

JANUARY 1985 \$1.50

Popular Mechanics

Step-By-Step
Build Cabinet
Doors Like
A Craftsman



NEW SUBS That Carry Men Miles Under The Sea

**SNEAK
PREVIEW**

4 American
Sports Cars
From European
Stylists

**FLYING
FORTRESS**

50-Year-Old
Warplane Still
Packs A Wallop

PLANS: Make Our
6 Solid-Maple
Home Accessories

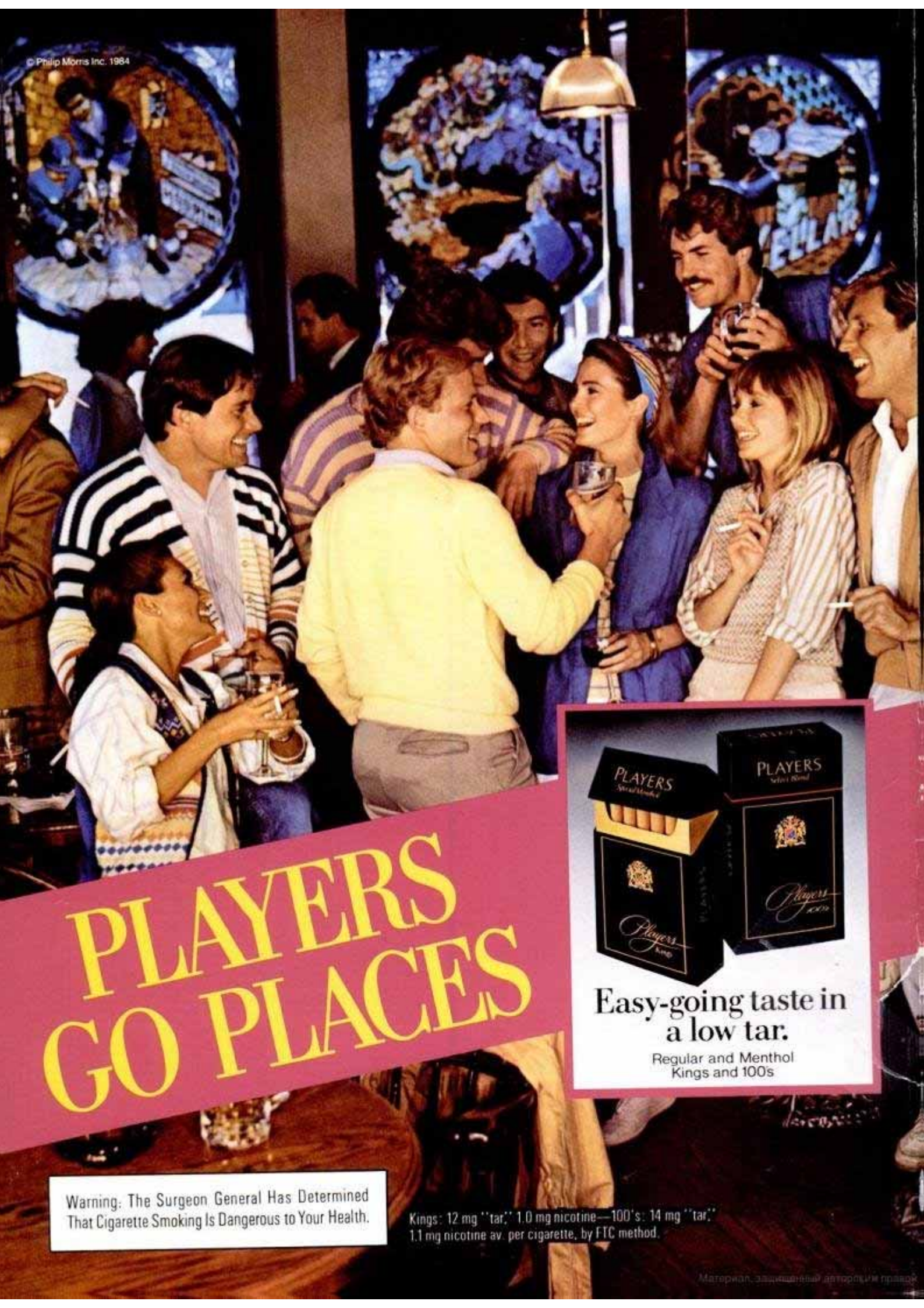
EXCLUSIVE: Russia's
New Space Shuttle

SNOW-TIRE GUIDE
PM Tells You Exactly
What They'll Do For You



Deep Rover
'Flies' Underwater
Like A Helicopter





PLAYERS GO PLACES



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wherever you are!*



HX1000



HX2000



HX750



HX650

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increments, the HX2000 is a sure winner.

If you don't need the extended coverage, there's the HX1000. It let's you cover your choice of over 15,000 frequencies on 30 channels at the touch of your finger. No crystals are necessary. Six band coverage, search and scan, priority control, and a liquid crystal display with special programming messages and clock are all part of the package. And with the sealed rubber keyboard and die-cast aluminum chassis, the HX1000 is the most rugged and durable hand held on the market.

CRYSTAL-CLEAR

If you don't need all the features of programmables, but you want the convenience of portability, we've got you covered. Our two crystal controlled hand held scanners, the HX650 and HX750, offer

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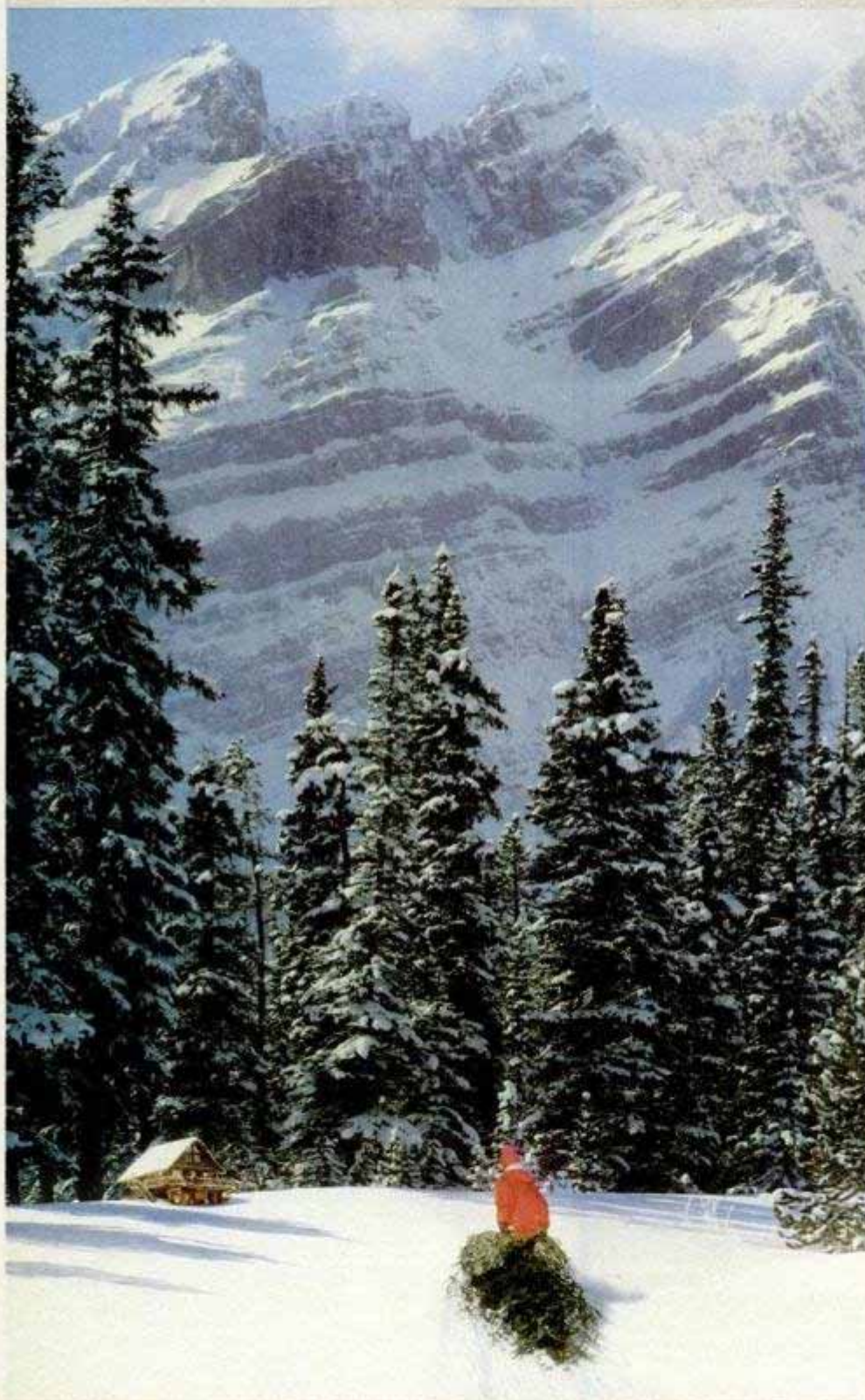
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Your Regency Scanner dealer would be happy to give you a free demonstration of these and other new Regency Scanners. Stop in today. Or, write Regency Electronics, 7707 Records St., Indpls., IN 46226.


Regency®

ELECTRONICS, INC.
7707 Records Street
Indianapolis, IN 46226

Waputik Mountain. A rugged place for the holiday spirit to start.



ALBERTA, CANADA

I come back to this cabin every Christmas.

When I was a kid, we spent summers here. But we always came up once in the winter too, just before Christmas. We'd stay for a few days. Cooking. Singing. Telling stories. Celebrating Christmas in the traditional way. So now I always try to give my family the same wonderful experience.

Sure it's cold. But there are ways of dealing with that. A fire of pine logs. An old patchwork quilt. A bottle of Windsor.

Particularly the Windsor. It's made right here in Alberta from the water that melts off these very mountains. It has a taste so smooth that whenever I take a sip, no matter where I happen to be, I can always conjure up images of Christmas on Waputik Mountain.

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WINDSOR
CANADA'S SMOOTHEST WHISKY.



ON THE COVER

Searching the sea floor at 3,000 feet, *Deep Rover* is one of the remarkable deep-diving submersibles that are helping to unlock the secrets of the ocean's depths. Read the exciting account of their exploits in the story on page 86.

—PM painting by Ed Valigursky

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Don't Buy a Big Tiller...

For A Small Job!



Don't let its small size fool you!

Warranty on the tines (if they ever break, we'll replace them). A *Lifetime Replacement* agreement on the engine. And, best of all, a *3 Week In-Your-Garden Trial* (if you don't like it, we'll take it back and give you a full refund!)

Buy a Mantis!

If your garden is an acre or more you may want to buy a big tiller. If it's any less, you should buy a Mantis-20 (and hire somebody to plow or till your garden *once a year*).

Big tillers weigh almost 300 lbs. The Mantis weighs just 20 lbs. (women and older gardeners love it!)

Simply turning a 300 lb. tiller in a backyard garden without running over crops (or yourself) is a challenge. Mantis, on the other hand, starts with a flick of the wrist...turns on a dime...and weeds in and around plants, between narrow rows and along fence lines.

Most big tillers were designed to just till (although many now offer clumsy "add-on" attachments to try to justify their high cost). The Mantis-20 was designed *from the beginning* to precisely match a small, powerful engine to a variety of useful attachments for your yard and garden. Tiller. Cultivator. Furrower. Edger. Lawn Aerator. Lawn De-Thatcher. Hedge Trimmer. Despite the fact that the Mantis-20 is a tough, durable, precision instrument... it costs a *fraction* of what you'll pay for a big tiller.

3-Week In-Your-Garden Trial!

Finally, look at the warranty. Most machines are *partially* covered for 90 days to a year. The Mantis has a *Lifetime*

We have a 30' x 100' garden that is fenced to keep woodchucks out. We own a Troy-Bilt and had to take the fence down each time we wanted to till. Not any more! With our Mantis, we get in and out easily. My wife and I both think it's a great little machine!"

**B.S.G.
Gansevoort, NY 12831**

EARLY ORDER BONUS
MAIL THIS COUPON TODAY!

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Huntingdon Valley, PA 19006

Please send more information on the Mantis-20 Tiller Cultivator... and your special FREE limited time offer!

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City _____
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EDITOR'S NOTES

There were lots of entries . . . lots of good ideas . . . and one happy winner in PM's Forest Ranger contest. We received thousands of entries, and read them one by one. After Alex Thurocy's letter had been chosen as the winner (see page 144) we spread the mail across our conference table (photo) while judges Joe Oldham, Wade Hoyt and Norman Mayersohn re-enacted their roles with me for the camera. . . . **One of the best ideas we've seen** for sprucing up a kitchen is that of putting a laminate on your cabinets while they are in place (*Resurface Your Kitchen Cabinets For A Brand New Look*, page 100). You'll likely need a bit of paint, as we did for the "after" photo. Try our team method: a Design Director



Picking the pickup prizewinner.

(Ira Herrick) to supervise and a Home Improvement Editor (Penny Spangler) to do the work. . . . **The Flying Fortress is 50 years old** this month—and still flying. It's hard to believe that this great bomber of World War II was almost rejected before the war, as you'll read in *Our Still-Flying Fortress Turns 50* (page 79). On the day author Jeff Ethell went to Mesa, Ariz., for a refresher flight, he found that five of the six available Forts were battling a blaze in central Arizona and the sixth was grounded for repairs following forest-fire duty. Pretty active for such oldies, we think! (Author Ethell managed to get his flight in a B-17 owned by the Confederate Air Force.) . . . **Since the Soviets won't unveil** their new space shuttle for us, we had artist Brian Sullivan create a model (see *Technology Update*, page 61). Working from a U.S. Air Force intelligence report, Sullivan determined that the Russian version, though more massive, is very much like the U.S.



Final touches for a spruced-up kitchen.

shuttle. When the Russians claim they invented it, just remember you saw it first in PM. . . . **The team of Jim suits** (photo) is graphic evidence of today's growing armada of undersea explorers. Jim suits let men work hundreds of feet below the surface while manipulating robot arms. And newer craft are letting us work as deep as 20,000 feet. The rewards for each new advance into the underwater frontier are truly vast. There are new sources for oil and minerals, and, of course, sunken vessels that we've never been able to reach before. You can read the whole fascinating story in *Conquering Our Deepest Frontiers* (page 86).

John A. Silbitt



A huddle of deep-diving Jim suits.

True Value
HARDWARE STORES®

TOOL VALUE OF THE MONTH



only **9⁹⁹**

Master **MECHANIC** Thermogrip
Electric Glue 'n Seal Gun

Bonds permanently in 30 seconds, caulks and seals, too! Offer good from Dec. 10 while supplies last only, at participating True Value Hardware Stores and Home Centers. MM207



HARDWARE VALUE OF THE MONTH **17⁹⁹**

Servess® 1320W Fan-forced Electric Heater

Automatic thermostat and safety tipover switch. Offer good from Dec. 20 while supplies last only, at participating True Value Hardware Stores. HR10B

There are more than 6,000 True Value Hardware Stores and Home Centers in 50 states. Look under "Hardware" in the Yellow Pages.



Survival of the fittest.

Ford's tough Ranger 4x4 has the tough it takes for you to bash around the boonies.

And the optional V-6 power no other small V-6 pickup beats!

You head off-road in a tough Ford Ranger, riding the rough country with Ford's unique front suspension to soak up shocks—Ranger's proven four-wheel drive to keep you rolling.

But you get another powerful edge in Ranger—

the performance of a tough 2.8L V-6 engine with power unbeaten by any small V-6 pickup!

New 2.3L with EFI.

And that's not all the tough stuff Ranger offers.

You can get a new electronically fuel-injected 2.3L four... plus Ford's 5-speed transmission, standard. And your choice of manual or optional automatic locking hubs.

Tough Ford Ranger. Its got the tough it takes to be on top—another reason why it's part of America's best-selling truckline.*

Best-Built American Trucks.

At Ford, Quality is Job 1. A 1984 survey established that Ford makes the best-built American

trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1983 models designed and built in the U.S.



Lifetime Service Guarantee.

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

Dealer-installed light bar not for occupant safety.

*Based on final 1984 MY manufacturer's reported retail deliveries.



"My Ford Ranger & Me."



FORD RANGER
AMERICA'S TRUCK BUILT FORD TOUGH



Get it together—Buckle up!

LETTERS TO THE EDITOR



Classy replica of a classic car



Shades of 1940: PM's old-time Woody Wagon built on a VW Beetle chassis by reader Ken Lettau. Roof vent, fender skirts and wide whitewall tires are extra features still to come.

I was immediately intrigued (my wife would say "obsessed") by your sporty replica of the 1940 Ford Woody (*Build PM's Woody Wagon*, page 137, July '83). Before the week was out, I had ordered the plans and purchased a used VW Beetle for the chassis and mechanicals.

Today, we are proudly touring around in the little beauty you see in the photo (above). We plan to add a roof

vent, fender skirts and wide whitewall tires to make it even classier. Thanks for a great inspiration.

KEN LETTAU
RICHLAND, WASH.

Thanks for the photo; you did a great job. For others who may be interested, plans for the Woody Wagon are \$14.95 postpaid from Stevenson Projects, Box 584, Del Mar, Calif. 92014.

Ford wasn't first

Regarding your article about Ford being the first to develop an antiskid braking system (*Antilock Brakes: Ford's First*, page 98, Oct. '84), I'm sure I won't be the only one to remind you that Chrysler was actually the first to have such a system. It was offered as an option on Imperials in the early '70s. I know because I was in charge of the system's development program.

J.W. DOUGLAS
CHELSEA, MICH.

Wrong connection

Your article *The Canadian Connection: Cars You Can't Buy Here* (page 61, Sept. '84) contained the statement that "In Canada, summer is defined as two weeks of bad skiing." I think your author should get his facts straight. Except for our northernmost regions, our climate is comparable to Montana,

Minnesota and the rest of your upper states. And we don't refer to them as the Great White U.S. Tundra.

L.A. CHOW
VANCOUVER, B.C.

The average temperature in Edmonton, Alta., for June, July and August is 70° to 80° F. Now if you can tell me how to make snow in this heat, please let me know. I could make a fortune!

BERNA LETKEMAN
HINTON, ALTA.

Mud, sweat and cheers

Thanks for the great story on the Camel Trophy rally and the Land Rovers that participated in it (*Mud, Sweat and Gears*, page 68, Sept. '84). I cherish my own Landy and enjoy reading about others' exploits. Three cheers to you.

JOANN PRATT
CHURCHTON, MD.

Big, but not that big

Your story on the high-explosive simulation of a nuclear blast (*Technology Update*, page 101, Sept. '84) was of great interest to us as we designed and erected the charge container and support tower for this test. Consequently, we were somewhat startled to see your description of the charge as "1 million tons of ammonium nitrate."

The correct weight is 600 tons (1.2 million pounds), the equivalent of a 1-kiloton nuclear explosion. This was the largest above-surface nuclear simulation test ever conducted.

DELMAR CALHOUN, DIRECTOR
NEW MEXICO ENGINEERING
RESEARCH INSTITUTE
ALBUQUERQUE, N.M.

Space Station for war?

I found it interesting that President Reagan's article on the Space Station (*Space Station: 'The Next Bold Step'*, page 64, Sept. '84) scarcely mentioned what will almost certainly be one of its primary uses: the militarization of space. Could it be that the President doesn't want to draw our attention to the current arms race?

Both the United States and the U.S.S.R. would be wise to negotiate a stop to this dangerous new threat to peace while they still can.

EDWARD YARBOROUGH
GRASS VALLEY, CALIF.

Butcher block it's not

I was surprised to see such an excellent magazine as PM make such a gross error as calling a strip-laminated work surface a butcher block (*7 Expert Ways To Make Butcher Block*, page 76, Sept. '84). A true butcher's block employs vertically joined pieces of wood to provide end grain, which is much more durable for cutting on than side grain. I would have thought you would have known the difference.

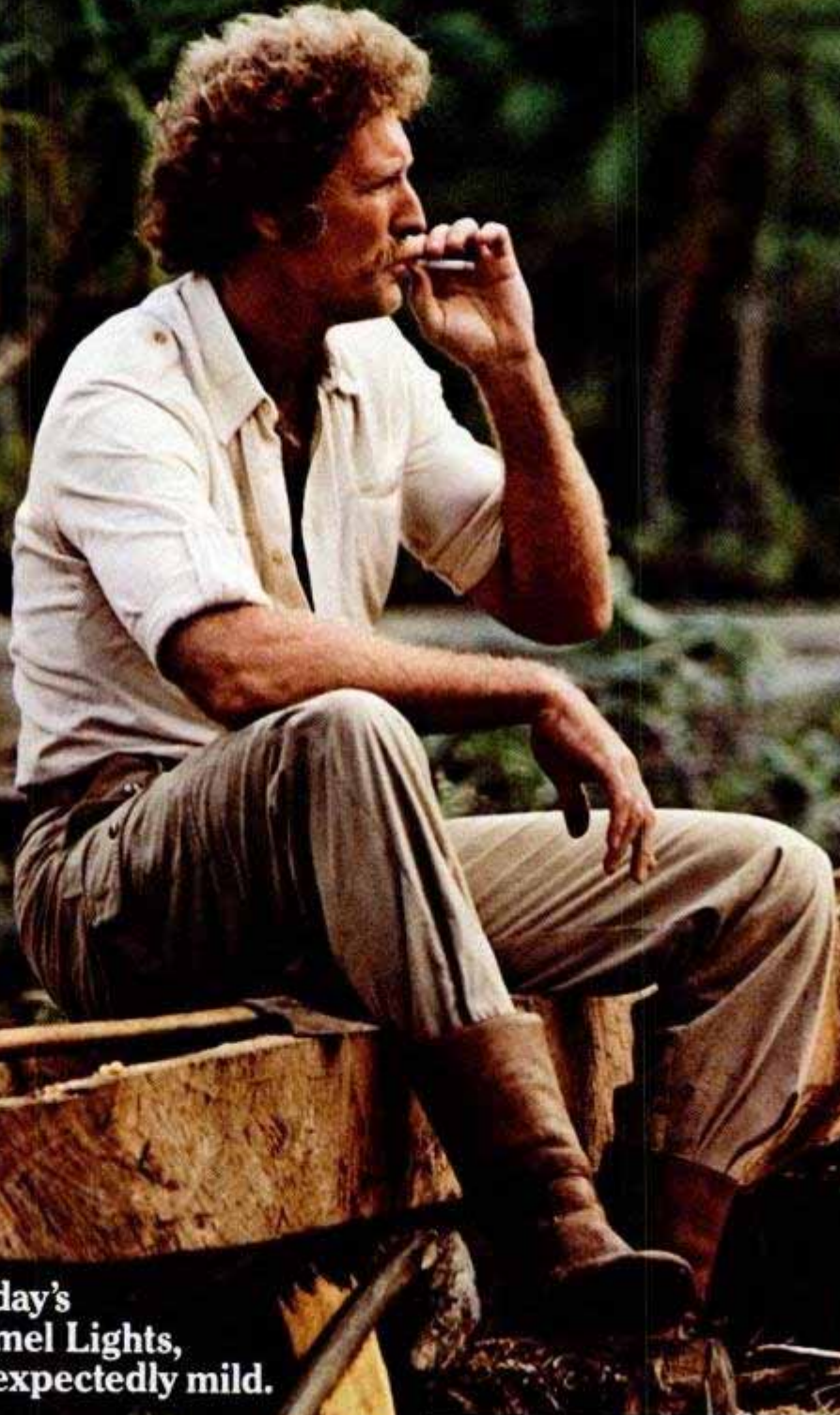
WILLIAM HUPPING
MERRICK, N.Y.

You're right, of course, and we do know the difference. We were referring, however, to the more common strip lamination construction that is called butcher block because of its similar appearance.

PM

CAMEL LIGHTS

It's a whole new world.



Today's
Camel Lights,
unexpectedly mild.

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

IMPORTS & MOTORSPORTS



Not just another pretty face

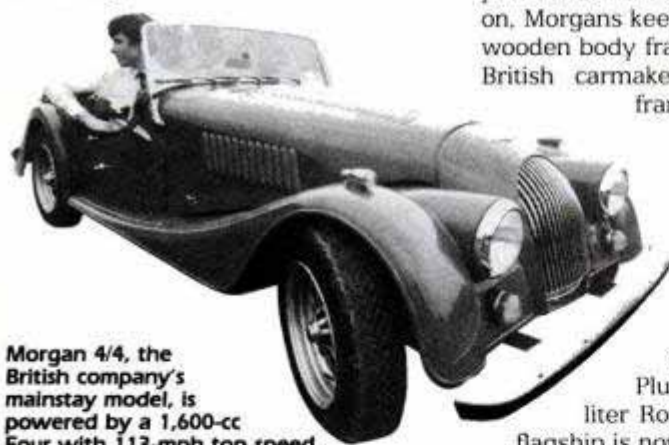
With its new sedan and wagon, Subaru jumps into the mainstream of good-looking car design. The turbo version of the sedan, an aerodynamic low rider in its front-wheel-drive mode, does another kind of a jump—hopping up on its suspension to stand an inch taller when in four-wheel drive. You goose the top-of-the-line Subaru into its upright, rugged-road position simply by shifting into 4wd. The secret is a microprocessor-controlled, air-spring suspension. Also new for '85 is an overhead-cam design for a more powerful Four, which is still a horizontally opposed mill displacing 1.8 liters. It's good for 82, 94 or 111 hp, depending on whether it's carbureted, fuel injected or turbocharged. Power windows



Subaru GL-10 sedan is one of five new fwd four-door models, two of which—GL and Turbo—offer "on demand" four-wheel drive.

get new circuitry that lets you operate windows after turning off the engine—until you open the driver's door. We hope every other carmaker copies it.

Seventy-five years of Morgans



Morgan 4/4, the British company's mainstay model, is powered by a 1,600-cc Four with 113-mph top speed.

While infatuation with electronic suspensions sweeps the industry, and experiments with advanced materials go on, Morgans keep bouncing along with wooden body frames. White ash is the British carmaker's medium for the frame supporting the steel and alloy body. Morgan just celebrated its 75th anniversary in Malvern, Worcestershire, and more power to 'em! And more power is just what they're delivering with the latest Plus 8 model. The 3.5-liter Rover V8 in the Morgan flagship is now fuel injected for 190

hp, giving it 0-to-60 times under 6 seconds and a top speed of 130 mph.



The framework for the Morgan hand-beaten steel and alloy body is white ash.

More imports are putting down the top

Ask anyone, they'll tell you: convertibles are drafty, leaky, hot, dangerous, impractical rattletraps. They're even more expensive than sedan versions of the same car. But aren't they wonderful!

And the choices are getting better every day. Toyota's first convertible, the Celica GT-S, is available now and it's especially significant since it puts the Japanese manufacturers into the game. It should inspire more open-car noodling from the Nipponese.

Europe's tried-and-true open cars

are the Alfa Spider, Bertone X1/9, Pininfarina Azzurra, VW Cabrio and Renault Alliance. High-dollar models are the Aston Martin Volante, Mercedes roadsters, Porsche Cabrio and Rolls

Corniche. Saab's due with its open car next year and the latest in the wings is a Targa version of the Porsche 924/944 spotted in Europe recently and shown here.

PM



The Targa version of the 924/944 will join the 911SC Cabrio in the Porsche model line.



**Now they last even longer.
(Hot dog.)**

In the dog-eat-dog world of batteries, Duracell has always been famous for long life. Which, admittedly, is a pretty good thing. Good, however, can always get better. So over the years, we've kept looking for ways to make them last even longer.

The result: Today's DURACELL® batteries last up to 20 percent longer than the ones we made three years ago.

And we'll keep on improving them.

To do it any other way would be, well, the tail wagging the dog.



**When it comes to making them last longer,
we never stop.**

PM ELECTRONICS MONITOR



'85 marvels from electronics Mecca

TOKYO—Japan's electronics manufacturers unveil their latest home entertainment wares every October at the All-Japan Audio Fair and Electronics Show. We attended to get this preview of the electronics gear you'll see during 1985. We also got a good glimpse at emerging technologies that are sure to be incorporated in the electronics products of the future.

Among the show's many highlights was a miniaturized digital audio Compact Disc player from Sony that proved a crowd-pleaser. The company also showed us its new, supercompact, front-projection TV system (see box on page 16).

Casio and Sanyo demonstrated flat, thin LCD (liquid crystal display) screens that may make wall-hung TV screens a reality in time for Christmas '85.

What's farther down the road? The formerly separate technologies of audio, video, computers, photography and communications are fast merging into a single home-electronics concept. Confirming this trend, nearly every company demonstrated the video storage ability of digital audio CDs. Some even showed laserdisc recorders for sound and video. The new Japanese MSX-format computers connect to videodisc players for games and graphics. Yet another development marries electronics and photography by "shoot-

ing" pictures on magnetic discs instead of film.

The suggested retail prices quoted in our report reflect the 246-yen-per-dollar rate current during the Tokyo fairs. Prices and model numbers may differ when the items arrive stateside.

Hi-fi audio

Virtually every manufacturer exhibited new digital audio Compact Disc players, boasting reductions in size and price made possible by the development of space-saving integrated circuits. These "chips" enable manufacturers to tack on many convenience features once found only in top-of-the-line machines.

Whereas a typical CD player cost \$1,000 two years ago, suggested retail prices as low as \$400 are commonplace today. Sony, in fact, goes as low as \$300 with its miniaturized D-5 player. The machine measures about 5 inches square—just slightly larger than the 4³/₄-inch diameter of the disc.

Sony's CD midget uses the same miniaturized laser and circuitry as the company's previously announced in-dash car stereo CD players (*PM Electronics Monitor*, page 46, Oct. '84).

Alpine, Panasonic/Technics and Yamaha also demonstrated in-dash CD units with a worthwhile new twist: The disc is sealed in a clear plastic tray. Disc and packaging are inserted into the player together, eliminating the dangerous fumbling that would be necessary if the CD were packaged in a traditional hinged-box.

To hi-fi buffs awaiting the arrival of digital audio cassette recorders, don't hold your breath. Manufacturers tell us the DAC is at least two years off.

By that time, digital audio recording on cassette might already be obsolete. Hi-fi makers are experimenting with laser systems that can record and erase on a disc. Sanyo demonstrated a prototype system that gets 30 minutes of digital recording time on a standard CD. Nakamichi, Panasonic and Sansui have shown similar systems in the past. Panasonic's uses a camera to record sound and moving images.

Sound plus pictures

Audio-video recording with lasers isn't available to consumers just now, but [\(Please turn to page 16\)](#)



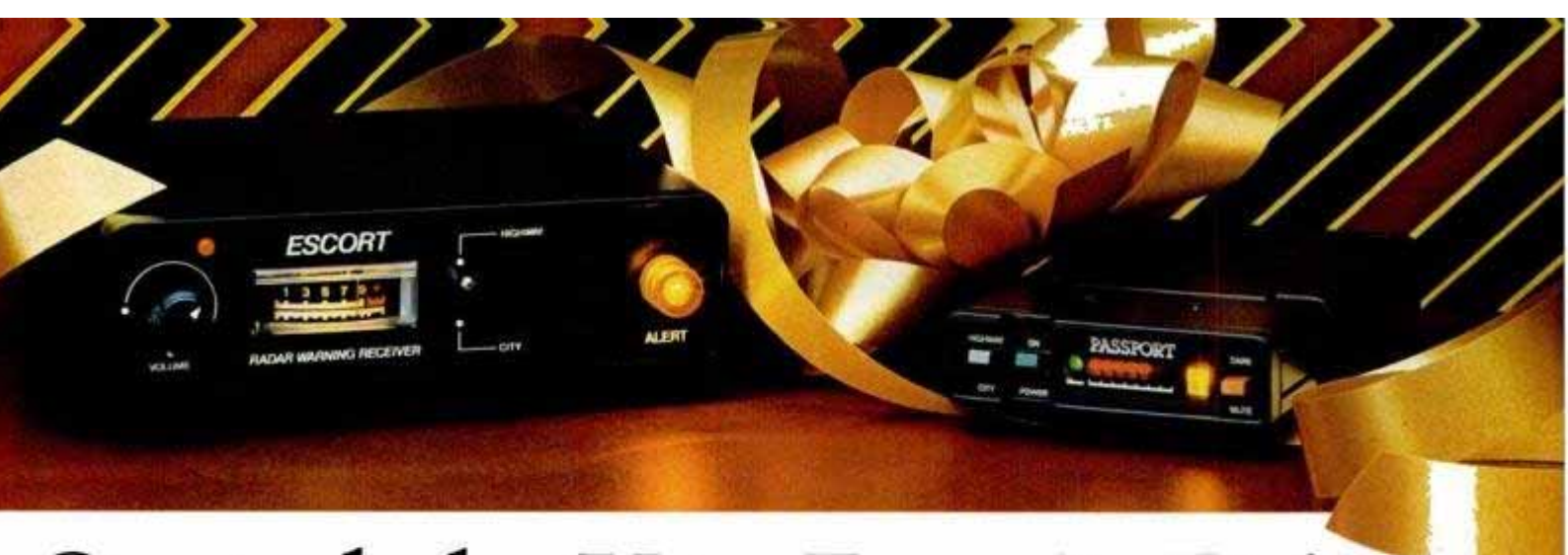
Sony's \$300 CD "Walkman" (5 × 5 × 1½ inches) is seen with larger home and car models. It connects to hi-fi systems, or battery case (\$50) powers headphones for up to five hours.



Combination CD/videodisc player takes 4³/₄-inch CDs, 8- and 12-inch laser videos.



Graphics stored on digital audio CD projects album notes and song lyrics on TV screen.



Overwhelm Your Favorite Driver

The perfect gift is more than a surprise; it hits the mark. If there's a driver on your list, you can give ESCORT or PASSPORT with absolute confidence. Here's why:

Head Of The Class

Car and Driver magazine rated ESCORT number one in its most recent test, calling it "...clearly the leader in value, customer service and performance..."

In fact, in the six years since its introduction, ESCORT has become the classic instrument of radar detection.

PASSPORT is brand new. For the person on the move, switching between cars or using rentals in distant cities, it provides ESCORT performance and features in a convenient miniaturized package. You can carry it in your pocket like, well, a passport.

The SMD (Surface Mounted Device) circuitry that made PASSPORT possible is simply light years ahead.



PASSPORT is only 3/4" tall and 2 3/4" wide.

First Class Performance

When radar is out there, the super-heterodyne circuitry in ESCORT and PASSPORT will find it: over hills, around curves, hidden in the bushes, anywhere. But that's just half the story.

Just as important is the unique way they give you a full, easily understood report on the radar they find. ESCORT has led the way with its variable pulse audio warning,

analog meter and amber alert lamp. These all work together to give you a precise indication of radar type and range. In PASSPORT, a bar graph of eight Hewlett-Packard LEDs replaces the meter. This allows the same thorough radar report in a pocket-size package.

Attention To Detail

The main point of a radar warning device is performance, but the perfect gift brings something more: pride of ownership. Both ESCORT and PASSPORT are finely-crafted instruments that look right at home in a Porsche, Mercedes, or any car.



ESCORT and PASSPORT come complete with accessories.

Apart From The Crowd

While our system of factory-direct sales was not designed specifically for gift givers, it does offer some rather special benefits. For example, you needn't worry about buying a discontinued model still in a store's stock. Your gift will never be seen marked down in the discount chains. More importantly, giving either ESCORT or PASSPORT shows you were concerned enough about quality to track down the only source. And there's one more advantage.

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ESCORT and PASSPORT let you do your Christmas shopping by phone and avoid

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Car and Driver called us the "class act" in radar detection. So order now, and let ESCORT or PASSPORT overwhelm your favorite driver.

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Built to take it. All.

Ford Club Wagons out-power, out-tow, out-room any other wagons. And for '85, they give you peak performance in your choice of high-output engines—both gas and diesel.

Here's where you find all the room and power that's missing in today's small minivan wagons.

Ford Club Wagons give you the true luxury of spacious design. No other wagons, big or small, provide so much usable space—for people and/or cargo. You can seat up to 12 in roomy comfort (15 in Super Wagon).

More power to you.

What a power choice you get! Five engines, from biggest standard Six to the biggest V-8 in any

wagon. Included: husky 6.9L diesel, the most powerful in its class. Plus Ford's 5.8L High Output V-8 with 4-barrel carb... and 27% more horsepower than Chevy can offer you.*

Tops for towing.

Only Ford Clubs have strong body-on-frame construction. That's why they can be equipped to tow up to 10,000 lb.—much more

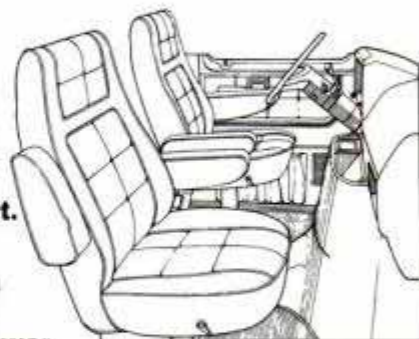
than Dodge or Chevy. They're built to take it.

"Out-front" comfort.

Ford's out-front design gives you extra room plus easy walk-through to the rear. Power steering is standard. Options include speed control/tilt wheel...and new power door locks/windows.

You can choose buckets or Captain's Chairs up front. Plus rear bench seats with quick-remove feature for increased cargo space and flexibility of use.

For a wagon that's great for everything from family use to recreation to van pooling—join the Club!



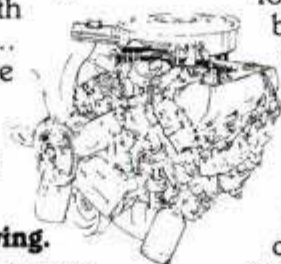
Best-Built American Trucks.

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

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

*Optional: not available in California or with manual transmission. Horsepower based on SAE Standard J1349.



"My Ford Club Wagon & Me."



FORD CLUB WAGON
AMERICA'S TRUCK BUILT FORD TOUGH



Get it together—Buckle up!

Breakthrough in projection TV

Sony's Vidimagic will put a TV picture right on the wall of your room. Unlike other front-projection TVs, precise placement relative to a focusing surface isn't necessary. Its single-lens indextron tube lets you focus it like a slide projector for bright 30- to 200-inch diagonal images. Vidimagic is only available to institutions right now, while Sony considers a consumer model. The FP-62 model measures $26\frac{1}{2} \times 11\frac{3}{8} \times 9\frac{1}{8}$ inches (l/h/w), weighs 30 pounds and costs \$2,195. Another version of the Vidimagic, the FP-60, incorporates a Beta VCR, costs \$2,995 and weighs 35 pounds. Both models include a 181-channel tuner, audio amp and speakers.



Sony Vidimagic: New tube design breeds small, lightweight, portable projection TV.

PM ELECTRONICS MONITOR

(Continued from page 12)

laser playback of audio and video is here and becoming more varied.

Last month's *PM Electronics Monitor* (page 30) reported Pioneer's introduction of a combination Compact Disc/Laser Videodisc player. Now, Sony and Teac join Pioneer with combo players priced around \$1,000. More widespread at the fair were demonstrations of still video images stored on CDs and displayed on TV screens. Typically, the visuals convey album liner notes and song lyrics (synchronized to the music), and the display resembles simple computer color graphics. The graphics processors and suitably encoded discs are expected on the market this year.

Beyond simple graphics, some manufacturers are eager to put photographic-quality still images on the CD. This is possible by sacrificing some music storage capacity. Stay tuned.

For the present, videocassettes remain the most popular medium for storing and displaying sight and sound. The wide assortment of hi-fi receivers and command centers introduced here sport multiple inputs and switching facilities to integrate audio and video units in a home-theater concept.



"Avility" video processor from Akai: Joystick controls colors through built-in TV.

Home video

The miniature 8-mm VCR format (see *The Expanding Universe Of VCRs*, page 92), made giant strides here toward wider acceptance.

Fuji, Sanyo and Sony are joining Kodak and Polaroid in the 8-mm launch. This month, Fuji's Fujix-8 camcorder goes on sale in Japan for less than \$1,250. The machine, built by Sony, weighs in at $4\frac{1}{4}$ pounds; features include an electronic viewfinder and semiconductor image-pickup (nontube) good for light conditions as low as 20 lux. Sony will market its own version later this year.

No longer can 8-mm be criticized for its relatively short, 90-minute recording time. Kodak's now offering a two-hour cassette, and Sanyo's doubling the pot with a home/portable 8-mm VCR capable of standard- and half-speed recording (up to four hours). These developments make prerecorded rental cassettes and home time-shifting as feasible with 8-mm as with $\frac{1}{2}$ -inch Beta and VHS.

Meanwhile, to challenge 8-mm technology in the camcorder business, some manufacturers are developing lightweight ($6\frac{1}{4}$ -pounds) one-piece camera/recorders that use standard size VHS cassettes.



Two-piece home/portable 8-mm VCR by Sanyo is for standard, long-play recording.

LCD and digital TV

Digital is the new buzzword in TV (*PM Electronics Monitor*, page 30, Dec. '84). Sony and Hitachi displayed models that use digital circuitry to improve their picture quality; Toshiba and Mitsubishi apply digital technology for special effects such as screen-within-a-screen viewing.

Now for sale in Japan, new 14-inch (\$550) and 21-inch (\$815) Sony TV monitors use an outboard digital processor (\$815) that doubles the number of vertical program lines for remarkably improved resolution. Plans for U.S. introduction aren't finalized. Hitachi's 19-inch digital set (\$685) limits itself to eliminating ghosts.

Though the flat-panel TV suitable for wall mounting isn't here yet, prototype LCD color sets from Casio and Sanyo indicate that the day of their arrival isn't far off. Casio's prototype showed 216 lines of horizontal resolution, with 288 possible (conventional TVs have about 250 lines; monitors have about 350). The company says it will offer a 12-inch diagonal LCD color TV late this year—only 4 inches thick and priced around \$400.

Computers and more

Japan's electronics makers have entered the personal computer business en masse after adopting a single operating system, the so-called MSX format. Though underpowered by U.S. standards (only 64K of RAM), the MSX system is designed to interface with other products, including videodisc and the infant "Mavicrography" system, which takes still pictures on magnetic disks instead of film. Again, stay tuned.

Like any carnival, the annual Tokyo electronics fairs have their freak shows, and October's oddities included CD jukeboxes, computer-and-TV navigation systems for cars—even a 10-foot-wide hologram theater that presented 3-D moving images. Quaint? Amusing? In the world of consumer electronics, one should never laugh too soon. **PM**



Toshiba's digital TV monitors second program on a $\frac{1}{4}$ - or $\frac{1}{16}$ -size inset screen.

Wouldn't you like to have a new skill you could call your own? Learn TV, audio, and video servicing with at-home training from NRI.

You can learn to service and repair TVs, stereos, electronic musical instruments and amplifiers, car and portable radios, record and tape decks, videocassette recorders and disc players, almost any kind of electronic equipment on the market. And you can learn to do it at home, in your spare time, without quitting your job or wasting time and gasoline on night school. NRI will train you. We've trained over a million and a quarter others, with effective methods proven over 69 successful years.

Hands-On Training

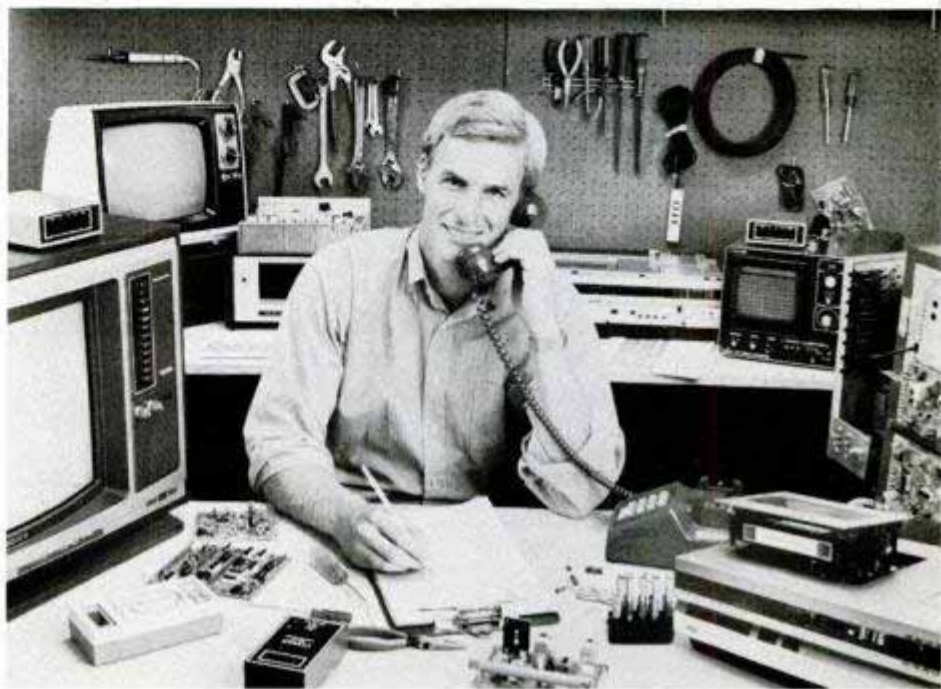
NRI training is practical training all the way. Throughout your course, you'll perform hands-on experience projects that make theory come to life and give you real understanding.

Includes Both 25" TV and VCR, Plus DMM and More

As part of your training, you'll build your own 25" Heath/Zenith color TV a state-of-the-art unit with infrared remote tuning, programmable channel selection, and the incredible space phone



Learn by doing with NRI hands-on projects and professional instruments that you use and keep.



for remote calling. You also get a front-loading remote-controlled videocassette recorder to play your videotaped lessons and learn about servicing this complex instrument.

You'll learn troubleshooting techniques using a professional 3½-digit digital multimeter. You'll use it when assembling your TV to check demonstration circuits you build on the NRI Discovery Lab, and in your professional work. It's the equipment and training you need for success.

Exclusive NRI Training on Videotape

In addition to profusely illustrated lessons, you get NRI Action Videocassettes . . . videotaped lessons that show you graphic presentations of electronic systems, vivid closeups of servicing techniques and professional "shortcuts" to study and replay as often as you want.

Training For Success

NRI not only prepares you to become a top technician, we get you ready for independence. NRI Video/Audio servicing gives you a great new way to earn extra money doing part-time servicing for appliance and department stores . . .

building a good-paying new career with an electronics firm . . . or even starting your own business. You can start small, even part-time in your basement or garage, make the most of your opportunities to grow into a successful businessman.

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SCIENCE WORLDWIDE



Snap, crackle and bam!

Early in 1984, eight West German grainery workers were killed when a cereal grain silo exploded "spontaneously." Spontaneous explosions have been reported at other grain silos and at an oil pipeline in Kuwait. Physical laws say that the flashpoint of a fluid—grain dust and oil are both fluids—decreases as pressure goes up. With oil, the flashpoint is relatively low under normal circumstances, and static electricity building up in the pipe may cause the blast. With grain dust, the flashpoint goes down as it compresses within a silo and friction between individual grain surfaces builds up additional static electricity. Thus, a sudden static spark in a grain silo where the flashpoint has been decreased may account for the blast. Just how much fluid is needed to make a given volume explosive remains a mystery. So does the nature of a static spark that is big enough to cause an explosion.

British scientists, working under a United Nations grant, are beginning to unravel the mysteries. Using a tank and



British scientists use metallic sphere to collect electrons to help explain "spontaneous" silo and pipe explosions.

pipeline system, they are monitoring the flow of gritty materials. They already have confirmed that static sparks build up in humid conditions.

Plastic charge

University of Pennsylvania researchers treating polymer plastics with iodine have created an inexpensive conducting material. One future use may be in batteries. With plastic center cores in dry cells, water solutions could be used to conduct a charge instead of the corrosive solvents in batteries today.

Oversupply of methane

The amount of methane gas in the Earth's lower atmosphere has increased 1.1 percent in the past seven years, says the University of California at Irvine. Methane comes from plant decay and animal manure. The buildup of methane may become a serious pollution problem.

Two heads better

No matter how much memory a computer has, it can only work one step at a time. Thus computers have been disappointing mimics of the human brain. Now the Defense Department is experimenting with parallel processing whereby dozens of computers do one task. A central computer gathers up all the data. Parallel computing may mimic human reasoning in this decade.

Moon base rising

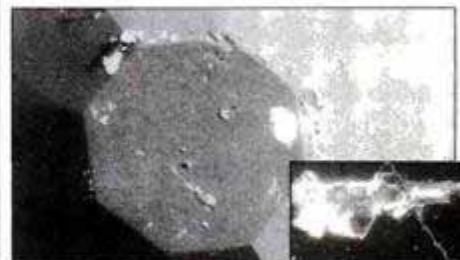
NASA stopped talking about establishing a moon base five years ago, but is now apparently considering a base for the late 1990s. Scholars will submit papers for a moon base meeting in May. Watch this space for more.

Physics crash course

Brookhaven National Laboratory physicists Arthur Damask and Arthur Paskin recently used basic physical laws and computer simulation to help clear a teen-ager charged with vehicular homicide. The case turned on whether the teen had been the driver of a 1972 Mustang that went out of control, killing four other teenagers in the car. Calculating the inertial forces involved in the crash, the physicists showed that the driver would have had injuries the passengers didn't receive because his body would have struck the steering wheel and windshield. (The restraints were removed from the car). Using anatomical studies and pure physics, Damask demonstrated in court that the driver would have injured several organs and bones. Indeed, one of the victims had all the injuries that could only have been sustained by the driver of the car. The suspect was acquitted.

Diamonds aren't forever

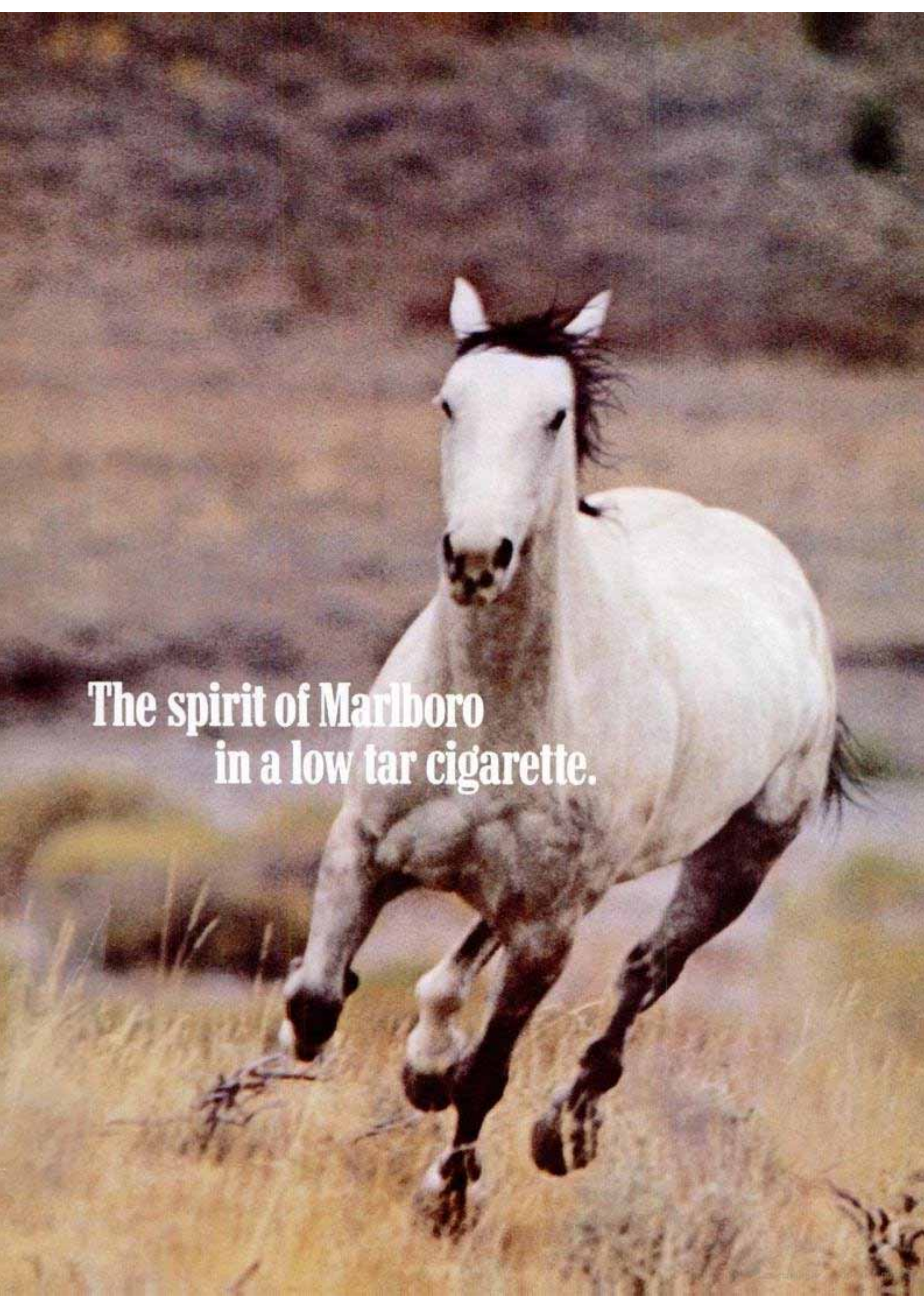
Cornell University geologists doing research on the melting properties of carbon have stumbled onto an interesting find. They had set carbon material atop a tiny diamond anvil placed in a pressure chamber. The pressure was set at 100,000 times that of our atmosphere. Then the carbon was struck with laser light briefly, producing temperatures over 3,000° F. On examining the anvil after the experiment, the



An electron micrograph shows diamond surface magnified 100 times. At 400x (inset), the diamond is shown melting.

researchers found that a microscopic furrow had been melted into the face of the diamond. The finding may help confirm a theory that the Earth's lower mantle is liquid carbon. More importantly, the Cornell team has established conditions under which a diamond surface begins to melt.

PM

A white horse with a dark mane and tail is captured in a full gallop across a dry, grassy field. The horse's front legs are tucked under its body, and its hind legs are pushing off the ground. The background is a blurred, natural landscape with dry vegetation and a hazy horizon. The overall tone is warm and dynamic.

**The spirit of Marlboro
in a low tar cigarette.**



Marlboro

A cowboy wearing a white cowboy hat and a bright yellow jacket is riding a brown horse. He is holding the reins with his left hand and has his right arm extended outwards. The background is a blurred, natural outdoor setting.

ro Lights

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

11 mg "tar," 0.7 mg nicotine av. per cigarette, FTC Report Mar '84

APPLIANCE CLINIC



Dishwasher leaves its mark

We have a General Electric dishwasher, Model GSD-281, serial No. 02-TP-676177-B. My problem is that some of our dishes, when placed on the lower rack, come out with black or gray streaks on the bottom rims, or on the edges resting on the racks. We've tried cleaning out the machine with bleach and replacing the supply hose, but to no avail. We replaced the lower rack but the condition only worsened. Would you have a solution to this problem? Your advice will be very much appreciated, since the only way the streaks can be removed is with "soft scrub" cleaner, and our Lenox dishes won't tolerate too much of this treatment. Thanks for the help.—John Vicsak, Orlando, Fla.

It sounds as if something made of metal or aluminum—a pot, pie pan,

cookie sheet, metal utensil—has come in contact with the dishes either before putting them in the dishwasher or during the wash cycle. The metal object has rubbed against the dish causing a mechanical transfer of the metal to the dishes, which leaves a gray or black mark. This could also happen while stacking or storing aluminum utensils with dishes or when storing soiled dishes in a stainless steel sink.

To see if my suspicions are correct, first clean all the marks from the streaked dishes; try using a pencil eraser or silver polish. Then put the dishes in the dishwasher without anything made of metal. Put the dishwasher through a complete wash cycle, and check the dishes. I think you will find that they come out streakless.

Freezer defrost won't drain

I have a Hotpoint refrigerator/freezer, model No. 2CTFG314J, serial No. PB4826542. When it defrosts, ice forms on the bottom of the freezer section. As a result, I must unplug it every week and clear the ice manually. The opening where the melted ice is supposed to flow out must be clogged. Can you tell me how to clear the drain? Thank you.—Leopold Feher, Miami

Your 1968 refrigerator may be suffering from either a clogged drain or a defective defrost drain heater. To check the drain, unplug the refrigerator and empty the freezer compartment. Then look for the drain tube near the bottom of the rear cover.

If you cannot see the tube easily, you will have to remove the three screws that secure the plastic fan guard to the back cover. Remove the guard, then remove the four screws that hold the rear cover and gasket to the back of the freezer compartment. With the rear cover and gasket off, you should be able to see the drain tube.

There will normally be a small white cap over the drain hole that is held in place by a spring. The cap should not be removed. Check around the cap for debris that may be preventing the water from draining. If you find that the drain is not restricted, a defective defrost drain heater is most likely causing your problem.

The heater is located on the underside of the freezer compartment at the back. To replace this part properly, you must remove the doors and the entire plastic breaker strip, then slide the freezer liner out of the freezer compartment. This is not an easy job, even for a service technician. The best thing to do is have the GE service people come out and replace the heater for you.

