Luggage Capacity:
Sedan—17.0 cubic feet*
Wagon—81.0 cubic feet*

Major

Standard Equipment:

The MT-5 (5-speed manual) and GL include an electronic AM/FM stereo, 4-way front headrests, interval wipers, and many other standard features.

The LX (pictured) includes air conditioning, front seats with power lumbar supports, power windows/door locks, and much more.

All Wagons include a 60/40 split-folding second seat, two-way liftgate, and roof-mounted luggage rack.

**Preferred Equipment;
and Special
Value Packages:**

There are several Preferred Equipment Packages that combine the most popular options for up to hundreds of dollars less than the price of these options ordered individually. Plus, when you purchase a Taurus L, GL, or MT-5 with these packages and a 2.5L engine, certain options will be included at no extra charge. See your local Ford Dealer for details.

*Based on EPA Cargo Volume Index.

Buckle up—Together we can save lives.



Taurus is dedicated to the principle that successful design anticipates the needs of the user.

The result of this vision is an automobile of innovative design which is not only handsome, but also makes a great deal of sense.

► **EXTERIOR DESIGN.** To the wind, Taurus presents a clean, almost unbroken surface. The headlamps, side windows, even the door handles lay flush to the body. While the effect is pleasing to the eye, it also pleases the ear by reducing interior wind noise.

The overall shape is designed to enhance Taurus' stability on the road. Even the underbody is shaped to reduce aerodynamic lift and channel cooling air to the engine compartment.

► **INTERIOR DESIGN.** Taurus seats are designed to satisfy two important criteria. One: For refreshing comfort during long drives. Two: For firm lateral support in turns.

Controls are placed and shaped so your hands can find and identify them easily (your eyes stay on the road). The steering wheel is sized, placed and designed to make it comfortable to grip. Even the safety belts are easy to fasten and adjust.





VISION.

TAURUS



This One



JN7R-ZGJ-5BUC



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**ON THE COVER**

The Davis Flying Wing has a lot going for it. It's responsive, stable, and a blast to fly. But maybe the best thing is that you can build it yourself. Read about our test flight of this revolutionary homebuilt in the exciting story on page 53.

—PM photo by
Jim Campbell

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SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.

16 mg "tar," 1.0 mg nicotine
av. per cigarette, FTC Report Feb '85

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Editor's Notes



Most people probably wouldn't think of POPULAR MECHANICS as an "arty" magazine. Yet, the fact is, we've won 22 awards for art direction and graphic design in the past year alone. The latest awards include a Certificate of Distinction at the highly regarded Creativity '86 Art Show, which is sponsored by *Art Direction* magazine. We also received awards at this show for photography and illustration. Our Car Care Guide that appeared in the May 1986 issue was so highly regarded that it became part of the exhibition itself and was displayed throughout the run of the show. We're particularly proud of our awards for graphic design because, frankly, we like to think of ourselves as a bright, contemporary, visually exciting magazine. Awards like these kind of reinforce our own perception of ourselves. Each month, our art department, headed by Graphics Director Bryan Canniff and very ably assisted by Art Director John Johaneck, Associate Art Directors Alan Andresen, Ann Bennett



Canniff and our Car Care Guide exhibit.

and Diane DePasque, and Art Secretary Candy Chimples, works with our editors, writers, photographers and illustrators to make sure every page of POPULAR MECHANICS tells its story with excitement, clarity and style. . . . **Never let it** be said that our editors aren't ready for anything, anytime. Recently, our friends at New York radio station WMCA called in a panic. One of their talk show hosts bombed out and couldn't do the show for the next two Saturdays. Each show was 3½ hours and we could do just about anything we wanted (within reason). Could we help out? A few days later, Shop and Tools Editor Joe Truini and Science/Technology/Aerospace Editor Dennis Eskow were on the air. They hosted a talk show that covered the gamut from homeowner tips to simple science around the home to a call-us-with-your-homeowner-problem segment. . . . **Our Special Report** this month, put together by Electronics/Photography Editor Steve Booth, focuses on cameras and what you can do with them (page 79). Besides attempting to guide you through the thicket of equipment, we've also included information on how to make better pictures and how to make your equipment last longer and work better. I advise you to shoot some still photos right now, or find your best stuff in the shoebox, and send the photos in to us. You may win one of the state-of-the-art Canon cameras we're giving away as prizes in our new photography contest. Details are on page 98. . . . **There's something** especially fascinating to aviation buffs about a flying wing. The very thought of it—a wing, flying, with no fuselage attached, no tail, no nothing, just that wing—has driven men for years to find a design that works, *really* works.

Now freelance writer Jim Campbell reports in this issue's cover story (page 53) that you can actually build and fly your own flying wing—if you're so inclined. The design exists, it works and he flew it. Come along for the ride. "Til next time.



Eskow and Truini on the air.


Joe Oldham

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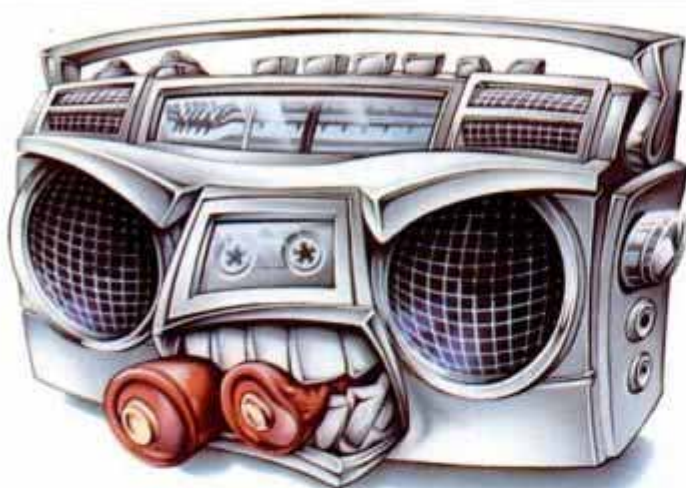
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Letters



On The Right Track



Steam trains story inspired Jones' locomotive painting.

As a lover of steam locomotives I thank you for your story, *Steam's Back On The Fast Track*, in the September '85 issue (page 90). I've painted a picture of "Old Number 90" and enclosed a Polaroid of it hanging on my wall. It was entered in a local art exhibit and I received many encouraging remarks.

UDELLE T. JONES
VICKSBURG, MS

You're on the right track as far as we're concerned, too.

Way off-road

In commenting about the Jeep Wrangler in your September '86 issue (*PM Comparison Test: Off-Road Warriors*, page 74), your writer used Harley-Davidson's name. Normally that would be just wonderful—if only the writer knew what he was talking about. In this case, he's lacking current information about events in the motorcycle industry.

Further, it sounds like you are implying that Harley-

Davidson motorcycles are unstable. In fact, they are well known and appreciated for stability and comfort—and this judgment comes from independent testers.

Harley-Davidson Inc. has worked very hard to build a better quality product to compete with foreign competition. We agonize over an old stereotype that our products are not competitive. We have progressed dramatically in recent years, but unfortunately, your comments only reinforce that old myth.

BUZZ BUZZELLI

PUBLIC RELATIONS MGR.
HARLEY-DAVIDSON INC.
MILWAUKEE, WI

We subscribe

Recently, I thought I was renewing my subscription to *Popular Science*, and actually ended up subscribing to *POPULAR MECHANICS*. After viewing two issues of *PM*, I believe the mistake has been to my advantage. The article on IBM clones (*Target: Big Blue*, page 80, Oct. '86) was of particular interest.

HENRY W. FLORA
FRUITLAND PARK, FL

Interjection

According to your "Technical Highlights" section (*New Cars 1987 Special Report*, page 143, Oct. '86), the GM 2.8-liter V6's fuel-injection system has been modified for '87. The modification avoids deposits plugging port injectors. GM also offers a 5.0-liter V8 with what they call tuned port injection. Were deposits (or anything else) a problem for this injection system and, if so, has GM made modifications for '87?

GEORGE E. ERTEL
CHICAGO, IL

The new-style injectors will be phased into other problem engines as availability increases. In the meantime, more oil companies are introducing "super detergent" gasolines that help eliminate injector deposits on existing engines.

Some hazard!

First, accolades to a consistently fine publication. It's the only one of my several subscriptions that I manage to get through cover-to-cover on a monthly basis. Keep up the good work on the many diverse subjects that appeal to my diverse interests. Second, my sincere condolences to Auto Editor Wade Hoyt for having to ride in a nonair-conditioned Trans Sport (*Driving The Future*, page 76, Oct. '86) with cover model Lynne Austin. Hope he got hazardous-duty pay!

J.W. BUSH
COLUMBUS, IN

Friendly swing

The swing you show in the July '83 issue is a masterpiece (*Build PM's Old-Fashioned Porch Swing*, page 94). The plans included with the story couldn't have been better for building it. I started with scrap lumber: pallets, old oak 4x4s and such. And after two years working part time, I finished mine. Except I built it to be 6 ft. 6 in. long, so I added an extra back frame side and seat frame nailer (N and O in the Materials List) for support. I made it for good friends and they are real proud of it. *PM's* a great magazine; keep the projects coming.

WILLIAM R. CLARK
MEMPHIS, TN



Clark modified *PM* plans to build a wider porch swing.

Flip side

There is another side to the position taken in "Why a Russian-type nuke disaster can't happen here," an article which appeared in the July 1986 issue of *PM* (*Technology Update*, page 61).

While the nuclear industry insists that the Three Mile Island experience was used to enhance the safety of all U.S. plants, the U.S. General Accounting Office found in September 1984 that there were more unresolved safety problems affecting nuclear plants than there were before the TMI accident.

Further, documents released by the Nuclear Regulatory Commission show that Chernobyl did have a pressure suppression containment system similar to many nuclear plants in the United States—despite initial reports to the contrary.

There are unresolved safety problems, management failures and flawed plant designs associated with American nuclear power plants—the other side of the rosy picture depicted by the nuclear industry in its advertising campaigns. In the wake of the Chernobyl tragedy, it is increasingly important that the public hears both sides of this critical issue.

SCOTT DENMAN
DIRECTOR, SAFE ENERGY
COMMUNICATION COUNCIL
WASHINGTON, DC

Watch your fingers!

In your story, "Fixing Windows And Door Locks" (*Saturday Mechanic*, page 155, Nov. '86), you should have warned readers about the counterbalance spring in window regulators, especially in Ford cars. You should always secure the sector gear with a strong clamp—or, as shop manuals advise, drill a 1/4-in. hole through sector and bracket and insert a bolt and nut to restrict movement when the motor is uncoupled. Otherwise, the mechanism can easily cut hands or wedge fingers when the gears are unmeshed.

DAVID BUSH
PENSACOLA, FL



Bronco II four-wheel drive



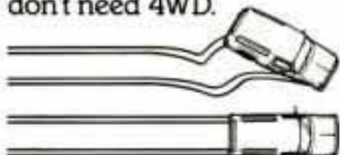
Bronco II two-wheel drive



Now, Two Ford Bronco II's ...4-wheel and new 2-wheel drive models.

Choose a Ford Bronco II to suit your active lifestyle—with traditional four-wheel drive, or a new two-wheel drive only model.

For those who love their town and country driving, Bronco II gives you more ways to have fun with style: either tooling around the out-back or threading city streets. That's because there's now a two-wheel drive model available... great for people who like the kick of a Bronco II but don't need 4WD.



New rear antilock brake system.

Both Bronco II's feature a first in their class—new rear antilock brakes. They're designed to help you make straight stops when you're traveling in 2-wheel drive. Only Ford has them, and they're standard!



Touch and go.

Just push a button on the 4WD Bronco II and Ford's electric "Touch Drive" option automatically kicks from two-wheel drive into 4WD high at any speed. The traction you want in all-weather driving is there instantly. You don't have to stop, get out, or shift.

Eddie Bauer

Eddie Bauer Bronco II features unique two-tone paint and special trim, high-style interior with dual Captain's Chairs for extra comfort. And it comes with "Ford Care" extended service plan** protection too—24 months or 24,000 miles, whichever comes first. Plus an Eddie Bauer garment bag and 6-pocket gear bag.

Unbeaten V-6 power.

For '87 Bronco II turns loose the juice with an electronically fuel-injected 2.9L multi-port V-6. This powerplant is unbeaten by any standard engine in its class! On the freeways or in the mountains you have 140 hp* at your command.

The Ford Bronco II is versatile and fun to drive. Its "command seating" puts you in charge of the road. On or off road, it's the way to go first class!

Free air conditioning.

Free air conditioning is available when you buy any Bronco II Special Value Option Package. The option content varies with your choice of package. The savings are based on the manufacturer's suggested retail price for the Special Value Package compared to traditional suggested pricing for the options purchased separately.

Best-Built American Trucks six years running.

"Quality is Job 1." In fact, for the past six consecutive years, Ford quality has led all other American automotive companies. This is based on an average of owner-reported problems in the first three months of service on '86 models and in a six month period on '81-'85 models designed and built in North America.

Buckle up— together we can save lives.

*Based on SAE Standard J1349.

**Limited warranty. Ask to see a copy at your dealer.



FORD
Bronco II

Imports

BY BILL HARTFORD



Jaguar's New Sedan



Obviously Jaguar: Shape of the all-new XJ6 sedan coming in April.

Time, gentlemen. Time to trade in your nostalgic attachment to Jaguar's old, emblazoned XJ6 for a real passion. The new XJ6 is going to seduce your senses—and intellect. Its speed and ride will leave you breathless, its handling burn holes in your driving gloves, its luxury fill your nostrils with Essence of Jaguar, the sweetest smelling leather interior on wheels. And the new Jag promises to be a car you can still respect in the

morning—cold, damp mornings when you're happy to just get started. We spent several nights, mornings and hundreds of miles with the new XJ6 and know how well it delivers. We know, also, that your first response upon hearing that Jaguar was planning to update its XJ6 would have been "Leave it alone!" because we, too, were counted among the faithful whose appreciation for the original styling has only grown since it was introduced back in '68. That's a long run, especially in this age of intense jousting among luxury car-makers. It's not enough to hand-sew hides and match walnut veneers. Today's luxury car has to do more than ever before, and do it efficiently and reliably. That's why the new XJ6 starts life in modern manufacturing facilities where Jaguar has made a huge investment in advanced technology to meet the growing demand for its cars. The new XJ6's smoother styling is obvious, but also



Jag's J-gate (on rh-drive car) lets you shift auto like manual.



Dual exhausts say it's a Jag; taillight lenses are body color.

streamlined is the overall design and the way the car is put together. Come April, push the \$40,000 price aside and look for:

- Emphasis on finish, including clear coat over non-metallic colors, too.
- More aerodynamic body that's 1.2 in. longer and 150 to 200 pounds lighter. Roomier cabin and boot. Single wiper arm. Taillight lenses that match body color, but light up red.
- Stainless-steel trim and exhaust system. Strict Canadian Anticorrosion Code for bodywork.
- Traditional interior using wood, wool and leather. Analog speedo and tach; fluorescents for info and self-diagnosis. Humidity control on air conditioner.
- All aluminum, 3.6-liter, 24-valve, dohc, inline Six with electronic fuel injection and ignition; top speed in 130-mph range. Multiplex-type wiring and seven micro-processors.



Rectangular headlights replace old quads and "eyebrows."

- Antilock brakes including yaw control for when only one side of the car is on a slippery surface.
- Antidive, antisquat self-leveling suspension with superior road noise isolation.
- Power rack-and-pinion steering (turning circle at 40 ft. 8 in. could be better).
- Unique J-gate selector allowing a manual-like throw between SECOND and THIRD on the 4-speed automatic

gearbox. It's for when you really want to make time, gentlemen.

New wagon

It's easy to get a favorable impression of a new car driving it around the block at your dealer's, but we got ours on the track at Lime Rock Park in Connecticut. That's where we had our



Mazda 323 5-door station wagon has 57 cu. ft. of cargo space.

first crack at Mazda's 323 wagon, new to the line for '87. That's where we wound out the 82-hp, 1.6-liter, fuel-injected Four; felt the Twin Trapezoidal Link independent rear suspension and front and rear antiroll bars doing their job; and counted all the standard features on the good-looking carryall—base priced at \$8799.

Top wagon

The station wagon to beat, when it comes to numbers, is Subaru's. It outsold all others, imported and domestic—even Celebrities and Escorts. The tally (for '85 model year) was 84,758. That's 47 percent of total Subaru sales.

Top down

There's a new wagon among Toyota's 1987 offerings, too—in the restyled Camry line. It's nice, but a new model that's a lot more fun is the power-top convertible version of the Celica. Wind in the hair is courtesy of Toyota's 115-hp, 2-liter, 16-valve, twin-cam Four. **FM**



Celica convertible with power top has rear seat that folds.

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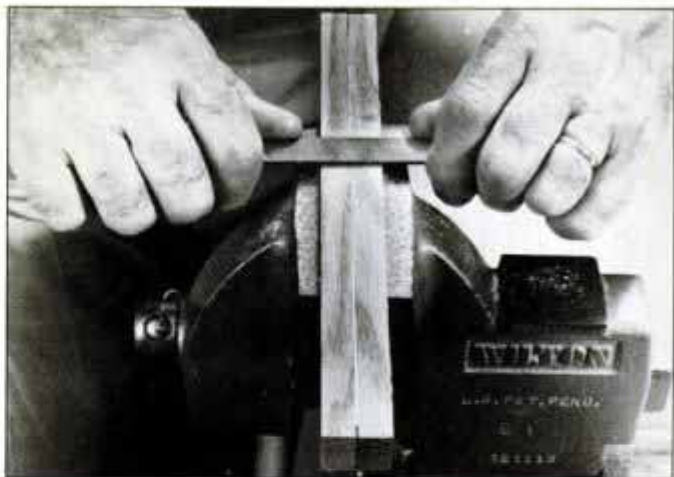


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Workshop Minicourse

BY ROSARIO
CAPOTOSTO



You can file a smooth straightedge on thin sheetmetal by clamping it between two scrap hardwood blocks. Make sure the blocks are aligned with each other, then draw-file the edge.

Using Files: Part 3

Up to now, our focus has been on the common filing techniques, but there are many other filing operations. Here are a few other examples and some finer points on how to use files.

Though most files are used with two hands, some aren't. Needle files are usually used with one hand because of their small size. Edge tools, like hatchets, are often held on the bench with one hand and sharpened with the file held in the other hand.

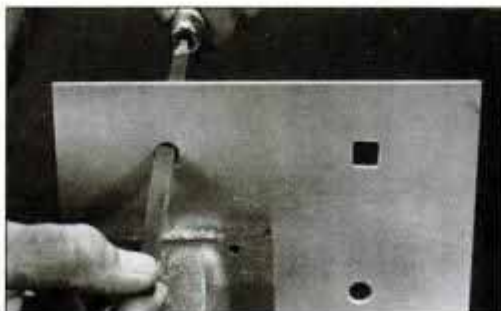
Remember, unlike other tools, files can't be resharpened. Though hard use will dull a file, improper use will dull it just as fast. Apply ample pressure to the file to make it cut; do not just slide it over the work. Sliding the file will rapidly dull it.

Avoid touching the work or the face of the file with oily fingers, and make sure the work surface is free of oil. This way the file will not slide over the workpiece.

Scale, a black hard crust often found on cast iron, should be removed before filing because it dulls a file.

Similarly, avoid filing over a vise's jaws because they are made out of extra-hard steel and can rapidly dull a file. Also, files are so hard they are actually brittle. So avoid striking or dropping them.

Never store or carry files in a pile, where they can hit or rub against each other. Hang them up separately or store them in a drawer with partitions. **PM**



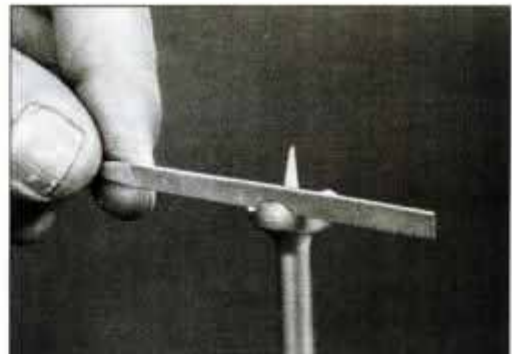
To square a hole, first draw a square outline around the hole, then file to the line. Start the cut with the file held on a diagonal slant.



To form a rounded slot, use a hacksaw to cut a V-notch, then use a round file to shape the slot. For a large curve, use a half-round file.



To file with one hand, place your forefinger on top of the file and apply downward pressure. Note: Hatchet is elevated to allow for a clear stroke.



Special files are available for sharpening drill bits, but a smooth, flat, needle file with a safe edge can be used as a good substitute.



Rotary files with broken flutes are best for work on ferrous metals. Burrs with continuous flutes are best for work on nonferrous metals.



A warding file is very thin in cross section and is used for working in narrow spaces. Here, one is used to file a slot in bar stock.

Screen Test.

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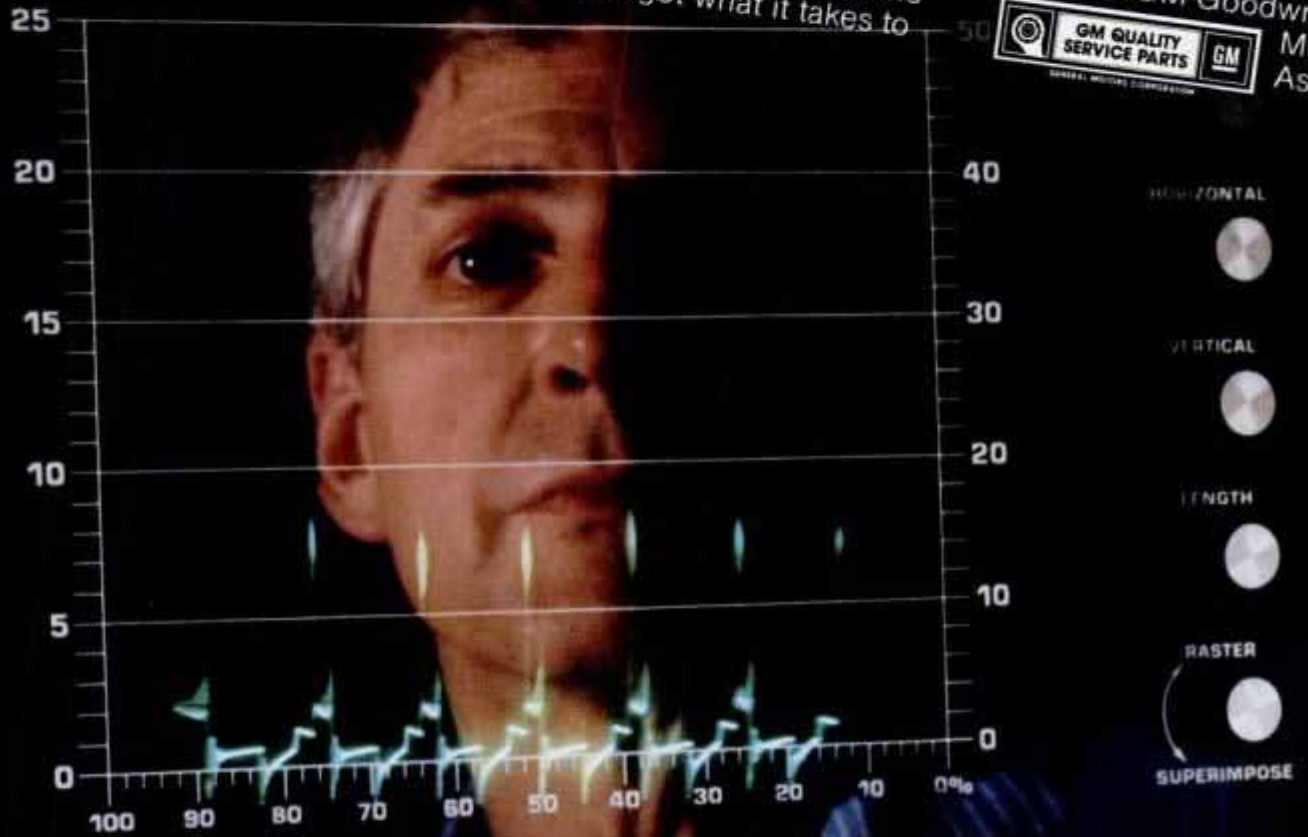
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Electronics



BY STEPHEN A. BOOTH

Colorful New Apple



Apple IIIGS runs color programs such as Activision's *Paintworks Plus*.

For as long as anyone can remember, Apple Computer has promised to keep its Apple II line alive and vibrant. Now the company is delivering on that commitment to the legions of II lovers with the new Apple IIIGS, a machine that preserves the heart of the IIe intact but adds striking new capabilities.

This is Apple's answer to Atari's ST and Commodore's Amiga, a "turbo II" that combines enhanced speed and memory, Macintosh-like ease of use and, importantly, software compatibility with most of the 10,000-plus programs already written for the II series.

Decked out in Apple's new platinum look and now sporting a detachable keyboard, the IIIGS definitely has an

updated appearance. But what's inside is much more dramatic.

The IIIGS—the GS stands for graphics and sound—offers a 16-bit 65C816 microprocessor with three times the speed of the 1-megahertz IIc and IIe. Its 256,000 bytes of RAM is standard issue, but the IIIGS can be expanded (this is as open a machine as the IIe) up to a hefty 8 million characters. Apple has also increased internal read-only memory to 128,000 bytes (expandable to 1 megabyte) to host the QuickDraw II routines that give the IIIGS its Mac-like personality with mouse, icons and pull-down menus—but in color.

No, the IIIGS isn't the hoped-for "color Mac" under another name. But the IIIGS

effectively apes the Mac's personality. The new Apple micro now offers seven video modes, all of those offered in previous II-models plus two new resolutions, 320 x 200 and 640 x 200 pixels. Up to 16 colors can be displayed at one time on the new computer's RGB analog monitor—from a total palette of 4096. A 16-shade gray scale is also available. Sound capabilities are equally impressive, featuring a built-in 15-voice synthesizer with 64KB dedicated RAM plus highly realistic voice synthesis.

Apple has enlisted a sizeable cadre of software developers to write programs that can exploit the IIIGS's aptitudes. Expect to see at least a small body of IIIGS-specific software programs available now, with considerably more arriving later in '87.

In the meantime there's that cache of earlier II software to run, using the IIIGS either at regular 2.8-megahertz clock speed, or downshifted to the rate of older IIs when faster performance isn't wanted—when playing games, for example.

With the IIIGS priced at just under \$1000 for CPU, keyboard and mouse, a full-blown color system with RGB monitor and two 800KB micro-floppy disk drives will cost between \$1500 and \$2000—a bit higher than a IIe color system, though actual dealer prices are likely to be less.

The IIIGS won't be the cheapest PC on the block, particularly compared to the Atari ST and some of the new low-end IBM compatibles. But Apple believes the machine's power and software compatibility makes it the most versatile—equally adaptable for home, school and business.

By the way, Apple II owners won't necessarily have to buy a complete IIIGS system to savor its power. Apple plans to offer an upgrade IIIGS logic board that will effectively convert the IIe into a IIIGS.

Souped-up C64

The legions of Commodore 64 owners, estimated at some 5 million strong, can taste a bite of the Macintosh thanks to a new \$60 program from the California-based Berkeley Softworks.

Dubbed GEOS (for Graphic Environment Operating System), this program gives the venerable C64 its own multitasking, desktop-look operating system.

You'll find the simplicity of GEOS quite appealing: The program lets you view, load, copy and delete files by moving a pointer icon with a mouse or joystick, instead of typing BASIC commands.

GEOS, like Apple's MAC, features pull-down menus, icons and windows, and includes a new disk operating system that offers additional file-handling capabilities. And C64 buffs will be delighted to hear that GEOS promises a marked increase in disk-data transfer rates. Berkeley Softworks claims the new operating system can accelerate data flow on the notoriously tortoise-like Commodore 1541 disk drive by as much as seven times.

Along with its new operating system and the desktop user interface, the GEOS package comes with two applications programs. One is geoWrite, a what-you-see-is-what-you-get word processor that also includes the ability to use multiple, proportionally spaced fonts. The other bonus is geoPaint, a graphics editing program that incorporates a range of painting tools. Users can cut or copy images from one application and paste them onto the other. **FM**



Geos: Speed, better graphics for C64.

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How to get out



The Civic Wagon is as unconventional as a woody. And just as much fun.

Of course, there are practical reasons to own a wagon. Efficient transportation. Room for passengers, pets and all sorts of oversized cargo. The problem is most wagons are so full of sensible ideas, there's no room left for fun.

The Civic Wagon takes a different road. It has been variously described as cute, perky and even unusual. But never dull. In fact, it's full of nifty and imaginative features to discover.

Tall windows. Skylights. Secret compartments. A pop-up air vent. A sliding drawer. Seats that flip and fold ten ways.

of the wagon rut.



And the way it handles, you can let your imagination run wild. We're not talking about beating an Italian sports car off the line, but definitely fun to drive.

You can also choose front-wheel drive. Or Honda's Real Time™ 4WD, an advanced system that kicks in automatically whenever extra traction is needed. This wagon

is designed to get you out of a rut in more ways than one.

While you're at it, maybe you ought to get some fuzzy dice for your woody, er, wagon. Nah, that's probably going too far.

HONDA

The Civic Wagon

Old House Restoration



BY BOB VILA

Working With Contractors

The satisfaction you'll derive from a major home improvement project will, for the most part, depend on how well you select and work with a single individual: a general contractor.

Unless you are unusually handy, own a diverse array of tools and equipment, and have the time to do the work, you'll probably need to hire a general contractor to put the pieces of the project together. He or she will coordinate everything from material deliveries to satisfying building codes to actual construction, as well as hire the specialized tradespeople necessary to complete the job.

The problem is that contractors have you at a disadvantage. When working with them, you are, in essence, an amateur dealing with professionals. In order to even this disparity and turn the relationship to your advantage, you'll need to do some research.

Planning the remodeling

Before hiring the contractor, you need to sit down and determine what you want to accomplish. If you're not quite sure, try a little impromptu self-education. Take a tour of the neighborhood and, with the permission of your neighbors, snap

Contributing Editor Bob Vila is host of public television's "This Old House," funded by Owens-Corning Fiberglas.

some photos of homes that match your style preference. Look through remodeling magazines, marking ideas, special features and products that appeal to you.

If you're still not sure which direction to take, consider investing in a consultation with an experienced architect or interior designer, especially if the project will involve major structural changes. These professionals can determine whether your idea is feasible and affordable for your budget. If so, they can then draw up the plans the general contractor will need to get the project under way. You may wish to retain the architect or designer to supervise the entire job for you.

In any case, once you're satisfied with your remodeling plans, it's time to find a contractor.

Selecting a contractor

Finding the right contractor is the key to the success of your project. The best way to locate a reliable one is through relatives, friends and neighbors who have had similar work done recently.

Your next best source of recommendations are impartial professionals, such as carpenters, architects, engineers or even a local mortgage or real estate agent. You can pick up some leads from a branch office of a major trade association, such as the National Association of Home Builders or

the Home Remodelers Assn. You might ask local contractor supply houses, paint stores, lumberyards, building supply outlets, electrical wholesalers or plumbing supply houses for referrals.

After compiling a list of candidates, evaluate them carefully. Check that each has a clean record with the local Better Business Bureau. Next, ask each contractor for photos of previous work and a list of former customers. Ask these homeowners if you can pay them a visit. Take a look at the contractor's work and find out how the owner felt about working with the contractor.

Never automatically hire the low bidder. A contractor you can trust, one that comes highly recommended or whose past work is to your liking almost always turns out to be the best choice.

should problems arise.

Here are some of the important points that you'll want to address:

Spell out the details of the work to be performed by the contractor and list materials to be used. Even include things that seem insignificant, such as drawer pulls and cabinet hinges. Remember, an unlisted item that needs to be added later could result in higher costs.

Note the price presented in the bid along with the terms of payment. Never pay more than 10 to 15 percent as a down payment. Authorize subsequent payments in stages tied into completion of major portions of the job. But hold back the last 10 percent until 30 days after the job is finished (most states give you this legal right). This will give you time to check out the job as



Teamwork and planning are necessary for a successful remodeling job. Choose a contractor who you can trust and work with.

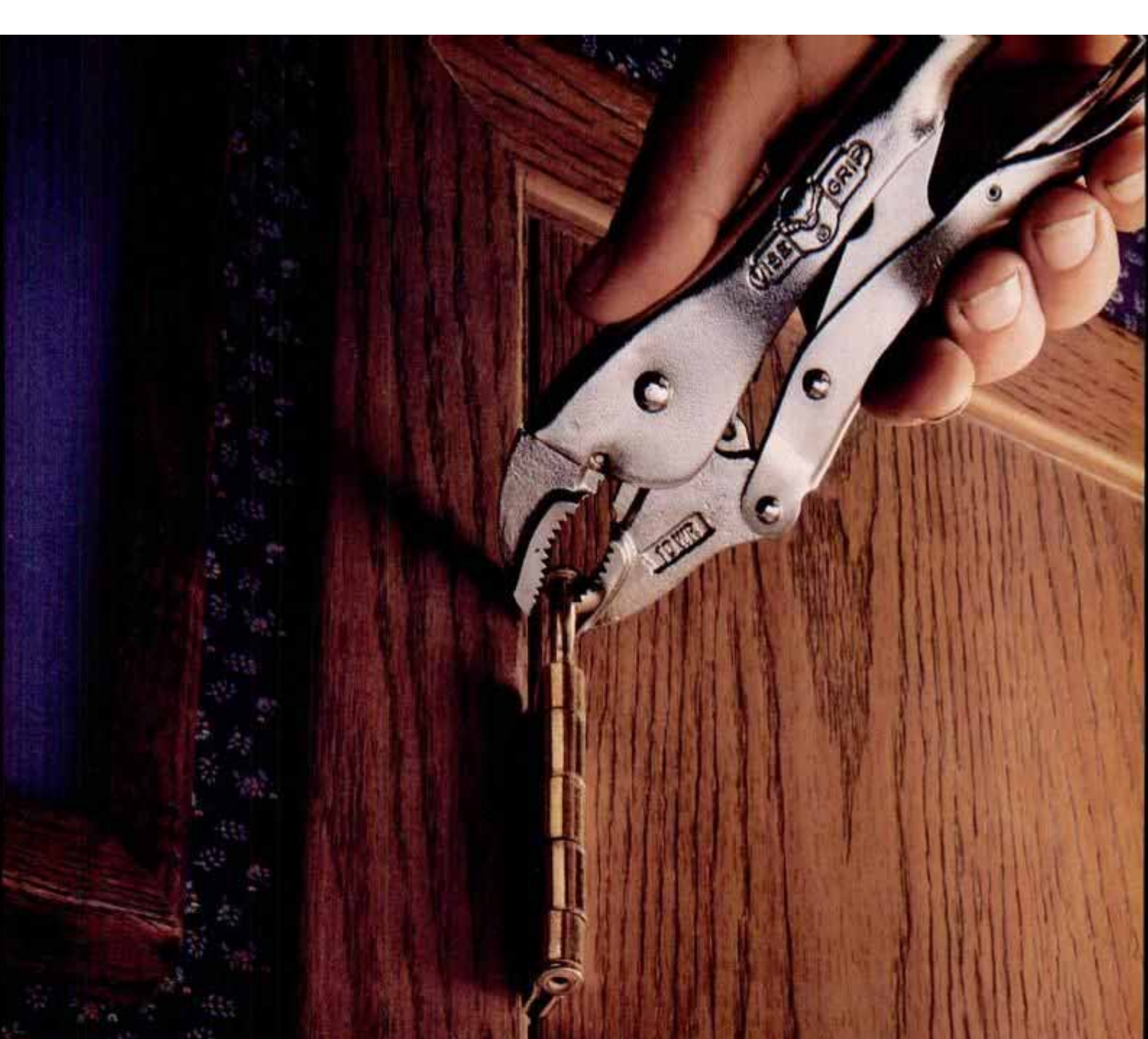
Drawing up the contract

Once you've accepted a bid from a remodeler, the two of you will need to draw up a contract. A good one contains not only names, dates, dollar amounts and other specifics, but also is a format for making changes as well as providing for mediation

well as the leverage to insist that the contractor completes it to your satisfaction.

State when the job will begin and approximately when it will end. Include a sentence calling for "continuous work effort" while the job is in progress. This clause won't guard against

(Please turn to page 24)



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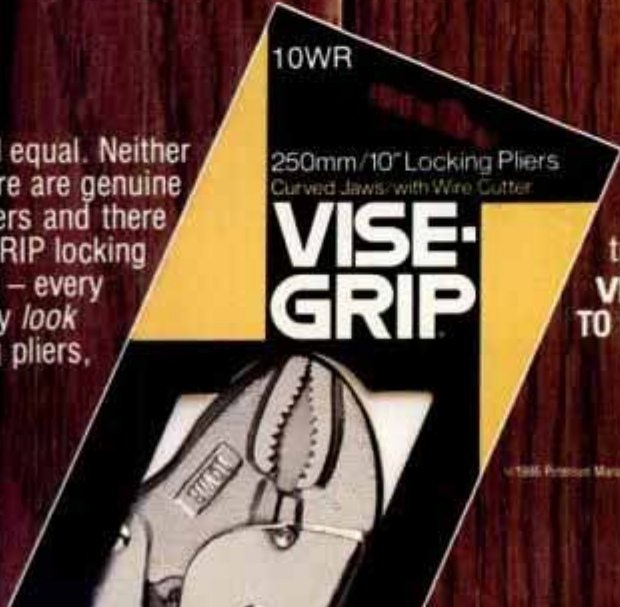
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OLD HOUSE RESTORATION

(Continued from page 22)

unavoidable delays caused by such factors as strikes or inclement weather, but it will protect you against a contractor who begins a project then departs to work elsewhere.

Your contractor should have liability insurance to cover damage that occurs while working on your property. Ask to see the contractor's workmen's compensation certificate. This will protect you from a lawsuit should one of the workers be injured on your property.

A great deal of dust and debris is likely to be generated at the site every day. If you expect the contractor to clean up and cart this away daily, periodically or at the end of the job, the contract must say so.

State clearly how any changes you or the contractor requests will be handled, including an agreed-on price for these changes. Specify that the contractor is responsible for performing all work in accordance with local building codes and for acquiring all necessary approvals and certificates from local building departments.

Specify that the contractor will furnish a waiver of mechanics lien rights from all suppliers and subcontractors involved. Without this, in most states,

these tradespeople can sue you or attach a lien to your house in case the general contractor fails to pay them—even if you've already paid the contractor in full.

Stipulate that, in a dispute, both parties agree to binding arbitration administered by a mutually agreed on outside organization, such as the American Arbitration Assn. or a local chapter of the Better Business Bureau. This will help you avoid having to go through a long and expensive court procedure.

Make sure the contractor warrants materials and labor for at least a year and also passes on all manufacturer's warranties to you.

In most cases, the homeowner has a Right of Recision, which means that after officially hiring the contractor, you have three working days to back out of the deal without penalty.

Working together

In the course of a major remodeling job, it's normal for problems to arise. To deal with them, you and your contractor should establish some basic rules.

Most importantly, either you or the person you designate to supervise the job should be present regularly to answer the contractor's questions or resolve unforeseen developments. If no one is around to provide direction, the

contractor may have to make an important decision that may have bearing on the completed job. Therefore, plan intermittent meetings to discuss job progress, upcoming work and any possible delays or changes in the plans.

Never direct or criticize workers or subcontractors directly. Speak to the general contractor about the problem first, or a work stoppage could result.

When work has been completed for the day, inspect the area. Make sure that what is being done is what you want. If an error is made or if a product is defective, inform the contractor immediately. The earlier a mistake is made known, the easier it is to correct.

Before you make the last payment, both you and the contractor should inspect the project together. Go over every detail. Keep in mind that your final check signifies that you are satisfied with the job as it stands. So don't write out the last payment until you're satisfied each and every nail is in place.

Remember: Construction almost always takes longer than expected, costs more than planned, and may not turn out exactly as imagined. But if you've checked out your contractor thoroughly, negotiated a tight contract, and insisted on quality workmanship, chances are you'll be happy with the results. **PM**

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Dept. 380X

Outdoors



BY TIM COLE

Rollover Rescue Refined



The Hurricane rollover rescue boat goes through R&D in Vancouver, top. Right, the topsy-turvy view from the helm.

I have been fascinated with rescue boats ever since PM traveled to Cape Disappointment, Washington, last year to research the U.S. Coast Guard's venerable 44-footer (*Surfbusters*, page 84, Apr. '86). Any boat that can take the punishing wind and wave conditions that prevail on the Columbia River bar is worth a look.

So when we received word that a new rigid hull/inflatable hybrid was being built in Vancouver, we took more than a little notice. The Hurricane by Hurricane Rescue Craft (above) is designed to blast out to the site of a mishap at sea at a cruising speed of 29 knots and self-right with ease in any wind or sea state. The Coast Guard's 44-footers can make only 12 knots, and a 360° rollover is possible, but becomes a discomfiting experi-



ence for passengers and crew.

The 46-ft. 9-in. Hurricane draws only 2 ft. 3 in. and is powered by twin Cat diesels through two Parker jet pumps. The aluminum hull (with aluminum superstructure) is ringed by an inflatable 32-in. collar that has seven separate air chambers. The crew of four can ride out practically any weather from inside the cabin, and rescue victims sit inside a special passenger pod. Towing bits fore and aft are also built-in. The Hurricane is currently under review by the Canadian Coast Guard.



Swiss Army watch rotates 180° to reveal compass.

Swiss Army watch

Leave it to the Swiss. The same people who put that folding tool chest in your pocket have just come up with a multifunction wristwatch. Rotate the 7-jewel

quartz timepiece 180° and you find a compass, handy for hikers and hunters using topography maps well off the beaten trail. The compass also incorporates a range scale, expressed in kilometers, and a speed-calculating tachymeter. The analog watch face is traditional Swiss Army red, with date window. The antimagnetic steel case is resistant to shocks and scratches, and divers can take it to a depth of 100 meters, using the ratcheted safety bezel to keep track of bottom time. The 1.55-volt battery lasts for almost 2½ years.

For more information, contact Swiss Army Watch Co. Inc., 105 Fifth Ave., New York, NY 10003.

Something fishy

Technology that was once considered high tech aboard Navy submarines is finding its way aboard the family fishing boat. The latest fish-finding sonars are able to detect individual or schools of fish, bottom structure, profiles—even differentiate between fish species. The latest twist in fish-finder technology comes from Humminbird by Techsonic Industries. Its LCR 4 ID positively identifies fish suspended in water, and marks them in red on the unit's 4-in. x 3-in. LCD screen. A fish no more than 3 in. off the bot-



Humminbird's new LCR 4 ID positively spots fish in red.

tom can now be separated from the usual clutter. For more information, contact Humminbird, Techsonic Industries, #3 Humminbird Lane, Eufaula, AL 36027; (205) 687-6613.

Color stocks

You wouldn't think there was too much improvement left in the tried-and-true rifle stock. But synthetic materials like Kevlar and fiberglass have become important features in the gun trade, while the latest variation in wood stocks comes from Sturm, Ruger & Co. It's come up with stocks of laminat-

ed hardwood that are color dyed, glued and impregnated with resin under pressure. The company offers the new laminated stock rifles in its popular



Ruger's famous rotary-clip .22 has green and brown laminated stock.

