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new turbo bike

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19 PAGES

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m toolb
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od joinery



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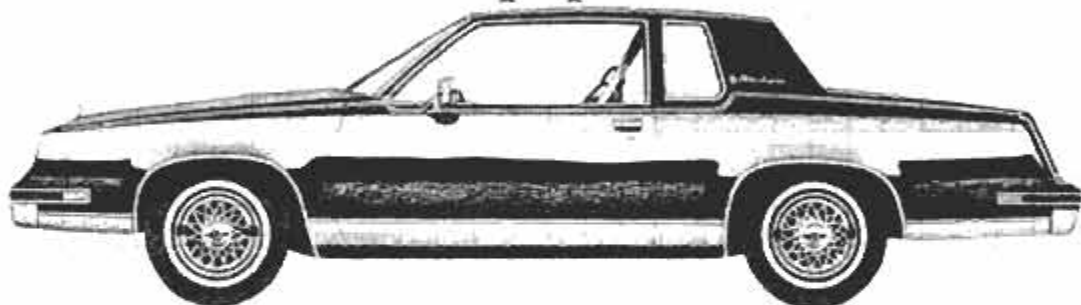
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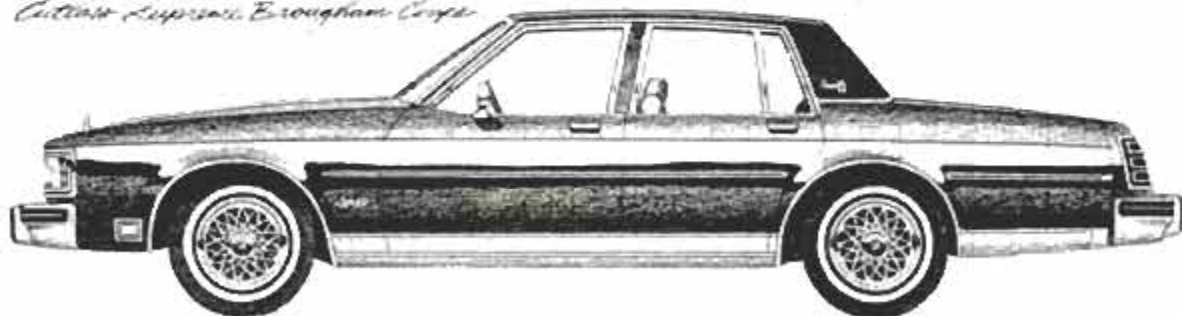
Rockwell
International

where science gets down to business.

Diesels. How did Oldsmobile make them so popular? They put them in popular cars.



Cutlass Supreme Brougham Coupe



Delta 88 Royale Brougham Sedan

In 1977, Oldsmobile made an innovative move. They introduced the first American cars with available diesel V8 power. Now, with over 387,000 diesel Oldsmobiles on the road, Oldsmobile is the number one seller of diesels in America, and diesel Oldsmobile popularity keeps growing.

A new diesel V6 for 1982. The number of diesel engines available in Oldsmobiles is growing, too. In addition to the diesel V8, a new diesel V6 is now available for 1982 Cutlass Supreme Coupe and Sedan models to offer a great combination of high mileage and high style.

Altogether, more diesel-powered Oldsmobiles will be sold in the next year than in any year in the past. But, it isn't just because there will be so many diesel Oldsmobile models to choose from. Or even because of the impressive diesel engineering

advances, like the Fast-Start Glow Plug System, roller hydraulic lifters and the inherent smoothness of the V-type design.

It's because diesel Oldsmobiles offer some very basic and important things people want.

Impressive fuel economy.

Diesel Oldsmobiles offer comparable fuel economy to that of many smaller cars and a cruising range few can match. All on diesel fuel which is traditionally less expensive than unleaded gasoline.

Added value at resale.

While it may vary by geographic location, many used car guides indicate that current resale prices, averaged out, show a substantial recovery of the original cost of the diesel option.

Room. Comfort. And style.

We could get more technical. But let's face it. What really counts:

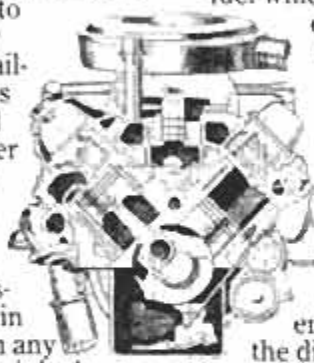
what a diesel does. Not what it is. And what a diesel does in an Oldsmobile is to give you roomy, comfortable and stylish alternatives to the proposition of making very practical choices. So that even today, there's still room to do it with style.



Diesel mileage estimates.

MODELS	Fuel Tank Cap.	Est. Hwy. Range	Est. Hwy. Range	EPA Est. MPG	Est. Range
Cutlass Supreme (V6)	19.8	36	712	25	495
Cutlass Supreme (V8)	19.8	34	673	23	455
Cutlass Cruiser (V8)	18.2	34	618	23	418
Delta 88 (V8)	26.0	34	884	23	598
Ninety-Eight (V8)	26.0	33	858	22	572
Custom Cruiser (V8)	22.0	33	726	22	484
Toronado (V8)	22.8	36	820	21	478

Use estimated mpg for comparison. Your mileage and range may differ depending on speed, distance, weather. Actual highway mileage and range lower. Range estimates are obtained by multiplying EPA estimates by the standard fuel tank capacity rating. Some estimates lower in Calif. Some Oldsmobiles are equipped with engines produced by other GM divisions, subsidiaries or affiliated companies worldwide. See your dealer for details. Oldsmobile rates. See your



V6-Lite Diesel V8

America's number



el cars.



Come to
**Marlboro
Country.**



Famous Marlboro Red
and Marlboro Lights—
either way you get a lot to like.



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

Lights: 11 mg "tar," 0.8 mg nicotine—Kings: 16 mg "tar,"
1.1 mg nicotine av. per cigarette. FTC Report Mar 81



On the cover

This classic European workbench—the dream of any serious woodworker—was handcrafted in the PM shop by Rosario Capotosto from a design by Woodcraft Supply Corp. The antique toolbox reproductions were created by Harry Wicks. Complete plans begin on page 126 in this issue.

—PM photo by Dick Frank
—Eagle pattern by Constantine's

Popular[®] Mechanics

NOVEMBER 1981

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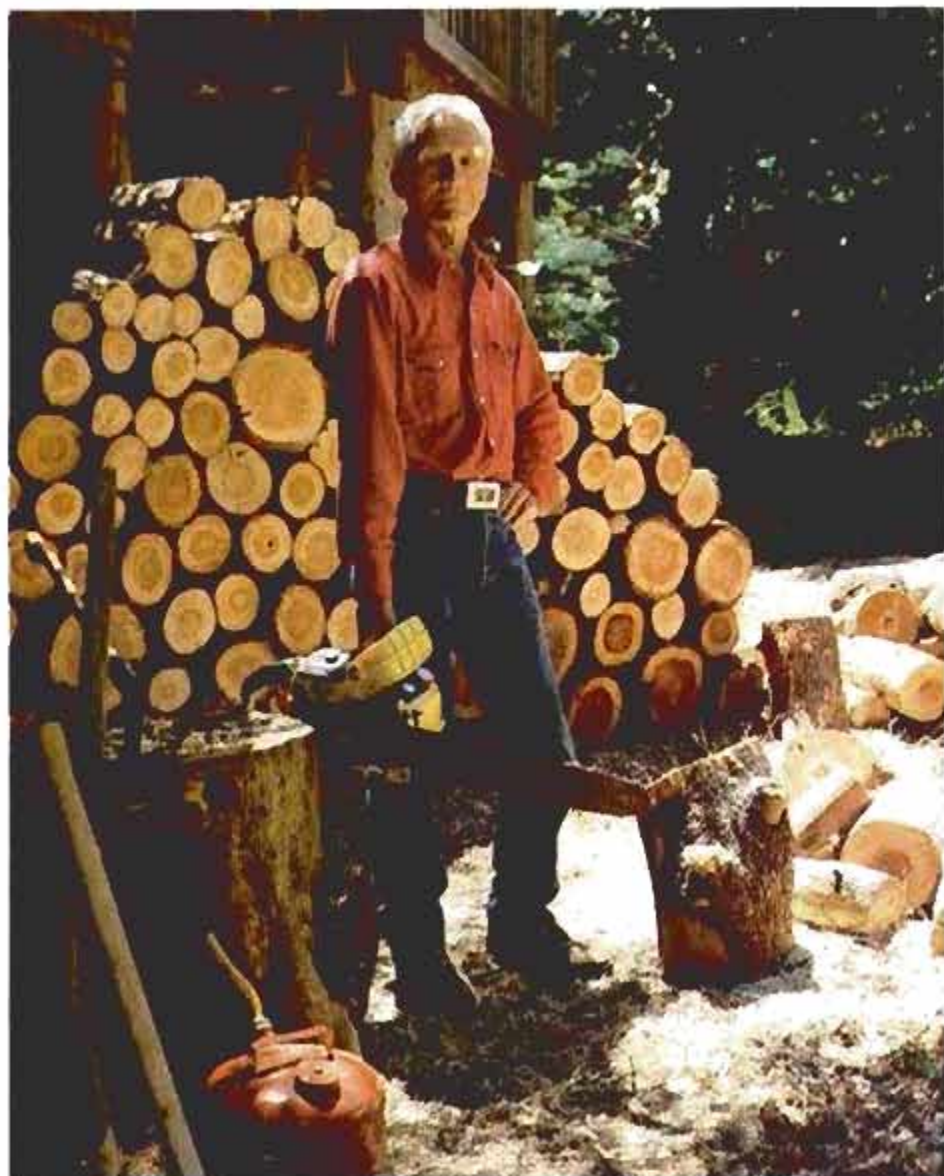
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Every once in a while, the boss hires some kid who thinks he can cut wood faster than I can.

It doesn't really matter how big or how tough he is, it always ends up the same way.

The kid comes over here with a big chip on his shoulder. We head over to the wood pile. He grins. I smile and start up my John Deere Chain Saw.

By the end of the day, I have more wood cut than he does. But I can't take all of the credit. This John Deere Chain Saw runs so smooth and cuts so easily, it feels like part of my arm after a while.

So I just keep on cutting and cutting.

And when the kid's beat and feeling a little low, I walk over and give him a pat on the back and say, "You're a real good woodcutter, kid. But a John Deere Chain Saw could make you a better man."

Someone's got to teach these kids a lesson.



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TOO MANY LAY DOWN ON



SPLIT SOLE

Construction Worker—Chicago, Illinois

CRACKED LEATHER

Gas Station Owner—Troy, New York

WATER DAMAGE

Mailman—Des Moines, Iowa

If you spend a good part of your day working in a pair of boots, obviously, you depend a lot on them.

Unfortunately, though, most boots don't deliver.

Their problems run from shoddy and uncomfortable construction on the one foot, to no waterproofing and no insulation on the other.

At Timberland®, we make what we think are the best work boots around.

Here's why:

**YOU HAVE TO WORK IN RAIN AND SNOW.
SO DO OUR BOOTS.**

If there's one time people who save a few dollars on a pair of boots really pay the price, it's when it rains or snows. Because most boots won't keep you dry.

But it's in weather like this that Timberland boots really shine.

Our boots are made of silicone or oil-

impregnated waterproof leathers.

To resist rust, we use only solid brass eyelets. And because any needle hole is a potential water hole, we seal every seam with not just one coat of latex but two.

How dry will Timberland boots keep you?

Well, on a machine called a Maser Flex that tests waterproof leathers, Timberland leathers must withstand a minimum of 15,000 flexes, twice U.S. Military standards.

WE WON'T LEAVE YOU OUT IN THE COLD.

It's been estimated that on extremely cold days, you lose 80% of your body heat through the top of your head.

Yet, inevitably, your feet are always the first things to go.

To prevent the inevitable, your feet are surrounded with a layer of nitrogen filled closed cell insulation that'll keep your feet warm to temperatures well below zero.

WORK BOOTS THE JOB.