Old toaster repair

I have a Toastmaster pop-up toaster, Model 1B14, serial No. A4023682, that needs new heating elements. The local appliance shop told me that parts for this model are no longer available. Have you any idea where I might find parts for this toaster?—A. J. Ciarrocca, Coraopolis, Pa.

Repair parts for your 35- to 40-year-old toaster are no longer available from Toastmaster. However, there is a company in California that services older-model toasters, and they still have a limited number of parts for old Toastmasters. They tell me there's an 80 to 90 percent chance they will be able to repair your toaster. Send it by either United Parcel Service or U.S. mail to Huff's Wholesale Distributor, 11742 East Imperial Hwy., Norwalk, Calif. 90650. Once they receive the unit, they'll test it and send you a written estimate for the repair.

Kenmore repair manuals

I have a Kenmore automatic washer, model No. 725.50600, and a Kenmore dishwasher, model No. 587.761400. I cannot get a repair parts manual for either. Not wanting to take them apart without a guide, I'm stuck with two unusable appliances. Can you help?—Franklin Laversdorf, Reeseville, Wis.

Sears does sell repair manuals for both your washer and your dishwasher. Although the manuals do not cover a specific model washer or dishwasher, they are designed to provide a basic knowledge of the operation of the machine, and cover in detail the repair of most components used on any model. Both include installation instructions and service procedures. They are available at Sears repair centers, or can be ordered through Sears stores. The part number for the automatic washer manual is 821462-D; the dishwasher manual is 808353. Each costs about \$6. Sears also has manuals for its gas and electric dryers, and compactors. **FM**

SERVICE TIP



Six free "How to Buy" booklets tell what's available in appliances, and how to select features that suit your needs.

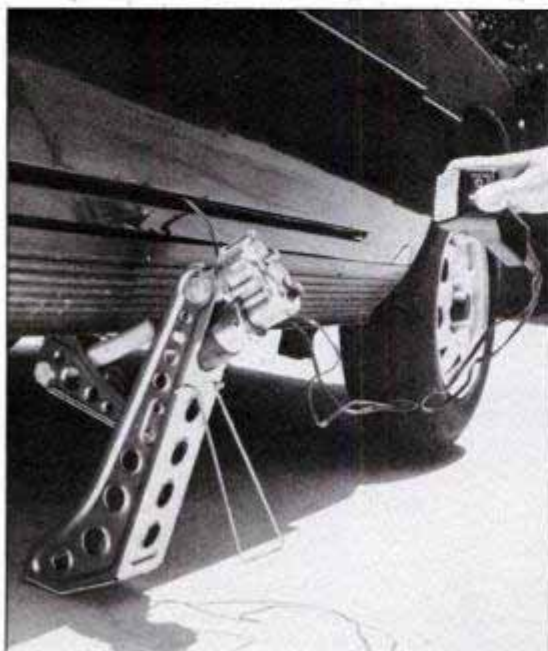
These 16-page booklets offer tips on purchasing refrigerators, air conditioners, washer/dryers, ranges, dishwashers and microwave ovens. In addition to analyzing your needs, each booklet provides information on warranties, safety and service. The six-set package can be obtained free by calling the GE Answer Center toll-free at 1-800-626-2000.

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

THE PM GARAGE



Up, up and away



Battery-powered Electrojack plugs into cigarette lighter and can lift up to 2 tons. Pushbutton control operates chassis model, left, and bumper-style jack at right.

Changing flat tires with a balky bumper jack always used to ruin my day. But I'll never do that again. With Electrojack, the push of a button lifts my car.

Three versions of the power jack cover most models: a scissors-style jack for most foreign and mid-sized American cars, a bumper model for the domestics, and a chassis model for Mercedes-Benz. Just position the Electrojack, plug the 9-foot-long cord into the car's cigarette lighter and you're ready to lift. A remote-control switch-

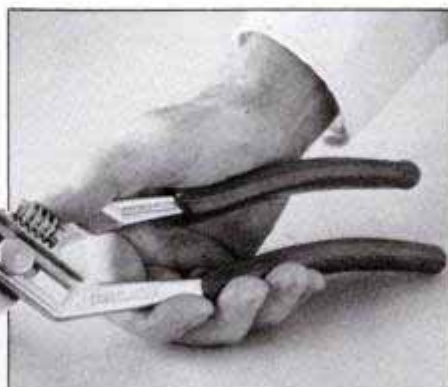
box for lifting and lowering is connected to the jack. The 9-pound jack will safely support 2 tons for a spare tire swap. Manual release also is possible with a supplied hand crank.

Combine the Electrojack with a 12-volt impact wrench and even the daintiest family member can handle roadside emergencies unassisted. All models retail for \$79.95 at auto supply stores, or contact Electrojack Inc., 8383 Wilshire Blvd., Beverly Hills, Calif. 90211.

—N.S.M.

No-slip grippers

This hybrid tool combines an angled slip-joint plier with an adjustable wrench. The Shift-o-fix has hardened steel jaws that can be set parallel in positions from closed-up tight to 1 1/4 in. wide. Once set with the worm wheel, the adjustment won't change until you re-set it. Plastic sleeves over the handles cushion your grip, and serrations help grip pipes or round objects firmly. Made by Bahco, they're available for \$17.95 postpaid from Speedy Products, Box 1617, Jacksonville, Tex. 75766, or call (800) 527-8651.—Angus Laidlaw



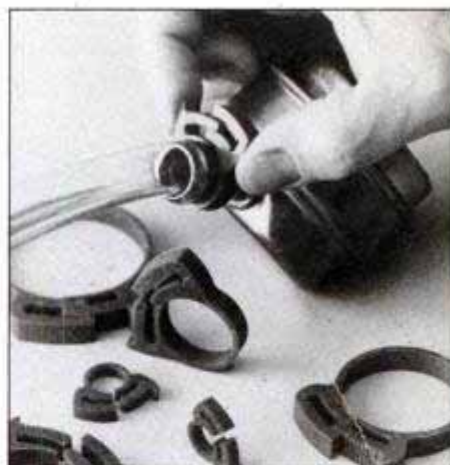
Swedish-made pliers have positive screw positioning to prevent unwanted slipping. Jaws grip round objects firmly.

Smart torquing

Baffled by the metric torque figures in your import-car shop manual? I can't convert Newton-meters to foot-pounds in my head either, so Sears' brainy electronic torque wrench ought to save the day. Three operating modes allow the wrench's LCDs to display the torque applied, retain the highest figure reached in memory or sound a buzzer when the pre-selected torque is reached. It's accurate to plus or minus 2 percent. Get it from the 1984/85 Power and Hand Tools catalog for \$80.—W.H.



Electronic torque wrench offers choice of foot-pound, Newton-meter and meter-kilogram settings.



Nylon hose clamps use toothed locking grips and can be cinched down with pliers.

Toothy clamps

Little hoses like vacuum lines require leakproof clamping just as much as radiator or heater hoses. Nylon Speedy Clamps work great. Open the clamp by twisting its jaws sideways. Clamp it by pressing the tongue into the jaw, engaging the teeth. The clamps come in 23 sizes from 1/8 in. to 2 3/8 in. A sample pack costs \$6 from Speedy Products, Box 1617, Jacksonville, Tex. 75766.

—Angus Laidlaw



A true story by
Wilton Hildenbrand

**"This is the business
that turned our
dreams into reality"**

I never made "real money" until I quit working for someone else and started my own Duraclean business

"When I was with the New York City Fire Department—with a wife, and three children to raise—I felt I spent most of my time putting out financial fires at home! It occurred to me that I could never achieve the financial security and independence we craved working for someone else. The obvious answer—start a business of our own. But what? Sure, we had been able to

I rendered the service. When we discovered how much money there was to be made in a Duraclean dealership, I took early retirement from the fire department. Before long, I had to hire part-time servicemen. Soon, profits paid for our first van. Now most of the work is done by our four servicemen. Marge schedules the jobs, sends out mailings and does the bookkeeping. I do the job estimating, special spotting jobs and contact new prospects."

Now at this point you're probably asking yourself, what is this Duraclean business Wilt Hildenbrand keeps raving about? Well quite simply, it's a unique, superior system for cleaning upholstered furniture, rugs and carpets (don't confuse it with "steam cleaning" or ordinary shampooing methods). It not only cleans but restores and revives colors. It does not wear down the fiber or drive the dirt into the base of the rug as ordinary cleaning methods do. Instead it *lifts out* dirt by means of an absorbent dry foam.

Today the Hildenbrands provide cleaning for banks, country clubs, churches, offices, hotels, motels, funeral parlors, theaters and homes.

Carpet and furniture stores gladly recommend Duraclean to customers. It helps them close sales. 45% of the Hildenbrand's business is from customers' referrals and repeat orders.



put a little money aside, but nowhere near what it takes to start most businesses. I looked for something I could get into with a small amount of borrowed money.

So Easy to Get Started

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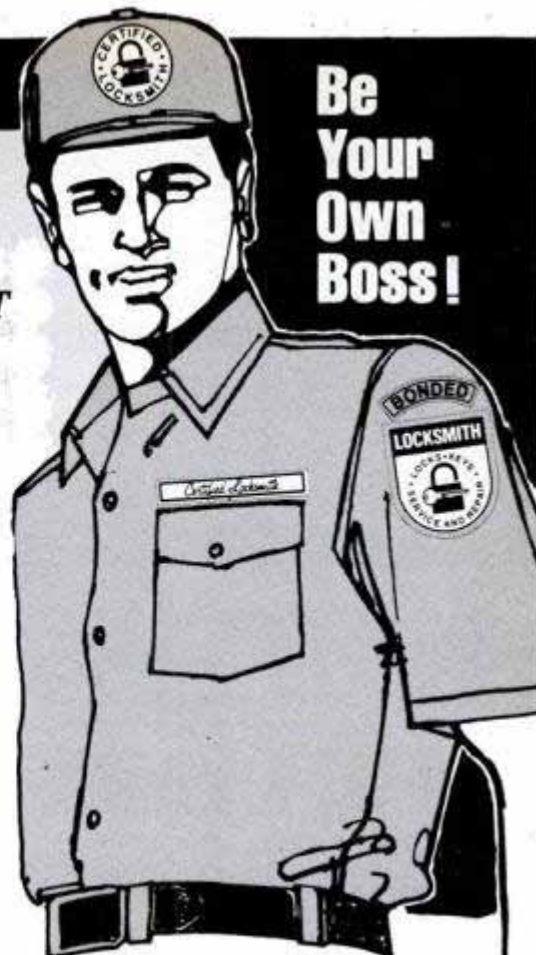
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HOMEOWNERS' CLINIC



Roofing under solar panels

I will soon need new shingles on the roof of my house. The problem is I have solar panels for my hot water heater—three panels, each about 3x6 ft.—mounted side by side in the center of the roof. They are held 6 in. off the surface by brackets bolted through the roof. Roofing contractors claim that since they can't get under the panels, they can't guarantee a watertight roof.

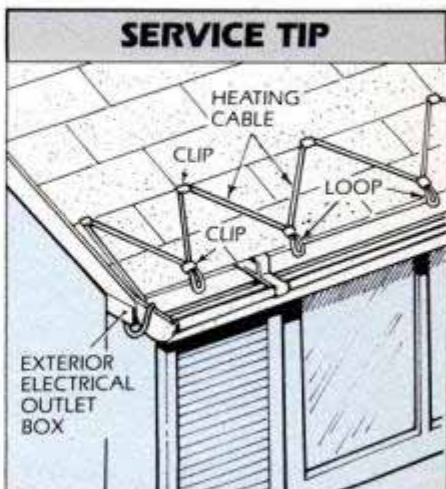
I've thought of two ways to solve the problem but both have disadvantages. The first is to remove the panels while the roofing is being done. This involves unbolting the brackets, draining the antifreeze solution from the system and unsoldering the copper pipes that carry the fluid in and out. Then the system would have to be recharged by a professional, since it must be done under pressure. The second method would be to box in the panels and effectively close off that part of the roof. I want to avoid this because a great deal of heat is generated under the panels and I've read of roof fires caused by wood drying and igniting. I haven't been able to figure out any easy way to do this job. I hope you can help.—Leonard Bailey, Somerville, N.J.

There's no easy way to solve your

problem. Apparently your solar panels were installed without considering the eventual need for reroofing. This is a problem of great concern to the roofing industry, and should also concern any homeowner contemplating the installation of solar panels. Panels should be mounted on brackets that provide sufficient clearance on the underside, and between the panels, to enable a roofer to install a new roof.

Either of your solutions will solve the problem. If you remove the panels, however, be sure to remount them on brackets that provide adequate strength as well as clearance. According to the U.S. Department of Housing and Urban Development, solar panels are subjected to uplifting force by wind striking the undersides. A panel array should be built to withstand wind gusts of at least 100 mph. These gusts result in an average wind load of 25 pounds per square foot on a sloped surface.

If you decide to box in the panels, strip the existing roof shingles down to the deck so the box/roof joint can be flashed in the conventional manner. Installing louvered vents on the sides will prevent excessive heat buildup under the panels.



SERVICE TIP
Electrical heating cables installed along the roof edge and in gutters can prevent roof leaks caused by an ice dam.

For maximum effectiveness, heating cables in gutters and along the roof edge should be turned on when a snow or ice buildup is anticipated, rather than after an ice dam has developed. This prevents damage to shingles, and subsequent leaks when the ice begins to melt. Tied into an exterior electrical box, one cable can be run as a single circuit for both gutter and roof edge. For longer distances, two separate circuits can be used to melt snow and ice. De-icing cables are available at local electrical supply stores.

Attic vent requirements

The June 1984 Homeowner's Clinic (page 46) said the effective openings for attic ventilation should be "1/300 of the attic floor area." In May 1983 (page 24), it said that the minimum amount of free air ventilation should be 1/150 of the area. Apparently one is incorrect, unless I should be considering one half of the openings at the top and one half of the openings at the bottom, in the soffits. I intend to buy and install the ridge vent type illustrated in your June 1984 article. Please clarify.—Michael Caruso, Trenton, Mich.

Most houses today have insulation in the attic that has a vapor barrier on the underside, facing the heated portion of the house. When there is a vapor barrier, the ventilation openings should be 1/300 of the attic floor area. With no vapor barrier, the openings should be 1/150 of the attic floor area. If you intend to install a ridge vent, also install soffit vents for adequate circulation.

Condensation on glass door

In the winter, we get a lot of moisture, and even an ice buildup on our sliding glass door. This causes a growth of mold in the carpet, and the plaster around the door has peeled and cracked off. Is there a way to prevent this?—E. Claar, Roaring Spring, Pa.

The problem stems from too much heat loss through the door, which causes excessive condensation buildup. Reducing heat loss will reduce the condensation. Although you didn't say, it sounds as if you have a single-glazed, aluminum-framed, sliding door without a thermal break between the interior and exterior surfaces. The purpose of the thermal break is to cut down heat loss, which in turn, reduces condensation. Because of the extreme temperature difference between indoor and outdoor glass surfaces, there will be more condensation on a single-glazed door than one that's double glazed.

If you don't use your sliding door

during the winter, you can reduce the condensation by covering the outside with large plastic sheets mounted on a wood frame. The plastic can be removed in the spring and reused the following winter. If you use the door during the winter, consider installing a storm door over the sliding door.

Another possible cause for the excessive condensation is high indoor humidity. This can occur in a house heated by a warm-air furnace equipped with a humidifier that isn't functioning properly. Check the humidity in your house with a hygrometer; for average winter heating, indoor relative humidity should be about 25 percent. **PM**

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

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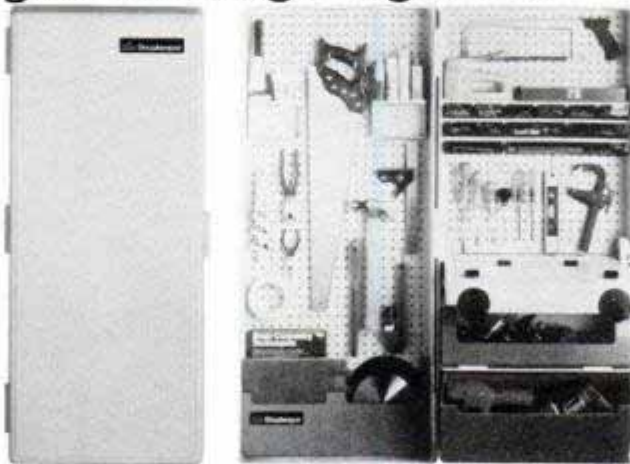
Monte Carlo

THE PM WORKBENCH



Space-saving tool storage organizer

Does lack of space force you to store tools under the kitchen sink or at the bottom of a closet? You can end tool clutter with Shopkeeper, a cleverly designed wall-hung cabinet that provides storage for tools, accessories and hardware. Two space-saving designs are available. The Model 300 (\$80) measures 9x19½x31 in.; the Model 500 (\$100) shown is 9x19½x48 in. Both feature a back panel with hooks, tilt-out storage bin, small parts drawers and a fold-down worktable/viser. Shopkeepers are available at hardware stores and home centers. For details,



Compact tool organizer measures only 19½ in. wide when closed. The cabinet is constructed of impact-resistant polymers. Features include a fold-down, dual crank worktable/viser.

write to Arrow Group Industries, Marketing Dept., 100 Alexander Ave., Pompton Plains, N.J. 07444 or call toll free 1-800-526-9011.—J.T.

Select-a-speed grinding



Variable-speed grinder lets you choose the right speed for grinding, buffing, polishing and sharpening. Features include plastic eye shields, quench tray and spark arrestors.

A new variable-speed bench grinder has been introduced by Sears. The Model 19213 (\$70) is equipped with a sliding switch that allows you to select the wheel speed, up to 3,800 rpm, depending on the work being performed. The grinder's two ½ x 6-in.-dia. aluminum oxide grinding wheels are powered by a direct drive motor constructed with permanently lubricated sleeve bearings. It's available at larger Sears stores and through its 1984-85 tool catalog. Contact Sears, Roebuck and Co., Sears Tower, Dept. 703-PM, Chicago, Ill. 60684.—J.T.

Novel knife design

Stanley's new Swivel-Lock utility knife enables you to change blades quicker and easier than ever before and without using a screwdriver. To change blades, depress the button on the handle end and swing the knife case open. The die-cast aluminum knife comes with three blades, has a seven-blade storage compartment and is curved for a comfortable, sure grip. The Swivel-Lock knife is available at hardware stores and home centers for \$4.15. For more information, contact William Shanahan, The Stanley Works, Box 7000-PM, New Britain, Ct. 06050.—J.T.



Quick-change utility knife swings open at the touch of a button. After changing blade, close knife and push button to the lock position. Storage bay holds seven blades.

Goodbye masking tape

Masking windows with tape before painting has been simplified by Wagner, 1770 Fernbrook Lane, Minneapolis, Minn. 55441. Glass Mask is a liquid masking solution that comes with a sponge applicator. Run the 1⅛-in.-wide applicator along glass to leave behind a thin, wax-like film. Glass Mask produces about 700 linear ft. of solution at 1⅛ in. wide. It's available at paint and hardware stores for about \$7.—J.T.



Liquid masking solution has a sponge applicator and a snap-on carbon steel scraper (top). Apply the solution to glass before painting. Plastic tip controls applicator.

Update

Heat 'N Strip

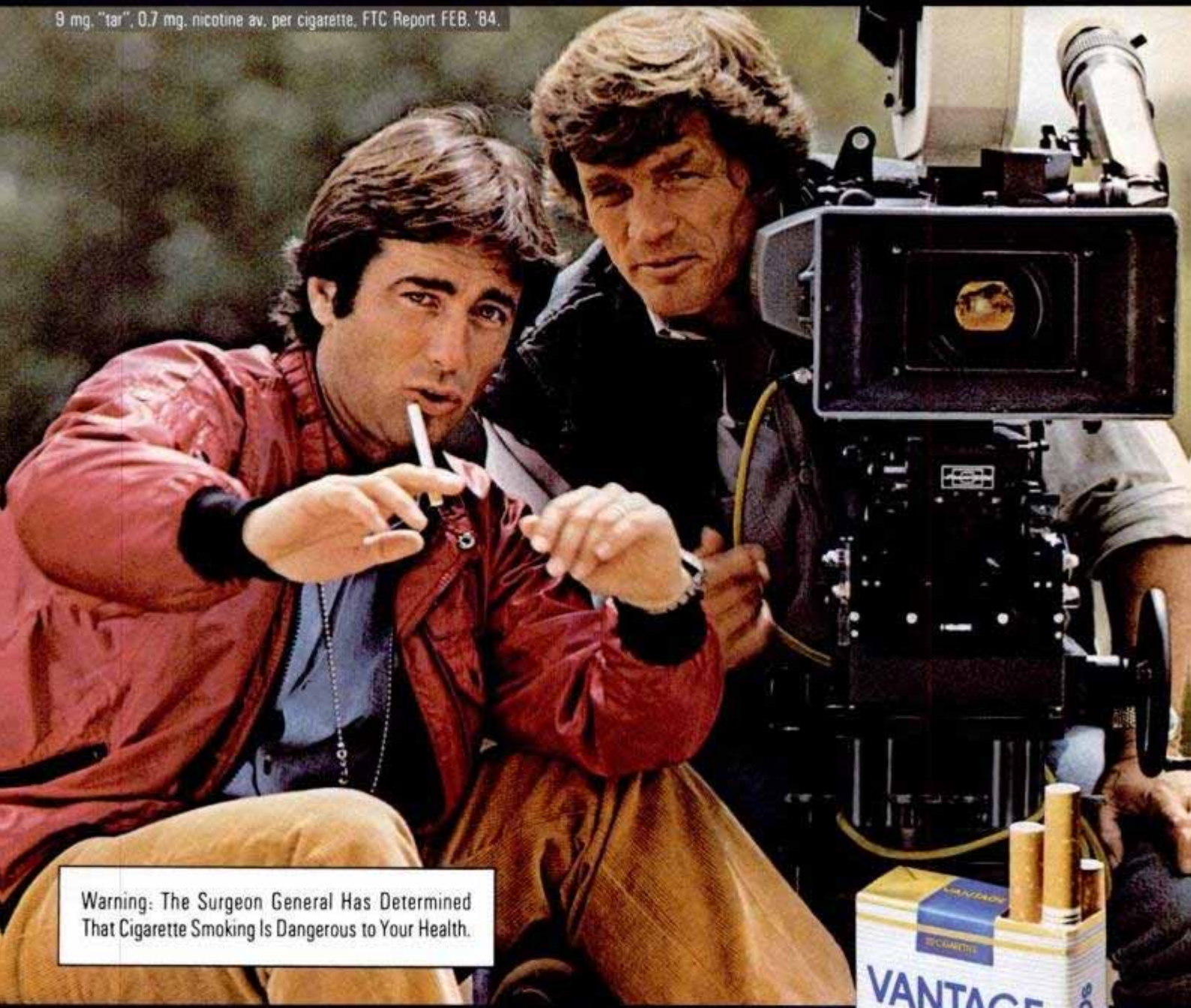
Black & Decker's Heat 'N Strip electric heat gun was shown in the Oct. '84 *PM Workbench* with an incorrect price. The Model 9751 heat gun sells for about \$49. Accessory nozzles (\$7.49) and scrapers (\$5.49) are also available. Contact Black & Decker, 3012 Highwoods Blvd., Raleigh, N.C. 27625.

Micro II lathe

Inquiries on the Micro II lathe shown in the Oct. '84 issue, pg. 60 should be sent to Caldwell Industries, 3619 Bear Lake Dr., Kingwood, Tex. 77339. Inquiries previously sent to Caldwell's old address will be forwarded by the Postal Service.

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

9 mg. "tar", 0.7 mg. nicotine av. per cigarette. FTC Report FEB. '84.



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WORKSHOP MINICOURSE



Using hot-melt glue

The hot-melt glue gun is a handy tool to have around the home and shop for joining just about any porous material. The big advantages of hot-melt glue are convenience, speed and strength of bond.

Conventional glues and adhesives take time to set and cure, but things joined with hot-melt glue are ready for use in only 60 seconds. And with the gun's narrow tip, you can apply glue neatly in hard-to-get-at spots.

Because the bond is almost immediate, this glue is not intended for large or complex constructions. The surfaces to be bonded must be joined within 15 seconds from the time the glue is applied; that's how long the melted glue remains viscous.

But for small assemblies or repairs, hot-melt glue is unbeatable because it requires no clamping. This makes it particularly helpful in shop work involving irregular assemblies that are either difficult or impossible to clamp, such as those shown in the photographs. Cured glue remains pliable, so squeeze-out can be trimmed with a razor blade.

The glue is waterproof, so it can be used for outdoor as well as indoor jobs. And by inserting hot-melt caulking sealer cartridges, which are also available, indoor and outdoor caulking jobs can be accomplished easily and neatly.—Rosario Capotosto



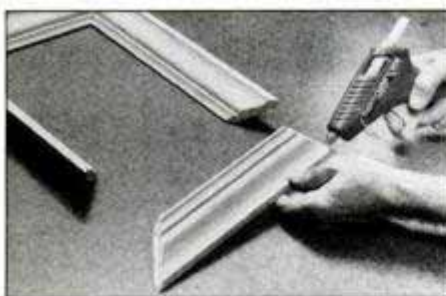
Hot-melt glue gun dispenses glue by means of a trigger-action feed. Glue comes in stick form.



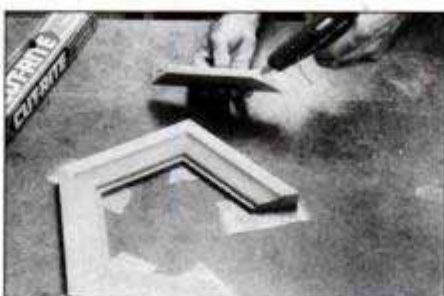
Broken plastic figure is too fragile and irregular to clamp. A thin bead of hot-melt glue makes the repair without clamping damage.



Another use: applying decorative carvings or trim. Apply glue sparingly, and keep it away from edges to avoid squeeze-out.



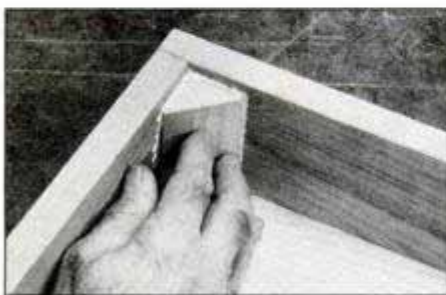
Crown molding can be joined to make a frame without clamping. Glue two corners, keeping assembly square. Add last piece.



Odd shapes, like pentagon, require precise cuts, but assembly is easy. Wax paper prevents squeeze-out from sticking to table.



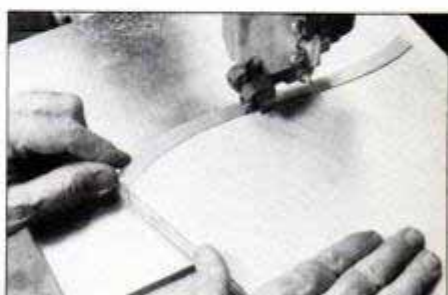
Fingers are the only clamps you need for irregular assemblies. Parts need to be held in place for only 60 seconds.



To attach corner reinforcing blocks, first join the rails or aprons together, let dry, then press glued block into place.



Eliminate the gap that usually results when joining mating curved pieces: First, tack add-on piece to work with hot-melt glue.



Next, resaw directly on the joint line so the kerf straddles both pieces. This will eliminate any gap when you reglue.

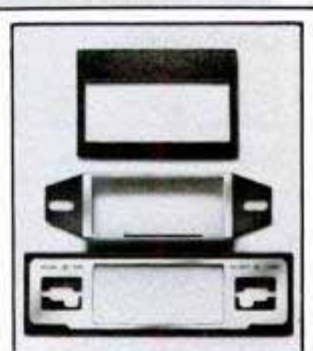
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CAR CLINIC



GM's oil policy debated

Your September Car Clinic item about GM's latest motor oil requirements ('Oil's' well, page 22) sent me to the owner's manual for my 1985 Buick Electra. Much to my surprise, you are right. SAE 10W-40 oil is verboten.

Your article states that GM says the reason is piston ring sticking due to deposits. Is this something new? Does it only apply to GM engines? Does using synthetic oil change the picture?

I am an AMS/OIL dealer and have used SAE 10W-40 synthetic oil in every car I've owned since 1973. I've never had a single problem. Can you shed more light on this development?—Robert V. Hamilton, Santa Cruz, Calif.

Yours is typical of dozens of letters I've received since this item appeared. I hope the following answers will help clarify matters:

■ *Is piston ring sticking because of deposits left by oil something new?* Not according to GM. The company has suggested for some time that owners of GM cars use SAE 5W-30 or SAE 10W-30 instead of SAE 10W-40. However, only recently did it make this mandatory to keep warranties from being voided.

Some people at other companies I've spoken with contend that the piston ring story is a smoke screen. "There is even more VI (viscosity index) improver in most brands of SAE 5W-30 oil than there is in SAE 10W-40 oil, and it's this additive that causes deposits," one engineer told me. According to this person, GM's real reason for outlawing SAE 10W-40 has little to do with piston ring sticking.

"The truth involves GM's efforts to

meet CAFE (Corporate Average Fuel Economy) requirements," he contends. "By using oils other than SAE 10W-40 in engines tested for fuel economy by EPA, GM is able to squeeze out a few more tenths of a mile per gallon. But the oil used in tests must be made a mandatory condition for owner operation, otherwise tests wouldn't be valid. This is why GM has made it a condition of the warranty that SAE 5W-30 or 10W-30 be used. Once an owner's warranty expires, switching to SAE 10W-40 oil would have no ill effect on the engine as far as we're concerned."

■ *Does the requirement apply only to GM engines?* Yes, although Chrysler "recommends" it in '85 V8s, again to meet CAFE specs.

■ *Does using synthetic oil change the picture?* No. To keep the GM warranty in effect, the oil you use must be SAE 5W-30 or SAE 10-30—synthetic or not.

Fwd rear tire wear

The rear tires of my 1983 Ford Escort have worn badly in 25,000 miles. The car dealer blames the tires, the tire dealer blames the car, and I'm left holding the bag. What now?—John Carey, Youngstown, Ohio

You touch on a problem that's been affecting front-wheel-drive cars regardless of make. It's called diagonal tire wear.

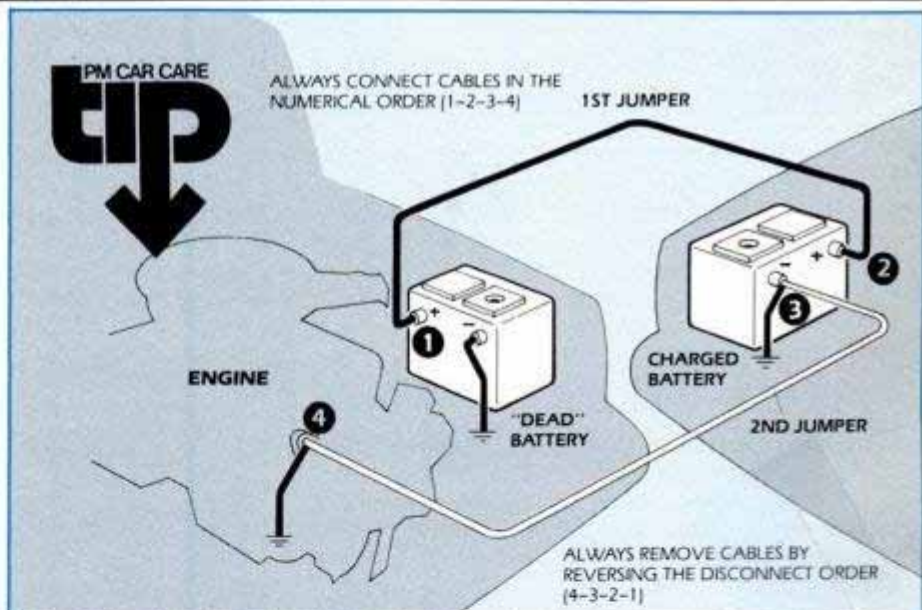
Typically, wear starts as flat spots on inner and/or outer tread surfaces and spreads across the face of the tread at an angle of about 45°. Often, drivers become aware that wear exists by a humming noise from the rear of the car.

What can you do about it? If wear isn't too far along, keep tires in use, but have tire and wheel assemblies balanced. Then, cross-rotate the four of them. That's right! Cross-rotate—even though they are radials. Move the right front tire to the left rear, the left front tire to the right rear, the left rear tire to the right front, and the right rear tire to the left front.

If worn tires have to be replaced, put the new tires on the front wheels and cross-switch the tires that were on the front; that is, right front to left rear, and left front to right rear.

Other things you should do are make sure tire pressure is correct, have rear wheel bearings adjusted as spelled out in the service manual, and have a wheel

(Please turn to page 40)



Eye bawling

When winter arrives, many of us will use boosters to jump-start engines having run-down batteries. I know—there's nothing I can tell you about using a booster, so I'll direct my remarks to the other guy to keep him from becoming one of possibly over 14,000 people who will suffer serious eye injuries this year resulting from exploding batteries. Last year, says the National Society to Prevent Blindness, 14,238 fell into this category.

The best way to prevent an accident

when boosting a battery is to observe these precautions:

■ Make sure the car with the dead battery and the one giving the boost don't touch one another.

■ Never connect the NEG jumper cable directly to the NEG terminal of the dead battery. Find a spot that's at least 12 in. away—an alternator or air-conditioner bracket, or a bolt head is suitable.

■ Connect and disconnect cables in the numerical order given in the diagram.

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I found the most enjoyable and profitable business working with my hands and the only tools I use are a hack saw and measuring tape. The really nice thing about it is any man, woman or ten-year-old can do it.

What Do I Do?

I make beautiful indoor/outdoor P.V.C. pipe furniture. Such as chairs, lounges, tables, swings, and all kinds of baby furniture out of P.V.C. pipe; even birdhouses and feeders. P.V.C. pipe furniture is the hottest selling furniture on the market today, because it is unique and beautiful and will not rot or rust and it will virtually last a life time.

Profit Unbelievable!

The fantastic part of this business is the profit.



Just go look at some of this furniture in the stores and see some of the unbelievable prices it is selling for.

A chaise lounge that costs \$62.25 in material and three

hours of work is selling for over \$189 in the stores. I can sell my chaise lounge for anything I think my labor is worth.

Where can you buy the P.V.C. Pipe?

You can buy the P.V.C. pipe from any local hardware store to start. Plus I will supply you with the name and address of one of the largest manufacturer of pipe, fitting, cushions, and table tops who will sell to you at wholesale prices and you do not have to buy a minimum amount. You can buy one cushion or 50 plus I will supply you with my shop manual and six detailed shop drawings with pictures and measurements of six different designs.

Do you need my shop drawings?

No, you don't need my shop drawings unless you want to save hundreds of hours of trial and error work and thousands of dollars that I had to spend before I finally

found the right design and measurements and tricks to the manufacturing of P.V.C. pipe furniture. I only wish that when I started, I could have bought these shop drawings and I would have gladly paid \$100 for just one of them.

I will pay you!

Yes, I will pay you \$25 for any unique design shop drawing that I can use in my collection and workshop manual.

How do you start?

1) Decide if you like to work with your hands to create things and want to make money.

2) Can you afford \$12.00 for my shop manual and six drawings.

3) Send me your name and address along with your check for \$12.00 to:

Philip E. Brancato Sr.
P. O. Box 237 P-10
Riverview, Florida 33569
(813) 677-6948

Please allow about two weeks for delivery.

CAR CLINIC

(Continued from page 36)

alignment specialist check all four wheels. Make sure he is equipped to perform rear wheel alignment.

When you take your first ride after doing all this, you may notice noise and vibration, especially if you keep original tires in use. Not to worry. The condition will disappear as the abnormal wear pattern smooths itself off.


To keep rear tires from again falling victim to diagonal wear, maintain correct tire pressure and cross-rotate tires every 7,500 miles.


In search of Biobor

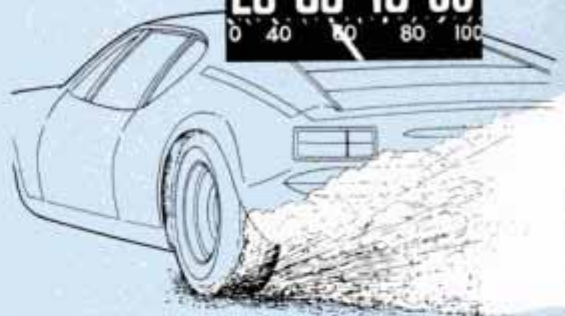
In the July 1984 Car Clinic under the item titled Sidewindin' critter (page 18), you stated that a biocide additive will rid diesel fuel of bacteria and fungus that can clog the fuel system. You mentioned in particular Biobor, made by U.S. Borax Co. I've searched, but haven't been able to find this product. Could you tell me who sells it?—Edward Hertz, Cleveland, Ohio

Biobor J.F. is available at many boat marinas. However, since my last report on this problem and the use of a biocide to control bacteria and fungus growth,

PM CAR CARE







A bomb waiting to explode

Here's another wintertime warning "everyone" knows—yet it takes its toll of victims every year: spinning tires when pushing another car stuck in snow or mud. An explosion can result when a wheel on the pushing car's drive axle spins freely. The free-spinning wheel turns at almost (get this) twice the reading on the speedometer. If that speedometer reads 35 mph,

which it often does in the car giving the push, the free-spinning wheel is going around at about 60 mph. This sets up high centrifugal force on the tire, which can explode. The result may be damage to the vehicle, and injury to anyone standing nearby.

new events have occurred that are important to owners of vehicles having diesel engines.

More has been learned about the damage caused by microorganisms, which use diesel fuel as a source of energy. As they feed and multiply, they alter the fuel chemically, producing

acid and sludge that can clog fuel filters and cause metal fuel system components to corrode. Symptoms of bacteria and fungus contamination are engine missing, engine noise, rough idling, loss of power on acceleration, stalling and heavy black exhaust smoke.

U.S. Borax now has available a bio-

40

POPULAR MECHANICS • JANUARY 1985

cide specifically formulated for automotive diesel engines. It is called Biobor Diesel Doctor and is less concentrated than straight Biobor J.F. It is therefore easier to use.

If automotive stores in your area aren't yet carrying the product, you can write to U.S. Borax and Chemical Corp., Box 75128, Sanford Station, Los Angeles, Calif. 90075.

At the bottom of things

Is there a solution for rear end bottoming exhibited by my 1983 Plymouth Reliant when two or three people ride in the back seat? The rear suspension of this car leaves much to be desired when I'm carrying passengers.—John Horn, Independence, Ohio

You can go one of two routes. You can install heavy-duty shock absorbers that are equipped with a helper spring or air lift device. Or you can order a Polyair Bag Kit (part No. 4271374) from a Chrysler dealer.

Placed inside the rear coil springs and then inflated, these suspension devices will do a very good job of preventing rear-end sag whenever pas-

sengers are riding in the back of a K-car or when the car is pulling a small trailer. The Polyair Bag Kit will cost approximately \$50.

Lighten up

The choke light in my 1982 Pontiac Trans Am comes on frequently, for no apparent reason. If I switch the ignition off and then back on, the light will often go off.

Can you tell me what's happening and what to do about it?—Ken Rudd, Akron, Ohio

If you haven't done so already, install

a new choke relay which has a lower voltage rating than the relay originally installed in this car. You can get it at the Pontiac dealer under part No. 14039662.

If you already have the new relay in use, you should start to look for a problem with the alternator. Alternator performance is extremely easy to check.

Next time the light comes on, put the transmission in NEUTRAL and briefly rev the engine. If you see that the light goes out, the alternator's causing the trouble. You'll very likely find a bad bridge or diode. **PM**

SERVICE TIPS

- GM says 1983 models with 2.5-liter EFI engines and four-speed manual transaxles that perform badly until they're warmed up may need a new computer PROM. It's part No. 1226480.
- Chrysler handles cold-engine stalling differently from GM. The condition is liable to strike a car equipped with a 2.2-liter carbureted engine. Chrysler says to increase the fast idle speed to 1,850 rpm if the car has an automatic transaxle—to 1,700 rpm if it has a manual. TSB 14-23-84 spells this out.
- A clunk from the rear suspension of an Escort, EXP, Lynx or LN7, heard especially when going over a bump at slow speeds, is curable. Your mechanic should retorque rear suspension fasteners to the specs given in TSB 84-16-24. He should then install a new upper shock mount kit (part No. E4FZ-18198-A).
- All AMC/Jeep/Renault models should use an improved brake and clutch hydraulic system fluid (part No. 8982200215).
- A GM 1983-84 model with 1.8-liter engine that has oil running down the side of the filter may be sending false signals. The leak is probably coming from the galley plug just above the filter. If so, the plug is not sealed properly. Remove it. Clean the plug and plug hole threads. Then, apply thread sealer, install the plug, and tighten 15 to 18 ft.-lb. torque.

DO YOU HAVE A CAR PROBLEM?

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

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High-climbing mountain bike



Chainrings of Montare mountain bike are slightly oval-shaped to aid in hard climbing.

When we ran our last major article on mountain bikes (*Biking The Badlands*, page 82, July '84), the Montare, built by Fisher Mountain Bikes, arrived too late to be included. In a separate test on this bike, we found it to be an outstanding example of an all-terrain bike with excellent balance and quick, responsive handling. Gary Fisher along with Tom Ritchey are the pioneers in mountain bike design, and the tube set, all chrome-moly frame, frame geometry and detailing are experience-proven.

An excellent climber, the Montare

uses Shimano Biopace chainrings. Slightly oval in shape, these front sprockets help even out the pedal stroke during hard climbing. For more weight distribution over the rear wheel, the seat tube angle puts the saddle closer to the rear axle. The Montare is one of the few bikes we've tested that gives you the feeling of being able to do almost anything you want. The bike retails for \$679, and is available at select bike shops. Or write to Fisher Mountain Bikes, 1501 San Anselmo Ave., San Anselmo, Calif. 94960.

Fish for the record



New Stren Class Line is designed to break as close as possible to record class limits.

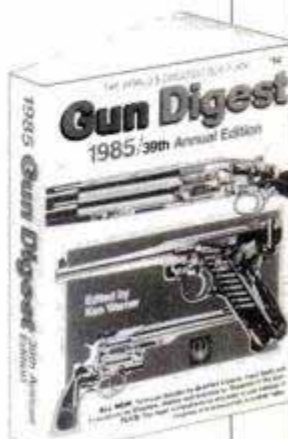
If you're into fishing for world records rather than for a fryer to be flipped in a pan of melted butter, DuPont has a new fishing line for you. Stren Class Line, a nylon monofilament line, is engineered to break as close as possible to the world record line class category limits of the International Game Fish Assn.

Stren Class Line owes its precise breakload strength to a number of factors, including the use of laser micrometers during the manufacturing process. The laser measures line diameter during manufacturing for a highly uniform product.

The line will be available in pound-test ratings for the most sought-after IGFA world records—1 kg, 2 kg, 4 kg, 6 kg, 8 kg, 10 kg and 15 kg. It's available in 100-, 250-, and 2,400-yard spools at sporting goods or fishing shops.

1985 Gun Digest

Why did Gary Cooper use a Luger and not a .45 in his legendary portrayal of Sgt. York? You'll find the answer in the 1985 edition of the *Gun Digest*. You'll also find a comprehensive 185-page catalog section of guns and gear for the shooting sport. All told, the '85 *Gun Digest* has 488 pages, including over three-dozen feature articles covering everything from gun history and black powder weapons to guns in the movies. Other tidbits include how to safely shoot aerial targets with a handgun, and why fast-draw enthusiasts load .38-cal. wax bullets into .22-cal. revolvers. The *Gun Digest* sells for \$14.95 from DBI Books, One Northfield Plaza, Northfield, Ill. 60093.



Gun Digest is almost 500 pages.



Impact meter is for joggers.

Meter for safer running

Did you know that you risk foot, leg, hip and back injury when jogging? If you weigh 150 pounds and your strides measure a 5 on the RunAlert, you are impacting the ground at five times your body weight, or 750

pounds on each stride. A new impact meter called RunAlert weighs 2 ounces and clips to your running trunks or belt. Set the meter for a specific foot impact force, and the unit sounds a warning beep if you exceed that force. It's all explained in the booklet that comes with the \$29.95 impact meter. Run-Tronics Corp. is at 1301 Shoreway Rd., Belmont, Calif. 94002.

PM

Save Gas, Save Engine with 'POLY'

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

WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man (1981 Guinness Book of World Records, p. 188). The Petrolon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature, thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The "Consumers Digest" magazine (March/April, 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon." Researchers at the Franklin Institute Research Laboratory, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine, were surprised at its permanence. They stated, "We actually expected the Petrolon Slick-50 TFE Resin coating to also be removed, but later found it was still there."

The FAA (Federal Aviation Administration) has fully accepted Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

2500 miles after removing Slick 50 from the crankcase, lab tests at a leading university engineering experiment station showed that the benefits of Slick 50 were still there. They reported a horsepower increase of 16.9% and 9.9% for light and heavy loading respectively. The senior engineering researcher at the University of Southern California in San Diego stated this, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a tor-



ture test overseen by the Automotive Services Council for Pennsylvania and shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars were driven without the oil plugs for about a half hour. The water temperature never rose, and the engines sustained no apparent damage. There are many more tests available. If you are still skeptical, send \$2.00 to defray printing and postage costs, and we will send you additional, more detailed test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. A few minutes before oil and filter change, add engine flush (sent free with each order) to clean out the engine. Let the engine idle for 10 minutes. Then drain the oil, change the filter, and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the polytetrafluoroethylene between the parts where it is burnished into the pores of the metal. Once impregnated, it is permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4-, 6-, and 8-cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OILS? Yes, Slick 50 will work with all petroleum-based oils and all synthetics that are compatible with petroleum-based

oils. An exception is graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, weather, and geographic area. By reducing friction, Slick 50 does all of the following: It increases gas mileage. It increases horsepower—small economy cars and large RV's really need this! It reduces operating temperatures, thus increasing the lubrication and life of the oil and the engine. Last but not least, the drastic reduction in engine wear defrays or eliminates costly overhauls which could save you up to \$1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the engine wear on a car can be caused by this lubrication starvation. You receive all of these benefits for \$34.95, less than the cost of two tanks of gas.

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, Slick 50 is the only product of its kind to have both an API (American Petroleum Institute) and an SAE (Society of Automotive Engineers) rating imprinted on the package. It also has a SF-CC-CD service classification.

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

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information, call toll-free 1-800-525-8624 (in Colorado call 1-303-762-1385) or send to SLICK 50, 3148 S. York St., Englewood, CO 80110.

I enclose \$34.95 + \$4.00 shipping and handling.
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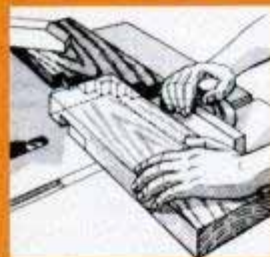
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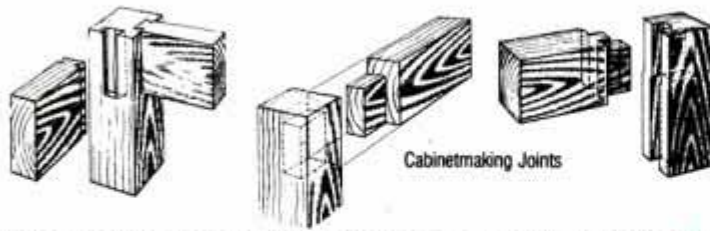
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by John L. Feirer

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DETROIT LISTENING POST

Eldorado and Riviera for '86

Shown here are some of the first clear pictures anywhere of the Cadillac Eldorado and Buick Riviera. A few major changes in the cars are immediately apparent.

The Eldo, expected late this year as an '86 model, will finally receive an overdue trimming of about 16 in. from its wheelbase, 20 in. in overall length and drop about 600 pounds. The length reductions are due in part to Cadillac turning its engines to an east-west, or transverse, layout. The manufacturer's new engines are expected to include Cadillac's exclusive 4.1-liter aluminum V8 that, along with a Touring Suspension, could put the new Eldorado firmly in the sporty car zone.



Eldorado for 1986—Instrumented for testing—displays the traditional Caddy lines.

The traditional Cadillac grille and quad rectangular headlamps carry on the Caddy look. New model interiors can be expected to shape up as they have in the C-cars—officially five or six seaters, but best suited to a four-passenger load.

The Riviera gets similar styling, but with a recognizable Buick grille. It will share engines and dimensions with Oldsmobile's Toronado.

The Toronado will retain the front-wheel drive it has had from the beginning, but

returns to a concealed headlamp scheme not seen since the 1965 debut model. With its new wheelbase a trim 108 in. and overall length down to 186 in., the Toronado will, like other GM-30 cars, be considerably lighter than the model it replaces.

The Toronado's smooth, rounded "character lines" and uncluttered style are reminiscent of the new, smaller GM-20 Olds Calais and Pontiac Grand Am fwd cars, so fuel economy ought to be improved. The car's performance will be good: The Toronado's standard engine will be Buick's 3.8-liter, multiport, fuel-injected V6.



The '86 Riviera was snapped along its test route.

Setting a Precedent

Shown below is the designer's original rendering of a brand-new vehicle from a brand-new manufacturer. We've seen the full-size clay model, and the picture doesn't begin to convey the excitement of this vehicle.

The Precedent is a luxurious front-engine, rear-drive van/limo/touring car. Its concept is so unique that when designers Alain Clenet and Mark Stehnenberger went to DOT to get a rules

classification under which the vehicle would be built, *there wasn't any*. DOT had to create a brand new vehicle designation—utility vehicle hatchback.

The six-seater will be produced by Lands Motors Inc., an Elkhart, Ind., luxury van converter. It will have an overall length of 221 in. atop a 200-in. wheelbase. Track is 66 in., and the Precedent is expected to trim out at a curb weight of about 4,400 pounds. Dick Guldstrand designed the chassis,

which has Chevy S-10 front-suspension bits both fore and aft, for fully independent suspension. Power is provided by a 184-hp Ford 5-liter V8, coupled to a four-speed automatic gearbox. Engine, transmission and headlamp assemblies are from the Lincoln Mark VII LSC. Being considered for later models are a Chevrolet 5-liter H.O. V8 and four-wheel drive.

Taillamps will be mounted high in the hatch for a distinctive style in



Precedent will use steel doors and a fiberglass-sandwich body to provide custom-van luxury without trucklike ride or styling.

compliance with the new federal rule for rear lights. Six bucket seats will be mounted in three rows of two, with considerable head and leg room for passengers. Elaborate leather trimmings with wood inserts, stereo, television and telephone are in a mix of standard and optional equipment.

Company president Fred Lands thinks the Precedent could fill a niche in the \$35,000 to \$40,000 market for people who want the luxury of a top-notch van conversion without the fit, finish, performance and handling of a truck.

A-car converts

Hess and Eisenhardt, America's oldest custom coachbuilder, is introducing a line of GM A-car convertibles through Olds, Chevy, Buick and Pontiac dealers across the country. The neat-looking ragtop Cieras, Celebrities, Centuries and 6000s come with power tops and quarter windows, as well as tempered-glass rear windows with optional defoggers. The H&E boys claim that substantial reinforcing plates help to retain "a high percentage of the original body strength and integrity."

Van poolers, beware

If you're a member of a van pool, the Insurance Information Institute says you should give serious consideration to the van owner's insurance. A serious van accident involving a dozen or more people could mean enormous medical costs and high jury awards in the event of a lawsuit. "Van drivers who are uninsured or underinsured are inviting financial calamity," says the I.I.I.

Van riders who ignore the question of insurance leave themselves open to extensive financial problems if they're injured in a crash. In most states, personal auto insurance won't do the trick, and a special commercial policy is required. I.I.I. recommends that the van driver have at least the minimum coverage required by state law.

I.I.I.'s toll-free Insurance Hotline can give you further details. It's (800) 221-4954.

Ear to the ground

Indy '85: Oldsmobile will provide a customized open-roof *Olds Calais* as the pace car for the 69th running of the Indy 500 in May.

Resin wheels: Pontiac may offer *plastic wheels* on some cars as early as 1987. A development of Motor Wheel Corp. in Lansing, Mich., the wheel is said to be 17 percent lighter than pressed steel wheels, yet stronger and easier to style. The wheel is made from fiberglass, resins and carbon fiber. **PM**

POPULAR MECHANICS • JANUARY 1985



H&E ragtops: Buick Century, Chevy Celebrity, Olds Ciera, Pontiac 6000.

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The sport truck taken to the max.



Chevy S-10 Maxi-Cab 4x4. This is a truck that looks as good as it goes. Just add the Sport option package and get front bucket seats, rear jump seats and Sport Two-Tone paint. Plus you can add chrome pickup-box side rails and grille guard with fog lamps. But you get a lot of built-in muscle, too.

Powerful new fuel-injected Tech IV. The new 2.5 Liter Tech IV engine is electronically fuel injected for more power and torque than last year's standard engine.

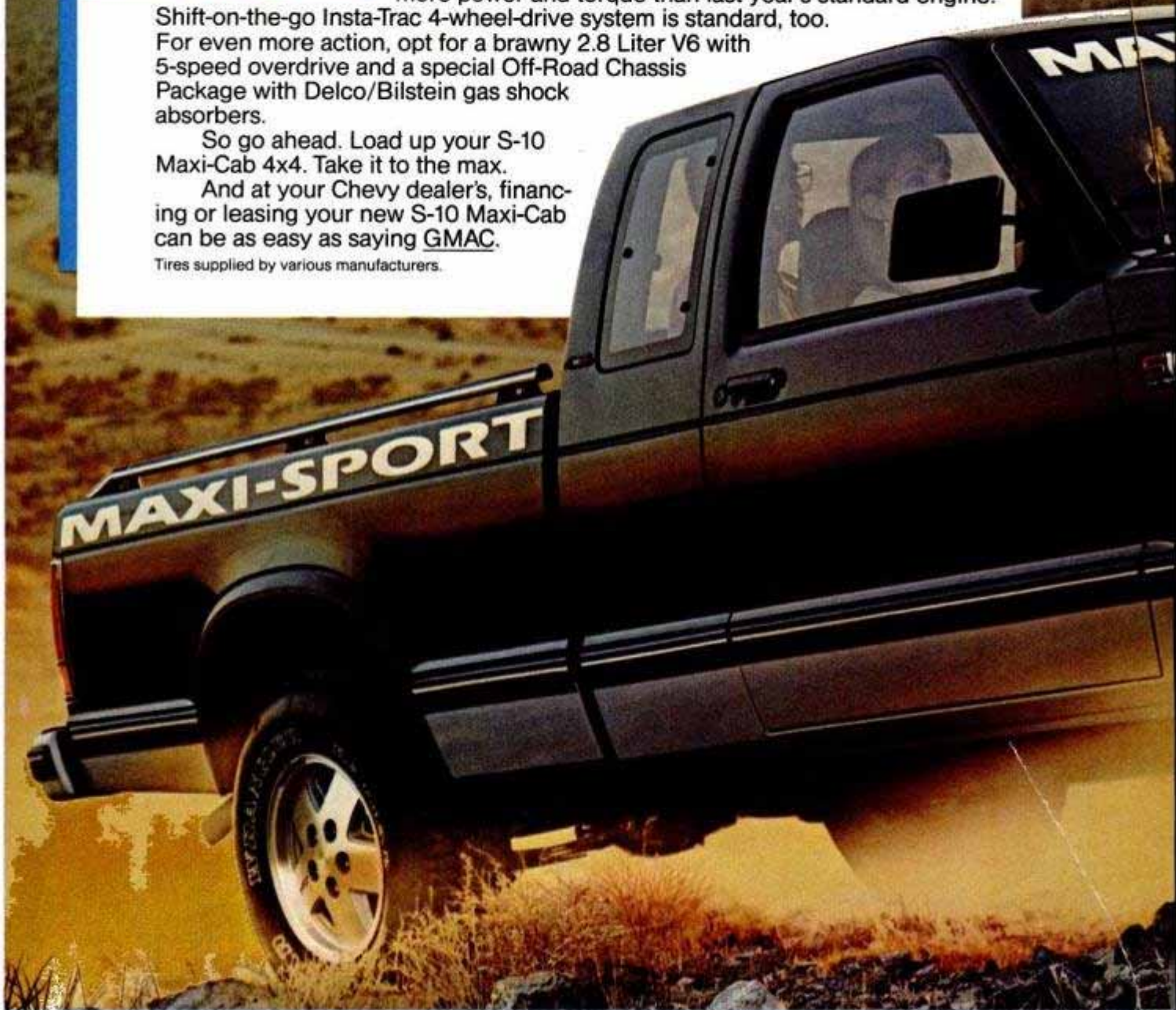
Shift-on-the-go Insta-Trac 4-wheel-drive system is standard, too.

For even more action, opt for a brawny 2.8 Liter V6 with 5-speed overdrive and a special Off-Road Chassis Package with Delco/Bilstein gas shock absorbers.

So go ahead. Load up your S-10 Maxi-Cab 4x4. Take it to the max.

And at your Chevy dealer's, financing or leasing your new S-10 Maxi-Cab can be as easy as saying **GMAC**.