Mini-14 semi-auto, 10/22 rimfire semi-auto, 77/22 rimfire bolt-action, and the M-77 centerfire bolt action in .30-06, .270 and 7mm calibers. For more information and further details, contact Sturm, Ruger & Co., 49 Lacey Place, Southport, CT 06490.

Hand warmers

Outdoor clothing designers have recently turned a lot of attention to keeping your extremities warm in cold weather—tending toward greater use of synthetic materials in specialized designs. Recently, we toured the horizon for advancements in boot design. Now it's time for a closeup on gloves and mittens. As with most outdoor clothing, the layered look is definitely in style this season.

Most modern gloves, in fact, keep you warm with three layers—some built in, some removable. An outer shell protects against wind. An insulation layer is designed for warmth. And an inner liner is designed as a moisture vapor permeable barrier, made of Gore-tex, Entrant or Bion II, which wicks moisture away from the hand.

Variations on the theme range from maker to maker, with some firms opting for 2-glove systems that combine a lightweight outer shell with an insulated liner. You can pull the liner away from the shell to dry, which is a big advantage.

But these systems are sometimes bulky, and it can be hard to get the two components to fit correctly. Kombi and Grandoe are two of the big names using the 2-glove approach. Kombi has a zip-in liner. Grandoe's Glove Component System uses Velcro.

For the heavy hitters mounting an assault on K2, or shoveling out a driveway in the Snowbelt, 3-piece glove-and-mitten systems are appearing on the market. Cashmere or polypropylene inner gloves are worn on the inside. They're warm and they wick away moisture. They can also be worn tight enough to achieve a semblance of dexterity, and, as I found on a snowmobiling expedition to Iceland with Ski-Doo, they're great in conjunction with electric handlegrip hand warmers.

These lightweight liners can be covered by a bunting or fleece insulated mitten. A Gore-tex or Taslan outer gaiter that continues up the arm resists chafe and prohibits heat from escaping at the wrist. Versatility and an ability to be donned easily characterize these mittens, particularly from makers like Outdoor Research. But Gates is able to achieve nearly the same result in its brand new Teton gloves, which are thin, warm and attractive. They deserve a close look.

Some details to keep in mind:

■ **Gloves**—Make sure there is lining on four sides of each finger, the wrist fits snugly, and there is reinforcement in high stress areas like palms and fingers. A pull-out lining adds flexibility, particularly when it can be used on a stand-alone basis for close-in work that demands high dexterity.

■ **Mittens**—The keys here are equal

insulation distribution and a good fit between inner and outer layers. Some makers offer insulated finger mitts inside, which are highly desirable in extreme weather.

■ **Materials**—Gore-tex, of course, is the granddaddy of the new moisture vapor permeable fabrics. But Bion II, a 1-piece membrane, may deserve some consideration. Taslan, a light nylon, is flexible and quick drying, but may be less durable. Leather is heavy, but it's tough and soft—great for high-chafe areas. Tuffgrip is a new synthetic reinforcement that is replacing leather in many high-wear areas. Ambush is strong and totally wind resistant.

In the insulation area, down is the tried-and-true material, and it'll probably be around for a long time. It can be expensive, however, and can bunch up inside linings if not sewn properly. It can also be too warm, in which case a good moisture vapor permeable layer becomes necessary. Thinsulate from 3M is finding its way into more and more outdoor clothing applications, and



High-tech gloves and mittens hit the trail.

you find it inside modern gloves. It's warm, but might be a little stiff. DuPont's answer to thin insulation is Thermolite, which seems just as warm but is more flexible.

Liners should be light and strong and made of material that can wick away perspiration. If the glove or mitten has an insulated liner, it should be quick drying and light, and not bunch up underneath the glove's outer shell. Light polypropylene gloves work well as liners with heavy-duty mittens.

Of course, a need analysis will help you answer the very simple question of which hand warmer works best for you. Hunters and fishermen require a high degree of manual dexterity. But, keep in mind that thin gloves or mittens with trigger-finger cutouts often mean a sacrifice in insulation. (Although dexterity is definitely getting easier with the recent trend toward thinner insulation.) Snowmobilers, ATV riders and skiers don't require as much fine-motor finger movement, so they can get away with thick gloves or even mittens. All sportsmen in really extreme climates, regardless of their winter-time diversion, obviously require maximum cold protection. **PM**



Bill Koch
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Olympic Silver Medalist
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Aviation



Business And Pleasure Mix

We were in England two weeks before the Farnborough Air Show last summer and heard from aviation insiders not to expect much news. So we passed it up and headed to Anaheim, California, for the National Business Aircraft Assn. show instead. That turned out to be a good move. The NBAA was buzz-



Canadair's new jet (top) may be an airliner. But the Agusta 2-seater (above) is strictly for low-priced fun and high-speed aerobatics.

ing with so much new material, it was hard to believe that the general aviation industry is in a virtual depression. Despite all the bad news about small-aircraft sales the past five years, the industry is moving full steam ahead with hot aircraft for business and pleasure, and with good news for those interested in becoming professional pilots.

Canadair flies

Canadair, recently sold by the Canadian government to Bombardier Ltd., rushed out of the starting gate with its Challenger 601-3A twin

turboprop jet. A list price of just over \$12 million covers the airframe and a factory-installed Sperry flight guidance system. It can seat as many as 20 passengers, making it a good corporate jet candidate, and maybe even paving the way for some use on commuter routes. The jet's initial cruise altitude is 39,000 ft. with a normal cruise speed of 528 mph.

Come down from the clouds, you say. Let us hear about something that costs less than \$12 million green. Okay, how about a 2-seater from Agusta. The Caproni-C22J is to become FAA cer-

tified this spring, at which time Americans will be able to buy the sporty jet already flying in Italy for just a tad over \$400,000, minus the engines. Adding the twin TRS 18-1 Microturbo jets puts the price a little under \$2 million. If you think owning a little jet capable of 7 positive g's and 3.5 negative g's is important, the money will seem totally unimportant. We're talking about a little jet fighter that does aerobatics, with a service ceiling of 25,000 ft. and a range of 650 nautical miles. (I have been

flight testing and hit Mach .76. One sortie reportedly lasted 5½ hours, indicating some hefty range. The FanStar prototype gets 17,000 pounds of thrust from a pair of GE SF-34-1A turbofans. In addition to long range and low noise, the FanStar is expected to come in fully loaded for under \$20 million, making it highly competitive for the business market.

FanStar was built in Mojave, California, not far from aircraft design genius Burt Rutan, who is working for Beech Aircraft these days.

Rutan drew a lot of oohs and aahs as he described three radical new aircraft on his drawing boards. Two are cabin-class planes—one flying on piston twins, the other on a turboprop. A 5-seat single-engine plane capable of transcontinental flying is also on the boards. Rutan's Scaled Composites Inc. is turning out prototypes of the cabin-class twins already.

More pilots

Meanwhile, a paper in *Airline Pilot*, the authoritative industry journal, notes that air carriers hired 3168 new pilots in the first five months of 1986, about 20 percent more than were hired during the same period in 1985. The figures show similar growth for the past two or three years. Let me throw just one more statistic at you: The Air Line Pilots Assn. (ALPA) figures that 7161 unionized pilots will reach retirement age by 1995. These figures cover airline pilots only. The need for corporate aircraft and military pilots is also expected to balloon. —D.E.

offered to go up in the first FAA-rated version later this year. Watch this space for details.)

FanStar fanfare

Not as thrilling as the Agusta jet, but breathtaking for other reasons, was the unveiling of American Aviation's FanStar business jets. When the first prototype touched down at Long Beach Airport, it had only 14 hours flying time. Pilots flocked to the newly rolled out craft like kids going to see Santa. The FanStar had flown at 38,000 ft. during the envelope expansion phase of



The FanStar was unveiled at the fall aviation show. It has gone to Mach .76 and has reached a 38,000-ft. ceiling in early testing.



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Motorsports



BY WADE HOYT

All crossed up



Finnish driver Matti Alamaki tries to slide his 360-hp slope-nose Porsche past Martin Schanche's homemade 4-wheel-drive Ford.

The European equivalent of off-road stadium racing is called rallycross—a wild mixture of rally cars and motorcross racetracks that is popular throughout northern Europe. Sweden alone has over 30 tracks, France 10, and many more are found in Austria, Belgium, Germany, England, Norway, the Netherlands and Finland. With massive TV audiences and major tobacco company sponsorship, rallycross is one of the most popular sports in Europe, attracting some 30,000 fans to

tracks in remote Norway.

It all began with an outbreak of hoof-and-mouth disease in Great Britain during 1967. Thousands of animals were destroyed and movement through agricultural areas was restricted to prevent spreading the disease. This forced cancellation of the RAC Rally, and stranded all the world's top rally teams in England with no place to play.

Even more serious, nowadays, it left a TV contract unfulfilled! Millions stood to be lost if the rally teams



A pair of Austrians battle it out in a hot-rodged 3.4-liter Porsche and a mid-engined, Ferrari-powered, 3-liter Lancia Stratos.

couldn't cobble something up for the tube. The result was a "special stage" in which the Rally teams threw away their banks of driving lights and raced against one another for the cameras, rather than racing one at a time against the clock in normal rally fashion.

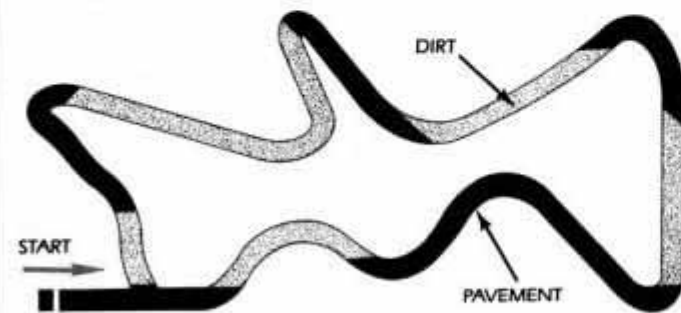
The result was so popular that soon special tracks with grandstand facilities were popping up all over the place. The typical rallycross track is a mixture of pavement and dirt or gravel with only about 1000 yards to the lap. The cars race six at a time in qualifying heats that are three to four laps long. The finals are only two laps longer, so the action is flat-out all the time. Like a motorcycle motorcross, the cars start side by side on a short spur that isn't used for the rest of the race.

There are several classes, with "specials" being the wildest. The rules require only that the engine block be made by the same manufacturer as the body, and have the same number of cylin-

ders as the original. Otherwise, any modification is allowed to the engine, suspension and transmission. The result is a wide variety of 4wd sedan-shaped projectiles with uncanny handling and staggering acceleration.

European champion Martin Schanche of Norway has a 4x4 Ford Escort that pumps about 560 hp through its variable torque-split transfer case. Its tiny 1.9-liter Ford Four is turbocharged to within an inch of its life and will accelerate this winged shoebox from 0 to 60 in under three seconds! Front-to-rear torque split varies with the traction available, and an antiwheel-spin system prevents it from just standing still and digging into the soft stuff.

Now that such megapower 4wd specials are being phased out of city-to-city Pro Rallies in Europe, factory specials like the ultrashort-wheelbase Audi Quattros (with a rumored 600 hp) are likely to be the next hot set-up in rallycross. **PM**



The 1100-yard-long Ring Knutstorp in Sweden is a typical track.



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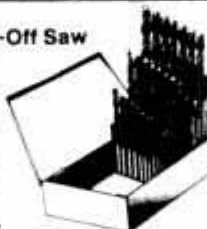
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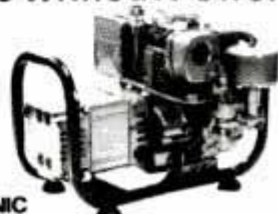


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DOUBLE BARREL KIT, when used with above kit will convert it into a double barrel stove. The secondary gases are trapped and create greater efficiency as they travel through the top barrel.

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|--------|-----------|---------|----------------|
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| Descrp | Ship Wt. | List | Sale |
|---------------|----------|----------|----------------|
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Science



BY DENNIS ESKOW

Flying Comes Naturally

In less than a decade, the Imax film technique, in which motion picture frames are 10 times larger than 35mm, has gone from an interesting experiment to a spectacular medium of science. Earlier films like "To Fly" and "The Dream Is Real" depicted aviation and aerospace developments in a breathtaking way: across a 5-story screen. The latest Imax film takes us into the natural realm of flying. "Skyward," being shown this winter at museums across the nation, intersperses historic, and sometimes amusing, aviation scenes with the birth, rearing and flight of Canada geese. We get a behind-the-scenes glimpse (below) of the film crew leading a trained flock of geese in a 60-mph chase with the boat that served as a filming platform. The Imax crew trained the geese with "imprinting" techniques in which the birds learned to fly in formation according to arm signals.



Imax crew gives an arm signal to trained geese used in film.



GM scientists' pollution lab is taking readings inside clouds.

Cloud heads

Motor along the Mount Mitchell ridge in western North Carolina these days and you may run into a team of General Motors scientists. They won't be interested in your car, however. The GM team has its head in the clouds. Working out of a computer-equipped trailer hooked to a range of sensors, the GM scientists are making 14 different chemical analyses of clouds at the 6600-ft. Clingman's Peak. They're looking for acid depositions, air pollution and other factors that may be related to a decline in the growth of trees in the region.

Mount Mitchell is the highest peak in the eastern U.S. and has a cloud cover just below the summit some 250 days per year. Thus, the GM scientists are literally living inside a cloud.

The sensing devices will accurately measure ozone, nitrates, acid, hydrogen peroxide and heavy-metal content. Using mathematical techniques, the scientists hope to follow the clouds that cover the mountaintop from their "birth" until their dissipation. This will give them some idea of the origin of certain rainborne pollutants.

It is hoped that the GM team will release a report shedding new light and suggesting ways of control.

Star struck

Add another type of star to the growing family of celestial objects. Cal Tech scientists say they have discovered a new kind of quasar that glows intensely in the infrared. They think the newly discovered heavenly body may be the result of a collision of two galaxies.

Calling all inventors

If you fancy yourself an inventor, I have a new challenge for you. It involves a new type of chemically treated material called orange phosphor. When exposed to ordinary incandescent light, it will glow in the dark for a few minutes. It is being used experimentally in some hospitals and other institutions where the marking of emergency exits is critical. An orange phosphor exit sign will continue to glow minutes after a blackout.

Furthermore, NASA scientists are studying types of phosphor materials to help create guidance lighting systems for Space Station docking bays. I told the people at Edmund Scientific that we have a very inventive body of readers, and the Edmund people said let them have a swatch of Quantex F-15 orange phosphor and see where it leads.

If you'd like to have a free swatch of orange phosphor, send a self-addressed, stamped, No. 10 business envelope to: Popular Mechanics, Science Dept., 224 W. 57th St., New York, NY 10019. After you experiment with your swatch, I'd like to hear your ideas of new ways to use this product.

The nerve of science

Using a bioengineering method called "cell culture," Johns Hopkins Medical Institution's scientists have grown light-sensitive nerve cells from human eye tissue. The cells are being used to conduct light-sensitivity experiments only. But they may some day be used for nerve implantation. **PM**

Car Clinic



BY MORT SCHULTZ

Yellow flag

On two occasions the automatic transmission in my 1986 Chrysler Le-Baron jumped from PARK into REVERSE. The first time was when our maintenance man left the car with the engine running to get something from the garage. When he returned, he found the car 20 ft. away with the rear end against a tree. A week later, I put the transmission into PARK, turned off the engine and parked on a slight incline. When I returned, I found the car several feet from where it had been, with the shift indicator in REVERSE. Does the Chrysler automatic transmission present a threat to safety?

JOHN HAGERMAN
SPRING, TX

I can't honestly say. I've gotten two different stories on this subject.

The Center for Auto Safety says it has reports of Chrysler automatic transmissions jumping out of PARK into REVERSE. Chrysler, on the other hand, contends that if the transmission is properly engaged in PARK, it's impossible for it to jump out of gear since there is a positive lock engagement between the parking pawl and sprag.

Chrysler defines "proper engagement" as applying the parking brake before you shift into PARK and making sure the shift lever is shoved all the way into the PARK gear.

To these I would add other precautions. One is never leave the car unattended

while the engine is running. Another is to set the front tire against the curb when parking on an incline to prevent the car from rolling if the PARK gear fails. These precautions aren't a bad practice for any make of vehicle.

As for mechanical conditions that can cause a transmission to shift out of PARK by itself, an improper park/lock control cable adjustment is the most likely.

Where does the oil go?

As many do-it-yourselfers have done, I've been bringing drained engine oil to a local service station. Now, the manager refuses to take any more. He says recyclers who once paid him for used oil are no longer around; therefore, he has to dispose of it as a toxic waste, which means paying to have it hauled away. What are environmentally conscious do-it-yourselfers supposed to do with the stuff if gas stations won't take it?

BRIAN SHONAMON
LOWELL, MA

There are two environmentally acceptable ways to handle this problem:

1. *Canvass service stations until you find one that will take old oil, even if you have to pay a nominal fee—10 to 20 cents per quart seems fair.*

2. *Call the environmental hotline listed in your phone*



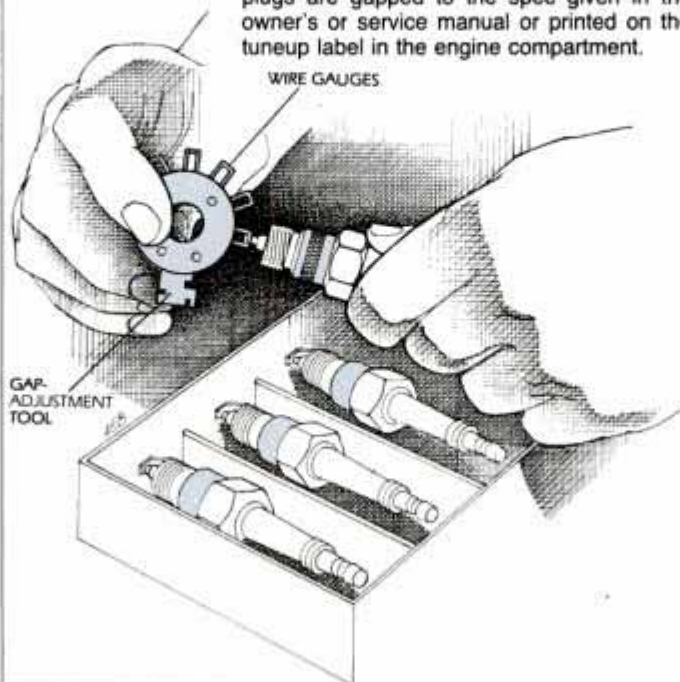
Gap trap

E.E. Brownd of Raleigh, North Carolina, who has been a mechanic for "many years," warns that too often both do-it-yourself and professional mechanics don't take the time to adjust gaps of a new set of sparkplugs to spec.

"Some believe that electrodes burn themselves to the proper gaps. Others think new plugs come from the box properly gapped," he says. "That kind of thinking screws up otherwise excellent engine tuneups."

The message? Use a gauge to make sure plugs are gapped to the spec given in the owner's or service manual or printed on the tuneup label in the engine compartment.

WIRE GAUGES



book under the heading "Massachusetts State of" to find out if there's a nearby toxic-waste dump site where you can take oil. Some municipalities have used-oil collection centers, so also check with city hall.

If neither of these works out, as a last resort pour oil into plastic containers, cap them tightly and put them out with the trash. The used oil will at least end up at a controlled landfill and not in the ground or down a storm drain where it can affect ground water.

According to the Environmental Protection Agency, do-it-yourselfers generate about 300 million gallons of used oil each year.

More missing oil

I have a problem with a 1985 Ford Econoline 7.5-liter engine. On a drive to Florida right after taking delivery, the engine used a quart of oil every 250 miles. It now has 6000 miles and is still using a quart every 250 miles. Two dealers say there are no leaks, and Ford policy is not to do anything about oil consumption unless an engine has rolled up 7500 miles. Do you have any information about an oil problem with this engine?

JOHN MCDONOUGH
TOMS RIVER, NJ

Ford policy is that 7500 miles should be accumulated before doing tests if an oil consumption condition is borderline—say, if an engine is using a quart of oil every 750 to 800 miles. Ford's maximum oil consumption guideline is a quart in 900 miles.

An engine that consumes a quart of oil every 250 miles is obviously using too much, and there is a defect that should be corrected. In the case of the '85 7.5-liter engine, that defect will probably be eliminated by taking the following action:

1. *Make sure the oil dipstick is recording the amount of oil actually in the engine. If the dipstick is incorrectly calibrated, it*

(Please turn to page 39)



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hi-potency Formula in the super
5.7 liter size.**

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Моторная, специально-ный на торсионном пружинном

(Continued from page 37)

should be replaced or recalibrated.

2. With the engine warmed up, tighten intake manifold bolts to between 22 and 32 ft.-lb. There are 16 bolts that should be tightened in the sequence found on page 37 of Technical Service Bulletin (TSB) 86-16.

Torquing these bolts eliminates the chance of oil leaking under a loose intake manifold gasket and entering the cylinders through the intake ports.

3. Install a new oil-fill cap assembly (part No. E5UZ-6766-A), which has a revised PCV valve grommet. Also, replace the PCV valve hose with one that is $\frac{1}{8}$ in. long.

If oil consumption persists, the dealer should install new intake valve guide seals (part No. E6TZ-6571-E).

4. Finally, if all else fails, the engine will have to be torn down to check for possible assembly errors such as incorrectly sized valve guides or improperly installed oil rings.

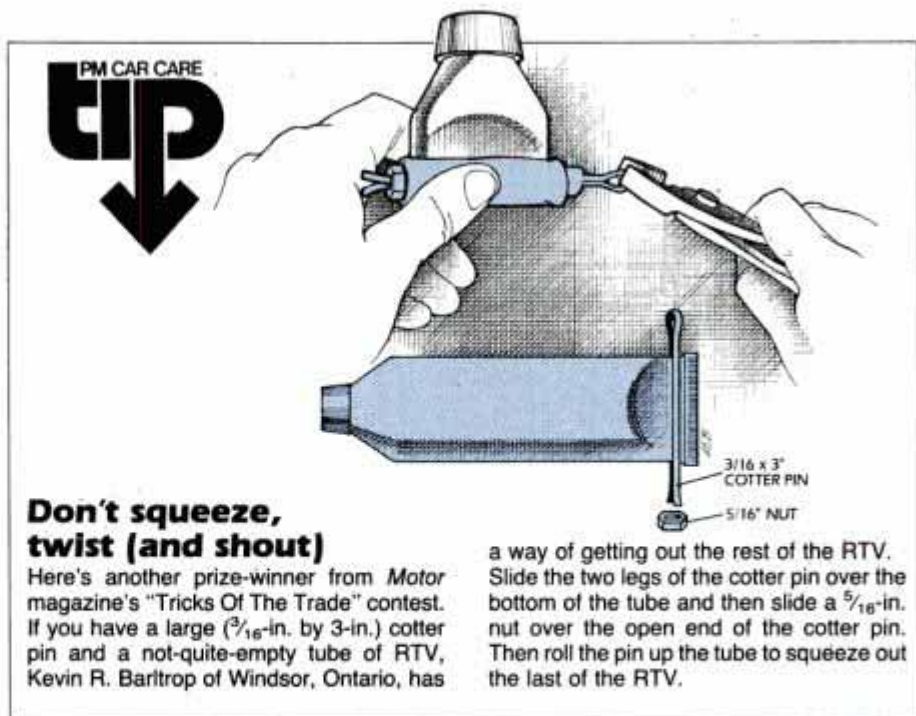
Just like school

My 1986 Pontiac 6000 (2.5-liter engine) is significantly noisier and vibrates more than my 1980 Chevrolet Citation and 1984 Pontiac 6000 ever did. The dealer says it's normal. True or False?

DOUGLAS J. MANDEL
GURNEE, IL

SERVICE TIPS

- In December's *Car Clinic* (page 29), I reported that Ford was coming out with a catalytic converter to eliminate an exhaust odor from Sable and Taurus. It's part number E7DZ-5F250-B.
- If your 1986 Buick Somerset/Skylark, Olds Calais or Pontiac Grand Am with 3-liter fuel-injected V6 engine has a stingy heater, check with your dealer to see if your car qualifies for a new 195° thermostat (part No. 3037747).
- New kits issued by Chrysler Corp. are designed to eliminate cold-engine stalling and acceleration sag with 2.2-liter engines in 1986 Caravans, Voyagers and Ram Vans. TSB 18-31-86 lists the kit part number for vehicles with manual transmissions as 4419410; it's 4419411 for vehicles with automatic transmissions.
- Toyota has issued a new lock cylinder bracket (part No. 69005-17020) to replace those on 1986 MR2s whose trunk lids aren't opening when the inside remote release is used.
- If you have to replace a head gasket of an AMC 4.2-liter engine, install an all-metal gasket. A composition gasket will lower the compression ratio, adversely affecting performance, because composition gaskets are thicker than metal. However, if a check of block and head gasket surfaces with a straightedge and feeler gauge finds warpage of more than .003 in., use the composition gasket or have the decks machined. Metal gaskets require a near perfect mating surface.



Don't squeeze, twist (and shout)

Here's another prize-winner from Motor magazine's "Tricks Of The Trade" contest. If you have a large ($\frac{3}{16}$ -in. by 3-in.) cotter pin and a not-quite-empty tube of RTV, Kevin R. Barltrop of Windsor, Ontario, has

a way of getting out the rest of the RTV. Slide the two legs of the cotter pin over the bottom of the tube and then slide a $\frac{5}{16}$ -in. nut over the open end of the cotter pin. Then roll the pin up the tube to squeeze out the last of the RTV.

False. To find the general area where the cause of noise and vibration lies, notice at what speed noise and vibration are most pronounced. Then, parked in your driveway, rev the engine to approximately that speed and let the engine decelerate. If you don't get the sensation, you've isolated the cause to the transaxle or tires and wheels. Ask the dealer to check drive axle shafts by drawing them out to feel for looseness or grittiness. Other reasons include out-of-round tires, unbalanced tire/wheel assemblies, loose or worn wheel bearings and an incorrect drive axle angle.

If you get noise and vibration during the driveway test, it confirms that the trouble is with the engine or exhaust system. A mechanic using a stethoscope should be able to find the cause by tracing the exhaust system from stem to stern and listening at brackets attached to the engine. Amplified noise at a bracket means the bracket is loose.

New oil coming

I read that there will soon be an oil designation to replace SF. What can you tell us about this? Why the new oil? When will it be here? How does it differ from SF?

PETE MCKINNEY
SEATTLE, WA

According to GM, a new engine oil designation currently referred to as P-S3 will probably show up within the next two years and will be called SG oil.

"The new oil will provide improved wear and deposit protection as compared to SF oil," a member of the GM research laboratories told me. Company lubrication engineers are working

with various interested technical societies to develop field data and test procedures to define SG oil. The technical societies involved are the American Society for Testing and Materials, American Petroleum Institute and the Society of Automotive Engineers.

Drain pain

If my 1985 Toyota Camry is not driven for about a week, the battery goes dead. The dealer checked out the electrical system, including the theft alarm. He found no shorts, a sound battery and a functioning alternator. I don't drive the car much—5300 miles in 15 months. Can this be the reason?

GLORIA SAWAN
BROOKLYN, NY

You can bet on it. Driving the car an average of only 90 miles a week may not be enough for the alternator to restore battery charge. The solution to battery draining, therefore, may be more highway driving. Before drawing that conclusion, however, have your dealer check on one other possibility.

If a theft system not recommended by Toyota has been installed, it could be pulling 100 or more milliamps when your car is not being used, which is enough to drain the battery in a week's time. The system built to Toyota standards, which is made by Zemco, draws only 30 milliamps—a rate that won't drain the battery for 30 days. **FM**

DO YOU HAVE A CAR PROBLEM?

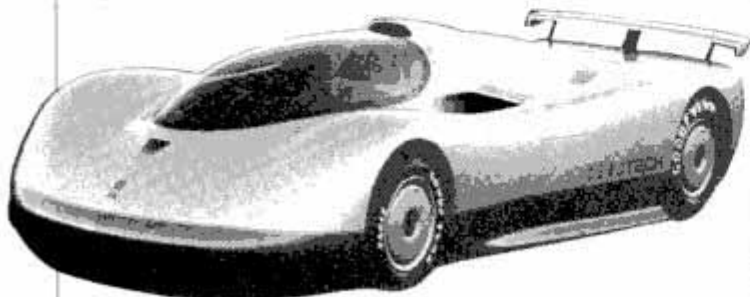
Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

Inside Detroit



BY JIM DUNNE

Olds Record Car?



Oldsmobile Aerotech may be slated for possible land speed record.

Why would Olds build this test car that weighs only 1600 pounds, but has an engine that develops "many hundreds of horsepower?" Apparently to set a land speed record. That's the logical conclusion you reach after checking out the specifications Olds set up for the car. The aerodynamic single-seater is powered by a special version of the 16-valve double-overhead-cam engine Olds will offer on the 1988 Calais sedan.

Named Aerotech, the car will be built in three versions—one for show, two for "testing." Of the number of engines installed, one will have a single turbocharger, another a twin turbo setup. Olds is playing it cute when questions are asked about the reason for building Aerotech, but is more candid about other details.

While the exterior surface is obviously aerodynamically correct, there are some complex aero systems under the skin that help keep the car pinned to the ground at high speed, and ensure that it maintains a straight line. Air scoops around the cockpit

draw air into the body, beneath its aluminum honeycomb surface. The air is directed past some adjustable vanes that impart downforce or control any tendency to yaw at high speed. Top-performance Goodyear tires are rated at 260 mph, but Ted Loukes, Olds chief engineer, says that stronger tires will be installed in the future. Maybe when speed record runs are made?

An interesting feature of the tires is their extra-stiff sidewalls, necessary to withstand the heavy downforce applied by the aero vanes. Aerotech's engine is mounted midships in the 111.3-in. wheelbase chassis to get the car's overall height down to 40 in. The body rides as low as 1 in. off the ground, but it can be ratcheted up for more clearance if the road, or track, is not smooth.

Keep it clean

Disc brake dust can be a problem, especially if you have those fancy alloy wheels. The dust, residue from the wear of the front-disc pads, seems to cling to the wheel, turning the

bright finish dingy. So how come some wheels stay clean? Pontiac designers explain that their painted wheels—some even white—can be cleaned easily, with just an ordinary rinsing. The secret is the way the wheels are painted. Pontiac uses dry powder paint for color. The powder sticks on the wheel through electrostatic attraction, something like the pull of a magnet. After the powder is applied, the wheel is heated so that the powder melts, forming a paint that covers every crevice in the wheel evenly.

"It's like a glazed coating," Pontiac chief designer Terry Henline explains. "The surface is so hard, the brake dust can't get a hold. It just slips off." The powder paint process is not exclusive to Pontiac. Just about all the auto companies use it for parts where perfect appearance is not needed.

Audi's first V8

Audi will surprise a lot of folks by bringing out a V8 engine for its luxury line of 5000s sometime within the next two years. The company that dared to offer the rotary engine and an unusual 5-cylinder will go to the V8 for more power in a smaller package size. Displacement of the engine, which will be developed from the basic Audi 4-cylinder design, is expected to be 3.8 liters. Audi places its engine longitudinally, so there's plenty of space to accommodate the V8's wider dimension. With the commitment to high performance shown in the Quattro, Audi needs the added power of a V8. The Quattro's performance is now limited by the small size of its 2.2-liter turbocharged engine.

Oops!

The sleek, low, white prototype coupe identified as an Olds Touring Coupe last month (page 40) is actually a test vehicle for the now defunct GM-80 project—the 1989 Camaro/Firebird. That project was dropped in mid-summer of 1986 when GM's bean counters figured that the money needed to make an all-new car was too much.

Design details for the two sporty coupes included a new V6 engine, front-wheel drive, and a Fiero-style "space frame" chassis of steel with bolt-on plastic body panels. It might even call for a new transmission to handle the higher horsepower of the 4.2-liter V6. Right now, GM has no heavy-duty front-drive transmission.

Still, the prototype shown in the photograph is not completely dead. Even though it is out of the official GM schedule, work continues. Chevrolet insiders say about 10 people are still at work on the project. The hope is that the GM-80, as was the case of the Fiero during its development, will be reinstated to "GO" status.

Upgraded Escort

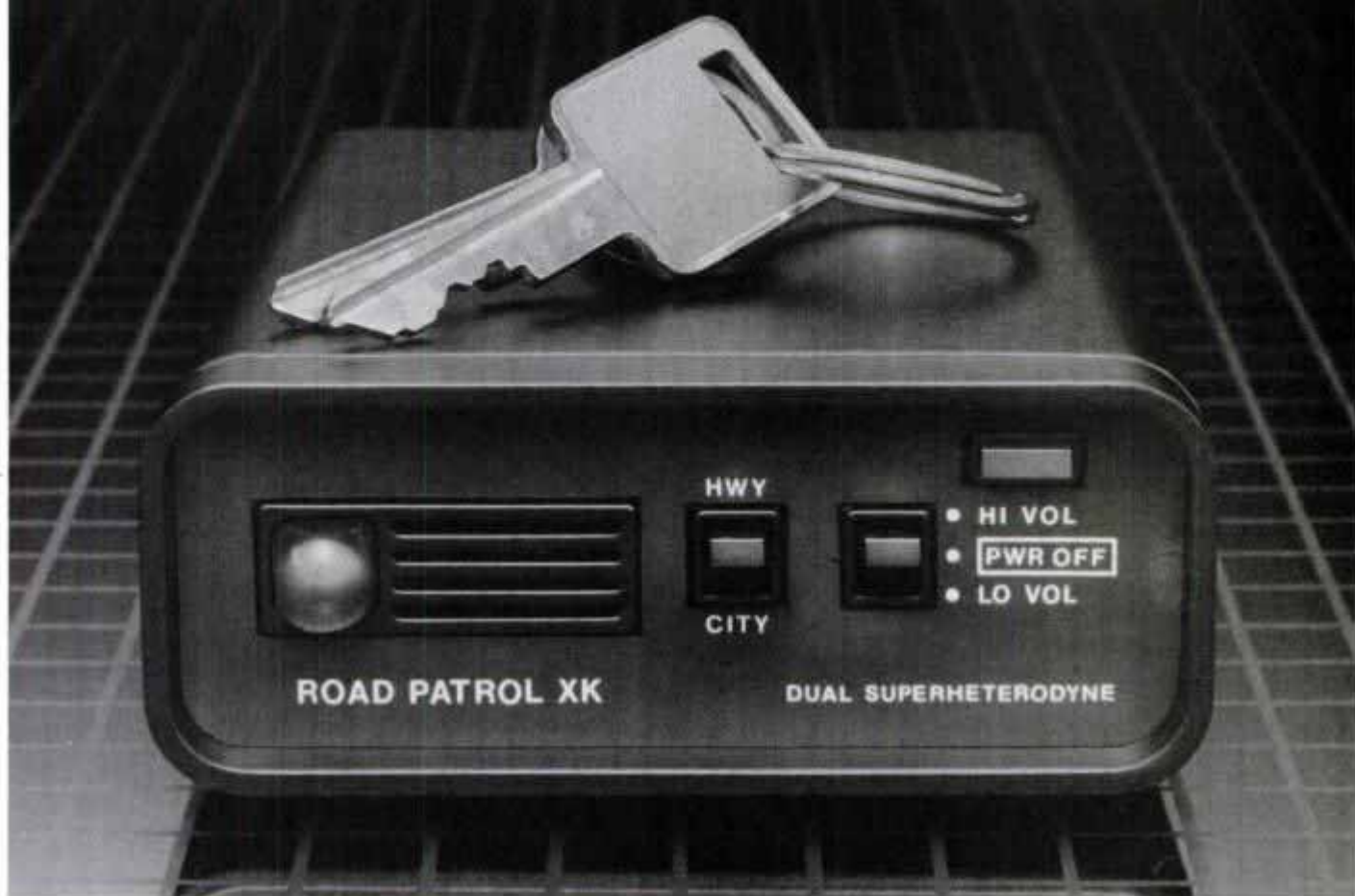
Look closely at this Escort and you will see a number of changes that will hit the streets in a couple of months. The automatic seat belts are visible through the front door window. They are a motorized type that adjust to fit when the front doors are closed. The belts are carried along a track above the door opening, moving forward when the door is opened, rearward when the door is closed. Bumpers are new, too, of the same type used on the Escort GT and EXP.

(Please turn to page 42)



Ford Escort gets freshening of interior and exterior for 1987½.

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INSIDE DETROIT

(Continued from page 40)

They're plastic and wrap all the way around to the wheel openings. Tail-lights have a different texture, while the center stop light is integrated into the sheetmetal.

Breaking the codes

Inside the auto companies, codes like X-cars or A-cars are used to designate entire families of cars. Codes make it easier to talk about groups of cars without taking the time to name each one. A GM plant manager can order 5000 new sets of A-car front suspensions knowing that the same suspension will fit all four cars—Celebrity, 6000, Ciera, Century—on his assembly line.

Car buyers can benefit, too. Say you want to get a new Celebrity. It's easy to make price comparisons with similar cars if you know that Pontiac, Olds and Buick build cars that are almost identical to the Celebrity. Only the surface trim is different in most cases. The same V6 engine, automatic transmission, radio and air conditioning in the Celebrity go into its sister cars.

Prices of related cars are almost equal. In fact, the prices of all the options mentioned above are exactly the same for the cars carrying the same code. Smart buyers who like the Celeb-

city, but have no local Chevy dealer, will look to the Pontiac, Olds or Buick dealer who may be closer to home.

We've broken the code for Detroit's big three automakers. Here's the way they line up:

General Motors

A: Celebrity, 6000, Ciera, Century
B: Caprice, Custom Cruiser, Estate Wagon
C: Ninety Eight/Regency, Electra/Park Avenue, deVille, Fleetwood, Limousine, Funeral Coach, Sixty Special
D: Cadillac Brougham
E: Toronado, Riviera, Eldorado
F: Camaro, Firebird
G: Monte Carlo, Grand Prix, Cutlass Supreme, Regal
H: Delta 88, LeSabre, Bonneville
J: Cavalier, Sunbird, Firenza, Skyhawk, Cimarron
K: Seville
L: Corsica/Beretta
M: Sprint
N: Grand Am, Calais, Somerset/Skylark
P: Fiero/GT
R: Spectrum
S: Nova
T: Chevette, T1000
V: Allante
W: 1988 Grand Prix, Cutlass
Y: Corvette
Z: 1988 Reatta
(GM has tried to institute number codes for new models, but these are of little use to car shoppers since they duplicate the letter

codes and are more complicated. One example: "GM30" is the code for Toronado, Riviera, Eldorado and Seville. But Allante is "GM35" because it is a derivative design. Most GM personnel still use the old letter codes. Inside GM, certain projects may be given name codes. New engines for the 1990s are the Manhattan and the Victor, while Saturn's engine is called Trident.)

Ford

Erika: Escort, EXP, Lynx
Topaz: Tempo, Topaz
Fox: Mustang, Capri
L: LTD, Marquis (now dead)
LS: Continental, Mark VII
S: Thunderbird, Cougar
Taurus: Taurus, Sable
Panther: LTD Crown Victoria, Grand Marquis, Town Car

Chrysler

A different approach is used here. Even closely related cars are given separate letter codes. Reliant is much like Caravelle, but one is the K body, the other an E.
CV: LeBaron sedan, Town & Country
C: 1988 full-size sedans for Dodge, Plymouth and Chrysler
E: Caravelle, 600, New Yorker
G: Daytona
H: Lancer, LeBaron GTS
J: LeBaron Coupe, Convertible
P: Sundance, Shadow
K: Reliant, Aries
L: Horizon, Turismo, Omni, Charger
M: Gran Fury, Diplomat, Fifth Avenue
S: Voyager, Caravan

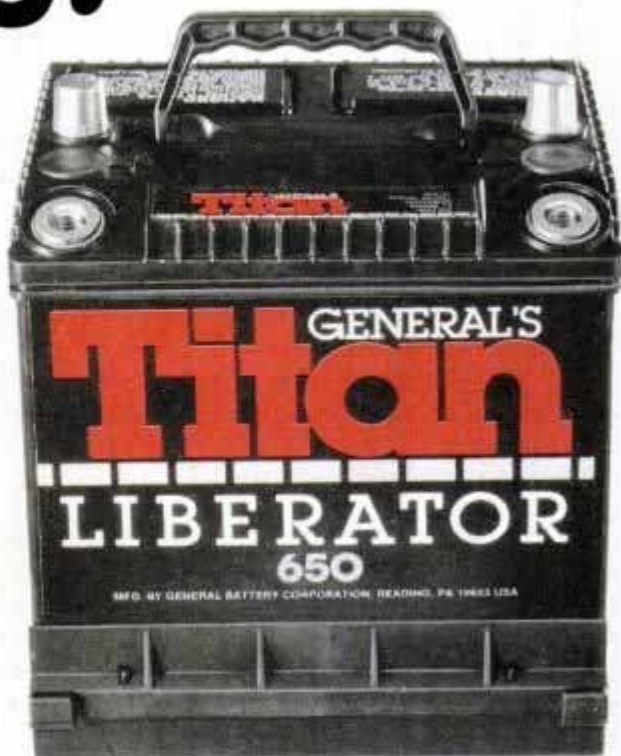
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PM TECHNOLOGY UPDATE 1/87



Mechanics Go Bowling

It's the height of the holiday football bowl season and TV sets across the nation are aglow with visions of flowered cartoon characters, ships, planes and what have you. All are entrants in the big bowl parades. The granddaddy of all bowls—the Rose Bowl in Pasadena, California—is a haven for young mechanics and electronics wizards.

The Bubble Trouble float pictured above stole the show last year. It was the first float with 4-wheel steering. Each of the float's four driving wheels (inset below) had independent hydraulic drive. The 351-cu.-in. Ford V8 which powered the float feeds on propane. Rose

Bowl floats move along the avenue at a steady 12 mph and are not allowed to break down. Four-figure fines have been issued for breakdowns in the past.

A typical major bowl float costs more than \$100,000 to build and decorate, even with corporate donations of computer equipment to operate moving parts, and the free time given to the floats by engineering students.

Beneath the floral decorations on the float shown are motor drives that give the rigid set the look of a hot-air balloon swaying gently in the breeze. The movements are actually precise, programmed and monitored by computer.



Float (top), with 4-wheel independent steering, moves at 12 mph on propane engine (above). Wheels (right) have independent hydraulic drive.