Our boots aren't just better insulated than most boots, they're better insulated than most houses.

OUR BOOTS ARE TOUGH ON THE JOB. NOT ON YOUR FEET.

One of the biggest qualifications a work boot must have is an ability to take punishment.

Timberland's stand up to whatever you dish out.

Thanks to little things like four rows of nylon stitching instead of cotton in all key stress points. And big things, like heavy-duty molded soles permanently bonded to the uppers so they can withstand a tremendous amount of abuse.

But there's a soft side to our boots as well.

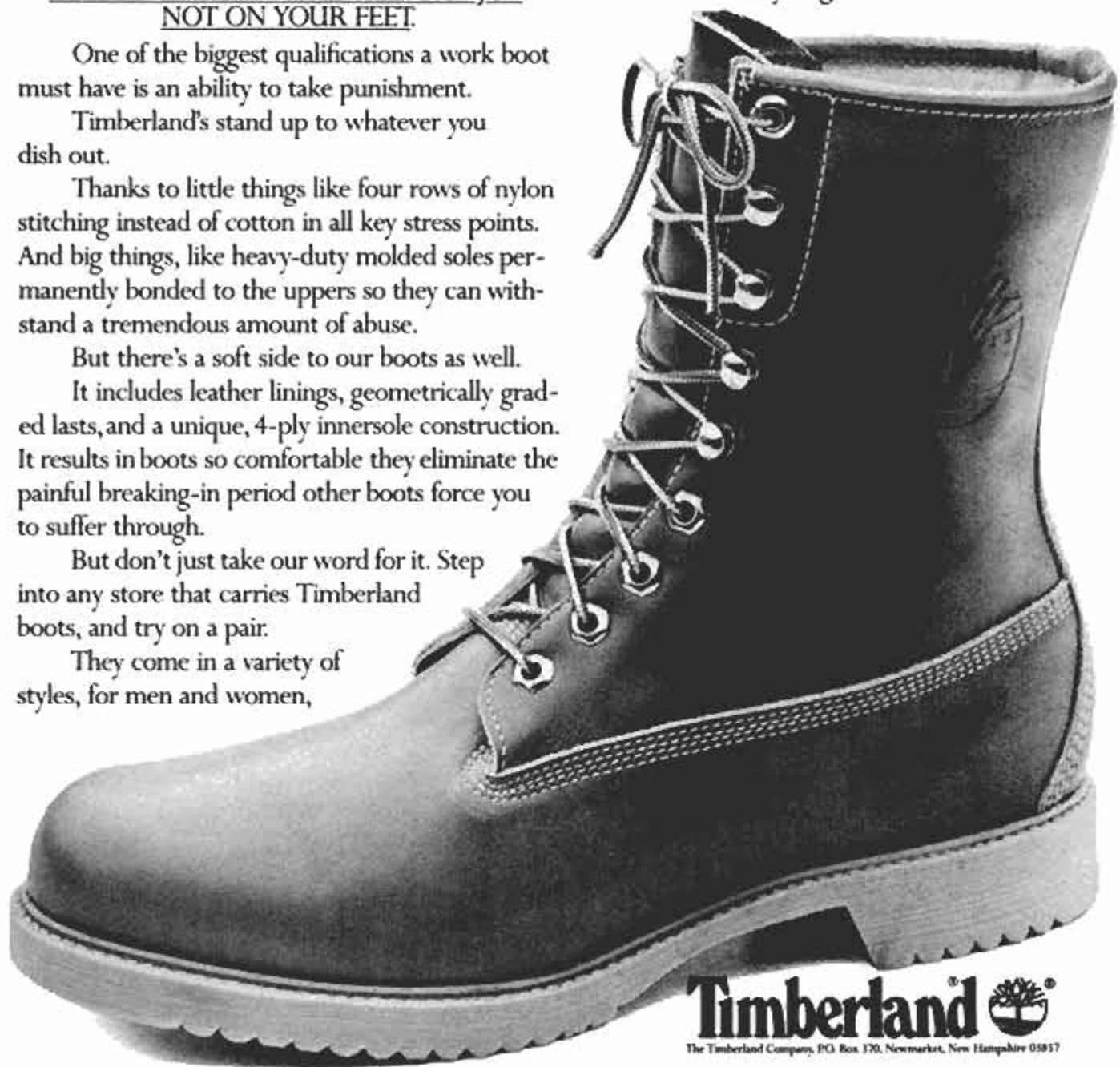
It includes leather linings, geometrically graded lasts, and a unique, 4-ply innersole construction. It results in boots so comfortable they eliminate the painful breaking-in period other boots force you to suffer through.

But don't just take our word for it. Step into any store that carries Timberland boots, and try on a pair.

They come in a variety of styles, for men and women,

starting at about \$60.00. Which, in all honesty, might be a few dollars more than you now spend.

But we think you'll find it's worth spending a little more money to get a lot more boot.



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LETTERS TO THE EDITOR

Where are the cops?

As a police officer, I was disturbed by Wade Hoyt's article *Oh, to Be a Traffic Cop for a Day!* (page 96, Sept. '81). Hoyt's pet peeves that he'd give traffic tickets for are precisely the things I give tickets for.

Everyone believes that the nerd pulling those stupid, reckless maneuvers should get a ticket—or maybe the death penalty—but when he himself gets caught, he thinks he should get off with a warning or nothing. I got the impression that Hoyt is just a little bit anticop. He should know there are many of us out here who really do care.

TIM D. JACKSON
FORT MORGAN, COLO.

I'm a police dispatcher and I agree wholeheartedly with every statement you made. Many times, while off duty, I've seen the violators you described and have said to myself, "Where are the cops when we need them?"

TIM FISCHER
JEFFERSON POLICE DEPT.
JEFFERSON, WIS.

As a driver-ed instructor, I couldn't agree with you more.

DALE WUNSCH
PENNDL, PA.

PM has received a staggering volume of mail as a result of this article. Comments from our readers will form the basis for a follow-up feature in a future issue. Meanwhile, we can assure law-enforcement officers that we're aware of their problems and know that most are doing a fine job. Author Hoyt was calling attention to the seemingly many violators who go unpunished, not because police aren't doing their duty, but because there aren't enough to be everywhere at once.

What goes up . . .

I enjoyed your greatly informative article on the Alternate Aircraft Takeoff System (*Airborne From the Ground Up*, page 92, Sept. '81). But I have one question: After the fighters are launched from those bombed-out runways, how do they get back down? They'll have to run out of fuel some time.

CHARLES M CRITTI
CHATTANOOGA, TENN.

Good question. In a national emer-

gency, first priority would have to be given to getting our fighters airborne, but this doesn't mean they would be considered expendable. Because an enemy would concentrate on military air bases, returning aircraft would have a wide choice of other airfields, including civilian airports, that probably would have escaped attack.

PM's table goes on TV

On ABC's *Good Morning, America* TV show, they showed a beautiful folding picnic table—just what my family needs! They mentioned that plans for building the table were available from PM, but I missed the details. How can I get them?

MARY CONOVER
CHICAGO

A number of TV viewers have asked about the table. Complete plans for making this unusual stowaway design are \$4.70 postpaid from Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101 (request plan No. PL-1716).

A frisky horse, but fun

When our granddaughter was about to become a year old, we found a challenging project: your wooden hobby horse (*12 Gifts You Can Make*



PM's hobby horse, with "Grandpa" Hefter, its builder, and a young and happy rider.

and Give, page 122, Nov. '79). I'm enclosing a photo (above).

The plans were excellent, but we did find one fault: The horse rocks beautifully, but sometimes tips sideways. I added a footrest.

SY HEFTER
WILKES-BARRE, PA.

Glad you like it. Actually, the horse was designed for a somewhat older child, whose feet would reach the

floor. This would prevent it from tipping. That's why no footrest was included on the original.

Artistic computers

Your article *New Computer Animation Fools the Eye* (page 76, Aug. '81) was tremendously interesting and entertaining. I was fascinated to find out how those unbelievably real scenes are produced.

RICHARD H. ANDERSON
EL PASO, TEX.

More on 'unsafe' motors

I read with interest the letter in your July '81 issue (*Letters*, page 10) warning against the use of "unsafe" shop motors having thermal-overload cutouts. I agree that a thermal overload could cause an accident if the operator weren't smart enough to turn off the switch when the motor stopped. But I believe anyone operating shop tools would have this much intelligence.

I've equipped many of my tools with appliance motors so I could have a choice of two or three speeds—with no problems.

GEORGE W. HOCKADAY
SCHENECTADY, N.Y.

We know PM readers are intelligent; what we can't assume is that all are equally well informed. In the interest of making sure that everyone is aware of the possible hazard, we felt it important to publish the reminder.

Ragtop mixup

Your story on convertibles (*Hardtops to Ragtops: The Rebirth of the Convertible*, page 70, July '81) contained two errors. First, the Mercedes shown is not a 300SD, but a 300CD. The 300SD is a four-door sedan; the 300CD is a coupe.

Second, the POE price of the 300SD in July was not \$43,000, but \$34,185. The 300CD's price was \$29,231.

A. B. SHUMAN
MERCEDES-BENZ
OF NORTH AMERICA INC.
MONTVALE, N.J.

We know the Mercedes isn't cheap, but we shouldn't have made it more expensive than it really is. For more on this fine luxury car, see next month's issue for a firsthand driving report on the new 300D and 300CD turbodiesels.

PM



Get in on the PROFITS in SMALL ENGINE service and repair Start your own money



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46-million small engines are in service today!

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You don't need to be a 'born mechanic' or have prior experience. If you can read, you can master this profitable trade right at home, in your sparetime, without missing a single paycheck. Lessons are fully illustrated—so clear you can't go wrong.

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KEEP!**

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Miniature Mercedes

Small and elegant Mercedes would prove popular with car buyers who want to drive the best.



This from the long-wheelbase specialists? Our spy photographer was maintaining his watch on the Rhine when it came by in a caravan. With no three-pointed star and the rear lopped clean off, the truncated hatchback was hard to identify as a Mercedes, but come from Stuttgart it does. We've learned that it won't be tested on the public at any European auto shows and it's not sched-

uled for production, but it is evidence that Mercedes is thinking small. With the current trend—small, economical cars selling fully loaded at prices in the \$10,000 range—we'd say there's definitely a market for an impeccably crafted little jewel, with Mercedes engineering, leather seats, high-quality finish and all the extras—yes, even if it would have to sell for \$20,000.

New BMW 528

Under the hood of a new BMW 5-series in Europe you'll find any one of four different engines. They range from 90 to 184 hp and establish the pecking order on the *Autobahn*—about 100 mph with the small engine, 130 with the biggest one. Here, even if you ride the fast track, you can't express it by driving faster than everyone else. So, when we get the new \$24,000 U.S. version it'll be offered with one engine only: a 2.7-liter Six—an electronically controlled powerplant, BMW's so-called



New BMW 528: Subtle changes cut drag.

ETA engine—that'll sacrifice top speed for a torquey bottom end and improved mpg. More when we drive it.

S-class coupe

Sorting out Mercedes-Benz models has become a rite of spring—or fall—for PM.

For 1982, Mercedes succeeds its 380SLC coupe with an S-class version, the 380SEC. The designation number stays the same since the strong and smooth 3.8-liter, aluminum V8—introduced just last

year—also beats in the new body. We'll drive this one soon.

We've already had a turn at the wheels of the 300D sedan and 300CD coupe, both of which are essentially the same except that their diesels are now turbocharged. Our test report will appear next month.

The 280E and 280CE six-cylinder, gas-engine cars are discontinued for '82, now that the 300D and 300CD are turbocharged: Mercedes buyers are very receptive to diesels and the turbodiesel Five provides fine performance and fuel economy.



New M-B coupe is designated 380SEC.