Tires supplied by various manufacturers.



NOTHING WORKS LIKE



LET'S GET IT TOGETHER...BUCKLE UP

A CHEVY TRUCK



Soft bathtubs: A comforting experience

Cold, hard bathtubs may eventually become a discomfort of the past with the advent of the Soft Bathtub Co.'s new soft tubs. The fiberglass tubs are lined with an inch of plastic foam. A durable, flexible surface skin covers the foam and resists scratches and most punctures.

The tubs come in 40 colors and three sizes, and can be equipped with an eight-jet whirlpool system. The Personal tub, \$1,180, measures 18 x 32 x 60 in.; the Soaking tub, \$1,326, is 20 x 36 x 60 in.; and the spacious 22 x 48 x 72 in. Double Wide costs about \$2,100. The whirlpool is an additional \$1,650.

Call 800-882-7638 for additional information, or write to the Soft Bathtub Co., Box 81125, Seattle, Wash. 98108.



This new comfortable bathtub is lined with 1 in. of soft plastic foam (left). The foam is covered with a tough, flexible skin.

Prestaining conditioner

Staining softwoods such as pine, fir and spruce often results in blotching and streaking due to uneven grain patterns. Minwax may help the do-it-yourselfer obtain a more professional finish with their new Wood Conditioner. It's formulated to assure even penetration of stain on softwoods without changing its natural color. Wood Conditioner is available in pint (\$4) and quart (\$6) sizes. Write Minwax Company Inc., 102 Chestnut Ridge Plaza, Montvale, N.J. 07645.

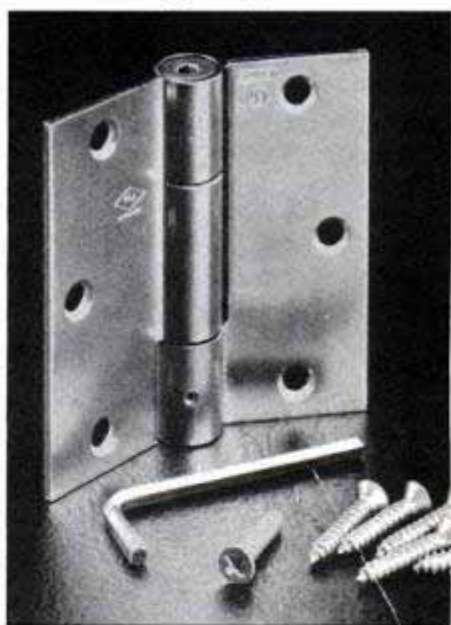


Garage door insulation

If your garage doubles as a winter workshop, Stanley's garage door insulation kit may be for you. Foil-backed, 1 1/2-in.-thick polystyrene panels fitted with retaining clips snap onto door sections to make your garage a warmer place to work. Stanley recommends having a professional installer adjust door springs to compensate for the increased weight due to the panels.

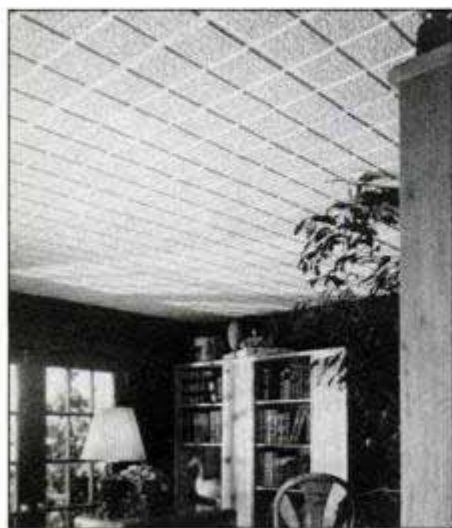
One kit (\$100) covers a 7 x 8 or 7 x 9-ft. door. Order through home centers, or write Stanley Door Systems, 1225 East Maple, Troy, Mich. 48084.

Self-closing hinge



What looks like an ordinary door hinge is actually Stanley's spring-loaded hinge, which closes a door automatically. The hinge is available in 3 1/2-in. (\$10.37) and 4-in. (\$11.79) sizes. Spring tension is adjustable or can be relieved completely if the door is to be left open. Each hinge comes with mounting screws and an adjusting wrench. For details, contact William Shanahan, Stanley, Box 1800, New Britain, Conn. 06050.

FM



High-tech ceiling

Armstrong has added a new pattern to its Headliner series of suspended ceiling panels. The Rock Ridge panels, shown here, measure 2 x 4 ft. and are deeply scored to look like individual 6 x 6-in. tiles.

Armstrong now offers a 10-year guarantee against manufacturing defects when purchasing the panels and metal-grid support system. Sold separately, the components are guaranteed for five years. The Rock Ridge panels sell for about 95 cents per square foot, including installation instructions, at most home centers. For more information, write Armstrong World Industries Inc., Box, 3001, Lancaster, Pa 17604.

WE BUILD OUR STOVES WITHOUT COMPROMISE.

Most stoves and fireplace inserts built today reflect a spirit of compromise. Styling is compromised for the sake of efficiency, efficiency for ease of use, ease of use for lower costs. While a spirit of compromise is, in the appropriate circumstances, very noble, we believe it has no place in the building of fine wood and coal stoves. Simply stated, we build our stoves and fireplace inserts without compromise, because we believe that you should not have to.

SAFE, STURDY CAST-IRON CONSTRUCTION

All Consolidated Dutchwest stoves are built entirely from durable, virgin cast iron. They are cast and assembled by hand and sealed airtight. Each meets or exceeds all national and local safety codes. **And now, every Consolidated Dutchwest stove can accept, at the owner's option, a catalytic combustor, so that it will meet anticipated safety and pollution control requirements of the 1990's today.**

EXCEPTIONAL PERFORMANCE

Consolidated Dutchwest stoves employ an intricate baffling system to encourage secondary combustion, maximize and direct heat transferral, and permit catalytic woodburning. **In a word, they are exceptionally efficient stoves.** Many models can heat most to all of a typical home, and hold a fire 12 hours or more on a single loading.

EASY TO USE

Consolidated Dutchwest stoves do not let you down where most others do — convenience. Most models burn both wood and coal. An ashbin and slide-out tray make ash removal clean and easy. A shaker grate, front and side doors, cook top, probe thermometer, glass windows, and firescreen are among the other standard features.



Compare Our Stoves With Any Others

Compare these features, standard on our most popular model, the Federal Convection, with those on any other stove:

- All cast-iron construction
- Wood and coal burning capabilities
- Ashbin with slide-out tray
- Front and side loading doors
- Double-chambered baffle
- Convection (circulating) system (optional blower)
- Catalytic adaptability
- Glass viewing windows
- Firescreen for open fireplace burning
- Polished cooking top
- Internal temperature gauge
- Primary and secondary air
- Solid brass trim
- Available freestanding or as a fireplace insert

FREE CORNING CATALYTIC COMBUSTOR

To encourage everyone to take advantage of the most important advance ever in the technology of safe, clean woodburning, we will be giving away a free Corning Catalytic Combustor with every stove purchased this spring. A Corning Combustor can increase the efficiency of your stove as much as 50%, while reducing creosote build-up and smoke pollution 90%. We are also holding over our 1984 pricing until May 22, 1985. You can save up to \$164. Write or call for details.



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**Easier cold weather starting, better fuel economy,
better performance, and longer engine life.**

For more than 20 years lubrication experts have been wrestling with the problem of finding a way to combine PTFE, commonly known as Teflon® or Fluon®, with motor oil to reduce friction. Finally a breakthrough was achieved. The result was a product that is changing the way people think about lubrication — TUFOIL® for ENGINES. TUFOIL®, added to your favorite motor oil is better at reducing wear, increasing power, improving fuel economy, and enhancing overall performance than *any* engine lubricant you can buy. Much better!

Furthermore, TUFOIL® will improve the efficiency and performance of standard transmissions and differentials by reducing their internal friction.

At the suggested list price of \$12.95, a little TUFOIL® goes a long way and pays for itself many times over. Next time you change your oil, really change it! Add TUFOIL®.

Users everywhere praise TUFOIL — you will, too!

"There are lots of slick oils on the market but we've found one that does what it promises... TUFOIL works. It stayed in dispersion and cut the fuel bill 10%."

Popular Mechanics Magazine, January 1982

"With \$25,000 engines generating in excess of 3000 HP, you don't take chances. Tufoil... I wouldn't run without it."

AL SEGRINI, Owner/Driver, National Champion/Brut Faberge/Top Fuel Funnycar

"Lubrication engineer Franklin Reick succeeded where everyone else had failed... TUFOIL is a unique, different, but safe kind of Teflon/oil additive."

Motor Age Magazine, April, 1982

Accept no substitutes!

Many have tried to combine PTFE or TFE in motor oil. Only TUFOIL has succeeded. In all other products the PTFE will settle out of dispersion and coagulate. Such products instruct, "SHAKE WELL BEFORE USING". Many suggest engine flushes and extended idling time after addition. None of this is necessary

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With numerous U.S. and international patents, TUFOIL is the only recognized, stable combination of PTFE and motor oil. TUFOIL is patented, insured and guaranteed!

How TUFOIL Works

TUFOIL coats all the moving parts of engines with micro-miniature particles of PTFE, the slipperiest substance known to science. This coating minimizes friction well beyond the capabilities of any other lubricant.

Only in the patented TUFOIL process the PTFE particles are given a uniformly negative charge which causes them to repel each other so that they remain in dispersion. This dispersion serves two very important values. One, it prevents the particles from forming clumps which can clog oil lines and oil filters. Two, it keeps surplus PTFE particles suspended in crankcase oil ready to replace any particles dislodged from metal surfaces by the action of the engine's moving parts. This is accomplished by means of a chemical agent which causes the dispersed particles to seek out and continually coat metal surfaces as they become exposed.

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PM LONG-TERM CAR TESTS

MAZDA RX-7 GSL-SE

Fun with an old friend

FORD TEMPO GLX

Sensible—almost sporty—family transportation

BUICK REGAL T TYPE

Red hot and trouble-free

OLDSMOBILE CUTLASS CRUISER

Back on the right track at last



Rotary-engined Mazda RX-7: high-tech performance and luxury.



Aerodynamic Ford Tempo GLX: quiet, reliable, good family fun.

We just took delivery of a hot Mazda RX-7, and we're rolling up the miles on our hard-working Ford Tempo. Meanwhile, the turbocharged Buick Regal T Type and Olds Wagon have been returned to their manufacturers, and we've included a wrap-up report here.

Mazda RX-7 GSL-SE

You can't please all of the editors all of the time, but Mazda's RX-7 GSL-SE comes darned close. Recently delivered to us well broken in, with 3,500 dealer-demo miles, the metallic black Mazda wins universal praise from everyone who has driven it. In every case the most repeated phrase is "fun to drive," and the new SE package is largely responsible for that.

The leading attraction of this top-of-the-line RX-7 is its 13B twin rotor engine, an improvement that boosts output from the 12A's standard 101 hp to an inspiring 135. The 80-cu.-in. 13B saw service 10 years ago in the RX-4, but has been considerably refined since then. It features electronic fuel injection (standard 12A engines still use a two-stage four-barrel carburetor), auxiliary secondary power ports that come into play only at high engine speeds and a tuned port Dynamic Effect Intake tract design.

Performance improvements don't stop at the firewall, though. The SE option has been upgraded to include 60-series V-rated Pirelli P6 tires, 14-in. alloy wheels and ventilated disc brakes on the rear as well as the front. Creature comforts in the package include air conditioning, cruise control, multi-adjustable driver's seat, a pop-up-or-remove sunroof and an average-sounding radio/cassette deck with graphic equalizer.

Gas mileage in our first few tankfuls has hovered around 18 mpg, rather good for all the power available and the thrashing about the car has seen. Complaints at this point are limited to minor details: a too-loud rear wiper motor, a

stereo speaker joystick control that is easily bumped out of position and an alarming over-rev warning beeper. Probably due to its several-year-old design, the RX-7 also has wind noise levels noticeably higher than more recent sports car offerings.

The rotary engine is smoother than most of the four-cylinder cars that pass through our garage. It makes wonderful sounds when pressed, and has plenty of power to allow throttle steering when desired. No doubt about it—the 135-hp RX-7 is happiest as a tail wagger, and even with light-touch power steering remains predictable and entertaining to throw around.

From the experience of the RX-7 owners we know, it seems that the reliability problems of rotary engines are well under control, and the gas mileage is much improved. When you factor in the sheer joy of driving the super-quick GSL-SE model, it has to rank as one of the world's best sports car bargains at \$15,295.—N.S.M.

Ford Tempo GLX

When Ford introduced its front-drive Tempo compact in May 1983, it was a radical departure from the rear-drive Maverick it replaced. The new five-seat family car had the tuberous aero look of Ford's radical T-Bird and SVO Mustang. But would the aero look sell to the family sedan crowd? That was Ford's big gamble. After rave reviews in our *PM Owners Report* (page 94, Dec. '83), we decided we'd like to live with a Tempo for a while to see what all the fuss was about.

We took delivery of a gray four-door some six months ago. With only 1,000 miles on the odometer, it was barely broken in. So far, our half year with the Tempo has been absolutely boring—nothing serious has gone wrong with the car, which is exactly what most people expect in the way of

(Please turn to page 58)

PM LONG-TERM CAR TESTS

(Continued from page 57)

reliable family transportation.

The Tempo is not very exciting or fast (nor was it designed to be), but it has willingly performed every task we asked of it—from vacation excursions, to the daily commuting grind, to just sitting in airport parking lots: Such reliability may not make for great reading, but it would be appreciated by any owner.

The 84-hp, 2.3-liter pushrod Four is the car's weak point. It's a regular tractor motor, with just enough power to get the job done, but hardly any left over for fun. You've got to really row the five-speed transaxle to get any performance out of the car at all, but at least it's faster than the automatic. For '85, Ford has rectified this power shortage with an optional 100-hp HSO engine with throttle-body fuel injection, freer-breathing cylinder heads and a lower 3.73:1 final drive ratio (vs. 3.33 on our test car).

Once past the flat spot in the middle of its rev range, the carbureted '84 model is an excellent road car that really likes to be driven quickly on winding, undulating roads, despite the annoying moan of the Michelin XA4 all-season radial tires. Although the 175/80R13 tires tend to whimper when pushed, they're big enough to provide plenty of traction to make the Tempo move.

If you keep the windows closed, the aerodynamic Tempo is an exceptionally quiet car, and we were often shocked to glance down at the speedometer and find that we were going 20 mph faster than we thought. The car's so quiet that the speed just sneaks up on you. This is where cruise control can keep you out of trouble, and Ford's system is especially handy, with its COAST and ACCELERATE buttons. Unfortunately, they're located on the steering wheel spokes, where they can be triggered accidentally.

Our test car had a headlight flasher, which we greatly appreciated, but no rear window defogger, which is required by law on cars sold in New York state, but apparently not in Michigan, where this car was registered.

One staff member felt that the Tempo's interior, with its high window line, thick pillars and wraparound aero roof was claustrophobic. Brighter colors might have cured that, but our test car was dark gray with a gray corduroy interior—a favorite combination at Ford this year. Despite the grim color, the upholstery has held up remarkably well in tough family use, and shows absolutely no signs of wear.

The car does have a couple of annoying traits. One is the harsh rebound characteristics of the shock absorbers,

which cause a horrible thud when the wheels drop into sharp depressions like potholes or displaced paving slabs.

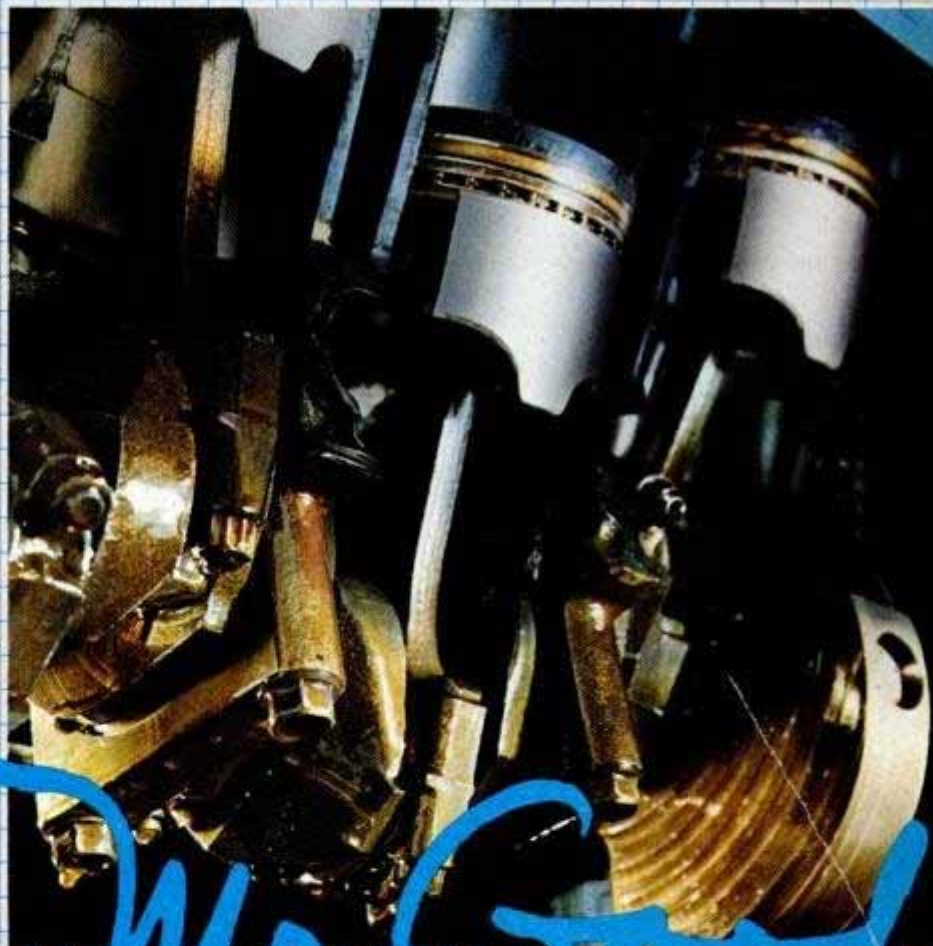
The other problem is a deceitfully optimistic gas gauge that hangs around the "F" level for over 120 miles, then takes a plunge for the cellar. Two staffers ran the Tempo out of gas when they assumed that "E" meant "nearly empty." Having run out of gas one night near home, I found that a 2 1/4-gal. can of gas would bring the needle for our Tempo's 14-gal. tank to above the "1/4" mark. The '85 Tempo has a new 15.2-gal. tank, and hopefully a more accurate gauge.

Despite these minor quibbles, the Tempo has provided over 6,000 miles of reliable service. So reliable, in fact, that we never thought to bring it in to have three minor problems addressed: a squeak in the steering column, a slight engine stumble on cold mornings and fuel economy of "only" 22.4 mpg. But, Ford insisted we bring it in: They fixed the squeak, and a carburetor adjustment upped our average to 25.5 mpg while eliminating the stumble.—W.H.

Buick Regal T Type

When we set out to test the Buick Regal T Type, what we really were

Worn oil grinds your engine's life away at 200 strokes per second.



Mr. Good

testing was its turbocharged engine. You readers, and we, wanted to know if a turbo engine held up as well as a normally aspirated engine. And we also wanted to find out if a turbo engine required extra special maintenance or attention.

Now, after brutalizing our turbocharged Regal T Type test car for over 7,000 miles (probably the equivalent of 15,000 normally driven miles), we have our answers.

The Buick Regal T Type is one of the hottest cars sold in the U.S. of A. With 200 hp on tap, this Regal will smoke the rear tires from a standing start whenever

you want to impress the guys at Pizza City. And, with the standard T Type suspension setup, you can run rings around most of the so-called sports cars you'll meet at your favorite on-ramps. This is a car that loves to be pushed. And we pushed it.

So what happened? Except for a mighty sore right leg—from pushing down on the gas pedal all the time—not much.

The only notes in our logbook relate to some things breaking on the car itself, never on the engine. At 4,682 miles, we had to replace the fuse that controlled the operation of the lighter,

radio and electric door locks. Also at 4,682, one of the sound system's rear shelf speakers fell out onto the trunk floor, which may have caused the fuse to blow. At 4,815, a tree got in the way of the radio antenna and snapped it off. And that's about it.

As to maintenance, we found out that there is actually *less* scheduled maintenance required on Buick's turbo engine compared with Buick's normally aspirated V6. For instance, since there is no carburetor or distributor on the turbo engine (it has electronic sequential fuel injection and a computer controlled ignition system), there is no such thing as a carburetor or distributor adjustment. The fuel injection and turbo units themselves require no scheduled maintenance. Other items, such as oil changes and sparkplug replacement, are identical to regular Regal V6s.

A recent bit of research by Runzheimer and Co. consultants shows that there is a definite cost disadvantage to owning and operating a turbocharged vs. nonturbocharged car. Runzheimer research says that it will cost you \$4,816 per year to own and operate a turbo Regal vs. \$4,299 for a normally aspirated Regal.

We're sure that most of this difference comes from increased fuel usage. With all that power under our foot, we used it. Often. As such, our average fuel usage was 13.9 miles per gallon, whereas the federal EPA rates the Regal T Type at 17 mpg city and 28 mpg highway. Obviously, the lighter your foot, the better your fuel mileage will be. We got as much as 20.5 mpg on one tank and as little as 11.4 on another.

Another difference in cost of operation is that Buick recommends premium unleaded fuel be used in their turbo engines. And high-test costs more than regular.

We liked the Buick Regal T Type a lot. Everyone on the staff who drove it raved about the car's performance and handling.

No one liked the fuel economy. But, of course, the Buick Regal T Type is not meant to be an economy car. It's a performance car, pure and simple.

If you want, and can afford to operate, a performance-oriented car, don't be scared off by the horror stories regarding turbocharged engines. Based on our experience with this Buick Regal, turbocharged engines will stay together and the maintenance is no more involved than on a normally aspirated engine. Turbos forever.—J.O.

Oldsmobile Cutlass Cruiser

Our trials and tribulations with the front-drive Cutlass wagon were well-documented in our last episode (see *PM Long-Term Car Tests*, page 70, July [\(Please turn to page 163\)](#))

New life-saving fluid eases the grind.

Your car's engine is incredible. As Mr. Goodwrench explains, "At 55 mph, a 6-cylinder engine makes about 14,000 piston strokes just to carry you a mile. Many engines may last over 100,000 miles—or more than a billion-and-a-quarter strokes. Yet, many engines don't last that long. Too many of those strokes caused wear. The culprit could be worn motor oil.

Worn motor oil shortens your engine's life quickly. It's full of dirt, water, metal particles, gasoline and nearly countless other abrasives and chemicals.

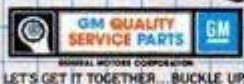
What can help make the difference in engine life? Regular oil changes. New life-saving fluid. And choose the right motor oil... a fine quality oil like GM Goodwrench Motor Oil.



GM Goodwrench Motor Oil meets or exceeds all GM specifications for General Motors cars and light trucks. So ask for this fine motor oil by General Motors whenever an oil change and lubrication are recommended by your GM maintenance schedule."

While you're there ask Mr. Goodwrench to check your

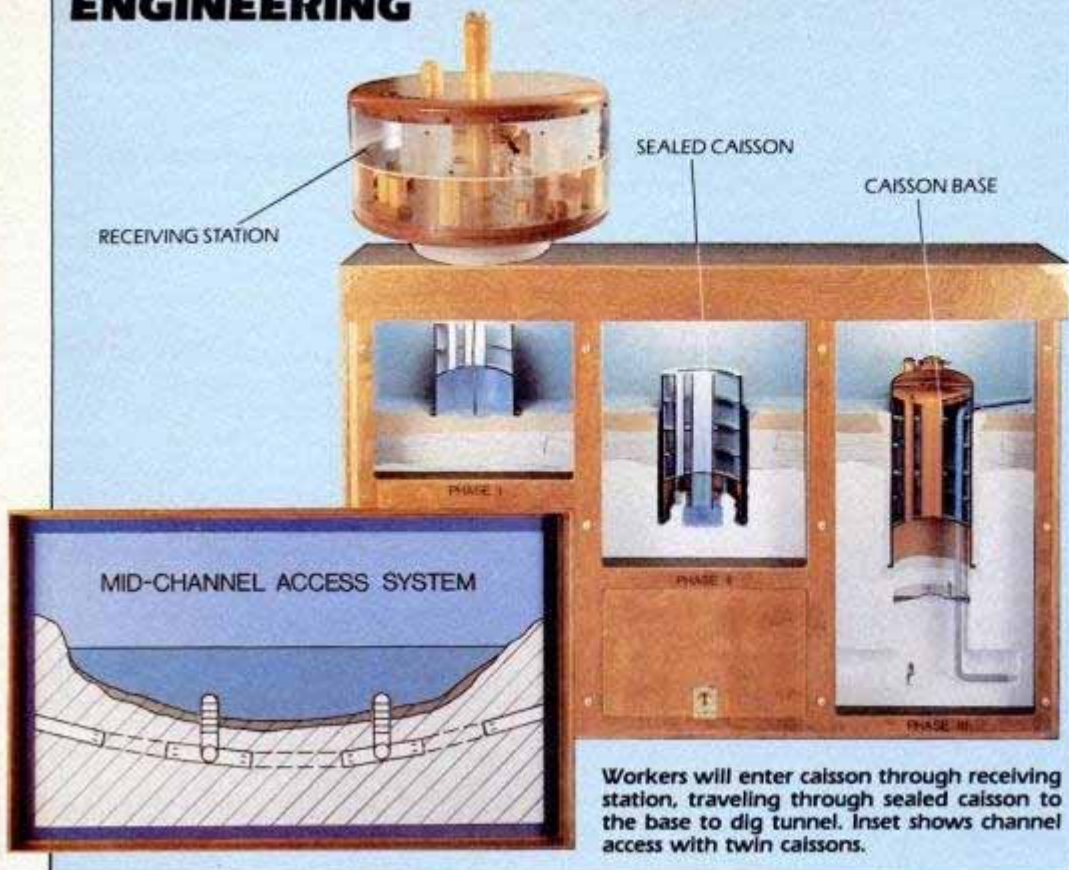
filters. New filters should help protect your engine, too. Mr. Goodwrench has quality GM parts available. Plus he has the right equipment and training. GM training. He's at participating independent GM dealers who sell Chevrolets, Pontiacs, Oldsmobiles, Buicks, Cadillacs, GMC and Chevy trucks.



Goodwrench

KEEP THAT GREAT GM FEELING WITH GENUINE GM PARTS

ENGINEERING



Workers will enter caisson through receiving station, traveling through sealed caisson to the base to dig tunnel. Inset shows channel access with twin caissons.

COURTESY STONE AND WEBSTER

Channel tunnel

England and France have long been talking about building a tunnel under the English Channel. The main problem has been the cost. During the construction, interest rates alone would cost hundreds of millions of dollars. But Taurio Corp. engineer J. Vincent Harrington has designed a tunnel-building caisson system that promises to cut the project time in half, and now the French and English are talking tunnel again. The caisson system allows engineers to tunnel in opposite directions at the mid-channel with one caisson. That cuts construction time in half. If two caissons are placed equidistant from the channel center, construction time would be two-thirds shorter. A model, made by the Stone and Webster engineering firm of Boston has been shown to the Europeans, and they like the concept.

Fireproof fuel for safer flying



Test plane carrying untreated fuel bursts into flame as it impacts at 170 mph. It was launched from a ramp to simulate crash landing.

The most fearsome killer in airliner crashes is fire caused by spurting jet fuel. According to FAA statistics, it accounts for 35 to 40 percent of all deaths in accidents that would otherwise have been survivable.

In order to ignite readily, jet fuel must form a fine mist, as it does when it spews from ruptured fuel lines under pressure. Now an antimisting additive, known as Avgard, prevents this, greatly reducing the chance of fire. The additive, a particle-trapping



No fire follows crash of second plane using Avgard-treated fuel.

polymer developed by ICI Americas of Wilmington, Del., causes the fuel to thicken as it's exposed to air, keeping it from breaking up into flammable droplets.

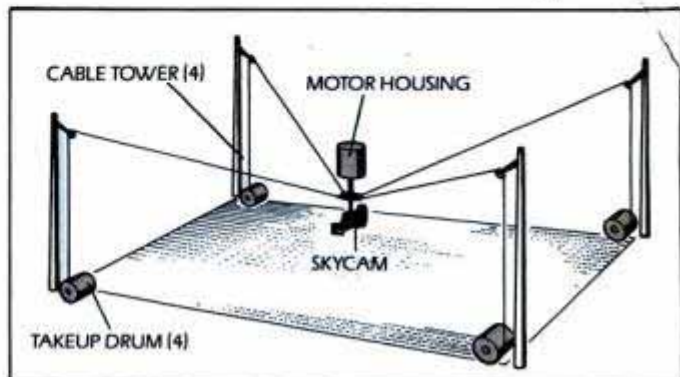
Editor: Dennis Eskow
Contributors: Sheldon M. Gallager, Frank Davidson,
Steve Eskow, Ida Beck, Joel Rieman.

MOVIES Flying camera

In Neil Simon's new film *The Slugger's Wife*, we follow an athlete as he rounds the bases. The camera is always just over the runner's head, so the shot in the Columbia Pictures movie is breathtaking. It was made with a Skycam, invented by Garrett Brown. The motorized camera runs along four cables that play out of drums. By tightening and loosening the cables, Skycam can gain and lose altitude as it shoots.



Skycam (above) runs on cables to move over its subject, as shown in drawing (below).



SPACE

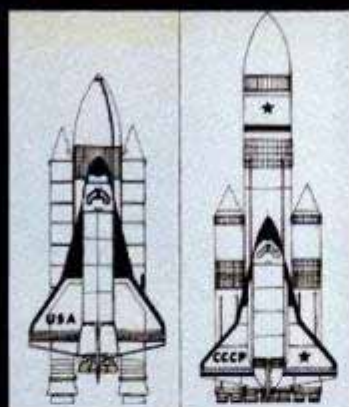
Soviet shuttle is a copycat

Are the Soviets about to launch their own version of the Space Shuttle? Defense Department sources say it's a sure bet.

Reconnaissance photos taken late last year caught what intelligence analysts believed to be the recovery at sea of a scaled-down Russian shuttle prototype called the space plane.

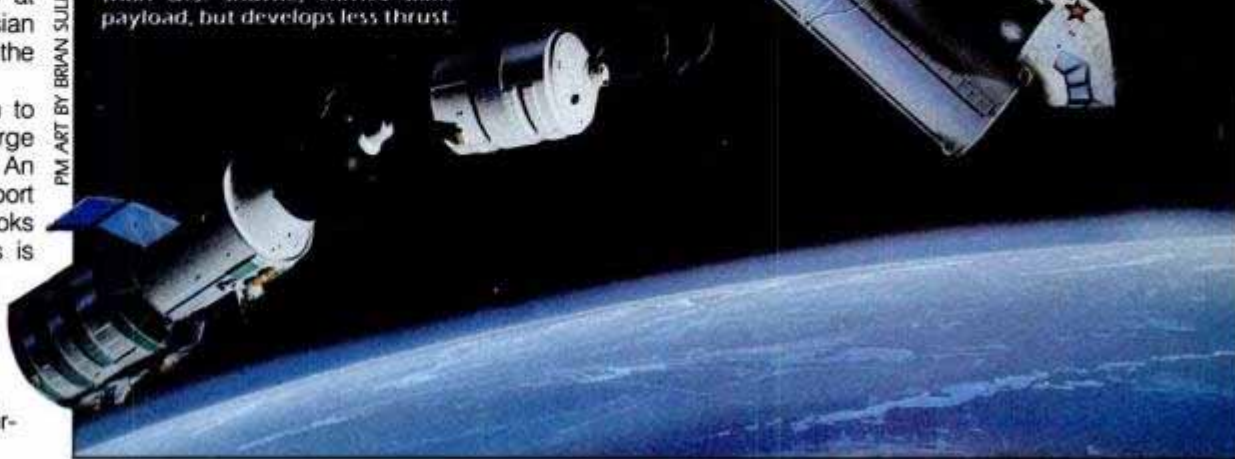
The Soviets are known to be furiously building large launching pads this year. An unclassified Air Force report says the Russian shuttle looks a lot like ours, but theirs is much more massive (see comparison sketches inset).

The Russian model also has less takeoff thrust, making it less maneuverable than ours.



Soviet shuttle (right) is bigger than U.S. shuttle, carries same payload, but develops less thrust.

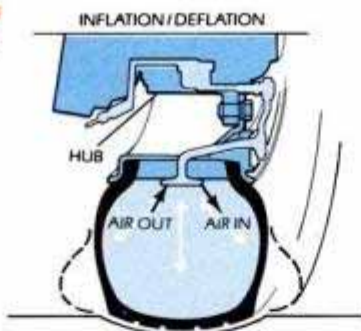
PHOTO BY BRIAN SULLIVAN



AUTOMOTIVE

Highway footprints

When you're hauling cargo on a truck, different road conditions call for different tires. But AMC General is introducing a military truck tire that changes all that. The enhanced mobility system (EMS) tire rides on a wheel that carries an air tank in its hub. A tube from the tank can be opened to add air to the EMS tire, expanding the tire's footprint. Unlike your car's tires, these radials are *deflated* down to a point where they have a



645 cm² HIGHWAY
1,250 cm² COUNTRY
1,677 cm² SNOW

Truck's EMS tires inflate or deflate with an air supply that sits under the axle (far left). Tire footprints have 645 to 1,677 square centimeter range for handling various terrain.



645 cm² footprint for highway driving. Or they inflate up to 1,250 cm² footprint for country roads, or 1,677 cm² for snow or mud. The Army is experimenting with the tires, which may see civilian use within the next five years.

Gas pump bits

Self-service gas will soon be going to a new extreme. NCR Corp. and Wright Express have developed a gas pump that serves credit card customers automatically. Insert a credit card, punch in a secret code, fill the tank and you get back your credit card and a bill. Depending upon what gas station you patronize you can use anything from a bank debit card to a Wright Express card. If you enter your odometer reading when using the Wright Express card, you'll also get a cost-per-mile statement with your monthly bills.



At the new gas pump, insert your credit card, punch in secret code and fill the tank.

MEDICINE

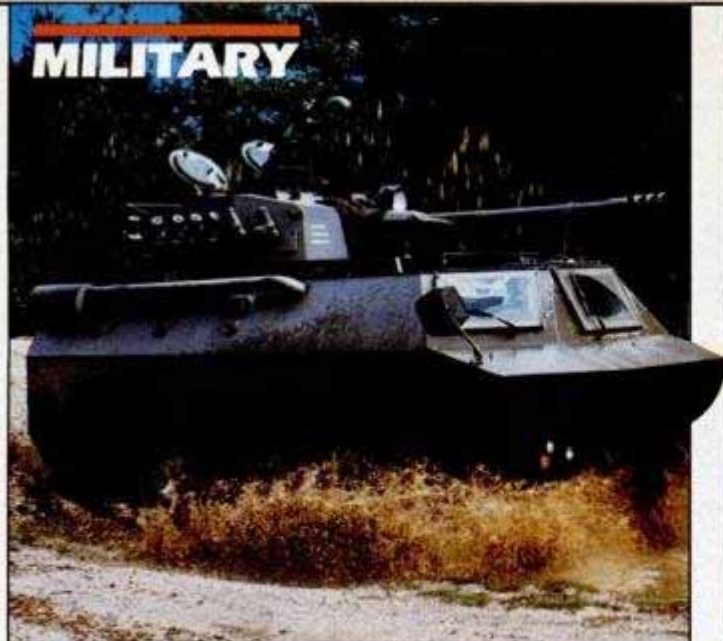
Recounting calories

Most food calorie tables used today are based on data collected at the turn of the century when fresh foods were dominant. Processed foods may contain more calories than their fresh counterparts. Thus, Agriculture Department researcher C.E. Bodwell has developed a "live-in calorimeter." The chamber's 1,600 sensors measure various body functions. By next year, the calorimeter is expected to update most calorie charts.



Scientist monitors a patient to check calories in his food.

MILITARY



Wheels for the light brigade

Britain is following in the footsteps of the United States by adding quick-strike light-weight armored vehicles to its defense establishment. The Valkyr, shown above, carries 10 soldiers at top speeds of more than 60 mph. A turbo-

charged diesel engine propels the vehicle over any terrain. Light tanks and other armored vehicles will be NATO's mainstay for European defense. The vehicles are easier to air-drop and lighter on fuel than their ancestors.



New jump jets go supersonic

The long-sought supersonic V/STOL fighter may become a reality sooner than expected. Both McDonnell Douglas and General Dynamics have announced plans to produce a vectored-thrust interceptor that will combine Mach 2 speed with the ability to move straight up and down like a helicopter.

The General Dynamics E-7, shown as a scaled-down wind tunnel test model at left, above, embodies a slightly modified concept known as STOVL (for Short Take Off and Vertical

INVENTIONS

Odd hybrid lifts heavy loads



Small test model lifts 2 tons. Larger versions will haul 16 tons.

It's sort of a blimp, helicopter and airplane all rolled into one. Designed as a heavy lifter for the logging industry, the Cyclo-Crane consists of a gas bag surrounded by four wing-and-engine clusters on outrigger stalks.

For takeoff, the wing-and-engine clusters turn lengthwise and the entire rig rotates

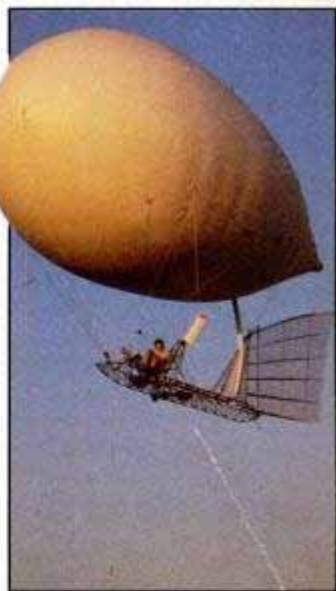
on its horizontal axis, clawing itself upward like a vertical paddle wheel. For forward flight, the clusters swing crosswise to provide horizontal lift and thrust.

The control cab and load will hang from bearings that allow the bag to rotate. It was developed by Aero Lift Inc. of Tillamook, Ore.

AVIATION

We're walking on the clouds

Inventor Bill Watson, who helped Paul MacCready build the fabulous Gossamer Albatross man-powered airplane, has introduced a man-powered blimp. The helium-filled White Dwarf uses aluminum tubing for its fuselage ribbing. A layer of sealed Dacron forms the air bag. The pilot sits in an open one-man cockpit and pushes pedals that drive a movable propeller shaft. Moving the propeller up or down gives the White Dwarf forward thrust as well as the ability to correct pitch and yaw in flight. Directional control is achieved with a hand-operated over-sized rudder. It has to be large to give steering stability to the slow-moving blimp. Watson sold the first White Dwarf to a California comedian who bills himself as "Gallagher." He'll use the airship as a prop.



Man-powered blimp "White Dwarf" has a sealed Dacron body. Pilot sits in open cockpit.

PHOTOS BY JOEL REIMAN



General Dynamics E-7 [facing page] gets vertical lift from downward rush of compressed air through ducts in wing. Duct doors, shown open here, swing closed for forward flight. McDonnell Douglas 279-3 [above] uses thrust-boosted version of famous four-nozzle Rolls-Royce Pegasus engine that powers current Harrier jump jet. Nozzles tilt down for vertical lift, up for forward thrust.

Landing). While it will be capable of landing vertically, it will make use of a short takeoff run to permit the carrying of greater payloads. For vertical lift, it will draw air in through auxiliary ducts in the top of its delta wing. This air will then be compressed and expelled downward to produce upward thrust. For forward flight, the ducts will be closed and the plane will operate as a conventional rear-thrust jet.

The McDonnell Douglas Model 279-3, shown in the artist's impression at right, above, is an advanced canard-winged configuration designed around the same four-nozzle Pegasus

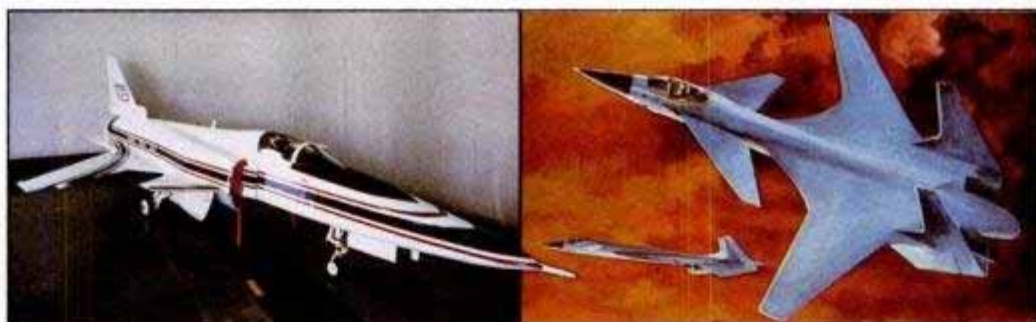
engine used in the current subsonic V/STOL Harrier, but with added combustion chambers to provide supersonic thrust (see *Coming: Jump Jets That Break The Sound Barrier*, page 59, June '84). Like the Harrier, it will be capable of vertical takeoffs and landings, but will have twice its speed and payload.

Vectorable engine nozzles—exhaust ports that tilt up and down to change the direction of thrust—will be used by both fighters not only to shorten takeoffs and landings, but also to increase their maneuvering agility in combat. Both prototype planes could be operational as early as 1990.

Fighter for the future

Grumman's exotic new forward-swept-wing X-29A (near right), the first government-backed experimental fighter in more than a decade, has made its public debut and will soon begin flight testing.

The radical front-swept wings, not practical on a supersonic aircraft until the recent advent of high-strength composites, offer many known aerodynamic advantages over conventional aft-swept wings. Because of better airflow control, they increase lift, reduce drag,



Grumman's X-29A (left) and futuristic concept (right) both employ stubby canards as well as forward-swept main wings. Canards act as elevators, increase maneuverability and improve low-speed control.

save fuel, lessen the danger of stalling and greatly improve combat maneuverability.

Expected to cost up to \$140 million, the X-29A program is jointly funded by

Grumman and DARPA, the Pentagon's Defense Advanced Research Projects Agency. At far right, above, is a Grumman concept for an even more radical future ver-

sion with forward-sweeping tail fins. The X-29A may spawn a whole new generation of forward-swept-wing aircraft—not only military, but commercial as well.



Oops! Your tail is dragging

Ever wonder if the tail of an airliner can hit the ground as the plane rotates steeply for takeoff? Well, see for yourself. The rare sight at left is of Boeing's new 737-300 jetliner deliberately dragging its tail on the runway as it attempts a low-speed takeoff during FAA certification tests.

The tests, known as Velocity Minimum Unstick measurements, determine the slowest takeoff speed that will still permit an aircraft to become safely airborne. The tail, protected by a wood skid, scrapes the pavement due to the low acceleration. But don't worry, folks, it only happens in tests.

TU



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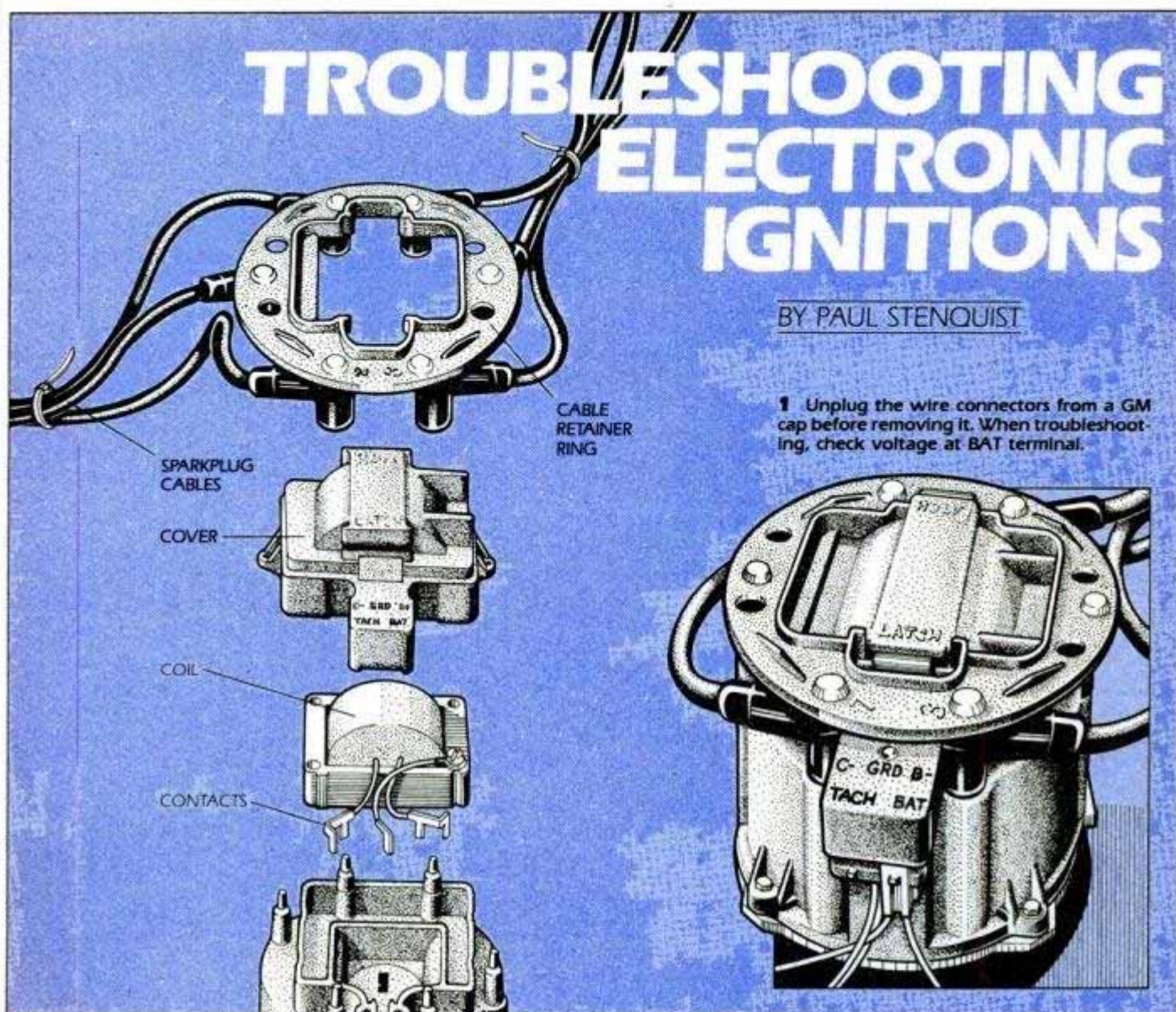
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TROUBLESHOOTING ELECTRONIC IGNITIONS

BY PAUL STENQUIST



1 Unplug the wire connectors from a GM cap before removing it. When troubleshooting, check voltage at BAT terminal.

GM's High Energy Ignition (HEI) system mounts the control module and coil inside the distributor. On most other makes, these items are elsewhere in the engine compartment.

The nearly universal use of electronic ignition systems has totally changed the traditional tune-up. Gone forever are the days when a knowledgeable home mechanic could solve almost any ignition problem with a test light and a feeler gauge. Gone, too, is the periodic parts-replacement ignition tune-up. In their place are some regular maintenance checks and the sometimes complex fault-finding procedures that are used only when performance or driveability problems appear or when a vehicle fails to start.

Ignition maintenance

Electronic ignition maintenance should be part of your 15,000-mile checkup. Start with an inspection of the coil on vehicles equipped with an external ignition coil. (Most GM engines mount the coil within the distributor cap.) Look for evidence of external current leaks or oil leaks. Check the tower (where the coil cable plugs in) for signs of carbon tracking, arcing or burn-through. Now examine the coil cable itself for split or cracked insulation, corrosion or any other signs of damage.

Replace both the coil and cable if the coil tower shows any evidence of electrical leakage. A slightly defective cable connection can quickly ruin a new coil. Replace just the cable if it is beginning to deteriorate but has not yet caused leakage at the coil.

Once you've completed your inspection of the coil, remove the distributor cap. The cap is retained by screws or spring clips.

Before attempting to remove a GM HEI cap with an integral coil, disconnect the wiring connectors from the terminals marked BAT and TACH (Fig. 1). HEI caps are retained by four screw latches; some late-model HEI caps have four conventional screws.

Carefully examine the inside of the distributor cap. Use a flashlight or drop light, so that you won't miss the more subtle signs of failure. Look for the carbon tracks that indicate current jumps. Check for cracks in the carbon button that joins the center of the distributor's rotor to the central cable terminal in the cap. Examine the entire inner surface of the cap carefully to make sure the plastic is not cracked. Replace the cap if it is even slightly damaged.

Check the metal terminals within the cap. If they are only slightly corroded, attempt to clean them by scraping with a sharp knife (Fig. 2). If they don't clean up easily, replace the cap.

Note the condition of the distributor rotor. It should be free of cracks, signs of arcing or burn-through, and serious corrosion. Again, a small amount of corrosion can usually be removed from the rotor's outer contact with a knife, but deep erosion or corrosion on the rotor's inner contact is reason for replacement.

While the rotor is off, check to see if

the distributor is equipped with centrifugal timing weights that are mounted directly under the rotor. These spring-loaded weights swing away from the center of the distributor as engine speed increases, changing the position of the rotor and, consequently, advancing the spark.

If the weights are corroded, clean them and apply a very small amount of white lithium grease to pivot points and other wear areas. If the weights stick in the advanced position, hard starting and spark knock can result.

When reinstalling the rotor, make sure it is fully seated on the distributor shaft. All rotors are keyed so that they can only be installed one way.

The tips of some rotors are coated with a special silicone grease. If you found this substance on your old rotor, make sure you apply it to the new one. You should be able to purchase the right compound at a good auto parts store or from the parts department of your dealership.

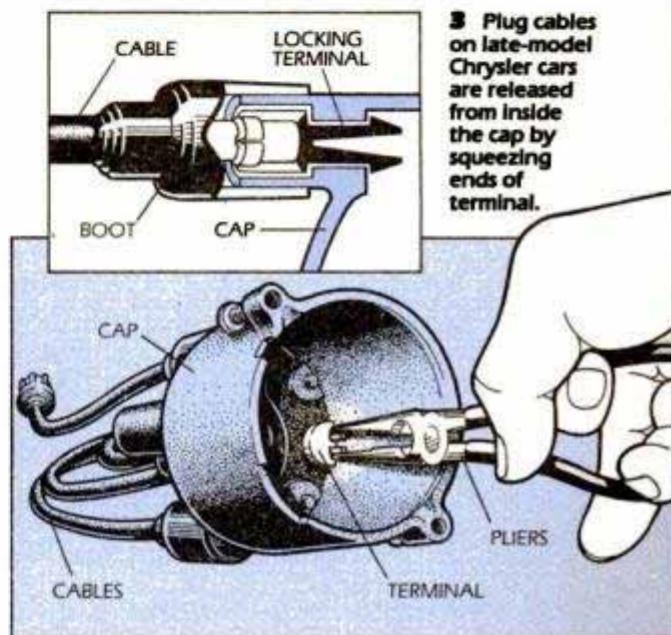
Next, examine the terminal connections on the top of the distributor cap. On GM HEI caps, you'll have to release the latches that hold the cable retaining ring in place. Each cable should fit tightly on or in its terminal, and the connection should be free of corrosion. Check for signs of burn-through, arcing or current leakage

around each terminal, but don't remove the cables from the cap unless signs of damage are present. (On HEI caps, the wires disengage from the cap when the retainer is removed.) Plug cables on late-model Chrysler Corp. caps are retained by locking terminals and must be released from inside the cap (Fig. 3).

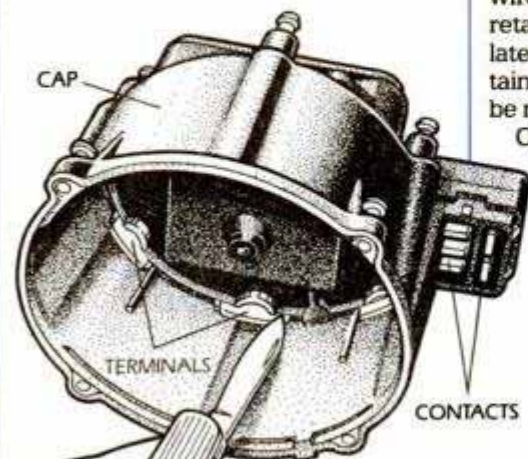
Clean the sparkplug cables with non-flammable solvent on a soft rag. Do not, however, remove any insulating lubricants from the wire terminals. Examine the wires for brittleness, cracking, insulation cuts or other signs of damage. If cable condition is generally deteriorated, replace the whole set. If one cable seems to have suffered isolated damage, replace just that cable.

engine is running if misfire has been a problem or if the cables are suspect. Do not attempt this test on late model GM or Ford cars, as serious electrical shock and ignition system damage can occur.

To test for cable leaks on Chrysler products, connect the blade of a screwdriver to a ground with an alligator-clip jumper wire. The screwdriver must have a plastic or wooden handle so you'll be insulated from the current. Disconnect the suspect plug cable from the plug before starting the car and position it so that it cannot arc to ground. (Any metal part of the car is a ground.) Start the engine and move the blade of the grounded screwdriver along the length of the disconnected



3 Plug cables on late-model Chrysler cars are released from inside the cap by squeezing ends of terminal.



2 Clean corroded terminals inside the cap with knife blade, if possible. If not, replace cap.

Voltage leak tests

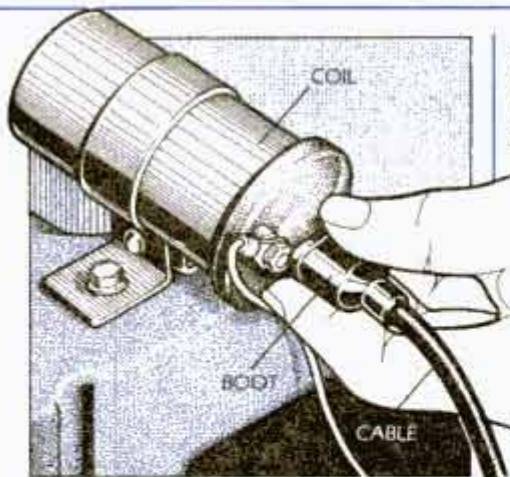
Chrysler Corp. ignitions operate at relatively low voltage levels, so cables can be tested for voltage leaks while the

cable, watching for the telltale arc of a voltage leak. Don't touch the cable end or the screwdriver blade. Shut off the engine after each test, reconnect the cable and remove another for testing.

You can test the coil cable in the same manner if you disconnect one plug cable. Total test time must not exceed 10 minutes or catalytic converter damage can occur.

Ford suggests testing plug wire and cap terminal condition with an ohmmeter. With the distributor cap off and cables in place on the cap, connect the ohmmeter to a terminal within the cap and to the sparkplug end of the cable joined to that terminal. Resistance should measure less than 5,000 ohms per inch of cable length. If it does, the distributor cap and cables are okay, providing they are free of cracks or any other visual damage.

If the resistance of the cable and cap terminal combined exceeds 5,000 ohms per inch, check the cable alone



4 To seat a cable connector properly, squeeze the boot to release trapped air.

after removing it from the cap. If resistance still exceeds 5,000 ohms per inch, the cable is defective and must be replaced. If resistance is now okay, the distributor cap is the source of the problem and must be replaced. Check all cables, one at a time.

If you find that you have to replace the ignition cables, purchase a high-quality brand-name set that is designed specifically for your car.

If the terminals of the original wire set were coated with some type of silicone grease or other lube, make certain that the same coating is applied to the new wires.

Route the wires in exactly the same way as the original equipment, using all the original looms, separators and supports. When inserting wires with nipples into the cap terminals, push in the cable slightly, squeeze the sides of the nipple to release trapped air, then push the cable the rest of the way in (Fig. 4). It should snap into place. Make certain that the plug end of the new cable seats fully on the plug terminal. A poor connection at either end can result in damage to other ignition components.

Fault-finding diagnosis

The troubleshooting of specific ignition problems—such as misfire, no-start and intermittent die-outs—can be rather complicated.

Most procedures begin with a simple spark test. This test will at least tell you if a no-start condition is the result of an ignition fault, because it can verify that current is being supplied to the sparkplugs. The test is a simple one, but the procedure differs for cars equipped with high-output systems.

To test for spark on Chrysler products and other cars with low-output ignition systems, remove the large secondary cable from the center tower of the distributor cap. Wearing a leather

glove or using a pair of insulated pliers, hold the exposed terminal end of the wire $\frac{3}{16}$ to $\frac{3}{8}$ inch away from a good engine ground (any exposed steel or aluminum on the engine). If you can't find a bare metal spot, scrape a bit of paint off a bolt head. Have a helper crank the engine while you watch for the ignition spark to jump from cable to ground. It should be a bright blue, constant spark. If it's intermittent, weak or completely lacking, the ignition system is the cause of the no-start problem.