Editor: Dennis Eskow
Contributors: Jack Harmond, Richard Schrader, Ted Francis, Jim Campbell, Steve Eskow, Steve Parker

TECHNOLOGY UPDATE

SPORTS

Training you cannot resist

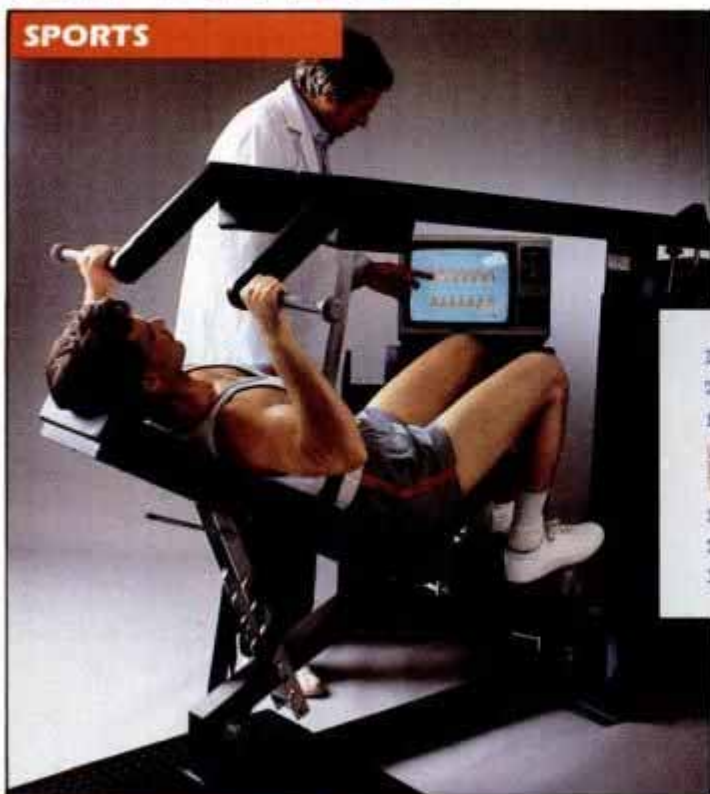
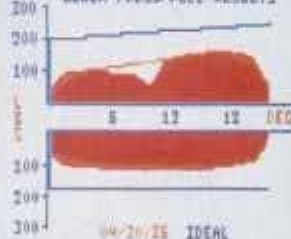
Resistance training works by having the athlete exert a force against an almost-immovable object, thereby putting a muscle to work. The new Ariel Computer Exer-

crocomputer and video monitor to the exercise system. As you work out, the computer keeps a record of the amount of force exerted for each specific exercise. The computer can change weight resistance up to 16,000 times per second as it senses the motions and stoppages.

The CES system thus revolutionizes resistance training, which up until now required the athlete to get off the equipment after each set of exercises and make changes in the weight or resistance levels according to his sense of how hard he was working. The new system also provides printouts (inset left) giving precise readings of resistance in pounds (vertical axis) against the degree of difficulty. It will be marketed in the spring.

cise System (CES), licensed to Wilson Sporting Goods, takes the idea a step further. The CES connects a mi-

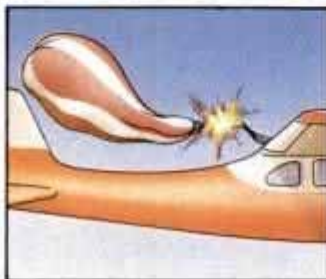
BENCH PRESS/PULL RESULTS



AVIATION

Chute the works!

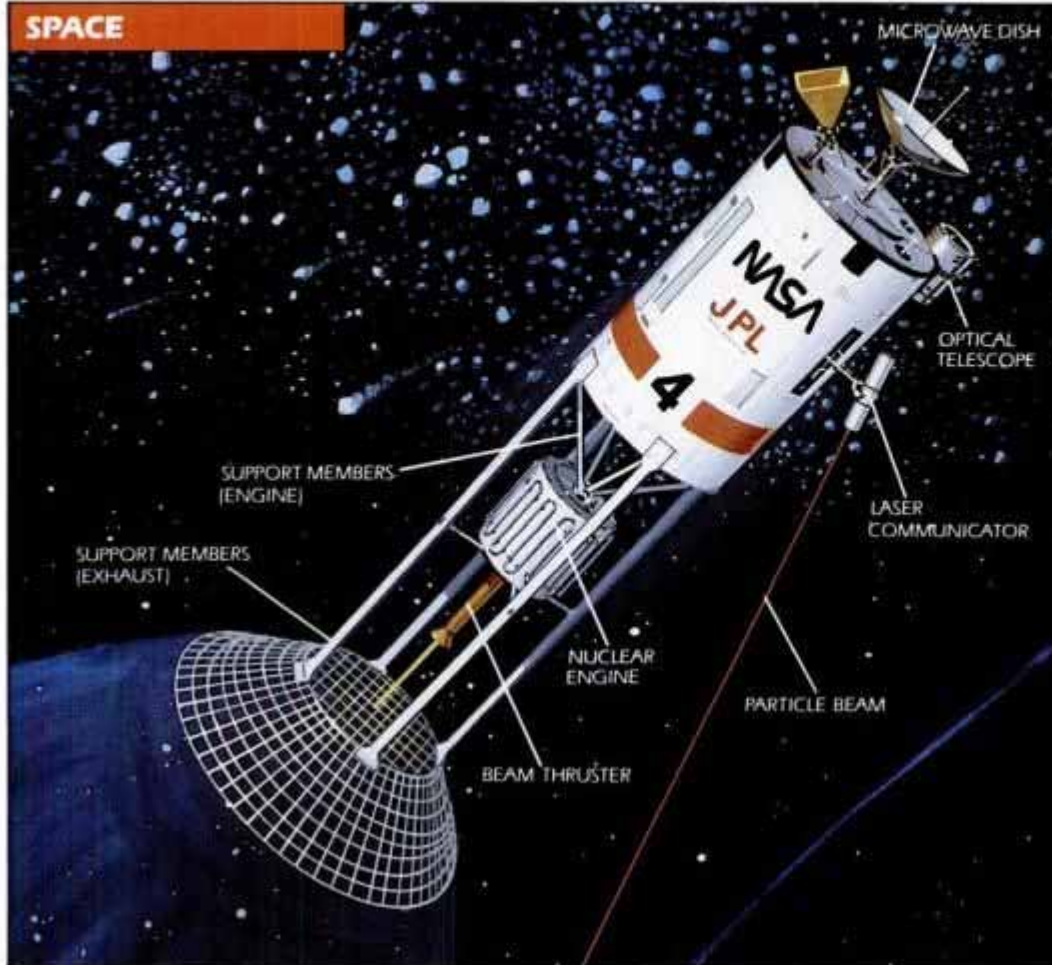
Last April, master-rigger Jim Handbury and aviation writer Jim Campbell took a Cessna 150 plane on a historic climb to 6500 ft. With the plane moving at cruise speed, the two pilots sat back, pulled a release lever, shuddered as a small explosion went off, and gripped the arm rests as a parachute opened above them. It billowed to its full 55-ft. diameter and tugged at the 100-ft. lines as the Cessna stalled. The plane descended slowly about 3000 ft. until Handbury released the parachute package with a second small explosion, and finished the descent back under power. The test demonstrated the value of a new safety system for small planes. Handbury was killed a short time later in an unrelated air crash. But his wife, Dana, also an FAA certified master rigger, is continuing research on the Advanced Ballistic Parachute Recovery system.



Props rise again

In the past two years prop-driven aircraft have made a tremendous resurgence. New prop technologies by NASA and several manufacturers and new turboprop technologies introduced by British Aerospace have become the answer to a growing concern about fuel consumption and noise in some of the smaller jets. But the latest prop-driven craft—the new twin Embraer from Brazil—brings props back in an old-fashioned way. In fact, some say the new Brazilian plane, designed for airlines, is reminiscent of the DC-3. It cruises at well over 300 mph on twin Pratt & Whitney props and will be in America next summer.

SPACE



Starship is a 2020 sureshot

Scientists at Jet Propulsion Laboratory have begun working on the design of the world's first starship. The ship is expected to be an elongated satellite with a nuclear engine that produces an ion beam of electrically excited atomic particles. The beam would be directed into a magnetically controlled thruster that sends a thin cloud of particles away from the ship, pushing it at speeds of more than 200,000 mph. NASA engineers believe the starship's first voyage could be to the Oort Cloud—the region where comets are formed, and the entryway to the universe beyond our solar system. Such a ship could be launched early in the next century for an Oort rendezvous around the year 2020.

WEATHER



Big system for small airports

Automated Weather Observation Systems (AWOS) are beginning to show up at small airports around the country where many or most pilots have instrument rat-

ings. The Handar AWOS-1, the first such system certified by the FAA, has been installed at Ada, Oklahoma. The system provides automatic weather updating every 60 seconds. It provides data on wind speed and direction, temperature, dew point, barometric pressure and time. The data can be picked up on a special cockpit radio frequency. The AWOS tower (left) includes an anemometer, wind vane, temperature and humidity sensors, surge suppressors for lightning, and a VHF antenna that transmits to pilots voice reports through a sophisticated voice-synthesizing system.

N-ROSS is supreme

Lockheed has released its concept art on the Navy Remote Ocean Sensing System (N-ROSS). The satellite would orbit Earth every 101 minutes, sweeping the globe below with a scatterometer to measure ocean-wave

heights, a microwave imager to measure wind speed and temperature, a microwave radiometer to map ocean currents, and an altimeter which would back up the scatterometer in determining ocean-wave characteristics. It would give extremely accurate weather reports as never before.



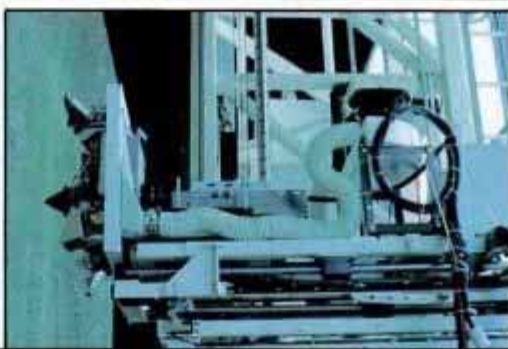
TECHNOLOGY UPDATE 1/87

INNOVATION



Heady LAMARS

We've been invited to fly simulators before, but never one that required a full-fledged flight physical. The Large Amplitude Multimode Aerospace Research Simulator (LAMARS) does require a physical before flying. As well it should. The pilot module sits at the end of a 30-ft. steel beam that moves in all directions with "5° of freedom," meaning that it can produce pitch, yaw and roll changes of a stomach-churning 60° per second. The LAMARS system can put the pilot under 3g's of positive gravitation. Its graphics are top-notch, taking the pilot through blue skies, thunderstorm conditions and veritable hurricanes produced on a huge 3-dimensional wall map (bottom right) by a scanning camera system. LAMARS is being used at Wright-Patterson Air Force Base to help the Air Force Flight Control Development Lab make flying safer.



MILITARY



All-in-one missile system

The Army is teaming with LTV Aerospace to produce a new weapon known as the Tactical Missile System

(TACMS). The TACMS 2-pod launcher will fire long-range, surface-to-surface missiles using solid-propellant rocket motors. Guided by ring laser gyros, the missiles will have four movable

tail fins for steering. The payload and accuracy are classified, but Navy documents indicate TACMS will have a 60-mile range and will be able to carry a variety of warheads and munitions.

ELECTRONICS



Speak, and ye shall dial

We were impressed recently in trials of a new voice-commanded automatic telephone dialing system called Voice Dialer. The system "files" 100 telephone numbers in a central processor. After filing a number, you speak the person's name into the phone and the number is dialed up directly. **TU**

Build This Beautiful Wooden Ship Model

Wouldn't you love to build this historic ship model? It's a true-to-scale, 21" replica of the 2-masted schooner *Swift*, a Virginia pilot boat of 1805. Well, now you can! And you don't have to be a skilled craftsman to do so.

It really isn't hard

Even if you've never built a model before, you can experience the relaxing pleasure and pride of accomplishment that is offered by this fascinating hobby. You can build the *Swift*. The secret's in our kit, designed especially for the first time modeler, with pre-cut parts that make assembly easy. Clear, large scale plans and instructions that virtually take you by the hand and guide you every step of the way through hours of the most relaxing fun you'll ever have. And when completed - a museum quality model you'll display with pride, with gleaming brass fittings, walnut planked hull, delicate rigging - lifelike in every detail.

Quality you can see and feel

The materials in our kit may be better than those used in the original *Swift*. The keel section and frames are pre-cut plywood, ready for quick assembly. The *Swift's* hull is planked twice; once with thick, flexible limewood for strength, then overlaid with planks of African walnut for lasting beauty.

You don't have to make the fittings - we've done that for you. Our kit contains ready-to-use blocks and deadeyes of rare, yellow boxwood. We include eyelets, bracers and belaying pins - over 70 parts of solid brass! Even the cabin door hinges are brass, as are the 250 miniature nails you'll use to fasten the planking to the hull and deck. And, since the original wooden *Swift* had no plastic parts, our kit doesn't either - anywhere!

Creative? And how! Overwhelming? Not a bit! But be prepared for hours of the most challenging, engrossing, relaxing fun you've ever had.



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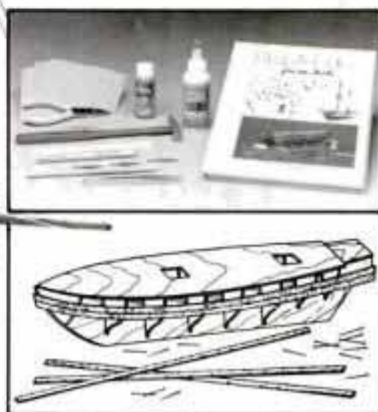
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Homeowners' Clinic



BY NORMAN BECKER, P.E.

Oily Well Water

We have a second home in the northern Catskill Mountains. Our well is about 185 ft. deep with a submersible pump. Two years ago, the pump broke and had to be rebuilt. Since the installation of the rebuilt pump, our well water has had an oily smell and leaves a film in the toilet. We expected this to disappear with time, but it hasn't.

The person who did the repair claims the oil is from when the pump broke.

Can you tell me how to

remove this oil from the water? The only access to the well is through an 8-in.-dia. pipe. Must we drill a new well to get rid of the oil? Sure hope you can help.

JOHN T. CARLSON
EAST ISLIP, NY

It sounds as if you have a "weak well" rather than a "strong well." In a strong well, the water level doesn't rise and fall and, consequently, if oil gets into the well, it floats on top of the water and doesn't get down to the pump. In a weak well, the water level rises and falls frequently and so the well components become coated with oil.

Since the oil condition has lasted for two years (an excessively long time, when you consider that there is only about half a cup of oil in the pump) under normal

Oil floating on the top of well water can find its way into the pump.

use, it should take only a few weeks to flush out the oil. It's possible that the oil is from a leak in a buried fuel oil tank. I suggest you have a water sample tested to determine if it's fuel oil or lubricating oil. If it's fuel oil, you'll have to find and repair the leaking tank.

If it's pump oil, you should check further to see if the water is contaminated with PCBs, a known carcinogen. Apparently, some well pump

motors made prior to the mid-1970s had starting capacitors that were immersed in an oil that contained PCB. Possibly your old pump was one of these.

Removing oil from the well is difficult and not a do-it-yourself job. It should be done by a professional pump installer or well driller.

Tight fit

I have a problem with noise in my house's hot water pipes. When I first turn on the hot water in either of the two bathroom tubs or lavatories, I hear a sound like someone is hitting the pipes in the attic with a hammer. There are about 12 to 15 knocks at 1-second intervals. I have vertical standpipes or air chambers in the attic. I'd appreciate any ideas that would help in getting rid of the noise.

WILLIAM GIBSON
HOUSTON, TX

Although the noise sounds like water hammer, it's probably caused by an expansion of the domestic hot water pipes. Water hammer occurs when the water is shut off fast, not when it's turned on.

Unless there's a hot water recirculation line, and there usually isn't one in a private home, the water temperature in the pipe drops when the water is not turned on at a sink or tub.

When the water is turned on, the cool water in the pipe flows out the faucet and is displaced by the hot water produced by the water heater or the tankless coil inside the boiler.

The high-temperature water, in turn, causes the hot water pipe to expand slightly. If the pipe passes through a hole or hanger that is a tight fit, or rubs against floor or wall framing members, the expansion will cause a series of creaking noises, which will stop when the pipe stops expanding.

The problem can be eliminated by allowing for the expansion of the hot water pipes. If a pipe rubs against wood framing, separate the

two with foam rubber. If a pipe hanger is too tight, replace it with one that has a larger diameter.

Sometimes, expansion noises are heard after there has been carpentry or renovation work done in an area that has hot water pipes. The carpenter may not have allowed enough space between framing members and pipes. If this is the case, you'll know where to look first to correct the problem.

Blistered

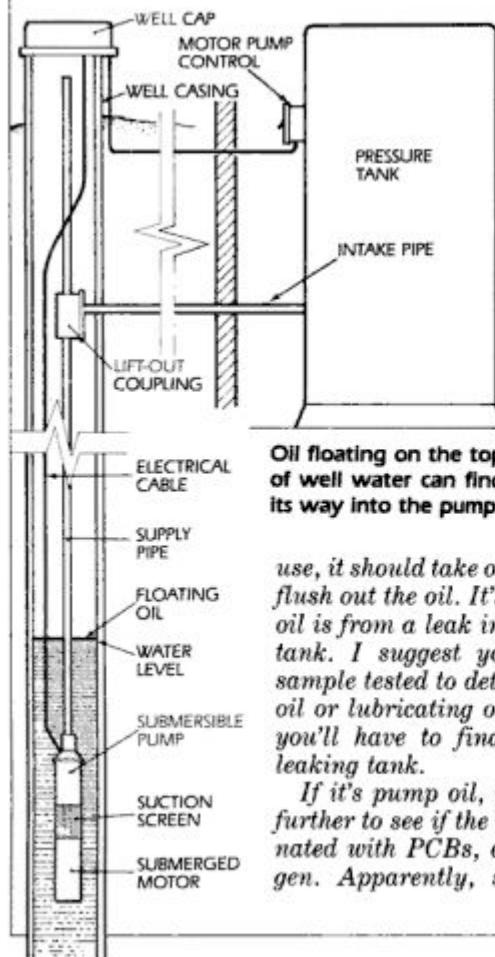
Three months ago, I laminated the tops on two Ping-Pong tables, a card table and three round tables. I used 3/4-in. plywood on all the pieces and a nonflammable glue. Last week, I noticed that blisters had formed on some of the tops. Is there a way that I can get these blisters down flat?

ANTHONY BUZZLO
FLUSHING, NY

Blisters in plastic laminate are difficult to fix, and we discussed the problem in our June '84 Homeowners' Clinic (page 46). If the glue you used is a contact cement, you can try to reactivate it by heating the area with a hair dryer. You need a temperature of about 200° F on the surface over the blister to do this. You should then press the area with a roller and clamp a board over it.

If this doesn't work, you can drill a tiny hole into the area below the blister from underneath it. Be careful not to damage the plastic laminated surface. A white glue such as Elmers can be injected into the area. The blistered section should then be pushed up and down to spread out the glue. Then clamp a board over it until the glue dries. **PM**

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



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Appliance Clinic



BY STEVE TOTH

Off-Temp Oven

I have a Magic Chef gas range, model No. G31CA-19W, serial No. H09469BD. The oven is off 50° no matter what setting it's on. Can you help?

PAUL MEIER
RAPID CITY, SD

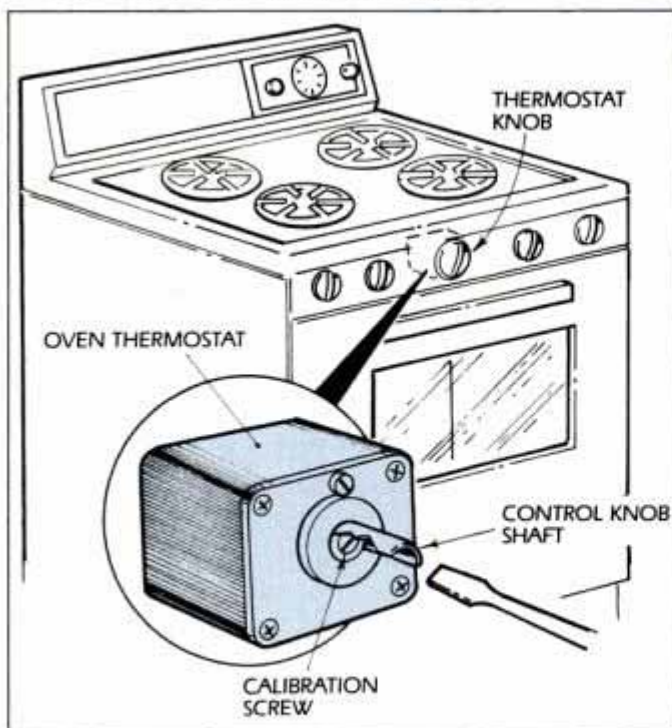
First, check oven temperature accuracy with a mercury oven thermometer.

Place the thermometer in the center of the middle oven rack. Close the door and set the heat at 350°. Allow the oven to cycle three or four times (gas on, gas off) while you record the highest and lowest temperatures. This should take about 15 or 20 minutes.

The average of the highest

and lowest reading is the oven's actual temperature. It's acceptable if the average is 25° higher or lower than the dial setting.

If the temperature isn't within the 25° range, adjust the thermostat. You'll need a long, narrow-bladed screwdriver. Set the thermostat dial at 350° and remove the dial. Under it is the thermostat. Down the center of the knob stem is a small calibration screw sealed in epoxy. Turning the screw clockwise will decrease the oven temperature; turning it counterclockwise increases it. Note: A quarter turn in either direction changes the temperature by 25°.



Adjust a gas oven's thermostat by turning the calibration screw that is located at the base of the control knob shaft.

Grasp the thermostat shaft with a pair of pliers to prevent it from moving while you turn the screw. Recheck oven temperature.

If the temperature is within the desired range, reseal the adjustment screw with a dab of fingernail polish or white glue. Gently turn off the thermostat and allow the polish or glue to dry before turning it on again.

The heat is on

We have a portable Arvin electric heater, model No. 29H90, serial No. 298, whose plug and about an inch of cord get very hot when the heater is used at high thermostat settings. Is this condition ordinary with this kind of appliance? Is it safe?

WILLIAM PEROTTI
GREENVILLE, PA

The model and serial numbers indicate you have a 1968 dual-heat unit that draws 1650 watts on the high setting and 1320 watts on low.

There could be several things causing the problem. The power cord may be cracked or worn, or have a bad internal connection.

The outlet where you plug in the heater may have a corroded or burned receptacle, or loose connections. Also, there may be something within the heater causing the problem—like a loose or burned electrical connection or a bad contact.

You can perform a quick test to determine if the problem lies with the heater or the outlet. Plug the heater into the outlet, then turn it on high for 5 to 10 minutes. Turn off the heater and unplug it. Caution: The plug may be extremely hot, so it would be wise to wear a glove. Next, feel the plug's prongs. If they're cool or room temperature, then the problem is most likely in the heater. If they are hot, the problem is in the wall outlet. It should be checked by a qualified electrician.

If you suspect the problem is in the heater, I recommend—for safety's sake—you take the heater to an authorized Arvin repair cen-

ter to have both the heater and its cord checked. For the nearest repair center, check the Yellow Pages or write to Arvin Industries Inc., Consumer Housewares Division, Box 3002, Columbus, IN 47202-3002.

Slow fill

My 1972 Kenmore clothes washer, model No. 110-7214600, is normal in all respects, except that the cold water fill is extremely slow. What should I do?

EDWARD D. GRISWOLD
HUNTSVILLE, AL

There's a good chance that you have a clogged hose strainer at either the faucet end or the water mixing valve end of the fill hose.

Over a period of time, residue collects in these strainers and restricts water flow. Disconnect the power to the washer and shut off both the hot and cold water faucets. Using pliers, remove both hoses from the faucet.

Check inside the hoses for either a fine stainless-steel or plastic cup. Remove these by gently prying them out with a fine-tipped screwdriver. Scrub them clean and reinstall them in the hoses cup-side up.

Next, place a bucket under a faucet, open the faucet all the way and fill the bucket to remove any material in the pipe above the faucet. Do this to both faucets.

Finally, reconnect the hoses to the faucet and remove them from the mixing valve. Remove the screens there and clean them. Reinstall the hoses, turn on the water and check for leaks. Plug the machine back in and test it.

If cleaning the screens did not help, then the water mixing valve will need to be replaced. Its part number is 358277 and it costs about \$12 at Sears stores. **PM**

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

M I T S U B I S H I



News for those who take their fun seriously.

If you take your fun seriously, you'll be pleased to know that we feel the same way about building trucks. And to prove it, we proudly introduce the all-new Mitsubishi Mighty Max pickup.

This new Mitsubishi is more than just a compact truck. It's a new idea in trucks, patiently crafted to put fun and value back in the fundamentals.

Consider its vigorous new shape, aerodynamic

contours and wide aggressive stance. Mighty Max is built to play as hard or easy as you like. With an efficient 2.0-liter engine, a rugged double-wall cargo box, 5-speed manual overdrive transmission and independent front suspension. Even power assist front disc brakes and radial tires are standard.

And with Mighty Max, the fun isn't just on the outside. Inside you'll find an all-new interior ergonomically designed

for functional efficiency and comfort: Including a roomy sport bench seat, headrests, full carpeting, tinted glass and a tilt steering column.

The new Mitsubishi Mighty Max pickup. At **\$6289***, it's serious fun for the money.

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WING DING

'The Davis Flying Wing really didn't want to land, and I didn't want to either.'



TEXT AND PHOTOS BY JIM CAMPBELL

There I was—a man with a mission. I was lined up at the end of Nampa, Idaho's main runway, with a hailstorm 20 minutes behind me, lots of trees about a mile in front of me, and a new, revolutionary, experimental flying wing strapped to my body. It was time to take a test flight.

Absurd things go through your mind when faced with the first flight of a radical new design. One somber thought that kept running through mine was the fact that Edwards Air Force Base

(the home of most high-performance aircraft testing) was named after a pilot who had lost his life in a flying accident. I've flown more than 100 experimental aircraft over the years, but the Davis Flying Wing definitely gave me the biggest case of the willies I've ever had—this thing was simply too exciting and radical to treat with anything less than a lot of respect.

Throwing caution to the wind, I recited my final test-flight checklist and added full power to the wing. I slowly worked my way down the runway,

WING DING



Test craft has a small, air-cooled Kawasaki 2-stroke engine. The next version will have a more powerful Rotax 532 engine.



correcting for the gusty wind conditions first with the brakes and then, as speed increased, with the rudders. Finally, I pulled back gently on the right-hand control stick at 50 knots. I was airborne.

The World War II era saw a spurt in aeronautical design activity that has never been equaled. Many new types of aircraft, systems and powerplants worked their way into the skies during this period to confirm or deny some engineer's pet theory. These were exciting times—especially if you were a test pilot.

The really unique ideas to get started in this time were the legendary Northrop flying-wing designs. The flying-wing concept was considered the simplest way to extract a lot of performance from an airframe—due to the absence of all the weight and drag of a fuselage structure. They were seen to be about as aerodynamically efficient as a complete airframe could ever be, and so were viewed with much promise by the military, aerospace industry and the Washington hierarchy. Northrop's head man, Jack Northrop, was convinced of the potential of this configuration and actually flew in it many times during serious test flying.

The biggest flying wing to take to the skies was the YB-49. It flew nonstop from Edwards AFB in California to Andrews AFB near Washington, D.C., at a speed of 511 mph in early 1949 (see *Historic Wings* on the facing page).

Gilbert Davis of Boise, Idaho, learned of the properties of flying wings with the help of a talented Northrop protégé named Joe Rosales. Conversations with Rosales, as well as with the legendary Bill Lear and other aeronautical giants, convinced Davis that such a design was feasible, and would make an outstanding small recreational aircraft. Out of this thought came Davis's Starship Alpha.

Starship Alpha is a composite, retractable geared flying wing with a pusher-mounted engine that's very faithful to Northrop design principles. This 35-ft. wing has been flying

for several months in a single-seat configuration with only a small, air-cooled Kawasaki 2-stroke engine, which is barely capable of 30 hp in its present setup.

Designer Davis, pilot Bernie Fisher (a retired Air Force pilot who has received the Congressional Medal of Honor, and our photo pilot for this story) and I have had the chance to fly this strange apparition. All of us are, without a doubt, impressed with its properties. Although my three flights were short ones, the Daviswing does seem to have a lot going for it. Especially after watching it maneuver in 35-mph wind, rain and close formation with our camera ship.

The control system is simple and effective. At the outboard end of each wing, where ailerons would normally be located, is a surface that's split horizontally so as to open and close like a clamshell. When opened, they produce drag that yaws the wing in the direction of the deployed drag rudder. Both pitch and roll are augmented by the surfaces that take a position on the inside of the drag rudder. A mixer system allows these "elevons" to operate both as an elevator and as an aileron. The control stick and rudder pedals are of normal configuration and operate just like any normal general aviation aircraft.

In flight, the Daviswing is responsive, fairly stable and exhilarating. Visibility is pretty good, though the available power was not much to write home about (due to such a small engine) and control pressure varied from light to moderate. Pitch is particularly sensitive because of the short moment arm, but I found little that was tricky or objectionable in its handling. Stability is far better than some of the antiflying-wing fanatics might have you think, though there is a little yaw instability at times—but not any more than that exhibited by some of the popular V-tail general aviation designs that have been flying for many years now. There is a mild control reversible evident in the landing mode. And the flying wing tends to nose up just



Instrumentation in the Davising is simple. The panel includes altimeter and banking instruments and mechanical compass.



Historic Wings

Jack Northrop, it is said, was one of the few men to charm Gen. Hap Arnold in the formative years of the U.S. Air Force. But charm him he did with the flying-wing design. The Northrop N1M's maiden flight in 1940 convinced Arnold that the flying wing was a great idea for getting planes to go higher and faster. But the first flight also showed the plane to be underpowered for its 4000 pounds.

Over the next decade, Northrop built dozens of flying wings that proved the concept theoretically but showed constant mechanical problems. As jet power came into being, the flying wing became the next hope for stealthy high bombing. But the planes again had power problems, and in June 1948 an experimental flying wing crashed in the California desert, killing Capt. Glen W. Edwards (for whom the airbase is named) and the flying-wing program as well. Some reports say, however, that the flying-wing idea may live on in the stealth bomber. Northrop aviation, which is building the prototype, may have gone back to the flying-wing idea.—D.E.



A YB-49 on test flight before fatal crash (top). An N9M (above) in an early test. It was last of the prop-driven Northrop wings.

WING DING



before it sets down, so you have to ease the stick slightly forward as you feel it.

Additionally, the Daviswing is a clean little bird— aerodynamically speaking—and can take a little while to slow down and descend from altitude. The plane didn't want to land, and I didn't want to either. Deploying both rudders simultaneously can increase the drag a bit, but the addition of some type of spoiler on the final version would seem to be a good idea. The Daviswing is fast and responsive, so some experience with high-performance aircraft comes highly recommended—though it should be noted that designer/pilot Davis is a “low time” private pilot with a limited amount of experience, most of it, apparently, in his own flying wing. Not many pilots can claim to have a majority of their flight time logged in such an aircraft!

The lightweight instrument system in the Daviswing bordered on meager, but some formation flying earlier that day confirmed that this first prototype is already capable of about 120 mph flat-out, and can fly quite controllably at speeds below 45 mph. Its climb rate is rather slow, but the installation of a larger engine will solve that.

Room for two

Starship Alpha was to be the first prototype of a series of flying wings that would be initiated with a single-seat kit for those homebuilt aircraft buffs with a flame for the unusual. Instead, Davis has been besieged with requests for a 2-place airframe. As a result, Starship Alpha is to be the first and last of Gil's single-place flying wings. Work has already commenced on a 2-seater that might be flying this spring. The name? Starship Gemini, of course.

The kit is expected to require about 700 hours to complete and will be fabricated from premolded composite components that should require very little construction expertise. Premolding allows many of the critical items to be completed safely and accurately by the manufacturer, leaving the simpler work for the builder—such as the lay-up of flat parts like wing ribs.

The Starship series will make great use of Nomex honeycomb, various glass fibers, graphite and several types of foams. Some steel and aluminum components will also be incorporated. Structural limits are expected to exceed 4.4 g's though Davis is targeting an absolute limit in excess of twice that—just to be safe.

The new powerplant will be the Rotax 532 liquid-cooled, 2-stroke engine—well known for its smooth power output, fuel economy and very reliable 65 hp. A mechanical gear drive will keep the prop rpm within an efficient operating range since most 2-stroke engines develop peak horsepower at speeds well above the efficient range of current propeller technology.

Starship Gemini will also have a retractable landing gear. This is to be a hydraulically actuated system with a backup designed to lower the gear in the event of a failure. The wings can be removed in less than 10 minutes for storage or transport, though the long, thin profile is not going to require much hangar space. Full VFR instrumentation will be included with each kit, making the Gemini a complete kit—no need for the expensive add-ons necessary to get most aircraft flying.

When I first saw this aircraft at the Oshkosh fly-in I knew I wanted to fly it—very much. My time with Starship Alpha was short, but I've been invited to do some of the test work on the 2-seater this spring. This time I expect to be more relaxed about the matter.

Kit prices are expected to be in the neighborhood of \$18,000. Cruise speed should be at least 150 mph and the range could be as great as 2000 nautical miles if not loaded too aggressively. Even more important than these impressive numbers is the fact that the Davis Flying Wing is a ball to fly, and an impressive sight to all who see it. **PM**



The Vista Bahn ride up Vail Mountain in Colorado is three times faster than conventional ski lifts.

Skiers have always traded stories about their favorite runs *down* the mountain. Now they're talking about how they got *up* the mountain. Take the Vista Bahn Quadruple Chairlift at Vail Mountain in Colorado. As you stand on the loading point, the quad chair approaches you at the surprisingly slow speed of 165 ft. per minute—half the speed of a beginner's lift and one-third the speed of a standard, fixed-grip double or triple chairlift. Once safely seated, you are accelerated in the space of 30 breathtaking feet from 165 fpm to 1000 fpm, coupled to the main haulrope, and catapulted from the terminal at 1200 fpm, three times faster than conventional lifts.

If the day is cold and windy, you can lower a Plexiglas bubble over the chair, protecting you from the elements while allowing a quiet, 360° view of beautiful Vail Valley. (The bubble is automatically opened when you arrive at the top.) Powered by a 1000-hp Toshiba DC electric motor and a gearbox weighing 6.7 tons, Vista Bahn whisks you and your companions up 9191 ft. of slope and nearly 2000 ft. in vertical rise in a mere 9 minutes. What used to be 18 cold, windy minutes aloft has become an unexpected thrill ride.

Built by Doppelmayr Co. Inc., the American subsidiary of an Austrian-based parent, Vista Bahn is the flagship of four expensive "detachable grip," or high-speed, chairlifts that Vail in-

UPHILL RACERS

Getting up a slope is becoming as exciting as the trip down, thanks to high-speed technologies.

BY BRUCE MOST

Aspen's *Silver Queen* gondola ride will be patterned after Poma setup in the Swiss Alps (right). It will rise 3267 ft., longest in the world.

stalled for the 1985-'86 ski season. The four lifts, which doubled previous capacity, so impressed skiers that they often told the lift attendant during loading to "Beam me up, Scotty."

These high-speed chairlifts are an example of the latest in ski-lift technology, as ski resorts and lift manufacturers around the world scramble to put up bigger, faster, longer lifts to meet skiers' increasing demands for comfort, shorter lift lines, and most of all, more time to bump the moguls instead of dangling in chairlifts and gondolas.

Observes Jerry Blann, president of Aspen Skiing Co., "What we (ski resorts) have experienced is what could be likened to an arms race in lift technology."

Aspen's entry in that expensive lift race will be the world's longest single-stage gondola system, due to be completed for the 1986-'87 skiing season. Built by Poma of America Inc., a subsidiary of Pomagalski of Grenoble, France, Aspen's *Silver Queen* gondola will span 13,194 ft. of slope and rise vertically 3267 ft. The vertical rise will be the longest by a single-stage gondola in the world, and the *Silver Queen* will run from downtown Aspen to the top of the mountain, the only gondola in North America to go from the bottom to the top of a ski area.

Traveling at 1000 fpm, the 6-passenger carriers, with unique back-to-back seating for more leg room, will convey skiers to the summit in 13 minutes. Driven by a 1700-hp electric motor, the 165 gray and red cabins will move 2000 skiers an hour, which, in ski technology jargon, converts to an impressive 6534 VTFH, or vertical transport feet per hour. The monocable gondola will be Aspen's first gondola, says Planning Di-



POMA PHOTO



The speedy *Silver Bullet* will rival Aspen's *Silver Queen* ride.

rector Fred Smith. Smith says that until recently, gondola lift technology had not produced the speed and capacity necessary to justify the expense.

Not to be outdone, one of Aspen's rivals, Steamboat Skiing Corp. in Steamboat Springs, Colorado, will also debut a new, high-speed gondola system this season. Its 8-passenger, sit-down *Silver Bullet*, designed and built by Doppelmayr, will be the largest sit-down skiing gondola in the world.

The *Silver Bullet* will rise 2170 ft. along a slope length of 8875 ft. for an estimated VTFH of 6076. The gondola

will be supported by and ride on a single haulrope, a 2-in. plow steel cable. A GE 1100-hp DC electric motor will drive the gondola.

With competition for the skier dollar heating up the slopes, superlifts are setting records every year around the world. In Kitzbühel, Austria, Doppelmayr's 2-year-old monocable 6-seater gondola carries 2400 skiers per hour up a vertical rise of 3238 ft., making it the largest lift installation (measured by VTFH) in the world. Poma claims the fastest and highest-capacity detachable quad in the world at Squaw Valley, California (1050 fpm and 3060 skiers per hour).

Massive lifts, using cables running in parallel, go even higher. At Le Saulire ski resort in Courchevel, France, each of Poma's two cable cars carry a world-record 160 skiers at a crack. But even that record will soon fall with the completion at the Val D'Isere resort in France of a funicular tramway whose cabins will carry 300 passengers each, built

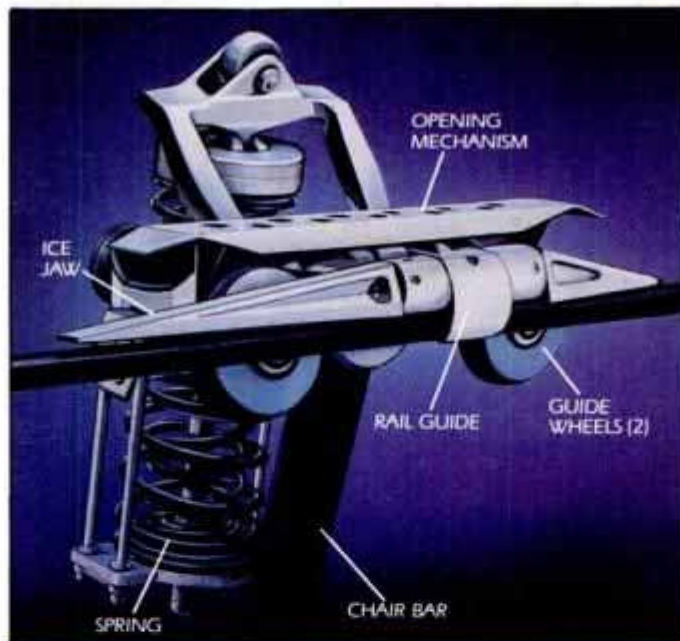
at the small price of \$8 million.

Experts do not see such large tramways on North American slopes, where terrain is less rugged and skiers unaccustomed to standing. What they do see are larger, more comfortable sit-down gondolas and an explosion in the building of detachable quad chairlifts. While detachables are nearly as expensive as gondolas—Vail's Vista Bahn alone cost \$2.5 million—the technology is too exciting to pass up.

Detachables borrow much of their design from detachable gondolas. With Vail's detachables, for example, each chairlift is clamped to the steel haulrope by a spring grip. As the chairlift enters the terminal, small wheels on the grip slip into a U-shaped channel. A bar depresses a lever on top of the grip to release the spring tension and a toggle is flipped to disengage the grip from the main haulrope. At this point, small, pulley-driven pneumatic tires, each run-



High-speed, lightweight lifts have broken more than speed records. In New Orleans, world's tallest gondola tower graced World's Fair.



Vail's new terminal area provides cable protection from ice.

The Poma T-Grip has a spring with extra travel room to break up snow and ice on opening and closing. The ice jaw is stainless steel.

ning at a decreasing speed, slow the chairlift until its speed is synchronized with a roller chain of nylon teeth that snag the chair and swing it around the bull-wheel toward the skiers at a slow, safe loading speed.

Once the skiers are loaded, the process is reversed.

The chair is disengaged from the roller chain and the tires quickly accelerate its speed to match the speed of the main line. The grip spring is reattached to the cable and the skiers shoot out onto the line at 1000 fpm (line speed can be slowed if desired).

Along the entire decelerator/accelerator system, microprocessor-controlled sensors monitor 12 different safety functions, from spring tension to spacing between chairs. If anything appears out of the ordinary, the system automatically shuts down. Larson said

Doppelmayr's lifts "ran better than our expectations," suffering no serious mechanical breakdowns.

Though detachable lifts are far more complicated and more expensive than fixed grip, the improved technology pays off in the long run. One reason is safety. According to Jim Fletcher, an independent design engineer, 83 percent of lift-related accidents occur during loading or unloading, particularly on fast-moving fixed-grip chairs. The slower detachables are dramatically reducing such accidents.

Problems loading and unloading are also the primary cause of delays and stops on a fixed-grip line, thus reducing capacity. Detachables run much closer to 100-percent capacity, which translates into shorter lift lines.

Future superlifts will provide skiers with yet more time on the slopes. Capacities on detachable trams may soon climb over 5000 skiers per hour. Sit-down gondolas will likely carry as many as 10 to 12 passengers. Simplified, less-expensive detachable technology and more powerful electric motors will make high-speed chairlifts, many with bubbles that open and close automatically, commonplace. In light of escalating insurance prices, the lifts' safety record is too good to ignore. Main-line speed is expected to increase beyond 1200 fpm in the near future, though large jumps in speed are not anticipated because such jumps force major technological changes.

All of this makes the skiers happy. "I think it's revolutionizing skiing," one Colorado skier commented about the detachables at Vail. "It's doubled my skiing time. I had friends come out from the East Coast and all they wanted to do was ride the lifts." **PM**



PM COMPARISON TEST:

THIS SPORTIN' LIFE

These 4-door family hot rods are America's fastest-growing market segment. We test eight new entries with sports car performance.



PONTIAC BONNEVILLE SE

ACURA LEGEND

There are more world-class sports sedans on the market than any other type of car. When we tested them a little over a year and a half ago, there were so many entries we had to divide our test into two groups. The imports included the Audi 5000S Turbo, BMW 325e, Mercedes-Benz 190E 2.3, Merkur XR4Ti, Nissan Maxima, Peugeot 505 Turbo, Saab 900 Turbo and Volvo 740 Turbo. From the domestics, we had a Buick Century T Type,

Chevrolet Celebrity Eurosport, Chrysler LeBaron GTS, Ford LTD LX, Oldsmobile Ciera GT and Pontiac 6000 STE (*Sports Sedans* page 92, Mar. '85, and page 80, Apr. '85).

Since those two tests were published, an astonishing eight new models have entered the sports sedan market. We felt we ought to test them, as well. With the exception of the Ford LTD LX which has been superseded by the best-selling Taurus, all the cars we tested in 1985 are still on the market. You could

THIS SPORTIN' LIFE

think of this most recent test as a continuation of those two earlier shootouts.

The new sports sedans in our test group are made all over the world. From Europe, the Alfa Romeo Milano, Audi 4000CS Quattro, Saab 9000 Turbo and Sterling 825S. From Japan, The Acura Legend and Toyota Cressida. And from America, Pontiac's downsized Bonneville and Mercury's Sable (similar to its sibling Ford Taurus).

As before, we did our track testing at Raceway Park in Englishtown, New Jersey, and our over-the-road evaluations on our usual driving loop outside Princeton, New Jersey. As always, our rankings are the consensus opinion of six testers after driving each of the cars in back-to-back sessions.