All in all, there are eight models for '82—down from 10 in '81—and they're sorted out in our chart. Memorize it and, however modest your means, you'll be able to stroll confidently into any Mercedes showroom and display such a familiarity with these expensive and world-famous motorcars that you'll get a test drive, or—at least—a brochure. **PM**

1982 MERCEDES-BENZ MODELS

Model	Type/passengers	Engine
Intermediate sedans and wagon (110.0-in. wheelbase)		
240D	sedan/5	2.4-liter diesel Four
300D	sedan/5	3.0-liter turbodiesel Five
300TD	wagon/5	3.0-liter turbodiesel Five
S-class sedan (115.6-in. wheelbase)		
300SD	sedan/5	3.0-liter turbodiesel Five
S-class sedan (121.1-in. wheelbase)		
380SEL	sedan/5	3.8-liter gas V8
Coupe (106.7-in. wheelbase)		
300CD	coupe/5	3.0-liter turbodiesel Five
Sports/grand touring cars (96.9 and 112.2-in. wheelbases, respectively)		
380SL	coupe/roadster/2	3.8-liter gas V8
380SEC	coupe/4	3.8-liter gas V8



Room under the hood could fit a Six.

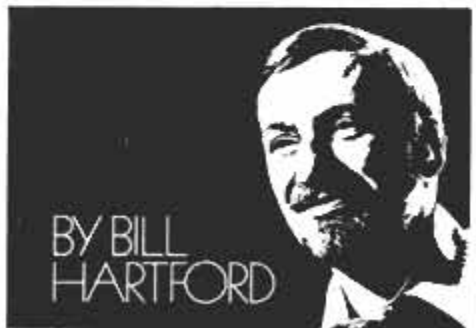
uled for production, but it is evidence that Mercedes is thinking small. With the current trend—small, economical cars selling fully loaded at prices in the \$10,000 range—we'd say there's definitely a market for an impeccably crafted little jewel, with Mercedes engineering, leather seats, high-quality finish and all the extras—yes, even if it would have to sell for \$20,000.

One-liter Honda

Okay, stop right there. I won't accept anything smaller, unless it's for cutting grass. This "down-sizing" has resulted in an Incredible Shrinking Car—a liter-bit of a thing



Honda microcar for '83 is 1500 pounds.



BY BILL HARTFORD



How to pick a pocket.

To prove a point, we stitched together half a pair of the best-selling jeans and half a pair of JCPenney Plain Pockets.

The point is, both feel great, fit great. They even look alike.

Till you look at the pockets. The best seller's have a little extra stitching. And that can cost you extra.

Plain Pockets only cost you \$13.50. Which pocket should you pick? It's as plain as the pocket on your pants.

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PM ELECTRONICS MONITOR

Better text processing

Many people—from famous authors to small businessmen—have been using their home computers as word processors. The latest word-processing program we've seen—called Wordstar—will really let an inexpensive home computer play in the same league as the big fellows.

The version of Wordstar we saw will run on an Apple II computer, if the computer is equipped with two accessories. The first accessory is an 80-column display board and the other is the new Z-80 "softcard" from Microsoft. The "softcard" is unique in that it turns the Apple's 6502 "brain" into a Z-80—which is needed to run Wordstar. Other variations of Wordstar will be able to run on computers such as the Radio Shack TRS-80.

Once set up, the program does absolutely everything that one of the much more expensive terminals will do.

One of the most likable features of Wordstar is its accessibility: It's a very friendly program to learn. As with all word processors, there are many special commands to master in order to do such things as delete lines or letters and move text to other areas of the document. To ease this process, Wordstar offers very detailed and complete on-screen "help menus."

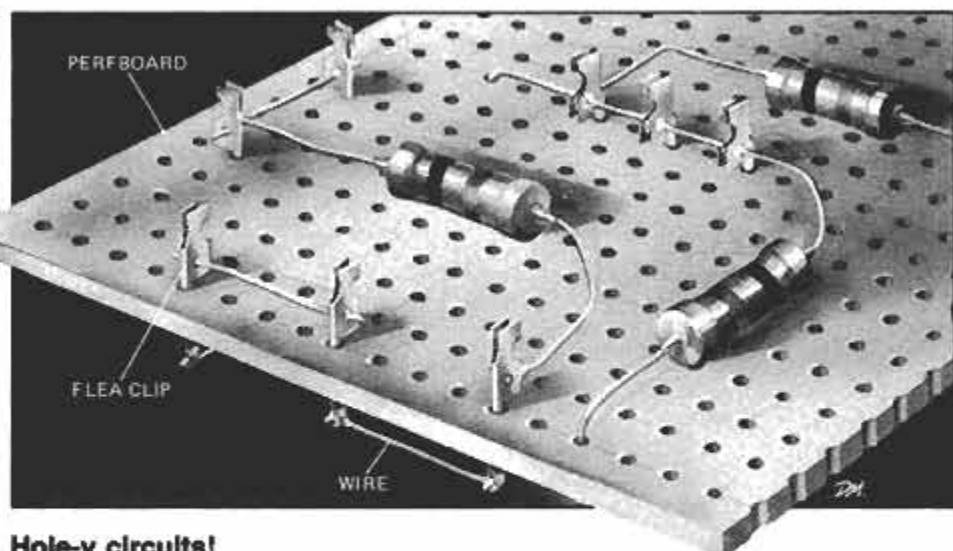
These unique menu name and describe every key function. It is possible to begin using Wordstar right away, with only a cursory glance at the all-inclusive manual. As you get more familiar with the program, you can cut down on the size of the help menus and leave more on-screen room to view text.

Wordstar is not cheap (it sells for around \$395). And, if you install it on an Apple II, you will have an additional hardware cost of around \$500. (Of course, this expense depends on which 80-column display you choose. We recommend the Videx Videoterm board.)

But if you want truly professional, bug-free word processing, in an office environment or home, we think Wordstar is worth it. No other program of equal complexity we've seen—in any area of computing—is as easy to learn and use.

A cell of an idea

Line up all your kid's toys. Now line up all the batteries that fit into them. In all likelihood, you've got a



Hole-y circuits!

If you have ever struggled to make a printed-circuit board, or tried to rework a prototype, point-to-point wired chassis, you've probably wished for a better way. Next time, use our own favorite construction method—flea clips and perfboard. Available under a variety of brand

names in any electronics store, the clips plug into the holes in the board. The clips hold wires and components just where you want them. You can get the entire circuit arranged to your own particular design before you start the soldering process.

lineup of D-cells, Cs, even double-As, facing you like so many tiny soldiers. But what do you do if you have only a handful of D-batteries and a toy takes AAs?

You may never again have to face such a terrible dilemma.

Enter the Super Battery System from Dynamic Instrument Corp. (Hauppauge, N.Y.). The Super Battery is basically a rechargeable double-A size (penlight) battery that fits into a series of cardboard sleeve holders.

Slip the Super Battery into a C-size sleeve, and it fits a C-size battery holder—and it works the same way with D-size. Or you can skip the sleeve and use the battery in a AA holder.

When we first heard about the concept, we thought it novel, but worried that a rechargeable double-A might not be able to withstand the same kind of usage required of a big D-cell.

But our own tests and information supplied by both the company and our own consultants, convinced us otherwise. The system does work. What sets the Super Battery apart from most double-A cells is the nature of its power output. Unlike conventional batteries, which get weaker and weaker before failing, a rechargeable battery reaches a weak point and then shuts down immediately, without generating (usually useless) very low power for a long time.

The system should be on sale at J.C. Penney stores by the time you read this. Advance information has the retail price set at around \$10 for two Super Batteries and four sleeves, and an additional \$10 for a charger. (Extra sleeves may be purchased separately.) We think these little wonders should catch on.

New secret frequencies

Readers of this column know that I'm a scanner enthusiast. And to all you other scanner buffs—here's some good news. The new, fourth edition of *The Top Secret Registry of U. S. Government Radio Frequencies* is out in an expanded, book-format version. A total of 50,000 frequencies are listed for everything from the military to the FBI to the White House. The volume is available by mail order for \$9.95 plus \$1 for first-class mail from CRB Research, Box 56, Commack, N.Y. 11725. **PM**



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NOTES FROM THE EDITOR

John A. Sillitto

Air travelers passing through Chicago's O'Hare terminal one recent Sunday morning perhaps wondered exactly where United's flight No. 5700 would wind up. On the departures and arrivals board, they saw FLIGHT 5700, DESTINATION: POPULAR MECHANICS.

Well, the 727 jet did not end up in our office. (Never on Sunday, we protested.) The jet and some 80 PM staff members and guests landed at Oshkosh, Wis., in the middle of a truly great aviation event.

It was the 29th annual Oshkosh Fly-In, an event that surpasses even the Indy 500 in attendance. (This year, more than 500,000 buffs came to view the magnificent flying machines at Wittman Field.)

As PM readers know, for the past nine years we've been publishing our pick of the homebuilt planes exhibited at the Fly-In. (For the record, the event is formally known as the Annual International EAA Convention and Sport Aviation Exhibition.) This year, PM's Shel Galager and photographer Howard Levy, our Fly-In reporting team, were probably a bit surprised to have an additional airplane load of staffers and guests appear on the Oshkosh scene.

We were particularly eager to have everyone see PM's own ultralight airplane—one that you can really build and fly (page 110)—on display at the Weedhopper of Utah exhibit. The idea of joining in this newest facet of sport aviation was too good to keep hidden.

Of course, ultralight plane or not, the Oshkosh show makes any aviation fan feel like a kid in a candy store. We've never seen such an assemblage of airworthy planes before—some 10,000 in all. There were the Cessnas, Pipers and the like flown in by families who camped out all week alongside their craft. And there were hundreds of homebuilts on display... and ultralights... and rotor craft... and a couple of the Navy's formidable F-14s... and a spine-tingling array of World War II fighters and bombers—all flying!

Some show! we say to Paul and Tom Poberezny, respectively founder and show chairman. We'll see you next year—in our own homebuilt ultralight.



United Airlines President Percy Wood (right) joined PM's flight. That's publisher Dan Coleman at the left.



Paul Poberezny and son Tom (photo, left), creators of the Oshkosh Fly-In, are shown addressing PM's 80 guests at lunch. At right: our arrival in Oshkosh.

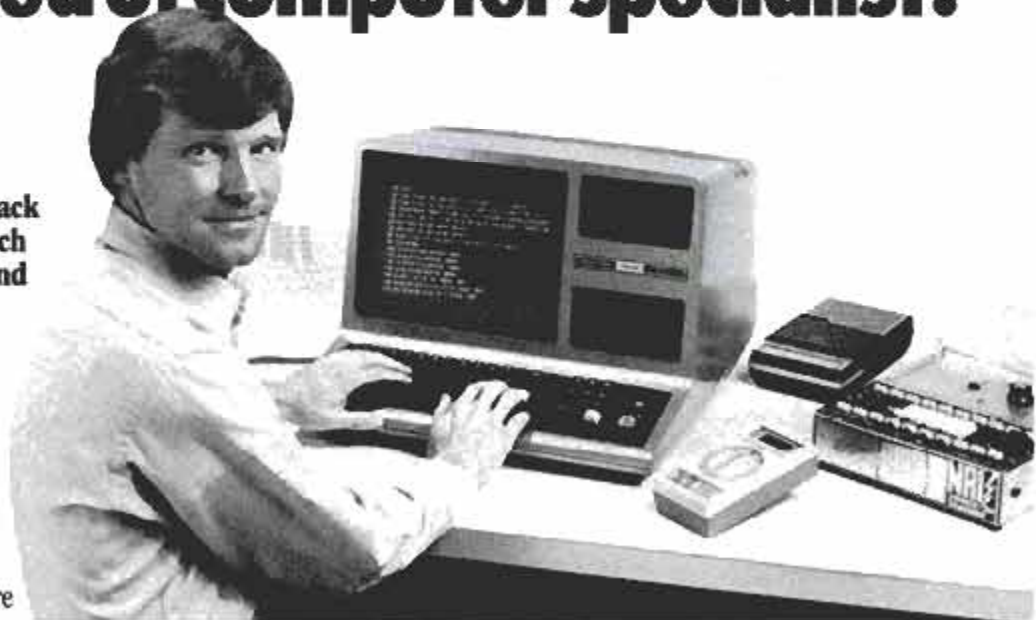
Now NRI takes you inside the new TRS-80 Model III microcomputer to train you at home as the new breed of computer specialist!