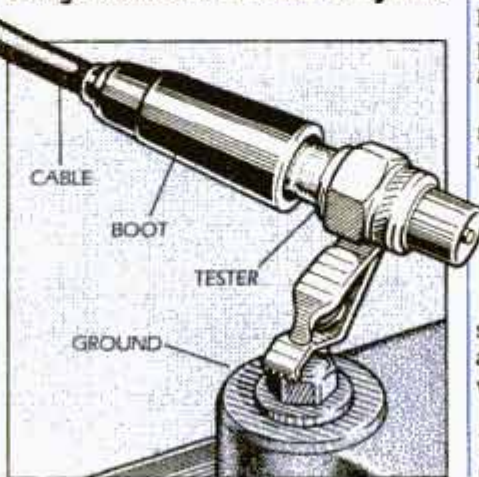
While the wire is arcing and the engine cranking, begin moving the wire farther away from ground while watching for a spark at the coil tower. If a spark occurs at the coil, replace it and the coil cable.

To check for spark on high-voltage late-model GM and Ford systems, you'll need a spark-test device. This tool resembles a sparkplug with a spring clamp attached to its base. It allows you to test for spark without holding the dangerous high-voltage cable. You can purchase this tool at a good auto parts store.

To test, connect the ignition coil cable (or, on GM cars with integral coil, one of the sparkplug cables) to the end of the tester and clamp it to a ground (Fig. 5). Then, crank the engine while watching for spark between the center electrode of the tester and the grounded shell that surrounds it. If you don't get a bright blue spark, the ignition system is not functioning properly and further diagnosis will be necessary.

To perform further diagnosis of an electronic ignition system, you should have a factory service manual for your vehicle. The manual contains specific troubleshooting directions for determining the cause of no-start, misfire and intermittent die-out problems. In most electronic systems, possible fail-

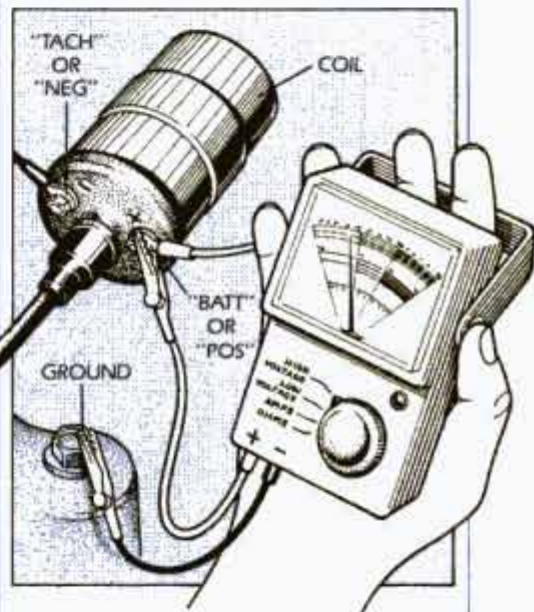
5 Use a tester to check for spark on high-voltage late-model Ford and GM systems.



ures include the pick-up, which determines the sparking intervals; the control module, which triggers the coil; the coil; primary wiring; and in many cases, an engine control computer that determines spark advance. Some manufacturers use different names for these devices.

The second step in diagnosing most systems is a check to see that voltage is reaching the positive (+) side of the coil (the BAT terminal on GM HEI systems). This check is made while the engine is cranking (Fig. 6). Specifications for the amount of voltage necessary vary, but in most cases the figure is 6 or 7 volts.

If the amount of voltage available is less than that specified, there is a problem that is preventing voltage from reaching the coil. It could be a



6 If the car won't start, make sure sufficient voltage is reaching the positive coil terminal (or the BAT terminal on GM HEI).

broken wire, a rundown battery, a failed ignition-system resistor or resistor wire, a starter motor that draws too much current, an ignition-switch problem or a fault in any other device that is part of the circuit between the battery and ignition coil.

From this point the procedures vary significantly, even among the different models produced by one manufacturer.

As an example of what's involved, we'll present the rest of the procedure for late-model GM vehicles with integral ignition coils but without electronic spark timing (those with centrifugal advance weights and a vacuum advance mechanism on the distributor).

If you found less than 7 volts at the BAT terminal of the distributor with the engine cranking, repair the primary

circuit between the terminal and switch. If you found 7 volts or more, check for voltage at the distributor's TACH terminal.

If 1 to 10 volts are present at the TACH terminal, replace the module and check for spark from the HEI coil, using the test setup illustrated in Fig. 7. (When installing a new module, coat its metal base and the mounting surface in the distributor with the silicone grease that is packaged with the new replacement module.)

Testing the coil

To perform this test, you have to cut the small end off an old sparkplug boot. The boot is then used to attach your spark tester to the center terminal inside the HEI distributor cap. A voltmeter is connected between the TACH terminal and ground. The rotor is removed from the distributor, the module leads are disconnected and a test light, with its lead connected to the battery's positive post, is touched to one module terminal.

On a four-terminal module, connect the test light to terminal G. On a five-terminal module, connect the test light to terminal D. On a seven-terminal module, connect the test light to terminal P. Make sure you don't leave the

test light connected to the module for more than five seconds.

As the test light is removed from the module terminal, you should get a spark at the spark tester. If you do, the module was the source of the difficulty and the system should be okay. If you don't, the coil is also defective and should be replaced.

If you found 10 volts or more when you checked "TACH" terminal voltage, check for spark at the coil output terminal by connecting your spark tester to the center terminal of the distributor cap, using the boot. Ground the tester and crank the engine while you watch for a spark.

Color coding

If you get a spark, check the color coding and routing of the wiring to the control module and coil. If these parts have been replaced, the wrong ones may have been installed, or the wires may be misrouted.

If the module connector is yellow, the wires from it to the pickup coil should be green and white and the coil wires in the cap should be yellow and red. They should not be crossed.

If the module connector is clear, black or blue, its pickup wires should be green and white. The coil wires should be red and white. Both pairs of wires should be crossed. If the wiring checks out, the rotor or cap is the source of the problem.

If you don't get a spark, hook up the coil spark test as described above. With the ignition on, keep your eyes on the voltmeter as the test light is connected momentarily to the appropriate module terminal.

If there is no drop in voltage, check

the module ground and check for an open circuit in the wires from the cap to the distributor. If both the ground and wires are okay, replace the module and again check for spark at the coil. (A GM dealer would test the module on an expensive module tester before he'd consider replacing it.)

This is where the do-it-yourselfer may run into trouble. If you buy a new module and it does not solve the problem, you're stuck with the new module just the same because electronic parts cannot be returned.)

Check ignition coil ground

If a new module does not solve the no-spark problem, check the ignition coil's ground. If it and the module are okay, the coil itself is the cause of the problem.

If voltage dropped when you connected the test light to the module terminal, check for spark from the coil as the test light is removed from the module terminal.

If spark is present, the pickup coil or its wiring is the source of the no-start problem. In this case, the distributor must be removed from the car and disassembled in order to replace the pickup coil.

If spark is not present when the test light is removed from the module terminal, check the ignition coil ground circuit.

If it's okay, replace the ignition coil and repeat the coil spark test. If a spark is now present, the coil was the source of the problem.

If it is not, your original coil was okay, and the module is the source of the no-start problem.

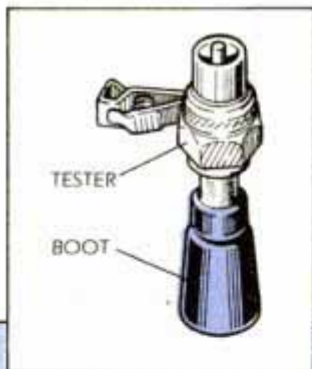
D-I-Y dilemmas

As you can see, the do-it-yourselfer who attempts to troubleshoot the system may end up spending more money than he needs to in order to perform the two substitution tests. The module tester that eliminates the need for this type of testing is very expensive. This will be the basic problem you'll run into over and over again when you are trying to troubleshoot advanced electronic ignition systems.

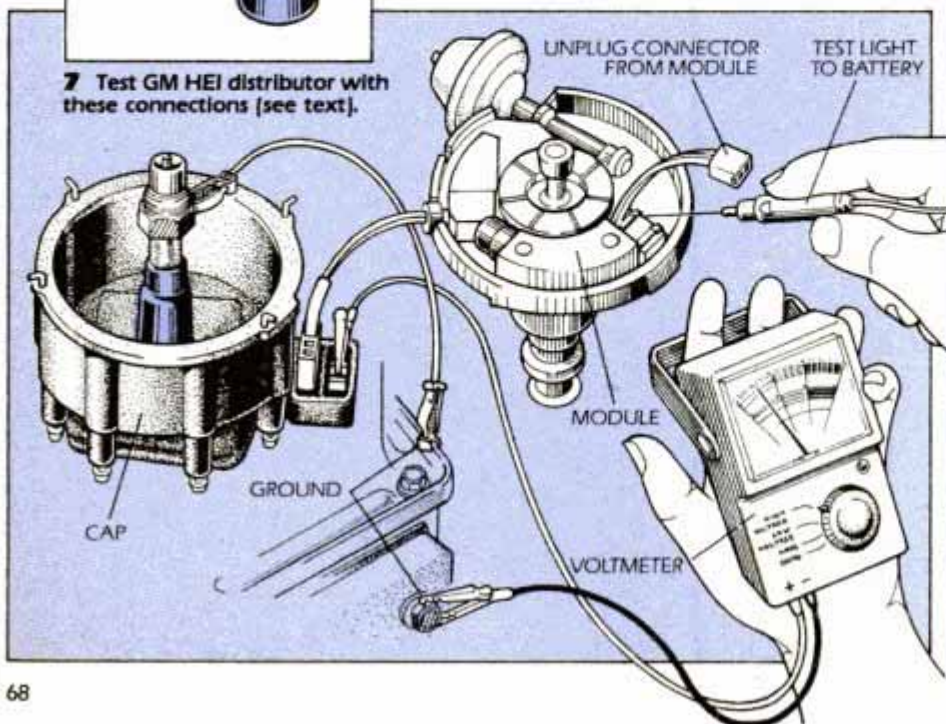
If you don't mind stocking an expensive spare module or coil, do the job yourself; after all, you may wind up using the spare some day. And, the savings in labor may outweigh the cost of the part.

But make sure the procedure you follow is the right one for your car, and don't even begin if you don't understand the instructions fully. A misconnected test instrument can damage a lot of expensive parts in just a few seconds.

FM

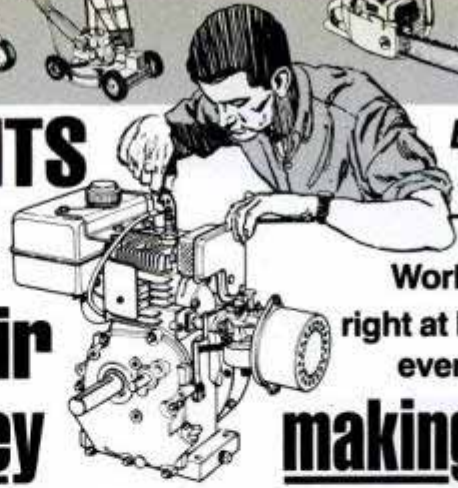


7 Test GM HEI distributor with these connections (see text).





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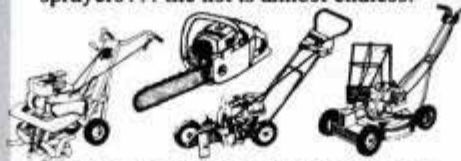
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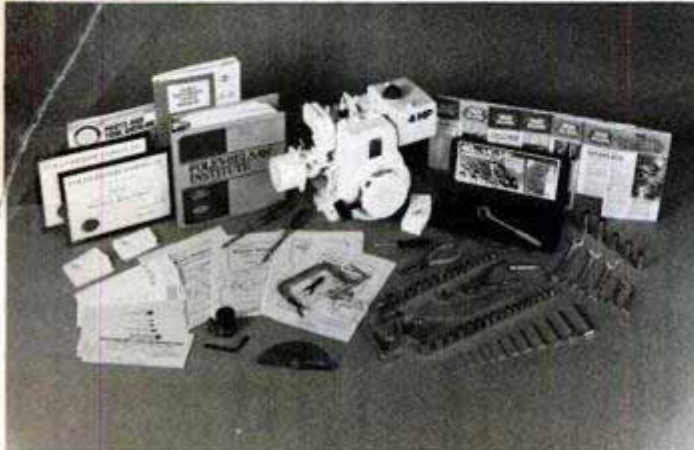
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HOW TO PICK THE RIGHT WINTER TIRES

Depending on where you live, you may not need snow tires at all. PM went to the experts for advice.

There's a revolution going on in snow tire design. Thanks to portable computerized test equipment, Akron's tire engineers can now go to the snow easily and bring back reliable comparisons between different types of tires—something that was much more difficult and time-consuming until just a few years ago. And the results prove conclusively that the best tire for most winter driving is *not* a snow tire.

To find out what's going on, we spent some time at BFGoodrich's Brecksville, Ohio, test lab. BFG assembled a blue-ribbon panel of their tire experts—tire scientists, compounders and testers—and we tapped their cumulative knowledge of how to go in snow.

The first thing you have to understand, say the BFG experts, is how a tire—any tire—does its job. Where the rubber meets the road is a hand-sized area that allows you to go, stop and turn. Several things determine how effectively this "contact patch" will work. The first is the chemical compounding of the rubber. The second is the internal construction of the tire (bias, bias-belted or radial-ply). And the third is the tread design that is molded into its surface—snow, all-season or highway-rib (what the tire industry

BY RICH TAYLOR

calls a conventional passenger-car tire).

On dry pavement, the contact patch does its job through simple friction between the pavement and the rubber. Up to a point, the more rubber you can bring into contact with the road surface, the more traction you'll have, which is part of the rationale behind super-wide racing tires with a perfectly smooth "tread." The most important component of dry traction is the surface area of the contact patch.

Wet pavement is a different problem. A racing slick will just hydroplane on top of a thin film of water, and you'll slide uncontrollably. A passenger-car tire works on wet pavement by forcing the water into grooves, then channeling that water to the outside of the contact patch. The raised tread elements can thus cut through the water and press rubber against the pavement underneath.

Going in snow involves an entirely different principle. A snow tire works by compacting the soft snow into firm ridges, then pushing against those ridges in order to move the car. Simple friction between the tire's rubber and

the surface has little to do with it.

What's most important in a snow tire is the depth of penetration and the number of biting edges, not surface area. Because you could encounter deep snow, a snow tire should also be relatively narrow as compared to a dry-traction tire. The narrow tire will have a smaller frontal area, so it won't have to push away as much snow to get through.

The traditional snow tire has large voids in its tread design to form the necessary ridges in the snow. It's very important that these voids clean themselves out before they come around to take another bite at the snow. If the tread clogs up, you could have little more traction than a racing slick.

According to BFGoodrich, this type of large element tread design is superior only in deep virgin snow. Virgin snow has such minimal sheer strength that you need to build large ridges in order to have anything at all to push against. And virgin snow tends to be sticky, almost like mud, so it's tough to get the necessary self-cleaning action from small tread voids.

But, most of us don't drive in virgin snow more than a few times each

(Please turn to page 74)

WINTER TIRES

(Continued from page 72)

winter, if that. Unless you live in rural Canada or Michigan's Upper Peninsula, the worst conditions you're likely to encounter in North America will be deep slush or compacted snow on a freshly plowed road.

All-season advantage

According to all BFG's testing, the best tire for going on compacted snow or slush is an "all-season" radial. Why? Look at the tread design. In anything but virgin snow, many small ridges give better traction than a few large ones.

The all-season tire has a tread design somewhere between the less aggressive-looking conventional highway-rib passenger car tire, and the deeply lugged traditional snow tire. It has a lot of small tread elements, and each element has slits—tire engineers call them *kerfs*—to further help pack the snow into ridges.

If you compare an all-season tire with a conventional highway rib design, you'll see that the tread extends part way around onto the sidewall on the all-season tire, and has shoulder voids similar to a traditional snow tire to aid self-cleaning.

You'll also see that the all-season tread grooves have a distinctively zig-zag design, compared to the mildly wavy grooves on a conventional highway-rib tread. Each turn of the groove creates a lateral ridge in the snow for the tire to push against, either straight ahead for braking and acceleration or at an angle when steering.

Amazingly, the all-season tire also out-performs the more conventional highway-rib designs on almost every other type of surface, too. On dry pavement, the all-season can put down almost as much rubber as a high-performance street radial. (The high-performance designs ultimately work better on dry pavement for three reasons: The tread design puts more rubber in contact with the pavement. There are no lateral kerfs and sipes in the tread

blocks, so the tread elements are more stable. The compound of the rubber is superior in dry traction. Of course, all three attributes become liabilities on ice or snow.)

On ice, the all-season is superior to high-performance radials, in small part because the aggressive tread design of an all-season tire disperses water so efficiently, but mainly because its special compounding retains elasticity.

The all-season generally is quieter than a typical snow tire. Tire noise is produced primarily by the edges of the tread blocks creating a siren effect and also slapping the pavement and setting up vibrations in the tire. Traditional snow tires are extremely noisy for that reason. The all-season tire, with its small tread elements and variety of edge angles, is uncannily quiet.

Compounding mystery

Tread design is a logical science that you can understand just by looking at a tire, but rubber compounding is a hazy art that's not completely understood,

(Please turn to page 76)

How BFGoodrich Tests Snow Traction

Each winter, the BFG outdoor testing team encamps at Sault Ste. Marie, Mich., where they headquarter at an abandoned air base. To ensure uniformity of data, every test tire is measured against the industry "control" tire—a Uniroyal TPC steel-belted radial. Every tire company uses the same control tire, so that—in theory at least—data from every manufacturer is comparable. The control tire is given a nominal performance rating of 100 on any test, and the test tires compared to it.

The testers begin by plowing the old runway, then redepositing a 2-inch layer of hard-packed snow. On top of this goes a 4-inch layer of medium-compaction snow

measured with a compaction meter to an SAE standard that is also industrywide. The surface is groomed with a toothed drag sled after every run.

Temperature and load

Testing is only performed when the ambient temperature is between 15° and 25° F. The tire to be tested is mounted on the right rear wheel of a heavily modified Chevy pickup truck.

According to the SAE procedure, all light-truck tires are tested with a load of 1,250 pounds, regardless of their size; but passenger-car tires are tested at 85 percent of the maximum load rating stamped on the side-

wall. Unfortunately, this means that there can be no direct comparisons of light-truck and passenger-car tires.

The pickup is totally computer-controlled by an onboard computer crammed into the cab and powered by its own DC-AC inverter in the truck bed. The truck's forward speed is held at 5 mph, while the test tire is independently accelerated to the equivalent of 25 mph. Strain gauges and speed transducers mounted on the hub measure tractive force.

Comparing data

The end result of all this effort is a mound of data on a variety of tires, all of which can be accurately compared because the test conditions—despite the incredible logistical problems of mid-winter outdoor testing—are as nearly consistent as possible.

Admittedly, all the data is measuring performance in only one "medium-compaction" snow condition, with one load rating within a narrow ambient temperature range. Eskimos and skiers use over a dozen words to describe the different kinds of snow found in the real world. But, compared to the old days, when snow-tire design and testing was very crude and involved a fair bit of educated guesswork, things have come a long way indeed.

Secret results

The snow-tire traction chart on page 76 shows traction results in this SAE test for various types and brands of tires tested by BFG engineers.

Every big tire company tests the competition's products along with its own. The results of these tests are closely guarded trade secrets in Akron. BFG was willing to give us traction ranges (more than other manufacturers were willing to do), but they would not identify the brands or tire models involved in the testing.—R. T.



Toughest part of testing is changing wheels with cold tools (above). Rear wheel (right) of heavily instrumented test truck (above, right) operates independently of the other three wheels to generate traction data. Snow is groomed to test specs for each run.



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"How could a guy like me save up enough money to start my own business? To get into most businesses you have to own a corner of Fort Knox. If I could only ease into a business without giving up the regular salary I had to count on to put food on the table. And without making any investment. As long as I was dreaming, wouldn't it be great to find something where every single spare time order could bring in *really big* extra money.

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WINTER TIRES

(Continued from page 74)

even in the tire industry. Still, compounding is a major contributor to the performance of any tire.

According to BFG passenger-tire compounder Bill Wagner, "Almost all high-performance tire treads are pure styrene-butadiene rubber (SBR). From a compounding standpoint, that's not the best way you can go for snow traction. In cold weather, you want a mix of SBR and polybutadiene (PBR) or natural rubber."

According to Wagner, the most important factor in a tire's tread compound is called "glass transition temperature." This is the temperature at which the rubber molecule gets stiff, and becomes like plastic. Once this happens, the tire no longer responds the way it should for best snow traction.

The glass transition temperature of styrene-butadiene is around -55°C . Natural rubber has a glass transition temperature of around -75°C . Polybutadiene—which is what most manufacturers use in their snow tires—has a glass transition temperature of -100°C . What this means is that polybutadiene rubber stays flexible at lower temperatures.

A number of European tire manufacturers sell snow tires that they claim are "hydrophilic"—made with rubber that has an affinity for water. Analysis of these tires by experts shows that they're made from much the same rubber that everyone else uses. That means a combination of natural rubber, SBR and PBR.

As you might expect, there's often a tradeoff. Natural rubber and PBR are softer than SBR, so snow tires—including all-season tires—that use high percentages of these softer rubbers will often wear out sooner than conventional highway-rib radials. However, some all-season and highway-rib tires use the same rubber, and should have similar tread life.

Some high-performance radials (so-called V-rated, especially) are made from pure styrene-butadiene rubber that gets "as hard as the road" at low temperatures, says Bill Wagner, and

*'Use four snow tires.
If you put snow tires
just on the front of a
fwd car, you'll spin . . .
just on the rear of a
rwd car, you'll slide.'*

can lose snow-tire capability. So, you shouldn't try to use V-rated high-performance tires as regular snow tires, according to the BFG experts. All-season tires would be a much better bet.

Expert tips

William Shufflebotham is a tire development scientist at BFGoodrich. We asked him whether you really need four snow tires on front-drive cars, if studs do any good and how inflation affects traction. Here are his answers:

"If you only buy two snow tires, they should go on the driven wheels. Having snow tires at all four corners would give

(Please turn to page 78)

HOW DIFFERENT TIRES GO IN THE SNOW

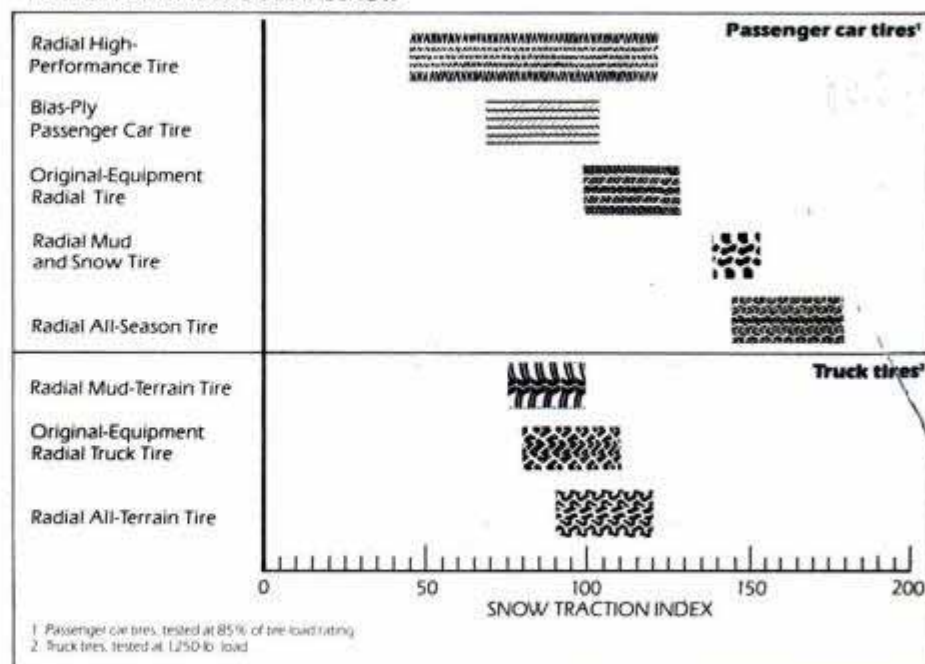


Chart above shows how different types of tires did in BFGoodrich snow traction tests. The engineers' truck and car tire tests are not comparable (see box on page 74).

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WINTER TIRES
(Continued from page 76)

better braking traction, among other things; but that's optional, of course. However, if you are going to buy studded snows, you *must* use them at all four wheel positions.

"Obviously, on a four-wheel-drive vehicle, you'd use four snow tires. All-season tires are designed to go on all four wheels, year-round, regardless of the type of vehicle.

"I'll tell you why you should use four snow tires. Most cars are nose-heavy and 70 to 80 percent of their braking force is on the front. If you put snow tires just on the front of a front-drive car, it'll be easy to lock up the rear wheels, and you'll spin.

"If you put snow tires just on the rear of a rear-drive car, most of your braking will be on the regular tires at the front, and you'll slide. Either way, you're not going to like what happens.

"Studded tires *will* help you on glare ice, but they have almost no effect in snow. You can only get them in traditional snow tires, and I'd rather see you on all-seasons.

"I did a test on our traction truck with the same tire inflated to 25 psi, 30 psi and 35 psi. You could see the traction go right up. The best snow traction is at 35 psi.

"You should keep your tires inflated to the car manufacturer's recommendations under all conditions. Most manufacturers now recommend inflation pressures in the 32- to 35-psi range.

"Snow tires seem to be more sensitive to misalignment or worn suspension than regular tires. If you use four snow tires, you should rotate them front-to-rear, *diagonally*, every 6,000 to 8,000 miles. If you use just two snow tires on a rear-drive car, keep them in the same position."

Conclusions

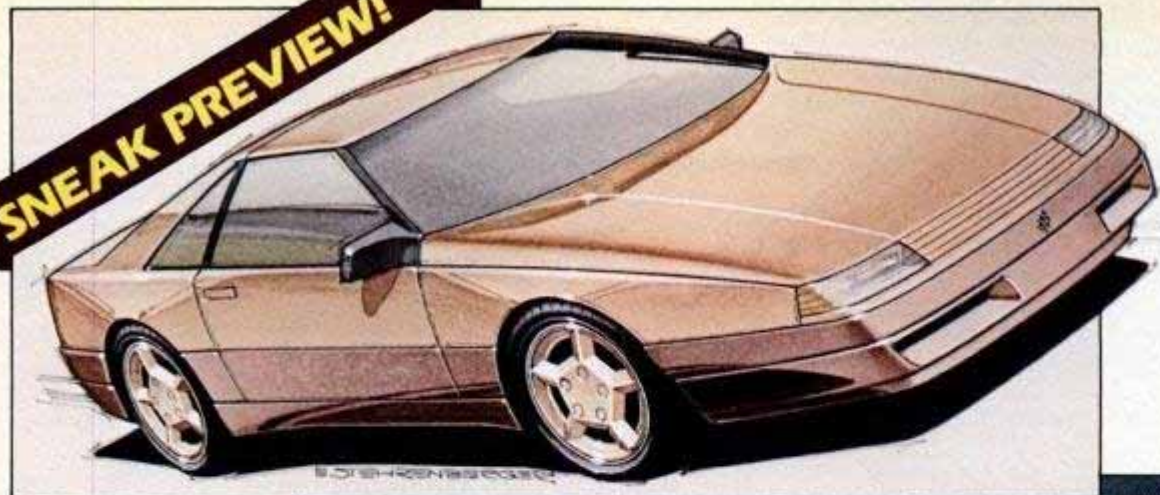
One thing to remember: Even an all-season tire—good as it is—can't be all things to all people. As the engineers say, "every tire is a compromise."

The all-season won't outperform a snow tire in virgin snow. It won't outperform a V-rated high-performance radial on dry pavement. It may not match a conventional highway-rib radial's 40,000- to 50,000-mile tread life. And it may cost more than an original equipment tire.

But, the all-season *will* outperform any other tire all-around, in the wide cross-section of conditions that most Americans face during 12 months of the year. This one tire will see you safely through the winter and the rest of the seasons, too. And it will eliminate the need for tire changes in the spring and fall.

PM

SNEAK PREVIEW!



Code-named GM-33, Buick's sleek two-seater coupe is a spinoff from the GM-30 platform—the 1986 Riviera, Eldorado and Toronado. With a 180-hp V6, front-drive and a German five-speed, performance will fall between Fiero and Corvette.

BUICK REATTA

DETROIT'S EUROPEAN CONNECTION

BY DANIEL CHARLES ROSS, Detroit Editor; Illustrations by Mark Stehrenberger

At least five American car companies are planning high-dollar two-seaters, with a little help from overseas.

Detroit is feverishly working on a pride of high-priced, high performance two-seater sports cars for the '80s, and virtually all of them are being aided by some form of European input—sort of a reverse Marshall Plan for car design. From our informed sources and intelligence gathering ac-

tivities, we can tell you about the following five cars now in the works:

Cadillac Callisto

GM's prestige division goes for broke with its Callisto two-seater personal luxury car, a front-driver slated for late 1986

FORD GHIA

Ford's Italian design firm, Ghia, has whipped up this 2.3-liter turbo Four with four-wheel drive. With 180 horses available, maybe more by 1987, it will be fast and agile.



as an '87 model. Its exterior is loosely based upon GM-20 (Buick Somerset Regal, Olds Calais, Pontiac Grand Am) sheet metal, but better done and with a convertible top. The coachwork will be assembled by Pininfarina in Italy and air-freighted to a spanking new Detroit plant for final assembly, the ultimate in just-in-time delivery strategies.

With no need for rear seats, Callisto will probably cleave close to the GM-20 wheelbase of about 103 in. Power will likely come from Cadillac's exclusive 4.1-liter aluminum V8, mounted transversely and coupled to a four-speed self-shifter.

Alternative horsepower choices include engines from other GM divisions, perhaps Buick's potent 3.8-liter and 3.0-liter Sixes.

Early reports indicate the roadster will sell in the \$45,000 to \$50,000 ballpark.

Chrysler-Maserati

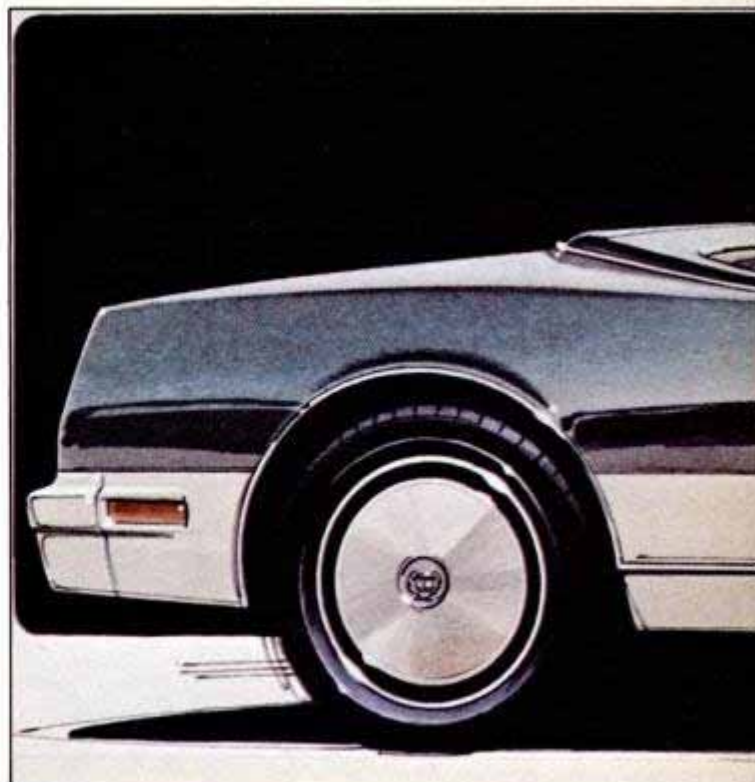
Lee Iacocca, in his heart, *loves* performance cars. At Ford, he brought out the Mustang and brought over the de Tomaso Pantera. But Lee Iacocca also loves profits, and his association with Alejandro de Tomaso and Maserati is still a key to them.

Although Pantera has been suggested at least as a code-name for the innovative Chrysler two-seater, de Tomaso is still selling the old Pantera with its Ford V8 in Italy, and that might lead to confusion. Production of the car is being considered in Italy, with parts and engines supplied by Highland Park. The car would then carry a "Built by Maserati" label under its name badge. Our picture indicates a strong resemblance to Chrysler's "Stealth" show car of two years ago.

Chrysler will pull out all the stops on this car, powering it up to drive as many as four wheels with a turbocharged and intercooled 16-valve Four, mounted amidships, displacing either 2.2 or 2.5 liters. Horsepower could be as mild as 175, or as wild as 210.

This model is seen as selling for as much as \$30,000 per copy in 1986 dollars, though one theory is that it will be price-competitive with Corvette. Only 7,000 to 10,000 units are to be built each year.

Chrysler will also have a Maserati-designed, U.S.-built "entry level" domestic two-seater of great performance but significantly lower cost, carrying the styling flavor of the premium model.



Ford Ghia

Ever since the Audi Quattro debuted, Detroit has been in search of its own streetable 4wd production car. At Ford, the Ghia could be it.

The Ghia design house in Italy is owned by Ford, so access to its creative talents is assured. We don't think Ghia will be the production car's name—"Cobra ME" has been suggested—but we think this car is pretty darn close to what may be seen here as early as 1987.

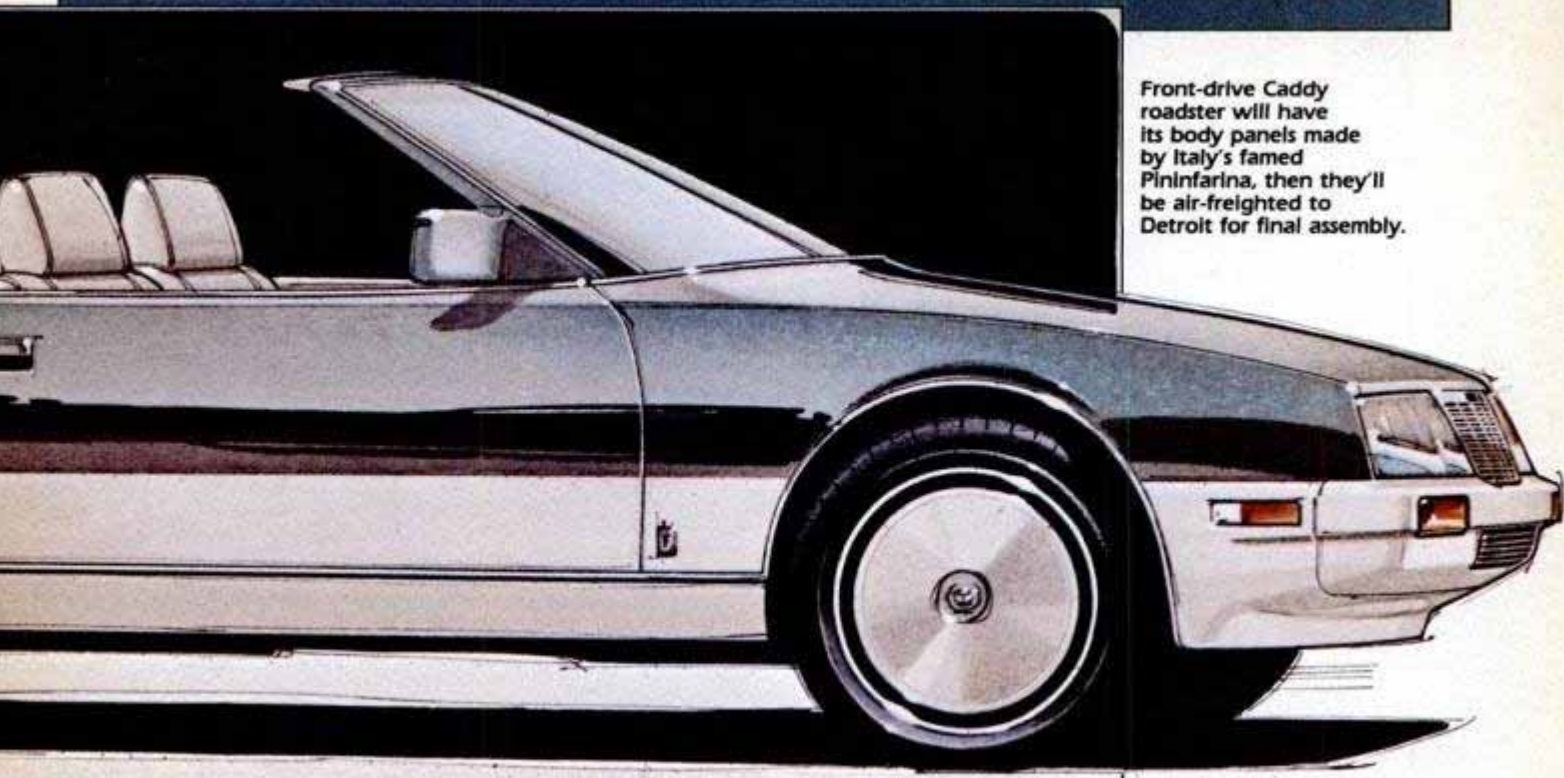
An intercooled turbo will breathe life into an overhead-cam inline Four of 2.3 liters at a rate of about 175 to 180 hp. It will approximate the present-day size of the Mustang coupe in length and width, and be a front-driver if the 4wd mechanicals can't be sorted out. Price is estimated at between \$28,000 and \$32,000.

RENAULT-ALPINE GTA

A rebodied version of the nimble Renault-Alpine A310GT that's been available in Europe for several years now, this mid-engined V6 is destined for the U.S. market and will be turbocharged to produce up to 240 hp. With that much push, and Alpine's legendary handling, this should be the one to beat. Imagine, AMC/ Renault with the hot setup!



CADILLAC CALLISTO

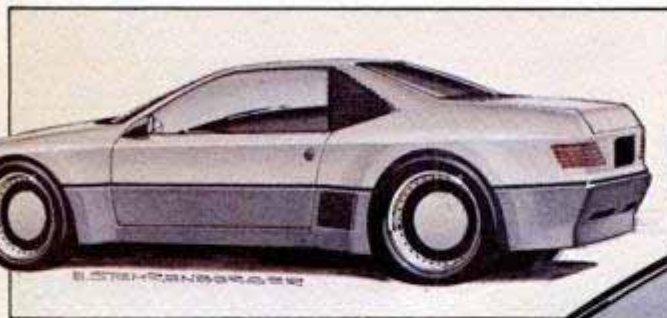


Front-drive Caddy roadster will have its body panels made by Italy's famed Pininfarina, then they'll be air-freighted to Detroit for final assembly.

The Ford-Ghia is a cipher at the moment, more in the "what if" talking stage than the others. Any number of handsome Ghia prototypes have come and gone on the European auto show circuit without reaching production. We hope Ford is serious about this one.

Renault GTA

This car is largely based on the Renault Alpine A310GT, its pretty predecessor in Europe. Here, the GTA's fiberglass body panels will be modified slightly for less radical fender



Chrysler may go as far as four-wheel drive and a 16-valve turbo-charged Four in the exclusive mid-engined two-seater that will be built by Maserati in Italy.

contours, and the Euro-car's "whale tail" rear spoiler will be muted to a sliver of its former self. New taillamps adorn the rear, and a new Heuliez chassis has independent front and rear suspension components from the European model.

A 2.8-liter turbo V6 will provide as much as 240 hp, with a new cam and crank for the venerable "PRV" (Peugeot-Renault-Volvo) engine. This is almost *too much* power in a car that weighs a bit more than 2,460 pounds in U.S. trim. Retaining the European wheelbase of only 89.4 in., the GTA will still have a roomy passenger cell. It will be your basic hot-stuff-in-the-summertime car.

In Europe, the Alpine is famous for tenacious handling on the twisty mountain roads that its name suggests. Alpine racing cars have dominated the smaller classes in the


(Please turn to page 138)

CHRYSLER-MASERATI



CONQUERING OUR DEEPEST FRONTIERS

Deep-sea vehicles are taking us deeper than
20,000 feet. And that's where
the treasures lie.



*Sea Shuttle Saga-N lowers
a Remotely Operated
Vehicle to explore and do
salvage work aboard the
sunken Titanic. Sea Shuttle
owners are mainly interested
in the nuclear craft's oil
exploration capabilities.*

A technician inside a robot arm-equipped diving suit works with salvage and oil equipment down to 600 feet. Going more than 2,000 feet below him, the one-man *Deep Rover* vehicle performs welding duty. *Deep Rover* carries an array of camera and sensing gear and has a flash lamp that gives its cameras the equivalent capability of 200,000 ASA for sharp sea-floor photos.



BY ALAN SAUNDERS
Illustrated by Jeff Mangiat



Author Alan Saunders joins an unmanned submersible on a 50-foot dive.


With a muffled thud, the aluminum-banded plastic dome of the atmospheric deep-diving suit closed hermetically over my head. I quickly reached out to adjust my oxygen supply, while also glancing at the gauge on the CO₂ scrubber. After that, I checked out the thruster controls as the voice of Dick Clark, the diving supervisor, talked me through the operational checklist over the intercom. The checklist completed, I was ready for my dive.

Clad in borrowed coveralls on a hot May morning in Los Angeles harbor, I was being initiated into the world of the one-man submersible at Oceaneering's Commercial Diving Center, a school for professional divers. It is the only one in the world using Atmospheric Diving Suits (ADS). The suit kept me under normal atmospheric pressure as I descended into the ocean.

Weighing over half a ton and selling for several hundred thousand dollars, it is difficult to think of it as a suit—something to wear—even when going for something as exotic as a deep dive to the ocean bottom.

Wasp, the ADS I took on my first journey, is tethered, has four electric thrusters and an on-board air supply, and operates at close to neutral buoyancy. Like *Jim*, its predecessor, it has two Michelin-man arms through

HOW DEEP IS THE OCEAN?



Two tethered Remotely Operated Vehicles descend beyond 1,000 feet beneath the sea to perform mapping and sensing duties.

which my hands can operate a pair of brutal-looking claws at the ends. With either suit, I can roam the ocean bottom, but *Wasp* with its thrusters will "fly" me through the water, something *Jim* cannot do.


New undersea technologies have handed us the key to Davy Jones's locker and a taste of the fabulous treasures it can hold—oil for our current machinery; the promise of food for an exploding population; new mineral deposits to feed our factories; access to the energy inherent in wind, current, tide, wave and thermal gradient; and last, but certainly not least, the military advantage of hiding, or being able to find, nuclear subs.

Locating anything in the deep ocean is difficult, even when that something is clamoring to be found. Roger Chapman can attest to that. In 1973, he told us, he spent three days trapped in a tiny sub. "We had been laying a transatlantic cable off the Irish coast. On surfacing, while being readied for recovery by our support vessel, a valve on *Pisces III*, our two-man sub, malfunctioned. Suddenly, the aft compartment was flooded. Within seconds the sub, now standing on its tail, began to sink. At 1,575 feet, with a soft sucking sound, she settled on the bottom, still stern first.

"I thought I'd bought it," he continued, "but the pressurized hull held. Trembling, I checked the underwater radio telephone. It still worked. We had contact with the surface."

When the rescue ships arrived, not even the combined might of the U.S., Royal and Irish navies, plus the loud singing of Roger on the radio, could locate the sunken submarine. They could talk to her, but not locate her. It would take six and a half hours, after the arrival of *Pisces V*, a sister ship

DEEPEST DIVE (UNASSISTED)



Jacques Mayol,
282 ft. off
Elba, Italy,
November 1973

DEEPEST DIVE (SCUBA)




John Gruener
and R.N. Watson,
437 ft. off
Freeport, Bahamas,
October 1968

DEEPEST DESCENT OF A DIVING BELL



Comex MOB 1001/1002,
1,370 ft. off
French coast,
January 1977

DEEPEST DESCENT OF A HUMAN-CARRYING VESSEL



Trieste I,
35,820 ft.
off Guam,
January 1960

DEEPEST OCEAN POINT

35,820 ft.
(in dispute)



DEEPEST UNMANNED DIVE

DEEPEST OIL WELL

U.S. Navy,
20,000 ft.
off Hawaii,
(date is classified)

Discoverer
Seven Seas
6,492 ft.
off Virginia,
June 1984

Submerged *Argo/Jason* takes wide-angle photos from larger vessel and closeups from smaller ROV. Sonar steers the rigs.

flown in from Canada, before Roger's sub would be found.

"The cause was simple," explained Roger. "*Pisces III* had settled in a small depression, so the searching sonar simply passed blithely over her." Picture the same scene, but the sub is large and armed, the depression a half-mile-deep narrow canyon, the crew silent and determined not to be found. Nothing much except mutiny or bad luck would keep that sub from firing its warheads if it wanted to.

Except as war machines, manned submersibles had been of little use to mankind until the 1930s. Then, a daring American bathyscaph with William Beebe aboard made a half-mile dive. With that dive, the deep frontier was breached. Thirty years later in rapid succession, *Trieste*, another bathyscaph, manned by Jacques Piccard and Don Walsh, would plunge 35,800 feet into the Marianas Trench, the deepest point in the ocean floor. And *Triton*, a U.S. nuclear-powered submarine, would circumnavigate the globe under water. Depth and distance had been conquered.

It would now fall to others to fill the gaps between surface and deep bottom, between knowledge and myth. Two names leap up from a most distinguished roster: *Alvin*, a submersible, and Jacques Cousteau, the self-proclaimed man-fish. While *Alvin* would make scientific history, it was Cousteau who, with his love and understanding of the ocean, would bring that history to life.

Alvin, like nearly all scientific subs, is owned by the Navy and operated by academia—in this case, the Woods Hole Oceanographic Institution. Built in 1964, she is fat, squat, 25 feet long and displaces 16 tons. She can stay submerged for 72 hours with a full

complement of three (one pilot and two scientists). Maximum speed is a stately 1½ knots and she can go down 13,000 feet, double her original depth range.

Early in her career, she had the distinction of being the first, and to date the only, submersible to search for and locate a nuclear bomb. Extremely maneuverable, she is pushed by a large, trainable stern propeller and has two 360° thrusters as well. Three 5-inch viewports allow direct observation of the outside world, while two manipulator arms can gather samples, place instruments and perform other tasks.

Alvin's big moment came in 1977 while exploring the Galapagos Rift off Ecuador. Coming upon a cluster of hy-



The ROV *Epaulard* is prepared for a dive to 20,000 feet from International Underwater Contractors' ship *Aloha*.

We know how high the sky is, because we've traveled into space. But how deep is the ocean? Many geologists agree that the deepest part of the ocean was discovered in 1960 when the U.S. Navy research sub *Trieste I* landed in the Marianas Trench off Guam in the Pacific. Some oceanographers think we may find a sea rift in the Pacific that goes deeper, but for now it's just speculation.

The deepest unassisted human dive was made by Italy's Enzo Maiorca off Sorrento in 1974. But he surfaced unconscious, so the official record goes to France's Jacques Mayol, who dove 282 feet off Elba in 1973. That was 1 foot less than Maiorca's dive. (Duke University physiologist Richard Vann says the deepest dive recommended for a healthy human should be no more than 130 feet, if the diver has an air supply.)

The deepest diving bell dive was performed in the French Comex MOB 1001/1002 in 1977. But unmanned diving rigs have gone 20,000 feet below the surface. And many rigs with robot arms are performing salvage work at more than 5,000-foot depths today.—Fran Wenograd Golden

CONQUERING OUR DEEPEST FRONTIERS

drothermal vents, she discovered both new forms of life and a new source of metals.

Today, nearly all of the underwater industry is turning away from manned one-atmosphere vehicles as too expensive to operate. Yet, two men, both considered top-flight in this field, are continuing to build new submersibles.

The first is Graham Hawkes, an owl-faced Englishman, head of Deep Ocean Engineering of Oakland, Calif., and the father of the *Wasp*. His newest creation, *Deep Rover I*, is just now completing sea trials in Nova Scotia prior to acceptance by its new owner. It is a compact one-man vehicle with ample power, 3,300-foot diving capability, fantastic visibility and probably the best manipulators yet built. Looking at *Jim*, *Wasp* and *Deep Rover*, it's easy to see the evolutionary path followed by Hawkes.

Deep Rover's manipulators are 4-foot-long arms with sensory feedback capability. Simply put, this means the mechanical hands can sense the texture and consistency of materials they touch. "It is possible, even with the operator blindfolded, to differentiate between steel, wood, concrete, rubber or even painted surfaces," said Hawkes.

Deep Rover's owners are tight-lipped about the engineering details and full capabilities of the new craft. But one area in which the rig may see



Discoverer Seven Seas sinking the world's deepest sea oil well off the Atlantic Coast. Shell Oil plans other deep wells.

some early dramatic use is in the search for the *Titanic*, the luxury ocean liner that went down in 1912 in the North Atlantic after hitting an iceberg. Recent attempts by Columbia University scientists to locate the sunken ship were inconclusive. The *Rover*, oceanographers point out, working in tandem with another new vessel called *Sea*

Shuttle, may be able to pinpoint the *Titanic* and help start salvage operations. The ship's safe and stores are expected to yield a wealth of gold and gems.

At 3,000 feet, the *Deep Rover* will be able to maneuver close to the *Titanic's* suspected location. The luxury ship is believed submerged in 11,000 feet of water. The *Deep Rover* could lower sensing equipment from its 3,000-foot-deep vantage point to within sensing distance of the ship. And the *Sea Shuttle* could conceivably get much closer—close enough to release a remotely piloted vehicle from its hulk. The remote craft would crawl along the ocean bottom right onto the *Titanic*. Manipulating arms could then go to work recovering treasure.

The *Sea Shuttle's* designer is Jim McFarlane, head of International Submarine Engineering in Port Moody, British Columbia. McFarlane, a former Canadian Navy submariner, is responsible for more manned and unmanned submersibles than anyone in the world today. Where Hawkes' *Deep Rover* is a one-man, one-shift, battery-powered, 6,000-pound one-job submersible, McFarlane's *Sea Shuttle Saga-N* is a 125-foot, 50-ton nuclear submarine with a total complement of 13, and with enough hardware and capability aboard

(Please turn to page 132)

Ranching The Seven Seas

Modern fishing fleets, with all their high-tech gear, aren't much different from prehistoric hunting parties. They search out and catch their prey wherever they can find it. That kind of fishing has greatly depleted the world stock. Now we must learn how to raise livestock in

the sea. Coral reefs, unlike the nutrient-poor oceans, are among the most productive ecosystems on the planet. So, the Smithsonian Marine Systems Lab constructed an oceanic ranch at Grand Turk Island in the Caribbean. The key element at the ranch is an algae screen,

a yard-square section of plastic screening that can be used by even the least-skilled fisherman to construct a coral reef.

The screens, strung together and supported in the ocean by fishing floats, develop a thick cover of algae after two months. These algae-covered screens provide the "open range."

The other major element of the Smithsonian ranch is a floating habitat—a raft—shielding crabs from predators while leaving them accessible to the ranchers for care and harvesting. Looking at a raft from the bottom, you'd see an open-top basket made of plastic-covered wire mesh. A sealed ring at the top of the basket keeps it floating. Inside the bottom of the basket are several milkbox sections crabs use as caves for their homes.

The raft is seeded with baby crabs that graze along the algae screen. The screen can be changed when it gets grazed out. Scientists estimate ranchers need one screen per year for each crab grown to harvesting maturity (4 to 5 pounds). The crab ranch completed last year is experimental. But Smithsonian scientists predict they will become a working industry within 10 years.

—Lee Green

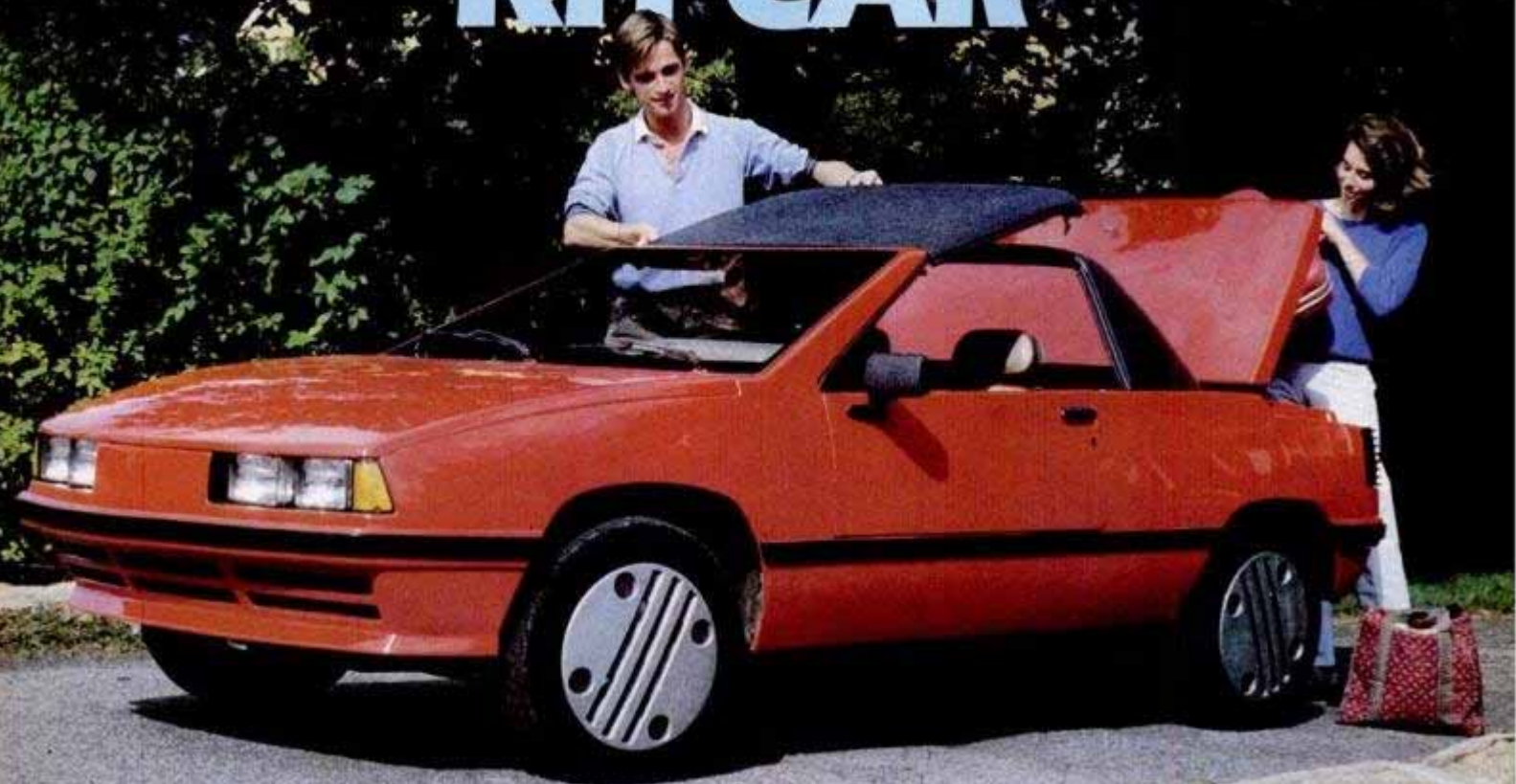


PHOTO BY ROGER STUBBE

A Smithsonian diver carries a crab habitat, or raft, to place under an algae screen at the Institution's Caribbean ranch. A train of yard-square screens (top) collects algae like a reef to feed crabs that will grow to a weight of 4 to 5 pounds (bottom).



At Last: The Thoroughly Modern KIT CAR



Clever two-piece rigid top uses stock Honda rear window, including defroster. Flush wheel covers snap over Honda wheels.



Lovely design looks like it was done by GM or in Italy. Stock Honda seats and instruments bolt into the modern Spex interior. You can use the Honda steering wheel, too, although the sport wheel is shown here.

Pretty Spex Elf uses a front-drive Honda chassis and costs under \$6,000.

BY RICH TAYLOR
Photos by Mike Batchelor

There's no use trying to hide it . . . this cute little roadster is a kit car. And I know as well as you do that a lot of kit cars aren't all they're cracked up to be. But this one is different. It is not built from old Volkswagen Beetle parts, it does *not* look like a 1934 Mercedes-Benz and it will *not* take \$50,000 and two years to build.

What makes this kit so special? Well, for starters, it's probably the first kit car since the Lotus Elite to be engineered and styled by a team of professional automotive designers, using the latest technology. There's nothing haphazard about it, not a raw edge nor half-measure in sight. And as you can see for yourself, the styling is fresh, sporty and delightfully unique.

How this kit came about is unusual in itself. About five years ago, a pair of young Canadian industrial designers

met when both were working on a project to create an advanced taxi for the city of Montreal. When the taxi project slowed down, the two left to start their own industrial design firm, Spex Design.

Paul Deutschman is a vehicle dynamics engineer, with a degree from Hatfield Polytechnic Institute in England. He worked at British-Leyland on Rover

engineering before returning to his native Montreal. His partner Kell Warsaw studied industrial design at the Cranbrook Academy outside Detroit.