Saab 9000 Turbo

Nearly unanimously, our testers picked Saab's sleek 9000 as not only the best car in this group, but probably the overall winner from all three of these highly competitive sports sedan tests. The 9000 is quick, comfortable, functional, fun-to-drive, and has styling that is, as one tester said, "downright pretty for a Saab."

The 9000 is a hot performer. Its 16-second quarter-mile time at 86 mph makes it not only the quickest car in this group, but the equal of many 2-seater sports cars. Its brakes were the best in this test, as well. Like many European cars, the Saab posts mediocre slalom and skidpad figures, but *feels* wonderful over the road. By contrast, the typical American performance car can put up world-beater times at the track, but often feels harsh and uncomfortable to drive over the road.

The 9000 is the only upscale 5-door hatchback on the market. This makes it more versatile than the 4-door notchbacks of other companies. Our testers praised its overall packaging, saying it's a nice compromise between usefulness and style. We also love the Saab's interior design. Our test car came with beautiful gray leather seats that provide exceptionally good ergonomics—the whole inside has a very modern, European feel.

We also like the 9000's controls and instruments, with the notable exception of the wobbly, too-short shift lever. "Reverse lockout is a pain in the finger—let's have a different shifter," complained one tester.

The steering and handling—no doubt aided by the excellent Pirelli P6 195/60VR15 tires—were high on every-

one's list of things to like, as was the rushing power of the turbocharged 2-liter Four.

Indeed, the Saab 9000—even at \$23,000—seems just wonderful to us. As one impressed tester put it, "I like the power, handling, styling, room—everything but the shifter. The 9000 has an overall aura of competence that's extremely reassuring. Saab has moved into the Mercedes/BMW market with this car. If the dealers can give it Mercedes-like service, it's a winner."

Audi 4000CS Quattro

Everyone knows about the little Volkswagen Golf and Jetta, just as they've heard about the big Audi 5000. But in between is another VW/Audi model that's been just about invisible in the United States, even though it may be the best car VW/Audi builds. In this country, it's sold as the Volkswagen Quantum wagon or the Audi 4000CS sedan. We tested the Quantum last month in our *Wonder Wagons* test (page 58), and said it was the most fun to drive in this



class. This month we have the sedan. The Audi 4000CS Quattro, like the Quantum Syncro, has the same 5-cylinder, 2.2-liter engine as the big Audi 5000S, plus the same full-time 4-wheel drive as the \$30,000 5000CS Quattro. At \$20,000, the 4000CS Quattro almost begins to look like a bargain.

It's also tremendous fun to drive. Every one of our testers remarked on the Audi's excellent handling and stability, not to mention the 5-cylinder's smooth power. Imagine this car with Audi's turbocharged engine!

SPECIFICATIONS AND DIMENSIONS

| CAR | BASE PRICE | PRICE AS TESTED | ENGINE | TRANSMISSION | WHEEL-BASE (in.) | LENGTH (in.) | WEIGHT (lb.) |
|-------------------------------|------------|-----------------|--------------------------------------|-------------------|------------------|--------------|--------------|
| Acura Legend | \$19,753 | \$19,998 | 151 hp SOHC 2.5-liter V6 | 5-speed manual | 106.7 | 189.4 | 3100 |
| Alfa Romeo Milano Gold | 12,850 | 16,480 | 156 hp SOHC 2.5-liter V6 | 5-speed manual | 98.8 | 173.9 | 2700 |
| Audi 4000CS Quattro | 19,045 | 20,075 | 110 hp SOHC 2.2-liter Inline-5 | 5-speed manual | 99.4 | 177.3 | 2850 |
| Mercury Sable | 12,574 | 15,991 | 140 hp OHV 3.0-liter V6 | 4-speed automatic | 106.0 | 190.0 | 3250 |
| Pontiac Bonneville | 16,281 | 18,000* | 150-hp OHV 3.8-liter V6 | 4-speed automatic | 110.8 | 198.7 | 3312 |
| Saab 9000 Turbo | 22,545 | 22,851 | 160 hp DOHC 2.0-liter Inline-4 Turbo | 5-speed manual | 105.2 | 181.9 | 3000 |
| Sterling 825S | 19,000* | 20,500* | 151 hp SOHC 2.5-liter V6 | 5-speed manual | 108.6 | 188.8 | 3164 |
| Toyota Cressida | 18,280 | 19,895 | 156 hp DOHC 2.8-liter Inline-6 | 4-speed automatic | 104.5 | 187.8 | 3150 |

*Estimate

1. Best speed while weaving through seven cones placed 100 ft. apart; the higher the speed, the better the transient handling.
2. G-forces generated during steady-state cornering around a 200-ft.-dia. circle; cw = clockwise, ccw = counterclockwise.
3. The number of standard-size grocery bags that will stand upright (1-in. crush space permitted) in trunk with rear seats up.



STERLING 825S



MERCURY SABLE



SAAB 9000 TURBO

Even in red, the 4000CS Quattro is not much of a looker. The styling is dated and sedate. In another year, we'll see a new 4000 body—already introduced in Europe—similar to the aero look Audi 5000. This should give the 4000CS the pizzazz it's now lacking. At the same time, our testers recommend that Audi update the interior.

For years, VW/Audi has used similar seats in the Scirocco, Audi Coupe, Jetta and 4000. They're comfortable enough, but rather undersized and flimsy. The rest of the interior ergonomics brought raves from our testers, but

Audi management needs to talk to the Art and Colour department. Our test car was bright red with a dark brown interior—a combination that brought groans from even the aesthetically insensitive.

At the track, the 4000CS Quattro is a winner. Even driving all four wheels, the Audi 5-cylinder returns the best fuel economy in this group—by a margin of better than 2 mpg. At the same time, it's just a heartbeat slower through the quarter-mile than the ultrasporting Alfa Romeo, Sterling and Acura, all of which have larger V6 engines.

TEST RESULTS

| GAS MILEAGE EPA city/ PM test | 1/4-MILE (sec. @ mph) | BRAKING (R.) (60-0 mph) | SLALOM ¹ (mph) | SKIDPAD ² (cw/ccw) | TRUNK SPACE ³ | INTERIOR SPACE INDEX ⁴ | TEST TRACK RANKING ⁵ | ROAD TEST RANKING ⁶ | OVERALL RATING ⁷ |
|-------------------------------------|--------------------------|-------------------------------|------------------------------|----------------------------------|-----------------------------|---|---------------------------------------|--------------------------------------|--------------------------------|
| 19/14.61 | 16.64 @ 83.95 | 157 | 57.38 | .75/.75 | 18 | 127.85 | 4 | 4 | 3 |
| 19/16.18 | 17.03 @ 82.11 | 162 | 58.74 | .74/.80 | 11 | 117.31 | 7 | 5 | 6 |
| 18/19.71 | 17.06 @ 78.26 | 128 | 59.24 | .76/.79 | 10 | 117.76 | 2 | 2 | 2 |
| 20/17.16 | 17.99 @ 77.38 | 207 | 57.25 | .74/.74 | 20 | 135.68 | 5 | 8 | 7 |
| 18/14.84 | 17.39 @ 78.67 | 180 | 59.88 | .77/.77 | 17 | 134.22 | 3 | 6 | 5 |
| 21/15.22 | 16.31 @ 86.20 | 118 | 57.17 | .76/.75 | 18 | 135.13 | 1 | 1 | 1 |
| 19/15.01 | 16.75 @ 82.51 | 160 | 57.20 | .74/.75 | 19 | 122.70 | 6 | 3 | 4 |
| 19/13.40 | 17.70 @ 80.21 | 127 | 55.64 | .75/.77 | 12 | 124.10 | 8 | 7 | 8 |

4. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom ÷ 1000.

5. Points are awarded from best (1) to worst (8) in each category. Fewest total points ranks first, and so on.

6. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.

7. Average of Test Track and Road Test ratings. Road Test score breaks ties. Bold numbers show best performance.

THIS SPORTIN' LIFE



AUDI 4000CS QUATTRO



TOYOTA CRESSIDA

No doubt helped by 4-wheel drive, the Audi was fastest around the skidpad and second through the slalom. Indeed, if you factor out our interior space and luggage measurements, the 4000CS Quattro is a clear winner at the track. It's a real driver's machine that rewards finesse.

Our testers definitely prefer the Saab 9000 but, particularly in the snowbelt, the 4000CS Quattro makes a lot of sense.

Acura Legend

Honda has done virtually nothing wrong since it entered the American market two decades ago, and the idea of entering the Mercedes class with a car for under \$20,000 is one that ought to make upscale families salivate with anticipation. Unfortunately, everything about the Acura—the advertising, the styling, the driving—is, not to mince words, boring.

This is the most competent, most advanced sedan in this group—maybe in the world. And it's no fun at all.

The best thing about the Acura is its wonderful 2.5-liter V6 engine. Since the World Championship motorcycle days of the early '60s, Honda has been able to build lightweight, powerful, technically overwhelming engines in any configuration you can imagine. The Acura's 24-valve V6 is the largest production engine Honda has offered, but like all the rest it's easy revving, smooth and quiet. All automobile engines should be this good.

The Acura chassis is like an enlarged Accord, which is no bad thing. Honda is moving away from MacPherson struts in favor of the geometric purity of unequal-length control arms. The front-wheel-drive, all-independent suspension, 4-wheel disc brake Acura chassis is as technically superb as the engine, but somewhere along the line it became softened and blurred, probably in a mistaken attempt to Americanize it.

At the track, the Acura engine hummed to second in this group of cars, just .3 seconds behind the turbocharged Saab 9000. You pay a penalty for this performance though: the Legend was next to last in fuel economy, with a poor 14.6 mpg. In our handling and braking tests, the Acura was mired in mid-pack. It's almost always neutral, but the limits are never very high.

The brakes are devoid of feel, the suspension gets upset on undulating roads and the steering has little feel, especially in the on-center position where *nothing* happens.

Like its performance, the Acura's styling got a mixed reception. Some testers thought it seemed modern, integrated and pretty, while others called it inoffensive and a nosed and decked Accord. The interior was faulted for its blandness, too short seats and oddly recessed instruments that look like "black pie tins."

Sterling 825S

The Acura Legend was actually a joint venture between Honda in Japan and Rover in England. For the European market, Rover assembles its own version, using Japanese engines and drivetrains. This is the Rover 825, and it gives

Honda an entree into the European Common Market while avoiding import restrictions on Japanese cars.

Florida businessman Norman Braman—he owns 17 car dealerships and the Philadelphia Eagles football team—is importing the Rover 825 from England and calling it the Sterling in this country.

Underneath, the Sterling is identical to the Acura Legend, except for narrower tires and different suspension settings. All the body panels are different, however, as is the interior.

Our testers thought the more traditional Rover styling was better looking than the flared fenders of the Acura. The wood-trimmed Sterling interior is more cheerful and luxurious than the austere plastic Acura's, but the ergonomics are roughly the same. The Sterling has a stiffer ride and sharper handling than the Legend, but even driving them back-to-back, it's hard to see why two different versions are necessary. Very minor differences in performance and interior space put the Sterling behind the Acura on the track, but our testers actually preferred the Sterling in their over-the-road evaluation.

The upmarket version of the Sterling—the \$23,000 825SL—has leather upholstery, ABS brakes, a trip computer and memory power seats—items people expect in this price range but that Honda forgot to put into the Acura. The most important difference between the two cars is that the Acura is built in Japan and backed by Honda, while the Sterling is built in England by a firm with a spotty quality record and imported by a well-meaning but unproven company.

Pontiac Bonneville SE

The Bonneville is Pontiac's belated version of the full-size Buick LeSabre/Oldsmobile Delta 88 sedan.

Like nearly all cars that have come from the drawing boards at General Motors lately, the Bonneville has a long nose, high deck and formal rear window. This style is pleasant enough, but we think it's time for GM Styling to come up with some new ideas.

Our testers liked the Bonneville interior, with surprisingly good ergonomics and very comfortable seating position. The Bonneville has lots of leg and head room and, aside from the burlled walnut plastic trim on the dash, the interior works quite well as a whole. The full instrumentation came in for special praise from our testers, as did the super sound system.

Our track test driver says the Bonneville is a great handling car. It won the slalom and was second behind the 4-wheel-drive Audi on the skidpad. Still, there's too much understeer, the brakes are poor and there just isn't enough horsepower. On the other hand, a lot of drivers will think it's just swell on the road.

Pontiac has had great success with the 6000 STE. As the "performance" division, we think Pontiac ought to offer an STE version of just about every model, just as Buick does with the T Type. Upgraded shocks and tires with less

(Please turn to page 114)

NAILS

Here's how to choose and use nails for various home and shop projects.

BY JOSEPH TRUINI, Shop And Tools Editor
Photos by Brian Kosoff



The simple chore of driving a nail with a hammer is the most frequently practiced do-it-yourself act. It's also usually the very first do-it-yourself accomplishment that most people experience. However, using the right nail for the job is as important as driving it correctly. If the nails are too small, the joint won't hold; too big and the wood will split. Nails are available in hundreds of styles, shapes and sizes and each is designed for a particular application. Shown here are 22 types of nails that every do-it-yourselfer should know about.

There are several factors to consider when buying nails, including the material that the nails are made of, length, gauge (diameter of shank), surface finish, and the type of head, shank and point. Most nails are made of mild steel, but aluminum, stainless steel, copper and bronze are also used. Nail length is designated by "penny" size—a term that originally indicated the price per hundred nails. Now the penny symbol, a lowercase "d," refers only to the nail length. The letter "d" derives from the denarius, an early Roman coin. Generally, as the penny size increases, the shank diameter increases, too. Therefore, a 4d (1½-in.) nail has a smaller diameter shank than a 20d (4-in.) nail.

Most nails have a bright, uncoated surface while others come coated to help the nail grip better or resist corrosion. The most common surface coatings are galvanized, cement- and resin-coated. The designed purpose of a nail is often indicated by its head. Large, flat-headed nails distribute pressure over a wider area; therefore, they hold best. Finishing and casing nails and brads have small, round heads for setting below the wood's surface.

For extra holding power, select nails with shanks that feature spiral grooves, flutes, annular rings or barbs. These nails are particularly effec-

NAILS

tive when installing flooring, shingles and siding. Most nails have diamond points. Needle, chisel and blunt points are also popular.

Whenever possible, nail through the thinner piece of wood and into the thicker piece. As a general rule, two-thirds of the nail's length should be driven into the thicker wood. Drive in nails at angles to increase their holding power. When nailing into hardwoods or close to the end or edge of a board, bore pilot holes first to prevent splitting. Clinch nailing provides the strongest joint, but it's also the most unattractive. It involves driving long nails through both boards then bending over protruding ends. *Caution:* Always wear eye protection when hammering nails.

Nailing down specifics

Common nails, as the name implies, are the most widely used. Shown are eight of the most readily available common nails from 4d (1½ in.) to 60d (6 in.). Use common nails for general construction and carpentry. Thick shanks and large heads allow the nails to hold fast. The nails shown have a bright finish, but for exterior use they're available with a galvanized finish to resist rust and corrosion.

The next most popular group of nails includes brads (No. 1) and finishing nails (No. 2). The two are similar except that brads are smaller. Brads are designated by length in inches and gauge number. The highest number represents the smallest diameter shank. Shown is a 1-in., 16-ga. brad. Finishing nails are commonly available from 2d (1 in.) to 10d (3 in.). Use finishing nails to install door and window trim, moldings and for lightweight construction. Shown are 4d, 6d and 10d nails. Finishing nails also come galvanized. Other entries in the lightweight category include wire nails (No. 3) and panel nails (No. 4). Wire nails, like brads, are listed by length in inches and gauge number. Shown is a 1½-in., 18-ga. wire nail. These superthin, flatheaded nails are indispensable for tacking thin materials that other nails would split or that small-headed brads couldn't hold.

Panel nails, identified by small, flat heads and annular-ringed shanks, are designed specifically for installing wall paneling. They range in size from 1 in. to about 2 in. and come in various colors to match the finished paneling.

The next nail group, numbers 5 through 11, are aluminum nails which have a couple of advantages over steel nails including being rust and stain resistant, and lightweight. Aluminum nails are particularly effective where exposure to weather is a concern. And, since nails are sold by the pound, you get more nails per pound. You can expect about 105 No. 8 common steel nails in 1 pound. A pound of No. 8 common aluminum nails yields about 230 nails. The nails shown include: 3d (1½-in.) screw-grip roofing nail with neoprene washer (No. 5) for use on aluminum roofs, 6d screw-grip aluminum and vinyl siding nail (No. 6), 1½-in.



wood siding nail with casing head (No. 7), 3d cedar shingle nail (No. 8), 2½-in. screw-grip redwood siding nail (No. 9), 2½-in. wood siding nail with sinker head (No. 10), 2d (1-in.) painted trim nail (No. 11) for installing hardwood molding.

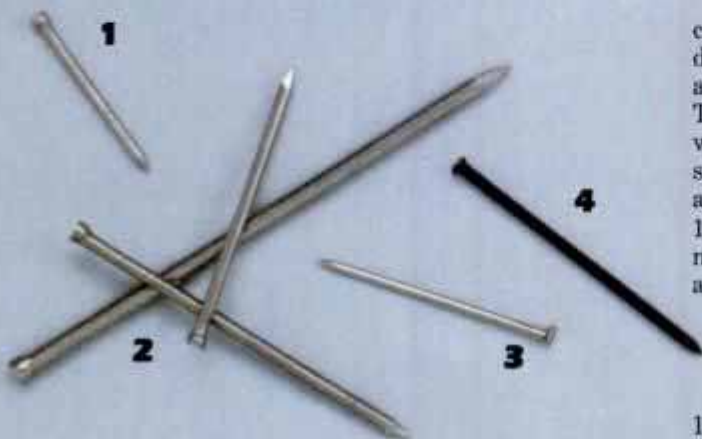
The remaining 10 nails are specialty nails made for specific applications. Shake nails (No. 12) are for installing wood shingles and hand-split shakes. The 6d galvanized nail shown features a small, flat head, blunt diamond point that reduces splitting, and a slender, annular-ringed shank.

The next two nails are similar in appearance and manufacture, but not in purpose. No. 13 is a 1½-in. drywall nail used to install gypsum wallboard. The 2½-in. box nail (No. 14) is used to build crates and boxes. Both nails feature long diamond points, small-diameter shanks and a resin coating to increase their holding power. However, drywall nails have large, flat heads that prevent pull-through to hold the wallboard tightly to the house framing.

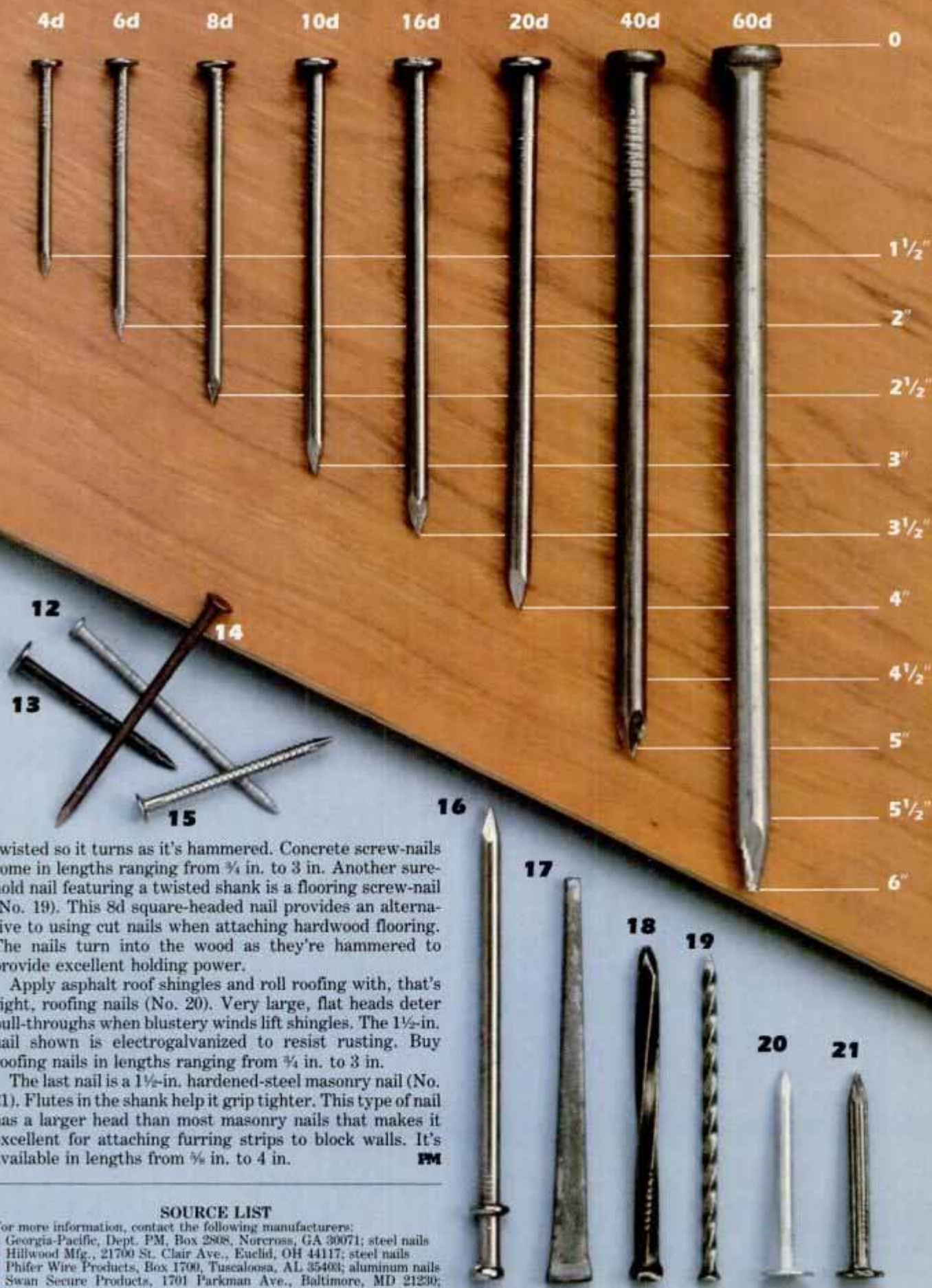
Next is a 1½-in. underlayment nail (No. 15). These nails, commonly available in lengths from 1 in. to 2½ in., are used to nail down plywood subflooring and other underlayment sheet material such as structural particleboard and oriented strand board. The nails feature medium-sized flat heads, long diamond points and annular-ringed shanks.

Leading off the last nail group is a 10d double-headed common nail (No. 16), also known as a scaffold nail or duplex head nail. This "removable" nail can be driven tight and then yanked by pulling on the protruding upper head. The nails are designed for temporary construction such as wood scaffolding and concrete forms. They're available in sizes ranging from 6d to 20d. The rectangular cross-section and tapering shank identifies the next nail as a cut nail (No. 17). Use cut nails to attach wood to concrete blocks (for nailing to poured concrete try nail Nos. 18 or 21). Cut nails are also used to fasten hardwood strip flooring to the subfloor. They're available in sizes ranging from 3d to 20d. Shown: a 10d cut nail. *Caution:* Cut nails are extremely brittle. Protect your eyes with goggles.

Penetrate cured concrete with a concrete screw-nail (No. 18). The nail, made from square tempered-steel stock, is



COMMON NAILS




twisted so it turns as it's hammered. Concrete screw-nails come in lengths ranging from $\frac{3}{4}$ in. to 3 in. Another sure-hold nail featuring a twisted shank is a flooring screw-nail (No. 19). This 8d square-headed nail provides an alternative to using cut nails when attaching hardwood flooring. The nails turn into the wood as they're hammered to provide excellent holding power.

Apply asphalt roof shingles and roll roofing with, that's right, roofing nails (No. 20). Very large, flat heads deter pull-throughs when blustery winds lift shingles. The $1\frac{1}{2}$ -in. nail shown is electrogalvanized to resist rusting. Buy roofing nails in lengths ranging from $\frac{3}{4}$ in. to 3 in.

The last nail is a $1\frac{1}{2}$ -in. hardened-steel masonry nail (No. 21). Flutes in the shank help it grip tighter. This type of nail has a larger head than most masonry nails that makes it excellent for attaching furring strips to block walls. It's available in lengths from $\frac{3}{8}$ in. to 4 in. **PM**

SOURCE LIST

- For more information, contact the following manufacturers:
- Georgia-Pacific, Dept. PM, Box 2808, Norcross, GA 30071; steel nails
 - Hillwood Mfg., 21700 St. Clair Ave., Euclid, OH 44117; steel nails
 - Phifer Wire Products, Box 1700, Tuscaloosa, AL 35403; aluminum nails
 - Swan Secure Products, 1701 Parkman Ave., Baltimore, MD 21230; stainless steel and nonferrous nails

A collection of vintage air pistols and a Boy Scout ring are displayed on a blue background. The items include a silver Boy Scout ring with a compass rose, a black and wood air pistol, a black and wood air rifle, and a black and wood air pistol. The text is centered at the top, flanked by two yellow horizontal lines.

Hitting the bullseye with safe, affordable—and surprisingly sophisticated—air pistols.

ON TARGET!

For a 10-year-old in rural Pennsylvania, some 40 years ago, there were three possessions which set one above all the other kids. A Boy Scout pocket knife, a Captain Midnight “Secret Decoder Ring” and a Daisy Red Ryder BB gun. With this triad of necessities, one was equipped to cope with any emergency, including foreign spies, space invaders or a plague of starlings. It was the lucky kid who had all three of these wonderful items at the same time, but it was the BB gun that was most coveted. Tin cans would be severely dented at under 25 ft., and discarded lightbulbs would shatter with a satisfying pop if the aim

were true. Each BB gun of that era displayed its own ballistic peculiarities, requiring a bit of holding high or low or to one side to ensure a hit. After shooting a thousand or so BBs, each owner knew his gun well.

Frankly, these spring-type air guns were toys, as the Europeans are so fond of telling us, but they served a useful purpose in teaching millions of American youngsters how to shoot a shoulder arm. They were the primary step in the eventual advancement to powder firearms. This has not been the case in Europe.

BY JIM BASHLINE; PM photo by Bill Dolce



A quartet of highly accurate .177-caliber pellet pistols from around the world:

- The Feinwerkbau Model 90 Match Pistol (top left) imported from Germany by Beeman.
- The RWS "Diana" Model 10 (below left), also from Germany.
- The futuristic Hurricane (top right) from Britain's Webley & Scott.
- The Daisy 777 Power Line Pistol (below right), made in America.

ON TARGET!

For a combination of reasons, including a reduced amount of open space, more restrictive firearms ownership regulations, economic pressures and social climates, European air-gun shooting has long been an adult activity. American shooters have only recently been drawn into more than amateur levels of air-gun shooting, and the sport has attained Olympic status for the 1988 Games.

In pellet-pistol competition, regardless of the scoring system used or size of target, the goal is to deliver all shots into the smallest cluster possible. In shooting vernacular, this tight clustering is called the group, with all holes from bullets or pellets simply enlarging the first hole, if possible. To do this, a gun must offer a smooth, crisp trigger pull, precise sights, finely rifled barrels and consistent velocity from shot to shot. The projectiles fired must also be highly uniform in diameter, shape and weight. If the combination of gun and projectile cannot fire 10 shots into a spot the size of your pinkie fingernail, it's not in the game.

Because highly accurate guns of all kinds are the most interesting to shoot, it follows that they are the most difficult to manufacture, and the most expensive. The cream of the crop does not simply fall off the end of any assembly line. They are hand-tuned and tested thoroughly before being boxed and shipped. This may be more the case with top-quality air guns than it is with powder handguns. I have yet to take a powder handgun out of its shipping carton and have it shoot as well without any alterations as the two German air pistols we fired.

The Feinwerkbau Model 90 .177-cal. Match Pistol imported by Beeman is a superb example of excellent out-of-the-box performance. Held on sandbags and fired at 10 meters, this pistol sends five shots into one ragged hole using almost any decent pellet. The grips on the Model 90 are adjustable in a number of directions, and so is the angle of the trigger. In fact, nearly every critical function of this high-grade gun is adjustable: sights, trigger pressure, grip and more. But it's the trigger that lifts this gun into the realm of high tech. It's powered by a camera-size battery for precise uniformity from shot to shot. It's the finest trigger I've ever used, and I predict we'll see more like it.

For its extremely good looks and excellent feel, I rate this pistol at 9.5 on a 1-to-10 scale.

The best shooting gun in the pure accuracy department proved to be the RWS "Diana" Model 10. It is a break-open design, which cocks by pulling a barrel shroud extension, twisting it 90°

and then cocking the barrel in a downward motion. This barrel shroud adds weight to the muzzle, which, in turn, gives this gun an extremely solid feel in the hand. The double-piston system employed by this German air gun provides a nearly vibration-free firing sequence. The fully adjustable trigger is one of the finest, and the high quality of machine work speaks perfectly of Old World craftsmanship. Several clusters with various pellets tore 1-hole groups at 10 meters that measured less than a



from the years of work devoted to the Model 84 rifle, Crosman engineers were given the task of doing something similar in the pistol department. They tapped the brain and skills of Ragnar Skannaker, the Finnish pistol wizard, for help in designing what they hoped would be the best shooting pellet gun in the world.

There is only one operative prototype of the Skannaker in existence at the moment and it has already performed admirably

The Crosman Skannaker—a new generation: This gas-powered working prototype is highly accurate. It has adjustable trigger and consistent pellet velocity.

ably in its first international match. American shooting champion Dan Nygard placed second at the Benito Juarez Match in Mexico last March. Okay, so he didn't take first, but this astounding second-place win was achieved after only 12 test shots by Nygard. It only required a dozen trigger squeezes to convince him to lay aside his favorite air pistol and go for the medal with this new CO₂ model.

The Crosman Skannaker pistol has all of the goodies competition shooters expect. Superb adjustable trigger, easily adjustable sights, movable stock panels and a profile right out of "Star Wars." The price will undoubtedly be near the \$1000 mark, putting it out of the reach of most casual shooters. But if it wins more medals, who cares? Based on what I saw the gun do and its sexy good looks, a rating of 9.8 is appropriate.

Another American name synonymous with air guns is Daisy. This company's Red Ryder carbine was the dream gun of two generations of kids in the U.S., and tens of thousands are still in use. Daisy has not stopped innovating, and its 777 Power Line Pistol is a fine example of excellent quality at moderate price—something Daisy has been famous for. Its marketing folks are quick to point out that it is the only World Class air pistol entirely manufactured in the United States. At a suggested retail of \$250, the 777 costs less

quarter inch. The adjustable stock can be fitted to any adult hand. I've got to give this pistol a 9.8 rating, even though the Feinwerkbau trigger was much smoother.

As good as the European air pistols are, and they are very good, one of the most exciting developments in .177-cal. pellet shooting is the ongoing research being done by Crosman here in the U.S. The Crosman reputation has been built primarily on CO₂-powered rifles and pistols and there is little question about this Coleman subsidiary being the leader in gas cylinder guns.

But frankly, up to now, Crosman didn't have what is popularly referred to as a World Class competition arm. A gap in merchandise was filled abruptly last year with the introduction of the Model 84 match-grade rifle.

The Model 84 was the first CO₂ rifle to feature a digital readout panel on the right side of the gun to indicate velocity level for the next shot, allowing pressure-regulated gas release. To the serious target shooter, consistent velocity from an air- or CO₂-powered arm is what the game is all about—other factors being equal.

Building on the technology learned

than many imports and will create groups that rival the best shot by much more expensive guns. The rear sight on the 777 is fully adjustable and then some. This is the only gun I tested that wears a rear sight on which the slot width can be altered. Since human



arms and eyes vary in many ways, the front sight in the rear notch does not always appear the same. With this Daisy, sight changes can be made until a perfect arrangement is found.

The good-looking walnut grips cannot be adjusted mechanically, but they are supplied oversize and can be rasped, whittled and sanded to an individual's liking. The gun's heft is nicely distributed in the hand, neither muzzle heavy nor muzzle light, and in this area rates as high as any gun tested. In fact, it feels better to me than many of the high-priced guns. Trigger let-off is a trifle creepy, but the gun shot good enough to be considered very accurate—a good gun at a good price that will shoot better than most of us can hold. A rating of 9.2 is well deserved.

The Spanish-made Marksman 17, imported and distributed by Marksman Products of Huntington Beach, California, is a slick-looking, good-feeling air gun. The frame and grip are of 2-piece molded synthetic construction and are about as streamlined as a gun can be. The sight picture is perfect for me, and the micrometer adjustments worked well. There was, however, a major problem with this gun. The trigger pull varied so much from shot to shot that it was nearly impossible to achieve a smooth let-off. Shooting without the aid of sand bags was difficult, but surprisingly, it shot very well from the bags. At \$80, this one isn't in the running with the superb German or Crosman pistols, but then, price does make a difference. For now, the Marksman 17 gets a rating of 7.0.

Another product imported by Marksman deserves some mention, even though it's not a match-type pistol. It certainly does qualify as a high-tech development in spite of a rather traditional profile. It looks very much like a Smith & Wesson K-38., swing-out cylinder and all. It fires six .177-cal. pellets with one loading. The six "cartridges" are primed by a hand pump and pellets are inserted into each cartridge. The pistol is then cocked and fired just as a cartridge pistol would be.

Named the Orion, and imported by Marksman via Great Britain (manufactured in West Germany), this is an air pistol that will appeal to the mechanical buffs. It's not a match-grade pistol but at \$125, it doesn't cost as much.

Beeman, the San Rafael, California, importer who searches the world for unusual air guns, has a couple more in its small arsenal. One is the Webley & Scott Hurricane, a futuristic-looking .177 pellet pistol. This isn't a match-grade pistol either, but it proved to be accurate in spite of a bit more kick at let-off than was experienced with other pistols. The spring is cocked by lifting the barrel, which then locks in place via a steel yoke on top of the breech. It looks fragile but it isn't, and the gun feels great in the hand. At \$149.50 it's affordable for most. While I shouldn't rate this with the match guns, I'd still give it an 8.0.

The other Beeman offering is the P1 Magnum, a totally different creature. This Colt .45 automatic look-alike actually has the same grip dimensions as the former government-issue sidearm. A small amount of recoil was planned as a simulation of shooting a real .45. For those who want to practice and still have a powder gun feel, the idea is worthwhile. This gun is available in .177- and .22-cal. I tested the .22-cal. With the Beeman Model 25, 2X20 telescope, it delivered good plinking accuracy at 10 meters. Again, this one is not match grade, but feels great in the hand. In fact, the balance is so good that I wish the West German manufacturer would make a similar gun with match features. Frankly, I could hold this gun more comfortably than I could any other air pistol, but then, I'm partial to the old Colt .45. Give this gun a 9.0 on the strength

of great feel in the hand and excellent workmanship. The price is \$199.95.

Regardless of any gun's capabilities, one can't be accurately fired unless the pellet is not well made.

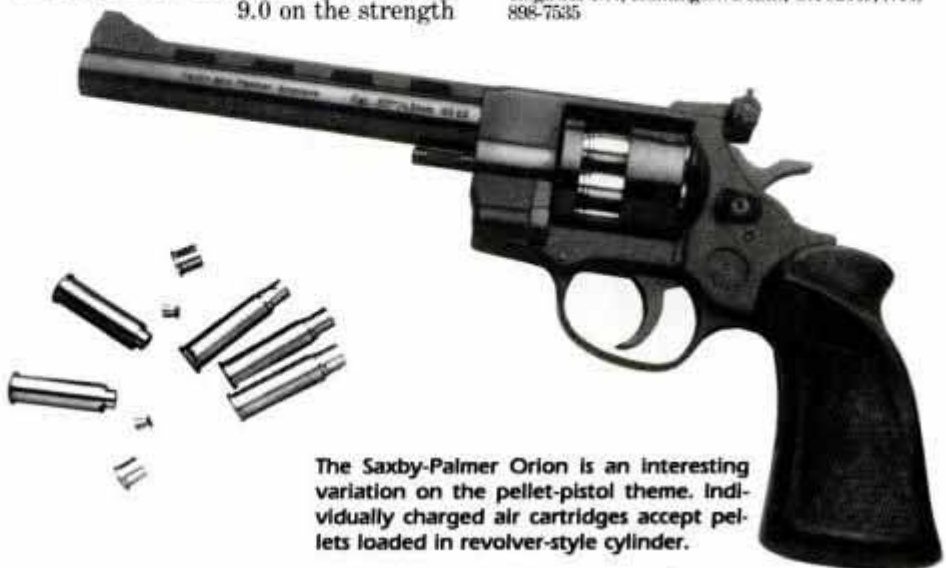
As its fine new Skannaker pistol was being developed, Crosman lifted quantity production of .177-cal. pellets to a new level of precision—weighing within one-tenth of a grain apiece. Beeman sells the famous Haendler & Natermann pellets, which have been winning matches for years. The shapes they offer should include one that will suit any air gun. They even offer their numerous H & N styles in a pellet sampler box so shooters can discover what shoots best for them. The old British firm of Eley, imported by Marksman in the WASP and Match grades, are solid performers. Dynamit Nobel, another old German firm, produces the excellent RWS pellets.

In addition, there is old reliable Daisy. Its pellets proved to be the sleeper in the bunch. Packed in a loose plastic box of 250, Daisy Quick Silver pellets, banging around against each other, weren't expected to shoot as well as the overseas products. But the Quick Silver pellets actually shot better in the Diana RWS gun than did any other.

The Europeans have been shooting and perfecting air guns for many generations. We've been shooting them too, but we haven't been doing much perfecting, nor have we taken the "quiet" guns seriously. All this is in happy transition today as our best shooters have discovered what air guns are capable of. And the rest of us who just like to pop away at targets and tin cans are getting in on the fun, too. **PM**

AIR GUN SOURCES

- Beeman Precision Arms, 47 Paul Dr., San Rafael, CA 94903; (415) 472-7121
- Crosman Air Guns, Routes 5 and 20, East Bloomfield, NY 14443; (716) 657-6161
- Daisy Manufacturing Co., 2111 S. Eighth, Rogers, AR 72756; (501) 636-1200
- Dynamit Nobel of America, 165 Stonehurst Court, Northvale, NJ 07647; (201) 767-1995
- Marksman Products, Div. of S/R Industries, 5622 Engineer Dr., Huntington Beach, CA 92649; (714) 898-7535



The Saxby-Palmer Orion is an interesting variation on the pellet-pistol theme. Individually charged air cartridges accept pellets loaded in revolver-style cylinder.



PIPE DREAMS



Custom-carved designs are hot stuff among pipe collectors. With imagination and the right tools, you can create your own.

BY CARL CAIATI

The current rage among pipe aficionados is for free-form, custom-sculpted smokestacks. These novel designs are easy to craft with simple mini-motor tools and home workshop materials.

To create your own individualized dream pipe, the first requirement is a briar pipe-blank block, sold by better pipe specialty stores. For working the blank, you'll need a machine motor tool (for shaping and etching), engraving bits and burrs, a belt sander, drum sanding bit and rattail file.

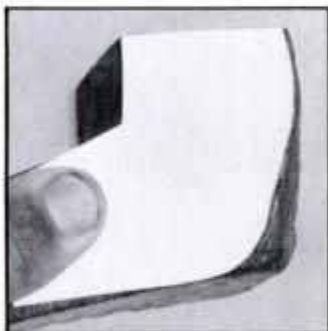
Pipe blanks are sold in a variety of sizes and shapes. Bowls are predrilled, as are the pipe-stem mounts and airdrawing tubes. The carving and decorative shaping are up to you. The only factors not under your control are grain patterns, and flaws or soft spots in the briar that show up as the wood is



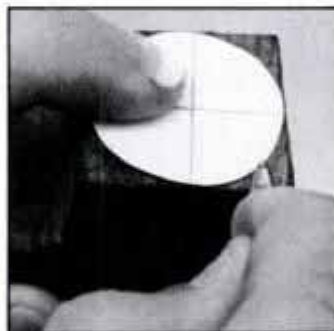
Use belt sander to trim the excess briar into rough contours.



Bowl and stem are rounded and shaped with the belt sander.



Make templates for the pipe's profile and bowl circumference.



Transfer template outlines to briar before rough sanding.



Cut contour grooves with the hand-gripping of the Dremel aids in heavy shaping.



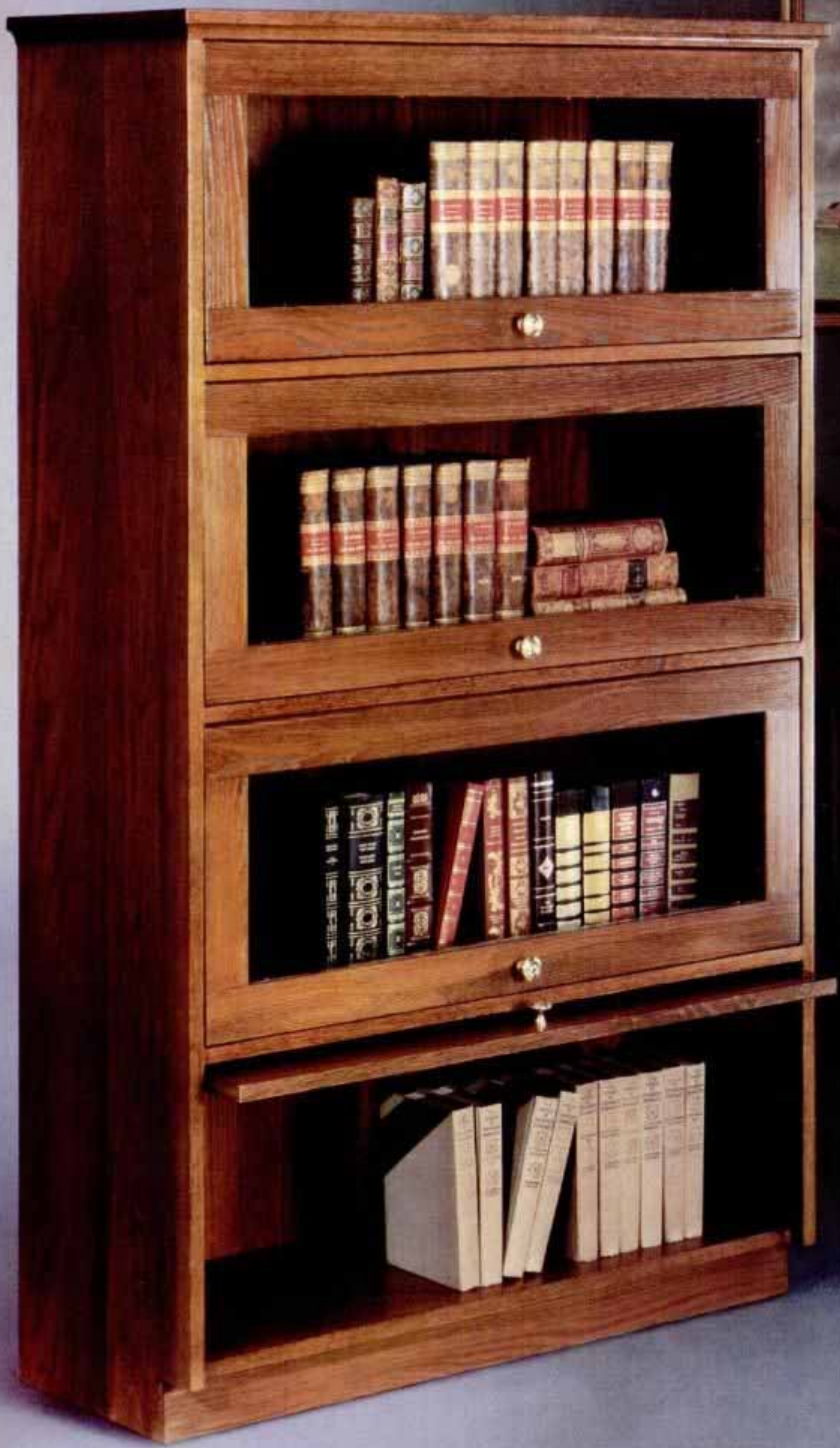
Fine-hone with a rattail file to remove machine markings.

shaved and sanded away. The grain pattern can be crafted in such a way as to exploit its inherent beauty. The flaws can be masked with decorative carving.