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and gain greater understanding of the information. Both microcomputer and equipment come as part of your training for you to use and keep.

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(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)

ALL OUTDOORS

Knotty questions

You drive or hike, pedal, cruise or fly hundreds of miles to cast for that special trophy fish. And then, even though you're lucky or skillful enough to hook it, if the fish is extra big and strong, chances are it will break off and be gone forever.

Weakest link in the reel-rod-line-lure connection between you and your world-record catch—or any other fish—is likely to be the knot you've used to tie the hook to the fishing line. Every year, hundreds of thousands of fish run off with favorite and expensive lures, while anglers reel in lines with nothing at the end. Often, you'll find signs that the line untied or broke off at the knot.

Laboratory machines can stretch line to its rated test strength to find how well various knots will hold. Some knots are nearly as strong as the line, while others unravel or cut through the line almost at once. A good reference book is *Practical Fishing Knots* by Mark Sosin and Lefty Kreh, available in hard-cover and paperback.

The ideal fishhook knot should be as strong as the line it's tied in, simple and easy to tie, and equally useful for light and heavy line. According to technicians at Du Pont Stren fishing line, the best all-purpose knots they've tested are the improved clinch knot and the Palomar (see *Best Knots for the New Fishing Lines*, page 178, June '80).

But there may be better ones, and Stren is putting up a \$2,500 prize to find them. The contest is simple. Describe your special, all-purpose, easy-to-tie fishing knot—one that's new or hasn't been published in any outdoor books, magazines or newspapers.

Send in directions and diagrams of how to tie it, plus 10 sample knots in a 20-inch length of line. Use a swivel for terminal tackle knots.

Entry blanks will be available at tackle shows, but they aren't required. Send entries to the Great Knot Search, Du Pont Stren Fishing Line, Room X38879, Wilmington, Del. 19898. Deadline is June 1, 1982. Among the judges are experts Homer Circle, Mark Sosin, Lefty Kreh and Jerry Gibbs.

Water landmark

Earlier this year, a 1909 device first called a "detachable rowboat motor" received the added name of "nation-



From cruiser with 235-hp, OMC chairman Evinrude and Pres. Strang view 1909 landmark.

al historic mechanical engineering landmark" from the American Society of Mechanical Engineers (ASME). This original Evinrude outboard became the first consumer product to receive the designation. Ole Evinrude's invention was not the earliest outboard, but it was the first to be mass-produced successfully and it eventually started a new recreation industry.

According to legend, Ole and his girl friend, Bess, were at a picnic at Lake Okauchee, west of Milwaukee, in 1906, when Ole volunteered to row a couple miles up the lake to get ice cream. By the time he got back, the ice cream had melted and he was determined to invent a replacement for oars. The next year, shortly after he and Bess were married, he completed his outboard-motor prototype. The invention ran so successfully that Bess insisted he put it into production. She wrote an ad: "Don't row! Throw the oars away! Use an Evinrude Motor." Orders poured in and a new business was created.

Fittingly, the ASME award was presented on the shores of Lake Okauchee to Ole's son, Ralph, chairman of the Evinrude and Johnson parent company, Outboard Marine. In the past, the mechanical-landmark award has gone to innovative steel mills and cog railways, rockets, subways and powerplants, but never to an invention designed primarily to increase outdoor enjoyment.

Checklist for the field

Surveys show that most people are not interested in learning more about safety. But statistics show they may not know enough. While gun mishaps are far down on the list of accidents that occur, even one is too many. During fall hunting season, both shooters and hikers should review precautions.

■ Know the range of guns. Even a

.22 can travel over a mile, so the sound of shooting in the distance means you should proceed with caution.

■ Don't consider a gun safe simply because the safety is on.

■ Never drive, cross a fence, climb or jump with a loaded gun.

■ Use safety glasses and hearing protection.

■ Always point a gun in a safe direction and stay away from any shooter who waves his muzzle around carelessly.

■ Carry handguns with hammer uncocked and down on an empty chamber.

■ Load only when ready to shoot.

■ Never fire unless you are absolutely sure of your target and everything behind it.

■ When they're not in use, keep all guns unloaded and locked up.

Good news for shooters is that the famous Winchester rifles and shotguns will not disappear or adopt another name. A new company, U.S. Repeating Arms, will continue making the guns in New Haven, Conn., under license from the Olin Corp.

Where it's at

Want to build a boat, log splitter, camper, or one of 900 other projects? Send \$1 for the new *Plans and Ideas* catalog to Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101.

PM



PHOTO HINTS

Taming temperature



Ice cubes in 11 x 14-in. tray keep developer in an 8 x 10-in. tray set atop them cool in hot weather.

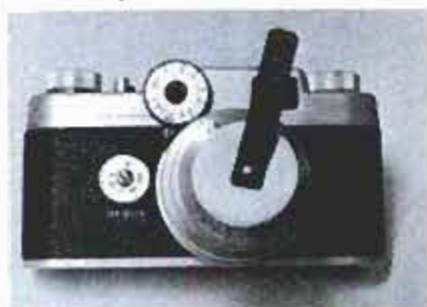
—Robert Hertzberg

Back to spool



If you have a darkroom stool and often misplace your towel, attach an empty thread spool to stool back as hanger.—A. Weber

Lens-cap alert



SLR owners can see if their lens cap is on, but rangefinder users can't. Attach a thin, flexible plastic strip to front of rangefinder camera's lens cap. Use a fine screw and glue. Make sure plastic is long enough to intersect viewfinder's view.—A. Weber



Turn down your thermostat. Turn up the Turco.

Take a moment to think about all those high heating bills you had last year. Then take a moment to think about this.

A Turco Portable Kerosene Heater lets you turn down your thermostat, and still have plenty of heat right where you want it, for just pennies an hour. And, it can keep an entire room heated for up to 18 hours on just one tank of kerosene.

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Under the limited warranty, Turco will replace or repair any parts that fail due to defects in material and workmanship for a period of one year from date of purchase, except for normal wear and tear items.



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In other words, when Sid Caesar wants to be entertained, he does what millions of people do. He curls up with a good book.

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Because we publish countless books. Best sellers in hard cover from Arbor House and William Morrow & Company. Paperbacks from Avon. And decorating, cooking, boating and do-it-yourself books from Hearst Books.

But Hearst is a total communications company. We also publish 13 newspapers, coast to coast. From the San Francisco Examiner to Albany's Times Union and The Knickerbocker News.

We publish 20 magazines like Cosmopolitan and Good Housekeeping. We're in business publications. And we distribute magazines in 30 countries, in 8 languages.



Sid Caesar, star of stage, screen and television, entertains himself with a good book. Taken from one of our current TV commercials.

We operate 3 television stations and 7 radio stations in major markets like Baltimore, Pittsburgh and Milwaukee. We're even launching cable TV networks.

King Features, home of "Popeye" and "Blondie," is Hearst too. And that's not to mention other industries we're involved in. Like forest products, ranching and real estate.

But basically, if you can read it, watch it or hear it, chances are Hearst is involved in it.

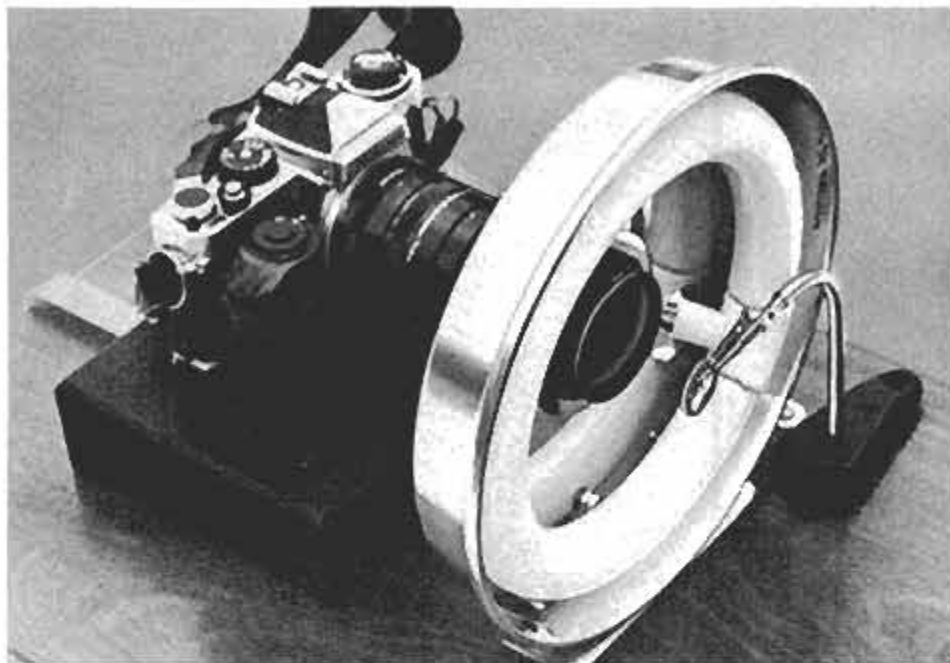
We inform you, entertain you, challenge you.

We give Sid, and millions of people, the chance to read about everything from Julius Caesar to Caesar Salad.

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Build this light for close-up photos

Illuminating the subject properly is a challenge to any photographer. This macro-light will help to make that job easier.

Thanks to a new, cool-running, ring-shaped halo bulb, it's now easy to build your own close-up macro-light like this one. Construction should take you only one or two evenings.

by Ray Hendrickson

Illuminating small subjects that crowd your lens poses a gadget bag full of problems. Although an expensive ring strobe serves to put the image on film, trying to judge the actual lighting effects and depth of field prior to shutter release

leaves considerable room for error. Happily, enjoyment came on the market about a year ago. It's a small, circular fluorescent bulb sold as a replacement for incandescent lamps; it screws directly into a standard light socket. This 22-watt, cool

halo, equivalent to a standard 100-watt bulb, is easily adaptable to macro-photography.

The fixture you'll need is called the Energy Saver Adapter; it comes complete with a molded-plastic ballast module and integral screw-type

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Poulan

Send Poulan/Wheel Eater Division, Emerson Electric Co., Stowport, PA

To receive your free 16" chain return this coupon along with the original bill of sale with purchase price of your Poulan chain saw circled plus the original warranty card found in the carton of your Poulan chain saw. This coupon, sales slip, and warranty card from each product may not be mechanically reproduced and are not transferable. Good only in U.S.A. and Canada. Void where prohibited by law. Limit one chain per purchase of one Poulan chain saw with 16 inch bar length. Rebate requests that are illegal or that contain materials altered in any way are automatically void. Saw must be purchased between September 15 and December 31, 1981. Your request for the free chain must be postmarked no later than December 31, 1981. Please allow 6 weeks for delivery. RETURN TO: POULAN P.O. BOX 725, DEPT. P, LUBBOCK, TEXAS 79401

Name _____

Poulan Model No. _____

Address _____

City _____
PM

State _____

Zip _____

FREE CHAIN OFFER

*suggested retail price

Get an extra \$23 chain FREE.

base. The circular bulb is held to the module with a simple spring clip, and the bulb, like its larger ancestors, is connected to the ballast pigtail with a plug.

First steps

Begin by unplugging and removing the bulb from the clip. Cut away and discard the formed portions of the spring clip, leaving $\frac{1}{8}$ in. projecting from each side of the ballast module. Drill a $\frac{1}{32}$ -in. hole in each remaining lug and dress the edges with snips and file.

Start the reflector by laying out all holes on a $9 \times 1\frac{1}{2}$ -in. cake pan before cutting. Locate the pan's center with a combination square, or by drawing two or three intersecting diameters. The two large holes can be fly-cut with the pan firmly clamped in a drill press. Alternatively, they may be cut out with snips, followed by lightly hammering the resultant ripples over a wood block to flatten them.