To help publicize their fledgling company and showcase their industrial design talents, they decided to build a car, engineered from scratch to be inexpensive, easy-to-assemble and durable. The first decision was the chassis. Paul says, "We immediately rejected the Volkswagen Beetle chassis. We wanted our car to be thoroughly modern, and you can't say that about the Beetle."

Paul eventually settled on the '73 to '79 Honda Civic as a likely candidate for a body transplant. The transverse-engine, front-wheel-drive Civic is state-of-the-art, parts are readily available and, conveniently enough, Civics have a well-known problem with body rustout in Canada. Paul figures that anybody with a Civic more than four or five years old is a likely prospect for a new body.

Civics with rusted bodywork but good mechanicals sell for \$500 to \$2,000 these days. And because of Honda's parts interchangeability, you can build the kit with anything from a 1,238-cc early Civic engine to a 1.8-

(Please turn to page 143)



General Electric's Model 5028 convertible home/portable VCR stacks recorder atop tuner/timer.



Kodavision Series 2000 camcorder from Kodak uses the new, smaller 8-mm tape format.



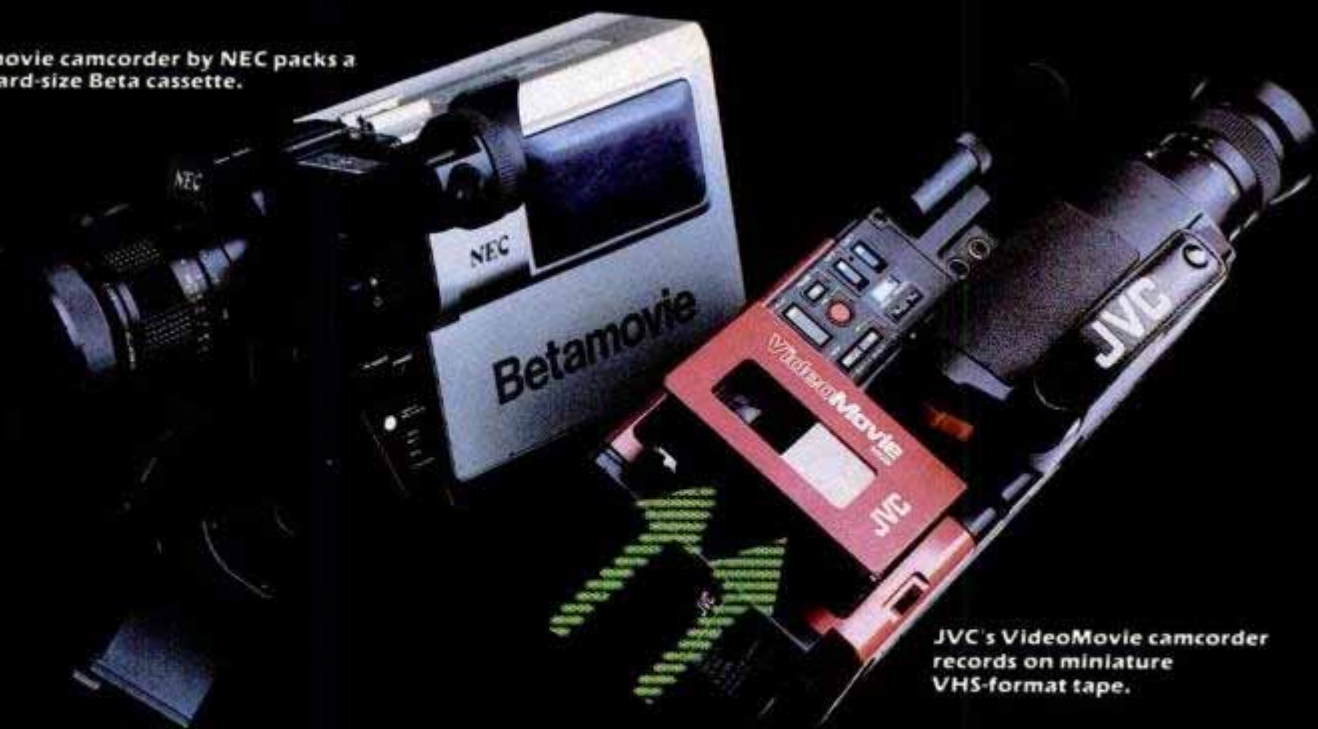
RCA's VKP-950 is a home/portable convertible with super stereo VHS hi-fi sound.

The Expanding Universe Of VCRs

The latest home VCRs boast digital-quality stereo and simple operation. New portable systems make shooting on the go a breeze.

BY STEPHEN A. BOOTH; Photo by Alan Zenreich

Betamovie camcorder by NEC packs a standard-size Beta cassette.



JVC's VideoMovie camcorder records on miniature VHS-format tape.

Digital-quality stereo sound comes with Panasonic's PV-1430 VHS hi-fi VCR.



Optional HFP-100 processor stacks below Sony's SL-HFR 30 Betamax to make it a super stereo hi-fi recorder.

Home video has traveled light-years in the decade since Sony introduced the first household recorder that could store TV programs for later viewing—or even turn the living room into a first-run movie theater.

That original Betamax VCR would record a single hour of moving images on magnetic tape, accompanied by monaural sound with a good deal more hiss than the average phonograph record. Special features were limited: It could be programmed in advance to record a single show. The old LV-1901 cost \$3,000 in 1975 and, because it was packaged with a 19-inch color TV, lugging it around to make videocamera movies was out of the question.

The latest generation of video recorders surveyed by

PM is a good deal more sophisticated in features and flexible in operation. There also are more choices—and more affordable prices.

Special picture effects once found only in the priciest models are now available across the board. For your ears, the newest and most advanced hi-fi VCRs can capture stereo sound on a par with laser-based music systems—just in time for stereo TV broadcasts. This also means you can play prerecorded videocassettes at home and hear the same super "Star Wars" effects you might in the theater.

For those who'd rather create their own movies, there is now a variety of convenient home VCRs that double as portables for recording on the go. Better yet, a new generation of one-piece "camcorders" combines camera,

EXPANDING UNIVERSE OF VCRs

recorder and power source in a single handy package weighing 6 pounds or less. The most recent of these, the 8-mm format adopted by Kodak and Polaroid, differs significantly from the familiar Beta and VHS systems.

To date, the greatest advances in VCR technology have occurred in sound and size. The so-called "hi-fi" VCRs get their name from a change in the way sound is recorded onto videotape, so it helps first to understand how music and pictures are recorded at all.

On a regular audio cassette deck, magnetic tape passes by a stationary recording head at the speed of $1\frac{7}{8}$ inches per second (ips). This speed is adequate for the stationary head to magnetize the tape with a replica of the original audio waveform, which can range from 20 to 20,000 cycles per second (or 20 Hertz to 20 kilohertz, abbreviated 20 Hz to 20kHz).

Getting the picture

Video signals are a good deal more complex than that, with a frequency range extending out to about 4 megahertz (4MHz), or 4 million cycles per second. That's 200 times greater than the audio range, and to re-create the waveform accurately, tape would have to move across the recording head 200 times as quickly. Accordingly, 200 times more tape would be required to record the same amount of video.

Instead, video recording is achieved by using a rapidly rotating drum on which the video recording heads (at least two) are mounted. The drum rotates 30 times per second, effectively increasing the magnetic "writing speed" as the tape moves by slowly (at about $\frac{8}{10}$ ips and $1\frac{1}{3}$ ips, respectively, in the fastest Beta and VHS speeds).

Additionally, wider tape is used for videocassettes: $\frac{1}{2}$ inch wide compared to $\frac{15}{100}$ inch for audio cassettes.

To further maximize the amount of video signal that can be stored on the tape, the tape is twisted around the recording drum at an angle. As a result, video signals appear to be recorded diagonally along the length of the tape, whereas audio signals made with a stationary head run longitudinally along the tape. This so-called helical scan recording results in video writing speeds as high as 270 ips—nine times faster than the best studio open-reel recorders.

Improved sound and small size are the most recent VCR technology advances.

That's how a VCR records video signals, but until the advent of the hi-fi Beta and VHS systems, the soundtrack was recorded in the old-time method—by a stationary head located at the very edge of the tape. The problem is that with tape speeds slower than the $1\frac{7}{8}$ -ips standard for conventional audio cassettes, sound fidelity is somewhat lacking. Few conventional VCRs can record audio signals much beyond 10kHz, which shortchanges the music's treble content. Meanwhile, the slow speed contributes quite a bit of distortion to the program. Signal-to-noise ratios aren't much better than 45 decibels (dB)—and that's for monaural sound! The ratio drops another 5 dB when the narrow soundtrack is split in two for stereo.

Mono or stereo, these ratios are pretty poor when you consider that the average phonograph record and cassette tape (the latter with Dolby noise reduction) clock in at 60 dB or better (in any signal-to-noise ratio, the higher the dB value, the better). All these ratings suffer further deterioration at slower video recording speeds such as Beta III, or EP (extended play) in VHS. Dolby and other noise reduction systems can clean up a little of the hiss on videotape soundtracks, but even this improvement is confounded by the wow-and-flutter contributed by the slow tape speed—alternately a slurring, then a warbling sound. The final handicap of conventional VCR sound has to do with the tape itself. Because the soundtrack is located at the very edge of the tape, poor tape slitting or any edge-damage caused in shipping or storage will detract from the already sorry quality of sound reproduction.

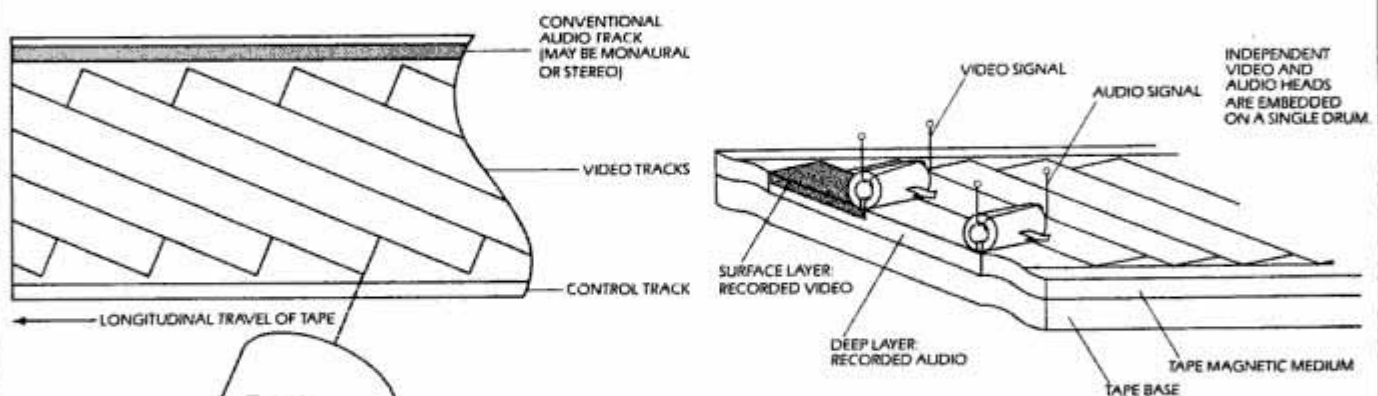
Let's get helical

The average VCR might be adequate for off-the-air recording of TV soundtracks, but because of its inherent sound impediment, the VCR hasn't been able to match the sonic splendor of videodiscs (especially the laser-read type) in reproducing the music and special effects of movie soundtracks. Until, that is, VCR makers in the Beta and VHS camps devised a way to convert audio to FM signals, and record it *helically* along with video signals. It's called audio frequency modulation, and you'll sometimes see AFM used as a synonym for Hi-Fi VCRs.

Sony and the other Beta manufacturers were the first to achieve the feat. In Beta Hi-Fi, the stereo audio signal is

(Please turn to page 139)

HELICAL RECORDING—THE SECRET OF HI-FI SOUND ON VIDEOTAPE



Conventional VCRs record low-fi audio (limited frequency response, high distortion) as a thin track running along the tape's edge (left). Meanwhile, the rapidly rotating (1,800 rpm) head drum positioned diagonally to the tape records video in a helical pattern. In Beta Hi-Fi, the audio is converted to FM signals and recorded helically along with the video by the head drum. This high-speed helical recording provides sound with full frequency response and negligible distortion. VHS Hi-Fi (right) achieves the same results, but differently. Independent audio and video heads mounted on the same drum first transcribe sound on the deepest layer of the helical tracks. Then, the heads superimpose video on the topmost tape layer. For simplicity, not shown on the VHS tape is the conventional audio track, which is retained for compatibility with older VCRs.

ENGINES

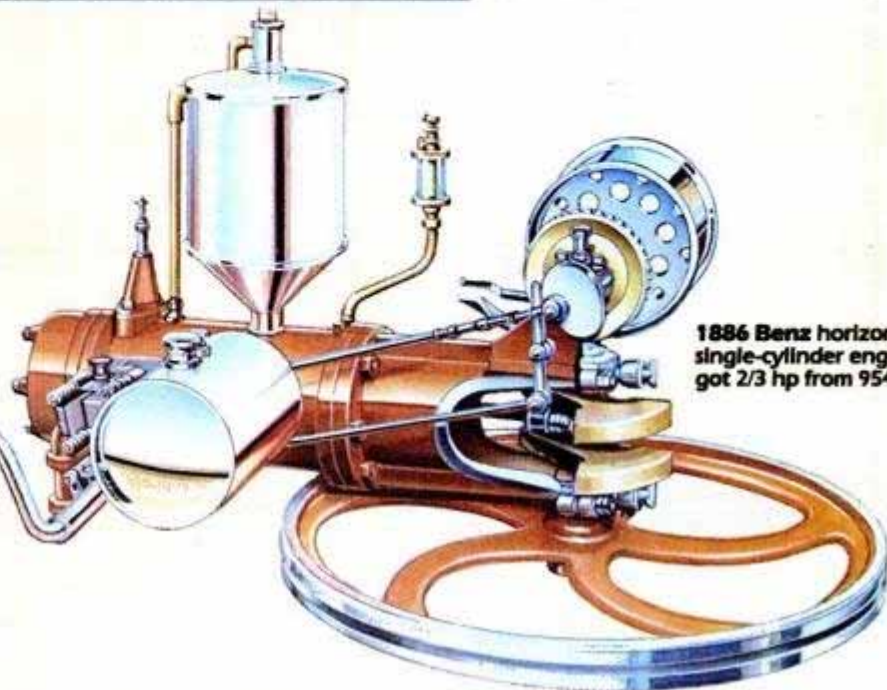
A CENTURY OF PROGRESS

100
YEARS

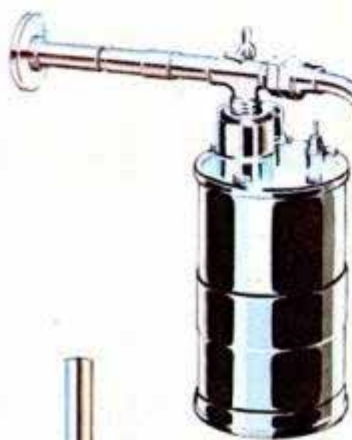
From single-cylinder thumpers to V8 screamers, auto engines have come a long way in 100 years.

BY MORT SCHULTZ

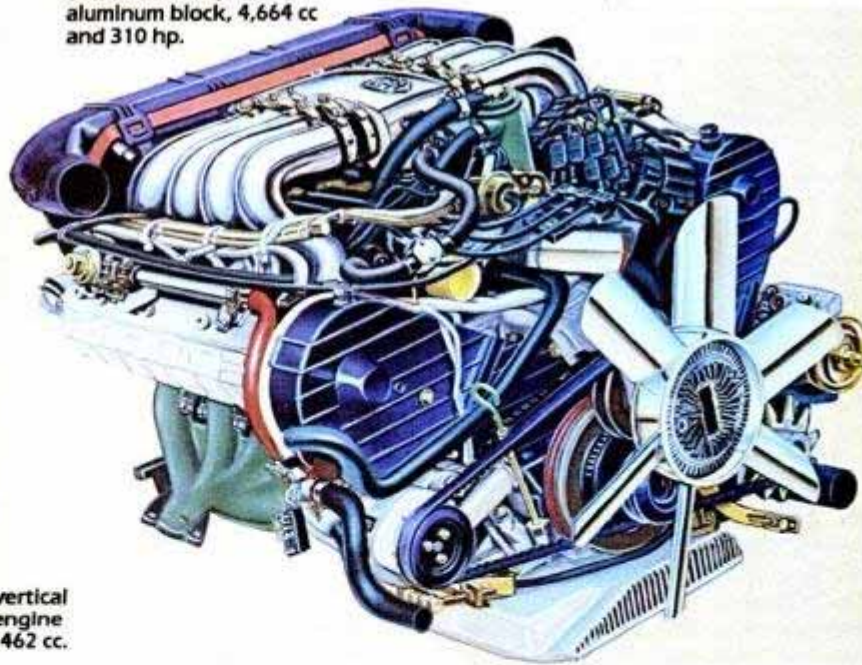
ILLUSTRATIONS BY PAT RUGGERO



1886 Benz horizontal single-cylinder engine got 2/3 hp from 954 cc.



1985 Porsche 928S V8: overhead cams, aluminum block, 4,664 cc and 310 hp.



1885 Daimler vertical single-cylinder engine got 1.1 hp from 462 cc.

Asked which motor they preferred in a car, visitors to the first-ever National Automobile Show in New York City made the electric their overwhelming choice. Steam engines came in second. And trailing the field with less than 5 percent of the vote was the gas engine, which one critic predicted would never last.

"Noxious, noisy, unreliable and elephantine, it vibrates so violently as to loosen one's dentures. The automobile industry will surely burgeon in America, but this motor will not be a factor," he wrote.

Others attending the show cited an additional reason for their displeasure—fear that these multifuel powerplants (they ran on stove gas,

PM wants to thank the research library of the Motor Vehicle Manufacturers Assn. (MVMA) for its help in preparing this series of articles.

100
YEARS



Early autos explored engine placement: Seldon's 1877 patent was for a transverse front engine (above). Pierce had a rear engine (right), and the 1899 Olds (top right) a mid-engine.

kerosene, naphtha, lamp oil, benzine, mineral spirits, alcohol and a relatively new fuel called gasoline) would explode and shower them with shrapnel and flame. Show officials increased the public's anxiety by summoning a standby bucket brigade whenever an engine was cranked. The year was 1900.

In 1903, to the surprise of most automobile observers (except those directly involved in engineering), a sharp rise occurred in the number of new cars outfitted with four-stroke internal combustion gasoline engines. By 1910, steam engines virtually disappeared as a vehicle powering agent. Electric motors hung on until 1915.

Forty years before and 20 years after the turn of the century are now known to have been the Golden Era in the development of the automobile gas engine. During this 60-year span, most concepts relative to gasoline engine development were conceived. Engines that have come along since have been refinements of those concepts, which awaited some technological breakthrough—either in fuel technology, metallurgy or machine tooling—to attain reality.

In 1860, Etienne Lenoir of France invented the first four-wheeled vehicle to be powered by a gas engine (see *Centennial On Wheels*, page 75, Dec. '84). It was a two-stroker that employed two concepts which are considered by some in the 1980s as new—stratified charging of the fuel mixture by introducing air and gas separately into the combustion

chamber, and water injection. Both methods were employed by Lenoir to keep his one-cylinder engine from knocking.

In 1906, *Cosmopolitan* magazine published a complete guide to the new "Gasoline Motor Cars." Thirteen models had one-cylinder engines, 54 had two-cylinder engines, five were equipped with three-cylinder engines and 59 sported four-cylinder engines. The remaining vehicles included one with a V8 engine built in Redondo Beach, Calif., (it was called The Coyote) and a 40-hp, six-cylinder engine in a five-passenger car. The latter vehicle, which sold for \$2,500, was manufactured by a motor company out of Detroit called Ford. It didn't sell and was abandoned after two years.

Although the typical gas engine at the turn of the century was quite different from today's engines, most modern powerplant technology had been tried by 1906. For example, the first in-block engine (one-piece cylinder block) had been made in 1896 by Charles B. King, but not even by 1906 had machining techniques reached a level that allowed such an engine to be manufactured inexpensively. Therefore, combustion chambers in the typical multicylinder engine were cast individually and bolted to the crankcase.

In 1906, science had not yet perfected a gasket capable of forming a seal between cylinders and cylinder heads. Thus, each cylinder had to have its head cast integrally, with intake and exhaust valves set in caps that were screwed into each head. They named this setup

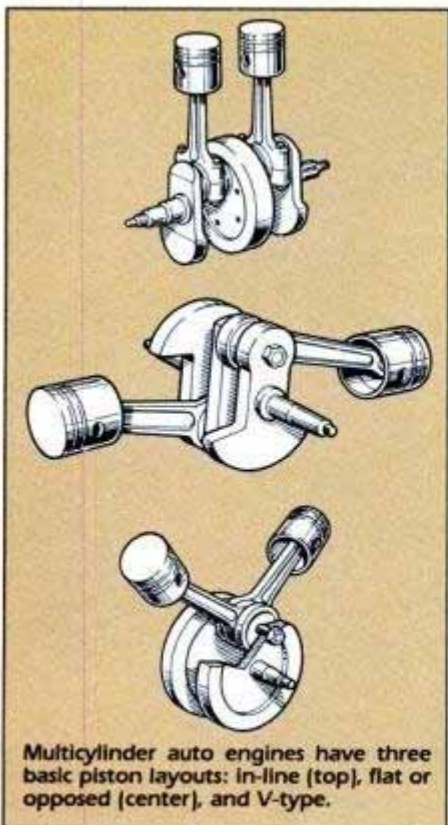
T-head, because the valves straddled the piston.

Each set of valves was operated by its own camshaft. The two shafts—one for intake valves and one for exhaust valves—were located in the crankcase. They pushed up on long stems that lifted the valves off their seats. As the cam lobes moved off the valve stem tips, heavy springs caused the valves to slam shut.

Since the material that the valves were made of was relatively soft, this gave rise to a particularly bothersome situation. Valve life was numbered in hundreds of miles. But car manufacturers had a way around this—they equipped new vehicles with a spare set of valves! When a person got stuck at the side of the road, he unscrewed the valve caps from the cylinder heads to replace the damaged valves.

The T-head engine gave way to the L-head (also called the flat-head or side-valve) engine in which valves were placed on one side of the engine. The L-head dominated the scene for years. Ford used it on V8s until 1953. But waiting in the wings was another design, introduced in 1898 by Wilkinson Motor Car Co.—an engine that had the camshaft and valves in the cylinder heads. You know it as the overhead-cam (ohc) or overhead-valve (ohv).

During this Golden Era, other notable innovations bearing on the development of the gasoline engine took place. The engine in the 1905 Knox was a horizontally opposed powerplant simi-

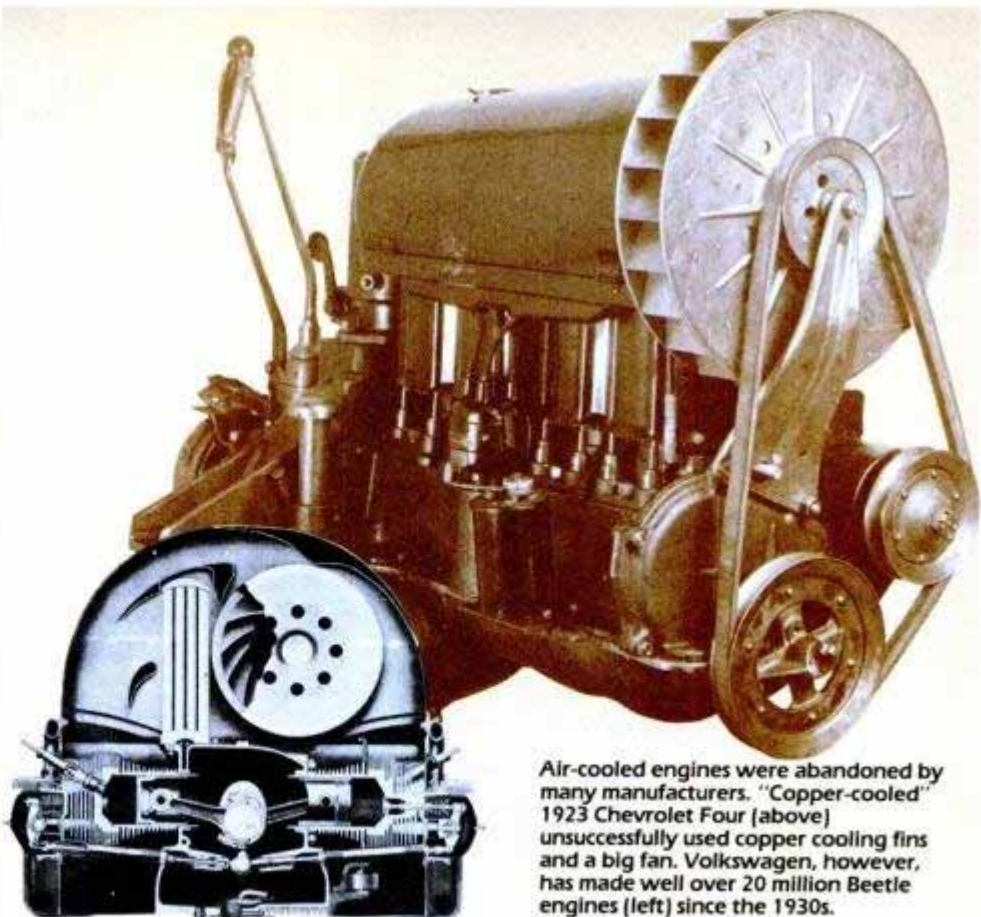


Multicylinder auto engines have three basic piston layouts: in-line (top), flat or opposed (center), and V-type.

lar in makeup to one adopted 30 years later by Volkswagen for use in the Beetle. Like the Beetle engine, the Knox engine was aircooled. Corrugated pins surrounding the cylinders made it possible to obtain 32 square inches of heat-radiating surface per square inch of outside cylinder surface.

Another noteworthy car was the 1906 Premier, with a four-cylinder vertical engine. It had a 4 1/4 x 4 1/4-in. bore and stroke, making it one of the earliest "square" engines.

As late as 1953, C.F. Kettering, automotive genius and inventor of the electric self-starter, wrote: "The so-called square engine with the bore more near-



Air-cooled engines were abandoned by many manufacturers. "Copper-cooled" 1923 Chevrolet Four (above) unsuccessfully used copper cooling fins and a big fan. Volkswagen, however, has made well over 20 million Beetle engines (left) since the 1930s.

ly equal to the stroke in order to reduce piston speed brought us a considerable way down the path to the modern engine." He was referring to engines in the 1949 Cadillac and Oldsmobile.

The early innovators were not adverse to shifting the engine from place to place. At first, it was put under the front seat. Then, it was moved under the hood. Some think it wasn't placed in the rear until VW did it with the Beetle. Surprise! In 1896, a car called the Hertel had an engine back there.

Most people today are familiar with front-wheel-drive (fwd) cars. Many probably think it's a new concept. Wrong! In 1900, the Pennington Car

Co. came out with a vehicle that had a gas engine driving the front wheels. This wasn't even the first fwd car. Electrics and steamers had been using fwd for years.

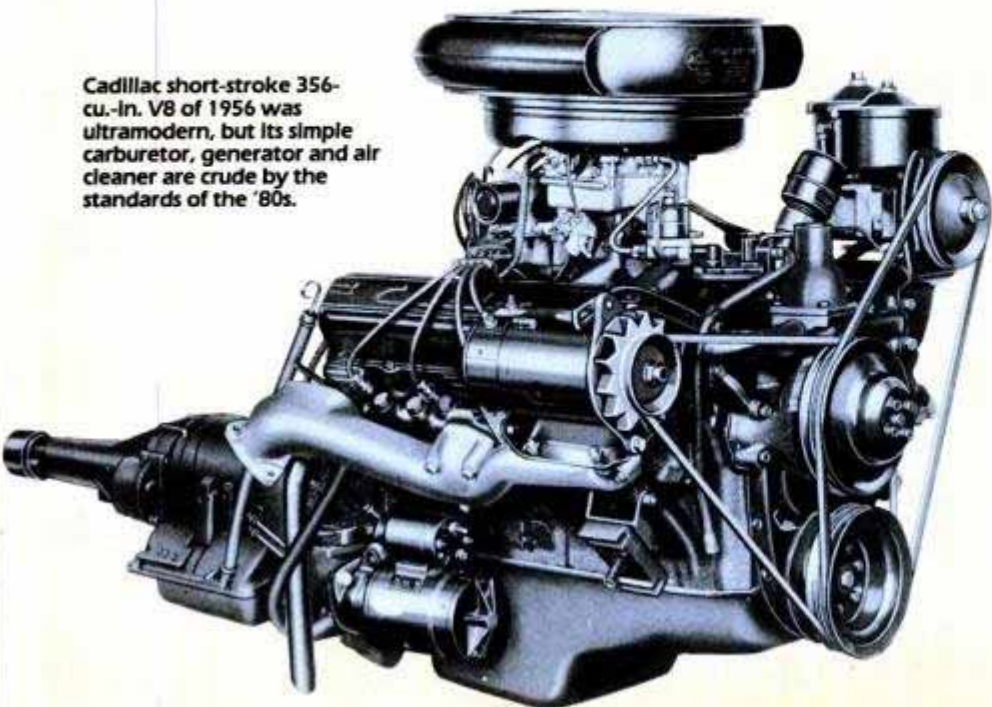
Coverage of this period would be incomplete without mentioning the 1908 Ford Model T, or Tin Lizzie. Its four-cylinder 20-hp engine was the first mass-produced, inexpensive powerplant to be en-block with an individual cylinder head. Perfection of a copper-asbestos head gasket was one of the key developments making this possible.

Engineers knew for a long time that they could theoretically design more efficient engines by increasing compression ratios. By squeezing the fuel mixture into a smaller combustion space before it was ignited, smaller, more powerful engines could be used. However, every time this was tried, engines reacted violently, knocking terribly. The problem was not the engine, but inadequacy of the fuel. So, until the mid-1920s, compression ratios of engines in cars sold to the public ran no higher than 4.3:1.

That limitation ended in 1923 when tetraethyl lead and improved refining methods gave gasoline antiknock qualities. This development allowed engineers to try certain mechanical improvements that increased engine efficiency still further without fear of knocking. Some of these improvements included redesigning combustion chambers, using differently shaped pis-

(Please turn to page 120)

Cadillac short-stroke 356-cu.-in. V8 of 1956 was ultramodern, but its simple carburetor, generator and air cleaner are crude by the standards of the '80s.



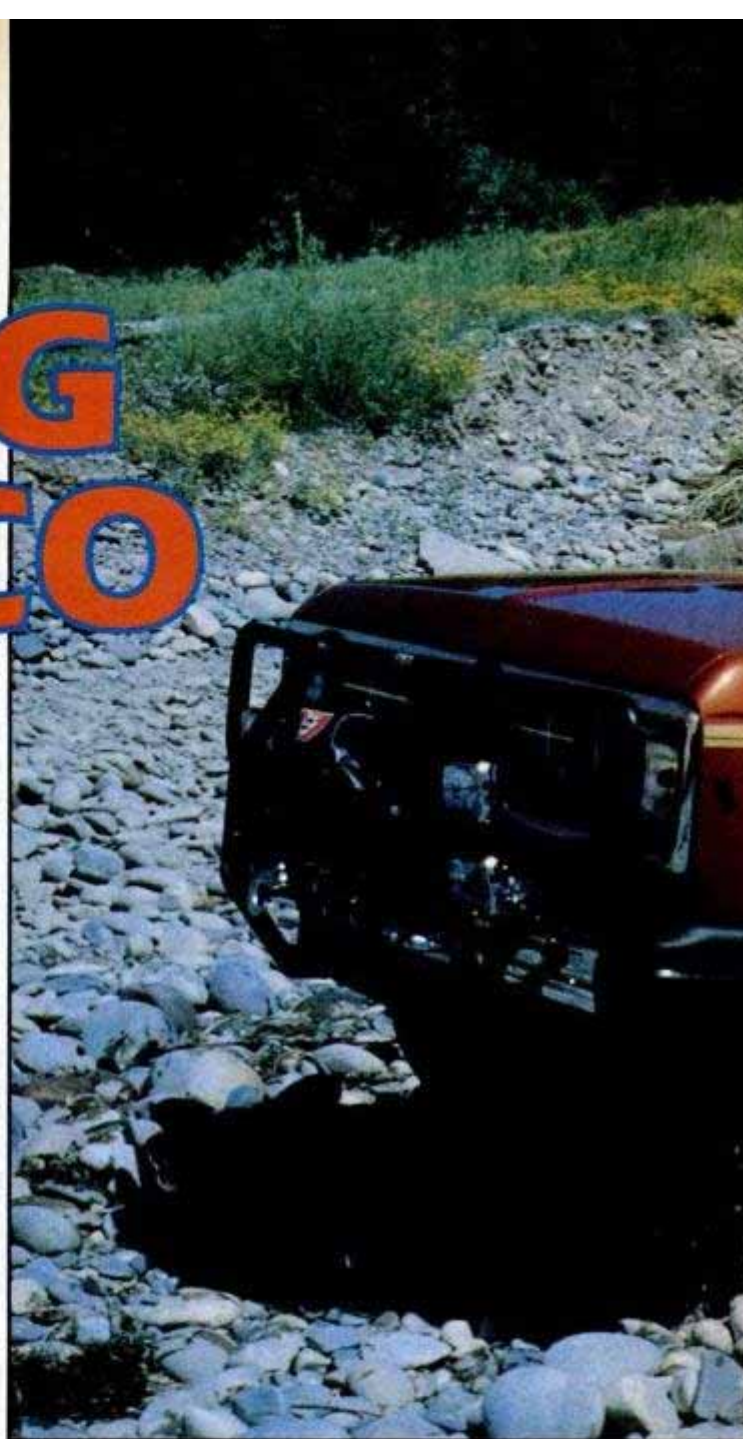


FISHING BRONCO

We prove that a downsized sports/utility vehicle can be a perfect packhorse for any fisherman.



The Bronco II is ready to accept the full complement of gear we've assembled behind it (top). The double-decker setup (above) is provided by the 4x4-foot Peg-Board.



Try and find a vehicle that does everything. It's impossible. Sports cars corner quickly, but drag mufflers on back roads and are limited in cargo space. Motor homes carry much and sleep many, but can't reach the secret fishing holes. Fishermen know that combination spin and fly rods do neither job well, and it's the same with wheels: Compromise transportation is never quite totally satisfactory.

Still, it was an interesting challenge to try and build the ideal vehicle for a fishing enthusiast. What you see here is our fisherman's dream machine, with the emphasis on fly fishing.

We decided to start with a Ford Bronco II because it will find any fishing hole on half the fuel needed to get there in a full-size 4 x 4. And because of its trim size, the Bronco II will be able to squeeze through to more of those secret spots. We chose the 2.8-liter V6 because many favorite trout streams are at high altitudes, where the current crop of four-bangers gets emphysema. We also specified the automatic trans-



On the way to back country, Bronco II climbs the river bank on its Goodyear Wranglers. Winch is a Warn Model 6000, and a brush guard protects front end.

mission, because fishing is the objective, not die-hard fourwheeling. We wanted air conditioning since some of the best hatches that bring the fish are on hot days, and you want to be fresh for a day of casting. Skid plates, to save the underside, and the rear-mount spare to save space inside were also ordered.

A limited-slip front differential and a Traction-Loc rear send power to the wheels. Then, to get it to the road—or no road—we mounted a set of Goodyear Wrangler radials. Fly fishermen should have such traction on slippery rocks! Heavy-duty shocks with matching springs, a 63-amp-hr. battery, automatic locking hubs, full dash gauge package, cruise control, tilt wheel, AM/FM stereo with cassette and four speakers, and the split fold-down rear seats completed the basic package.

The first garage project was installing a Warn 6000 winch and brush guard. Marchall quartz-halogen fog and driving lights came next, followed by Cibie Bobi quartz-halogen replacement headlights. These lights are legal in all 50 states, and when properly aimed are

not dangerous to oncoming traffic. They have less light scatter and are brighter than the factory-option quartz headlights. However, the whiteness and the brightness sometimes attract law enforcement interest, so we installed the new Regency RS



Console-mounted electronics—CB, scanner, driving computer—are a tether to civilization.


Also onboard is an M400 scanner for monitoring road and traffic reports and listening to weather-band broadcasts. Next to the M400, we mounted a GE CB radio and the brain unit for an Ungo Box, coupled to a

(Please turn to page 142)

Resurface Your Kitchen Cabinets For A **BRAND NEW LOOK**




Plastic laminate in an almond hue covers new doors and front surfaces of original cabinets. Minimal space between pairs of doors and wood trim give the kitchen a European look.



Covering old cabinets can give
your kitchen a dramatically new look
at a fraction of the cost
of a complete remodeling job.

BY PENELOPE A. SPANGLER
Home Improvement Editor



If your kitchen badly needs updating, yet remodeling it doesn't fit into your budget, resurfacing the cabinets with a plastic laminate such as Formica, and adding new doors and drawer fronts can rejuvenate your kitchen—and keep your budget balanced. If your present kitchen cabinets are in sound condition, and the present floor plan is functional, the savings can be substantial. In fact, in buildings with old plaster walls, some homeowners have preferred to resurface cabinets rather than risk serious wall damage by removing and replacing old cabinets.

Your selection of cabinet resurfacing material and cabinet door style helps determine the style of the kitchen. You can opt for a traditional look with wood-pattern laminate; go for a bright, upbeat kitchen with a solid-color laminate in a vivid hue; or elect a sophisticated solid-color laminate in pastel or white.

You can also choose the amount of work you want to do yourself. For the least outlay of money, construct the doors and drawer fronts and resurface the cabinets yourself. For information on building and hanging cabinet doors, see *How To Build Cabinet Doors*, page 104. Rather than building them, you might prefer to order the cabinet doors and door fronts custom-made to your specifications (see sources below). Then, resurface the cabinets in matching laminate yourself. You also can have a local home improvement or kitchen refacing company familiar with the process measure and order doors and resurface the cabinets for you.

Even if the resurfacing job is done by professionals, you'll still pay substantially less than for a total remodeling job. A professional resurfacing job for an average kitchen (about 18 to 20 doors and three to four drawers) costs about \$3,000, depending on door style and color. The job shown, done profes-

sionally, cost about \$4,000. This larger job, included more doors, four completely new drawers with new hardware and two countertops with special bevelled wood edges. (For tips on replacing a kitchen counter, see *Tile Or Laminate Countertop? Here's How To Do Both*, page 102, Feb. '83.)

In most cases, it is necessary to make new doors rather than resurface existing ones because many doors have rounded edges which must be trimmed square before they can be laminated. Trimming the old door usually results in it being too narrow and too short to cover the original opening.

Tools and supplies needed

With the exception of a router or power laminate trimmer, you can do the entire resurfacing using hand tools. However, other power tools can speed up the job. To prepare the cabinets, you'll need: a screwdriver, preferably a power driver to remove doors; prybar to remove trim; hand paint scraper or belt sander to remove old paint, varnish and grease; hammer to flush out bottom of wall cabinets if needed; saw to trim any frame overhang.

To laminate cabinets, you'll need a carpenter's rule and tin snips to cut the laminate. Although tin snips can leave a ragged edge, the laminate is cut oversize and the edge trimmed later. You'll also need a brush or a short-nap roller with a phenolic core to spread the contact cement; a paint pan, coffee can or other container to hold contact cement; a pressure roller, wood block and hammer or rolling pin to press the laminate to the core; a router with a flush-trimming bit to trim the laminate; and a fine mill file to smooth the laminate edge.

To install the cabinet doors and drawer faces you'll need a carpenter's rule, drill and screwdriver.

CREDITS AND SOURCES

Plastic Formica-brand laminate, doors and drawer fronts in 24 styles plus other needed material for do-it-yourself installation (and product literature, \$2.50) are available from Indoors by Interface Industries Inc., 96 Snediker Ave., East New York, N.Y. 11207; or write for a professional resurfer in your area.

Technical assistance: J & J Home Improvements, Bronx, N.Y.

PM photos: Steven Fay

Styling: Gabe Herrick

Technical art: Dyck Fledderus

Chairs: Model B-11 dark blue vinyl Breuer chair (about \$45), J & D Brauner, 11-15 49th Ave., Long Island City, N.Y. 11101.

Wood doors, drawer fronts and veneer for do-it-yourself installation: Quality Doors, 603 Big Stone Gap Rd., Duncanville, Tex. 75137; 12 designs are available in unfinished oak, ash, maple veneer or paint grade.

PREPARATION



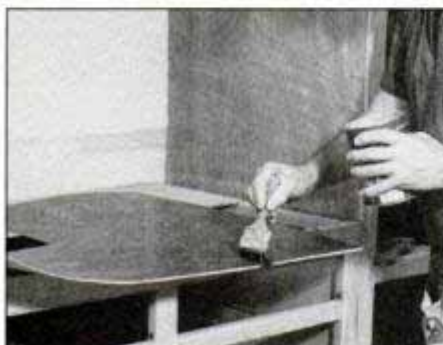
1 Remove cabinet doors, drawers, hardware, trim, appliances—and counters if you replace them. They are nailed to adjoining cabinets or screwed to cleats from below.



2 Flush out the bottom of wall cabinets so they can be laminated for a neater appearance. Use 1/4-in. plywood or fiberboard secured with 3/4-in. brads.



3 Apply fillers as needed to stiles depending on the hardware you select. In most cases, you need 1 3/4-in. minimum stile width to hinge two doors to the same stile.



7 Apply two coats of contact cement evenly to the back of the laminate, letting it dry between coats. Use adhesive liberally, but drips on edges make trimming difficult.



8 Since contact cement bonds instantly, position a piece of uncemented laminate or other material between prepared surfaces until the cemented laminate is in place.

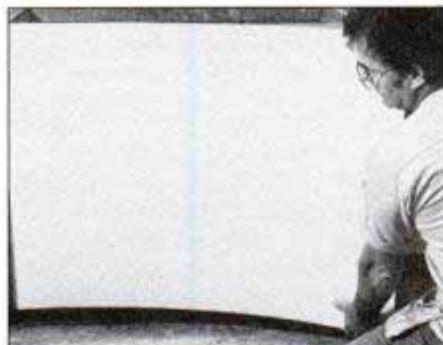


9 Use a router with a flush-trimming bit to remove excess laminate along the edge. First spray the bit with lubricant such as WD40 to ensure a smooth, even cut.

FAST, SEAMLESS. NO-MEASURE WAY TO RESURFACE CABINET FRONTS



1 Apply contact cement to the cabinet surface and to a sheet of plastic laminate.



2 Press laminate on the cabinet. Work over surface with hammer and wood block.



3 Use a file tang or drill bit to poke a hole through the areas that will be removed.

INSTALLING DOORS AND DRAWER FRONTS



To install doors, measure and mark cabinet frame for horizontal and vertical alignment. Note double thickness of laminate between doors maintains proper 1/16-in. spacing.



After aligning drawer front with the door hung below it, fasten the new front to the drawer box with two wood screws through the old front into back of new drawer front.

Supplies you'll need include: plastic wood to fill screw holes; possibly pine filler strips on stiles to accommodate new hinges of adjacent doors, depending on hinge spacing requirements; 1/4-in. plywood or fiberboard and 3/4-in. brads to flush out cabinet bottoms if needed; nonflammable contact cement; 120-grit abrasive for belt sander if used; and nonflammable cleaning solvent (111 trichloroethane) to remove cement from laminate surfaces. In addition, have the finished doors, drawer fronts, hardware and plastic laminate on hand. To measure for doors and drawers and to estimate other laminate needs, see *How To Estimate Materials* on page 130.

LAMINATION



4 A paint scraper with sharp blades makes quick work of removing varnish. A belt sander with medium-grit abrasive also can remove varnish, paint and grease.



5 Measure and mark laminate so piece to be cut is at least 1/2 in. oversize in both height and width. You can cut vertical grade laminate face up with tin snips.



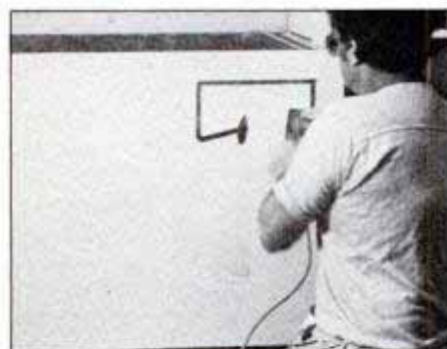
6 Apply contact cement to the prepared cabinet with a paintbrush or paint roller. Work over the entire surface, leaving no bare spots. Let adhesive dry and reapply.



10 Using a special laminate roller, rolling pin or wooden block and hammer, apply pressure evenly over the laminate to help the cemented surfaces make good contact.



11 Use a fine mill file to finish smoothing the laminate edge at the ends of the piece where the router can't reach, and along the entire length of the trimmed edge.



4 Use a router to remove excess laminate. Then, file all of the edges until smooth.

kitchen is an ideal work place. Open the windows or otherwise ventilate the room.

Remove doors, drawers, latches, hinges, molding and appliances if needed to expose the rails and stiles of the cabinets. Appliances don't necessarily have to be removed completely. For example, simply slide a gas stove out enough to work on adjacent surfaces. Remove the vent hood. You can slide out an electric wall oven.

If your job involves replacing counters, remove the old ones. They may be nailed into an adjacent cabinet, or fastened underneath by screws driven up through cleats into the underside of the countertop. If the front cabinet rails and stiles overhang the cabinet sides, trim the rails and stiles flush with the cabinet sides.

For the best appearance, plan to laminate the bottom of your wall cabinets. You will probably have to flush out the bottom with 1/4-in. plywood or fiberboard and 5/8- or 3/4-in. brads, depending on the thickness of the bottom. In many cases, particularly if you want a European look which involves using self-closing, hidden recessed hinges and oversize doors that hide rails and stiles, you must install vertical fillers onto the sides of the stiles. This gains extra width for attaching hinges of two doors to the same stile. Check specifica-

tions for your particular hardware.

Scrape or sand the front frames and end panels of each cabinet to remove surface finish. For an old varnish finish, use a scraper or a belt sander. Sharp blades are a *must*. On painted surfaces, a belt sander usually works best. If paint buildup is too much for a sander or scraper, or if cabinet surfaces are badly worn, cover exposed surfaces with new 1/4-in. plywood or fiberboard.

For best results, remove old plastic laminate. Pry up a corner of the laminate with a putty knife and apply contact cement solvent—111 trichloroethane—to soften it. Sand the underlayment with 120-grit abrasive. Smooth any spots where the underlayment is removed with wood filler. If the old laminate is in good condition and can't be removed, sand it with 120-grit abrasive to get good adhesive bond.

The frame fronts on metal cabinets can be covered with strips of 1 x 2 or 1 x 3 fastened to the cabinet with sheet-metal screws. Sides can be covered with 1/4-in. plywood or fiberboard. Stiles must be quite secure to hold the doors.

Laminating the cabinets

To apply plastic laminate successfully, make sure the cabinet surfaces are clean and that you apply sufficient cement. Work in a well-ventilated room; use nonflammable contact adhesive.

Laminate cabinet parts in this order: the bottom of all wall cabinets, all cabinet sides and finally cabinet faces. If you are working with a solid-color laminate, use the biggest piece possible to minimize seams (see *Fast, Seamless, No-Measure Way To Resurface Cabinet Fronts*, facing page).

If you've selected a wood-pattern laminate, cut oversized horizontal rails and vertical stiles separately so the wood grain is vertical on the stiles and horizontal on the rails, as with cabinets of real wood. Apply laminate to stiles, then to top and bottom rails.

Mark laminate for each piece and cut

(Please turn to page 130)

When ordering plastic laminate, keep in mind that there are two grades: standard and vertical. Vertical grade is 1/32 in. thick. It is easier to work with and is used for cabinet sides and fronts. Standard grade (1/16 in. thick) is used on horizontal surfaces such as countertops.

Preparing for the job

Before you begin the resurfacing job, remove all items from the cabinets, drawers and counters. If possible, remove the furniture and close off the kitchen by hanging sheets or closing doors. Gather tools and supplies and organize a work area where you can trim laminate and apply contact cement. An adjacent porch next to the



RAISED
PANEL



FOUR
PANEL



HORIZONTAL
V-GROOVE



GLASS
PANE



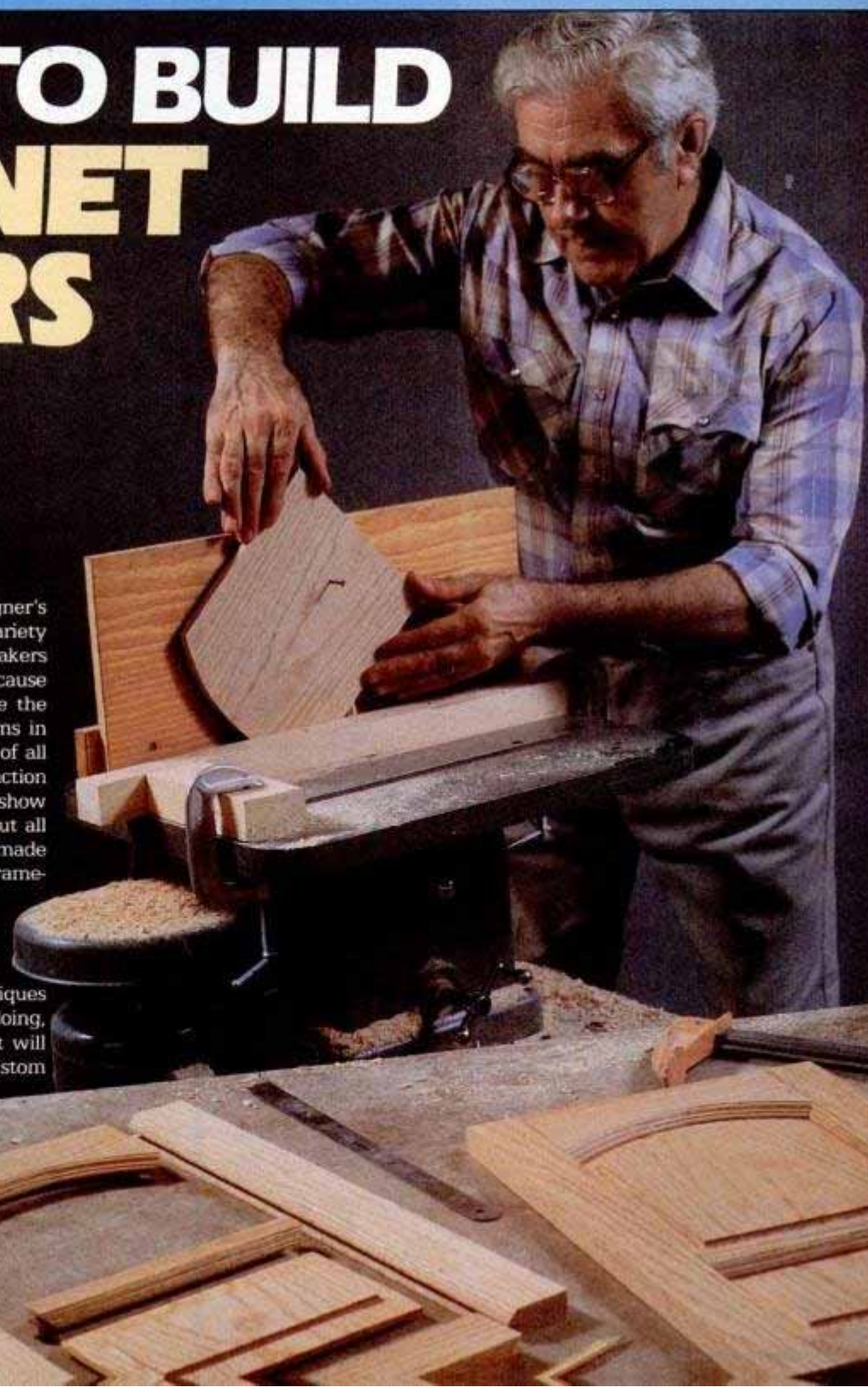
VERTICAL
GROOVE

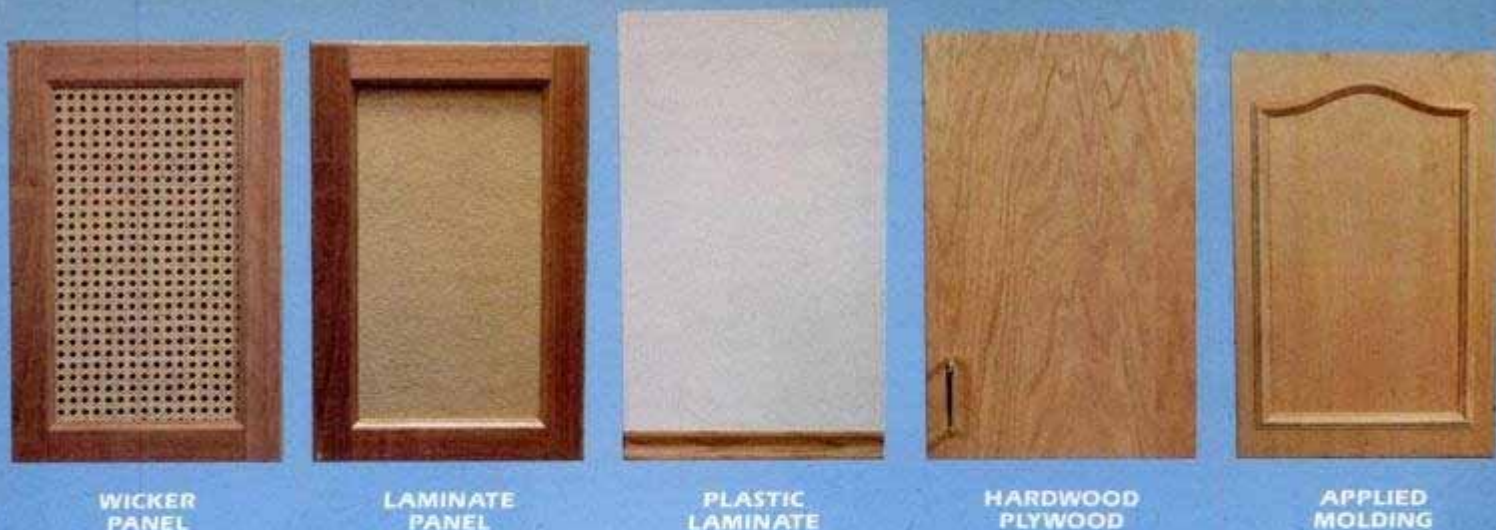
HOW TO BUILD CABINET DOORS

Learn to build cabinet doors using a variety of tools, techniques and materials.

BY ROSARIO CAPOTOSTO

A walk through any kitchen designer's showroom will reveal a wide variety of different cabinet doors. Cabinetmakers have created this wealth of options because they know that doors often constitute the primary visual component of the rooms in which they appear. However, in spite of all these possibilities, basic door construction methods are surprisingly few. Here we show how to build eleven different types, but all fall within two basic categories: doors made of various panels surrounded by a framework, and flat slab doors made without a surrounding frame. Because of this similarity of construction, you can either make the specific doors we show, or you can combine our techniques and materials in different ways. By so doing, you can create your own designs that will give any cabinets you build a truly custom appearance.





WICKER
PANEL

LAMINATE
PANEL

PLASTIC
LAMINATE

HARDWOOD
PLYWOOD

APPLIED
MOLDING



Arched raised panel door is made of seven parts: two panels, three rails and two full stiles. Rails and stiles are joined with glue; panels simply float in grooves.

Arched Raised Panel

Before discussing the specifics of building arched raised panel doors, let's cover a few general points regarding frame-and-panel door construction. Generally, two horizontal rails and two vertical stiles form the frame that holds the panel. The inside edge of the rails and stiles is shaped using a sticking cutter. Sticking refers to the molded profile of the frame. The rail ends receive coping cuts which match the sticking (see the drawing on page 107). No special cutters are needed if flat sticking is desired. Simply assemble the frame using doweled butt-joints or open mortise-and-tenon joints.

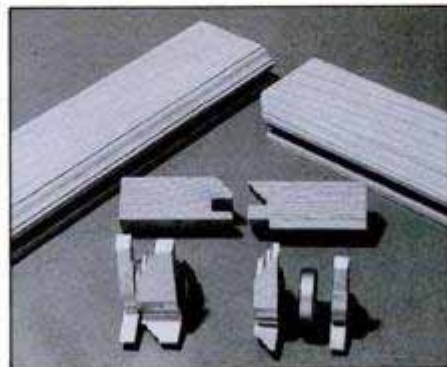
Door panels are made in two basic styles: flat and raised-bevel (see the drawing on page 106). Make flat panels from 1/4-in. hardwood veneer plywood. Raised-bevel panels are usually cut from 7/16- or 1/2-in.-thick hardwood. The

raised panels shown were cut on a table saw or shaper. At the end of the article we'll show alternative methods for cutting a raised panel.