Two motor tools we found most applicable to free-form pipe carving are the Dremel and the Foredom. The positive

controlled action of the Foredom's flex-shaft is ideally suited to intricate, decorative design work. Another tool that's helpful is Black & Decker's Shape And Sand unit, a belt-

(Please turn to page 115)



BOOK KEEPER

BY NEAL BARRETT

At one time, a barrister's bookcase was standard equipment in the law offices throughout old England, and here, too. Now, the bookcases have become very popular, and pricey, items at antique shops, flea markets and garage sales everywhere. Homeowners and apartment dwellers have discovered that a barrister's bookcase provides an attractive, practical way to store and display books—particularly encyclopedia sets and rare, antique book collections. Here, we present step-by-step instructions and plans to build a faithful reproduction oak barrister's bookcase including easy-to-follow details for making the lift-up, slide-back doors.

The bookcase is constructed of 4/4 and 6/4 red oak, surface planed to the thicknesses given in the materials list. Use 1/4-in. oak-veneer plywood for the cabinet back and 1/8-in. clear glass for the door panes. The four doors operate on Hafele pivot sliding door hardware (No. 408.01.009). For a Hafele dealer in your area, write to Hafele, 203 Feld Ave., High Point, NC 27263.

Stock preparation

Start by edge-joining boards together to form the cabinet top, sides and shelves. Rough-cut the boards slightly oversized and then smooth the mating edges on a jointer. Next, edge-join the boards together with glue and 1/4-in.-dia. × 1 1/2-in. hardwood dowel pins spaced about 10 in. apart. Be sure to mark dowel pin locations on the board

faces so that you don't accidentally cut through a dowel when trimming the panels to their finished dimensions. Leave the panels clamped together until the glue dries thoroughly.

Once the glue has dried, use a hand scraper to smooth the panel surfaces. Now crosscut the panels to the finished length using a portable circular saw and a straightedge guide (photo 1). Rip the panels to the finished width on a table saw.

Routing procedures

Next, using a 3/4-in.-dia. straight bit and a straightedge guide, rout 3/8-in.-deep stopped dados in the inside surface of the cabinet sides. The dados, which will house the four shelves, are stopped 3/8 in. from the front edge of the cabinet sides (see drawing detail 2). Square up the ends of each stopped dado with a sharp chisel. Then, use an edge-guide attachment on the router to rout a 1/4 × 1/2-in.-deep rabbet in the inside rear edge of the cabinet sides (photo 2). Also, rout a stopped rabbet in the inside rear edge of the cabinet top. Again, square the ends of the stopped rabbet with a sharp chisel. These rabbets will accept the 1/4-in. plywood cabinet back. Now readjust the router's edge-guide to cut a 3/8 × 1/2-in.-deep rabbet on both ends of each of the three *middle* shelves (parts C in the materials list). Readjust the edge-guide, once again, and rout a 1/2-in.-deep × 3/8-in. rabbet along the front edge of the middle shelves. These front-edge rabbets provide a step for the doors to close against while creating a 3/4-in.-thick reveal of shelving between the closed doors.

Next, prepare to rout the four matching pairs of L-shaped dados in the cabinet sides for installing the door

Build this traditional solid oak barrister's bookcase with lift-up, slide-back doors.

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

BOOK KEEPER

track hardware. To ensure consistent accuracy in routing the dadoes, make a template from $\frac{1}{4}$ -in. hardboard or plywood (see drawing detail). Remove the edge-guide from the router, install a $\frac{7}{16}$ -in.-dia. bit and attach a $\frac{3}{8}$ -in.-dia. guide bushing to the router base. Set the router's depth of cut to $\frac{3}{16}$ in.

To rout the dadoes, first clamp the template to the cabinet side flush with the inside edge of the back rabbet (photo 3). Position the template's bottom edge at the height of the corresponding door bottom. Rout the dadoes while holding the guide bushing firmly against the template edge. Advance the router slowly across the cabinet side and then down to form the $3\frac{1}{2}$ -in.-long leg of the L-shaped dadoes.

Repeat this procedure for the remaining dadoes—four per cabinet side.

Keep in mind that the matching dado pairs are mirror images of each other. Therefore, the template must be flipped over (bottom side up) when routing the second cabinet side.

Use a sharp chisel to square up the ends of the door track dadoes (photo 4). Also, use a saber saw to cut a $2\frac{1}{4} \times 2\frac{1}{4}$ -in. notch in the bottom front corner of each cabinet side for installing the kickplate (E).

Next, clamp the cabinet top to the workbench with its bottom side facing up. Then, use a $\frac{1}{2}$ -in.-rad. cove bit to rout the decorative detail along the front and two end edges only (photo 6). Lay out and bore $\frac{1}{4}$ -in.-dia. \times $\frac{3}{8}$ -in.-deep dowel pin holes in the top edges of the cabinet sides using a doweling jig and portable drill (photo 7).

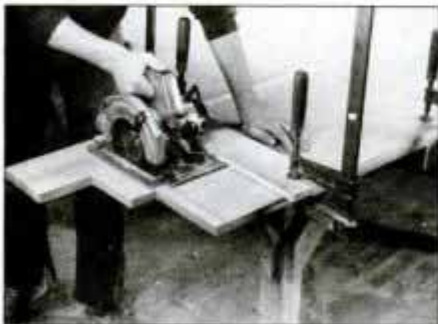
Bore matching dowel pin holes in the

underside surface of the cabinet top (photo 8). Finish-sand the cabinet members and shelves with 120- and 220-grit sandpaper.

MATERIALS LIST— BARRISTER'S BOOKCASE

| Key | No. | Size and description (use) |
|-----|-------|--|
| A | 2 | $\frac{1}{2} \times 13\frac{1}{2} \times 59$ " oak (side) |
| B | 1 | $1\frac{1}{4} \times 14\frac{1}{2} \times 36\frac{1}{2}$ " oak (top) |
| C | 3 | $1\frac{1}{4} \times 13\frac{1}{4} \times 34\frac{1}{2}$ " oak (shelf) |
| D | 1 | $\frac{1}{2} \times 12\frac{1}{2} \times 34\frac{1}{2}$ " oak (bottom shelf) |
| E | 1 | $\frac{1}{2} \times 2\frac{1}{4} \times 35\frac{1}{2}$ " oak (kickplate) |
| F | 1 | $\frac{1}{2} \times 35 \times 56\frac{1}{2}$ " oak plywood (back) |
| G | 8 | $\frac{1}{2} \times 2\frac{1}{4} \times 33\frac{1}{2}$ " oak (rail) |
| H | 8 | $\frac{1}{2} \times 2\frac{1}{4} \times 11\frac{1}{2}$ " oak (stile) |
| I | 8 | $\frac{1}{4} \times \frac{1}{2} \times 29\frac{1}{2}$ " oak (glass stop) |
| J | 8 | $\frac{1}{4} \times \frac{1}{2} \times 9\frac{1}{2}$ " oak (glass stop) |
| K | 4 | $\frac{1}{4} \times 9\frac{1}{4} \times 29\frac{1}{2}$ " glass (pane) |
| L | 4 | 1"-dia. brass knob |
| M | 4 pr. | Hafele pivot sliding door hardware; model No. 408.01.009 |

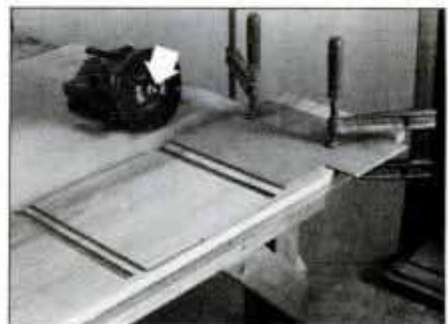
Misc.: Carpenter's glue, $\frac{1}{2}$ "-dia. \times $1\frac{1}{2}$ " hardwood dowel pins, assorted sandpaper, McCloskey's cherry (No. 938) and walnut (No. 937) stain, varnish, 4/0 steel wool.



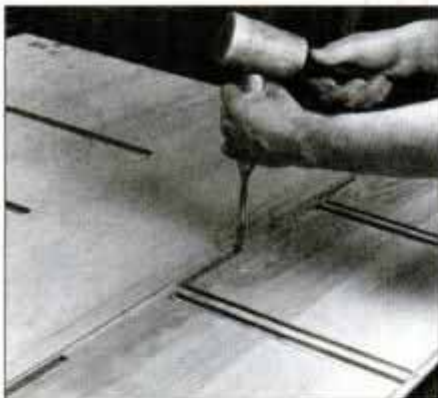
1 Crosscut edge-joined panels to length with a portable circular saw. Clamp a straightedge guide to ensure square cuts.



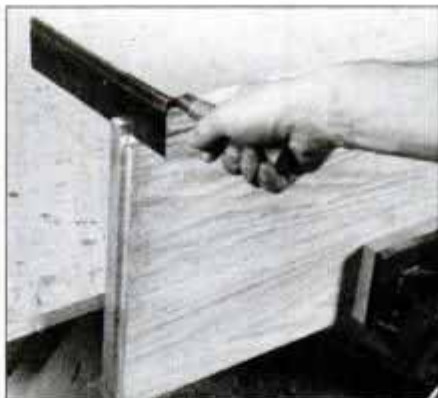
2 Rabbet the rear inside edge of cabinet sides and top to accept plywood back. Note edge-guide attachment on router.



3 Rout door track dadoes with the aid of a template clamped to cabinet side and a guide bushing (arrow) on router base.



4 Use a sharp chisel and mallet to square up the ends of door track dadoes. Be careful not to cut beyond the routed dado.



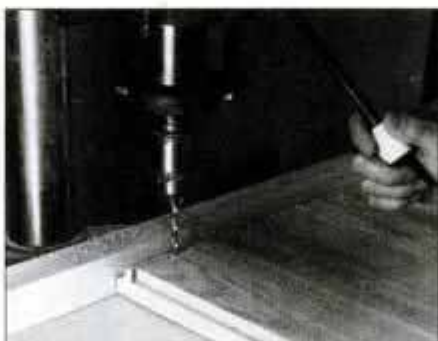
5 After rabbeting the ends and front edge of shelves, use a dovetail saw or backsaw to notch front corners of each shelf.



6 With cabinet top clamped upside-down, rout a decorative profile only in front and end edges with a $\frac{1}{2}$ -in.-rad. cove bit.



7 Bore $\frac{1}{4}$ -in.-dia. \times $\frac{3}{8}$ -in. dowel pin holes in top edge of each cabinet side. Use a doweling jig, as shown, to ensure accuracy.



8 Bore matching $\frac{1}{4}$ -in.-dia. dowel pin holes in underside of cabinet top. Here, a drill press is used with an auxiliary fence.



9 Assemble the cabinet with eight pipe clamps, as shown. Place cauls under clamp jaws to distribute even clamping pressure.

BARRISTER'S BOOKCASE

14-1/8" DEEP x 36-3/4" x 60-1/4" HIGH

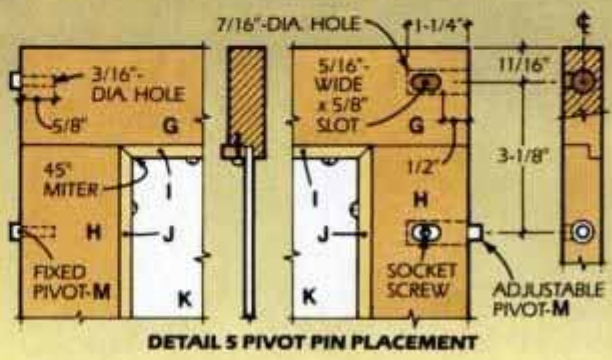
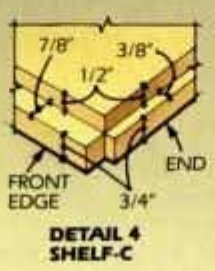
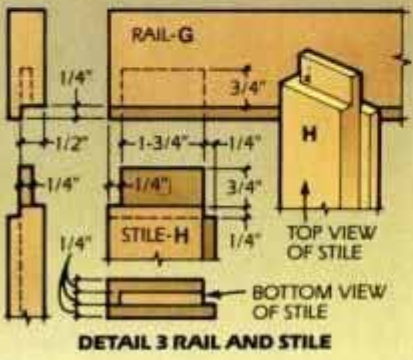
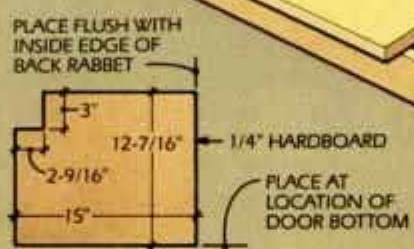
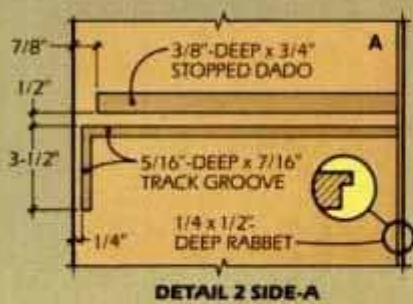
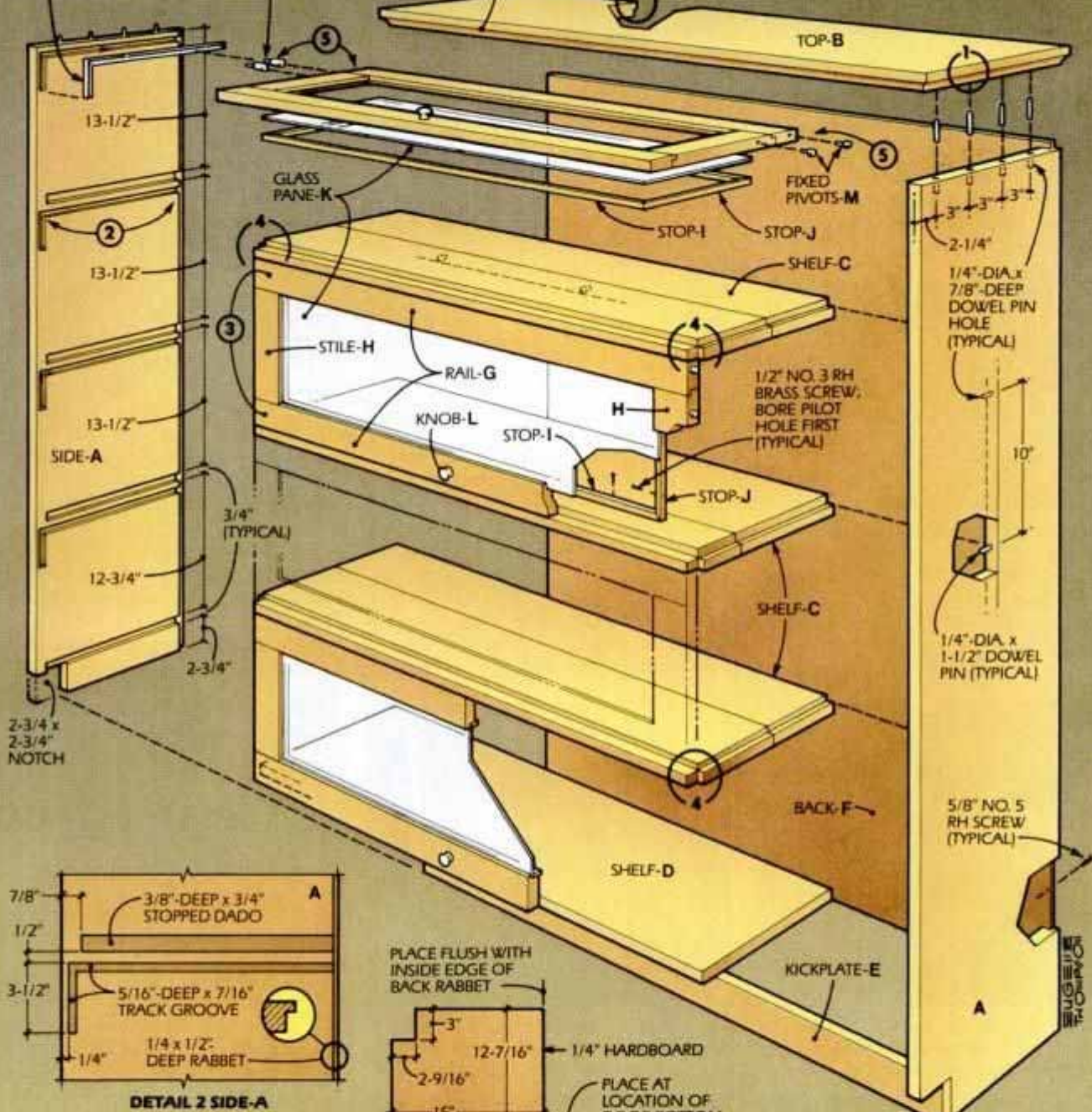
PLASTIC U-TRACK-M FOR PIVOT SLIDING DOOR HARDWARE

ADJUSTABLE PIVOTS-M

ROUT 1/2" RAD. WITH COVE BIT, ENDS AND FRONT EDGE

1/4" x 1/2"-DEEP STOPPED RABBET

DETAIL 1 TOP-B



BOOK KEEPER

Assemble the bookcase cabinet by applying glue to the $\frac{3}{4}$ -in.-wide dadoes in the cabinet sides and to both ends of each shelf. Clamp the cabinet parts together with eight bar clamps as shown in photo 9. Note that straight hardwood bars, known as cauls, are placed under the clamp jaws to distribute clamping pressure evenly across the joints.

Check the cabinet for squareness and make any necessary adjustments *before* the glue starts to set. After the glue has dried thoroughly, remove the clamps. Then, attach the top to the cabinet sides with glue and $\frac{1}{4}$ -in.-dia. x $1\frac{1}{2}$ -in. hardwood dowel pins. Also, glue and clamp the kickplate to the bottom front of the cabinet.

Door construction

Cut all the door parts to size as given in the materials list. Next, install a dado blade in the table saw and cut the tenon cheek on the outside face of each door stile (H). Use a miter gauge with a stop clamped in place to make accurate repetitive cuts. Then, readjust the stop on the miter gauge and cut the cheeks on the inside face of each stile (photo 10). Also, use this setup to cut the tenon shoulder on the outside edge of each stile. See drawing detail 3 for more information.

Now cut a $\frac{1}{4}$ x $\frac{1}{2}$ -in.-deep x $1\frac{1}{4}$ -in. mortise in each end of every door rail (G). Form the mortises on a drill press

by boring a series of overlapping $\frac{1}{4}$ -in.-dia. holes (photo 11). Use a sharp chisel to square up and finish the mortises (photo 12). Move to the table saw and cut a $\frac{1}{4}$ x $\frac{1}{2}$ -in.-deep rabbet in the rear inside edge of all the stiles and rails (photo 13) to accept the glass and stops (J). Dry-assemble each door to be sure that the mortise-and-tenon joints fit together properly.

You should correct a too-tight fit by paring the parts with a sharp chisel. Apply glue to the joints and assemble the doors with bar or pipe clamps. Be sure that the door frames are square before the glue sets.

After the glue dries, check the fit of each door in the cabinet. The doors should have a uniform $\frac{1}{16}$ -in. space at each edge. You should make any necessary adjustments with a hand plane or sanding block.

Next, bore holes in the door edges to accept the pivot pins. Note that each door receives four pivots—two fixed pivots ($\frac{3}{16}$ -in.-dia. holes) and two adjustable pivots ($\frac{1}{16}$ -in.-dia. holes). Also, bore and chisel two $\frac{3}{16}$ -in.-wide x $\frac{3}{8}$ -in. slots through the back of each door and into the *adjustable* pivot holes (see drawing detail 5). The slots allow access to the hex-socket adjusting screws. Tap the pivot pins into the holes with a hammer. Thread the hex-socket screws into the adjustable pivots with a hex-key wrench (photo 14).

Cut the U-shaped plastic door tracks

to length and press them into the grooves routed in the cabinet sides. If the tracks fit loosely, apply a few spots of hot-melt glue to hold them fast. Then, slide each door into the tracks from the rear of the cabinet.

Position the adjustable pivots as necessary to obtain proper tension for smooth door travel. Remove the doors from the cabinet after making the final adjustments.

Now cut $\frac{1}{4}$ x $\frac{1}{2}$ -in. oak glass stops for the doors, but don't install them yet. Also, bore holes for the door knobs. Cut the cabinet back (F) from $\frac{1}{4}$ -in. oak-veneer plywood. Sand all parts with 120- and 220-grit sandpaper. Wipe away sanding dust with a tack cloth.

To create a faithful reproduction finish, we mixed equal parts of McCloskey's Tungseal cherry (No. 938) and walnut (No. 937) stain. Wipe on the stain and let dry overnight. Then, apply two coats of McCloskey's Heirloom varnish. Let dry and sand lightly between coats. After the varnish has dried, rub the final coat with 4/0 steel wool to achieve a satin sheen.

Install the glass panes and mount the glass stops to the door frames with $\frac{1}{2}$ -in. No. 3 brass roundhead screws (photo 15). Bore pilot holes to avoid splitting the stops. Slide the doors into their tracks from the cabinet rear, attach the knobs and check the doors' operation. Finally, attach the cabinet back with $\frac{3}{8}$ -in. No. 5 roundhead screws. **PM**



10 Cut tenon cheeks on table saw with a dado blade. Handscrew clamped to the miter gauge fence acts as a stop.



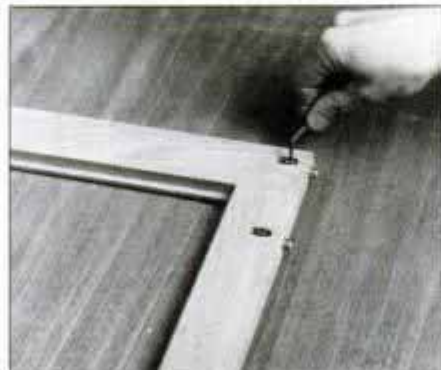
11 Bore overlapping $\frac{1}{4}$ -in.-dia. holes in door rail to form mortise. Clamp auxiliary fence to drill press table to position work.



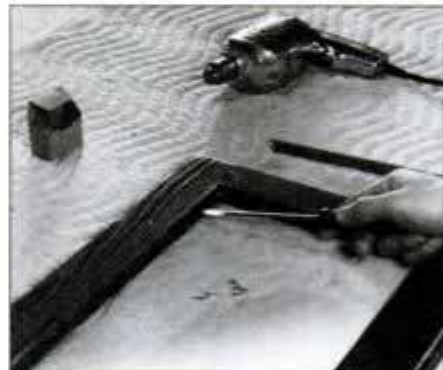
12 Use a sharp chisel to remove remaining waste from the mortises. Chisel the mortise walls smooth and square up the ends.



13 Use a dado blade and table saw to cut a $\frac{1}{4}$ x $\frac{1}{2}$ -in.-deep rabbet in each door rail and stile to accept the glass pane and stop.



14 Insert adjustable pivot pins in holes bored in door ends. Then, use a hex-key wrench to tighten the adjusting screw.



15 After finishing the doors, insert the glass panes and attach the oak glass stops with $\frac{1}{2}$ -in. No. 3 brass roundhead screws.

FOCUS



SUPER VISIONS

Technology is changing the way we make pictures

HOT SHOTS

Tips for taking photos like a pro

MAKING MOVIES

How to pick the right video camcorder

SNAPPY SHOOTERS

Today's cameras come with expertise built in

CLEAN MACHINES

What you should and shouldn't touch in your camera

NEW CONTEST

Your photo might win a state-of-the-art, super-computerized Canon camera

PHOTOS BY BILL DOLCE





A good photograph shows a story. And the process of creating a picture is much the same as the process of creating a poem.

At the outset, the human intelligence behind the viewfinder exercises imagination to see a story in the subject, just as a poet finds a message in a mundane, everyday event.

Once the story is conceived, the photographer then selects the basic building materials of photography—framing, composition, lighting, focus—and combines them in a way that gives physical shape to the concept. In the same way, a poet would decide whether the message is best conveyed in epic or sonnet form, in free-verse or rhyme.

After the architectural decisions are made, the building begins. This is the point where the photographer and the poet employ their know-how with the tools of the trade.

For the poet, those tools are words, rhymes and the arrangement of word syllables known as rhythm, or meter. For

the photographer, the tool is the camera, including its lens and film. Getting correct exposure entails hands-on selection of a shutter speed and lens aperture (f-stop) combination—a combination that takes into account the characteristics of the film in use.

It is this hands-on aspect of photography that technology is changing—and changing rapidly.

Few modern poets could get by without a thesaurus and rhyming dictionary, whether in book form or stored electronically on a computer program. Indeed, the tools available to today's wordsmiths make the job go much easier than it did in Homer's time.

Similarly, electronics now endows photography with effort-saving tools—but these tools were barely imaginable even a generation ago.

That genie of electronics can-do, the microprocessor circuit—known as the chip—now enables camera manufacturers to build the hands-on know-how of a trained photographer right into the camera. Meanwhile, infrared focus detectors

SUPER VISIONS

We're a nation of picture-takers and moviemakers. Technology's making it easier to do both—and eliminating the distinction.

BY STEPHEN A. BOOTH, Photography Editor

State-of-the-art image-makers opposite include (clockwise from bottom left) autofocus 35mm SLR Nikon 2020 and Minolta Maxxum 9000 with zoom lens, Ricoh XR-P programmed 35mm SLR, instant-print Polaroid Spectra, Canon VM-E1 8mm video camcorder, compact Tamron 28-70mm zoom lens, Olympus Infinity autofocus 35mm compact.

An American Portrait: Director John Huston

Can the camera play a supporting role in the way we conduct our lives? Should the techniques used in a photo or movie call attention to themselves, or should they simply reinforce the message?

John Huston proposes some answers.

The great director, now 80, has given us many indelible American portraits over the long span of his career.

In "The Maltese Falcon" he established the knight-errant character of the American private eye. He examined the pathology of greed in "The Treasure Of The Sierra Madre" and the pathology of obsession in "Moby Dick." "Prizzi's Honor," his most recent movie, explores the opposite pole from "The Maltese Falcon": that is, concepts of love and duty in an underworld family.

The camera, Huston says, is the basic instrument we use to look at ourselves.

"I'm not sure we are changed, that individuals do even change. But if there are changes, the really great photographers are responsible. Bob Capa, Ansel Adams and Man Ray certainly



'Pictures don't change human nature, but dramatic visual images can prompt us to action.'—John Huston

changed the way we look at things. So did the great fashion photographers—Cecil Beaton, Avedon.

"Pictures don't change human nature, but dramatic visual images can prompt us to action," Huston says. "Think of the huge outpouring of money, time and effort that was a direct result of the photographs from starving Ethiopia."

Huston believes that technique and technology should remain subordinate to a film's story and character.

His own most technical innovations involved handheld cameras and experiments with color, in "Moulin Rouge" and "Moby Dick." But even in these movies, the technology never called attention to itself, but supported the story by creating the mood. Huston says he'd rather have the viewer involved in what he is seeing than how he's seeing it.

"I don't think the most elaborate shot I ever made has ever been observed," Huston explains, "for the very good reason that you're following a thought, not the shot."

—Solange DeSantis

PHOTO • VIDEO

automate the keen eye of the professional photographer.

This technology isn't limited to the space program and doesn't cost millions of dollars. You'll find these innovations in a variety of moderately priced cameras at your local store.

Better images

By automating the process of setting film speed, shutter speed and f-stop for proper exposure, electronics eliminates the routine and noncreative aspects of picture-taking. This means you are left free to compose your photographs and focus—and autofocus cameras even take care of the latter for you.

If you remember the fixed-focus snapshot cameras of an earlier era, you might be wondering what all this electronics fuss is about. Simply stated, today's snapshot cameras are more sophisticated.

Compared to earlier amateur films, they use the sharp and relatively large 35mm format—available in a wide range of speeds to suit every picture-taking situation. The modern cameras offer selective focus, compared to a fixed lens that puts everything in focus. They choose exposure values from a wide range of shutter speeds and apertures, whereas older cameras were limited to a single setting or a narrow range.

To cite just one example of what today's electronically assisted camera can do, let's take a scene with varied lighting that makes selecting an exposure a difficult task.

The auto-exposure camera analyzes the lighting in the composition, then searches its electronic memory of hundreds of picture-taking situations. It finds one that matches the scene in the viewfinder and sets exposure accordingly. The old Brownie couldn't do that.

Better films

Electronics isn't the only shining light on the photographic scene. Chemistry is battling the darkness with an ever-wider selection of films.

Only 10 years ago, ISO 400 was the fastest speed available for color or black-and-white. Today, color slide films come as fast as ISO 1600, print film reaches ISO 3200, and these gains are achieved without excessive graininess. Such speedy films can help you freeze action, extend your ability to shoot without flash, and let you use long lenses without risking shaky images or sacrificing depth of focus.

Speaking of speed, advances in automated processing make a 1-hour turnaround on your prints commonplace today. If that's not fast enough, you can shoot Polaroid instant prints. In the past, these were limited to small-size prints.

But now, an electronic process that employs lasers and digital technology yields easy enlargements.

Filmless photos

Electronics technology, married to photography, promises more innovations in the years to come. One of these is filmless photography, which will yield truly instant images.

At this writing, cameras that record images on 2-in.-diameter magnetic discs are already in professional use. Much like a VCR, these "still-video" cameras display your snapshots on a television screen. Because the image is stored electronically, it can be transmitted over telephone lines. When connected to a printer, the camera produces snapshot-size copies instantly. There's no development involved, and you can use the disc over and over.

By the turn of the century, all-electronic cameras might be as inexpensive and commonplace as 35mm compact cameras are today.

But for all their smarts, the cameras of the future won't be able to compose a picture for you. A reconnaissance photo differs from a landscape panorama. And the mugshot on your driver's license isn't quite a portrait.

Whatever a camera's level of automation, it will still need human guidance to render a meaningful image. **PM**



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173 horsepower and 220 foot-pounds of torque. That makes Comanche by far the most powerful truck of its kind.

A WIDE RANGE OF VEHICLES: Comanche gives you the choice of two-wheel drive or shift-on-the-fly four-wheel drive. And you can choose between the new shortbed model or longbed with the largest optional



4-wheel drive payload capacity of any truck in its class.

OTHER OPTIONS: Comanche already has a lot going for it. And there's a long list of available equipment that includes a responsive new 4-speed automatic transmission with overdrive.

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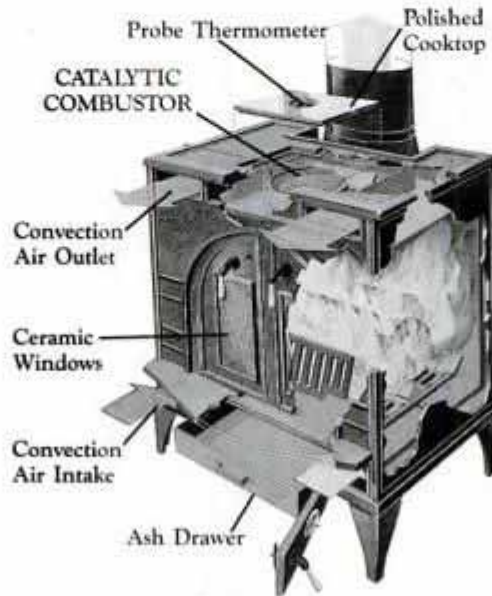
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Suddenly, everybody has to have one. The camcorder, that combination of video camera and video recorder in one easy-to-use package, has recently blossomed into one of the most popular electronics products since the VCR. And for good reason.

Until recently, most people who wanted to shoot video movies purchased a separate video camera and a portable VCR. It was an awkward, complicated and heavy way to shoot home movies. But the camcorder has changed all that. Usually weighing between 3 and 7 pounds, and with simplified and automated controls, today's camcorders make shooting video movies easy and practical—without compromising performance.

In fact, the most confusing thing about today's camcorders is choosing which one to buy. Not only are there more than 50 models available, but camcorders come in a confusing array of configurations and in four noncompatible formats. Picking the right camcorder format should depend largely on what sort of video equipment you already have. Owners of VHS VCRs often prefer to stick with a full-size VHS camcorder, or with one of the camcorders that uses the mini-VHS cassette called VHS-C. If you don't already own a VCR, or if you want to keep your video gear extremely compact, you might prefer the relatively new 8mm video format. Finally, owners of Beta VCRs may want to try out a Betamovie camcorder.

Camcorders that record using a full-size VHS cassette are by far the most popular, and for a good reason. Close to 90 percent of people who already have video cassette recorders in their homes own VHS models. When selecting a camcorder for shooting home movies, they tend to choose the same format.

There's a lot to be said for this approach: Nothing could be simpler than shooting a home movie with your camcorder and then popping the cassette into your VCR for viewing.

That's not to say you need a VHS VCR to play back your movies. All of today's VHS camcorders, available from almost every major VHS manufacturer, can play back VHS tapes by themselves. That means that even if you only own a camcorder, you can still play back your home movies—as well as the Hollywood variety you buy or rent—on any TV set. Camcorder playback is also handy when copying your movies. Simply connect the camcorder's output to your home VCR and copy the scenes you want to keep onto a cassette in your home deck.



PHOTO • VIDEO

MAKING MOVIES

The 1-piece video camcorder makes moviemaking easy—and there's no film to develop. But choosing the right model takes some prepwork.

BY JAMES B. MEIGS

Camcorders come in four different formats. Opposite, from top: Sony Betamovie, Zenith VM-6200 (VHS-C type), Nikon 8mm VN-800 Action-8, Hitachi VM-5000A (regular VHS).

PHOTO • VIDEO

Full-size VHS camcorders do have two handicaps: size and weight. Because they have to accommodate the bulky VHS cassette, these models are the largest, heaviest camcorders on the market. You'll need a good-sized carrying case to transport them, and they can get pretty weighty on the shoulder after a half hour of shooting.

But manufacturers have been making progress in these areas. The newest models weigh less than 6 pounds (at least before you put in the battery). The newest models also offer completely automated performance. This includes autofocus—a must in the minds of most consumers—and continuous auto white balance, which means the camcorder automatically adjusts to indoor or outdoor light.

Another innovation in recent models is the growing use of solid-state image pickups instead of tubes. The Hitachi VM5000A and the RCA CMR300, for example, use a new MOS (metal-oxide semiconductor) chip which not only allows great low-light performance, but should also prove more durable and less power-hungry than tubes. Another innovation in VHS camcorders is the use of the same HQ (High Quality) circuitry now used in most VHS VCRs. This has meant a noticeable boost in picture quality in the most recent generation of camcorders.

If you want compatibility with your home VHS decks, but don't want the hefty bulk of a full-size VHS camcorder, JVC, Minolta, Sharp, Toshiba, Zenith and other companies offer a variation on the VHS format called VHS-C.

The key to this approach is the compact VHS-C cassette, about the size of a pack of filtered cigarettes. It carries a short length of regular VHS videotape. The small size of the cassette allows a camcorder only about half the size and weight of its full-size VHS cousins.

Like the full-size models, VHS-C camcorders can play back your home movies for viewing on a TV set or dubbing to a VCR. Of course, they can't play Hollywood movies since they can't accept a full-size VHS cassette. If you're looking for a camcorder that can double as a home VCR, 8mm or full-size VHS are your only options. But VHS-C gives you another way to play back your movies: The camcorders come with a special adapter that's the size and shape of a full-size VHS tape. Pop the VHS-C tape into the adapter and it plays in any VHS VCR much like an ordinary VHS tape.

VHS-C camcorders, such as the JVC GR-C7 and the Zenith VM6200, include the same lineup of features as their full-size counterparts. But the VHS-C cassette has one limitation that some people see as a drawback: It only holds enough

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Conventional-size VHS format camcorder, Panasonic's PV-220 OmniMovie, boasts picture-improving HQ circuitry and half-inch tube pickup for low-light operation. The 6 1/2-pounder also features autofocus 6X zoom lens, AC adapter (below).

PHOTO • VIDEO

tape to record for 20 minutes at the standard speed. The other camcorder formats can handle at least two hours on one cassette.

Fortunately, VHS-C manufacturers have discovered that by using HQ circuitry they can add a second, slower recording speed called EP (extended play) with only a small reduction in picture quality. This allows the camcorder to record for one hour on a single cassette. Users have the option of recording at the 20-minute speed—which most people will find is more than enough time for most applications—or switching to the 1-hour mode.

If you're interested in extremely com-



Sony's tiny 8mm-format Handycam offers point-and-shoot simplicity, but the record-only camcorder needs a playback deck.

pact video, you might also consider leaving the world of VHS behind altogether. The 8mm video format uses a unique miniaturized cassette designed especially for the demands of shooting home movies. By using a special all-metal tape formulation, these cassettes just about match the picture quality of VHS despite using a much narrower tape. And because 8mm uses an AFM (audio frequency modulation) process similar to Beta and VHS Hi-Fi home VCRs, its audio quality is far better than VHS or Beta camcorders. Though there is a wide variety of 8mm camcorders available, they fall into two main groups: those that can play back and those that can't.

At the moment, Sony's Handycam is the only model without playback ability. Barely more than 2 pounds, it's the smallest, lightest 8mm camcorder on the market, offering virtually no features except true aim-and-shoot simplicity. To view the tapes you make with Handycam, you need the separate 8mm VCR sold with the camcorder. (Just a bit lighter than Handycam is JVC's GR-C9, a record-only VHS-C camcorder. You use the full-size VHS adapter to play the tapes back in a VHS home VCR.)

Compared to Handycam, the full-feature 8mm camcorders—available from Canon, Minolta, Nikon, Olympus, Pentax and others—all provide playback. This means you can watch your tapes immediately in the viewfinder, see them on TV or dub them to another VCR. These models include essentially the same feature lineup as the VHS models (though not all have continuous white balance), with a few twists unique to 8mm. The top-of-the-line configuration of Kodak's MVS (Modular Video System), for example, includes the ability to record stereo sound digitally using a PCM recording process possible only in the 8mm format.

Finally there's Beta, the original home video format and the original camcorder format.

Beta has slipped drastically in popularity recently, despite its high-quality pictures. Today, only Sony sells the Beta format camcorder, called Betamovie. Though short on features—it's a record-only system without an electronic viewfinder—Betamovie offers stunning picture quality, thanks to its Super Beta circuitry. If you own a Beta home deck you should seriously consider Betamovie as an option for home moviemaking.

Regardless of format, brand and features, the most important thing about any camcorder is that it suits you. No matter what type you're considering, be sure to give it a thorough workout in the store. Make sure it's comfortable, easy to hold and that you like the image and sound quality. You wouldn't buy a car without a test drive: A camcorder should get the same treatment. **FM**

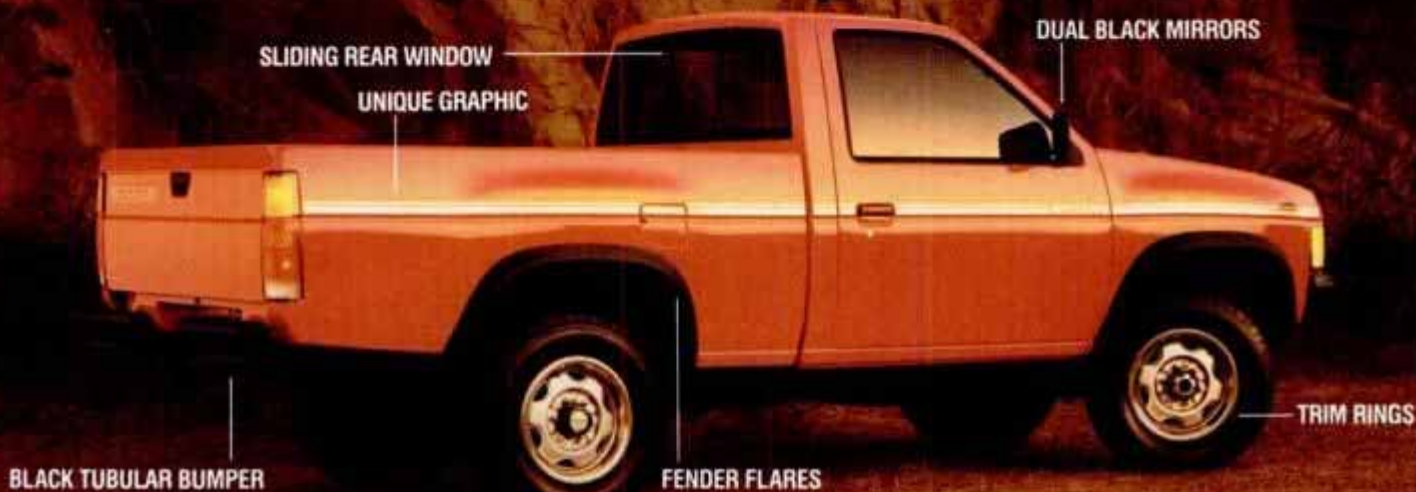
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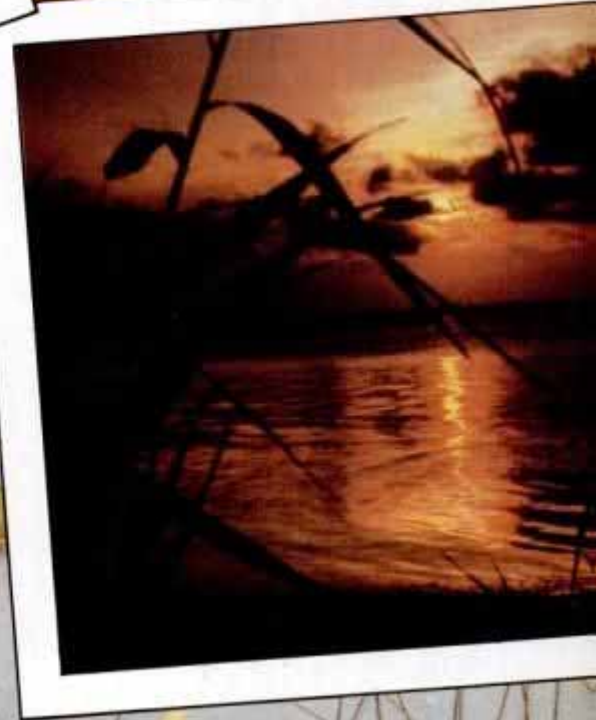
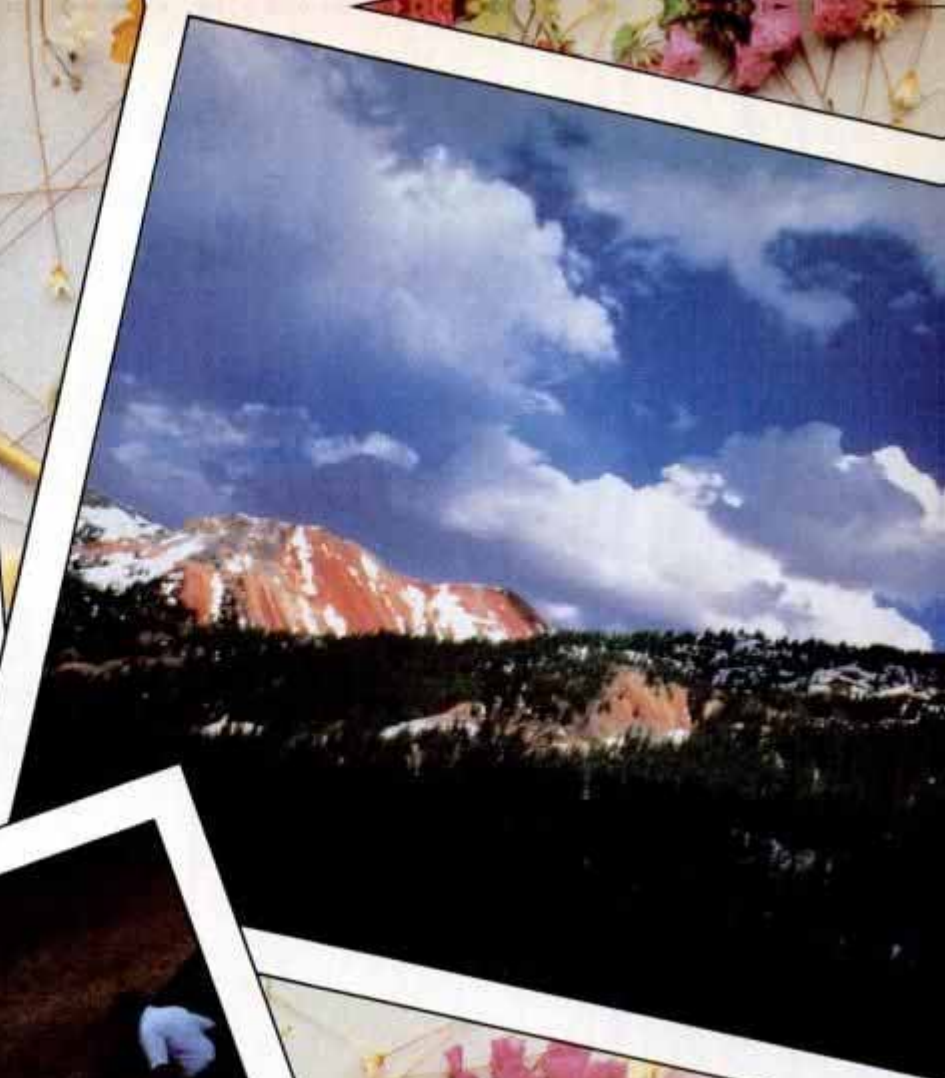


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Portraits

The key is soft, even lighting, which is plentiful outdoors. Soft lighting hides minor flaws by eliminating harsh shadows. On sunny days find a shaded area. On overcast days, simply shoot in direct light. In either case, add a little bit of reflected light to remove slight shadows that might emerge under the eyes and chin. For head-and-shoulder portraits, like the example shown here, hold a piece of white mattboard near the subject's chest, facing upward toward the chin.