Shape the reflector support, round the corners if desired, and match-drill the three $\frac{1}{8}$ -in. holes common to the reflector, but don't rivet. Fastening will be done after you use the support to locate matching screw holes in the platform.

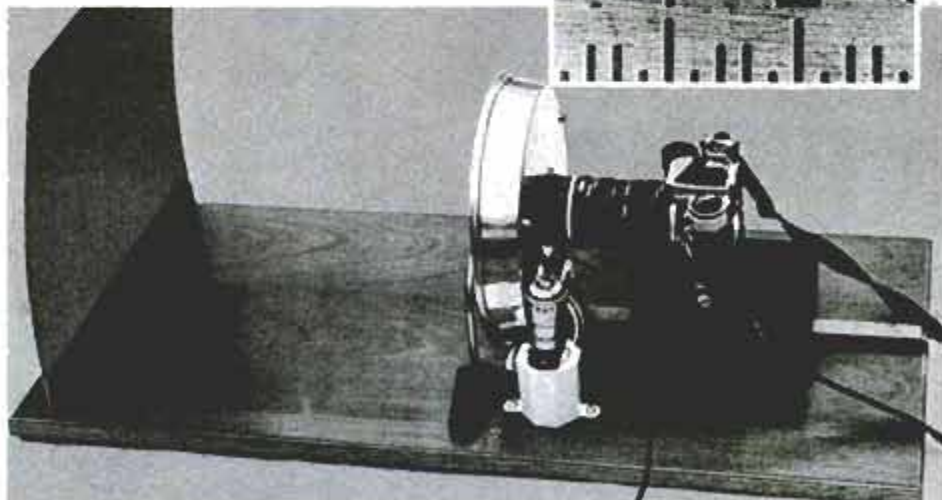
Make the platform from $\frac{1}{4}$ -in. plywood, preferably lumber-core, to assure flatness. Machine the track groove with a router or dado head. Either way, the blind end will be hidden under the reflector support. Cut the track bar from hardwood and glue it in place. Five-minute epoxy is a good choice, as you'll be using it for

several additional assembly details.

The lower angle for the background support is screwed directly to the platform with countersunk fasteners, and will remain fixed. The upper angle is slotted to permit clamping the background panel. Although $\frac{1}{16}$ in. approximates the usu-

(Please turn to page 68)

You can change the color of your background by sliding colored cards into holders at end of the macro-light's platform (below). Using this setup results in very detailed close-ups (inset) enhanced by perfect illumination technique.



Gas Saver Tested & Patented

DENVER—The Copley News Service reported that United States Patents have now been issued to Wm. Trevaskis, California veteran electrical engineer, for his Vapor-Jet® brand water vapor injector.

Trevaskis has developed what amounts to a 20 cents per gallon "rebate" potential on gasoline, by designing a low-cost injector for automobiles, light trucks, vans and recreational vehicles.

The Vapor-Jet® system has test results showing miles per gallon improvement of 17.3 per cent on Trevaskis' 1971 Ford Galaxy and 13.3 per cent on his 1973 Olds Starfire.

Water injectors were developed to a highly refined state during World War II, to give combat planes increased speed and extended range. However, up to now, the low price of gas and the high cost and extremely difficult installation required for earlier injectors combined to make them unattractive.

The Vapor-Jet® has an unconditional 60 day guarantee.

How does the Vapor-Jet® system work?

Vapor-Jet® operates very simply with no moving parts to wear out. It uses engine vacuum to pull outside air through a reservoir containing a water/methanol mixture which is attached to the car under the hood. This causes the fluid to bubble and a mist to form in the upper part of the reservoir. This mist is then drawn by vacuum through a hose which is connected to any intake manifold suction hose. This connection is made very simply by our exclusive hypodermic-like injector nozzle which contains a regulator to allow just the right amount of mist to pass into the combustion chamber.

The introduction of this mist into the fuel air mixture has a cooling effect that increases the mixture density, extends the burning rate, and improves combustion efficiency. This eliminates ping (predetonation) and dieseling (after running of motor). Since steam is a good cleaner it also helps dissolve carbon deposits on the spark plugs and cylinder walls of older vehicles and helps prevent carbon buildup in new ones.

How much mileage increase can be expected?

This varies from car to car. Independent testing on Trevaskis' car obtained improvements from 13.3% to 17.3%.

Will Vapor-Jet® fit all cars and is it



easy to install?

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Superferry

Finlandia, the 25,680-gross-ton passenger/car ferry now being operated in its first season between Helsinki and Stockholm by Silja Line, is the largest of its breed ever launched. Some 2,000 passengers can be accommodated aboard, plus up to 480 private automobiles (depending on the number of trailers). Over 900 people can be seated simultaneously in its restaurants, 400 more in various cafeterias and cocktail bars. There are two separate swimming pools, five separate saunas—plus a sauna bar (this beauty was built in Finland, don't forget). Not to mention the separate swimming pool and sauna for the crew. One thoughtful design element: 10 cabins are designed specifically to accommodate passengers confined to wheelchairs.



The large rectangle on the forward bulkhead is a panoramic picture window.

The 545-foot-long vessel seems rather blocky in the topsides—those bridge wings are 100 feet apart from tip to tip—but fine underwater lines give her a cruising speed of 22 knots from a four-turbocharged-diesel powerplant system that totals 31,200 brake horsepower. Not bad for a ship that's got 10 feet less beam than the QE II and about 55 percent of her length.



Superferry Finlandia is stubby-looking, but impressively commodious.

Well grounded

Twilight lingered at 30,000 feet, but the ocean below was in the dark. American Airlines flight 584, inbound from Barbados to New York's JFK airport, dived between two ominously flickering thunderhead columns and began its descent into the dusk. The plane was a DC-10. One constantly blinking overhead light in the main cabin reminded you that although pilots are still making noises about its electrical system, the 10 has been operationally debugged—at an exorbitant and tragically unacceptable cost—and is, by all odds, safe.

If there was a slightly higher than normal amount of passenger edginess aboard, it was because the U.S. air traffic control system was in its first week of operation minus 12,000 supposedly essential souls.

"I have some good news," intoned Capt. Deever over the cabin speaker. "We'll get into Kennedy without holding, although they'll vector us some to space out traffic. Be back to you later."

In due course, landing gear banged down and you felt the flaps dig into the airstream. But then we seemed to hang in time. Wingtip strobes flashed endlessly into white cloud, rain streaks painted the windows. Too long? Any ground lights? Right out of a low ceiling, the DC-10 began what seemed to be a landing flare, but a mite on the gradual side. Suddenly, the cabin TV screens came alive with bounding runway lights. Your landing shown live. No complaints about the touchdown.

"That landing," Captain Deever went on as we taxied in, "was totally automatic. JFK is one of about 15 airports that have the facility, and while the ceiling wasn't so low that we needed it, we like to do it whenever we can to, um, validate the equipment. Hope you enjoyed it."

Civil aviation never grabs headlines at times when things work nearly to perfection. But at those moments, the magic carpets of fable pale before it.

Supercat

Not to be outdone by Finland's launching of the world's largest ferry, the British recently pushed the world's largest catamaran into the River Clyde. Named *lolair*, the 250-foot-long, 170-foot-wide supercat is officially designated as an Emergency Service Vessel. She'll stand by in the North Sea, ready to take on any possible crisis arising on offshore oil drilling platforms—including fires and emergencies created by saturation diving operations. The vessel will be able to direct a water stream on a blazing platform from as far away as 600 feet. The minihospital unit on board includes a fully equipped operating room.

Speed's not terrific—12 knots. But a computer-regulated system of main propulsion and side-thrusters—all with controllable pitch propellers—enables *lolair* to hold a precise position in all wind/sea conditions.



One island's airport: Ideology may move heaven, but bulldozers move earth

They're building a long-awaited international airport in the small Caribbean island-nation of Grenada. It's a tough engineering job, since the 9,000-foot runway (in tradewind territory you need only one) on the island's south coast runs from a rocky point, where a lighthouse had to be knocked down, across undulating terrain that includes part of a small bay that must be dredged and filled in between dikes.

Work began early in 1980 and although the facility won't be open to international jet traffic until 1983, it has already become a symbol. By permitting international tourists to fly direct to this postcard-quality tropical paradise (Hollywood's "Island in the Sun" of 20 years ago) for the first time, the airport is held up by some as an economic panacea. Because Soviet and Cuban—not U.S. or British—technology and labor are prominently involved in its construction, it is also a symbol of a new wave of Castroism in the Caribbean. Some U.S. officials have even suggested that Grenada's Marxist-leaning revolutionary regime, now in its third year, is putting the big runway in not for tourism, but for the military requisites of its Soviet/Cuban alliance.

"That's nonsense, as you can see," says Grenadian civil engineer Ron Smith, showing PM sketches and feasibility studies dating back to 1966—when Grenada was ruled by the ostensibly pro-West prime minister Eric Gairy, a believer in flying saucers who apparently amassed a large personal fortune before being deposed in March 1979. "We have known for years that the economic future of Grenada depended on a first-class international airport," Smith emphasizes, adding that "Gairy didn't see enough in it for him or his friends to push it."

Beyond ideology and revolutionary rhetoric, Grenada's airport



Over 100 million cubic feet of earth and rock must be moved to put a 9,000-foot runway on the island of Grenada. Airport's construction access roads are unpaved, but are the nation's smoothest.



Japanese-made bulldozers are dwarfed by heaps of volcanic rock called tuff. Dozers are solidly built, but too low powered to rip the rock without extensive use of explosives.

project is probably unique as a sort of Olympics for heavy construction equipment. Some three million cubic meters of material must be moved—not including dredge spoil and sand fill—to prepare the runway area for final grading. Much of it is tuff—rock-hard compacted volcanic ash that can actually reset itself after being blasted.

"As far as earth-moving goes," Smith told PM, "we have 10-year-old Caterpillar equipment here in our Public Works inventory that outperforms Spanish-made units that were brand-new when the Cubans unloaded them. But I've got to say that the Russian trucks we're using are tough—they don't break down. And the Japanese bulldozers the Cubans brought in have been a revelation."

To rip the tuff directly, Smith points out, would require 300-hp bulldozers; the Cubans supply only 200-hp units. "...So we're blasting a lot of it," Smith says, "using nitrosamine. It's an East German/Cuban joint development that's a lot like standard contractors' blasting compound. Except that the diesel fuel component in the mixture is replaced by—would you believe it?—molasses."

In addition to this and other make-do ingenuities, the 250-man Cuban labor force gets credit for sheer industriousness. "It's the only place I know of in the Caribbean," an American charter-boat captain says, "where work actually progresses at night." Smith says the final cost of the airport would be some \$40 million more—for a total of \$120 million—if it were being built under a typical for-profit contract. That's as opposed to the terms of "socialist friendship" agreed to by Cuba with an as yet undisclosed *quid pro quo*.

"That may be so," an anxious hotel owner confided to PM, "but if the Americans were building it, it would be finished already."



Russian trucks get high marks for ruggedness, but front-end loader built in Spain sits idle due to yet another breakdown.



After this small bay is dredged, diked and filled with sand, the runway will traverse it. Miami-based dredging firm is the lone American contractor on project that showcases Cuban "friendship."

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reat gifts to make

Here's our fifth annual roundup of delightful gifts you can make in your workshop.

by Harry Wicks HOME AND SHOP EDITOR

One of the surest ways to show your feelings for someone is to give a gift you've crafted with your own hands. The thought alone will please, but when it is also a gift that is extra handsome or particularly functional, it is sure to be a favorite.

For the fifth straight year, we have rounded up workshop gift ideas that we think are extra special. Some are easier to make than others, but all can be crafted by a patient do-it-yourselfer following our how-to instructions and drawings. We

1 Stylized bookends, colorful pens and pencils in row, keep youngsters' coloring books corralled.

2 Toddler's first scooter helps to develop arm and leg coordination.

3 For preppies (and others who keep their shoes shined), a shoebox—complete with comfortable footrest for easy polishing.