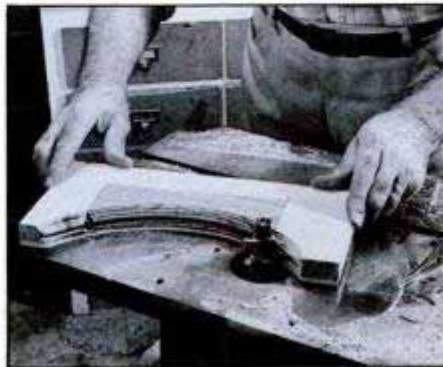
To make arched raised panel doors, start by cutting *three* rails and two stiles for each door. With the sticking cutter in the shaper, cut the inside edge of the lower rail and of both stiles. The middle rail receives sticking cuts on both edges. Now cut the arched upper

rail on a band saw. But first, make a holding jig to handle the upper rail safely when shaping the sticking. The jig consists of a board, cut out to accommodate the upper rail, and a 1/4-in. plywood template base. The template rides against the cutter guide-collar to control the cutter. Attach the template to the upper rail with 1/2-in. brads *before* bandsawing the arch.

Now, with the coping cutter in the



Use a set of matched shaper cutters to form the sticking (left) on inside edge of frame and the coping (right) on rail ends. Cutter profiles are revealed by sample cuts.



Make this simple holding jig for shaping the sticking on upper rail. A plywood template nailed to rail underside rides against the cutter's guide-collar to control cut.

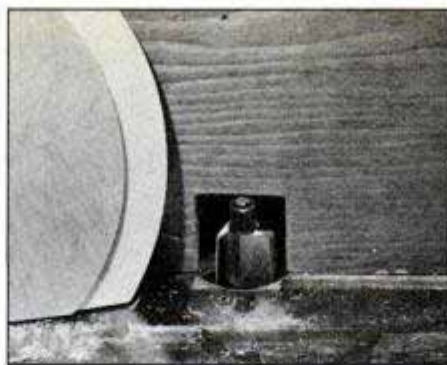
Photos: Rosario Capotosto
Technical art: Eugene Thompson
Caning, wood moldings and continuous oak pull supplied by The Woodworkers' Store, 21801 Industrial Blvd., Rogers, Minn. 55374.
Three-piece router bit set is available from Conover Woodcraft Specialties, 18125 Madison Rd., Parkman, Ohio 44080, for \$94.95 postpaid.



Screw a tall auxiliary fence to the shaper fence for cutting the raised bevel on the arched panel. Pivot the panel into the cutter on a nail driven into the auxiliary fence.

shaper, cut the ends of all the rails. For this operation, use a miter gauge equipped with a hold-down clamp. Next, dry-assemble the frame and measure between the sticking grooves to determine the panel sizes. Cut the panels $\frac{1}{4}$ in. shorter in width and length to allow for expansion.

Install a vertical panel raising cutter into the shaper. First, raise the bevel on the lower panel. Always make a test cut before shaping the workpiece. To cut the arched raised bevel on the upper

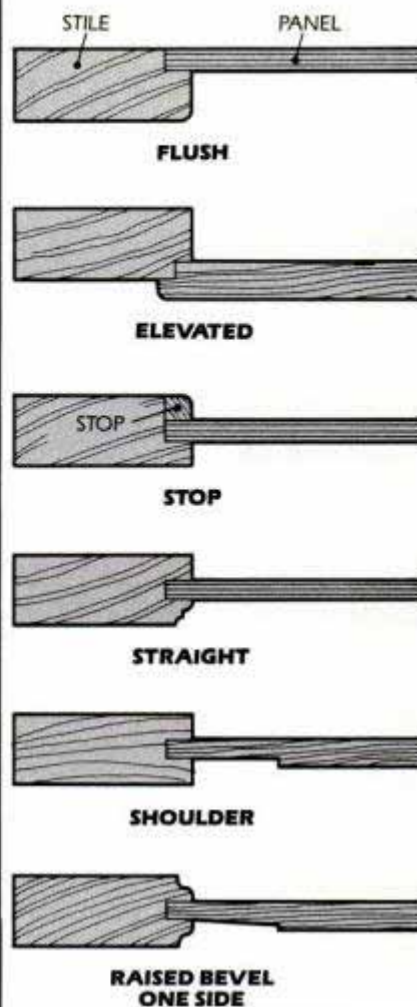


Close-up view shows the vertical panel-raising cutter used. Note that auxiliary fence must be notched around the cutter. Keep hands well clear of the cutter at all times.

panel, screw an auxiliary fence to the shaper fence as shown. Clamp a second board to the shaper table to hold the panel against the fence. Now bore a small nail hole through the panel centered at the radius of the arch. Nail through the panel and into the auxiliary fence. Hold the panel clear of the cutter, turn on the shaper and swing the panel into the cutter to form the bevel.

Finally, assemble the door frame using glue only. Don't glue the panel in the grooves.

COMMON PANEL STYLES



Raised Panel

This is the most popular cabinet door style. Raised-panel doors are an easy way to add a touch of class to any cabinet. The raised bevel

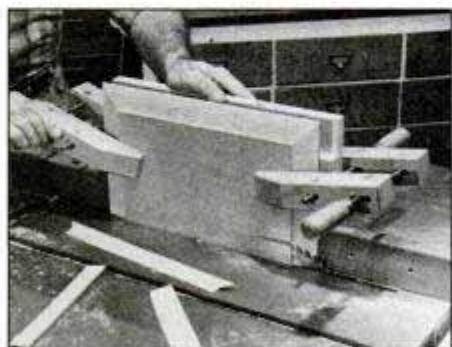
on this door panel is cut on the table saw. No special cutters or accessories are needed. Cut the stiles and rails to size. Dry-fit the frame and then measure to determine the panel size. Cut the fence $\frac{1}{4}$ in. shorter in width and length.

After surface planing the panel to $\frac{1}{2}$ in. thick, move to the table saw to cut the raised bevel. Elevate the saw blade to $1\frac{1}{4}$ in. and position the saw fence $\frac{3}{16}$ in. from the blade. Now tilt the saw

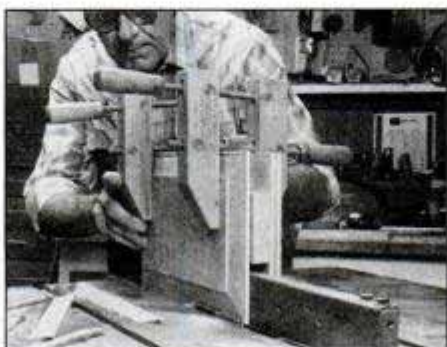
blade 10° away from the fence. Alter the above dimensions for panels that aren't $\frac{1}{2}$ in. thick.

To control the panel and to ensure safe, accurate cuts, make the simple guide of two wood blocks clamped to the panel, as shown. The assembly straddles the saw fence and prevents the panel from tilting into the blade. Be certain that the block in the middle is the same exact thickness as the fence. Clamp the three pieces together with the back block and panel resting firmly on the saw table.

Cut the raised bevel on the panel ends first and then on the two sides. This way, any cross-grain splintering will be removed by the bevel cuts on the panel sides. Use a sharp, smooth cutting saw blade when raising the panel. Burn marks and saw ripples caused by a dull blade are difficult to remove.



Cut the raised bevel with saw blade tilted 10° . To ensure safe, accurate cuts, clamp two boards to the panel and straddle fence. Rest back board and panel firmly on saw table.



It's necessary to make a shallow, perpendicular cut on the face of the raised-bevel if the panel fits the sticking grooves too tightly. Use the two-board guide as shown.



Assemble the door frame using glue only. Do not apply glue to the panel grooves. Panel must be free to expand and contract. Finish-sand all parts before assembly.



Four Panel

The four-panel door style features four flat plywood panels divided by a vertical mullion and a two-piece cross rail. Make the sticking and

coping cuts on the stiles, rails and mullion with a shaper or router table.

It's necessary to take certain safety precautions when handling the small cross-rail pieces. *Caution:* Failure to heed the following instructions could lead to serious injury. Clamp the cross rail to the miter gauge when making the coping cuts. Never try to hold the rail by hand. To make the sticking cuts safely, place the rail in a notch cut in a larger scrap board, as shown. Tack-nail a wood strip securely across the top of the

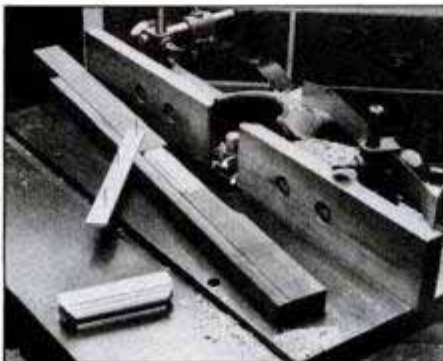


Clamp the short cross-rail pieces to the miter gauge when making the coping cuts. Never try to hold the rails by hand. Position the front fence to act as a stop block.

board to hold down the rail. The mullion can also be handled safely in this manner.

Note that in both of the above procedures it's not necessary to handle the cross rails during the shaping operations. Be sure to always keep your hands well clear of the shaper cutter.

After all the parts have been milled and finish-sanded, assemble the door by first gluing the bottom rail to the stile. Next, install two 1/4-in. plywood panels separated by a cross rail. Be certain to cut the panels about 1/4 in. shorter in width and length to allow for expansion. Then, glue the mullion to the cross rail and to the bottom rail. Add the remaining two panels and cross rail and then glue on the final stile and the upper rail. As with all frame and panel doors, don't glue the panels in place. Apply glue to the rails, stiles and mullions only.

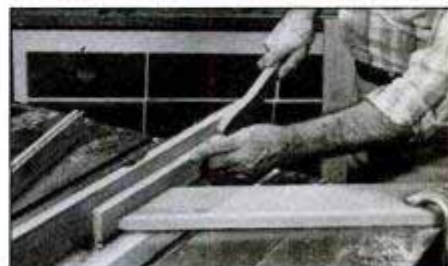


Make this simple jig to hold the cross-rails when cutting the sticking. Notch the longer board to accommodate rail. Tack-nail a strip across the top to hold down the rail.

Horizontal V-groove

The European-style horizontal V-groove door is assembled with tongue-and-groove joints. Cut the joints on a table saw using a molding cutter-head fitted with the appropriate knives. Adjust the cutters so that the joints are made slightly toward the back edge of the workpiece. This off-center positioning will result in an equal amount of flat gluing surface on either side of the joint after the V-groove is cut.

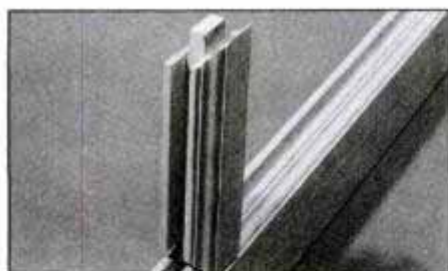
First, cut a groove on the inside edge



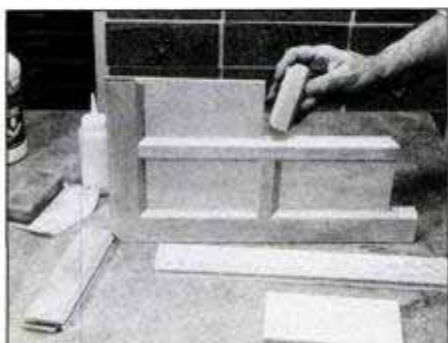
Cut the groove in stiles with the aid of a push stick and featherboard. The wood fence keeps cutter clear of metal fence.

of each stile. Then use a standard saw blade to cut a 45° bevel on the stiles' top edge. Now cut a matching tongue on both ends of each horizontal slat using a table saw tenoning attachment. This is the safest, most accurate means of cutting the tongues. Note that a backup

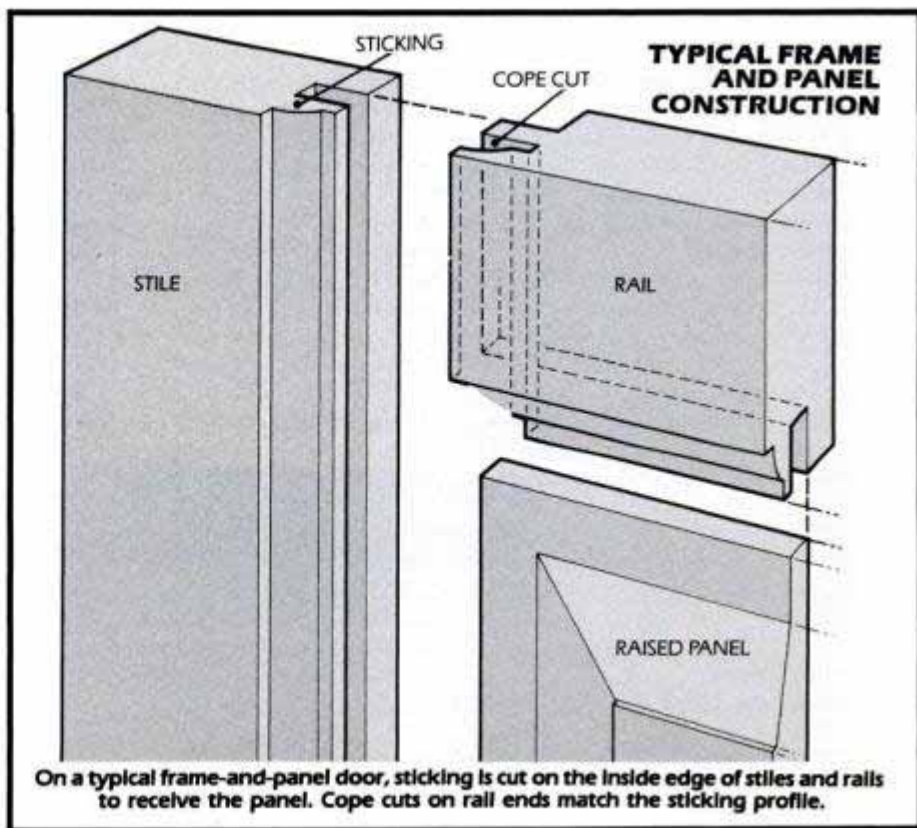
(Please turn to page 148)



Coping and sticking details are seen clearly in this close-up view of a finished cross rail. Rail is shown positioned on a stile.



The door is shown as it nears completion. Glue the second cross rail to mullion before positioning the last plywood panel. Apply glue to hardwood parts only; not to panels.



On a typical frame-and-panel door, sticking is cut on the inside edge of stiles and rails to receive the panel. Cope cuts on rail ends match the sticking profile.

BUILD PM'S VERSATILE SMALL TABLE

This maple table—built to dining-table height—can fit neatly into any room in the house.

BY NEAL BARRETT



Clean lines and a clear, natural finish give this small maple table a light contemporary feel that will complement anyone's decor.

Even though we all try to make the best of the living space we can afford, there always seems to be a corner here and there that could be put to better use. The problem is, this space won't accommodate a major piece of furniture no matter how many times we rearrange the room.

Here's a small table we designed for just this kind of situation. It can easily sit two for breakfast in a tight kitchen or fit in the corner of any living room for playing board games and cards. It can serve as a compact writing table in a small bedroom or as a convenient place in the foyer to drop keys, mail and a newspaper. And while our table is made of solid maple, any hardwood species would work as well, especially one that complements the rest of your furniture.

Preparing stock

Begin by selecting from 4/4 stock the boards to be used for the tabletop. Selection criteria should be matching grain and color. Crosscut the boards to rough length and true one edge on a

jointer. Rip each board at least 1/16 in. wider than the finished dimension, then use the jointer to surface the ripped edges to ensure tight glue joints. Edge-join the boards for the top using carpenter's glue and clamps. Be sure to spread a thin, even coat of glue across all matching edges. (If the boards are slightly warped, use 1/4-in.-dia. dowels spaced 6 to 8 in. apart on the edges to keep the boards aligned.)

Wait until the glue has started to set, approximately 20 to 30 minutes, then scrape off any excess glue with a sharp chisel. This will eliminate difficult cleanup later after the glue has completely dried.

Legs

Rip 8/4 stock to width for all the legs, then cut the legs to finished length and lay out the apron mortises according to the dimensions shown in the drawing.

Clamp a fence onto the drill press table to keep the workpiece properly positioned and bore overlapping 7/16-in.-dia. holes to remove most of the waste from the mortise. By using a brad-point drill bit, you can achieve a flat-bottomed hole and save considerable labor in squaring the bottom of the mortise later with a chisel.

Trim the sides of the mortise to finished dimension with a sharp chisel, making sure to remove all the ridges left by the drill bit. After all the mortises have been cut, lay out the tapers on each leg. Note that the taper only appears on the two inside edges and that it begins 4 1/2 in. down from the top of each leg. This detail permits a square joint between the legs and apron.

Cut the tapers freehand on the band saw, being careful to cut only on the waste side of the line. Then use a sharp plane, cabinet scraper or a belt sander to remove the saw marks.

Aprons

Rip 4/4 stock to 4 in. wide for the aprons and cut to finished length. At the

Color photo: Harry Hartman
Room stylist: Gabe Herrick
Black and white photos: Neal Barrett
Technical art: Eugene Thompson

same time, rip one piece of the stock approximately 20 in. long by 2 in. wide to be used for the wood buttons that attach the tabletop to the base. Set this board aside.

Next, cut the tenons on the ends of each apron piece using the dado blades in a table or radial-arm saw. Since these blades leave small ridges on the cheeks on the tenon, it's good practice to cut the tenons slightly thicker than required and trim to the finished dimension with a sharp chisel. Next, hold each apron board in the vise and cut the $\frac{3}{8}$ -in.-deep shoulder at the bottom of each tenon using a backsaw or dovetail saw.

This shoulder "hides" the bottom of the mortise for a better-looking fit.

Use dado blades again to cut the $\frac{1}{4}$ -in.-wide by $\frac{3}{16}$ -in.-deep groove on the inside of each board. This groove accepts the wood buttons used to attach the top.

While the dado blades are still in the saw, readjust the blade to cut the rabbet that appears on the end of each button in the stock that was set aside earlier for this purpose. Once the rabbet is cut, cut the six buttons to length.

Next, lay out the curved cutouts on the bottom edge of each apron. Using the dimensions given in the drawing,

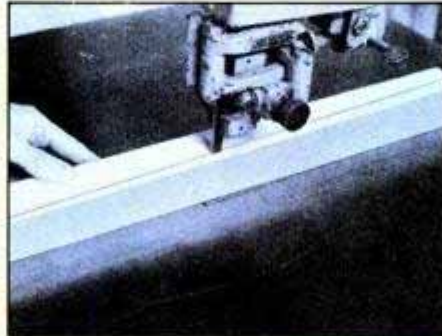
drive a 4d finishing nail at the apex of the curve which is at the center line of the length of each apron piece. Then clamp two blocks of scrap wood at the bottom outside edges of each apron as shown. Take a $\frac{1}{8}$ -in.-thick strip of pine and bend it between these three points, forming a gentle curve. Trace this curve with a sharp pencil, then repeat this procedure for the other apron boards, noting that the dimensions for the curve are different for the long and short aprons.

Use a band saw to cut the curves, again cutting on the waste side of the

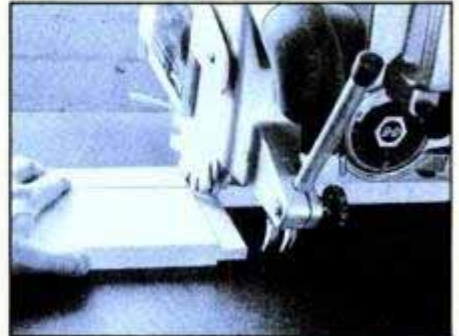
(Please turn to page 118)



Cut apron mortises in table legs by boring overlapping $\frac{7}{16}$ -in.-dia. holes using a drill press. Clamp alignment fence on table to ensure that all mortises are cut the same.



Use band saw to cut taper on inside edges of all legs. Cut can be made freehand as long as blade remains on waste side of line. Remove saw marks with a sharp bench plane.

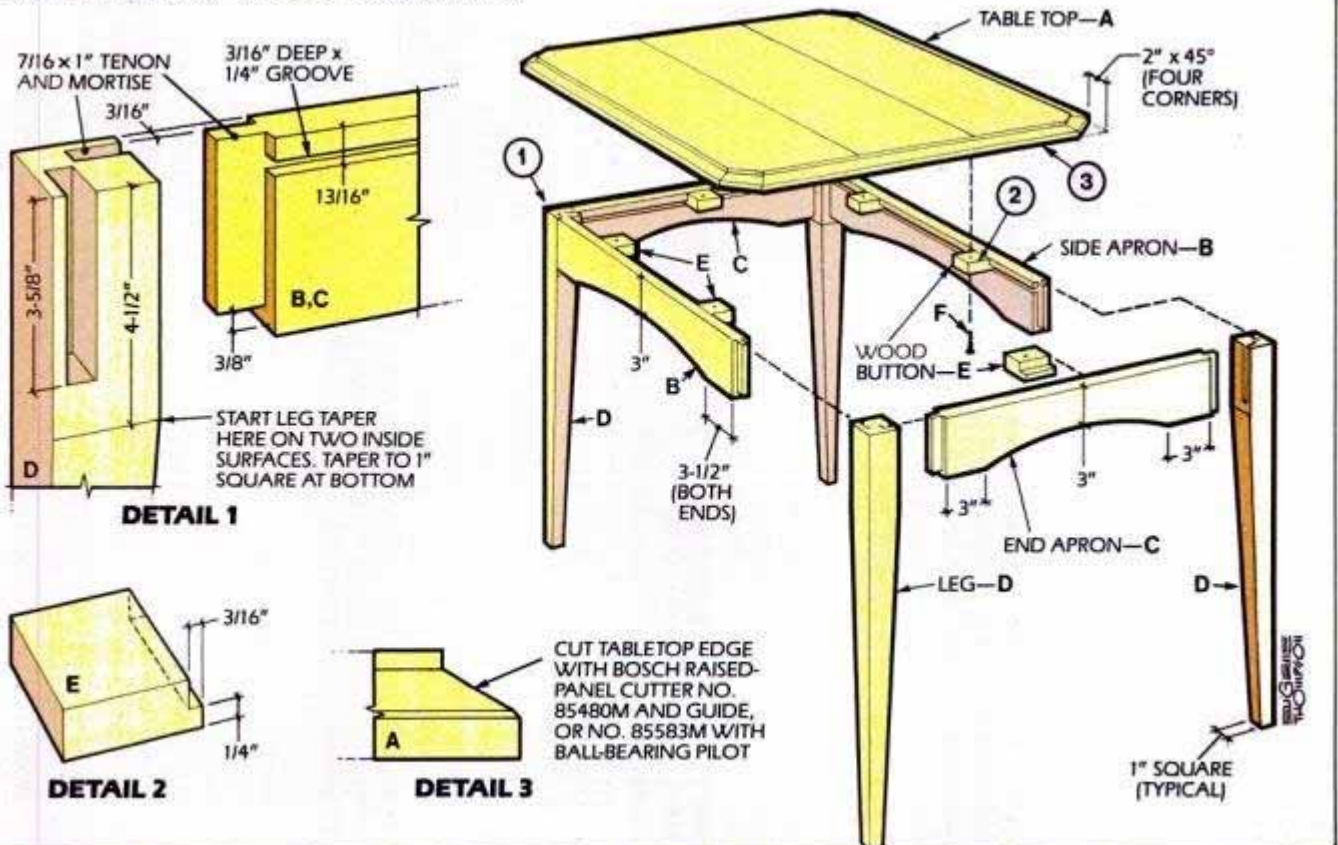


Cut tenons on ends of table aprons using dado blades in radial-arm or table saw, then remove saw blade ridges with sharp chisel. [Saw guard removed for photo clarity.]

MATERIALS LIST—SMALL MAPLE TABLE

Key	No.	Size and description (use)	C	2	$\frac{13}{16} \times 4 \times 21\frac{1}{2}$ " maple (end apron)	F	6	$1\frac{1}{4}$ " No. 10 rh screw
A	1	$\frac{13}{16} \times 27 \times 34$ " maple (top)	D	4	$1\frac{3}{4} \times 1\frac{3}{4} \times 28\frac{1}{4}$ " maple (leg)	Misc.:		Carpenter's glue, 120- and 220-grit abrasive paper, satin-finish polyurethane varnish.
B	2	$\frac{13}{16} \times 4 \times 28\frac{1}{2}$ " maple (side apron)	E	6	$\frac{13}{16} \times 2 \times 2$ " maple (wood button)			

SMALL TABLE 27" WIDE x 34" LONG x 29" HIGH

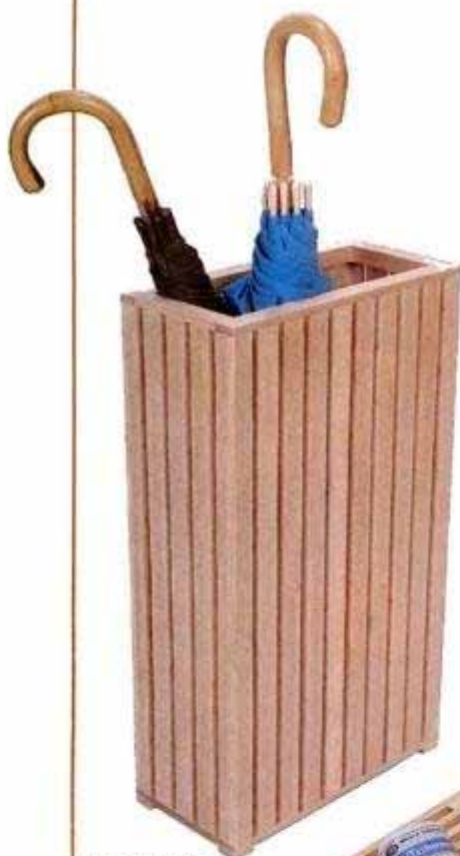


6

E·A·S·Y PIECES Using Solid Maple Slats



DISH RACK



UMBRELLA
STAND



PLANT
STAND



BREAD BOARD



BATH RACK

GENE AND KATIE HAMILTON
AND STEVE WOLGEMUTH



DOORMAT

Put together any one of these useful slatted furnishings in a weekend, and enjoy it for years to come. All are made of solid maple and bear a family resemblance to each other, so you can build several matching pieces if you wish. Each requires a minimum of materials—you may even find sufficient scrap around your shop for more than one item—and the simple yet interesting assembly techniques make each a pleasure to build.

1

DISH RACK

Our solid maple dish dryer rack is a functional work saver, and much better looking than the plastic variety you might

buy. It's sturdy, yet folds flat for easy storage.

Begin construction by ripping stock to $\frac{3}{8} \times \frac{3}{4}$ in. for the legs and supports. Then rip the slat material to $\frac{3}{8} \times \frac{3}{8}$ in. thickness. Make sure you use a push stick. Be careful to avoid kickback when you are ripping these thin parts. Cut all these pieces to the lengths given in the materials list.

Sand all parts lightly with 120-grit then 220-grit sandpaper. Assemble the larger outer frame first, keeping the frame exactly square and positioning the supports as indicated in the drawing at right.

Secure the supports with waterproof glue and $\frac{3}{4}$ -in. brads. Cut the head off a Brad and use it as a drill to bore pilot holes in the hard maple. Use the outer frames as an alignment jig when assembling the other two frames.

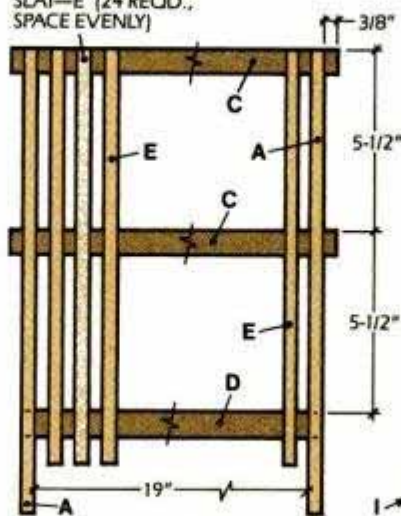
Place the framed sections together in proper position, and bore holes for the four $\frac{3}{16}$ -in.-dia. bolts that join the frames at the same time to assure alignment. Countersink the holes in the outer legs so the bolt heads will sit flush.

Bore pilot holes for $\frac{5}{8}$ -in. brads in the short slats and shelf frame. Then join with glue and the brads, spacing the slats equally along the length of the frame.

After the glue has dried, transfer the slat location from the shelf to the supports of the other two frames by mark-

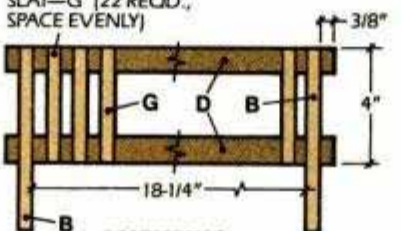
DISH RACK

SLAT—E (24 REQD., SPACE EVENLY)



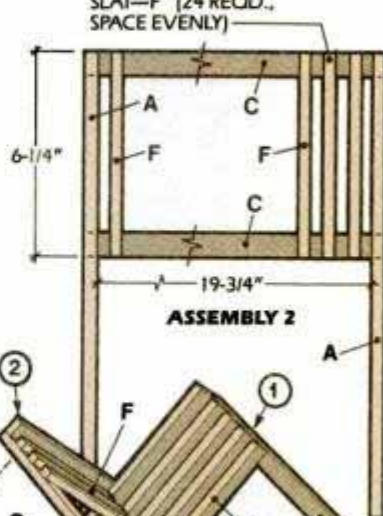
ASSEMBLY 1

SLAT—G (22 REQD., SPACE EVENLY)

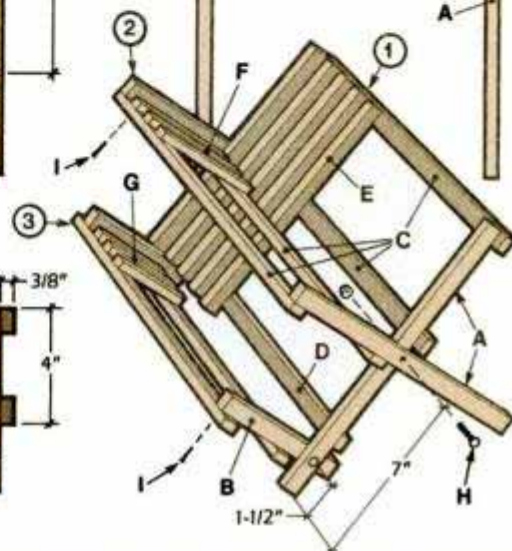


ASSEMBLY 3

SLAT—F (24 REQD., SPACE EVENLY)



ASSEMBLY 2



ing with a utility knife, as shown in the photograph. The slats on all three frame sections must be aligned, both for appearance and to hold dishes upright. Attach the slats on the other frames in the same way.

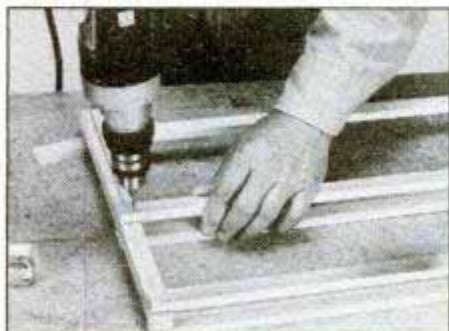
Finish-sand all parts, especially the end grain, and rub on a nontoxic mineral oil finish. Assemble the rack with flathead aluminum bolts and nuts. Notch out the ends of any slats that conflict with the nut. Insert the bolts,

tighten the nuts and nick the bolt thread with a nailset to prevent the nut from loosening.

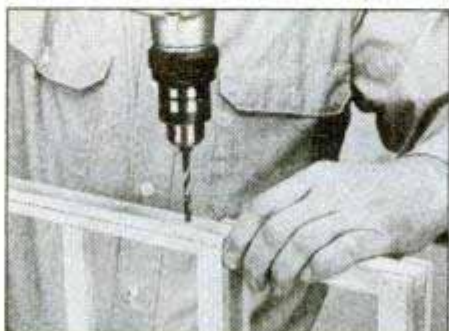
MATERIALS LIST—DISH RACK

Key	No.	Size and description (use)
A	4	$\frac{3}{8} \times \frac{3}{4} \times 14$ " maple (long leg)
B	2	$\frac{3}{8} \times \frac{3}{4} \times 5\frac{1}{2}$ " maple (short leg)
C	4	$\frac{3}{8} \times \frac{3}{4} \times 20\frac{1}{2}$ " maple (long support)
D	3	$\frac{3}{8} \times \frac{3}{4} \times 19\frac{3}{4}$ " maple (short support)
E	24	$\frac{3}{8} \times \frac{3}{8} \times 12\frac{1}{2}$ " maple (long slat)
F	24	$\frac{3}{8} \times \frac{3}{8} \times 6\frac{1}{4}$ " maple (medium slat)
G	24	$\frac{3}{8} \times \frac{3}{8} \times 4$ " maple (short slat)
H	4	$\frac{3}{16} \times 20 \times 1$ " rh aluminum screw and nut
I		$\frac{1}{8}$ " and $\frac{3}{4}$ " brads

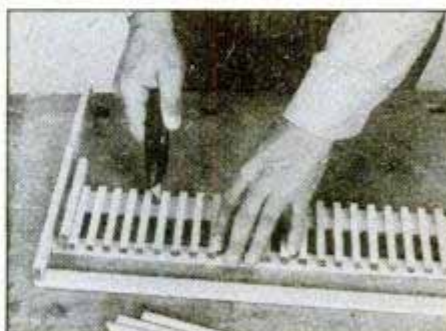
*As required



Assemble outer frame first. Then assemble inner frame inside outer frame to assure proper square and alignment. Bore pilot holes for brads before gluing supports.



Bore $\frac{3}{16}$ -in.-dia. holes for the four aluminum bolts in adjoining frame pieces at the same time to assure proper alignment. Countersink the outer frame for bolt head.



Glue and nail slats first to the small shelf frame, spacing them evenly. Then you can transfer the slat positions to the larger frames using a utility knife as a marker.

2

UMBRELLA STAND

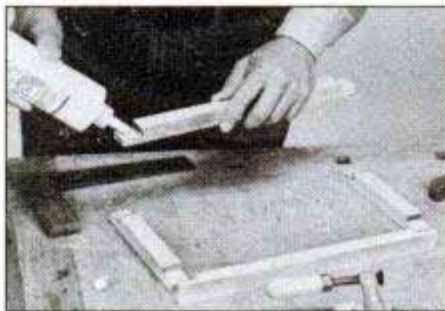
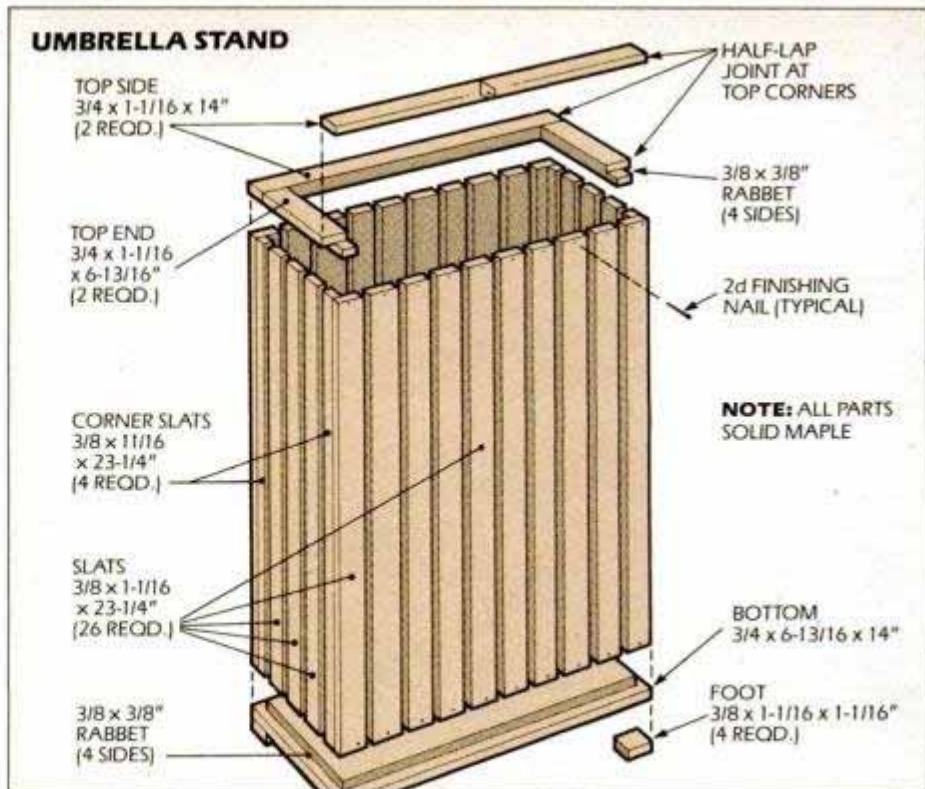
This compact, slatted maple umbrella stand keeps your raincatcher always at the ready. It is easy to assemble, and an attractive addition to any home.

Begin by cutting the side and end pieces for the top from $\frac{3}{4}$ -in.-thick stock. These parts are joined by a half-lap joint. Cut a $\frac{3}{8}$ -in.-deep \times $1\frac{1}{16}$ -in.-wide rabbet at the ends of all four pieces. Test-fit the joints and when satisfied apply glue and clamp together. Check for square.

Cut the bottom from $\frac{3}{4}$ -in. stock and the slats from $\frac{5}{8}$ ($1\frac{1}{16}$ -in.) thick stock. Cut four corner slats $1\frac{1}{16}$ -in. wide. Bore pilot holes, and glue and nail corner slats to full-size slats to form four corner posts. Then cut a $\frac{3}{8} \times \frac{3}{8}$ -in. rabbet around the top assembly and bottom piece for the slats to rest in.

Before assembling the unit, sand all parts lightly with 120-grit then 220-grit sandpaper. Start assembly by nailing and gluing the corner posts to the top and bottom. Check for squareness before the glue sets up. Glue and nail the remaining slats in place using a piece of scrap slat as a spacer, adjusting as necessary for even spacing. Cut small pieces of slat stock for feet and glue them to the underside of the bottom.

After the glue has dried, wrap 120-grit sandpaper around a block of wood and ease all sharp corners. Then sand the stand with 220-grit paper. For a natural finish, apply wipe-on tung oil.



Apply glue to the half-lap corner joints of top pieces, clamp and check for square. After glue dries, cut $\frac{3}{8} \times \frac{3}{8}$ -in. rabbets on lower outside edges for mounting slats.



Bore pilot holes for all nails before gluing. Glue and nail together the four corner posts, then glue and nail these assemblies to the top and bottom pieces.

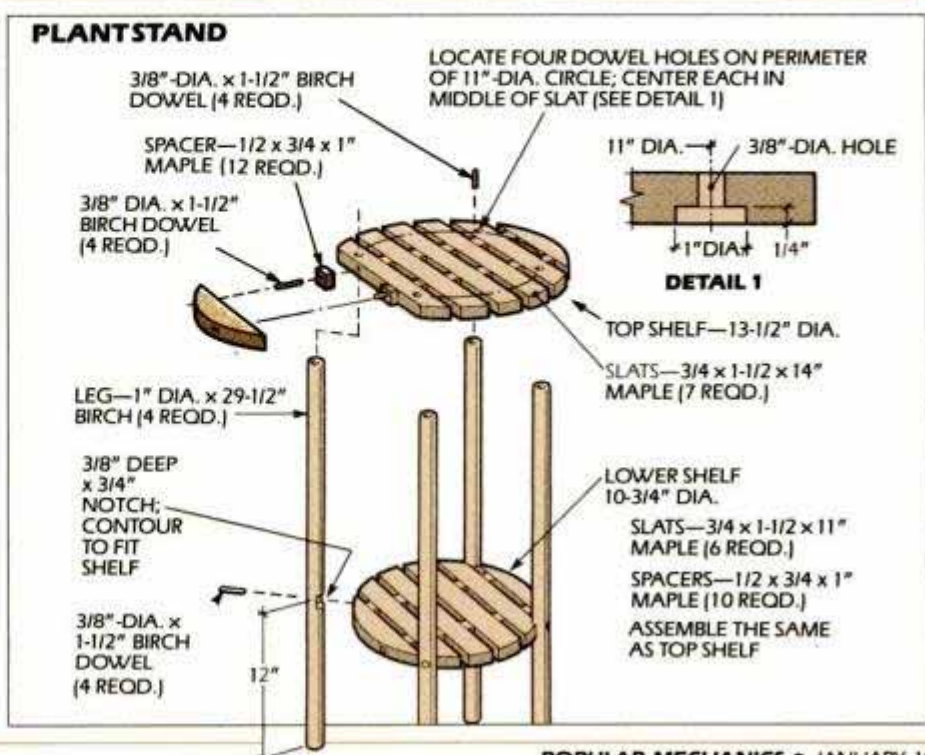
3

PLANT STAND

The round tabletop and shelf of this contemporary looking plant stand are preassembled, then cut into circles. Cut the internal slats and spacers to the sizes indicated, glue and clamp them together on a flat surface, and set both aside to dry.

Next, glue the outside slats and their spacers to both assemblies using the dowels shown. Clamp and let dry. Find the center of the tabletop and draw a $13\frac{1}{2}$ -in.-dia. circle outline. Mark a $10\frac{3}{4}$ -in. circle for the shelf. Use a saber or band saw to cut the circles.

Bore the 1-in.-dia. \times $\frac{1}{4}$ -in.-deep holes for the legs in the underside of the top. Bore $\frac{3}{8}$ -in. holes for the dowel pins through the center of these holes.



The shelf rests in notches cut in the legs. To form these notches, make two $\frac{3}{8}$ -in.-deep cuts, $\frac{3}{4}$ -in. apart in each leg at the height shown. Then remove the waste with a $\frac{3}{4}$ -in. chisel, and contour the notch to fit the rounded shelf.

Position the shelf so its slats are aligned the same as the top, as shown in the photo. Then begin assembling the

table by gluing the legs to the shelf. Hold each leg at right angles to the shelf, and bore a $\frac{3}{8}$ -in. hole through its center into the shelf edge. Apply glue to dowel and notch and drive the dowel into place; do the same for each leg. Place the assembly on a flat surface and put the top in position to hold the legs in alignment while the glue dries.

Attach the top by boring $\frac{3}{8}$ -in. dowel holes through the top into the legs. Apply glue to the joints and dowels and assemble. After the glue has dried, cut off all the dowels flush to the surface and sand smooth with a sanding block and 100-grit sandpaper. Finish-sand with 150-grit, then 220-grit, paper and apply a clear finish.



Draw layout lines on the tabletop and shelf slats to position spacers accurately. Then glue and clamp the parts, making sure that spacers remain properly aligned.



Center shelf on the top and mark leg locations where shelf edge crosses leg holes. Position leg between these marks when boring dowel holes to attach leg.



Bore holes for the dowel pegs with legs held at right angles to the shelf. Glue and tap dowels through the legs and into the shelf edge to complete the joints.

4

BREADBOARD

A handy addition to any kitchen, our breadboard has a knife storage rack and a slatted cutting rack that lets crumbs fall into the box below for easy cleaning.

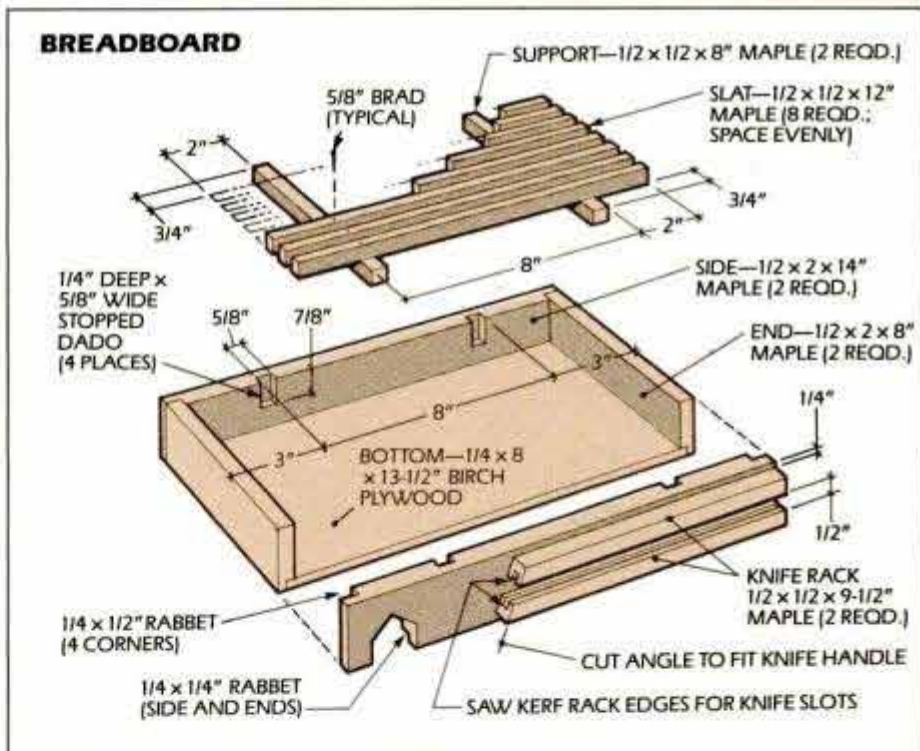
The breadboard is made from solid maple. Begin construction by cutting the 2-in.-wide ends and sides from $\frac{1}{2}$ -in.-thick stock.

Next, lay out and cut the stopped dados for the cutting rack support in the sides, using a router and a sharp chisel. Make them $\frac{1}{4}$ in. deep by $\frac{5}{8}$ in. wide by $\frac{7}{8}$ in. long.

For the corner joint of the crumb box, cut a $\frac{1}{4}$ -in.-deep rabbet in the sides, the same width as your stock. Next, cut the rabbet for the bottom along the inside lower edge of both sides and ends.

Dry-fit the parts and check the dimensions required for the bottom. Cut the bottom to size, then glue the ends, sides and bottom together in one operation. Clamp the parts together and allow them to dry.

Rip the $\frac{1}{2} \times \frac{1}{2}$ -in. slats and supports to size, then cut them to the proper lengths. These are glued and nailed together with $\frac{5}{8}$ -in. brads. Prebore pilot holes and be sure to set the brad heads below the surface. Place the supports in the crumb box and attach the outer slats first. Allow $\frac{1}{2}$ -in. space on all four sides. Then, remove the cutting board assembly and nail and glue the remaining slats in place.



Cut the knife holder parts from $\frac{1}{2}$ -in.-thick maple. One safe way to make these small pieces is to cut the $\frac{1}{4}$ -in.-deep saw kerf in both edges of a larger piece of stock, then you can rip both edges to yield pieces of the proper finished thickness.

Angle the ends to fit your knife handle, and attach them to the tray with glue and $\frac{3}{4}$ -in. brads.

Sand all corners and edges smooth with 120-grit sandpaper, then finish-sand with 220-grit. Apply a nontoxic mineral oil finish on the cutting slats, and crumb box.



Attach outer slats of cutting board with supports in the crumb box to maintain proper spacing. Then remove cutting board and attach remaining slats.

5

BATH RACK

Even the smallest bathroom has space for this three-shelf, folding maple rack. Begin by ripping the stock for the frame sides, frame backs and shelf sides, then cut these parts to length. Rip the slat stock to size and cut the back and shelf slats to length. Sand the parts lightly with 120-grit sandpaper.

Assemble the frame first. Bore pilot holes for the brads, and use waterproof glue on all joints. Nail and glue the frame back rails to the sides and check for square. When dry, assemble the shelves using the back frame as a jig. Place the shelf ends within the back frame and use a shelf slat to position the shelf bottom rails. Then, nail and glue the shelf rails and ends together.

Glue and nail the shelf slats in place using $\frac{5}{8}$ -in. brads. Then use these slats as guides when you glue and nail the back slats to the frame backs.

When the glue has dried, sand the four assembled pieces, especially the end grain parts, with 120-grit and then 220-grit sandpaper. Apply an oil finish before mounting the shelves.

The shelves are joined to the frame with dowel pins. Place shelves in alignment and bore dowel holes through both the frame sides and shelf ends. Insert dowels in the holes and glue them into the frame side only. Apply finish to the ends of the dowels.

BATH RACK

BACK SLATS— $\frac{3}{8} \times \frac{3}{8} \times 15"$
(11 REQ'D.; SPACE EVENLY)

FRAME BACK RAILS
 $\frac{3}{8} \times \frac{3}{4} \times 14\text{-}1/2"$
(4 REQ'D.)

FRAME SIDE
 $\frac{3}{8} \times \frac{3}{4} \times 15"$
(2 REQ'D.)

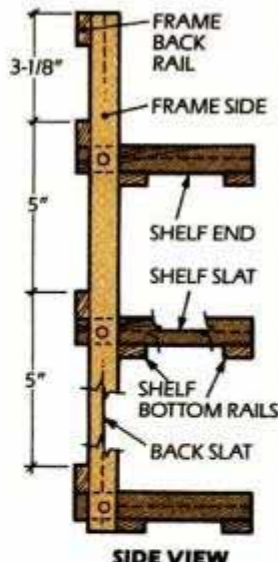
$\frac{5}{8}$ " BRAD
(TYPICAL)

$\frac{1}{4} \times \frac{3}{4}"$
DOWEL
(6 REQ'D.)

SHELF END
 $\frac{3}{8} \times \frac{3}{4} \times 4\text{-}7/8"$
(6 REQ'D.)

SHELF
BOTTOM RAIL
 $\frac{3}{8} \times \frac{3}{4} \times 14\text{-}1/2"$
(6 REQ'D.)

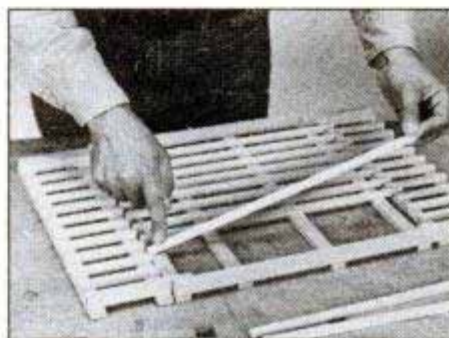
SHELF SLATS
 $\frac{3}{8} \times \frac{3}{8} \times 3\text{-}3/4"$
(36 REQ'D.) ALIGN
BETWEEN BACK SLATS



NOTE: ALL PARTS
SOLID MAPLE



Assemble the frame with waterproof glue and brads. Use a square to keep the frame in alignment while drilling pilot holes and nailing back rails to frame sides.



Use the assembled shelves as a guide to align the frame back slats. Glue and nail them in place so they lie between the shelf slats. This allows the shelves to fold flat.

6

DOOR-MAT

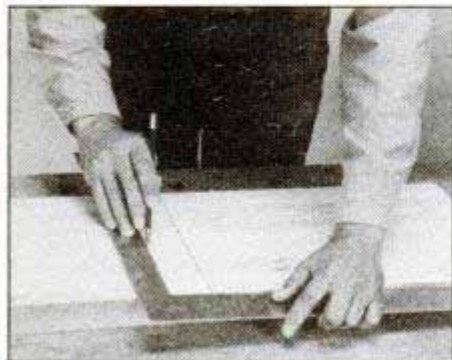
This easy-to-build doormat makes a handsome addition to your home's entryway and, with a wa-

ter-resistant finish, it will last for years.

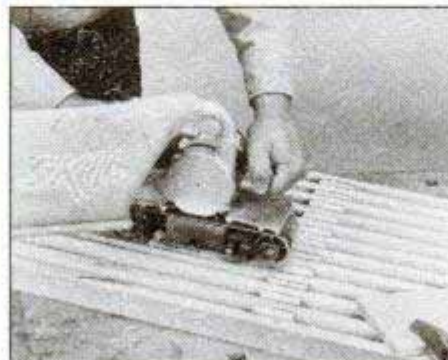
Cut the slats and spacers to size, then lay out and mark the location of the center and end spacers with a square. Bore two pilot holes in each spacer and apply waterproof glue, align and nail in place. Then apply glue to the mounted spacers and place a second slat in position. Align it with your layout lines,

bore pilot holes and nail in place. Stagger nails to avoid splitting the wood. After completing several courses, place the mat on a flat surface to check that it is not twisted.

Use a belt sander to smooth the top and bottom, and finish the doormat with several coats of wood preservative or spar varnish.



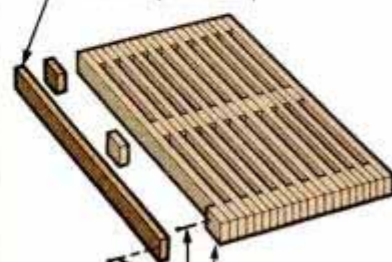
Position all slats so the ends line up perfectly. Then use a carpenter's square to mark the layout lines for the 2-in.-wide spacers on the ends and middle of the assembly.



Clamp assembled mat to a flat surface, then sand smooth with belt sander, using 100-grit then 150-grit sandpaper. Apply wood preservative or spar varnish.

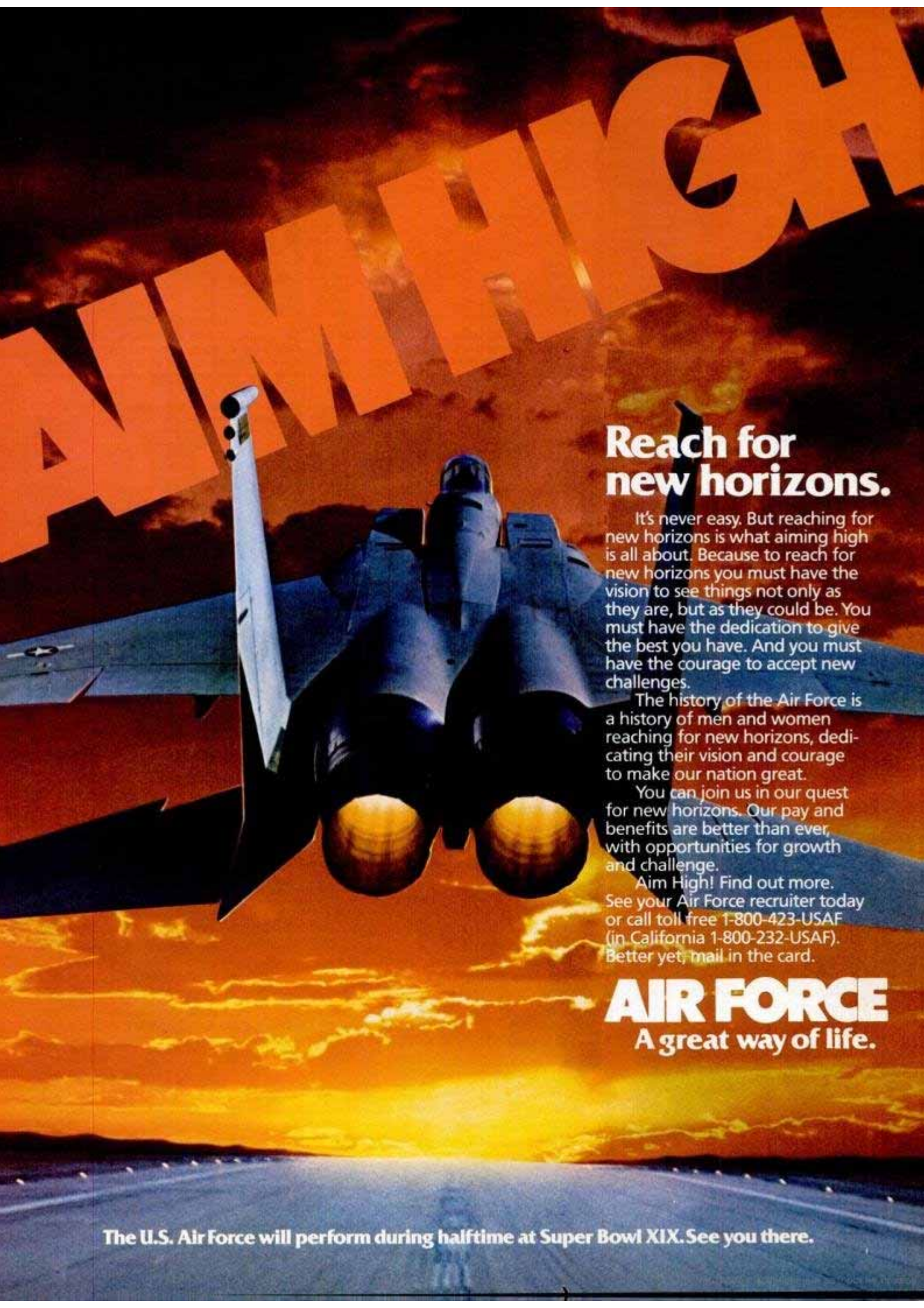
DOORMAT

SLAT— $\frac{3}{4} \times 1\text{-}1/2 \times 34\text{-}1/2"$
MAPLE (12 REQ'D.)



JOIN WITH GLUE
AND STAGGERED
4d FINISHING
NAILS

SPACER
 $\frac{3}{4} \times 1\text{-}1/2 \times 2"$
MAPLE
(33 REQ'D.)