Portraiture demands that you give full attention to the subject. Eliminate any distracting backgrounds, either by keeping them simple or putting them out of focus. If you have an adjustable camera,

use a large aperture opening (small f-stop number) to create a shallow depth of field that puts the background out of focus. A telephoto or zoom lens in the 80 to 135mm focal-length range will provide additional depth control. Longer focal-length lenses also minimize facial distortion that occurs when you're too close to your subject.

You'll have less flexibility with fixed-lens compact cameras. Get close enough to your subject to fill the frame. Hold the camera vertically, keeping the film plane parallel to the face. Use slow films, such as ISO 100, to force the autcamera to shoot at larger apertures.

Group portraits

Compose to fill the frame. Small groups might require you to hold the camera vertically, while larger ones need horizontal framing. Keep the camera parallel to the group to minimize the body distortion that occurs in pictures shot from eye level. Also, maintain proper body proportions by getting down on one knee and aiming at the center subject.

HOT SHOTS

Practice makes perfect, so practice these fundamental techniques to bring professional results to your photographs and video movies.

BY ARMAND ENSANIAN

The most popular subjects we photograph are shown opposite. Far left, from top: portrait, sports action, group portrait. Left, from top: scenic landscape, sunset. Snapshots by Armand Ensanian.



Camcorder focused on kids from above (left) seems like surveillance. Angle camcorder to record short subjects at their level (right).

Avoid lineups whenever possible. Have the subjects assume different poses—sitting or standing, leaning or kneeling. If you're photographing a special-interest grouping, take advantage of the props that relate to their activity.

Sports and action

The key to success is knowing the sport, so you can anticipate where the action will be. Prefocus to that spot and follow the action with both eyes open.

Action photography requires filling the frame for impact, but getting close is often a problem—especially when you're way up in the stands. The baseball shot seen here was taken under this handicap. Inexpensive teleconverters can add a lot of range to your lens. A 2x converter doubles the focal length of a 200mm lens to 400mm—without much additional size, weight and expense.

Long lenses require stability for sharp pictures. Steady your camera with a tripod or monopod. Shoot at speeds of 1/250 sec. and faster. Action-freezing fast speeds call for higher speed films—especially with long lenses. ISO 400

works well in bright daylight; ISO 1000 and up might be necessary when it gets cloudy, or indoors.

Scenic pictures

The slight wide-angle lenses of autofocus compact cameras make them ideal for scenic and landscape photography. To get the best results, use films with slow ISO ratings. If your camera's lens is adjustable, use small aperture openings (large f-stop number) and focus at about 30 ft. instead of infinity.

One way to enhance the beauty of a scenic is to shoot under early morning or late afternoon light. The long shadows that are cast will add dimension to your pictures, particularly if the scene contains large open spaces. As in the landscape shown here, keep the horizon above or below the center line for a more pleasing composition. Shots with large open skies benefit from the vignetting effect of a few tree branches around the upper perimeter of the picture.

For sunsets, shooting directly into a source of light fools most camera metering systems into underexposing the pic-

ture. This works to your advantage. Just point and shoot (don't look directly at the sun through your viewfinder) with any auto-exposing camera. Underexposing creates richer colors in the sky, and silhouettes foreground subjects.

Video movies

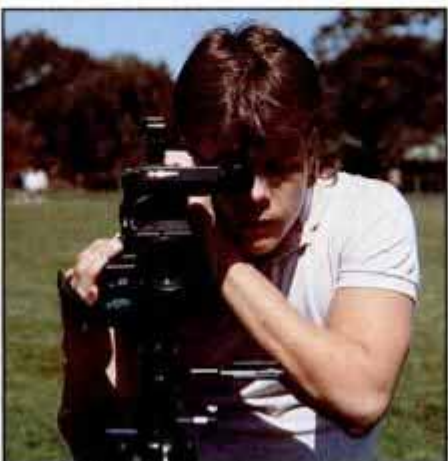
All of the techniques described apply to videography and cinematography. Consider movies as nothing more than a series of still frames.

Think of videotaping a story in terms of a newspaper report: Show your audience the where, when, who, what and why. Start with a long shot to show the overall environment—the where and when. Use medium shots to identify who, what and why. Insert interesting full-frame closeups for impact. Shoot short bursts rather than long stagnant scenes. To keep your audience interested, limit shots to 5 to 15 seconds.

Minimize camera movement unless you're following a subject. Jittery handheld images are hard on the eyes. Keep elbows tucked in and both hands firmly on the camcorder or camera. Tripods and monopods take some of the weight off your hands, and let you pivot the camcorder smoothly for panning sequences such as the one shown here.

Some occasions do require long continuous scenes. During speeches on-TV, pros keep the audience awake by slowly zooming between closeups and medium shots. If you stop taping for a few moments, change your camera angle. Use the autofading feature to open and close scenes. You can show passage of time between scenes by putting the image out of focus, then back in.

In movies, it's important to understand and relate to your subjects. Shoot short subjects at their level. Shooting down on children and pets is more akin to surveillance than moviemaking. **PM**



Steady camerawork prevents jittery images that are hard on the eyes. A tripod or a monopod help you pan across a scene smoothly and evenly, as shown.

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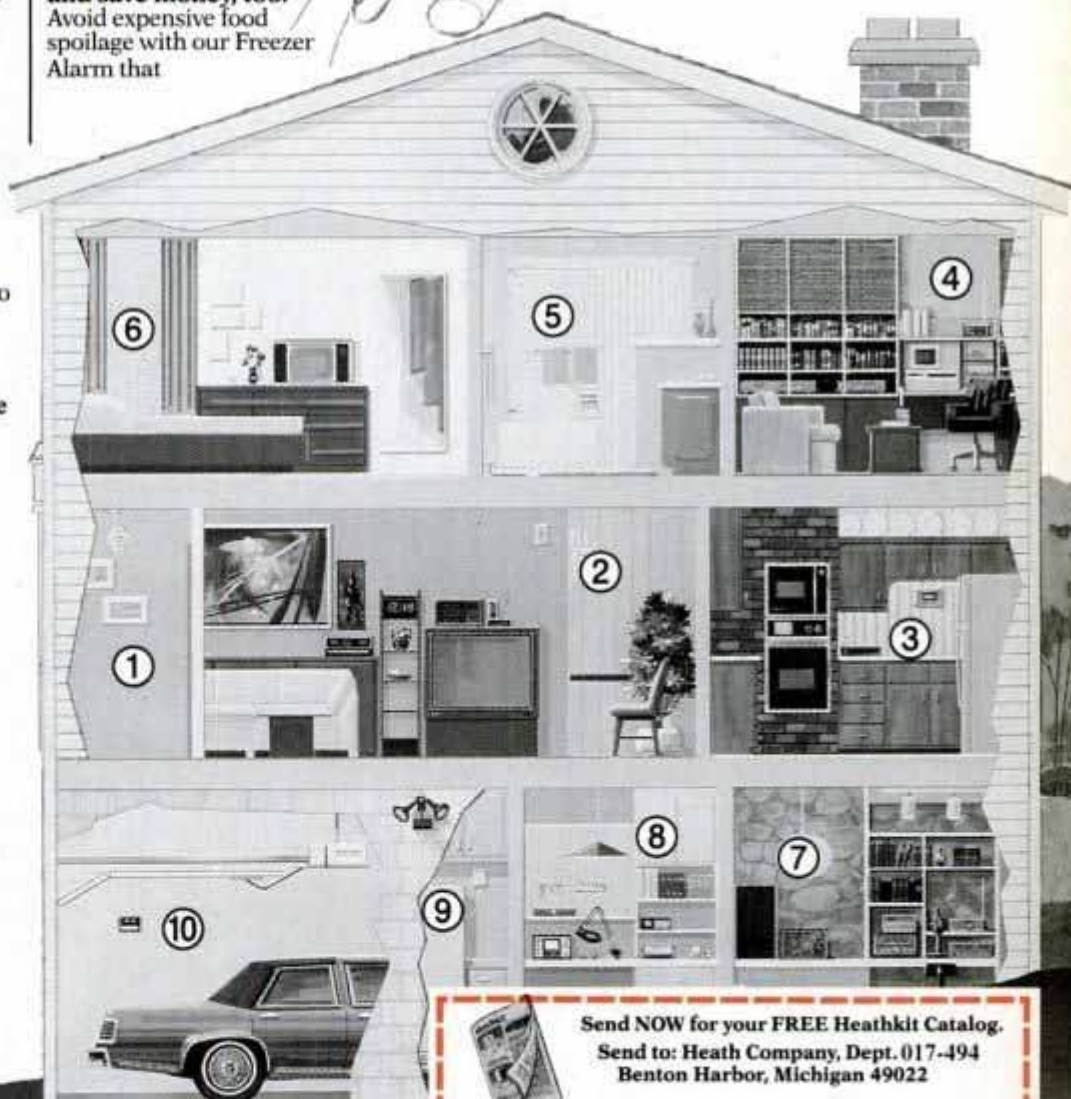


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The right tool can help make any job easier. But no matter how sophisticated or costly, a camera can't create a picture for you. In this month's Special Report, we've devoted space to tips that can help you make better pictures. For our new photography contest, we'd like you to show us what you've learned. Just give us a picture. In return, you'll get a chance to win one of three super-automated 35mm Canon cameras. These computerized tools can help make your future picture-taking easier and a whole lot better.

Top prize is Canon's T90, possibly the most sophisticated program camera available—and one of the easiest to use.

As we noted in our hands-on review (*Photography*, page 61, Apr. '86), the T90 is a camera you can grow with. For the novice, its computer program handles the fundamental chore of setting exposures—f-stops and shutter speeds. It even knows whether you're using a wide, normal or telephoto lens, and sets exposure values accordingly. For anyone who masters the 128-page manual, the T90's computerized bag of tricks includes three light-metering patterns and a motor

drive that lets you shoot a fast $4\frac{1}{2}$ frames per second. The shooting's comfortable, thanks to the T90's angled shutter-release button and contoured handgrip. For all this firepower, the T90 carries a suggested retail price of \$865 with 50mm f/1.8 lens. It's the camera/lens combo we use at PM when we test new films.

Our second prize, Canon's T70 program camera, has a 50mm f/1.8 lens and a \$470 suggested retail value. The computer in the T70 sets exposure values, and adjusts for the lens in use. The automated film-advance lets you fire a frame each second.

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PHOTO • VIDEO

With Canon's Sure Shot Supreme—our third prize—you won't even have to worry about focusing. This auto-everything 35mm compact gives you infrared automatic focusing, and as our hands-on evaluation found (*Photography*, page 64, Nov. '86), the Supreme fires its built-in flash automatically, when needed. Priced at \$301, it has the same contoured handgrip as the T90.

For a chance to win one of these cameras, send us a photograph that demonstrates your photographic skills. Any format is welcome: print or transparency, color or black and white. And any subject is welcome, too.

You can enter as many photos as you

wish, as long as each entry is accompanied by a copy of the official Entry Blank that follows this article. *Read the accompanying rules carefully.* If you want your entry returned after the judging, you must enclose a self-addressed envelope with sufficient postage. In any case, we strongly suggest that you keep a copy of your work. We can't be responsible for any photos not returned.

Your entry must be postmarked before midnight March 15 and received by March 22. Winners will be notified by May 1. PM's Photography Dept. will perform the preliminary judging, with the final selection made by Editor-In-Chief Joe Oldham. Good luck! **PM**

OFFICIAL CONTEST RULES

1. On the entry blank printed below, or on a separate sheet of paper, give us the information on how you took your photo: make and model of camera, type of film, accessories used, such as special filters or lighting. Also tell us when and where you took the photo and anything unique about the circumstances or the way you set up the camera.
2. Your name and address must be written on each slide or print submitted.
3. There is no limit to the number of entries you may submit. However, each entry must be mailed separately and be accompanied by its own entry blank.
4. All entries become the property of POPULAR MECHANICS and cannot be returned.
5. Entries will be judged on originality, imagination, visual impact and compositional skill.
6. Preliminary judging will be done by the Photography Dept. editors of POPULAR MECHANICS. From the initial selections, the final winners will be selected by Editor-In-Chief Joe Oldham.
7. The decision of the judges is final. No correspondence or telephone calls regarding the contest will be accepted or entered into.
8. The first-prize winner will receive a Canon T90 camera and 50mm f/1.8 lens, with a suggested retail value of \$865. The second-prize winner receives a Canon T70 camera and 50mm f/1.8

- lens, suggested retail value \$470. A Canon Sure Shot Supreme camera, retail value \$301, goes to the third-prize winner. All taxes and fees are the responsibility of the winner. POPULAR MECHANICS will ship prizes to the winner, prepaid, by common carrier.
9. No cash payment will be made in place of the prize. No substitutions for other equipment will be made.
10. The contest is open to anyone residing in any of the 50 United States except employees of The Hearst Corporation and their families.
11. Entries should be mailed to: Canon Camera Contest, Popular Mechanics, P.O. Box 1409, New York, NY 10101.
12. Entries must be postmarked before midnight March 15, 1987, and received by March 22, 1987.
13. The winner will be notified by May 1, 1987, and may be asked to execute a qualifying affidavit.
14. After the winner is notified, POPULAR MECHANICS will provide the winner's name to anyone who wishes it and who sends us a stamped, self-addressed envelope with the request.
15. The winner must agree in writing to his name and photos being used in conjunction with this contest and its results in a future issue of POPULAR MECHANICS and all media, advertising and/or trade.
16. This contest is void where prohibited.

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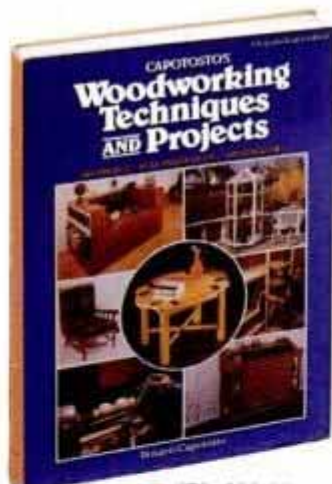
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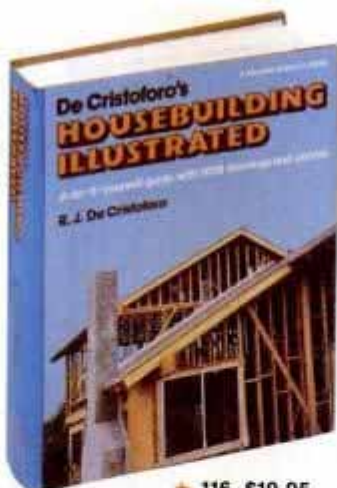
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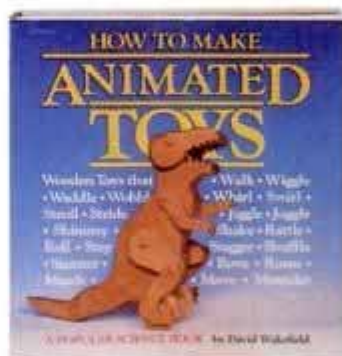
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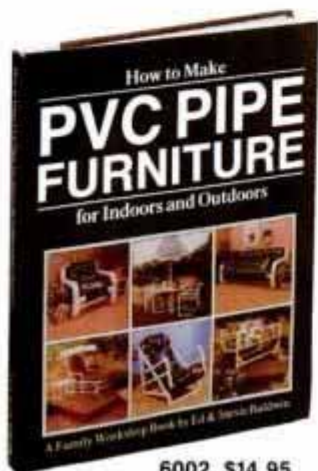
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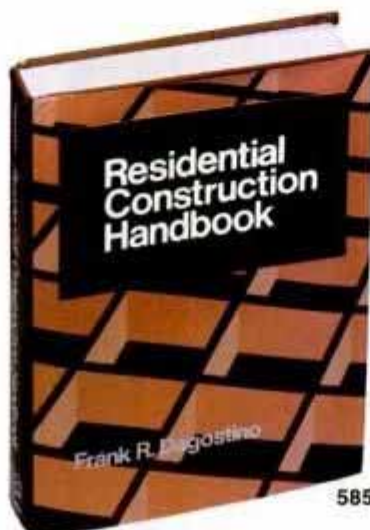
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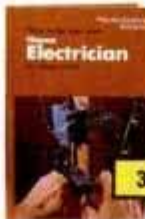
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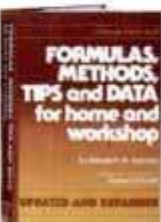
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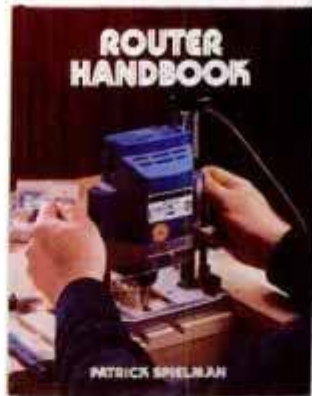
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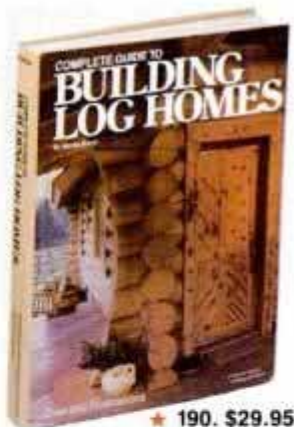
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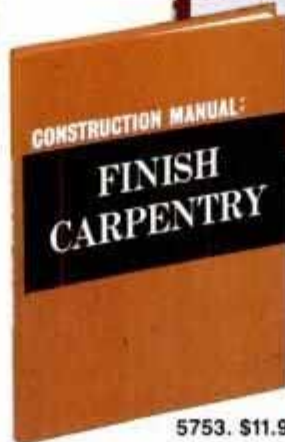
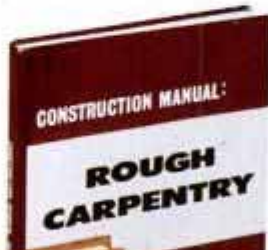


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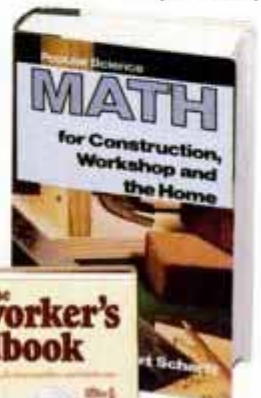


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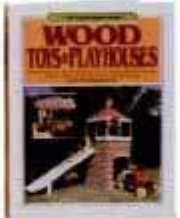


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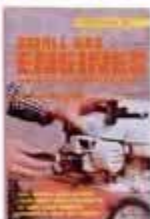


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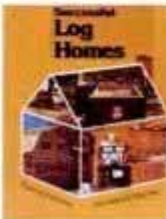


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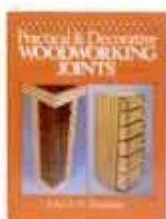
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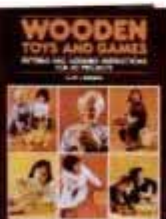
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It was 75 years ago that Missourian Guy Smith got the idea of loading motion picture film into a still camera. Today, the 35mm film format reigns as the most popular camera type worldwide. Its 1 x 1½-in. image size—capable of sharp enlargements—facilitates a small, portable camera suited for pros and amateurs alike.

Enhancing its popularity is the emergence of the totally automated point-and-shoot 35mm camera. In the past, the need to focus lenses, set shutter speed, aperture and film speed kept most casual photographers away from 35mm. Instead, they opted for fixed focus, fixed exposure snapshot cameras that use the smaller 110- and disc-film formats.

Now that electronics technology has automated these routine focusing and exposure chores, virtually anyone can obtain the superior photographic quality of the 35mm format. Besides its larger image size, it gives you a choice between slides and prints. With disc and 110, you're limited to prints. Additionally, the 35mm format boasts a wide selection of film speeds, from slow, super-fine-grain ISO 25 to action-stopping high-speed ISO 3200. No other film format has such a range to cover virtually every picture-taking situation.

You'll find two basic types of 35mm camera today. The top-seller is the fixed-lens, automated compact. The other is the larger, conventional 35mm camera with interchangeable lenses. Whereas compact 35s are almost always fully automated, including focusing, conventional 35mm cameras give you a choice of operation. At one end of the spectrum there's the totally manual camera, at the other end everything's automated, including focusing. Between these extremes you'll find cameras with varying degrees of automation. They're called program cameras because their internal electronics are programmed, computer-like, to automatically set the right exposure values for the type of picture you're shooting.

By the way, automated conventional cameras always give you the option of full manual operation and focusing. On compact 35s, manual controls are limited or nonexistent.

With few exceptions, compact 35s focus your picture for you, instantly and automatically. You simply line up your subject in the target area within the viewfinder, then press the shutter release button.

Most autofocus compacts use a beam of infrared light to measure the distance from the camera to the subject. Others

SNAPPY SHOOTERS

Today's 35mm cameras come plain or fancy. But built-in electronic circuits put a pro photographer behind every viewfinder.

BY STEPHEN A. BOOTH, Photography Editor

Varying levels of electronic assistance are found in (opposite, from top) Canon's T90 multiprogram SLR, autofocus OM-77AF Olympus SLR, Kodak K12 autofocus 35mm compact, FT-1 program SLR with motordrive by Konica.



The ability to change lenses is what makes the conventional 35mm camera so versatile. Football photos, taken last fall at New York Giants training camp with Canon T70 and zoom lenses, illustrate the effects you'll get with different focal lengths. Above, left to right: 35mm wide angle, 50mm normal lens, 70mm moderate telephoto. Below, left to right: 105mm, 135mm and 210mm telephoto.



Camera manufacturers produce a wide range of lenses for their cameras, such as the Olympus family of OM lenses pictured here. Additionally, there are specialty manufacturers who produce lenses for a variety of camera brands.



PHOTO • VIDEO

use sonar for rangefinding. In either case, once the distance is measured, the camera's electronics activate a motor that focuses the lens elements. If you're too close to the subject a light in the viewfinder tells you the camera can't focus.

Every compact 35 sets exposure for you, and most select the proper film speed, too. They perform the latter chore by reading the DX code found on most film canisters. To set exposure, the camera measures the amount of light in the scene, then selects the correct shutter speed and aperture (*f*-stop) combination for the type of film in use.

Compact cameras select exposure from nearly as wide a range of shutter speeds and *f*-stops as conventional 35s offer. Shutter speeds run from $\frac{1}{8}$ sec. to $\frac{1}{500}$ sec. at a minimum. Aperture varies from a relatively fast *f*/2.8 through a deep-focusing *f*/22. They'll handle film speeds from ISO 25 through 1600.

Their light-metering patterns read the average illumination in the entire scene, but are weighted toward the center of the image area—where the most important subject is likely to be. If there's a significant difference in the lighting between

the focus point and the the rest of the picture, the most sophisticated compacts adjust themselves to expose the focal subject properly. This might require the camera to fire its built-in flash. Just about every compact on the market incorporates a quick-recharging flash in the camera body. The most sophisticated compacts fire the flash automatically, when they sense insufficient illumination. Other compacts use an indicator light to tell you flash is needed.

As for the lenses on 35mm compacts, they are both the strength and the weakness of these snapshotters. The weakness isn't one of quality: The glass or plastic optics produce wonderfully sharp images. What makes this all the more amazing is the fact that most compacts use semi-wide-angle lenses, whose resolution can sometimes blur slightly at the edges of the picture. These semi-wides (35 to 40mm, compared to 50mm for a normal lens) are ideally suited for casual snapshotting in that they capture a broad field of view without overemphasizing the distance between objects. So what's the weakness of the compact camera's lens? The handicap is simply that you're stuck with that permanently mounted optic. Unlike conventional 35s, you

can't change lenses; for example, when you might want to use a telephoto to capture distant subjects.

This lack of flexibility was the shortcoming of the compact—until recently. The latest breed of auto-everything compacts coming on the market gives you a choice between normal (35 to 40mm) and moderate telephoto (60 to 80mm) operation. Some companies call them dual-lens compacts. Others dub the cameras bifocal. You select focal lengths either by pressing a button or by rotating the lens turret. In either case, the viewfinder image changes with the lens so you can see exactly what you'll register on film. Focusing is infrared-automatic at either focal length. Though these switch-hitting compacts still don't offer the infinite lens-selection flexibility of conventional 35s, they are quite versatile.

Other features you can expect to find in an auto-everything compact include motorized film loading, advance and rewind. Self-timer, frame counter and battery-check indicator are also par for the course. Some models let you override the auto-advance feature in order to make multiple exposures.

As a result of the auto-compact's success, many of its features are now finding

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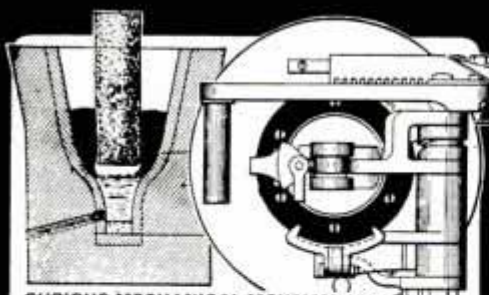
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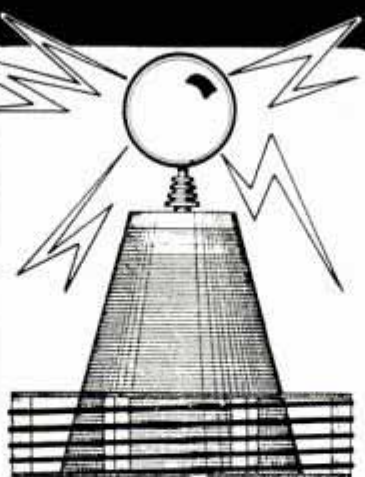
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their way into conventional, interchangeable-lens 35s. Though autofocus is limited to a handful of models, auto-exposure programs are widespread—but vary in the amount of AE they offer.

For example, some cameras simply give you shutter-priority or aperture-priority AE. This means you set one parameter—let's say a fast shutter speed for action-freezing sports photography—and the camera automatically selects the corresponding aperture. Other cameras might give you a totally automatic exposure program. Set them for PROGRAM and they select the best shutter speed and aperture for the lighting.

Besides a basic program, some cameras give you a choice of ACTION or DEPTH programs. The former gives priority to shutter speeds that freeze action. The latter favors small apertures (large f-stop numbers) that put more of the picture into sharp focus.

A variation of the action/depth programs results when the camera manufacturer devises programs for specific types of lenses—generally wide-angle, normal and telephoto. These programs take into account the optical characteristic of each lens type. With telephotos, for example, the program selects relatively large apertures (small f-stop numbers) to admit more light to the film, and relatively fast shutter speeds, to stop action.

Lenses—and the ability to change them—are what make the conventional 35mm camera so versatile. Each camera manufacturer offers a wide family of lenses that can be used with any of its cameras. Some are quite specialized. Others, like the zoom lens, lend themselves to multiple uses.

Sometimes, the lens is "dedicated" to perform a specific function with a specific camera. That's the case with the handful of autofocus conventional 35s. Only the dedicated AF lens will automatically focus for you when attached to the AF camera. Other lenses of the same brand will let you take pictures with the AF camera, but you'll have to focus manually. (Minolta's Maxxum series of AF cameras is the exception: Only Maxxum lenses can be used with a Maxxum camera, and they can't be used with any other Minolta camera.)

Given the similar amounts of automation available in compact and conventional 35mm cameras, making a choice between the two depends on your level of interest in photography. The conventional models give you the option of building a system of lenses and accessories as your interest and abilities grow. The compact is pretty self-sufficient and doesn't permit such expansion—but you can tote it to the New Year's Eve party with the confidence that your pictures, at least, will keep their resolution. **PM**

Today's cameras load themselves, set their own exposure, focus automatically, then rewind the exposed film. But one thing they aren't smart enough to do is take care of themselves. That's your job. Cameras and camcorders don't require a lot of maintenance. A few tips and common sense is all you need to keep them shipshape.

Most recent film cameras rely on battery power for built-in metering systems and other functions such as built-in flash, autofocus, film advance and rewind. The thing to remember about batteries is to use the correct type and prevent them from corroding.

Button-type batteries might look alike, but they vary in voltage rating. The same holds true for AA-size batteries. Rechargeable AAs put out lower voltage than the conventional throwaway kind. If your camera manufacturer specifies alkaline batteries, don't use rechargeables. It's okay to upgrade from alkaline to silver oxide batteries, where applicable, as long as you maintain the required voltage rating.

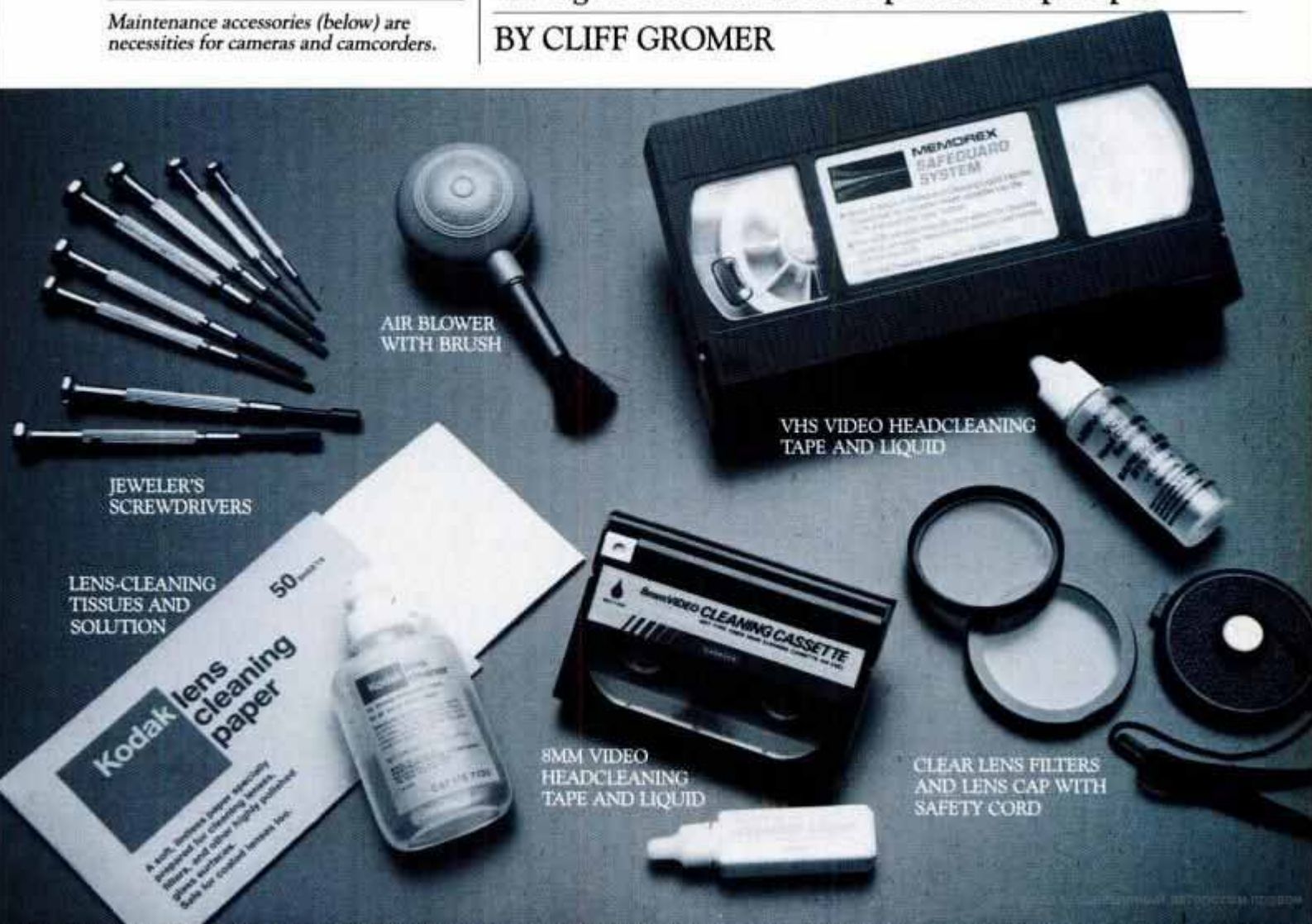
Most batteries will leak given enough time, so the trick is not to give them enough time. Unless the camera manufacturer says otherwise, always remove batteries when storing your camera for

Maintenance accessories (below) are necessities for cameras and camcorders.

CLEAN MACHINES

Cameras and camcorders are precision instruments that need tender loving care. Use the right accessories to keep them shipshape.

BY CLIFF GROMER



JEWELER'S SCREWDRIVERS

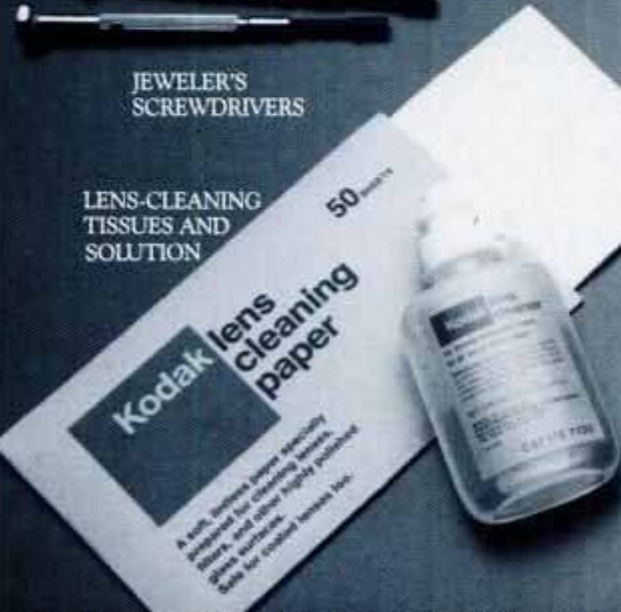


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more than a month, and install fresh batteries at least once a year—even if the old batteries are still good.

Fresh batteries are only part of the electrical story. Often, a thin layer of corrosion builds up on batteries and battery contacts. This creates high resistance, causing symptoms similar to those displayed by weak or dead batteries. To remedy this, periodically buff the battery contact surfaces by rubbing them on a coarse cloth such as your dungarees. An alcohol-moistened cotton swab will freshen up your battery compartment, and a rubber pencil eraser does a great job of cleaning fouled battery contacts.

Water is public enemy No. 1 to your camera—and you don't have to drop your snapshotter into the drink for water to do its deadly work.

A light drizzle, fog, mist and even high humidity can form moisture on delicate mechanisms, causing rust, corrosion and eventual breakdown. Even taking your camera from the cold outdoors into a warm room will cause moisture to condense on the body and lens, and eventually seep its way into the inner workings. The trick here is to put your camera inside a plastic bag before coming in from the cold. This way, moisture will condense on the bag, not on your camera.

Similarly, if you store your film in the freezer to keep it fresh, allow it to reach room temperature before loading it into your camera. Otherwise, moisture will condense on the film inside the camera and eventually cause big problems.

The plastic bag trick is also a good idea when shooting in a light rain. Punch a hole in the bag for the lens to peek through. Seal the bag around the lens with tape or a rubber band. A large, thin bag will let you operate the controls with little difficulty. Keep that plastic bag handy when you take your camera to the beach. That's because sand is public enemy No. 2. A grain of sand lodged in the wrong place can jam up the works and stop your camera cold. Grit in the back of the camera can scratch film.

When storing your camera, avoid high heat and humid conditions. The trunk or rear window shelf of a car parked in the sun can get so hot that lubricants inside the camera body and lenses might liquefy and run. This can create electrical and mechanical problems inside the body. In the lens, lubricant can run onto internal elements, causing optical problems. Melted lubricant also can work its way onto diaphragm leaves, where it might cause sticking and incorrect exposures. If this happens, you'll need a qualified repairman to undo the damage.

Storing lenses in high humidity can

promote fungus growth on the glass elements, so keep your cameras and lenses in a cool, dry location. For added moisture insurance, get a packet or two of silica gel to store with your equipment. You can buy this at most camera stores.

To clean your camera and lenses, get together the following materials: lens tissue (not eyeglass tissue), denatured ethyl alcohol (not rubbing alcohol) or commercial lens-cleaning solution, cotton swabs and a rubber squeeze-bulb with a soft camel's hair brush attached.

Rule No. 1 when cleaning your equipment is not to take anything apart, or adjust or lubricate your camera in any way. Do not touch anything inside your camera with your fingers, as oil from your skin can cause problems. Specks you see in the viewfinder might be caused by dirt in the pentaprism. This requires disassembly by a trained technician, and should be done only if you can't live with the offending specks. Otherwise, leave them alone. Don't try to clean the viewfinder by rubbing the focusing screen. This can damage the delicate moire pattern on the screen. *Dirt specks in the viewfinder will not affect your pictures.*

Rule No. 2: Don't use compressed air on functional parts of your camera. Once you've removed the lens on your 35mm SLR, it's always tempting to take a can of compressed air and just blast out all the

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PHOTO • VIDEO

dust from inside your camera. But cleaning a camera is not like blowing out a clogged fuel line.

First of all, technicians at major camera companies and independent repair centers warn that there's a chance some of the propellant will spray out along with the air. This stuff is oily and nasty and will coat lenses, mirrors and everything else inside your camera, especially the areas that should be clean and dry. Because this oily residue will not evaporate, you'll have a problem.

Secondly, the same experts caution that the air pressure from some of these cans might be too high for camera cleaning. It can blast dust into delicate mechanisms instead of out of the camera body. And some cameras with exposed light-meter components actually can be damaged by the air blast.

Remove dust from lenses and mirrors with the best tool for the job—a rubber squeeze-bulb with camel's hair brush attached. If the mirror is still dirty, use a cotton swab moistened with a drop of denatured alcohol. Don't use your finger and a piece of lens tissue, as you might hit other areas inside the camera, or scratch the mirror or knock it out of adjustment. Use the swab also to clean the ring-like lens mating surface of the camera body. Never breathe on lenses or mirrors and then wipe them off.

To clean lenses, first gently blow away loose dust. Then use lens tissue (not eyeglass tissue—which contains silicates that can scratch soft optical glass) moistened with a drop of denatured ethyl alcohol (not rubbing alcohol) or a commercial lens-cleaning solution. Clean the front and rear lens elements by rubbing gently in a circular motion. Finish the job with a piece of dry lens tissue, to pick up any remaining dust or moisture. The greatest danger in cleaning your lenses is to rub off their multicoating. So be gentle, and avoid overcleaning your lenses. Clean them only when needed. The same goes for camcorder heads: Use a video headcleaner only when you see picture deterioration.

You'll reduce the necessity of cleaning lenses if you keep a UV (ultraviolet) or skylight filter on your lens at all times. This will not affect your exposures or pictures, and will protect the front element of your lens. An even better way of preventing dirt from getting where it shouldn't is to secure lens and body caps when your equipment is not in use.

Camera and lens screws sometimes loosen due to vibration. Check them periodically with a good set of jeweler's screwdrivers.

Follow these simple maintenance tips and you'll help your camera keep collecting memories, instead of collecting dust on some repair shop shelf. **PM**

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THIS SPORTIN' LIFE

(Continued from page 64)

understeer would go a long way to making the Bonneville SE feel as good over the road as it does on the race-track.

Alfa Romeo Milano Gold

The Milano comes in Silver, Gold and Platinum models and, at less than \$13,000, the Silver model is much more car than other sedans in its price range. Even at \$16,000, our more pricey test car was still substantially cheaper than the other cars in this group, with the exception of the Sable. We'd say the Milano is a bargain.

Some sports sedans are mundane family cars hotted-up with better tires, suspension and appointments. The Milano is more of an Alfa GTV6 sports car with sedan bodywork. This puts it at something of a disadvantage in a test like this, which rewards the competent all-rounder and penalizes the very narrow-focus machine. And the Milano is narrow-focus. Drive it at 55 mph, and you'll think it's a noisy, bouncy bore. But hammer on it *con brio* in the Italian way and it springs alive.

Alfa's 2.5-liter V6 is smooth and powerful. It zipped the Milano to fourth at the dragstrip, while the highly refined GTV6 suspension got it through the slalom and skidpad third. Despite driving it flat-out nearly all the time, our testers were able to get 16 mpg out of the V6. It was mid-pack in things like luggage space and interior room, but that's not why you buy an Alfa.

You buy an Alfa because, as one tester said, "It's a real sports sedan, a real driver's car. Keep it on the boil and you'll have the time of your life. If you stopped to think about it, you'd realize you're really uncomfortable, you can't hear yourself think and your hot sports car looks like a test mule for a VW Jetta. But who cares? You're having too much fun to notice."