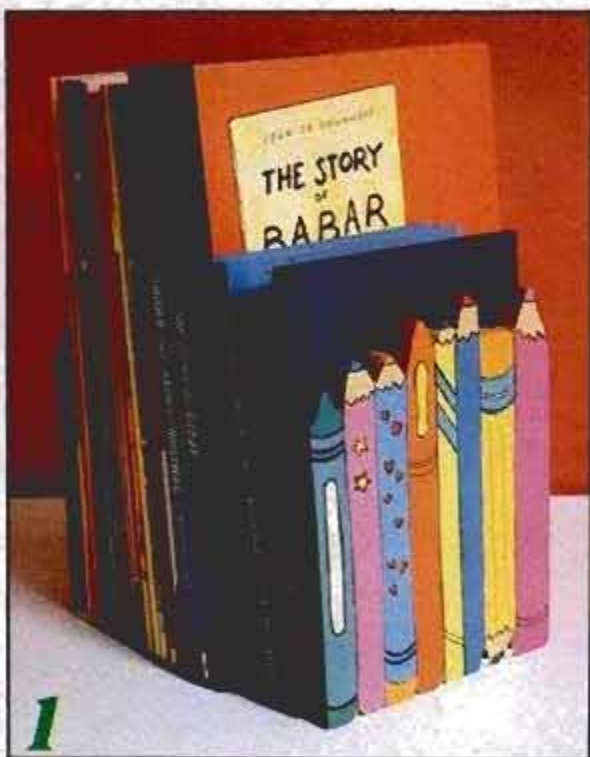
4 Number blocks are bright and gay, easy for little ones to

grasp. Bonus: They make an attractive dresser-top display when stored in the little hinged box.

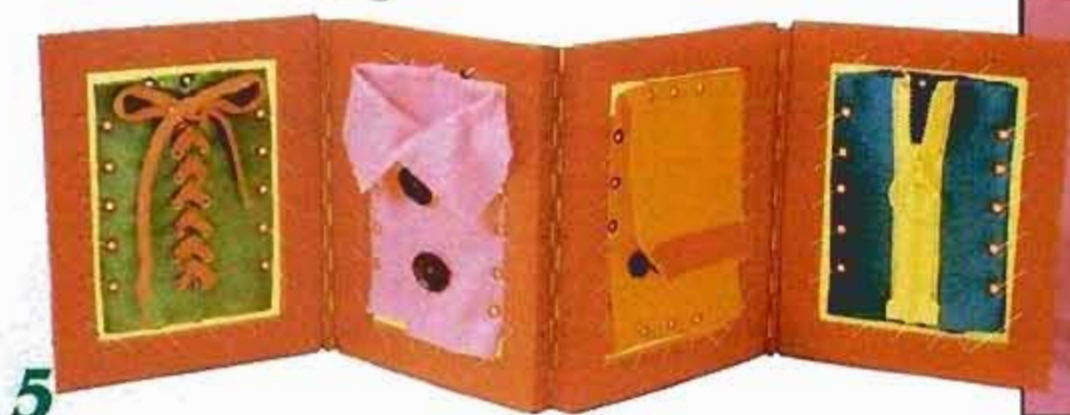
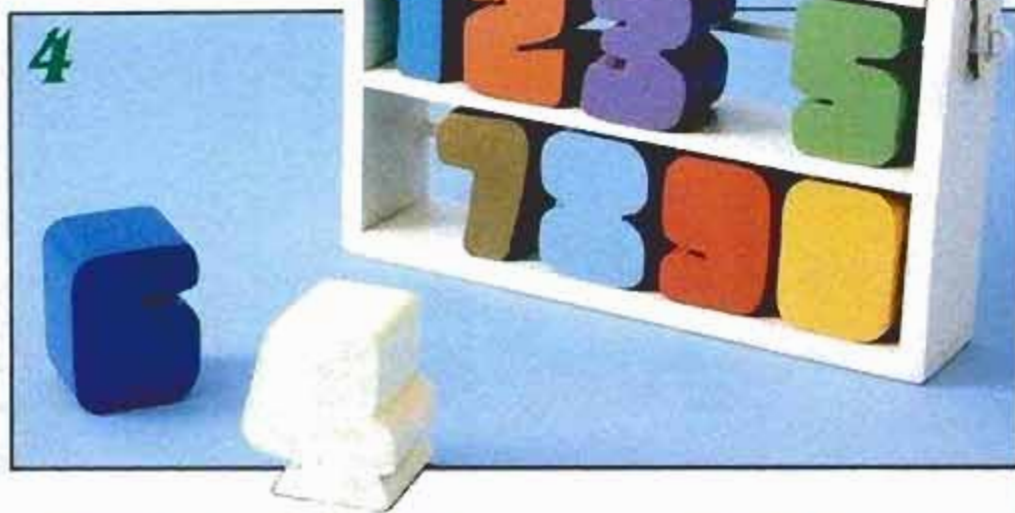
5 Learning frames help little ones master four important motor skills early—buttons, zipper, shoelaces and Velcro.

6 Rugged ram swing will provide back-yard fun for two youngsters for hours.

7 Our macropencil clothes-rack is sure to delight youngsters of all ages.



and give for Christmas



have included traditional items such as the Shaker stool and shoeshine box, as well as fresh, original ideas created by designers especially for PM readers. All were built in the Popular Mechanics workshop so that we could resolve any construction problems. The results are shown on these pages.

Do take the time to read through all instruc-

(Please turn to page 162)

8 Colorful clown puppet on a stick actually has a movable lower jaw. Our plans make it easy to duplicate.

9 Cat doorstep design is based upon the cast-iron versions of yesteryear. You can paint yours to match your house pet.

10 Shaker-like stool is extra

sturdy, despite the fact that it lacks a stretcher between legs. The secret is in the let-in diagonal braces.

11 Our toy village is scaled to suit Matchbox cars; you can create buildings to represent your own neighborhood. Streets are painted on a piece of canvas that rolls up.

Designs: Nos. 1, 2, 9, Bette Foster; Nos. 4, 5, 8, 11, Stanley Dunaj; Nos. 3, 7, 10, Harry Wicks; No. 6, Michael Murphy
Construction: Nos. 1, 2, 3, 4, 5, 7, 8, 9, 10, Harry Wicks; No. 11, Steve Willson; No. 6, Michael Murphy
PM color photos: Harry Hartman
Technical art: Eugene Thompson



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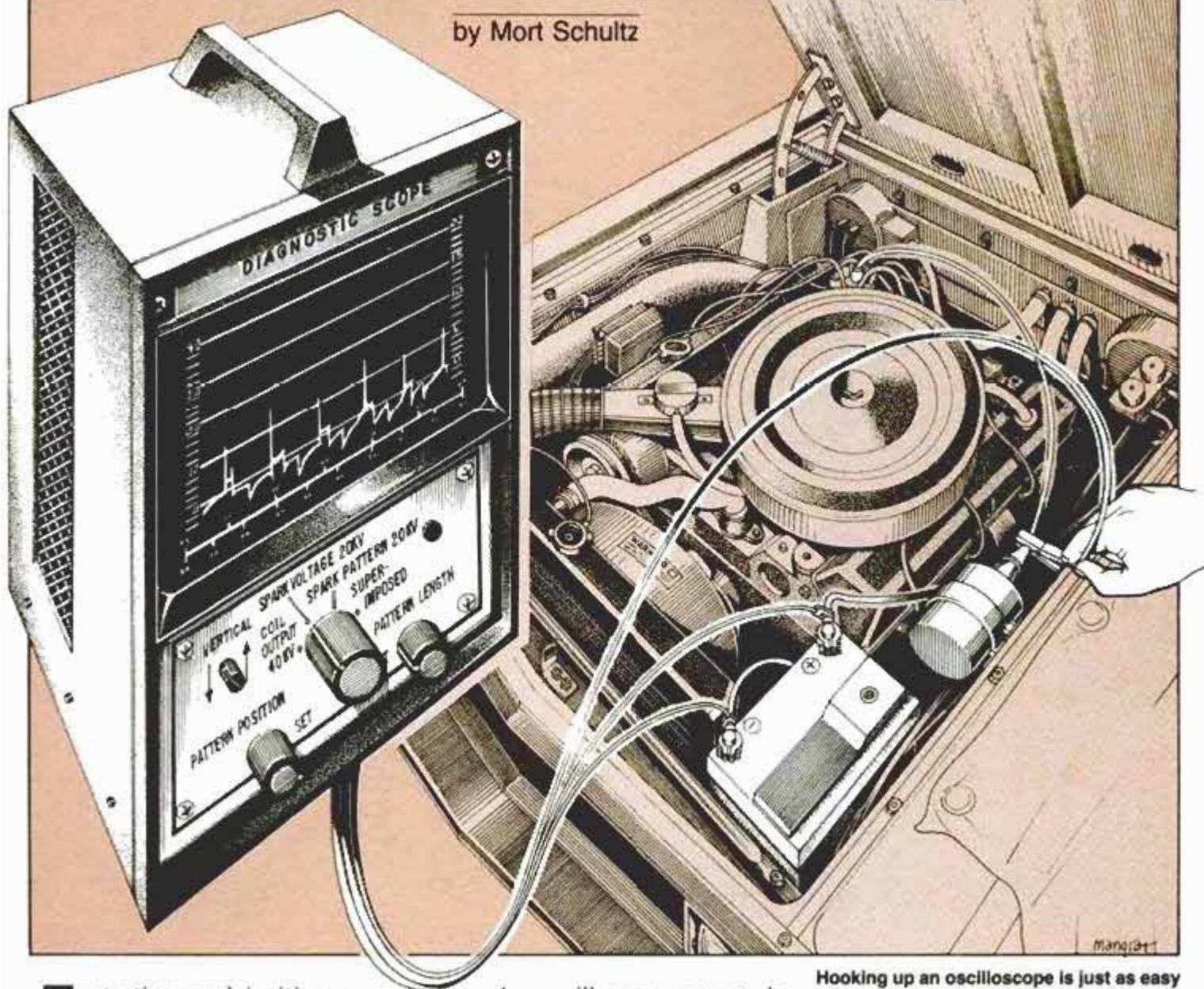
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Troubleshooting with an oscilloscope

by Mort Schultz



For testing spark-ignition engines, there's no automotive instrument like an oscilloscope—scope, for short. It gives you an accurate picture on its TV-like screen of the ignition process taking place inside the engine.

The term "spark-ignition" engine applies to engines that have either electromechanical distributors (those have breaker points and condensers) or electronic distributors (they don't have breaker points and condensers). As long as an engine uses sparkplugs (every spark-ignition engine does), you can test it with an oscilloscope.

An oscilloscope cannot be used for testing diesel engines. Fuel in a diesel is ignited by compression—not by sparks.

If your spark-ignition engine has four cylinders, an oscilloscope projects four pictures, called waveforms, on its screen. If the engine has six cylinders, you get six waveforms; with a V8, you get eight waveforms.

Each waveform consists of a series of peaks, plateaus and squiggly lines that tells a story about voltage being applied to ignite the fuel mixture in the particular cylinder. By comparing the peaks, plateaus and squiggly

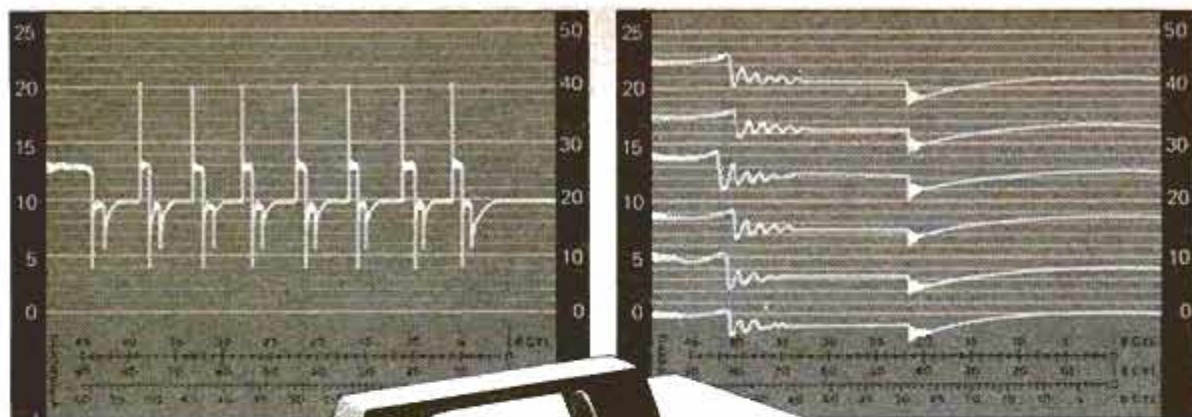
Hooking up an oscilloscope is just as easy as attaching a timing light or voltmeter. Depending on the test you'll be conducting, you connect a lead to the ignition coil or to a sparkplug using an inductive pickup.

lines of each waveform with an illustration of a normal waveform, you are able to tell:

- If a problem exists.
- Where the problem exists.
- The cause of the problem.