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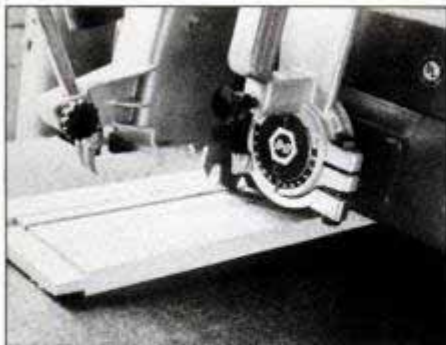
AIR FORCE

A great way of life.

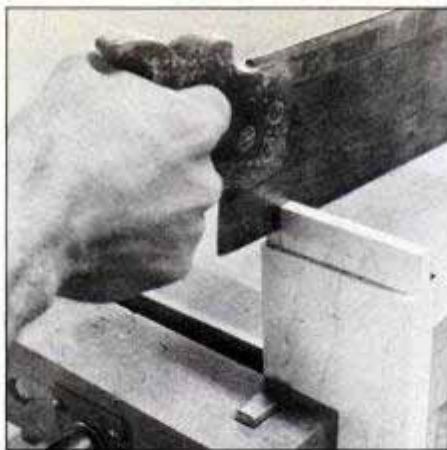
The U.S. Air Force will perform during halftime at Super Bowl XIX. See you there.

VERSATILE SMALL TABLE

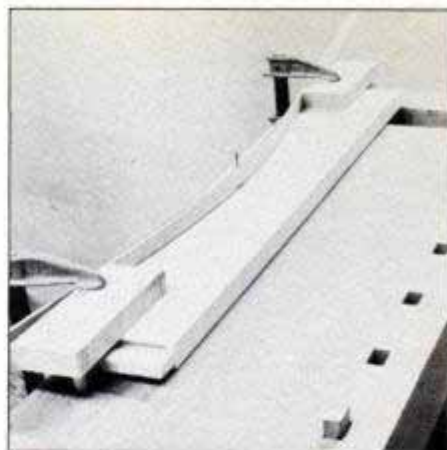
(Continued from page 109)



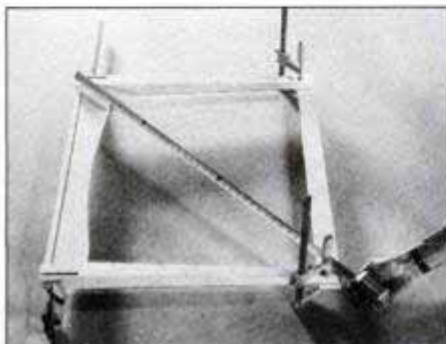
Use dado blades in radial-arm or table saw to cut 1/4-in.-wide by 3/16-in.-deep groove on inside surface of all aprons. Groove accepts wood buttons used to fasten top.



Clamp each apron in bench vise and cut 3/8-in.-deep shoulder on bottom edge of all tenons using a backsaw. Shoulder covers bottom of mortise and hides it from view.



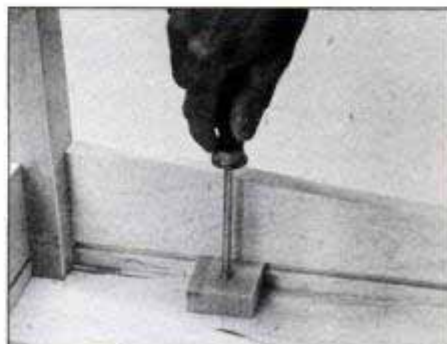
To lay out curve on aprons, clamp two blocks at bottom corners of curve, then drive 4d finishing nail at apex. Bend 1/8-in. pine strip between three points and trace.



Clamp apron to leg tops, then clamp board to leg bottoms so space is same between outside edges. Check for square by comparing diagonal measurements.



Cut raised-panel decorative edge on tabletop using router with edge-guide attachment or self-piloting router bit. Move tool in smooth, steady path for cleanest cut.



When finish on top and base is dry, turn top upside down on soft pad and center base assembly on it with equal space on all sides. Join the two by attaching six wood buttons.

line. Remove the saw marks using a spokeshave or cabinet scraper. Test each mortise and tenon joint to be sure of proper fit. The joint should be snug, requiring light taps with a hammer to close, but it should not require heavy blows to bring the joint tight.

Before assembly, sand all inside surfaces, starting with 120-grit paper and finishing with 220-grit paper. Smoothing these surfaces before assembly will eliminate the need for awkward hand sanding later on.

Assembly

Assemble the long aprons to the legs first. When applying glue to the joint, be sure to coat evenly both the walls of the mortise and the cheeks of the tenon, but don't fill up the mortise with glue. Clamp the legs to the aprons with pipe clamps, making sure not to overtighten the clamps, which would bow the aprons and distort the joint. Use a scrap board clamped to the leg bottoms, as shown, to maintain even spacing.

Test for squareness by comparing opposite diagonal measurements. If the assembly is square, the measurements will be equal. If they don't match, readjust the clamps so they do. Let the glue set for 20 minutes, then scrape off the squeeze-out with a sharp chisel. Do

not wipe it off with a damp rag, especially if you plan on staining the piece. This will drive the glue into the wood pores, where it will dry and not absorb stain or finish properly.

When the glue has cured, finish assembling the base by joining the short aprons to the long sides. Be sure to use a flat surface for assembly so the base will not be twisted. If all four legs do not rest firmly on this surface after assembly, readjust the clamps until they do.

Next, plane the tabletop smooth and cut to finished dimension. Since the size of the top may make it awkward to handle on the table saw, it can be crosscut to size with a portable circular saw. Just be sure to clamp a straight board in place to act as a guide for the cut. Cut off the corners to the dimensions shown in the drawing using the same method. Then, use a belt sander or cabinet scraper to smooth the edges and remove any saw marks.

Rout the edge detail on the top using a Bosch No. 85-480 router bit with an edge-guide attachment, or, if you prefer, use a Bosch No. 85-583 bit with a ball-bearing pilot.

When routing, be sure the workpiece is clamped firmly to the bench and move the tool slowly and steadily to achieve the smoothest possible cut.

Sand the top and the base using 120-grit abrasive first, followed by 220-grit abrasive.

Finishing

It's a good practice to apply the finish to the base and top separately, before assembly. This allows all surfaces to be sealed, which reduces the chance of the pieces taking on moisture from the air that would cause movement within and between the parts.

Before applying the finish, rub the entire piece with 4/0 steel wool and wipe with a tack cloth. We used McCloskey's Satin Polyurethane Varnish to finish this piece. Thin the first coat up to 25 percent with mineral spirits and apply two more coats full strength, allowing proper drying time in between. Sand lightly with 220-grit abrasive and wipe with a tack cloth between coats.

After the finish is completely dry, turn the top upside down on a soft blanket and position the base over it with equal spacing on all sides. Attach the two using the wood buttons as shown. Bore a 13/16-in.-dia. pilot hole in each button and a matching 1/8-in.-dia. pilot hole in the top. Fasten both together with 1 1/4-in. No. 10 roundhead screws.

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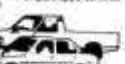
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ENGINE PROGRESS

(Continued from page 97)

tons, and bringing spark and valve timing into greater focus to attain maximum fuel combustion.

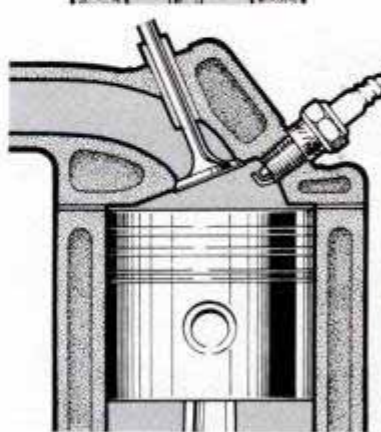
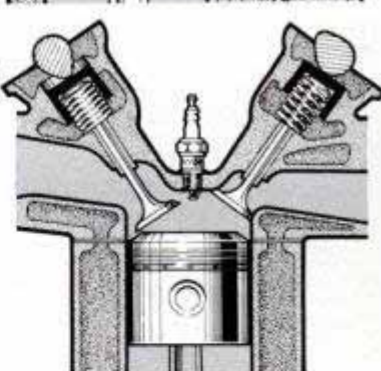
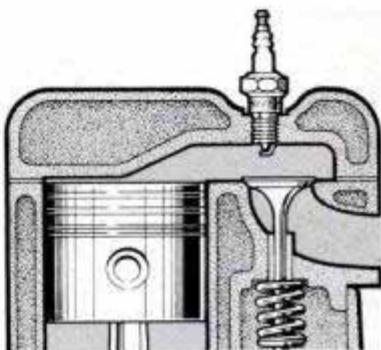
The search for better materials to withstand the increasing stress of higher speed engines became critical as more paved roads became available.

In the early days, when there were a limited number of dirt roads, heavy iron engines that lumbered along were met with little resistance by the automobile buyer. However, as more roads were opened to drivers and road conditions improved, driving became more popular and demand increased for lightweight engines that could take travelers longer distances economically.

The man who had most to do with the start of an automotive metallurgical industry in the United States was El-

(Please turn to page 122)

Combustion chamber progress



Earliest engines had low-compression L-head design (top). Hemi-head (center), first used in 1904, is most efficient. Modern wedge head (above) is less expensive.

You can own this automatic shift ATV

HEALD SUPER BRONC 3

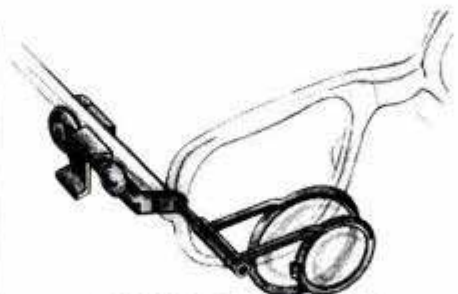
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JAY HEDDEN — Editor WORKBENCH Magazine

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ENGINE PROGRESS

(Continued from page 120)

wood Haynes. Among his accomplishments were the development of cobalt, chromium and tungsten alloys; discovery of stainless steel; and introduction of aluminum into automobile engines.

In 1893, Haynes invented and built a rotary gas engine. Did you really think Felix Wankel was the first to do this in 1955?

In 1912, an ad for the Type 35 Mercer, which sported an in-line six-cylinder engine, made mention of a "large and perfectly balanced crankshaft to make the engine practically vibrationless." The Mercer Automobile Co. recognized that as low-speed engines gave way to high-speed engines, vibration caused by crankshaft rotation was going to become troublesome.

Balancing the crankshaft became even more of a factor as the number of cylinders increased. In 1916, Packard introduced the first production 12-cylinder engine. To quell the effect of crankshaft vibration, Packard placed a small flywheel on the front end of the crankshaft that "slipped," as necessary, to help smother torsional vibration produced by the shaft. This we now call a vibration dampener.

Cadillac refined crankshaft balancing still further. On its 1923 V8 engine, the company arranged the four crankshaft pins in two planes to balance out the vibration effects of the reciprocating pistons and connecting rods. The four-crankpin arrangement, like the vibration dampener, is still with us today, but they probably played their most important antivibration roles in the early 1930s, when some car companies strived to have an engine with the most cylinders. For example, there were the Cadillac, Marmon and Packard V16 engines and the Lincoln V12.

By 1934, public interest in these massive powerplants started to wane, leaving six- and eight-cylinder engines to reign for almost 50 years. Today, the Four has returned and now it looks like two- and three-cylinder engines may make a comeback. In other words, we've gone from the one-cylinder gasoline engine to 16 cylinders and back to four. Is the return of the one-cylinder only a matter of time?

"Firm offers two models of high-speed motor with twin intakes and exhausts." This is not an ad for a modern Toyota 16-valve engine, but the way *Automobile Topics* described the four-cylinder, four-valve car engine made by Linthwaite-Hussey Motor Co. of Los Angeles. The year was 1916.

"The most marvelous automobile improvement yet invented," another ad

says. "Pull the little lever—your 12 is a 6; push the little lever, your 6 is a 12." This was the way the Enger Motor Car Co. of Cincinnati described the 1917 Twin-Unit Twelve. By means of a small lever on the steering column, the driver was able to cut out six of the engine's 12 cylinders to attain maximum fuel economy, and cut them back in just as quickly for maximum power.

The lever pulled the exhaust valves off their seats, so there was no compression in the cylinders. It also allowed a shutter to close the intake manifold feeding fuel to those six cylinders.

Are you surprised to learn that the 1981 Cadillac V8-6-4 engine wasn't the first that could have the number of its cylinders regulated? If so, get ready for another surprise. Neither was the 1917 Enger. The distinction belongs to the Sturtevant 38- to 45-hp six-cylinder engine of 1905. Three of its cylinders could be shut down.

Another gasoline engine development worthy of mention is the 1924 Chrysler six-cylinder L-head, which incorporated a hemispherically domed combustion chamber designed to combat detonation, and the first replaceable cartridge oil filter. But don't get the idea that this was the first hemi-head engine. It wasn't. As far as we've been able to determine, that distinction is reserved for the 1904 Welch Four.

Another car of the 1920s worthy of mention was the 1926 Cadillac V8, which introduced crankcase ventilation to get rid of contaminating agents that caused engine wear. This ventilation system, open to the atmosphere, continued until 1963 when positive crankcase ventilation (PCV), a closed system, came into use.

Many engines of the 1930s introduced exhaust-valve seat inserts to overcome burning and pitting, hydraulic valve lifters and lightweight Babbitt metal bearings that were able to handle loads imposed by higher and higher engine speeds. And 1949 saw the introduction of lightweight, square bore-and-stroke, ohv, high-compression V8 engines by Caddy and Olds.

What of the future? What will gasoline engines be like? Let's quote one of the most renowned auto experts:

"With higher compression ratios, improved transmissions, new materials, new manufacturing techniques and so on, you can practically draw your own picture of the engine of tomorrow: smaller, lighter, more reliable, smoother and 50 percent more economical."

The expert was Kettering. The year he made his prophecy was 1953. And if he were alive now to speak about the engine of the future, he would probably say the same thing. **FM**

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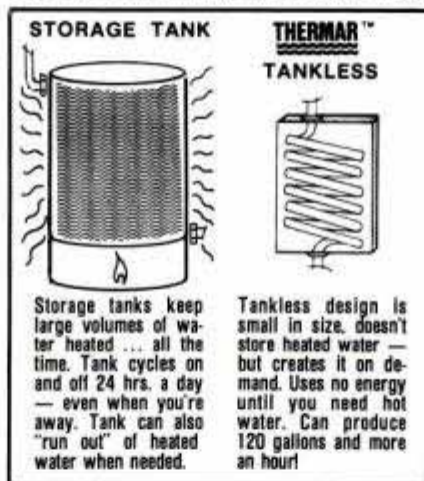
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OUR STILL-FLYING FORTRESS

(Continued from page 82)

pound bombs, was far superior. The company's future was bright when tragedy struck on Oct. 30.

After lifting off, the prototype 299 arched gracefully up into a full stall and crashed, killing two of the three people aboard.

A subsequent investigation revealed that the new control locks had not been released. There had been no checklist of items before takeoff since there were few complex aircraft in the Army inventory requiring one. Without a second aircraft, Boeing could not complete the required tests so the inferior Douglas product was ordered into production as the B-18.

Though Boeing was on the brink of financial disaster with the loss of over \$6 million (almost all of the company's working capital), an Army order for 13 test Y1B-17s kept the program, and the company, alive. The next major development, the Y1B-17A, incorporated turbosuperchargers, giving excellent high-altitude performance. There was a glimmer of fulfilling the Air Corps dream of long-range strategic bombardment, but the aircraft was not presented that way.

Ultimate 'defensive' weapon

The B-17 was sold to Congress as the ultimate "defensive" weapon, reflecting the spirit of the times. The bomber would be flown to protect the U.S. coast and overseas possessions from enemy fleets. In other words, this marvel of engineering would be an extended coastal artillery.

Within the Air Corps a determined cadre of believers in the B-17 began maneuvering behind the scenes to get the superior aircraft ordered in quantity. Within a year of first delivery, Y1B-17s attached to the 2nd Bombardment Group made two goodwill flights in February and March 1938 to South America. All kinds of records were broken, leading to a headline campaign to convince Congress and the public that the B-17 was worth having. A tremendous boost came with the aircraft's first screen appearance in MGM's 1938 release *Test Pilot*, starring Clark Gable and Spencer Tracy.

In July 1940, opposition faded and orders were placed for 512 B-17s. Though the crash of the prototype 299 in 1935 had almost wiped out Boeing, now it was seen to be a boon. Instead of building models based on experimental engineering, Boeing had been hard at work developing their bomber and now had versions ready for production far better than would have been possible otherwise. One of the most significant

(Please turn to page 128)

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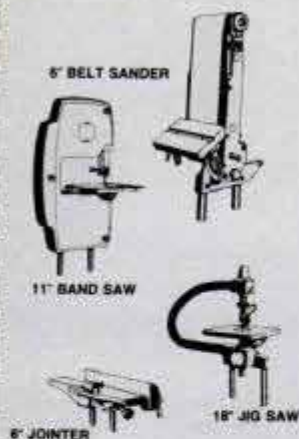
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OUR STILL-FLYING FORTRESS

(Continued from page 124)

weapons of World War II would be ready, but only by a hair.

Though some of the early production B-17Cs and Ds flew in combat with the RAF and the reorganized U.S. Army Air Force, it was the B-17E and F, with improved turrets, more armor and self-sealing fuel tanks, that slogged through German and Japanese opposition without fighter escort. Adherents of strategic bombing, sure of their theories, refused to believe those who said unescorted bombers would never make it through enemy fighter defenses. Through 1942 and 1943, bomber crews paid a high price to hit such targets as Schweinfurt and Wilhelmshaven. The British had long given up the idea of trying for pinpoint accuracy during the day and had switched to area bombing at night.

Daylight bombing

The AAF stayed with its belief in daylight accuracy and the stories of courage to see it through have become legend. On July 26, 1943, the 8th Air Force attacked targets in Hanover and Hamburg with over 300 bombers. Piloting the 92nd Bomb Group's *Ruthie II*, a B-17F, were 1st Lt. Robert L. Campbell and Flight Officer John C. "Red" Morgan. Just before the enemy coast, Focke Wulf 190s hit the formation—a single bullet split Campbell's skull and he collapsed over the control wheel, grabbing it blindly with both arms.

Morgan was locked in a fight with his dying pilot for control of the Fort and it took every bit of his strength to maintain control. Getting no response over the shot-up intercom, Morgan kept the bomber in tight formation and decided to fly it to Hanover alone.

Top turret gunner Staff Sgt. Tyre C. Weaver's left arm had been severed just below the shoulder during the same attack. When navigator 2nd Lt. Keith J. Koske was not able to stop the bleeding, he shoved Weaver out over Germany with an open parachute in hopes he would reach the ground before dying. Weeks later it was reported that Weaver was alive and well in a German hospital.

Morgan's ordeal at 25,000 feet was unknown to the rest of the crew, even through a successful bomb run. Not until the bomber was 15 minutes from the enemy coast on the way home did Koske find Morgan flying with one hand while keeping the still struggling Campbell off the controls. Morgan had been at it for two hours. Koske and Morgan got Campbell into the nose, where the bombardier held him.

Morgan made an emergency landing at RAF Foulsham and was awarded the

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third Medal of Honor to go to the 8th Air Force. His courage was later portrayed in the book and movie *Twelve O'Clock High*.

When fighter escort to the target and back became a reality in early 1944, the Fortresses and B-24 Liberators still faced tremendous opposition. This was never more evident than on the Berlin raid of March 6, 1944, when 69 bombers were shot down, the highest numerical loss for the AAF during any single mission of the war. One of those to bail out and become a POW that day was Red Morgan.

Flight Officer Bernie Dopko, flying B-17G *Little Willie* of the 388th Bomb Group, had two engines shot out by flak and fighters near Berlin. Leveling off at 50 feet, 350 miles inside enemy territory, Dopko could not coax any more than 115 mph or any more altitude out of his bomber. Ducking flak by flying behind buildings and lifting wings over church steeples, Dopko flew his faithful Fort all the way back to England. After being airborne for 9½ hours, Dopko's B-17 was the last bomber to return from the mission, a testimony for Boeing's ability to make a rugged, dependable aircraft.

From one Y1B-17 built every two weeks in 1937, Fortress production jumped to a peak of 16 per day in April 1944. By the time it was all over,

12,731 B-17s had been built and the Fort had become the most famous aircraft of World War II. The B-17 performed three full years of patrol duty without a fatal accident. Throughout the war the aircraft went through a series of modifications, fortifying the already strong Flying Fortress. By 1938, new engines with exhaust-driven turbosuperchargers were put on the B-17A. The B-17B got a plastic dome on the cabin roof. The 17C followed with six nose sockets to accommodate a movable .30-caliber gun. By June 1941 B-17Fs and Gs, with top gunpits and more bomb-carrying capacity, were rolling off the line.

That fame was firmly established by the 1949 20th Century Fox film *Twelve O'Clock High* starring Gregory Peck and Dean Jagger, one of the finest, most accurate aviation movies ever. The focal point was the psychological pressure of flying one maximum effort mission after the other in the face of almost hopeless odds. The film's producer, Darryl F. Zanuck, did not need fiction to tell the story since script writers Sy Bartlett and Bernie Lay Jr. had both served with the 8th Air Force.

The B-17 is now considered a collectible antique and many are being restored to fly in their combat configuration. No organization has done this with

more authenticity and enthusiasm than the Confederate Air Force's Arizona Wing. Their highly polished B-17G, named *Sentimental Journey*, carries an artist's reproduction of Betty Grable's famous swimsuit pose on the nose.

In spite of increasing antique value, around 40 B-17s are still airworthy, half in the States and half overseas. They continue to fly maximum-effort missions carrying maximum loads. In addition to Tom Hammon at Evergreen, Hank Moore at TBM Inc. in Tulare, Calif., Arnold Kolb in Alamogordo, Globe Air at Mesa, Ariz. and others fly their Forts regularly, doing combat with forest fires (they fly five under contract to the Forest Service). The Argentinian Navy uses the craft to fly coastal patrols, and a fleet of five B-17s carries mail in Paraguay. Fifty years old and still flying. Certainly Boeing's 1934 design team never dreamed that their progeny would serve so long and so faithfully. **FM**

Note: The incident illustrated by Keith Ferris' painting on page 80 is taken from Jeff Ethell's book Target Berlin, co-authored with Alfred Price, an exhaustive account of that single Berlin mission. Published by Jane's, it can be ordered for \$20 from Jeff Ethell, Rt. 1, Box 3154, Front Royal, Va. 22630.

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KITCHEN CABINETS

(Continued from page 103)

it with snips at least $\frac{1}{2}$ in. oversize in both directions. Trim the laminate later, after it is in place. Apply contact cement evenly to both surfaces with a paintbrush or paint roller. Apply a second coat to both surfaces and let it dry.

Since laminate adheres on contact and cannot be maneuvered into position, use a dry piece of laminate or other sheet stock between prepared surfaces while you are positioning the glued laminate. Then, slide out the dry piece and press the finished piece in place.

Using a wooden block and hammer, a rolling pin or a professional roller, go over the laminate to make sure it adheres securely. Next, use a router with a flush-trimming router bit to trim the laminate overhang. Since the router can't go to the edges, finish smoothing with a fine mill file. Then, smooth the entire edge with the file.

For complete information on installing doors, see *How To Build Cabinet Doors* on page 104. Briefly, begin by attaching the hinges to the cabinet door. To do this, place new doors face down on a soft work area. Measure

equal distance from the top and bottom and locate hinges at these points. Add door pulls or handles. Measure and mark the frame face to ensure horizontal and vertical alignment. Have a helper hold the door while you attach it in place. Most hinges can be adjusted slightly after installation. Pairs of doors should have at least $\frac{1}{16}$ -in. space between them. Place a double thickness of vertical-grade laminate between the doors as spacing guides. If cabinet stiles are not plumb, you can make the doors hang plumb by slipping a small washer—to act as a shim—over the screw between the hinge and stile.

If you are adding drawer fronts to existing drawers, install the base cabinet doors first. Then, use the new door as a guide for aligning the new drawer front above it on the old drawer. If the old drawer front has an overhang on the sides, cut it off. Then, fasten the new drawer front with screws driven from inside the drawer as shown. If the drawer is composed of two front pieces—a false front topped by drawer front—unfasten the old drawer front and secure the new one in place. After door and drawer adjustments, apply mitered molding and valences. **FM**

HOW TO ESTIMATE MATERIALS

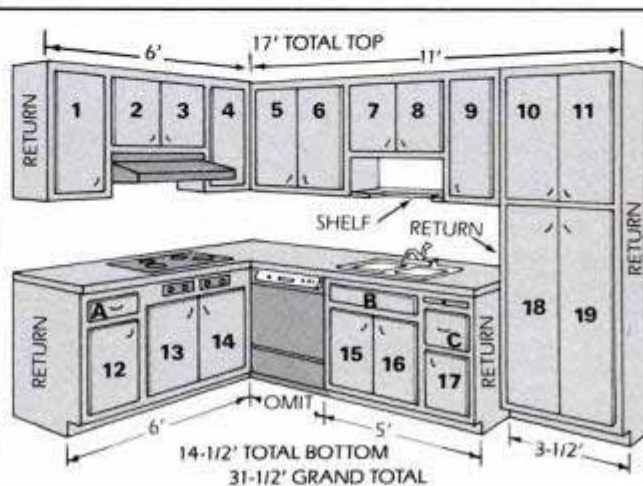
When planning the resurfacing job, make a sketch of your kitchen cabinets for reference. Number the cabinet doors consecutively; letter the drawer fronts in alphabetical order. Measure the linear footage to help estimate laminate needed for horizontal rails, vertical stiles, side panels (returns), cabinet bottoms and valences.

The "average" kitchen requires roughly five sheets of 4 x 8-ft. solid-color laminate for cabinet frames (not including doors and drawer fronts). Solid-color laminate is usually applied in full sheets to cabinet fronts, then openings are cut. This method results in minimum seams. Wood-patterned laminate, usually cut in strips for rails and stiles, has more seams, meaning less waste and material. When estimating laminate for rails, stiles, cabinet bottoms and returns, measure widths and heights and

then add at least $\frac{1}{2}$ in. for trimming.

When measuring to order or to build new overlay cabinet doors and drawer fronts, first determine if there are two doors that will be hinged off the same stile. The stile must be at least $1\frac{3}{4}$ in. wide. Otherwise, plan to add a filler strip on the stile side. On L- or U-shaped kitchens, check corners where two base cabinets meet to make sure there is clearance for door and drawer hardware, especially if an appliance is in the adjacent corner. Hardware may have to be changed or the drawer opening and box reduced to clear the adjacent drawer.

Measure cabinet openings (allow for any fillers) and list exact sizes. Plan door and drawer fronts to be $\frac{3}{4}$ -in. greater in height and width than the opening to allow for overlap and hinging.



Make a drawing of the kitchen cabinets with doors numbered consecutively and drawers lettered alphabetically. Use these keys when building or ordering your doors. Measure the cabinets to find their linear footage. This helps determine the number of full sheets of laminate you need for the cabinet rails and stiles for minimal seams when you are using solid-color laminate.

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DEEPEST FRONTIERS

(Continued from page 90)

to motorize and launch the kitchen sink. While his craft may help find the *Titanic*, his rationale for building it is simple and more down to earth.

The call of oil is strong. Much of the yet undiscovered reserves may be around the polar regions. The ideal environment for man and instruments is a stable one—one within the human comfort zone, one mobile but indifferent to storms and wind. In other words, a submarine. But the craft needs to stay below for weeks and travel long distances. Which means nuclear power. His SSS-N will be mother to one-atmosphere observers, to saturation divers and to undersea robots. All in all, the most ambitious sub so far. For other parts of the globe, this array would be ludicrous. It would be like a hunter carrying shotgun, rifle, crossbow, pistol and speargun. But for the ice pack regions, it may not be enough.

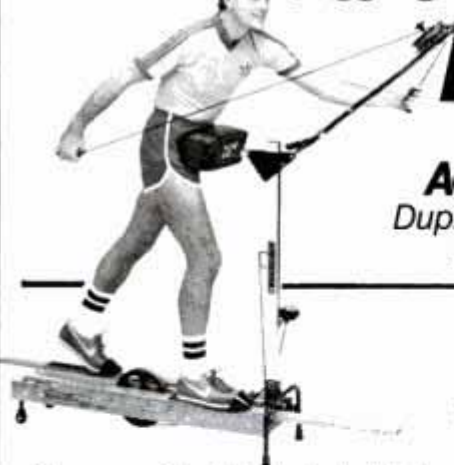
The sub's nuclear plant is a Canadian water-cooled, low-temperature reactor, licensed for unattended operation, the only one of its type in the world, according to A. J. MacDonald, president of Energy Conversion Systems of Port Moody, its developer and manufacturer. It uses a nonpressurized system whose temperature is kept below the boiling point. In this way, a heavy pressure envelope is not required, nor is a loss-of-coolant accident possible. Utilizing a Rankine cycle, the efficiency ratio will only be 9.5 percent—a fraction of that obtained in military subs, but enough to satisfy the 70 kw. needed to successfully operate the SSS-N and its subsidiary systems. Refueling is not anticipated for eight to 10 years.

Unmanned submersibles

Despite all the technological advances in manned submersible vehicles, there has been a segment of the oceanering community which believes that the future of deep-ocean exploration lies not with manned submersibles but with *unmanned* submersibles. They say that man's underwater frailties are well known, that the human body cannot stand the pressures, isolation, cold temperatures and other destructive forces at work in the deepest regions of the ocean. So, experimentation with robots and other unmanned submersibles is continuing at a fast clip.

At first the results were dismal. Robots malfunctioned, got lost, even self-destructed. Grossly underpowered, they floundered in rough seas or fast currents. Control systems jammed, and components which had performed fine on shore corroded in oceanic conditions. Often, divers and manned submersibles had to be called in to rescue

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helpless remotely operated vehicles, helplessly tangled in their own tethers.

But, as the learning curve flattened, Remotely Operated Vehicles (ROVs) became better, more maneuverable, less failure prone. New materials helped solve reliability problems. More efficient thrusters extracted additional power for quicker response. New operational procedures evolved from hard-earned experience. Specially designed TV cameras took over where water-proofed, off-the-shelf bank-surveillance units had been the norm.

Now, ROVs could be lowered into the water, maneuver to their station and



The Mini-Rover is a tethered and remotely operated deep-sea sensing machine.

send back good TV images. They began to be accepted as flying eyeballs, doing inspection and search work that divers had previously handled.

Before long, it became obvious that the ROVs might perform other tasks, as well. For more function, ROVs sprouted articulated arms with claws that could turn valves, cut cables, retrieve tools and parts.

Ten years ago, there were only some 30 ROVs in operation, mostly in academic institutions or the military. Today, there are over 700 civilian units. And, as pointed out by Frank Busby of Busby Associates, a leading authority on underwater vehicles, the market is as yet far from saturated. Today, ROVs come in many sizes, shapes, functions and price ranges.

Take the *Mini Rover*. I first met this 26-inch, 50-pound flying eyeball at one of the pools of the Town and Country Hotel in San Diego, where the Second Annual Underwater Vehicle Conference was being held. To the mortification of some of the tanning beauties, all the men around the pool were concentrating on the antics of the bright yellow machine being remotely controlled. With two tiny joysticks like the ones used for video games, Chris Nicholson, the president of Deep Sea International of Falmouth, Mass., could make the craft sink and surface, turn, move for-

(Please turn to page 134)

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DEEPEST FRONTIERS

(Continued from page 133)

ward and reverse. Meantime, the color TV monitor at poolside showed in clear sharp detail what the *Mini Rover's* underwater color camera was seeing. Powered by three thrusters, fed by 110-volt electricity from poolside, this tiny ROV can dive to 400 feet, make a speed of 1 1/2 knots and maneuver where larger units would get stuck. Nicholson says they already have sold 10 of the \$28,000 machines. Not a bad record for a company not quite a year old.

The best known research ROV is Scripps Oceanographic Institution's 20-year-old *Deep Tow*, whose operational depth is beyond 20,000 feet. Thus, *Deep Tow* can cover more than 90 percent of the ocean bottom. The 10 1/2-foot, half-ton tethered vehicle has downward, upward and lateral sonar for ocean bottom mapping. Its bottom sonar can penetrate the ocean bottom to reveal layers below the sediment. A range of sensors, TV cameras and lights make it a versatile seagoing machine.

But something even better may be going to sea this decade. Deployed from a support vessel, the *Argo Jason*, under construction at the Woods Hole Oceanographic Institute, will revolutionize undersea exploration. As its name implies,

the *Argo Jason* is a two-stage rig. The *Argo*, a large unmanned vessel, will be able to descend a few thousand feet, taking video and sonar readings at 160 acre sweeps. Its advanced strobing equipment will light the undersea world to the equivalent of a 200,000 ASA rating.

Once *Argo* captures the big picture, it will let *Jason*, a small undersea kite, float out of its holding tank into the sea for a closer look at the survey area. *Jason* will use six color video cameras to transmit pictures to *Argo*. The images will be sent along a fiber-optic cable to the surface ship, which will be able to transmit the pictures via satellite to labs all over the world.

The new machines for undersea exploration have led us into an exciting era of pioneering new territory and new resources. We have barely left the predator hunter stage where the sea's food supply is concerned, yet that frontier is already being explored. Japan harvests 500,000 tons of seafood a year at coastal farms. Israel and Indonesia also are harvesting fish from coastal pens.

The United States has put its engineering expertise to work building an artificial reef off the Bahamas where crab ranching is under way (see *Ranching The Seven Seas*, page 90).

Certainly, oil continues to be one of

the main incentives for undersea exploration. In 1955, our tallest well drilling platform stood in 100 feet of water. By 1975, the number had gone to 500 feet, and by 1978, to 1,000. Today, off the coast of Delaware, the drillship *Discoverer Seven Seas* is doing what only a few years ago was thought impossible—wildcatting at depths beyond 6,000 feet.

Petroleum isn't the only product beckoning. *Alvin's* discovery of hot ocean rifts more than 7,000 feet below the surface of the Pacific has yielded initial finds of rich copper deposits—far richer than the deposits found in mines on shore. Sea-mining licenses have been granted to several concerns and a new industry may open within the next few years.

Several research institutions are experimenting with heavy undersea currents as the power source for electricity-producing turbines. And one experiment in Hawaii is harnessing the temperature differential between surface and deep water to drive what is essentially a huge heat pump capable of producing vast amounts of energy.

Man has lived with the sea for eons. But the coming of new diving machines and high-tech sensing equipment promises to finally make the sea manageable in this generation. **PM**

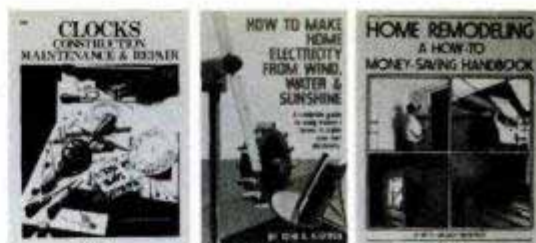
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VCRs

(Continued from page 94)

sandwiched between the luminance (brightness) and chrominance (color) information of the video signal, and deposited on the tape at the same time by the same heads. So the audio soundtrack benefits from the same super-fast writing speed of the helically scanning video heads. The result is a lack of hiss, inaudible distortion and unmeasurable wow-and-flutter.

With a signal-to-noise ratio of 80 dB or better, analog AFM recording approaches digital recording's sound fidelity to the original music. This means the softest sounds don't have to be boosted in order to be heard above tape noise, and the loud signals needn't be toned down to capture their intensity. As an added benefit, AFM recording yields the same results at any tape speed, in both VHS and Beta formats.

Depth-multiplexing

The VHS format manufacturers achieve identical results to Beta Hi-Fi, though in a different manner. Instead of shoe-horning the frequency-modulated audio between the brightness and color signals, then recording it as a video signal, VHS makers record the audio *beneath* the video information by a process known as depth-multiplexing. VHS Hi-Fi uses two independent audio recording heads mounted on the same drum with the video heads. In rotation, the audio heads precede the video heads and deposit the sound information helically on the deepest layer of the tape. The video heads pass by next and superimpose the color images on the tape's surface.

Both Beta Hi-Fi and VHS Hi-Fi retain the old stationary audio recording head, to maintain compatibility with older tapes and non-AFM machines. This longitudinal mono or stereo track also can be used for sound overdubs. You can't perform overdubs on the hi-fi Beta or VHS soundtracks, inasmuch as these are recorded between or beneath the video signal.

Just like audio tape decks, most AFM video recorders sport input-level signal controls and measurement meters to help you make a pleasing recording. In addition to video recording and playback, you can use hi-fi VCRs to copy up to five hours (Beta) or eight hours (VHS) of super-high-fidelity music—dubbing, for instance, from laser-read digital audio Compact Discs. The same audio input jacks can be used to record sound from FM radio or stereo TV. At this writing, few AFM decks have a built-in stereo tuner for TV audio.

Though most hi-fi Beta and VHS video recorders now available are designed as tabletop models for use in the

home, some two-piece portables and "convertibles" have appeared. Conventional two-piece portables (composed of separate recorder and tuner-timer components) have been around for some time, but the latest models boast many of the convenience features and special effects as house-bound tabletop units. A recent twist is the convertible—best described as a portable video recorder that docks vertically or horizontally in a chassis that contains TV tuner and program timer. Although some hi-fi VCRs on the market are advertised as portables or convertibles, not all will record AFM stereo when used with a videocamera.

The 8-mm format

Audio Frequency Modulation is part and parcel of the brand-new VCR format just appearing on retail shelves: the 8-mm camcorder system by Kodak, Polaroid and others soon to follow.

As its monicker indicates, 8 mm differs from the established Beta and VHS recorder formats in the makeup of its tape cassette: About 1/3 inch wide compared to 1/2 inch for Beta and VHS, and only slightly larger than an audio cassette. Tape composition (or formulation) is different, too. In order to pack all the video and audio information on a narrower tape, 8 mm uses "pure" metal particle tapes, compared to the metal-oxide formulations employed for most 1/2-inch tapes. Currently, metal particle cassettes can record up to 120 minutes of video with good, though monaural, FM audio (out to 14kHz).

Although convertible tabletop models are planned by some manufacturers, the 8-mm format currently is represented by camcorders designed for movie-making on the go. When inserted in special docking decks and connected to a TV, the results can be reviewed. These same decks enable camcorders to record TV off the air, though recording time today is limited to two hours per tape. Adaptors available from the manufacturers also will enable 8-mm camcorder users to dub their recordings onto half-inch tape and thereby maintain compatibility with their home and portable VCRs.

Like 8 mm, Betamovie and its VHS equivalent, VideoMovie, record at a single speed (the faster Beta II and "SP" modes) but obtain longitudinal, monaural sound on a par with conventional VCRs. The Beta camcorder uses a standard-size Beta cassette permitting up to 3 1/2 hours of moviemaking with an L-830 length tape. VHS VideoMovie employs the compact VHS-C cassette—slightly bigger than 8 mm—for up to 20 minutes of recording time. By inserting the "TC-20" into a special adaptor, you can review it on a regular VHS recorder

(Please turn to page 140)

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VCRs

(Continued from page 139)

connected to a TV. Or, the VideoMovie camcorder can be connected directly to a VHS home deck in order to dub the contents of one or more TC-20 cassettes onto a standard VHS cassette. VHS camcorders that use standard-size cassettes are now under development, and might appear this year.

How does the diminutive new 8-mm format stack up against the half-inch formats? Although independent tests were not available at press time, Kodak and Polaroid claim identical performance with half-inch machines: About 240 lines of horizontal resolution.

PM readers will notice that up to this point, there's been no mention of technical improvements on the video side of video recorders. In fact, advances in picture quality have pretty much been limited to such special-effects features as freeze-frame, slow-motion and high-speed forward and reverse scan. The stability and clarity of each of these has been improved by the incorporation of extra video heads—as many as five—in the head drum.

At this writing, VCR picture quality in regular playback and recording remains about where it's been for the past decade. Although the theoretical fre-

quency response of broadcast video signals extends out to about 4MHz, most VCRs pick up and reproduce no more than 3MHz. Because the finer details (or resolution) of an image are found at the highest frequencies, this means a current VCR will produce images somewhat less clearly defined than a good TV broadcast (or a laser videodisc, whose frequency response tops 4MHz).

Another way of describing picture definition is in *lines of horizontal resolution*. This is measured as the number of vertical lines that can be stacked side by side, left to right across your TV screen (and should not be confused with the vertical scanning rate of TV—always 525 left-to-right changing lines running from the top to the bottom of your screen). The more lines of horizontal resolution that can be crammed onto a display, the more detailed that display will be. VCRs currently average from 230 to 250 lines. By comparison, high-quality TV monitors can accommodate more than 300. (If you're playing your VCR through a conventional TV, you won't notice the difference.)

Signal-to-noise ratio for most VCRs—that is, the amount of snow you'll see when you play back a tape—is around 40 dB at present. Because the eye is more sensitive to distortion than the

ear, a minute 2 dB difference between VCRs will be visible. Manufacturers' printed specifications might not be much help when comparing VCRs, because there are no statutory standards for making measurements. Trust your eyes when shopping, or use comparative tests made by an independent third party that measures all VCR specifications by the same criteria.

According to domestic and foreign manufacturers, there is considerable work in progress to upgrade the visual fidelity of video recorders. Any improvement is likely to come either from the use of high-quality pure metal tape formulations or from the development of low-cost digital processing circuits that will record and reassemble images and colors as a series of numbers—much in the way the laser-digital Compact Disc player handles music.

The consensus among manufacturers places the introduction of these "eye-fi" VCRs some years off—and for good reason. They'll have to be able to play tapes made on current VCRs, so that the memories you record today won't be rendered obsolete by technological progress. When you play those memories back on the VCR of 1995, they might seem fuzzy compared to recordings of more recent vintage. But you'll still be able to recall and enjoy them. **PM**

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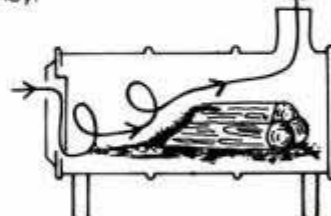
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FISHING BRONCO

(Continued from page 99)

Page Alert system. The Ungo Box and Page Alert combination will trigger an audible alarm and alert you, even if you're several miles upstream, that mischief is in the making.

So much for the easy part of setting up a fisherman's dream machine. Now for the packing. For example, how do you deal with soggy and muddy waders and shoes? Fish and fresh food in the same cooler, and no ice for sale anywhere? Broken lantern mantles, and stove fuel spilled on your leaders?

Two coolers

We started with a cooler, of course, but why not two—one for food, powered by the Bronco battery, and another to be kept closed until time to store the fresh catch? Ice would keep much longer if the chest were not opened every time someone got thirsty or hungry. A Bilan 12-volt refrigerator and a Coleman Super Oscar cooler paired up to solve that problem.

Using plastic dishpans to keep cooking and lighting gear organized is not original, but using a basket, set in an old darkroom tray, for waders and shoes is a tip you heard here first. The basket allows air circulation, the tray catches the drips, and a foam pad soaks up any water which might spill over, lets it evaporate, and allows you to wring it out.

We had hoped to rig overhead storage for flyrods in the Bronco II. Since it's too compact, we settled for the traditional rod cases for home-to-stream travel, but adapted rod holders to a roof-mounted boat rack for quick on-site changes of location. The Yakima system rack was added for carrying a canoe or cartop boat to reach otherwise inaccessible fishing sites.

Since you can argue about flyrods, reels, lines, fly patterns and things that most fishermen feel strongly about, we avoided getting specific about fishing tackle. Still, you have to find room for the equipment no sensible boondocker would leave behind—winch accessories, chains, shovel, tow strap, tool kit, flashlight, fire extinguisher, camp ax and bug juice. Then how to keep it from sliding into a pile to starboard when negotiating a steep left-hand side hill? The Peg-Board false floor plus several wire loops and shock cord solve that problem; and under the Peg-Board is room for all your sleeping gear.

PM's Fishing Bronco is sure proof that the new generation of sport/utility vehicles can chase fish as well as, if not better than, the big rigs. **PM**

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MODERN KIT CAR

(Continued from page 91)

liter, 12-valve Honda Prelude engine.

Transmission choices include four-speed, five-speed or automatic, and—thanks to a growing aftermarket—you can buy all sorts of hop-up equipment for Honda engines and suspensions. Coincidentally, the new CRX models have exactly the same wheelbase as old '73 to '79 Civics, so there will even be a continuing supply of Honda chassis in the future.

Deutschman and Warshaw have spent nearly four years bringing their kit to the highly refined form you see here. This is the first kit car I've ever seen that looks like a factory-built ma-

things, this makes it virtually impossible for the kit builder to get the interior wrong. Each panel fits exactly, and in only one position.

Assembling the Spex kit is about as simple as building a working automobile can be. The old Honda body is cut off using a jigsaw or metal nibbler. The assembly manual contains complete dimensions and the thin sheet metal is easy to cut. A couple of areas need persuasion with a hammer so the body will fit, but that's all.

The one-piece body has its own integral subframe that connects the front and rear suspension towers with a girder that reaches under the doors. This can be bolted to the remains of the Civic monocoque, though Paul recom-

mends welding the subframe and chassis together if possible—a simple job for any welding shop. There are no other changes to the Honda underpinnings. All engine, transmission and suspension pieces function intact.

Indeed, the Spex design uses many bits salvaged from the Civic. The instruments, for example, bolt right into the new dashboard. The steering wheel and column are stock. New slip-on seat upholstery to match the interior is supplied with the deluxe kit, but both front and rear seats remain in the stock locations.

The gas tank is stock, though the filler neck is rotated into its own locking, drip-proof cavity. All door hardware, the windshield washers and

wipers, heater, air-conditioning, wiring and even the Civic rocker panel trim pieces are reused without alteration. This makes the Spex one of the first kit cars to have adequate heater, ventilator, demister and air conditioner—important considerations for real-life transportation.

The quad headlights are from a Honda Accord, while the one-piece tail-light/backup light units are from a Mercury Capri. Add your choice of alloy wheels and high-performance tires—or use Spex own aerodynamic wheelcovers on the stock Honda wheels—and the kit is ready to roll.

Also included is an easily removable

hardtop which cleverly utilizes the Civic rear window with its defroster wiring. Unique among all cars, the front half of the top unbolts separately, so you can have a coupe, targa or convertible. Windows are rigid Plexiglas sidecurtains that are installed with two thumb-screws.

I drove two different factory-built Spex roadsters around the winding roads of Montreal's Mount Royal—Mulholland Drive of Canada—and I can attest that the 1,500-pound Spex, even with a stock Honda Civic powertrain, goes and handles like a Formula Ford. There's a slight bit of cowl shake over severe potholes, but the topless body is much more rigid than a factory-built Mustang or Chrysler convertible.

Fit and finish are fabulous. The fiberglass is flawless, everything fits, everything works, there is nary a squeak nor rattle to be heard. This is exactly what you'd always hoped a kit car would be. It's fun to drive, economical, durable... and the distinctive styling is enough to stop the crowd in its tracks.

Putting it all together

Paul and Kell figure you can assemble one of their kits in roughly 200 hours, even if you've never done anything like this before. I've built three other kit cars myself, and I'd say that's a very realistic estimate. There's really little to do to prepare the Civic for its new body, and the one-piece Spex roadster goes on in one easy motion. Detailing is what frustrates most kit builders, and even that has been designed to be as painless as possible.

Best of all, the price for the total Spex kit, including every last nut, bolt and washer individually bagged and labelled, is \$5,995, f.o.b. Montreal. A deluxe kit that includes wheels, tires, seatcovers, sport steering wheel and outside mirrors is \$6,995.

Bargain kit price

Compared to other, far less complete kits which start at \$8,000 and go up to \$30,000+, that's a bargain. Compared to new production convertibles—which start at \$10,000 for an Alliance and go up to \$156,000 for a Rolls—it's even more of a steal.

Paul and Kell call their car the Elf. Personally, I think most people will end up calling it the Spex Roadster. An information kit is \$5, a copy of the assembly manual is \$20, from Spex Design, 2135 Oxford Street, Montreal, Quebec, Canada H4A2X7.

If there's any justice in the world, you'll be hearing a lot more from them over the years. The world's first modern kit car isn't a bad project to have on the opening page of your design portfolio. Who knows? Spex could be the Ital Design of the '80s.

FM



Honda Civic chassis, minus bodywork, retains all of its modern features—transverse-engine, front-wheel drive, MacPherson strut suspension. Unibody platform is reinforced with steel subframe.

chine. The styling is *better* than you'll find on any small car.

The Spex kit takes advantage of modern production methods whenever possible. The body is foam-core fiberglass sandwich, one-piece except for the hood, trunk and doors. Like the latest "aero look" production cars, the windshield is flush-mounted with aircraft adhesive, and the trunk and hood overlap the fenders for a weatherproof, aerodynamic seam.

On the interior, the high-tech, high-style theme continues. The dash, door panels and interior panels are all low-pressure thermoplastic, with color and texture molded right in. Among other

**FOREST RANGER
CONTEST RESULTS**



Alex Thurocy
accepts keys to his new 4x4
from PM Editor John Linkletter.

CONTEST WINNER KEEPS ON TRUCKIN'

Actually, we weren't surprised at all. We know PM readers are full of good ideas and often share them with us. But frankly, when we thought up our Forest Ranger contest, we didn't expect so many good ideas.

You'll remember that the contest centered on your telling us what our next project vehicle should be and why. The winner was to receive our last project vehicle, the customized PM Forest Ranger Ford pickup truck (page 48, July '84). After we had read literally thousands of entries, Editor-In-Chief John Linkletter chose PM reader Alex Thurocy of Tulsa, Okla., as our winner.

Alex's entry was one of over a thousand based on the Pontiac Fiero. But his innovative thinking in the areas of new technology and use of nonautomotive materials for his proposed project garnered him the top prize.

Alex, 34, works as the director of program development at the Spartan School of Aeronautics in Tulsa. That's why he's so well-versed in aerospace technology and materials.

To accept his prize, we flew Alex to New York, where he stayed at the luxurious Marriott's Essex House hotel. A limousine whisked Alex, Assistant Auto Editor Norm Mayersohn and Ex-

ecutive Editor Joe Oldham to the fabulous Windows On The World restaurant high atop the World Trade Center building for dinner. The next day, Alex visited the *Popular Mechanics* offices and met Publisher Dan Coleman, Auto Editor Wade Hoyt, Managing Editor Bill Hartford and the rest of the staff. We had lunch at the New York Athletic Club. Then Alex was handed the keys to the Ford Ranger by John Linkletter and

'We had so many great entries that we decided to give consolation prizes as well.'

he was off on his drive back to Tulsa.

Originally, we had planned to give only one prize—the Ford Ranger pickup. But we had so many great entries that we decided to give consolation prizes as well. So, for their terrific entries, the following PM readers received two year subscriptions (or subscription extensions): Heino Schmidt, Torrance, Calif.; Elisabeth Landis, Los Angeles; Scott Frolich Jr., Sedro Wool-

ley, Wash.; Patrick G. Smith, Woodstock, Ill.; Chris Happel, Frazee, Minn.; William P. Young, Palmerton, Penn.; Samuel M. Mooney, Hershey, Penn.; Erin N. Kennedy, Seattle; Betty Fodor, Hollywood, Fla.; and Fred Bednar, Utica, N.Y.

As far as the entries themselves are concerned, the most popular vehicle mentioned for a future PM project was a Chrysler minivan. A few thousand of you asked us to do a project based on the Dodge Caravan or Plymouth Voyager. So, that's what our next project vehicle will be. You suggested we build everything from an all-out family camper to an all-out road warrior highway cruiser. We'll try to incorporate as many of your ideas as possible into our next project.

Since the second most popular vehicle mentioned was the Pontiac Fiero, our next project vehicle after the minivan will be based on the Pontiac Fiero. We might build a real Porsche-killer out of one. Then again, we may make it into the ideal sporty commuter car. Or maybe both.

Thanks to all of you who took the time to enter our contest. And stay tuned for the next one. It's going to be even better. **PM**

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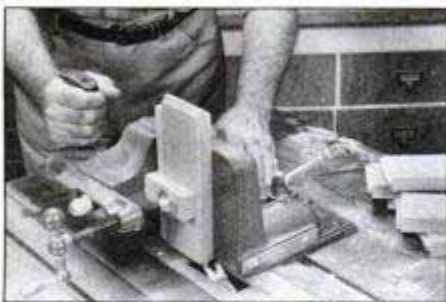
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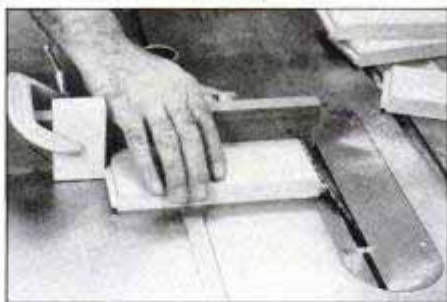
HOW TO BUILD CABINET DOORS *(Continued from page 107)*

block positioned behind the slat prevents the rear edge from splintering.



Cut the tongues on the slat ends using a table-saw tenoning attachment. Scrap block behind slat prevents splintering.

Reinstall the saw blade and cut 45° bevels on the top edges of all slats to



Cut a 45° bevel on the slat ends using a miter gauge. Note that a stop block is clamped in place to ensure uniform bevels.

form V-grooves. Apply glue sparingly and use three bar clamps: one across the top, one at bottom and one across the center.



Assemble the door on a flat surface. Apply glue sparingly to all contact areas. Then, clamp door square using three bar clamps.



Glass Pane

Glass pane doors are a popular alternative to solid panel doors and are commonly used on kitchen cabinets and china cabinets.

Make the door frame—the stiles and rails—as you would for any frame-and-panel door: Cut the sticking on the inside edge of the four frame members

and then cut the coping on the rail ends. Next, cut the vertical divider, or mullion, and the two-piece horizontal divider called the muntin. Then, make sticking cuts on each side of the mullion and muntin. Note that the sticking cuts are made in an oversized workpiece first, as shown, which is then sawed in half to produce the dividers. Now, cut the coping on the mullion ends and on both ends of each muntin piece.

Assemble the door by first gluing the muntin pieces to the mullion to form the

cross-shaped divider. Next, glue a rail to a stile, insert the divider assembly and add the remaining rail and stile. Clamp the frame square until the glue dries. Then, use a router fitted with a rabbeting bit to rout out the back side of the sticking. Rout away enough stock to insert the glass from the rear. Square-up rounded corners left by the router using a chisel. Insert the glass panes and then carefully attach $\frac{1}{4} \times \frac{1}{4}$ -in. wood stops with $\frac{3}{8}$ -in. No. 2 flathead screws.



Make the mullion and muntin from a single board. Mill the sticking, as shown, on the shaper. Note the use of a push stick. Saw the board in half to obtain two parts.



Glue the two-piece muntin to either side of the mullion. Once the glue dries, glue this cross-shaped assembly to one stile and rail. Then add the other stile and rail.



With the door clamped face down, rout out the back side of the sticking to permit installing the 1/8-in.-thick glass panes. Use wood blocks to support the router base.



Vertical V-groove

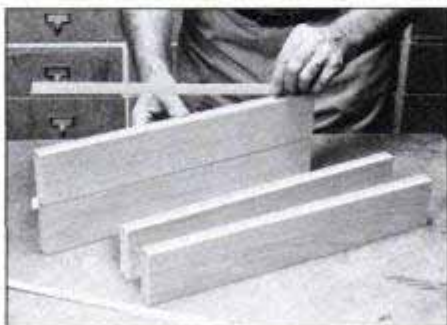
Make this style door from nominal 1-in.-thick lumber (actual thickness: $\frac{13}{16}$ in.). Edge-glue the boards together into a solid panel using

spline-reinforced joints. Then, cut the V-grooves into the panel face using a router.

Start by ripping the boards to the proper width. Next, cut $\frac{1}{8}$ -in.-wide $\times \frac{3}{8}$ -in.-deep spline grooves in the board edges on the table saw.

Note that it's necessary to adjust the saw fence so that the spline grooves are

cut slightly toward the back edge of each board. This off-center positioning will result in an equal amount of flat



Apply glue to the spline grooves before inserting the plywood splines. Cut splines about $\frac{1}{2}$ in. longer than needed. Glue the boards together and then trim spline ends.

gluing surface on either side of the spline after routing the V-groove.

(Please turn to page 150)



Cut grooves along the glue-joint lines using a router and a V-groove cutter. Set the depth-of-cut to $\frac{3}{16}$ in. Use a straightedge guide to control the router.

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THE MAGNIFICENT SEVEN*	0534212	THE AFRICAN QUEEN	0511022	ARTHUR*	6024092

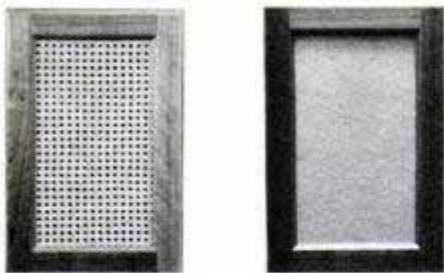
HOW TO BUILD CABINET DOORS *(Continued from page 148)*

Now, rip $\frac{1}{2}$ -in.-wide splines from $\frac{1}{8}$ -in.-thick plywood. Apply glue to the spline grooves, insert the splines and glue the boards together. Clamp the

door square until the glue dries. Then, rout grooves along each joint line using a router fitted with a V-groove cutter.