Mercury Sable

The Sable—and sibling Taurus—is the sales success of 1986, and no doubt these trendy sedans and wagons will continue to be popular for years. But the Sable is not really a sports sedan. It's a typical American family car with aero-look styling. And that's okay. The market for cars like this is a lot larger than the market for Alfa Romeo Milanos, for example.

Our Sable got excellent fuel economy, and it has the largest trunk and the most interior space in this group. At the track, however, the Sable was dead last or nearly so in every test. Part of the blame can be laid to the Firestone Supreme M+S tires.

No testers complained about the

mushy suspension, the ill-fitting plastic interior and the lackadaisical V6.

Summed up one: "Once he gets used to the zoomy styling, the traditional Mercury buyer will love it, but I don't see Ford stealing buyers from BMW, Volvo and Audi with this car. Obviously, that's not their intent." Like the Taurus, the Sable is an advanced family sedan with sporty styling—it's not yet a sports sedan.

Toyota Cressida

At \$20,000, the Cressida was anything but a cheap Japanese sedan. But while its excellent 4-wheel disc brakes brought it to second behind the Saab in our tests, it was no better than mid-pack anywhere else. It goes to show how rapidly development is taking place in this class—the Cressida has been in production for just a couple of years. The 2.8-liter, double-overhead cam inline-6 is wonderfully smooth and powerful, but it's stifled by Toyota's 4-speed automatic. The all-independent suspension is the same one used under the Supra, but with soft springs and shocks plus Toyo Eclipse tires, the Cressida is a flabby, unpredictable handler. The styling is boxy and unpretentious, but the interior is too glitzy.

As one tester put it, "The raw material is here to turn this car into a World Class sports sedan. It just needs to be Europeanized rather than Americanized."

Our advice to Toyota is to fit the firm suspension from the Supra, as well as that car's fat tires and wide wheels. Put in the new 3-liter engine and 5-speed. Redo the interior along the lines of the Saab 9000 or Audi, and for heaven's sake, get rid of those terrible automatic seat belts.

Conclusion

We like Saab's 9000 Turbo a lot. It's a grand combination of performance, function and fun. Audi's 4000CS Quattro is not so much our second choice, but an alternate. When the restyled 4000 appears next year, it'll be even more desirable.

The Acura/Sterling will no doubt be quickly improved in the Japanese fashion. If we were going to buy one, we'd wait a while, knowing that this already lovely car can only get better. Both the Pontiac Bonneville and Mercury Sable are classic American sedans with a thin veneer of sportiness, but Pontiac has done a better job. We think an STE version would be better yet.

Toyota's Cressida is about to be redone, and if we were in the market for one, we'd wait to see what the new car is like. And then there is Alfa's Milano. It's not a great sports sedan, but it sure is fun. And that's what sports sedans are all about.

FM

PIPE DREAMS

(Continued from page 73)

sander used for taking down and shaping excess briar.

To make your custom pipe, begin by cutting templates for the desired side profile and bowl circumference. Attach these to the pipe blank, transfer the markings, and grind away the excess briar with the belt-sander (powered by an electric drill). Straight cuts to the template outline tracing will suffice for rough contouring. After the bowl is rounded off and finished on the belt sander, use the same tool to shape the pipe's stem, once again following a template tracing. By now, a rough-hewn shape has evolved.

A contour groove is next machined behind the bowl, using the Dremel tool housing a sanding drum. Similar grooves are machined in the stem, under the bowl and around its side to the front. Finish the contours as finely as possible with the sanding drum.



Carbide ball cutter bit makes decorative carving in grooves, masks flaws in briar.

With the entire pipe body now fully formed and shaped, hone the rough machining marks and lines with a rat-tail file. Then, work it over with 100-grit sandpaper before a final sanding and polishing with 400- and 600-grit emery paper. The pipe should have a fine, smooth finish, except for any pits and flaws that emerged in the briar.

The roughage decor is carved into the grooved-out areas with a 3/32- or 1/8-in. ball carbide cutter tip. Use this to grind small hemispheres, adjacent to and overlapping one another. Allow the bit to do the cutting; only minimal hand pressure is necessary.

Once you've etched decorative pits into the grooved-out areas of the pipe, once again fine-sand the briar to the smoothest texture possible. Rub linseed oil into the external surfaces and wipe away the excess. Oil only the exterior of the pipe—not the bowl. Follow up with furniture polish and some vigorous hand-rubbing with a soft cotton cloth. This will impart a fine semigloss luster to the briar and highlight its grain pattern. **PM**

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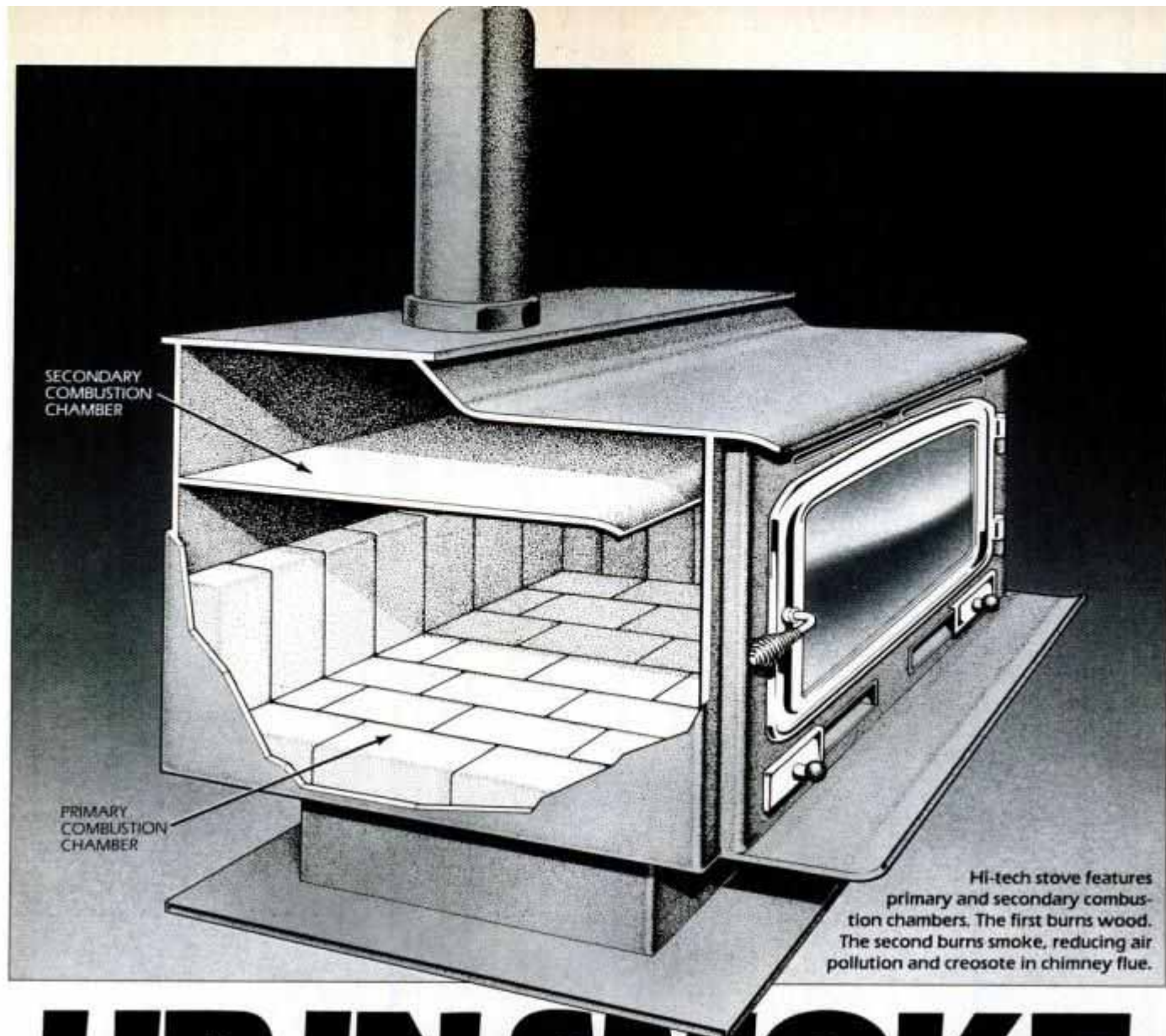
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UP IN SMOKE

New stove designs are more efficient and burn cleaner.

BY LEE GREEN; Illustrations by George Retseck

About 10 years ago, a new generation of Americans, shaken by skyrocketing energy costs, became aware of an old way to heat a house—the woodstove. The appeal was almost irresistible: Wood, unlike fossil fuels, is a renewable source of energy. And, for many Americans, wood was cheap and readily available. Couple these with the thought of independence from foreign energy sources, and the romantic association of wood fuel with pioneer days, and it's no wonder that more than 9 million new woodburners were sold between 1979 and 1982.

To meet that sudden demand, literally hundreds of stove manufacturers appeared. Some were old, established firms that had been making stoves for years, and simply expanded their manufacturing facilities. Others were

knowledgeable and conscientious newcomers. And some were fly-by-night operations out to make a quick buck with poorly designed and built stoves that were produced overseas or in backyard operations in this country.

This huge wave of woodburning brought a good deal of unexpected grief to many new stove owners. Some stoves failed to perform as promised, providing either too little or too much heat, and poor control over the heat they did produce. Wood, for many homeowners, proved to be a costly fuel, especially since woodstove efficiencies were often lower than had been expected. Further, the degree of attention demanded by a woodstove was an unpleasant surprise to folks familiar with gas, oil or electric heat.

Stove owners, and communities

where many stoves had been installed, found to their dismay that where there's fire, there's smoke. Entire towns were often covered with a smoky pall. And woodstoves proved to be responsible for much more than their share of home fires. In one New York State county, for example, more than half the residential fires reported in 1981 were woodstove related.

The woodburning situation was deteriorating to the point where something had to change—and something did. Or rather, two related things did. Community and state governments took regulatory action to try to control wood smoke and fire hazards, and the woodstove industry responded with newly designed breeds of stoves, incorporating the first major technology changes

(Please turn to page 118)



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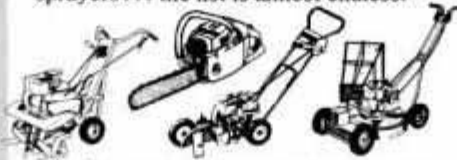
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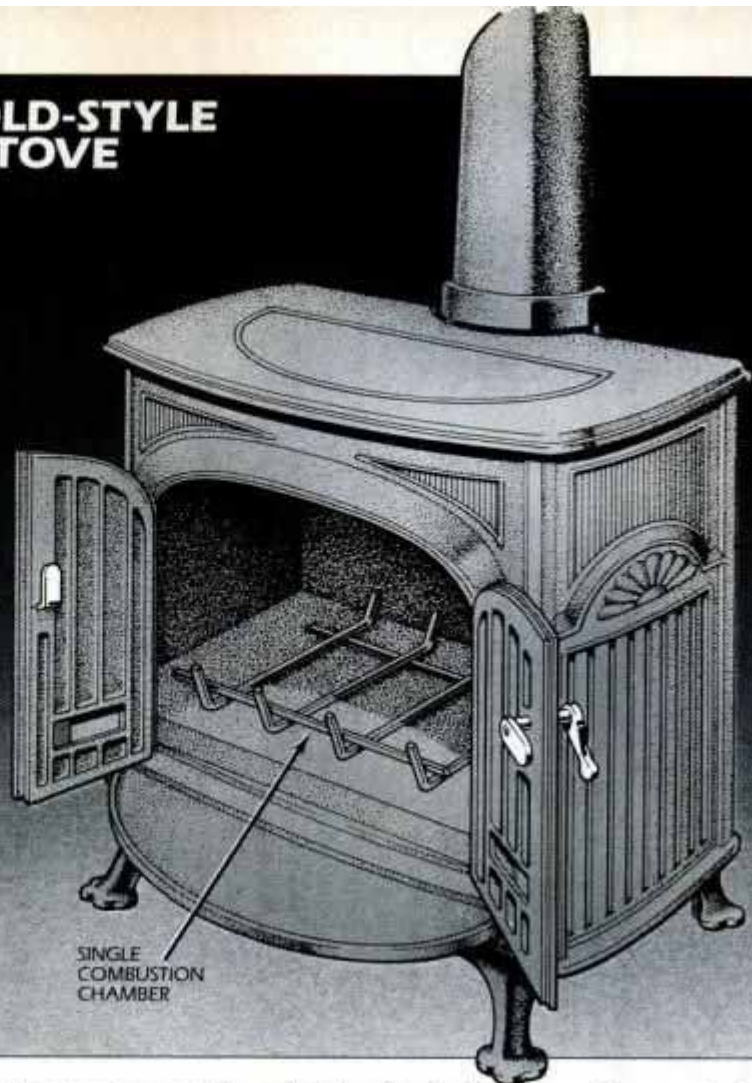
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COMBUSTION
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Most older stoves have a single combustion chamber that does not burn smoke. As a result, the stoves burn less efficiently and produce more creosote and air pollution.

UP IN SMOKE

(Continued from page 116)

in 200 years of stove manufacture.

As a result, the estimated 1.25 million people expected to buy woodstoves this year will find themselves with safer, more efficient, cleaner-burning stoves. Catalytic converters, a technology borrowed from automakers, and secondary "afterburners" are becoming commonplace on new woodstoves.

What was wrong with the old stoves

The problems with woodstoves stem directly from the way that wood burns. As Dr. Jay Shelton, one of the country's leading authorities on woodburning, has pointed out, wood doesn't really burn at all: When heated, part of it distills off as smoke, a mixture containing vaporized tarry materials and carbon monoxide, while the rest remains as charcoal. Charcoal and smoke, unfortunately, have very different burning requirements and characteristics.

Charcoal burns readily at temperatures in the 400 to 500° F range. It's much more difficult to burn the smoke. Generally, you need to reach about 1200° F to do it. If your stove can't burn that smoke, it goes up the chimney.

Some escapes to contribute to air-pollution problems while the rest cools in the chimney and condenses on the chimney walls as creosote, a highly flammable material that is a major cause of chimney fires. In an old-fashioned stove, it's not uncommon for *one-third* of the total energy contained in the wood to be lost in the form of unburned smoke.

A stove designer's main problem, then, is how to burn that smoke. This goal is complicated by several other factors: A woodstove, unlike a gas-burning or oil-burning heater, has a fuel supply whose shape, size and chemical composition changes drastically during the course of a burn. Further, the way a wood fire burns depends upon the type of wood burned—softwoods have very different burning characteristics than hardwoods—how the wood is cut, and the moisture content of the wood.

To make matters even more difficult, a successful woodstove design must have some means of adjusting the stove's heat output. Since you can't adjust the fuel supply, as is possible in a gas heater, for example, the only way to turn down a woodstove is to restrict its air supply. This leads to a choked fire, with an increase in smoke and creosote production. And so-called air-

(Please turn to page 122)

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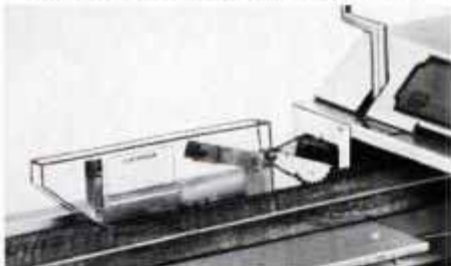
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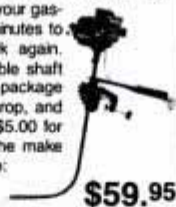
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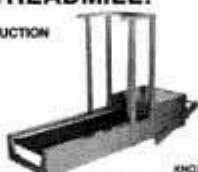
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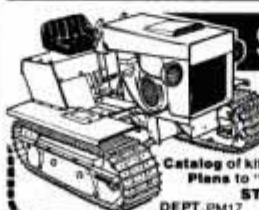


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UP IN SMOKE

(Continued from page 118)

tight stoves, which operate more efficiently than "loose" stoves because they do an even better job of limiting the fire's air supply, can be the dirtiest burners of all, especially when adjusted for minimum heat output.

These problems aren't nearly as noticeable with an open fireplace. Fireplaces almost invariably burn with a tremendous excess of air because there isn't any good way to control the amount of air drawn in by the fire. Glass doors are generally not tight-fitting enough to provide much control. Open fires usually burn hot enough to minimize smoke production, and the large amount of air acts to dilute the smoke that is formed and to prevent creosote formation.

Open fireplaces, though, aren't very efficient heating systems: The same excess air that limits smoke and creosote sends most of the fireplace's heat, typically around 90 percent, up the chimney. And if the fireplace is being used to supplement a central heating system, that excess air usually has been heated by the house's furnace, resulting in a net loss in heat.

The new breed

In broad terms, the problem of burning the smoke is a straightforward one: Just keep the stove's interior temperature at more than 1200° F. In practice, however, it's not that easy to do. To keep the internal temperature high, you must keep the stove from losing some heat. But losing heat to the room is a stove's reason for existing.

One solution to these conflicting requirements is to partition the stove's interior into two regions: One to burn the charcoal and a second, preheated by the charcoal fire and sporting secondary air inlets, to burn the smoke. This approach works reasonably well, and is the one used by almost all of the noncatalytic stoves that meet today's stricter emissions requirements.

There are a few disadvantages to this approach: At very low burn rates, the secondary chamber can cool off below the temperatures required for smoke combustion. And, in order to keep the temperatures high enough, stoves of this type usually have a small, fire-brick-lined fire box, which limits the size of the logs you can use and the amount of wood you can fit in.

Another solution is to equip the stove with a catalytic combustor, a device that lets smoke burn at a much lower temperature. Similar in design and function to an automobile's catalytic converter, a combustor will burn any smoke that contacts it, once it is "fired"

(Please turn to page 127)

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THE BETTER HOME



How To Install SOLID WOOD PANELING

Homeowners have long appreciated the warmth, versatility and value of solid wood paneling. Often reserved for family rooms and studies, wood paneling has long been the material of choice for comfortable, lived-in spaces. Today, it has moved into living rooms and dining rooms, as well.

Installing solid wood paneling is almost as easy as using veneered 4 x 8-ft. sheets. Though they make covering walls relatively easy, they are cumbersome and are limited to vertical application. Solid paneling is available in many

BY PAUL BARRETT
Illustrations by George Retseck

milled styles, including square edged for board-on-board and board-and-batten applications; tongue-and-groove with a V-milled edge or a beaded edge. It's also available in rustic patterns and more finished milled variations.

It can be had in many different species, including several varieties of pine, redwood, oak, ash, cherry and walnut. Ease of installation and availability depend on the type of wood and style of

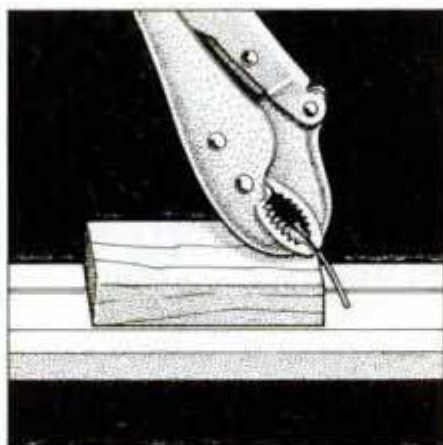
paneling. Most lumberyards stock pine, cedar and, sometimes, redwood. If they don't stock hardwoods, they often can order them for you. While hardwood paneling looks luxurious, it's more difficult to install. Nail holes, for instance, have to be predrilled.

Some lumberyards will carry the material as open stock while others will sell it in packages of random lengths. Its thickness may vary from $\frac{5}{16}$ to $\frac{3}{4}$ in.

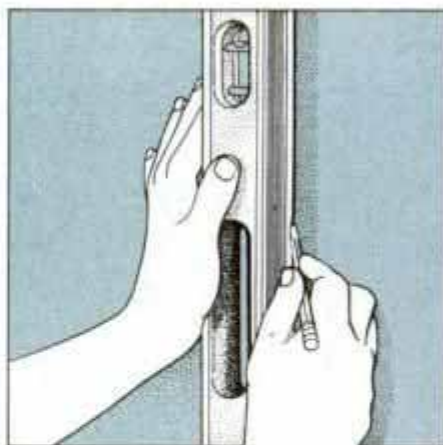
Since boards may be stored in outside warehouses, it's important to let them adjust to the humidity of the room they will be installed in. This reduces shrink-



1 To remove baseboard, gently drive a pry bar between the trim and wall. Then pry board away at all nail locations.



2 Use a pair of locking pliers to pull nails out the back of trimwork. This way, it can be reused after paneling.



3 Locate the center of a stud by driving a nail into the wall. Then mark a plumb line from the nail hole using a level.

age and expansion after installation. Store boards in the room for a week to 10 days before you install them.

Use 1-in.-thick stickers (wood slats) to separate the stacked boards to allow air to circulate between them. Tongue-and-groove boards should be pre-stained to avoid unstained tongues revealing themselves in the event of shrinkage. And in locations with high-heat and high-humidity conditions—such as bathrooms and kitchens—the backs of the boards should be sealed prior to installation.

For this article, we installed V-jointed tongue-and-groove boards vertically. The homeowner chose knotty pine, which was sold as open stock at the local lumberyard. Though sold as No. 3 grade (the grade below A, B, C Select, No. 1 and No. 2 softwood boards), the material was clean and straight, yet inexpensive for interior wall covering. If you go this route, buy enough extra material so you can eliminate unusable sections of boards.

Begin by removing trimwork on the walls to be paneled. Using a flat pry bar, pull the baseboard away from the wall. Pull the nails out from the back with a pair of locking pliers. This saves the surface of the baseboard in case you want to reuse it.

Pull casings from doors and windows the same way. Remove light and outlet covers and edging from heat registers. If you have radiators or baseboard heat, call a heating contractor to temporarily remove them.

Next, locate the studs by tapping across the wall with a hammer. You'll notice a solid "thunking" sound when you pass over each one. Using a 6d nail, drive test holes to find the center of each stud. Mark the nail hole and then

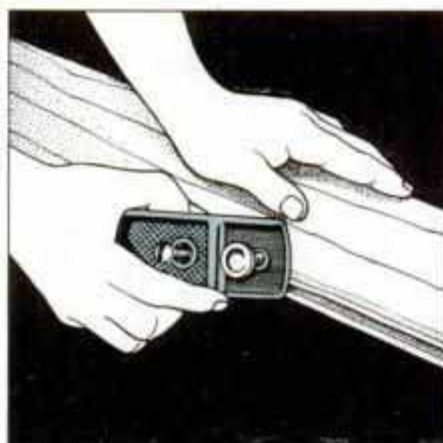
draw a plumb line through it with a level, going from the floor to the ceiling (or however high you are installing paneling). Then, drive a nail into the studs at the top and bottom of the line to double-check stud location. Correct the lines as necessary to correspond to the center of the studs.

Next, you must provide a nailing surface for the paneling because the majority of the boards can't be nailed to studs. Also, a nailing surface must be provided for door, window and duct openings.

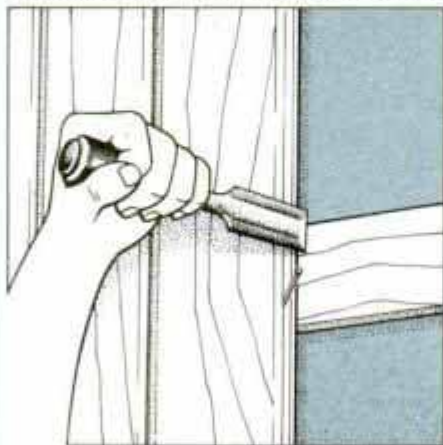
To provide a nailing surface for the paneling and various openings, nail 1 x 3-in. furring strips to the studs horizontally with 8d common nails. Space the furring 2 to 3 ft. apart. Shim the strips where necessary to make up for the dips in the wall.

One drawback to this is that the room's floor space will decrease by the thickness of the paneling and the furring strips (this can be as much as 1½

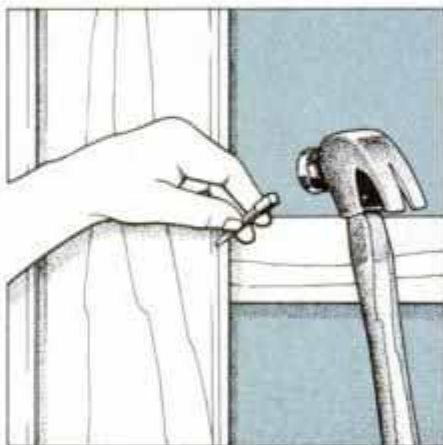
in.). To avoid this problem, you can cut away wall material where the furring is nailed to the studs (see *How To Wainscot A Wall*, page 80, June '84).



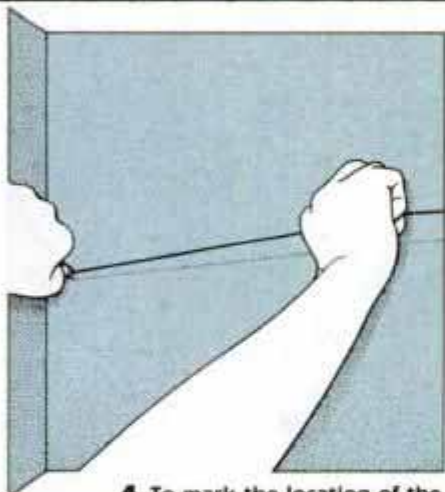
7 Using a block plane, remove wood from the grooved edge of the board. Work down to the scribed line, then test fit.



9 To wedge over a board with a bad crook, drive a chisel into the furring strip next to it, lever into place, then nail.



10 Nail boards through the tongue with 8d finish nails. Leave their heads above the surface and then bury them with a nailset.

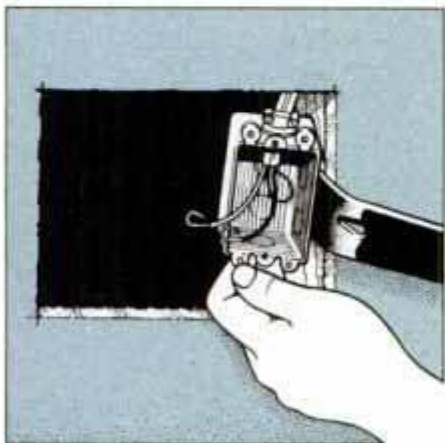


4 To mark the location of the furring strip nallers, snap a horizontal chalk line at intervals of 2 to 3 ft.

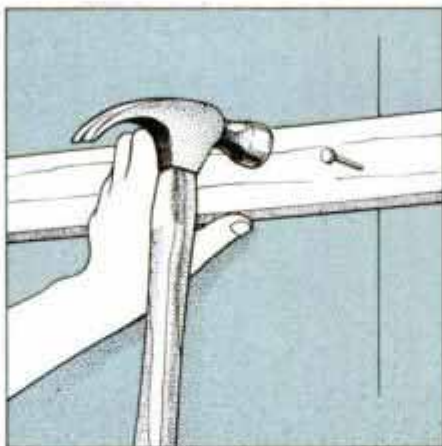
When working on masonry and concrete walls, the simplest alternative is to face-nail 2 x 4-in. furring to the walls (see Minicourse: *Anchoring To Mason-*



8 Hammer on a paneling scrap when you tap a board into place. Put the scrap's grooved edge over the board's tongue.



11 Relocate an electrical box so it's flush with the paneling's surface. First, gently pry it loose from the wall.



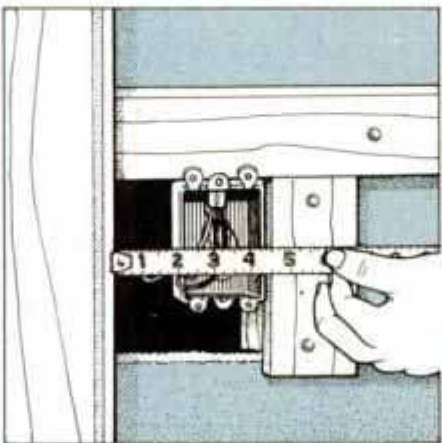
5 Nail the furring strip to every stud with 8d common nails. To save space, cut away wall material behind the furring.

ry, Parts I and II, page 86, May '86, and page 62, June '86).

If you're paneling the ceiling, the boards can be attached directly to the ceiling joists, through the drywall or plaster, providing they are running perpendicular to the floor joists. If parallel to the joists, you'll have to fur over the ceiling.

Should there be an electrical box in the ceiling, it will have to be lowered to accommodate the paneling. Turn off power to the room at its source, and cap all exposed wiring with wire nuts. Cut out a 16-in.-square section of the ceiling from around the electrical box. Remove the box and attach it to a 2 x 4-in. block that has been cut to fit between the ceiling joists. Hang the box so it will be flush with the paneling on the ceiling.

Relocating an electrical box on a wall is very similar. You can replace an existing box with a Grip-Tite or similar box that grips the paneling from behind



12 To scribe for an electrical box, take measurements from the board's side to the box side and from the floor to the box top.



6 Hold the first piece of paneling plumb at the inside corner. Use a compass to scribe the board.

or you can use a box with holes that allows you to screw it into the paneling.

In this case, we just removed the box and reattached it to furring material fastened to the stud by the box opening. If you are fastening the boards directly to the wall, you can buy extension collars for electrical outlets and switches that save the trouble of moving the box. For heating and air-conditioning registers, you'll have to have a heating contractor fabricate the extension collars.

Once the nailing surface has been prepared, begin by nailing a board at an inside corner.

Hold the grooved side to the corner, plumb the board with a 4-ft. level, and scribe the edge in the corner with a compass, using the wall as the guide. If necessary, rip off extra material. Then, use a block plane to work down to the scribed line. Fasten the board by nailing it through the tongue into the furring with 8d finish nails.

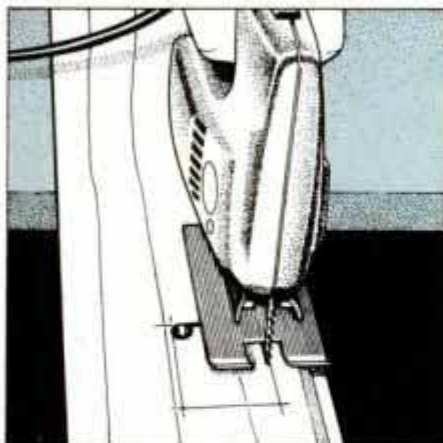
Leave the nail heads above the surface and sink them with a nailset just below the surface.

Tap the next board in place; use a scrap block cut from the grooved edge of a piece of paneling to avoid crushing the tongue.

If a board has a crook, drive a chisel into the nailer next to its tongue and pry it against the next board. Maintain pressure on it until you drive a nail near the pry point.

If the crook is bad, start a face nail and a tongue nail before you begin to pry the board, then sink both nails before releasing pressure.

After you've installed four boards, measure the distance from the tongue on the fourth board to the corner you're working toward, both at the ceiling and



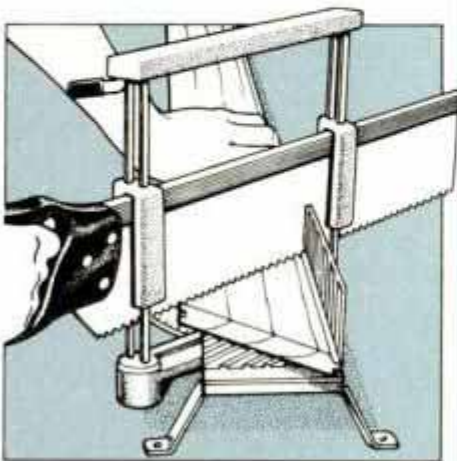
13 Cut out a box or switch opening with a sabre saw. First bore a starter hole at the corner of the opening.

floor. If the measurements differ, adjust the spacing of the boards so the difference gradually disappears.

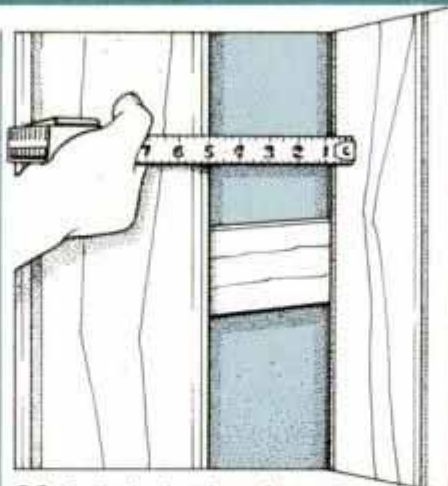
To scribe the cutout for a window, measure the distance between the edge of the face of the last board you installed to the outside of the nearest window jamb—measure at the top and bottom of the window. Then, measure from the floor to the bottom of the window stool and to the top of the window head jamb. Transfer your measurements to the board and cut the waste away with a sabre saw.

After all the boards are on the wall, apply extension jambs to windows and doors. These wood strips bring the jamb flush to the face of the paneling (see *How To Install Trimwork*, page 115, Dec. '86).

To apply the last board at an inside corner, measure from the edge of the previous board to the corner, at the ceiling and the floor. Transfer these

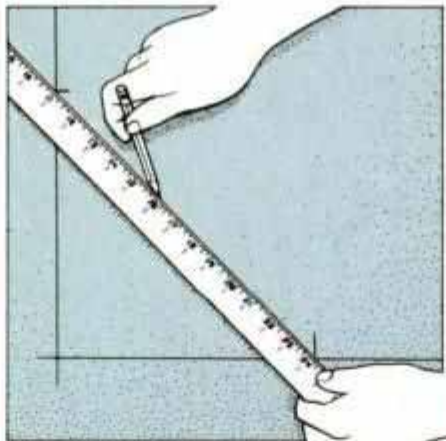


17 Use a miterbox to cut the diagonal on the end of a board. Note that the long point of the angle is on the tongue side.

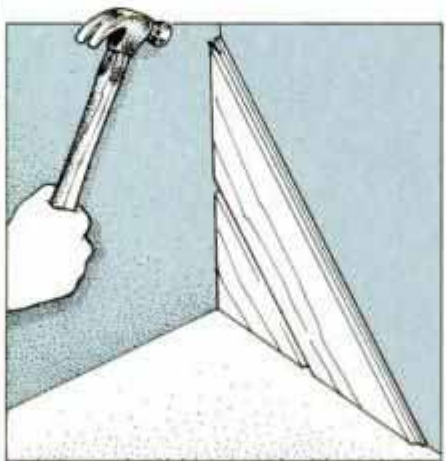


14 To fit the last board on a wall, measure from board's edge to wall opposite, at both its top and bottom.

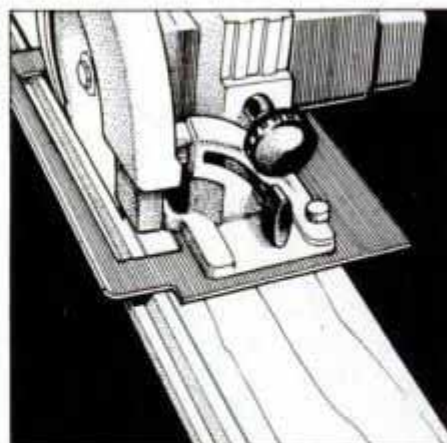
measurement marks to the top and bottom of the board. Now, hold the board about 1 in. from the corner, parallel to the board next to it. Set your



16 For diagonal paneling, mark horizontal and plumb references. Measure each 12 in. in, connect marks.



18 Nail boards through the tongue, into the corner stud, and along the plate. Baseboard covers nails along the floor.



15 Hold the last board in place, then scribe-fit it. Rip off the waste and then plane down to the scribed line.

scribe to touch the wall and the top measurement mark, then run it down the length of the board.

Rip the board as necessary, then plane off the excess, leaving half the line for a tight fit. Remove the backside of the groove, press the board in place, and then face-nail.

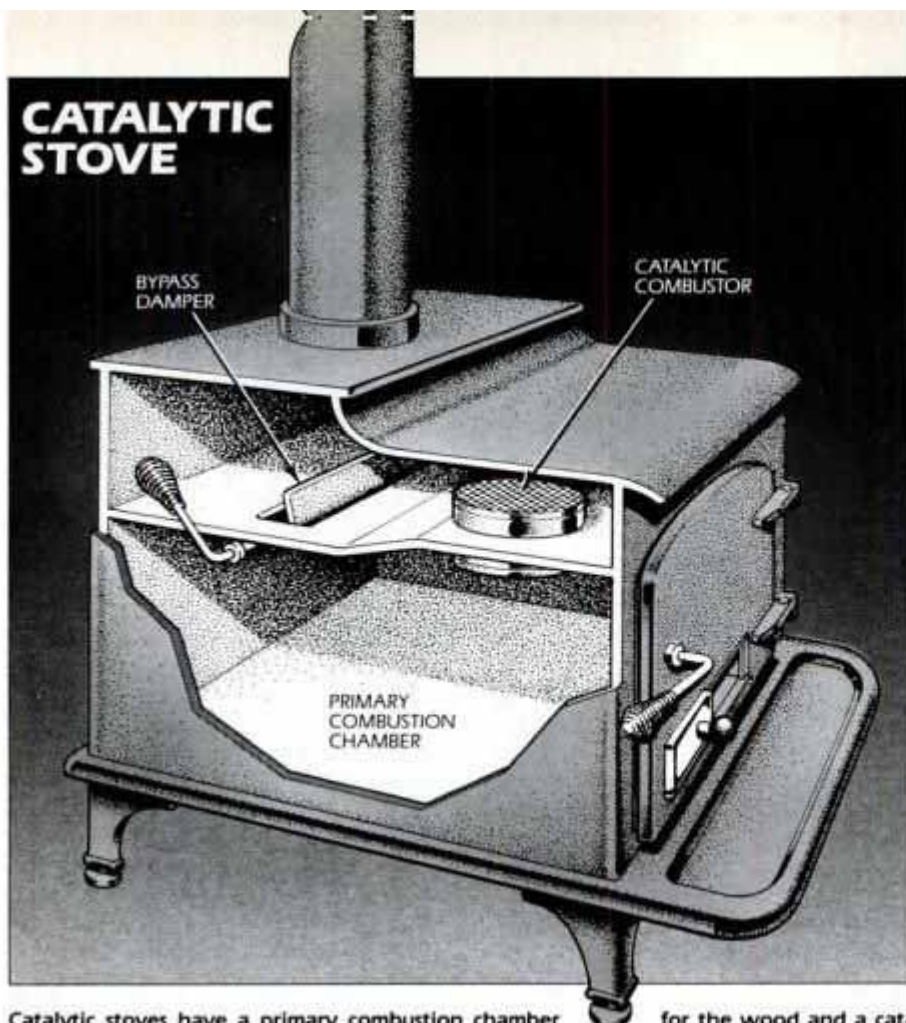
Finish outside corners by cutting the last board flush with the adjoining wall. Sand the edge of the board smooth and flush with the adjoining wall.

For diagonal pattern paneling, begin by laying out a reference line. For a 45° angle, measure 6 in. from the corner and mark a 2-ft.-long plumb line. Then, measure 1 ft. up from the floor and mark an intersecting horizontal line. Measure and mark 1 ft. up on the horizontal line and 1 ft. on the plumb line. Connect your marks, extending the line from the corner to the floor. Cut a 45° angle on the end of a board, with the long point on the tongue side. Then, cut the piece to fit tight to the corner and floor while being parallel to the reference line. Blind-nail through the floor plate into the corner stud.

While diagonal paneling does not require furring—if it runs from floor to ceiling—it does require careful cutting and fitting. For those boards used on long diagonal runs, you should try to cut them so their ends fall on the center of a stud.

After paneling and extension jambs are in place, apply window and door casing, and then baseboard trim. Fill nail holes with wood filler, then lightly sand the walls with 220-grit sandpaper. If you're going to paint the paneling, you should prime it with an alkyd primer. Another option is to finish the paneling with a top coat of natural or synthetic varnish.

CATALYTIC STOVE



Catalytic stoves have a primary combustion chamber for the wood and a catalytic combustor that burns the smoke as it passes through. For the combustor to operate, it must be heated to 500° to 600° F. Until it is, a manual damper remains open to let the smoke pass through. When the combustor is ready, this damper is then closed.

UP IN SMOKE

(Continued from page 122)

off by heating it to 500° to 600° F for 10 minutes or so, even if the smoke's temperature is well under 500° F.

Catalytic combustors work best with smoky fires: They make it possible to provide long, unattended burns with a minimum of air pollution and loss of efficiency. Catalytics are among the cleanest-burning stoves available today, as well as the most efficient. Catalytic combustors permit designers to come up with stoves that have a wide range of heat output without sacrificing performance. The major disadvantages to catalytic woodstoves is cost. A catalytic stove typically costs \$200 to \$300 more than its noncatalytic counterpart.

Measuring performance

A woodstove's performance can be described in a number of ways. Among the most common are combustion efficiency, overall efficiency, maximum heat output, maximum length of burn, size of the room that the stove can heat, and rate of emission of particulates. These various measures are all interrelated, and it's helpful to understand what they mean—and don't mean—if you're planning to buy a new stove.

Combustion efficiency in a wood-

stove simply describes how completely the wood is burned. If the wood in a stove burned with no smoke and left no ash, all of its energy would be converted to heat and its combustion efficiency would be 100 percent. In the real world, this just isn't possible: Old-fashioned stoves have combustion efficiencies in the 60 to 70 percent range while the better, new stoves can operate at combustion efficiencies of 85 to 90 percent.

Overall efficiency is a combination of combustion efficiency and the stove's ability to transfer its heat to the room, instead of up the flue. Overall efficiency is always lower than combustion efficiency—about 50 percent for old stoves, 60 to 65 percent for the newer noncatalytic ones. Catalytic stoves boast efficiencies of about 75 percent.

Both types of efficiencies depend on how the stove is loaded and operated, although catalytic models are less sensitive to these factors than noncatalytic ones. A small, hot fire will result in a higher efficiency than a large, air-starved one. And a load of well-seasoned, dry wood will burn more efficiently than a load of green wood.

Efficiencies vary with outdoor temperatures and humidities, as well as chimney location and wind speed. To obtain any reproducible numbers at all,

(Please turn to page 128)

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UP IN SMOKE

(Continued from page 127)

laboratories that test woodstoves are forced to run all the stoves they test under exactly the same set of conditions—which, unfortunately, may have little to do with how *you* operate a stove in your home. As a result, you're best off regarding these numbers in the same light as you would your car's EPA mileage numbers. They can provide a helpful comparison between different models, but they can be less-than-ideal predictors of what happens in real life.

A stove's actual overall efficiency can also depend drastically on the length of stovepipe present inside the house, as a good deal of the stove's heat can reach the room via the stovepipe. This depends upon the installation though, rather than the stove itself.

Maximum heat output, usually expressed as British Thermal Units per Hour (BtuH), is a rough measure of a stove's absolute maximum output. It is measured under conditions that are almost impossible to maintain: the stove's firebox virtually stuffed with small pieces of wood, which are replenished frequently to keep the stove full. Again, this may be of some value in comparing the heating capacities of different stoves, but it's not very useful for helping pick the stove for you.

Most woodstoves have too *high* an output for most homes, except possibly on the very coldest days of the year. As a result, most stoves spend most of their life running in a choked mode, with the resulting penalties in lower efficiencies and increased emissions. If you're choosing a stove, you're usually better off with one that's a bit undersized than one that's too large.