Even the most elusive problems are pinpointed by the oscilloscope. You'll find it more accurate and reliable than metered test instruments.

Depending on the oscilloscope,



Oscilloscopes display waveforms in either a horizontal or vertical format. The horizontal display is called parade (far left) while the vertical display is called raster. Usually only the more expensive scopes have the raster display capability. Variances in patterns show a problem.



Typical screen format of an oscilloscope shows voltage output in numbers printed on side of screen and dwell values along bottom of screen.

waveforms can be arranged in several different patterns. All oscilloscopes are capable of projecting a parade pattern. With this, waveforms are arranged horizontally across the screen, one after the other, following the firing order of the engine.

If engine firing order is 1-3-4-2, the first waveform is a picture of the ignition cycle for the No. 1 cylinder; the second waveform shows the ignition cycle for the No. 3 cylinder; and so on.

Some oscilloscopes also permit you to superimpose waveforms on top of

one another. You are able to see if one (or more) waveform is out of kilter with the others. A blurry image would be projected. You can then split the superimposed pattern into its individual waveforms to determine which waveform is not normal and which cylinder is, therefore, affected.

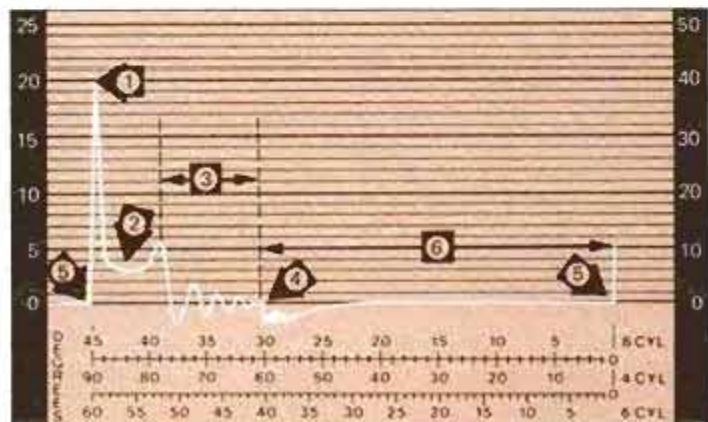
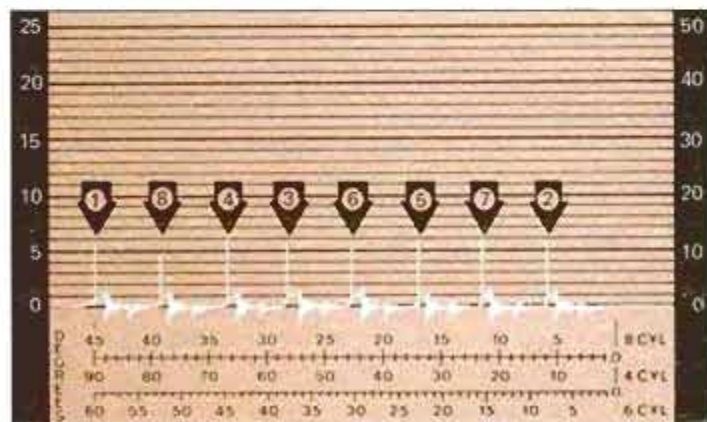
The more expensive oscilloscopes also have a raster display. Using a raster pattern, you can arrange waveforms individually, in a column from the top of the screen to the bottom, in an order that coincides with the engine firing order.

In addition, many oscilloscopes let you display the individual waveform(s) of any one (or more than one) cylinder by itself. You can get an enlargement of the waveform(s) for a closer examination of peaks, valleys and squiggly lines in case you're not sure if there's a deviation from normal.

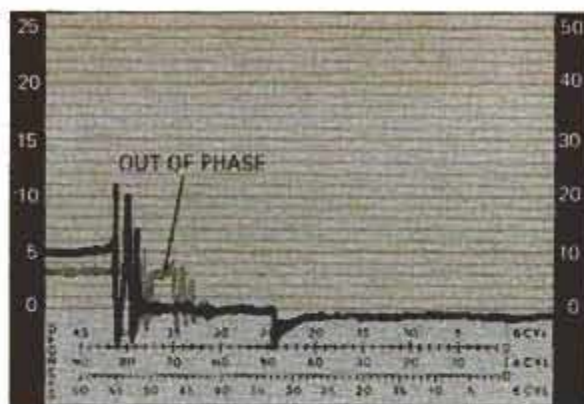
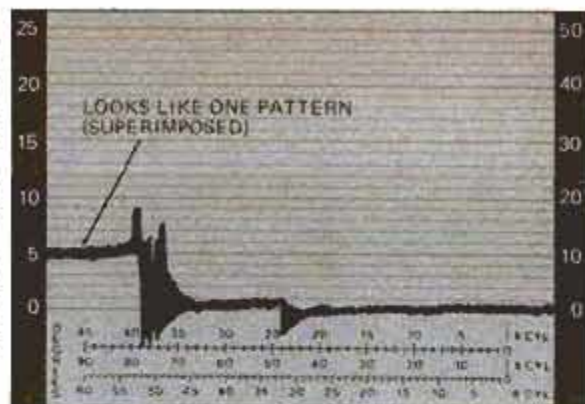
There are many ways a waveform can deviate from normal. To determine the meaning of a deviation, you must consult the instruction manual published by the manufacturer of the oscilloscope. You can't use a manual published by someone else, because shapes of waveforms often vary considerably between different makes of scopes.

Oscilloscopes display all phases of primary (low-voltage) circuit and secondary (high-voltage) circuit cycles. Therefore, any of the following problems can be uncovered with a scope:

- Damaged, worn or incorrectly gapped sparkplugs.
- Damaged sparkplug cables.
- High primary-circuit resistance.
- High secondary-circuit resistance.
- Defective distributor cap and rotor.
- Defective ignition coil.
- Defective or incorrectly gapped distributor breaker points (electromechanical distributor).
- Defective condenser (electromechanical distributor).
- Worn or damaged distributor cam (electromechanical distributor).



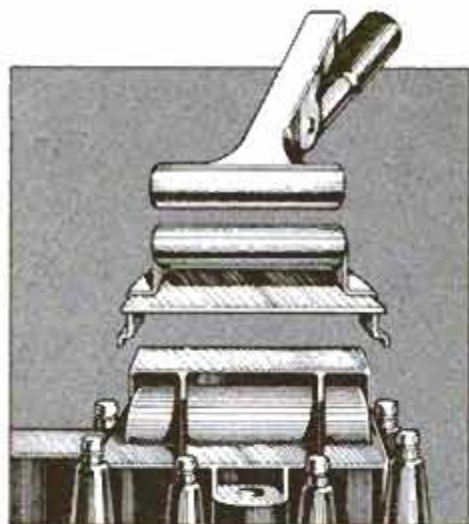
Patterns can be superimposed on each other to determine if one cylinder is out of phase with the waveforms of other cylinders. The first waveform (right) shows that the secondary circuit is firing properly. The second waveform (far right) indicates that the firing time is out of phase with the other sparkplugs.



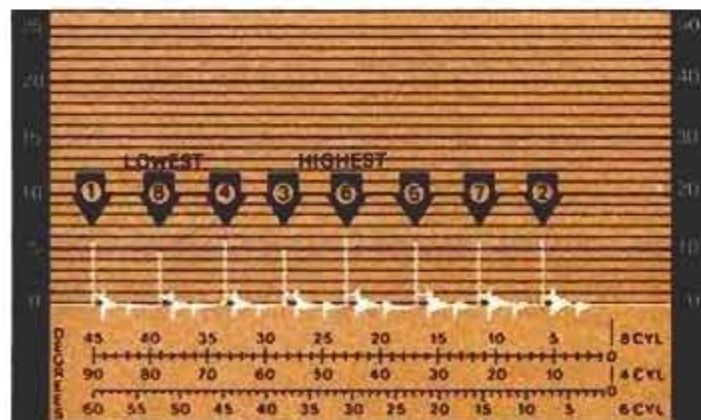
- Defective ignition module (electronic ignition).
- Defective pickup coil (electronic ignition).
- Worn or damaged spark-advance mechanisms.
- Incorrect ignition timing.

An oscilloscope that's to be used for testing a General Motors vehicle with a High Energy Ignition (HEI) system, which has its ignition coil inside the distributor cap, needs a special adapter. This adapter clips to the ignition-coil housing on top of the distributor cap. It picks up electrical pulses from the ignition coil inside the distributor.

Other ignition systems have ex-



To test a GM with HEI ignition you need a special adapter in order to hook up the scope. It clips on distributor.



The first step in a test procedure is to display all cylinders in firing order (far left). Peak voltages should be within 10 percent of each other. You can then zero in on any single sparkplug firing event (middle, see text). After correcting a problem, the highest voltage should be within the automaker's specifications (left).

ternally mounted ignition coils. You can reach them to attach the oscilloscope inductive pickup lead to the high-tension cable between the coil and distributor cap.

Other than this, connecting an oscilloscope is much the same from one ignition system to the next. Connect the power lead to the car battery and the other inductive pickup lead to the sparkplug cable of the No. 1 cylinder.

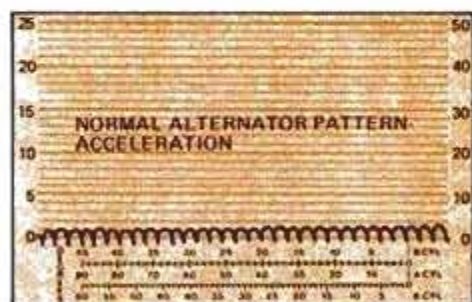
Important: There are slight variations in connections between different makes of oscilloscopes. With some models, for example, you have to connect a third pickup lead to the coil negative terminal.

An oscilloscope can also be used for testing an alternator, if a special alternator test adapter can be connected to it.

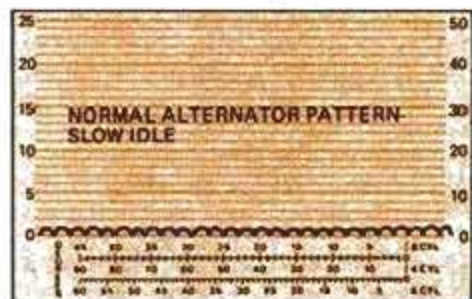
All about waveforms

Let's walk our way through a test using a typical oscilloscope, so you can get an idea what this instrument can do. Suppose your car has a V8 engine with a conventional (non-electric) ignition system. It has developed a misfire. You want to find out why.