To prevent the door from warping,

screw two $\frac{13}{16}$ -in.-thick \times $2\frac{1}{2}$ -in.-wide hardwood batten strips across the back of the door. Locate the strips about 3 in. from the top and bottom.



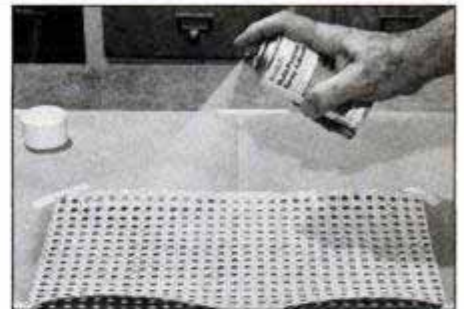
Flush Panel

The woven caning panel and plastic laminate panel doors are both flush panel doors. The panels are set into the rear of the frame, flush with the frame's back surface. Make sticking and coping cuts on the stiles and rails. Then, cut a $\frac{1}{4}$ -in.-thick plywood panel to size. Assemble the frame, but do not install the panel. Now use a router with a rabbet-



Use a felt-tip pen to mark the caning. Cut caning to size using tin snips or scissors. Caning is available in different weaves. Type shown is fine conventional weave.

ing bit to cut away the back side of the sticking to permit installing the panel. Adhere the plastic laminate to the plywood panel using contact cement. The caning is applied with spray adhesive (available at artist supply shops). Spray



Apply spray adhesive to the caning back side only. When the adhesive becomes tacky, press the caning onto the panel. Apply pressure with weights for good bond.

the adhesive on the caning back surface only, then press it onto the plywood panel. Now, spray three finish-coats of clear satin varnish to the caning face. Attach completed panel to the back of the door with small roundhead screws.

Plastic Laminate

The combination of plastic laminate and continuous oak pull is often used on contemporary style cabinet doors.

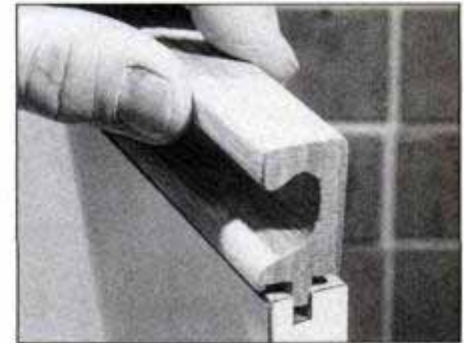
Cut the door from $\frac{3}{4}$ -in. particleboard. Birch

or mahogany plywood can also be used. Next, cut the plastic laminate about 1-in. oversized for the door back, face, sides and top. Laminate isn't needed for the door's bottom edge when a continuous oak pull is mounted as shown. Apply laminate in this order: back, top, sides and face. Install the laminate using contact cement and rout overhanging edges with a flush-trimming



Apply contact cement to the laminate and to the door. Cut the laminate slightly oversized to permit flush-trimming with router.

bit. Next, cut a $\frac{1}{8}$ -in.-wide \times $\frac{1}{4}$ -in.-deep groove in the door bottom on the table saw. (If the door is to be installed on a lower base cabinet, mount the pull on the door's top edge and laminate



Cut a groove in the door bottom to accept the tongue of the continuous oak pull. No laminate is applied where pull is mounted.

bottom edge.) Glue the pull to the groove with the fingergrip facing forward. Continuous oak pulls are available from The Woodworkers' Store (see credits on page 105 for the address).

Hardwood Veneer Plywood

This easy-to-make door is constructed from $\frac{3}{4}$ -in. hardwood veneer plywood. The plywoods most commonly used for

doors include birch, mahogany, oak and ash.

Cut the plywood on a table saw using a sharp, smooth-cutting saw blade to prevent splintering the hardwood veneer. This procedure is especially important when cutting across the veneer's grain. Always cut the plywood with the door facing up. This way, any

splintering will occur on the door's back surface.

If a radial-arm saw or portable circular saw is used to cut hardwood veneer plywood, the cutting is done on the other side, so place the door face down to prevent splintering the face.

After cutting the door to size, conceal the exposed plywood edges with $\frac{13}{16}$ -in.-wide iron-on veneer tape. Apply the veneer tape using a hot clothes iron. Once the edge cools, trim the excess tape with a sanding block or file. Veneer tape the four door edges in the following order: top, bottom, sides.

The exposed plywood edge can also be concealed with $\frac{1}{8}$ \times $\frac{13}{16}$ -in.-wide solid hardwood strips. Glue the strips to the door edges.

Hold the strips in place with several

pieces of masking tape until the glue dries. Then, sand or file the strip flush with the door.

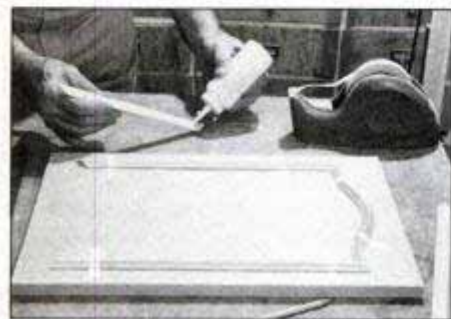


Conceal exposed plywood edges with iron-on veneer tape. Apply the tape with a hot clothes iron or a low-voltage strip heater.



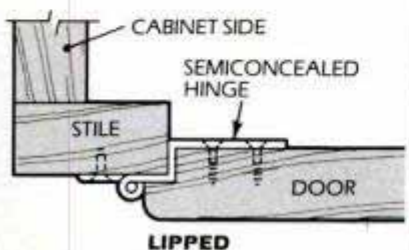
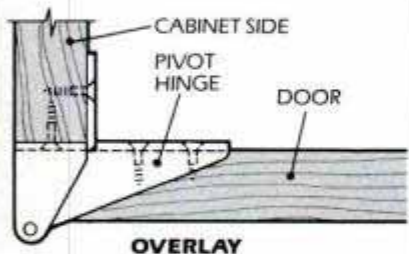
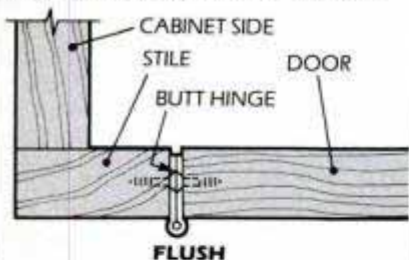
Applied Wood Molding

Add a custom touch to hardwood veneer plywood doors by using ready-made wood moldings. Apply the moldings to the door face using glue only. The moldings are available from The Woodworkers' Store (see credits on page 105) in a variety of shapes, profiles and wood species. Cut, fit and arrange the wood moldings on the door face as desired. Then tape each piece in position. Now, remove one piece, apply glue and replace. Continue this procedure until all pieces have been glued and taped back to the door.



Test-fit wood moldings by taping to the door face in the desired pattern. Remove each, apply glue and tape in place again.

DOOR HANGING OPTIONS



Alternative Panel Raising Techniques

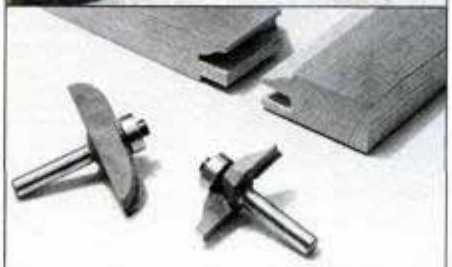
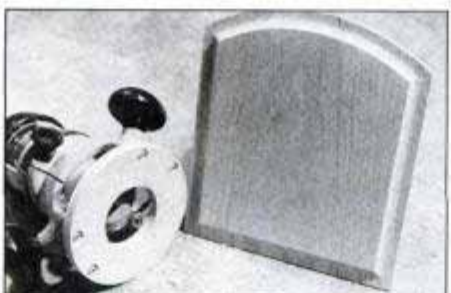
Here's how to cut a raised-bevel panel using a radial-arm saw or a router.

On the radial-arm saw, use the Sears rotary surface planer (No. 29513) as shown. Lock the saw carriage with the planer angled to the desired bevel. Then, guide the panel along the saw fence to raise the bevel.

A router bit set from Conover (see credits on page 105) contains three cutters: sticking and coping, raised beveling, and panel slotting. **PM**



Rotary planer is shown with blade guard removed for photo clarity. Planer has three cutters (right).



Economical carbide router bit set contains raised-bevel cutter (above left and top), combination sticking-coping cutter (above, right) and standard slotting bit (not shown).



Quality hardwood veneer plywood can be used for raised panels if the inner piles are thick and absent of voids. Note how the entire raised bevel is contained in one ply.

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How To

REPAINT KITCHEN APPLIANCES

You can change that old-fashioned appliance color to update your kitchen.



BY MICHAEL BARGO

The kitchen is often the first room to undergo major redecoration in a home. Yet an outdated appliance color can be a stumbling block to a completely new look. Stoves and refrigerators can last 15 years or more. However, colors that were in fashion 15 years ago in many cases aren't even used on appliances today.

An inexpensive solution is to repaint your appliances yourself. The job isn't as complicated as it seems, and the result can be a paint finish that equals or exceeds the original finish. But you must meet two conditions: 1, use a high-quality paint, and 2, use spray equipment equal to the job. You can rent a compressor and spray gun; or you can purchase an airless sprayer.

Two paint types and sprayer options

There are two major painting options open to you, depending on the type of paint you choose. If you pick an enamel paint like the original finish on the appliance, you

must apply it with an air compressor and a high-quality spray gun. These can be rented. Enamels and lacquers suitable for appliance use are available at automotive paint supply stores. The advantage of this choice is that there is an enormous variety of colors available, since cars have been painted in virtually every color.

The second choice is a different type of paint that is finding wide use in the automotive industry. These are the aliphatic polyurethane coatings, pure versions of the milder urethane paints available in hardware stores. They come in two parts: a pigment and an activator. These must be mixed together shortly before use. Ditzler's Durethane and Rust-Oleum's Rust-O-Thane are examples of these paints. Check the Yellow Pages under "paint" for a dealer of your selection.

With polyurethanes, a high-gloss, glass-smooth finish can be obtained with a simple airless paint sprayer. Polyurethanes are more durable than automotive enamels or lacquers and can withstand acids, alkalis, grease and oil. They also have excellent hiding properties and can cover dark colors with one coat. These paints dry to the touch in two to four hours and they can be handled within six hours. The disadvantage: Urethanes with their activator can cost up to twice the amount of an automotive enamel. However, the urethanes can be applied with a small airless sprayer, such as a Wagner 200 series sprayer, priced at less than \$100. Compare this to the two-day rental cost of well over \$100 for a compressor and quality spray gun used with

(Please turn to page 154)



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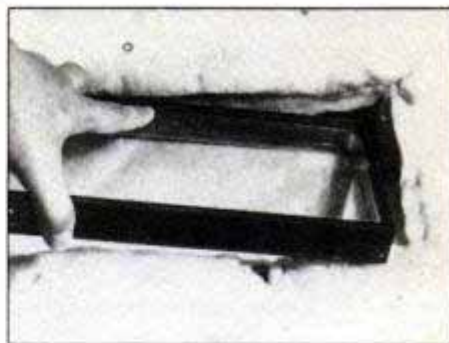
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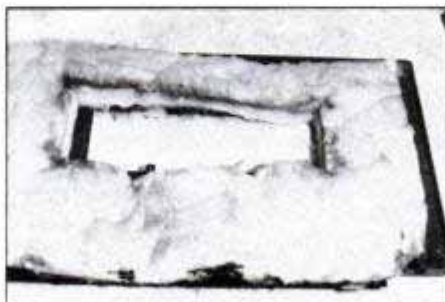
DISASSEMBLING A STOVE



Remove the oven door hinges. Pay close attention to the way they are fastened to the door and oven, since refastening the door may be the trickiest part of reassembly.



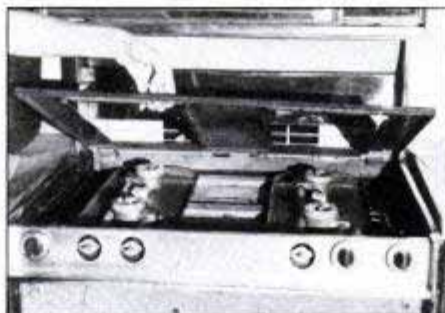
After removing Phillips screws on the inside door surface, outer and inner door panels come apart to reveal insulation bonded to sheet metal. The glass window lifts out.



Keep the insulation attached to the sheet metal for easy reassembly, and simply lift out the sheet. Now you should prepare the outer door panel for painting.



Broiler door (foreground) is held by machine screws reached from the interior. Screws for stove cover (background) are accessible after broiler door is removed.



After the burners and chrome trays have been removed, the top stove cover can be removed for sanding and painting. In this case the cover simply lifts off.

each of paint and activator, this type paint is available only in quart cans. Cost for both quart cans was under \$50. I also bought thinner for paint clean-up.

Don't be tempted to use aerosol spray paint cans to repaint a kitchen appliance. Spray paint cans don't deliver the high quality, durable finish found with other painting methods and materials. They should not be considered seriously for a kitchen that will be redecorated.

REPAINT APPLIANCES

(Continued from page 152)

enamels and lacquers. In addition, you have the airless sprayer on hand for other jobs.

Another important variable to consider when choosing a paint for a cooking appliance is the paint's sensitivity to heat. An oven door may attain temperatures exceeding 100° F. (A surface of 100° becomes too hot to touch.) Rust-O-Thane, a polyurethane, for example, can take heat up to 150°—some shades up to 300°—before it begins to darken.

I decided to paint my dark brown stove and refrigerator with a Wagner Power Painter Heavy Duty Series 200 airless sprayer and white Rust-O-Thane urethane. Although both appliances could have been covered with one pint

Preparing the appliances

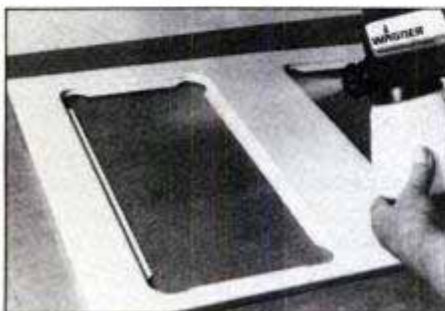
Two steps are involved in the paint preparation of any appliance. First, disassemble the appliance to some extent. If you must move the stove, shut off the gas valve and disconnect the stove line with an adjustable wrench. If it's electric, just unplug it. Remove and disassemble oven doors, range top and base piece to paint them. You should pay close attention to how the hinges are fitted on the oven door. I found them to be the trickiest part of reassembly. You can leave on the large side panels if it is possible to paint the stove in the kitchen or to move the entire unit to a painting area.

Disassemble the refrigerator gasket and shelves by removing the sheet-metal screws found inside the door perimeter. A gasket may be glued in place. If this is the case, carefully peel it away and store it on a flat surface. It can be replaced using automotive weather-

PREPARING AND PAINTING A STOVE



Rust-O-Thane paint and activator (background) are mixed in equal proportions. No. 500 or 600 abrasive and a rubber sanding block (foreground) prepare the surface.



Hold the sprayer about 12 in. from the item you are painting. Elevate the pieces on sheet material so you can turn them as needed to cover all sides and edges.

strip adhesive. If the gasket is cracked or peeling away and no longer seals the door adequately, a new gasket will not only improve the appliance's appearance but will save money on your electric bill. Check with a refrigerator parts supplier on the availability of replacement gaskets.

Refrigerator doors may be removed easily by unbolting the door-mounting hardware. Keep all appliance hardware, handles and fasteners in a box where they will be readily available for reassembly.

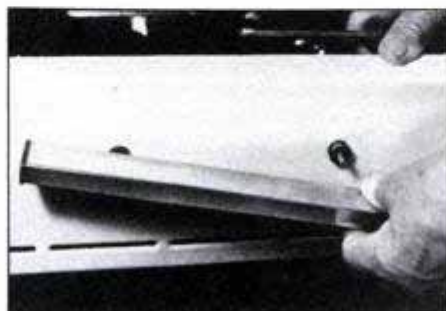
Wash and sand parts

After disassembly, wash the pieces to be painted. Thoroughly clean them with an abrasive-type kitchen cleanser to remove dirt and grease. Stubborn grease and oil can be removed with degreasing solvents such as ammonia.

Next, scuff-sand the surface for best adhesion. Use a small, hard rubber sanding block and 500- or 600-grit sandpaper. Wet-sanding is the preferred method. If your stove has a hard baked-enamel finish, lightly scuff-sand the finish with dry sandpaper before wet-sanding it. Be careful not to sand off all the paint. Bare metal surfaces have to be primed first, since many paints require either a base coat of old



Scuff-sand the appliance surface for the best paint adhesion. Wet-sanding with 500- or 600-grit abrasive wrapped around a small, hard rubber sanding block is preferred.



Assembly for the top, oven door, broiler door and bottom cover is the reverse of disassembly. Here the broiler door is reattached to the stove with machine screws.

paint or a sealer. Check the manufacturer's recommendation for the paint you intend to use to see how the paint adheres to bare metal.

Also, if you use a polyethylene, you should check the life of the paint after it's mixed so you'll know how much time you have to apply it.

Clean and dry surface

Carefully clean and dry the surface after it has been sanded, using a laundry detergent to remove remaining dirt. Then wipe the surface with the paint thinner used for the paint of your choice. This is to remove any residue left from the sanding operation.

Any factory-painted surface can be repainted, but some paints require that previously painted surfaces be dried and cured completely. Rust-O-Thane requires that previously painted surfaces be at least 6 months old. The best way to avoid paint-peeling problems is to test a small spot of the appliance with a brushed-on sample of the paint. After a half day or so, see if the appliance surface is scaling or peeling. If the surface is smooth, the entire appliance can be painted safely. This precaution is also necessary since some paint solvents may be incompatible, and the new paint you are using may lift off the old paint.

Completely tape surfaces not to be painted, such as chrome trim and handles. If any paint gets on chrome, it can

(Please turn to page 156)

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PREPARING A REFRIGERATOR FOR PAINT



Carefully tape surfaces not to be painted, such as chrome trim and handles. If any paint is accidentally applied to chrome, it can be removed with a paint thinner.

REPAINT APPLIANCES

(Continued from page 155)

be wiped off with paint thinner. Treat paint splatters as soon as they occur.

Paint appliances in a room suitable for spraying. This means adequate lighting, ventilation and protection for other items in the room. Wear a good quality painting mask when you work.

One easy way to protect a kitchen from overspray is to construct a small painting booth out of large cardboard panels. Thin, hanging plastic tarps are also an effective and inexpensive way to block off overspray. No matter how careful you are, however, some spray mist may drift. Remove anything from the room that can be damaged by a fine mist of paint.

Spraying procedures

Thoroughly review painting procedures in the sprayer's manual, and practice spray painting a piece of paneling, plywood or metal. This will prevent time-consuming mistakes when you work on the appliances.

For example, when I used my Wagner sprayer for the first time, I found that tip selection was very important. The .7-mm tip that comes with the sprayer was adequate for the urethane, but the .6-mm tip worked better, producing a finer spray. An optional "fine finish tip" is available that produces a narrower spray pattern. This is useful when painting close to an edge, where overspray has to be minimized. The fine finish tip splattered the urethane paint, however. I finally went back to using the .6-mm tip.

Check to make sure that the paint is thinned or mixed to the maker's specifications. Let a two-part paint interact for the recommended time before painting.

Spray in a hatch pattern, slightly overlapping previously painted portions, while always keeping the sprayer in motion. A spray gun kept on one spot will cause the paint to run. If this occurs, wet a clean rag with paint thinner and carefully wipe off the paint drips. Then, lightly spray the area again. If the paint has run in only a tiny



Loosen the gasket retaining screws and remove door shelves and gasket. Skip this step if it is possible to paint the refrigerator without removing the door.

area, you may elect to let the runs dry, then wet-sand them and spray them lightly to give the surface a gloss. If too much paint runs, strip all the paint off and repaint the entire section.

After spraying, keep doors to other areas of the house closed for several hours to minimize dust. Ventilation, however, should be maintained to rid the room of most of the solvent fumes.

Reassembling the appliances

When the painted parts have been sprayed and are dry enough to handle, remove any tape and paper. Carry the parts if possible to a clean, dust-free area to harden for at least a day before reassembly. Paint is still soft, even after it is dry to the touch, so minimize handling. When the paint has hardened sufficiently, reassemble the stove and replace refrigerator doors, gasket and shelving to original positions.

When reassembling the refrigerator, you may want to add decorative touches to the newly painted appliance. For a kitchen redone with oak cabinets, for example, you can purchase a small piece of oak molding and screw it horizontally across the top of the refrigerator doors, or vertically near the handles. Since the plastic door inserts are already removed, you can simply clamp the wood strip in place and bore pilot holes through the refrigerator door into the wood trim, being careful not to go entirely through the trim. Then fasten with sheet-metal screws.

The final result with my stove and refrigerator was well worth the effort. The stove's parts are glass smooth. The stove sides have the same orange-peel finish as the original, but with a higher gloss. Overall, both appliances have an appearance and finish that is more attractive than the original finishes. Most importantly, they now add a feeling of light and spaciousness to a kitchen that was dark and cramped. **PM**

SOURCES

Spray paint equipment: Wagner Power Painter Series 200 airless sprayer, Wagner, 1770 Fernbrook Lane, Minneapolis, Minn. 55441.
Aliphatic polyurethane coating: Rust-Oleum Corp., 11 Hawthorn Parkway, Vernon Hills, Ill. 60061.

Build A Customized SKI BOOT CARRIER

Here's a snappy ski boot carrier you can make quickly and easily from materials around the house. Start with a $\frac{3}{4} \times 4 \times 19$ -in. board (actual dimensions). Don't use plywood, as it might delaminate when wet. Cut off 4 in. for the carrier base. The remaining 15-in. piece will form the upright. Make two heel holders by cutting in half lengthwise a $\frac{1}{4} \times 4 \times 5$ -in. block of wood.

Trace a semicircle slightly larger than the ski boot back (not heel) on the heel holders. The boot heel should rest on the base, the back on the semicircle. Cut with a coping or sabre saw. Mark, bore and countersink screw holes.

Before assembling sand with 60-, 100- and 150-grit abrasive, dusting and wiping with a tack cloth between steps. Then, paint the upright, base and heel holders with a bright-colored polyurethane paint. You can match the carrier to your skiing attire. It's a good idea to paint on your name, too.

When dry, center the 15-in. upright on the base and affix with glue and two

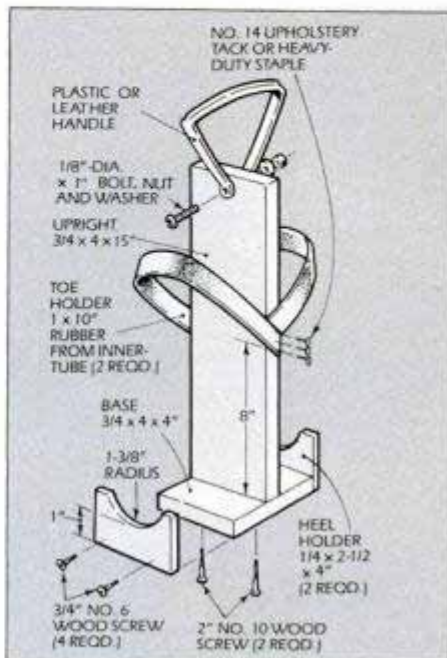
2-in.-long No. 10 wood screws. Affix one heel holder to each end of the base using two $\frac{3}{4}$ -in.-long No. 6 wood screws per side.

With the upright member lying horizontally, place a boot on it and stretch a 1 x 10-in. length of rubber tubing or elastic strip over the toe. Tack or staple the toe holder to the upright edge using heavy-duty staples or No. 14 upholstery tacks. Repeat with the other boot on the other side. For added holding strength, fasten the strap to the upright face.

For the handle, use a strip of leather or a plastic handle. I used a plastic handle from a milk carton. Cut the plastic support connector post from the handle ends. Force the post out and drill the other side. Center the handle at the top of the upright. Mark, drill and install the handle using a $\frac{1}{8}$ -dia. x 1-in. bolt, washer and nut to fit.

Insert the boot toe under the strap and push the boot up until the heel clears the holder. Slide it in place and head for the slopes.—Rod King

These lightweight, painted wood ski boot carriers are inexpensive and easy to build.



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PM PHOTOGRAPHY UPDATE

Shoot while you sleep

Canon's Command Back 70 does more than just imprint time information on film frames. As its name implies, the accessory sends programmed com-



New for Canon's T70 35-mm SLR (above) is programmable timer, seen fitted on the camera at right. The Command Back prints date and time on films, and also programs the camera to take exposures.



The Command Back also can be programmed to instruct the T70 to make time exposures while you're away. The time span of these exposures can be as long as 23 hours, 59 minutes. Additionally, the accessory can be set up as an extended self-timer—up to 24 hours.

When used in its information mode, the Command Back will imprint dates, times, frame numbers or other numeric and alphabetic data in the lower right-

mands to the company's T70 camera. With the Command Back attached, and the T70 set to any of its six automatic exposure modes, the camera can be programmed, for example, to make hourly exposures of a scene from dusk to dawn (the accessory can be set to trigger a flash). Set to a shorter time period, the T70 can record a dramatic sunset by time intervals. The maximum time period over which exposures can be programmed for with this camera is just one second short of 24 hours.

hand corner of the film. The Command Back can number up to four rolls sequentially. Programs are set by way of pushbuttons on the Command Back. The unit's digital readout displays the information you set, and also acts as a quartz digital clock. The accessory's printing and exposure functions can operate simultaneously.

The Command Back is priced at \$156. It adds 1/8 in. to the T70's depth, 1/2 ounce to its weight and operates on a 3-volt flat lithium battery for up to four years.

More new fast films



Fast 1000-ASA Agfa-Gevaert Agfacolor (left) and Agfachrome take normal developing.

Agfa-Gevaert's joining the faster-than-400 ASA color film race with 35-mm ASA-1000 rolls for prints and slides. While all so-called "fast" films expand your ability to shoot low-light images without a flash, Agfa promises another advantage.

The company's new Agfacolor XRS 1000 (print) and Agfachrome 1000 RS (slide) don't require special "push" processing. Instead, Kodak's popular E-6 (print) and C-41 (slide) developers can be used at their standard six-minute processing speed.

Agfa-Gevaert says processing will be included in the price of Agfachrome rolls marked CT.

Whistle while you learn

Planning a Florida vacation this winter? Why not improve your photo-taking skills while you're relaxing? Eastman Kodak's running hands-on clinics at the Walt Disney World "Magic Kingdom" in Lake Buena Vista.

The program, which is designed for beginning and advanced amateurs, runs Mondays and Wednesdays from 8:30 to 11:30 a.m. The \$10 fee includes Kodak's 108-page how-to book. Call 305-828-2405.

Improved disc film sheds grainy image

Kodak is now shipping improved Kodacolor VR film for disc cameras. The new film makes use of the company's T-Grain emulsions for greater sharpness—particularly when the frames are enlarged.

Kodak points out that the disc film's grain improvement is most noticeable in uniform color areas, such as the reproduction of blue sky. To achieve this without losing sharpness, the new T-Grain emulsions have been incorpo-

rated in both of the film's yellow layers.

A side benefit of this upgraded disc film is that it offers more uniform printing characteristics. For example, close-up flash



Improved Kodacolor VR disc film: New emulsion yields less grain when enlarged, better color and printing ability.

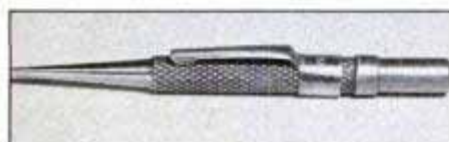
pictures will have less of a tendency to print "warm" in color, and shadows won't print green if the warm highlights are compensated for in printing. Overall, the new T-Grain emulsion film shows less of a printing variation between outdoor and flash-illuminated scenes.

The improved Kodacolor VR disc film is designated so on its package, and is priced the same as the original disc film it replaces.

PM

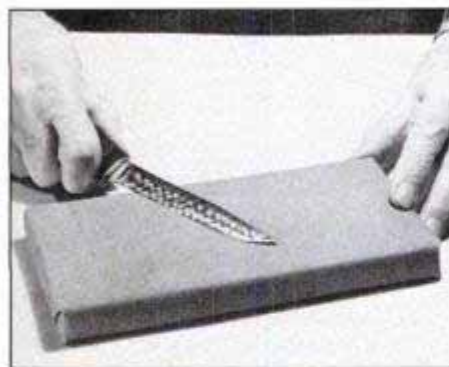
HINTS FROM READERS

Portable nail set



Fit a pencil clip to the shank of your nail set (above). When you aren't using it you can simply clip the set to your shirt pocket, where it's handy for its next use (top).—*Lane Olinghouse and Walter E. Burton*

Blade honer

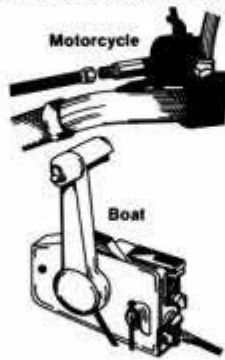


A strip of fine emery cloth tacked to a wooden block makes an excellent hone for sharpening pocket knives and other cutting tools. Hold the knife at the same angle as the bevel of its cutting edge and apply light pressure while you move the blade edge sideways along the emery cloth. Remove resultant burr by polishing the blade back.—*Walter E. Burton and Lane Olinghouse*

NEW TACH-O-BRASS

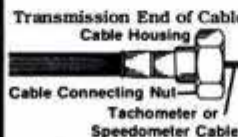
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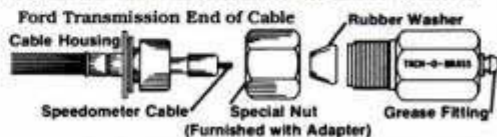


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Cable Housing
Cable Connecting Nut
Tachometer or Speedometer Cable
Model 7185 Patent Pending



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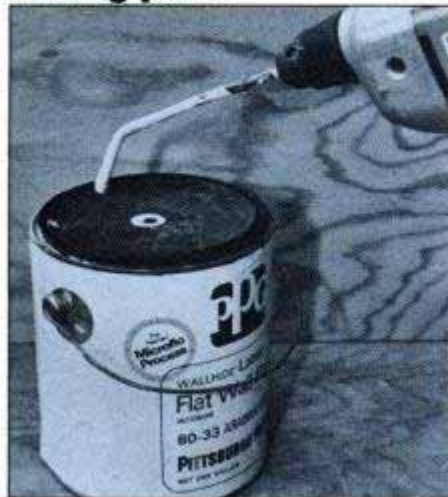
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10 Tips For Weekend Painters

Mixing paint



A used paint-can lid with a hole drilled in the center will allow you to mix paint in the can with no spatter. Make a paint stirrer from $\frac{1}{4}$ -in.-dia. steel rod by bending a 45° angle on one end. Chuck the other end into an electric drill. Be sure the hole is just large enough for the stirrer to spin freely in the can.

Coffee can container



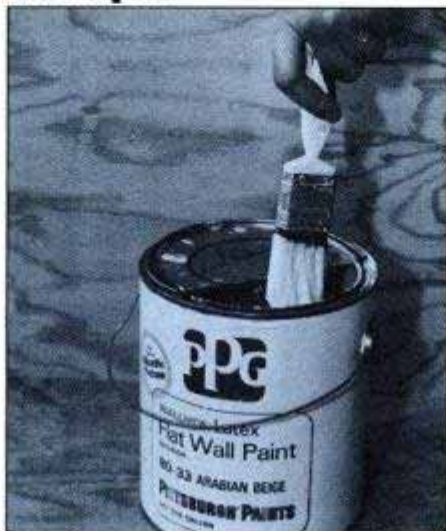
Painting from a full can is hazardous. Pour some of the paint into an empty paint bucket or plastic pail. A well-rinsed coffee can makes a hand-sized container that's easy to get to with a medium brush. It lets you take the paint conveniently up a ladder. And if it spills, you don't lose a whole can.

Disposable applicator

Use a disposable paint applicator to paint small, odd-shaped objects. You can make one from a piece of foam rubber with a cardboard handle stapled to it. It works as well as the foam applicators sold in hardware stores,

and you can toss the homemade brush when the job is done. No need to clean brushes—save that for big jobs.

Lid wiper



An old paint-can lid, cut off about two-thirds of the way across, provides a handy place to wipe excess paint from the brush, and prevents the lid groove from filling up with paint.

Paint mitt



A plastic bread wrapper or long bag inside an old tube sock makes a handy—and cheap—painting mitt for round and odd-shaped surfaces that can't be painted easily with a brush or spray gun.

Painting tight places

To paint shelf bottoms, the insides of small containers and other hard-to-reach areas, cut off part of a paintbrush handle so that the brush is short enough to fit the space. Leave enough handle to grip.

Painting metal tools

When painting metal equipment with polished machine surfaces, such as shafts or hydraulic cylinders, protect the machined surface from paint with a heavy coating of gear or gun grease. Any paint that spatters can easily be wiped off with the grease.

Draining the can rim



On a new can of paint, pound nail holes along the perimeter of the rim. As you work, paint will drain through the holes. When you hammer the lid tightly in place, little paint is left to splatter.

Storing paint



A simple method of preventing rinds from forming in a partially used can of paint is to close the lid tightly and store the can upside down. This effectively excludes air from entering the can.

Overnight brush storage

If you have completed your painting for the day and plan to continue the next day, it's not necessary to take the time to clean your brush. Simply store it in a plastic sandwich bag and seal the bag tightly. The brush will be flexible for use the following day. **PM**

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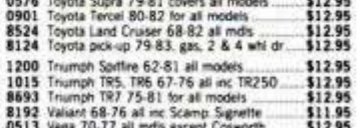
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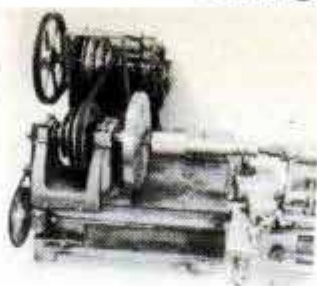
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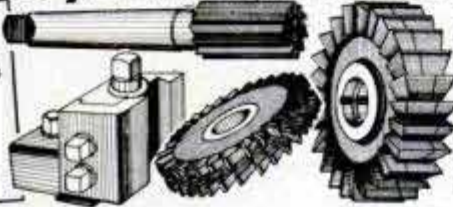
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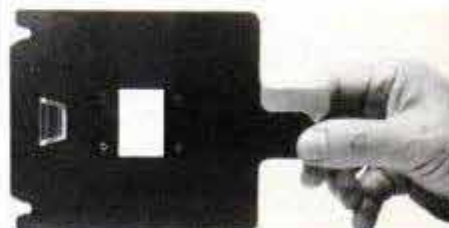
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PM LONG-TERM CAR TESTS

(Continued from page 59)

'84). So well-documented that Oldsmobile asked for another chance to make the car right. We returned our ill-handling wagon to the Olds Zone Office in Tarrytown, N.Y., where a great number of people tried to figure out what was wrong.

After keeping the car for two months, and adding 4,000 test miles to the odometer, it was finally returned with very little information about exactly what had been done to the car. We have a photocopy of a work order from Erickson Olds in Monsey, N.Y., that says, "Replace 1 front strut." Someone at the Zone Office told us they had "rebuilt the struts." In any case, the car now tracks straight on the highway, with none of the disconcerting lurching that we reported earlier.

One Zone employee confessed that he had lent the wagon to his wife before it was fixed, and she came back to report "something terribly wrong" with the car, so it wasn't just our imagination. A friend who runs a service station does a brisk business in Monroe replacement struts for GM cars, and the Zone employee did admit to having seen "several other cases" like ours. All the evidence points to poor quality control on the original equipment MacPherson front struts on many GM cars. If you have a wandering, tail-wagging problem similar to ours, suspect the Delco struts.

The former steering wheel shimmy has been reduced to the point where only a safecracker could feel it through ultrasensitive fingertips. But most of the annoying clanks and rattles remain.

The consensus at the Zone Office is that one should never order an Olds "for this part of the country" without heavy-duty suspension. We had tried to order this \$30 option to deal with city potholes and twisty suburban roads, but the car came through without it, which was a pity. Even now that it's fixed, we'd like more control over our Cutlass. As it stands, it's a wonderful cosmetic station wagon—perfect for dinner dances at the country club. But it has some way to go before you could use it as a serious working wagon, for hauling building supplies or an eight-body carpool.

Our fuel economy has remained unchanged in the 18-mpg range, which is good for this size car, driven by people who don't own it. Optioned out right, with the F41 Firm Ride and Handling package, Goodyear Eagle GT tires (\$58), a rear wiper/washer (\$120) and a lot less trivial flash, the Cutlass Cruiser would probably make a nice family wagon. We returned it with over 12,000 miles on the clock.—W.H.

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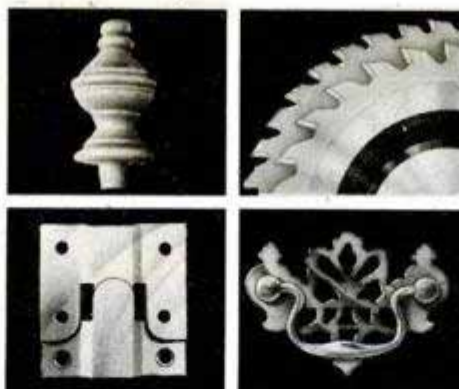
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SCIENCE & CHEMISTRY

1985 CHEMICAL CATALOG Lab Equipment-Glassware \$3.00 Refundable. Scientific Supply, P.O. Box 490, Ranger, TX 76470

1985 CATALOG, 200 pages. Thousands of chemicals, glassware, science/hobby equipment. \$2.00, Merrell Scientific, 1665 Buffalo Road, Rochester, New York 14624

LABORATORY Chemicals, Glassware—Apparatus, Catalogue \$1.00. Deluxe Scientific, 934 S. 13 Street, Manitowoc, Wisconsin 54220

FORMULAS, PLANS, ETC.

ANY FORMULA \$10.00. Catalog \$1.00. J. Belfort, Box 568, Chicago, 60690

MONEYMAKING FORMULA CATALOG \$5.00 (REFUNDABLE!) GWA3, Box 193, Brookfield, Wisconsin 53005-0193.

SMOKE Formulas 19 Formulas 15 Colors Bonus: Make Your Own Fuses \$5.00 and SASE. Formulas, Box 5563, Spring Hill, Florida 33526

SPECIAL SERVICES

INFORMATION On anything. Ferguson Research Specialists, 60-15 Woodside, Woodside, New York 11377.

"RESEARCH UNLIMITED"—Information and research on any subject. P.O. Box 94, Beaumont, TX. 77704. (409) 860-4520

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HEART Bypass Is Not The Only Way! Information \$10.00: Health Research, R4 Box 420, Denison, Texas 75020

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WHEN ILLNESS STRIKES. Home care for your loved one. **COMPLETE GUIDE.** Detailed and illustrated. Money back guarantee. \$14.95 postpaid Ct. res. add 7 1/2% sales tax. Autumn Leaves Press, 110 Malletts Lane, New Milford, Ct. 06776

REPAIRS & SERVICES

TRUCK MANUAL— Over 2,800 models of trucks and vans from 1974-1983. Detailed diagrams pulls step-by-step instructions help you repair and maintain your truck. This manual includes all popular makes of trucks and utility vans plus the new mini trucks. Send for Book. (#B-1503-\$27.50). P.O. Box 1014, Radio City Station, New York, NY 10101

DEADLINE FOR ADS: Copy and Payment must be in by the 5th day of the 2nd preceding month for the issue in which the ad is to appear. See Head of Classified Section.

HOW TO COUNT WORDS: Name and address must be included in counting the number of Words in your ad. Each initial or number used counts as 1 word: J.J. Smith, 224 West 57th Street, New York, New York 10019: 9 WORDS. Zip codes are not counted. Phone #: 2 Words. Symbols used as keys are charged for. City or State count as 1 word each: New Brunswick, New Jersey: 2 words. Abbreviations such as C.O.D., F.O.B., R.P.M., U.S.A., P.O., 5x7, 16mm are counted as 1 word. (P.O.Box 392 counted as 3 words) Webster's International Unabridged Dictionary will be used as our authority for spelling, compound words, Hyphenations, abbreviations, etc. Please make checks payable to **POPULAR MECHANICS**.

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No Charge for CAPS	2	3	4	5	6	7
8	9	10-\$62.50	11-\$68.75	12-\$75.00	13-\$81.25	14-\$87.50
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22-\$137.50	23-\$143.75	24-\$150.00	25-\$156.25	26-\$162.50	27-\$168.75	28-\$175.00
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36-\$225.00	37-\$231.25	38-\$237.50	39-\$243.75	40-\$250.00	41-\$256.25	42-\$262.50
43-\$268.75	44-\$275.00	45-\$281.25	46-\$287.50	47-\$293.75	48-\$300.00	49-\$306.25
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DRINKING WATER PURIFIERS

PURE WATER for pennies a gallon. Proven Technology, build with hand tools. Plans \$5.00 to: Concepts, Box 6626, Laredo, TX 78042

GARDENING & LAWN CARE

LEARN Gardening and Landscaping at home. Free booklet. Lifetime Career Schools, Dept. A-150, 2251 Barry Avenue, Los Angeles, California 90064.

GARDENING BREAKTHROUGH! Inexpensive, Revolutionary **MULCHING DISKS**. Brochure Rushed Free. Porterhouse, DWP Ranch, Skiatook, Okla. 74070

GREENHOUSING/GARDENING— Free Supply Catalog... Greenhouses to Hand Tools. Gothic Arch Greenhouses, P.O. Box 156P, Mobile, AL 36633

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AUTHENTIC Mexican Recipes Send \$3.95 + .50 P/H to: BC, P.O. Box 11678, Tucson, Arizona 85734

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WORLDS GREATEST TACO'S! Old Texas family recipe. \$3.00, SASE. Magnum Publications, 6890 S. Spencer, Las Vegas, NV. 89119.

BAKIN' WITH BOOZE - Orange Rum Cake - Bourbon Balls - Grasshopper Pie - 15 Favorites \$3.00. Private Collection, 7250 Auburn Boulevard, Suite 149, Citrus Heights, CA 95610

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SUPER BUT SIMPLE Sandwiches, 75 recipes \$3.00. Helen Hansen, 12114 E. Dodge, Dept PM, Otisville, MI 48463

CHINESE FOOD! Cookbook to save time and money with all your favorites, surprise your family today. \$5.00. M & J Lopes Co., Box 74, Jersey City, N.J. 07302.

NEW! MICROWAVE COOKING GUIDE. Helpful Hints, Delicious Recipes, Roasting Chart. Only \$4.95. **KIMBERLY PRODUCTS**, 970M Stony Lane, Wickford, RI 02852.

HAWAIIAN SHORT RIBS. 24 delicious recipes. \$3.00. HMA, 1750 Kalakaua, Suite 3527P1, Honolulu, HI 96826

TEN unique pie recipes. \$2.00: 188 S. Lincoln, #18, El Cajon, CA 92020

FUDGE 20 recipes \$2.00. Modar, P.O. Box 178, Richeyville, Penna. 15358

FREE CASSEROLE GUIDE with Soup Cookbook @ \$3.50. Robinson's PM1, 80 Canaan Street, Hartford, Conn. 06112

WINEMAKING, BEERMAKING, ETC.

WINEMAKING-BEERMAKING-GASOHOL. Free Supply Catalog. Yeast Equipment. Continental, Box 188PM, Casselberry, FL 32707

WINEMAKERS-BEERMAKERS— Free Catalog—Fast Service—Large Selection: Kraus, Box 7850-L, Independence, Missouri 64053.

FREE BEERMAKING BOOK Plus Catalog. Finest Equipment, Ingredients. Fully Guaranteed. SPI, Box 784-M, Chapel Hill, NC 27514

WINEMAKERS-Beer-makers: Free illustrated catalog of supplies. Semplex, Box 12276R, Minneapolis, Minnesota 55412-0276

BEERMAKERS ONLY! Free Catalog/Newsletter. Williams's, Box 461M, Oakland, California 94604.

FREE ENCYCLOPEDIA Winemaking, Beer-making Supplies, Equipment, Ingredients. Vynox, P.O. Box PM15498, Rochester, NY 14615

BEERMAKING, WINEMAKING beer malts, wine concentrates, yeast, books, barrels. Free Catalog. Mountain Cellar Supplies, 346 B Weaverville Highway, Asheville, N.C. 28804

WINEMAKING HOMEBREWING HERBS SPICES FREE catalogue. 1535 Windsor Street, Cornwall, Ontario K6H 3N6

BEERMAKING-WINEMAKING We're #1. Free Catalog. Vineyard & Brew, P.O. Box 401-B, Sault Ste. Marie, MI 49783

WINEMAKING/BEERMAKING, Equipment, Supplies. Free Catalog, Large selection, fast service. ASC, P.O. Box 335, Berwyn, Illinois 60402

MAKE QUALITY BEER, Wine. Free catalog. Village Store, Box C-51PM, Westport, MA 02790.

WINEMAKERS-BEERMAKERS Fresh Stocks, Fast Service, Free Catalog. O'Briens, Box 284D, Wayne, IL 60184

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BEER LOVERS—Brew your own. Delicious! Inexpensive! Free catalog. Beer Gear, Box 25093M, Lansing, Michigan 48909

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BURGLAR ALARMS & HOME PROTECTION

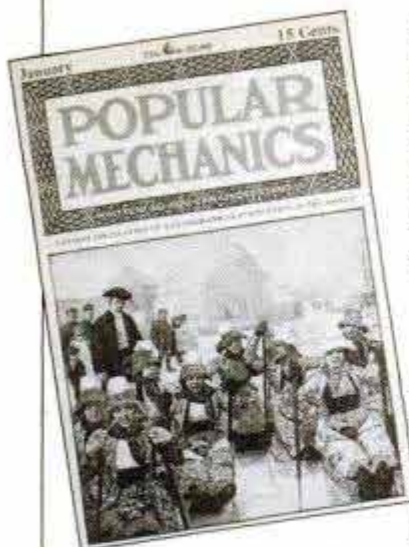
TRIPLE YOUR COST SELLING LOW COST ALL PURPOSE BURGLAR ALARMS. BROCHURES \$2.00 SAMPLES. S. TILLMAN CO., P.O. BOX 214030, DEPT 12, DALLAS, TX 75221

STRENGTHEN deadbolt installations. Instructions/Diagrams. \$2.00. C.R. Leonard, POB 695, Bastrop, Texas 78602

PROTECT YOUR INVESTMENTS AND VALUABLES with new anti-theft kit. Includes tungsten carbide engraving pen, record forms for keeping valuable serial numbers, and a **FREE** door alarm with security chain for ordering now! Send \$9.95 + \$1.00 postage to: Cypress Enterprises, 5415 Bellaire Blvd., Suite #120, Bellaire, TX. 77401

PM'S TIME MACHINE

75 YEARS AGO: January 1910



Holland's unique sled run.

Dutch treat

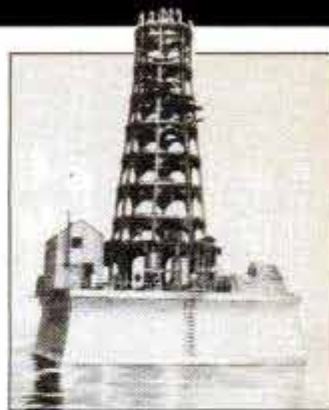
In 1910, we marvelled at the ice sleds of Friesland, Holland. The rider sat on the sled with its broad wooden runners and pushed along the ice with a pair of pikes. The Friesland winter festival still features the sleds.

Air to air

This month 75 years ago, we reported tests firing light artillery from an airplane to shoot a balloon target. Within a year, America was placing special cannons on military airplanes.

New lighthouses

America's first steel lighthouse was under construction off Mackinac Island, Mich. The \$250,000, eight-story, 200-ton tower was also the first with an aluminum-clad lantern and lantern deck. It was also one of the last of its type built. Open construction invited wind damage to the tower.

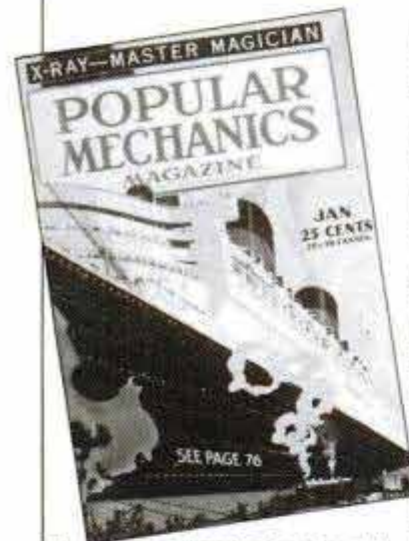


Wright brother takes stall dive

Wilbur Wright turned off the engine of his biplane while flying 150 feet above College Park, Md. With this feat,

he successfully demonstrated that a plane could remain airborne after experiencing an engine stall.

50 YEARS AGO: January 1935



The Queen Mary is about to sail.

Hail to the Queen

Fifty years ago this month, the *Queen Mary* was undergoing final fitting at John Brown's shipyard in England before launching into the Atlantic for her maiden voyage to New York. The 73,000-ton aquatic colossus was powered by four engines to cruise at 35 miles per hour under more than 200,000 hp. The *Queen* saw 32 years of transatlantic service, and her popularity and profitability as a shipshape means of bridging the continents gave rise to a seagoing sister, *Queen Elizabeth*.

Lifesaving gun

California race car driver C.R. Klein invented an air-powered harpoon gun that could fire a lifeline from a rescue vessel to a troubled boat. The Klein line is still in use today.



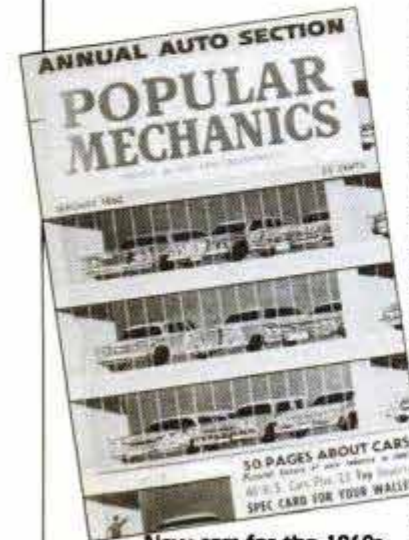
Sun power

Is there anything new under the sun? In 1935, we told of a miniature motor that runs on electricity generated by sunlight. The only problem was the inability to store energy. That remains a problem with solar power.

Backing up

A British inventor introduced backup lighting for a car. Shift the auto into reverse and a light went on with the word "reversing" on its lens. The wording was dropped, but we still have backup lights.

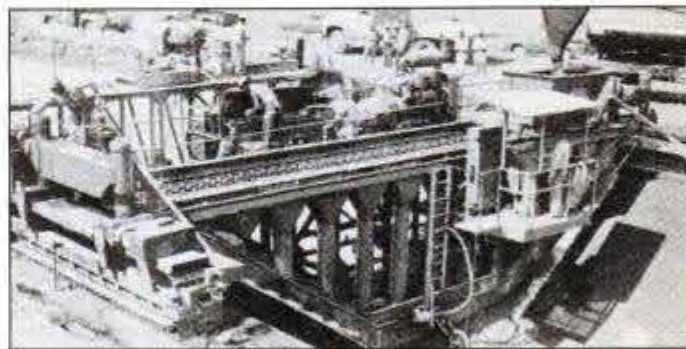
25 YEARS AGO: January 1960



New cars for the 1960s.

Cars for a hot decade

The 1960s were upon us and *Popular Mechanics*, in marking the vitality of the auto industry, noted that "Corvair long will be remembered as the most revolutionary car to hit the American automotive scene." But before the decade was over, Ralph Nader would draw attention to the Corvair's poor safety record and Americans would stop buying it. We also showed Ford's Falcon and new DeSotos—both of which were taken off the market by the close of the decade.



Huge machine practically builds canal itself

To cut, grade and spread concrete for building irrigation canals, a new electronic digging machine was intro-

duced. The 5-ton rig was easy to transport and operate and is still in service today in the Southwest. **PM**

Have another year on us.

One year in America and we knew.

Our Yamaha outboards were performing so reliably, our warranty claims were so low, we knew we could double the limited warranty on our recreational outboard motors.

Good for us and good for you. And the best thing about our new warranty is you'll probably never need it. For more than 20 years, Yamaha outboards have been confronting the world's worst waters. Often running on inferior fuels. Often in areas where routine service isn't routine at all.

What we learned in over 140 countries was applied to the

outboards we specially designed for American boaters.

For instance, all Yamahas go through a five-stage



painting process to guard against corrosion and wear. From the 9.9 hp model to the mighty V-6 Special, we put additional zinc anodes in the water jacket of the engine. Corrosion attacks these replaceable anodes instead of vital engine parts.

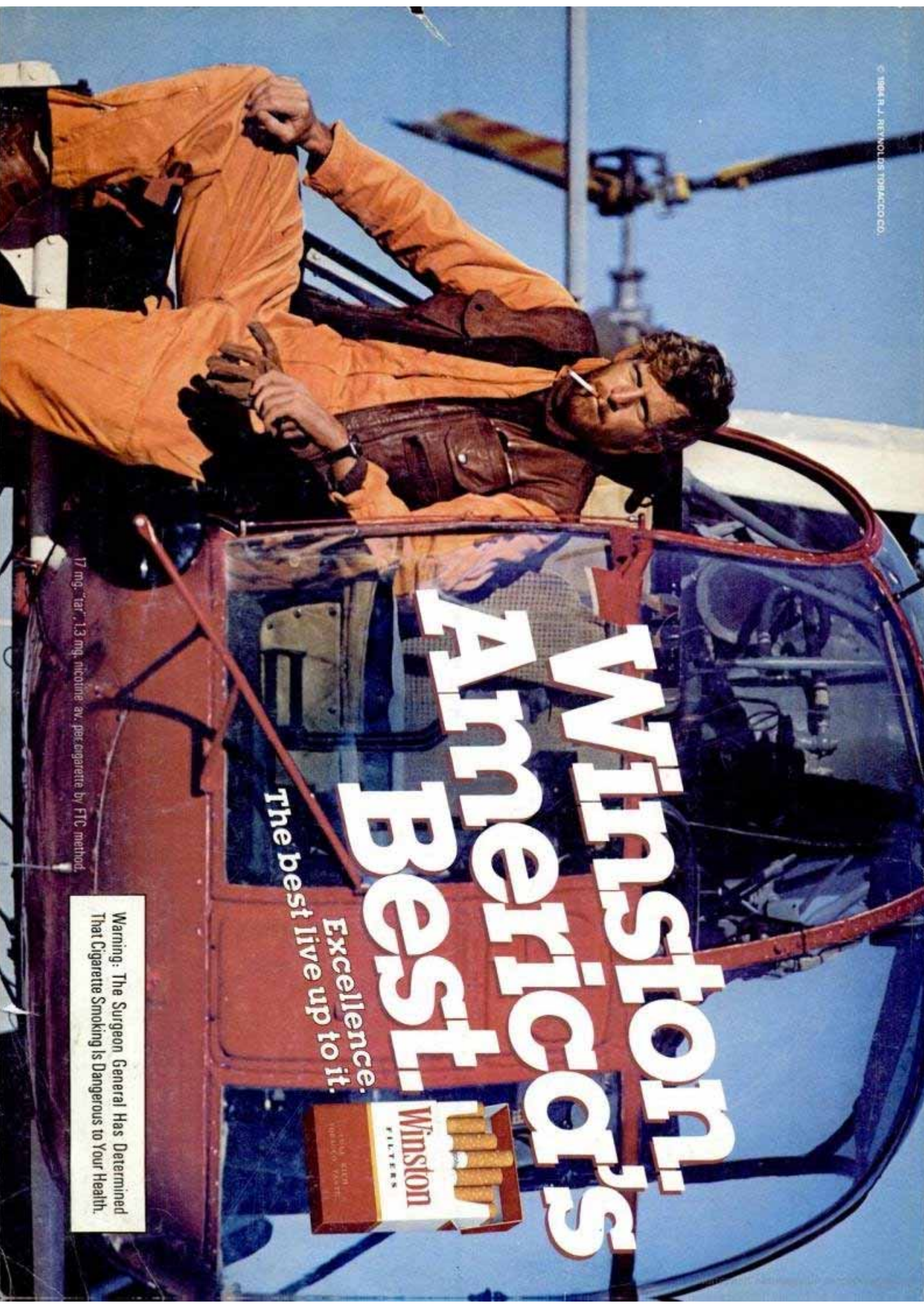
You get the idea. Quite simply, we can offer twice the warranty because we offer twice the motor.

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The best live up to it.



17 mg. "tar", 1.3 mg. nicotine av. per cigarette by FTC method.

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