Maximum burning time is a convenience factor. The longer a stove can burn (overnight, for example) the less often you have to reload it. Long burning is a result of two factors: the size of the firebox and how free of leaks, or how airtight, the stove is. Long, slow burns, convenient as they may be, are major culprits in smoke and creosote production. It's a bad idea to run your stove this way regularly.

Maximum room size the stove will heat is a piece of information sometimes provided by stove manufacturers. It is, at best, a guess. There's enough variation in room shapes, insulation, other heat sources and weather to render this value almost useless, except to point out that a big stove will generally heat a bigger room than a small stove. Further, as there's no standard method to determine this number, there's no assurance that you can even use it to compare different brands of stoves.

Rate of particulate emissions, ex-
(Please turn to page 130)

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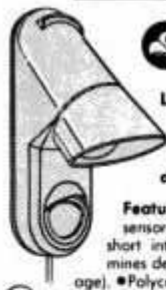
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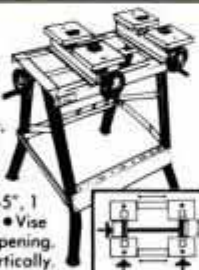
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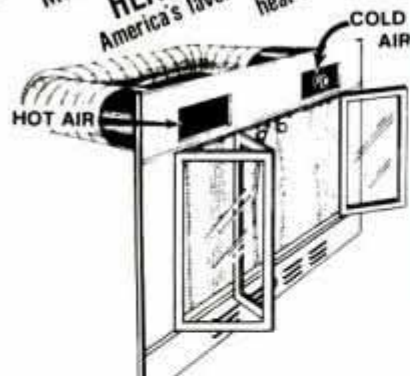
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USING YOUR
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UP IN SMOKE

(Continued from page 128)

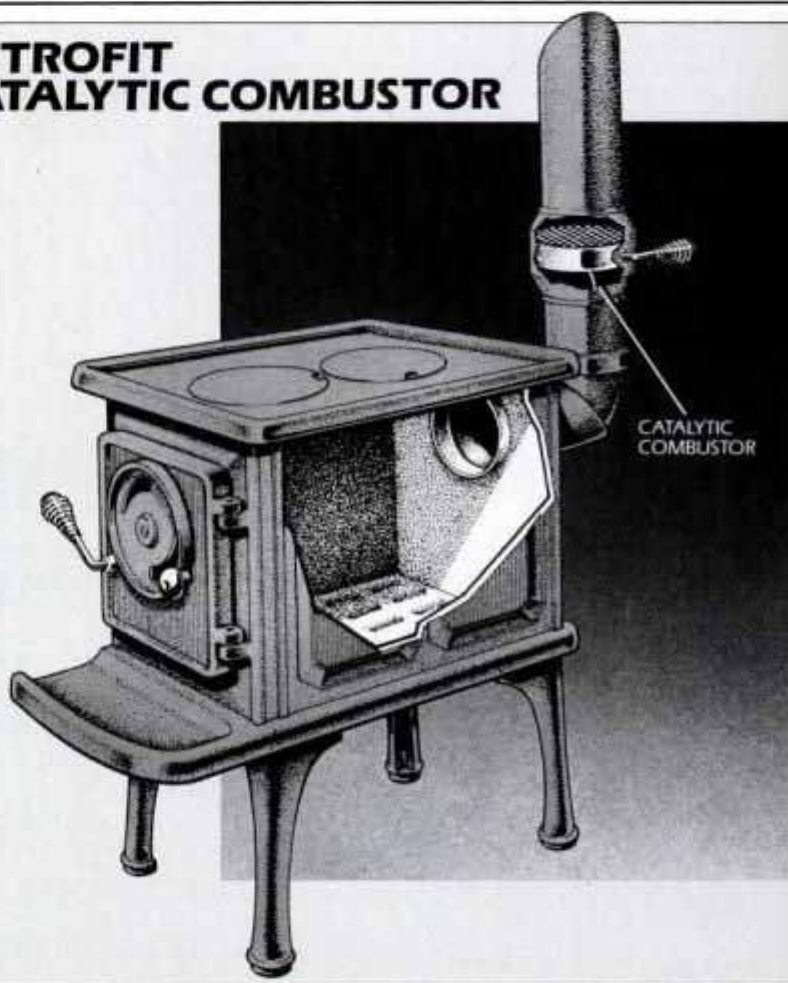
pressed in grams per hour, is the most recently developed measure of performance. It's use is a direct result of state (first Oregon, then Colorado) regulation to reduce air pollution. It would probably be clearer to refer to these as "grams of smoke per hour," as the particles measured consist essentially of tiny droplets of condensed creosote.

Recognizing that smoke production, like efficiency, depends upon the stove's adjustment, the measurement technique mandated by Oregon calls for

operating the stove at a number of air adjustment settings, and reporting the amount of smoke, as well as the efficiency, at each setting. Results for the various settings are combined to produce a single number for efficiency and another for grams of smoke. Oregon's standard, the only one in effect at this time as far as banning sales of unacceptable stoves, calls for no more than 15 grams per hour (9 gph for higher-priced catalytic models) in stoves sold from July 1, 1986, to July 1, 1988, and no more than 9 and 4 gph for noncatalytic and catalytic stoves sold after that.

(Please turn to page 135)

RETROFIT CATALYTIC COMBUSTOR



Older stoves can be retrofitted with a catalytic combustor to achieve more efficiency and less pollution. It is positioned inside the flue where the flue joins the stove.

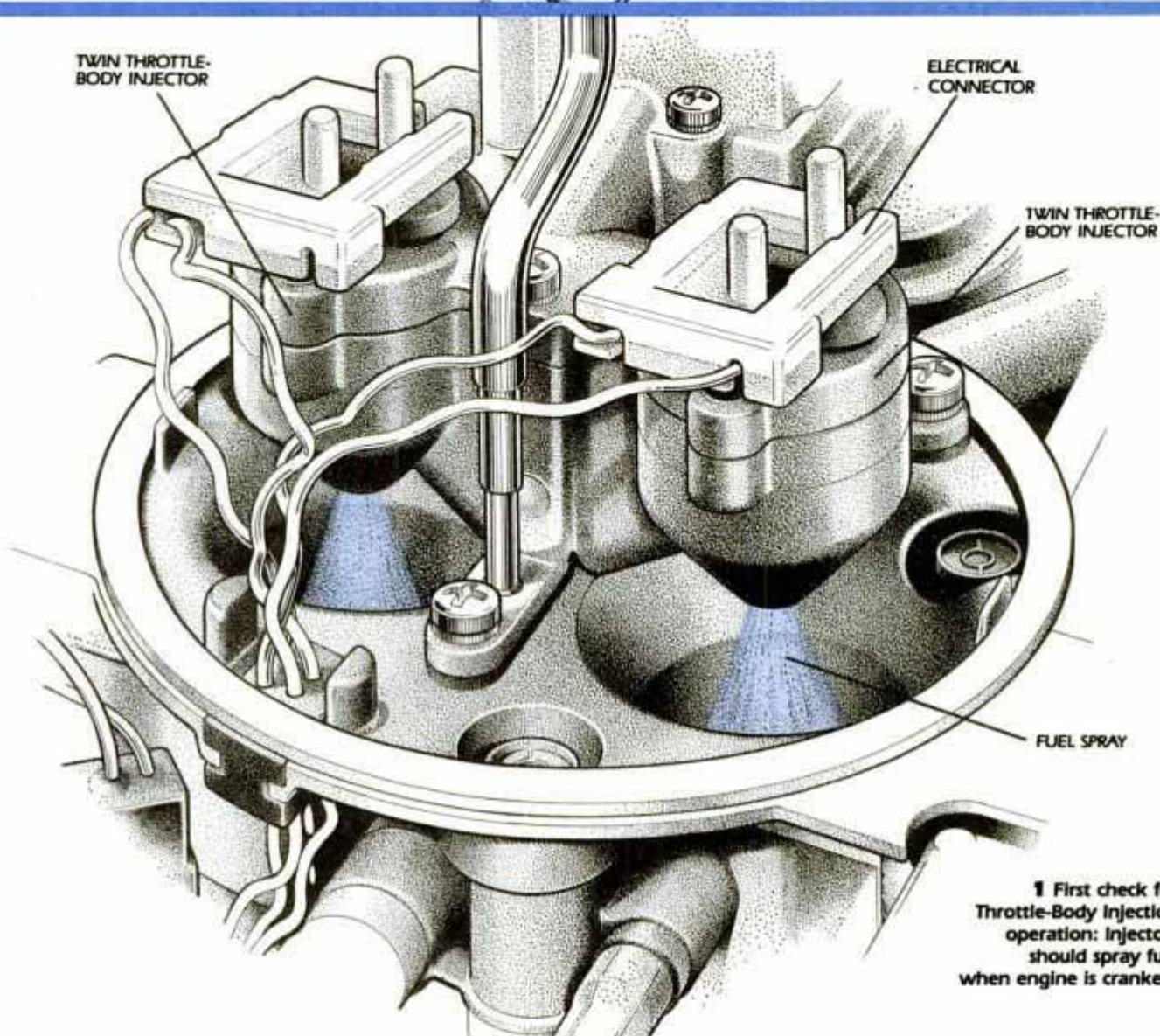
If you now have an old, but serviceable, woodstove and don't want to shell out the price of one of the new high-tech models, don't despair. Your stove may be a candidate for upgrading to a high-performance catalytic whiz. A number of manufacturers are selling retrofit catalytic combustors that, in many cases, can make an old stove behave like the newest designs. Prices are in the \$100 to \$200 range.

Retrofit combustors usually are mounted where the flue joins the stove. Typically, there's a 2-position lever extending from the combustor. One position starts the fire, the other swings the catalyst into the smoke stream after the fire has burned long enough to fire off the catalyst.

A retrofit combustor will usually make a

dirty-burning stove into a clean-burning one; its effectiveness on improving the stove's overall efficiency depends on whether there's enough stovepipe surface after the combustor to get the additional heat produced by the combustor into the room.

Is your stove a candidate for retrofitting? There are two major requirements. First, is your stove reasonably airtight? It is if adjusting the air inlet to OFF will drastically reduce the size of the fire. Second, is your stove's flue temperature high enough to fire off the combustor? To find this out, you'll need a flue thermometer, available for about \$10 from most stove dealers. If your flue temperature, measured at the base of the stovepipe, reaches 600°F when you have a good blaze going, a retrofit combustor will work.—L.G.



WHEN YOUR CAR WON'T START

It seems like it only happens when you're 10 minutes late for an important appointment. You hop in your car and turn the key. Nothing. The engine turns over fine, but it won't start. What to do?

Covering the basics

Before you even pop the hood, make sure you've covered the essentials—like putting fuel in the tank and using the proper starting technique.

A fuel gauge that reads FULL doesn't

BY PAUL STENQUIST

always indicate a full tank. If you can't remember the last time you filled up, and the gauge is still pinned to the F mark, try pouring a few gallons of gas into the tank before you look for a more complicated problem. On many cars, the fuel gauge will read FULL continuously if the sending unit isn't properly grounded.

If your engine is carbureted and the tank is empty, prime the engine by

pouring a few tablespoons of gas down the carb. But reinstall the air cleaner to prevent a backfire that could start a fire. Fuel-injected engines will usually prime themselves if the key is left in the ON position for a few seconds.

Improper starting techniques can also leave you with a no-start, particularly in cold weather. Most carbureted cars are started by pressing the throttle to the floor, releasing it and turning the key with your foot off the throttle. On some cars two pumps are necessary



2 Use fulcrum for screwdriver to pry injector from GM throttle-body injector.

in colder weather. Most fuel-injected cars are started with your foot off the throttle—pumping does nothing. Check your owner's manual for detailed starting information.

Fuel or spark?

Two things are necessary to make any gasoline-burning engine run: fuel and spark. Once you're satisfied that the problem is not simply an empty fuel tank or incorrect starting technique, you can tell whether it's due to a lack of fuel or spark with a visual check.

Although simple in most cases, the procedure is not the same for throttle-body fuel-injected, port-injected and carbureted engines.

Throttle-body fuel-injected

Begin your routine by turning the key to the ON position and noting the CHECK ENGINE light. (The name varies, but all recently produced engines have some type of light to indicate computer system problems.) The light should be illuminated with the key in the ON position. If not, there is probably a basic power-supply problem and you should consult your factory service manual for further directions.

If the CHECK ENGINE light came on and your car has throttle-body fuel-injection, remove the air cleaner and have a helper crank the engine while you observe the fuel injectors. You should see fuel spraying from the injectors while the engine cranks (Fig. 1).

If you do see fuel spray—disconnect the injector (or injectors—some have two) and have your helper crank the engine again while you observe. If one or more of the injectors sprays while it is disconnected, the injector or injector seal is faulty and must be replaced. In this case, the no-start is caused by flooding, and you should remove the plugs, clean them with dry cleaning fluid or sparkplug cleaner, and crank the engine with the plugs out and the new injectors disconnected for a few seconds before attempting to start it.

If, while cranking the engine with the harness disconnected, there was not visible fuel spray—but you did see fuel spray when you cranked with it connected—the problem is not due to a lack of fuel. Proceed to *Checking for spark*.

If you didn't see any fuel spray the first time you cranked the engine—with the injector harness connected—disconnect the injector harness and connect a test light across the harness connector. Special inexpensive test lights that plug into the harness are available for this purpose at auto parts stores.

Crank the engine with the test light connected. It should blink on and off, indicating that voltage is being supplied to the injector and the lack of fuel is due to either a faulty injector or a fuel-delivery problem. To determine which, turn the ignition off for at least 10 seconds and install a fuel-pressure gauge on the Schrader valve found on your engine's fuel-supply line or on the fuel-filter case.

On some cars, you'll have to use a

high-pressure gauge, like the ones sold specifically for fuel-injection diagnosis. But check your manual to be sure. Some TBI systems operate at low pressure, so all that's needed is a gauge with a Schrader valve attachment.

Within a few seconds after turning the ignition on, the fuel system should pressurize. If it does, the no-start problem is due to a faulty injector(s) that should be replaced (Fig. 2).

If it doesn't pressurize, the problem is due to a bad pump, a plugged in-line or in-tank filter, a restricted fuel line or (on cars with in-tank pumps) a leaking fuel pump coupling (Fig. 3).

Port fuel injected

The procedure differs for port-injected engines because you can't see the injectors without removing them from the intake manifold.

Because of this, most manufacturers recommend that you begin troubleshooting by checking the computer's memory for trouble codes. To do this, consult the appropriate chapter in your factory service manual.

If no trouble codes are stored, skip to the section below to check for spark.

If you find that spark is okay, disconnect an injector harness connector from one of the injectors and connect a test light. As noted above, special fuel-injection test lights are sold for this purpose. Crank the engine while you watch the light.

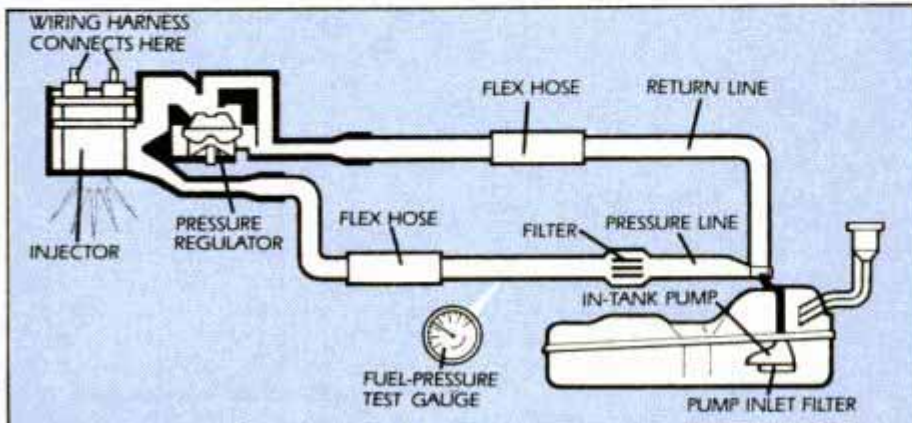
If the light blinks on and off, install a fuel-injection pressure gauge on the Schrader valve, which is probably located somewhere on the fuel rail. Turn on the ignition and note fuel pressure after the pump stops running (a few seconds in most cases). Pressure should be 30 to 40 psi on most port-injected engines. If it's not, check your service manual to make sure this spec is correct for your system. If you conclude that low fuel pressure is a problem, the cause would be comparable to TBI fuel problems mentioned earlier.

If pressure is okay, and all previous checks yielded passing grades, go to the section *Other possible problems*.

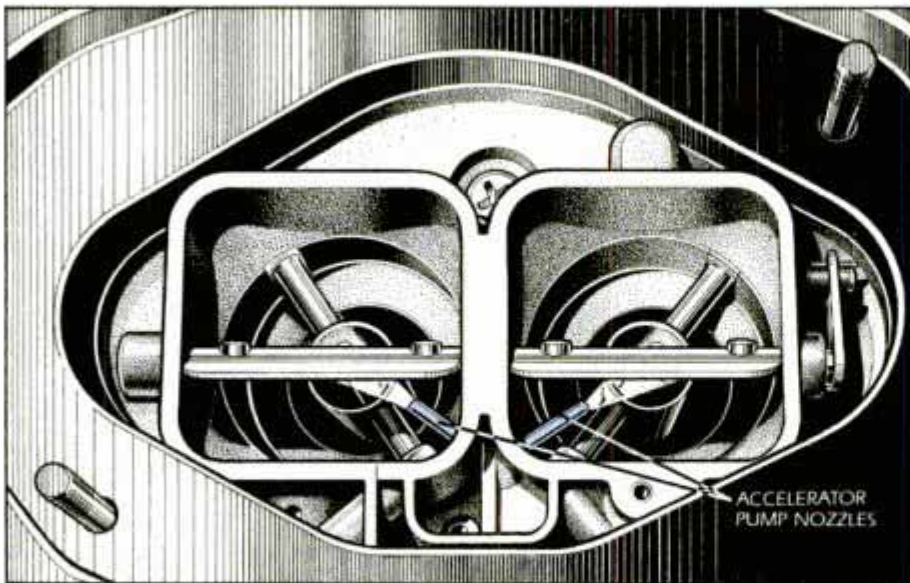
Carbureted engines

If your carbureted engine fails to start, check to see that the warning lights or CHECK ENGINE light comes on when the key is in the ON position. If it doesn't, there's a wiring problem.

If the lights come on but the engine won't start, remove the air cleaner. If the engine hasn't been running for six hours or more, the choke should be



3 Fuel-pressure test gauge is attached at Schrader fitting (see text for location).



4 Snap the throttle open and watch the carb accelerator pump nozzles for fuel spray.

almost fully closed. If it isn't, open the throttle. The choke should snap closed. If it doesn't, it's either dirty, broken or misadjusted.

If the choke seems to be working, look down into the carburetor. While holding the choke open, move the throttle rapidly to the full open position. You should see fuel squirt from the accelerator pump nozzles within the carb (Fig. 4). If you see fuel, proceed to the section *Checking for spark*.

If you don't see fuel squirt from the accelerator pump nozzles when you open the throttle, check once again to make sure there is fuel in the tank, then remove the fuel filter and check for restriction. On many cars the filter can be found behind the carburetor fuel inlet nut. Use two wrenches while removing the fuel line—one on the inlet nut, one on the fuel-line nut. It's best to use a special tubing wrench on the fuel-line nut if you have one, as this type wrench is less likely to slip on the nut.

Place a rag on the manifold under the fuel-line connection before you unscrew it. There should be visible evidence of filter contamination if it's bad enough to cause a no-start.

On cars with in-line filters, place a rag under the filter and release the hose clamps that secure it in the fuel line. With this type filter it's difficult to tell if it's contaminated (unless it's see-through plastic), so you may just have to replace it to tell if it's the culprit.

If the fuel filter checks out okay, check fuel-pump capacity by connecting a hose from the fuel-inlet line to a suitable, unbreakable container. Crank the engine. The fuel pump should supply a half-pint or more of fuel in 15 seconds. If the pump can't deliver enough or delivers none at all, it should be replaced.

It's also possible that the line leading to the pump or the inlet sock in the tank is restricted. You can determine if either of these is the cause by filling the

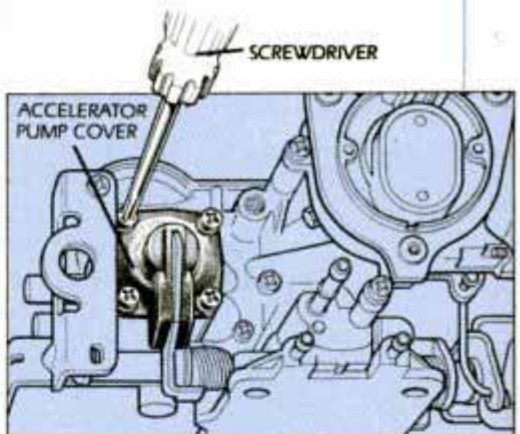
carb float bowl manually, starting the engine and then checking fuel-pump pressure and vacuum.

Before you remove a fuel pump, always disconnect the battery's negative cable to prevent the possibility of an electrical spark igniting any spilled fuel. When installing a new pump, make sure the pump push rod or drive cam properly contacts the pump lever.

If you found that the fuel-pump capacity was okay but there is no fuel squirting from the accelerator pump nozzles, the problem is inside the carb. On most cars, you can remove the carb air horn for basic inspection without removing the carb from the engine.

To remove the carb air horn (the upper part of the carburetor), disconnect the fuel line, throttle and choke linkage along with any other linkage rods that connect the carb base to the carb air horn.

Then, being extremely careful not to drop anything into the carburetor, remove the screws that join the air horn

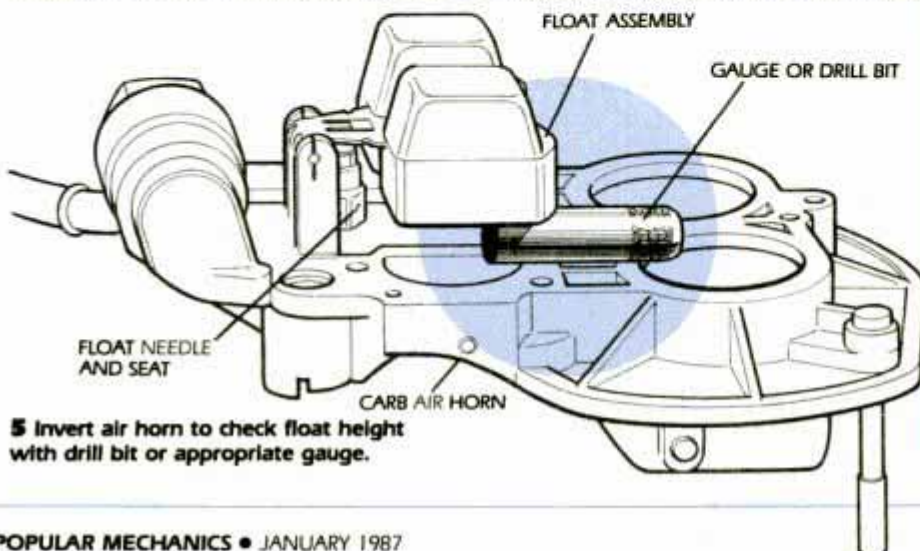


6 Remove the accelerator pump cover to check for a torn or leaky diaphragm.

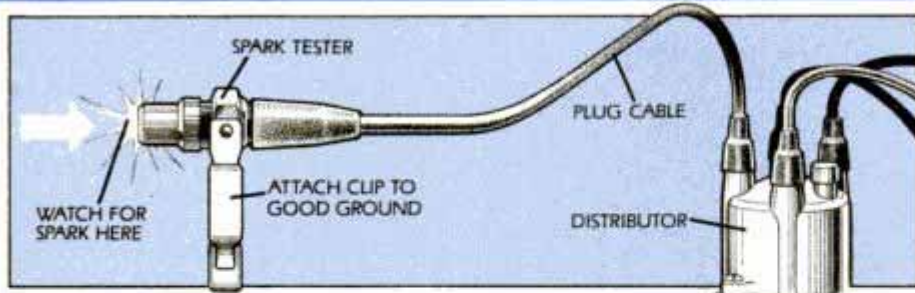
to the float bowl; some screws may be hidden within the air horn.

Once all of the screws are removed, you should be able to carefully lift the air horn off the carb base. The float assembly, and in some cases the accelerator pump, will come off with the air horn. Turn the air horn upside down so that the float is facing you.

The float, needle and seat control the amount of fuel flowing into the carb. When the carb fuel bowl is full, the float rises and pushes the needle into its seat, preventing any more fuel from entering the float bowl until some of it is burned in the engine. If the float is jammed in the up position (down with the air horn turned over), the needle will stay in the seat and no fuel will enter the carb.



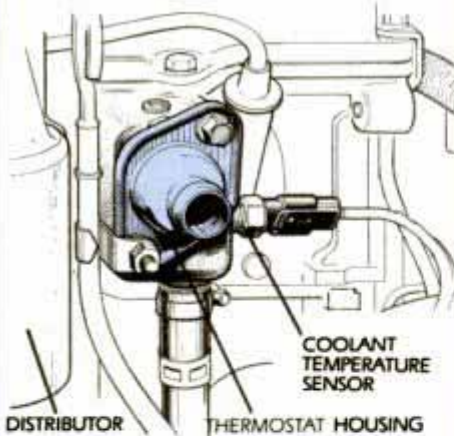
5 Invert air horn to check float height with drill bit or appropriate gauge.



7 Use the spark tester to avoid electrical shock and damaged ignition components.

Another possibility is a needle that sticks in its seat when the float drops. You can check for this by turning the air horn so that the float is facing down. The float should drop and the needle should move out of its seat. If it doesn't, it's stuck and it should be replaced. Wear has probably led to a ridge that causes the needle to stick in its seat. Replace it. Adjust float height before reinstalling the air horn (Fig. 5).

If the float bowl was full of fuel when you removed the air horn, examine the accelerator pump. On many carbs you'll find the pump hanging from the air horn. It consists of a rawhide or neoprene piston that pushes fuel through a chamber and into the accelerator pump nozzles. If the piston has deteriorated,



8 On Chrysler 2.2L engines, coolant temp sensor is in the thermostat housing.

fuel won't squirt out and starting will be difficult, if not impossible.

Some carbs have a diaphragm-type accelerator pump rather than a piston. This type pump is usually attached to the carb base with screws. Check for a torn diaphragm by removing the pump assembly (Fig. 6).

Checking for spark

Once you've determined that enough fuel for starting is available—or with port-injected engines before you check for fuel—you can perform a very simple

test to see if the second element necessary for starting an engine is available: ignition spark.

In the good old days of simple cars with points and condensers, all you had to do to check for spark was pull the coil wire from the distributor tower and hold it near the ground while cranking the engine. If it sparked, you did the same thing with one of the plug cables to make sure voltage was getting past the rotor and distributor cap.

With today's high power ignitions, you could end up with a serious electrical shock or damaged ignition components if you check for spark in this manner. Nowadays you need a special spark-test tool, but the job is still an easy one. This tool is available at most auto parts stores, or any GM dealer. Ask for the ST-125 spark tester. Because spark checks are an important part of many diagnostic routines, no serious driveway mechanic should be without this tool.

To check for spark, remove one plug cable from a sparkplug with the ignition turned off. Twist the boot a little if you have to. Install the spark tester on the end of the cable and attach the clamp to a good ground. Then, while your helper cranks the engine, watch the end of the spark tester. A well-defined spark should arc from the tester's center electrode to its housing (Fig. 7).

If you see a spark, check several other cables in the same way. If they all check out okay, you can be sure that a lack of spark is not preventing the engine from starting.

If there is no spark, remove the distributor cap and make sure the rotor turns when the engine cranks. If it doesn't, the pin that secures the distributor gear to the shaft is probably broken and the distributor will have to be removed for repair. It's also possible that the camshaft timing belt or chain is broken. If the rotor turns and there is no spark, check for broken or disconnected pickup wires. If everything looks okay, further diagnosis of the electronic ignition system is necessary.

Other possible problems

If your troubleshooting finds that the engine is supplied with both fuel and spark, you'll have to look elsewhere for the starting problem.

On many fuel-injected engines, a throttle-position sensor (TPS) that sticks in the wide open throttle position will cause the computer to go into the CLEAR FLOOD mode. This results in a lean fuel mixture that makes starting difficult, if not impossible.

If the coolant sensor on a computer-controlled engine fails in such a way that its circuit opens with the ignition off, the computer will think that the outside temperature is extremely cold. In warm weather, this condition can cause flooding, which will result in a no-start (Fig. 8).

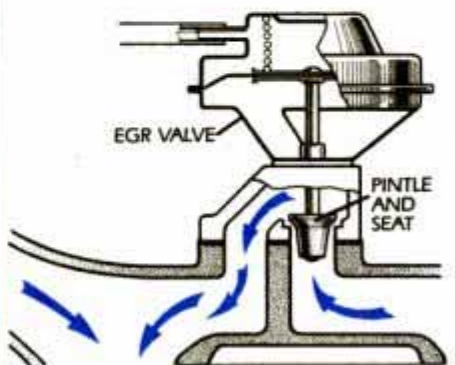
Water in fuel-system components can cause a no-start in cold weather, particularly if you get a load of gas that was blended for warm weather. The best cure is a warm-up indoors. If you have recurring trouble, add a can of gasoline winterizer.

An EGR valve that sticks open can cause an overly lean air/fuel mix during cranking, resulting in a no-start. Remove a suspect EGR valve and make sure its pintle is firmly against its valve seat (Fig. 9).

If an engine's camshaft timing chain or belt jumps one or more teeth on the gear or pulley due to wear, the engine will usually only snort and backfire when you attempt to start it.

To see if an engine has jumped time, turn the crank until the ignition timing mark on the crank pulley is aligned with the pointer on the engine, then remove the distributor cap.

The rotor should be pointing to the terminal in the distributor cap for the first cylinder in the firing order or the cylinder 180° across the cap. If not, the engine has jumped time, or—as explained earlier—the distributor's drive gear pin has sheared. **PM**



9 Remove the EGR valve to check the pintle for proper seal against seat.

UP IN SMOKE

(Continued from page 130)

How to pick a stove

If you're in the market for a woodstove, take a good look at one of the new high-tech models. They carry higher price tags than more traditional stoves do but, in several ways, you get more than your money's worth. Higher efficiency means less wood burned for the same amount of heat, and a stove with an overall efficiency of 75 percent will burn one-third less wood than one with a 50 percent efficiency. That means that if you would burn \$300 worth of wood with an old-style stove, you could save \$100 of that with a high-tech one.

That increase in efficiency carries with it three other advantages. First, since much more of the smoke is being converted to useful heat instead of going up the chimney, there's less smoke in the air to bother you and your neighbors. Second, there's much less creosote deposited in the chimney, so you'll save on chimney cleaning costs. Third, less creosote means less chance of a dangerous chimney fire.

Your next consideration in picking a stove should be the size you need. This requires some thinking about both heat output requirements and the room space available for the stove. The latter is usually more important. If you're using a stove to supplement a furnace, any stove with an output that can be reduced to 10,000 to 20,000 Btu/h will have ample capacity for heating even a large room. If the stove is your only heat source, a heat output in the 30,000 to 40,000 Btu/h range will keep you warm on even the coldest days.

Remember, if you're tempted by claims of very high heat outputs, a typical central heating system has a total heat output of only 60,000 to 80,000 Btu/h, and that output is distributed throughout the entire house. More woodstove users suffer from too much rather than too little heat.

Space requirements for a woodstove can be surprisingly large. A stove which measures 2 ft. square, for instance, may require a 3-ft. clearance on each side from walls or any other combustible surface. This adds up to 64 sq. ft. of room area. Clearances can be reduced by applying heat shields to nearby walls. Any Underwriters Laboratory (UL) listed stove will come with installation specifications.

For more information, consult *Wood Heat 87*. This soft-cover book is loaded with details about specific stoves, manufacturers, catalytic combustors, accessories and wood-burning techniques. It's available at newsstands or directly from the publisher, *Wood Heat 87*, Box 2008, Laconia, NH 03247, for \$6 postpaid. **PM**

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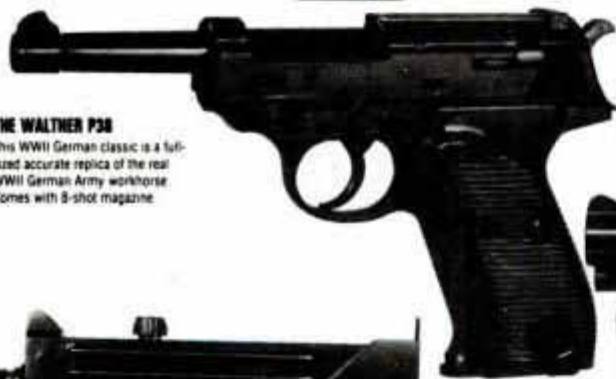
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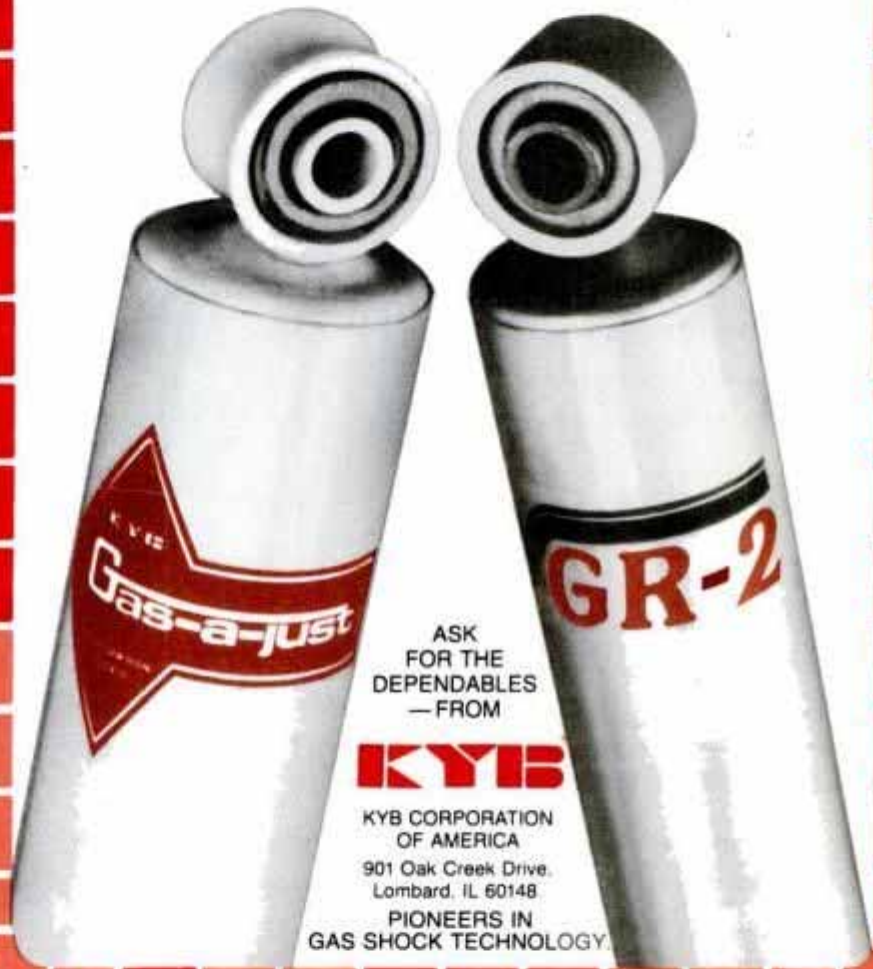
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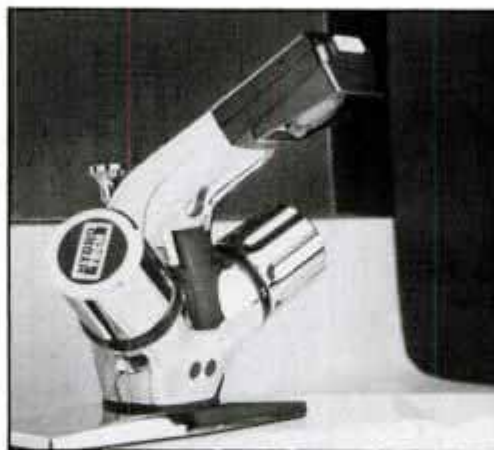
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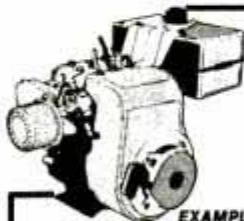


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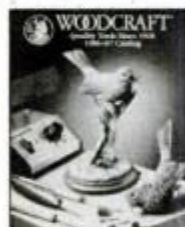


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TIME MACHINE

75 YEARS AGO: January 1912



A 60-mph sleigh takes off.

Sleigh belle

The Berlin auto show of 1912 featured a motor-sleigh that could travel over hard-pack at 60 mph. The auto motor that drove the sleigh was located at the vehicle's midline in front of the driver. The motor drove a rear-mounted aviation propeller through a shaft and chain drives. Steel arms trailing under the rear of the sleigh served as brakes. These were manipulated by sticks outside the sleigh body. These steel arms also steered the vehicle. The ride was noisy and bumpy.



A Great Lakes ice crusher

In December 1911, the *Chief Wawatam* steamed across the Straits of Mackinac that connect Lake Huron and Lake Michigan. It was a great feat for that day. The car-carrying ferry would in previous years have had to

be towed across the icy straits by barge. But the steel vessel with its three 2000-hp engines was a born ice crusher, the first of its kind. The ship had twin screws and cut voyage time by about 25 percent.

50 YEARS AGO: January 1937



Snow sedan for 140-mph trip.

Snow sedan

In 1937, the snow sedan was the dream machine of the future. Snowmobile builders, who had already perfected 2-man propeller-driven sleighs, were now working on the design of a 5-passenger enclosed vehicle driven by a 40-hp aircraft engine and twin-blade prop. Steering and braking mechanisms would be housed inside the enclosed cabin of the vehicle, which could cross a well-packed snow scene at 140 mph. The only thing standing in the way was lack of a good course for driving.

'Farming' gold

They were called "gold farmers" and their crops were precious yellow metals. These lucky men owned mineral rights in western canyons where they could literally scoop gold out of the silt in riverbeds during dry seasons (right). During the winter months, snow would mount in the highlands of these canyons and when the spring rains came, the gold would be washed downhill. Once the riverbeds dried out in early summer, the farmers took rakes and trowels and picked up the gold.



Rolling nests

Italian police armor-plated motorcycles and mounted machine guns on the front, creating rolling gun nests. These were used in attacks against organized crime.

25 YEARS AGO: January 1962



America moves to compacts.

Top compacts

POPULAR MECHANICS defined a compact car as one with a 100 to 114-in. wheelbase in 1962. A chart on the inside cover of the magazine listed all the new American cars of the year and the compacts were at the top. The cars included Corvairs, Falcons, Valiants, Chevy IIs, Comets, Buick Specials, Oldsmobile F-85s, Dodge Lancers, Rambler Americans, Ambassadors and Studebaker Larks. The lowest-priced car: \$1991 (Valiants). The highest priced: a Buick Special Deluxe for \$2593.



Laser grows up

The laser was just two years old in 1962, but rapid advances were already noted. In the photo above, a scientist demonstrated a ruby crystal in a new wave guide designed to intensify the laser beam for use in communications.

Making waves

A prototype of the Hoverbus, a new ground-effect machine, was rolled out in Scotland in 1962. It was designed to ferry 200 passengers at speeds approaching 80 mph over rivers and estuaries. The 66-ft.-long craft had hydrodynamic sidewalls that never completely left the water as the center of the ship rose above the waterline, where an air cushion created by twin outboard motors kept it slightly aloft. Jets of air exiting at each side of the ship gave it forward momentum. **PM**

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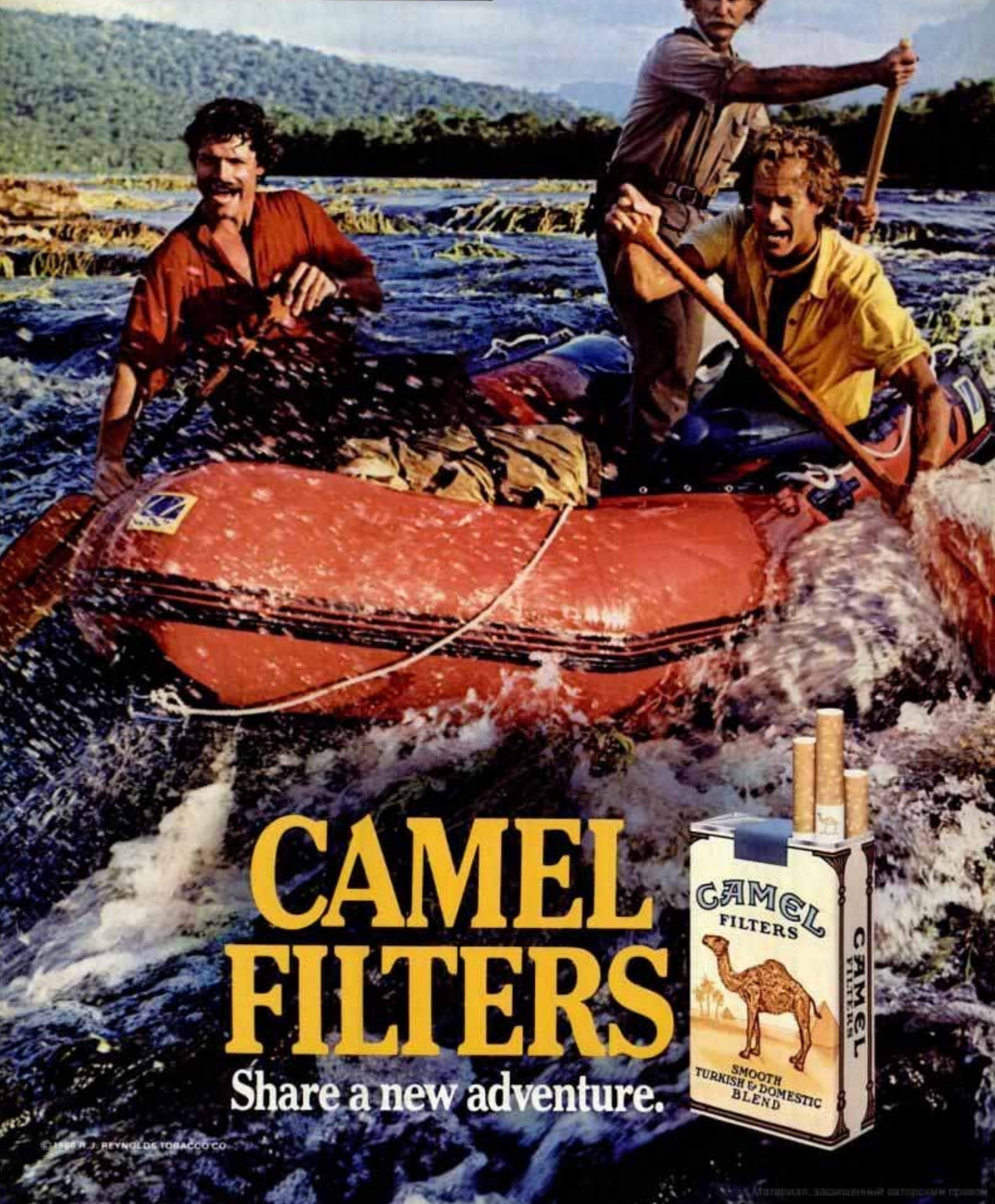
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