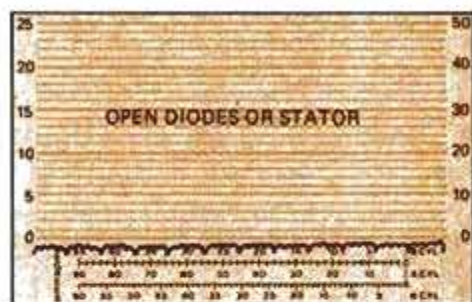
Warm up the engine and connect the scope. With the engine running at between 1,000 and 1,500 rpm, turn on the oscilloscope power switch and set controls. I've elected to use a parade pattern. Waveforms, therefore, represent the ignition for each cylinder in the order in which the engine fires. For our example, as-



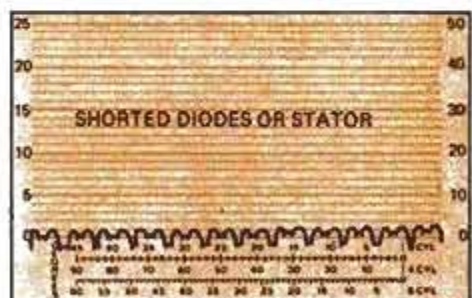
Oscilloscope pattern for an alternator that is functioning properly with the engine running at a fast idle is very regular.



At slow idle, the patterns look like this. The peaks are also regular, but they're smaller than those for a fast idle.



Open diodes or stator of an alternator look like this at slow idle on a scope. At fast idle, irregularity is more pronounced.



At slow idle, this is what the scope shows when alternator diodes or stator are shorted. It indicates impending failure.

Troubleshooting with an oscilloscope

sume a firing order of 1-8-4-3-6-5-7-2.

Now look at the figure at the bottom of page 36, which is the way a normal waveform projected by our typical oscilloscope should look. The waveform is divided into six parts that coincide with the six phases that take place during the ignition cycle. These phases are as follows:

1. Sparkplug-firing voltage phase. This peak of the waveform shows the amount of voltage needed to jump the gap between the sparkplug electrodes to ignite the fuel mixture.

2. Sparkplug-firing time phase. This plateau shows how long a time the plug continues to fire. If sparkplug-firing time (spark duration) is too brief, incomplete burning of the fuel mixture will result.

3. Coil and condenser action phase. This series of squiggly lines, which diminish in size, shows the dissipation of energy remaining in the circuit after the sparkplug-firing stage has ended. In a properly performing ignition system, not all voltage that's generated is needed by the sparkplug for firing. Some voltage remains and is expelled through the coil and condenser.

4. Distributor point close phase. This small peak shows the closing time of the distributor breaker points. It is the beginning of the dwell period, which is the length of time during which the points of a conventional ignition system stay closed to allow current buildup in the ignition coil. In an electronic ignition system, dwell is the length of time the electronic module is switched on to allow current to build up in the ignition coil.

5. Distributor-point open phase. This 90° angle shows the opening of the distributor breaker points, at which time the ignition coil expels the high voltage it has built up during the dwell period. In an electronic-ignition system, the electronic module switches off to end the dwell period, allowing the ignition coil to expel energy.

6. The dwell-period phase. The oscilloscope portrays this as a plateau between the point-close (electronic module on) and point-open (electronic module off) phases.

Now let's get back to our misfiring V8 engine. Compare the waveform of each cylinder with the illustration of a normal waveform. Pick the one (or ones) that doesn't look normal.

Let's suppose one sparkplug-firing voltage peak is substantially higher than the others. A substantial difference between the highest

and lowest sparkplug-firing voltage peaks means an abnormal amount of voltage is needed by the particular plug to generate a spark in the electrode gap.

Higher-than-normal voltage draw could indicate:

- A worn or damaged sparkplug.
- A defective sparkplug cable.
- Damaged distributor-cap tower electrodes.
- Uneven carburetion.
- A defect in the cylinder.

With all these possibilities, how do you proceed? No trouble. Just keep using the oscilloscope and you'll soon pinpoint the problem.

Zeroing in on a malfunction

If you can, switch the scope so only the abnormal waveform is displayed. It will present a large, sharp picture with which to work.

Using insulated pliers, disconnect the sparkplug cable from the affected cylinder and insert a thin screwdriver in the sparkplug boot so it touches the terminal. Being careful to hold the screwdriver by the handle, place the shank against the engine to ground the ignition. Keep your eye on the sparkplug-firing voltage peak.

Suppose the line drops. This means the sparkplug cable is delivering voltage to the sparkplug. The cause of the misfire is a faulty sparkplug, a malfunction inside the cylinder or uneven carburetion.

Turn off the engine and remove the sparkplug to examine it. If the plug is in good condition, use compression and vacuum gauges to test the cylinder for low compression and loss of vacuum. If you still haven't found the cause of the problem, check the carburetor.

If the sparkplug-firing voltage line does not fall when you ground the sparkplug cable, remove the cable from its tower in the distributor cap. Connect a jumper wire from

tower to ground, making sure the alligator clip of the wire is in contact with the terminal in the distributor tower.

Watch the sparkplug-firing voltage line. If it falls, the sparkplug cable is faulty, because voltage is getting from the distributor to, but not through the cable.

If the sparkplug-firing voltage line doesn't fall, the cause of misfiring is the distributor tower holding the cable. Perhaps the tower terminal is corroded or the electrode in the cap that picks up voltage from the rotor is burned. Replacing the distributor cap will clear up the misfire.

Testing the alternator

If your oscilloscope is designed to take an alternator adapter, testing the alternator is even simpler than testing ignition. Connect the scope and run the engine at slow idle, then at fast idle.

If the alternator is performing properly, you will see two waveforms on the oscilloscope screen—one for slow idle and one for fast idle. If a waveform is broken or irregular, it means the alternator is defective. One kind of irregular waveform suggests an open diode or stator. Another kind suggests a shorted diode or stator. Open or shorted makes no difference. The alternator should be overhauled or replaced.

Is it worth the investment?

That really depends on how serious you are about car maintenance and how much you want to rely on a professional mechanic.

Let's say that you're considering a \$400 oscilloscope—a good middle-of-the-pack unit. The cost of labor is currently about \$30 per hour. Thus, that \$400 could also buy you about 13½ hours of shop time—approximately three trips to the dealer. The decision is yours. **PPM**

OSCILLOSCOPE BUYING INFORMATION

As you might expect, oscilloscopes are not cheap. They range in price from \$200 to \$24,000. The price is dictated by several factors, among which are the size of the cathode-ray tube; types of displays that the scope is capable of projecting (parade, superimposed, raster, or all three); whether the scope is equipped with other test instruments and accessories (such as tachometer, timing light, dwellmeter, vacuum gauge and mobile cart); and other special features, such as the ability to assimilate information and print a diagnostic readout.

Listed (at right) are three oscilloscope makers I've selected because they are well

known and their scopes are fairly reasonably priced. They will send you literature about the instruments listed so you can compare features as well as prices:

- Heath Co., Benton Harbor, Mich. 49022
 - Model CO-1015, \$199.90 (comes in kit form)
 - Model CO-2600, \$499.95 (comes in kit form)
 - Model WO-2700, \$2,195
- Peerless Instrument Co., 8101 Gross Point Rd., Chicago, Ill. 60648
 - Model 21055, \$549.99 (made for Sears, Roebuck and Co.)
 - Model 510, \$895
 - Model 580, \$1,185
- Rite Autronics Corp., 3485 South La Cienega Blvd., Los Angeles, Calif. 90016
 - Model 7100, \$750

FROZEN

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DETROIT LISTENING POST

Future Ford concepts

Ford Motor Co. recently unveiled a quintet of running-concept vehicles that demonstrate the variety of things its designers and engineers have on their fertile minds for the latter 1980s and early '90s. We already know that the company has a lot of exciting new stuff coming between now and mid-decade, but take a look at some of these "better ideas" for the future:

Super Gnat: "Proves small, fuel-efficient cars don't have to look like boxes," brags Ford. This two-seater is only 48 inches high and 148 inches long on a 78.7-inch wheelbase but seats six-footers comfortably. Powered by a 1.0 liter four-cylinder, it has actually been around for about four years and has appeared at auto shows throughout the country.

Shuttler: Even smaller than the Super Gnat at 129 inches on a 77-inch wheelbase, but with better package efficiency, the sporty, wedge-shaped Shuttler two-seater boasts a drag coefficient (Cd) of 0.34. The light, nearly all-glass greenhouse and a pod-type instrument cluster on a sloped-away panel help prevent any sardine-can feeling inside.

Pockar: Four feet shorter than today's Escort at 114 inches on a tiny 75-inch wheelbase, this innovative concept seats four people comfortably. Because most of the interior is used for passenger room, there are luggage compartments in the lower doors, complete with luggage that just fits neatly into the space provided.

Aerovan: Most intriguing and practical of the five is Ford's idea of a minivan—a product we believe is long overdue for the American market. Built on a 94-inch-wheelbase Escort platform and only 157 inches long, it has a wind-cheating shape and room for seven passengers or plenty of cargo.

Cockpit: Also interesting but more controversial is the three-wheeled, two-seat (in tandem) Cockpit, so named because its interior gives the impression of the inside of a fighter aircraft. Unlike the others, it has rear-wheel drive and uses a 12-horsepower, single-cylinder motorcycle engine nestled *inside* the single rear wheel. It weighs only 770 pounds and should get something like 75 mpg, according to Ford



Experimental Aerovan has a small, 94-in. wheelbase but will hold seven passengers.



Cockpit, a micro three-wheeler, seats two in tandem. Engine powers the rear wheel.



Shuttler sits on minuscule 77-in. wheelbase and is powered by a sub-1-liter engine.

design vice president Donald F. Kopka.

In addition to maximum fuel and package efficiency, says Kopka, these concepts were designed to be "cars that people would like to own, that they would be comfortable with. They also had to look good, like automobiles, not motorized market baskets."

Also on display were a pair of experimental three-cylinder engines that could conceivably be in production well before anything like the above idea cars. The first, a 1.2-liter gasoline engine (essentially a lightened, high-compression version of the compound-valve, hemi-head 1.6-liter Escort Four, with one cylinder lopped off and a balance shaft added to counteract vibrations), could deliver as much as 50 mpg city and 70 highway. The second, a turbocharged, direct-injected diesel of the same displacement, could attain EPA ratings of 63 mpg city and 85 highway.

GM EV on hold

If you were saving up for a GM electric vehicle, which was originally supposed to be available by the '85 model year, you might consider investing in something else. Seems

there have been unexpected delays and budget cutbacks; though battery, d.c. motor and motor speed-controller development will continue.

The best hope is late '86 or '87 because of the long lead times required to get production facilities (for components as well as the vehicles themselves) in place even after the EV is considered ready for production. GM hints it will have re-evaluated the program by mid-1982 and doesn't want to talk much about it until then.

Meanwhile, GMC Truck and Coach general manager Robert W. Truxell says his division will almost certain-

(Please turn to page 44)



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DETROIT LISTENING POST

(Continued from page 42)

ly be producing battery-powered commercial vans sometime after 1985. He believes there's a market out there for short-haul, stop-and-go electric delivery units, and he intends to serve it.

Another encouraging word comes from Sears, which sent an experimental DieHard-powered Fiat up Pike's Peak last summer to establish a record of 32 minutes, 7.42 seconds for the 12.4-mile course. Though it was the first time an EV has

attempted an official run up the famous mountain, the 4,700-foot climb was completed with no trouble with Sears racing services manager C.F. "Joe" Ball at the wheel. Why? Because Sears plans to market DieHard EV replacement batteries through its catalog beginning next spring.

P-car back on track

Last month we reported that Pontiac's exciting mid-engined, fiberglass-bodied P-car two-seater was put in a holding pattern by the corporation due to development prob-

lems, but GM has again flashed the green light. Originally expected next fall as an '83 model (coincidental with rival Chevrolet's all-new Corvette), it now appears that sports-car enthusiasts will have to wait an additional year for this sexy little job. Better late than never.

Good stuff from AMC

The growing American Motors/AMC family tree will yield more fruit in '82 as Renault's sleek Fuego sport coupe is scheduled for a spring debut in American showrooms. Available for two years in Europe, the U.S. Fuego will be powered by the Renault 18's 1.8-liter four-cylinder engine and five-speed manual transmission. A turbocharged version should arrive about six months later.

By next summer, the long-awaited, jointly-developed AMC/Renault front-wheel-drive economy car should start rolling off the company's Kenosha, Wis., assembly line in preparation for an '83-model introduction. Available in sedan and hatchback body styles, it will likely replace the Renault LeCar and may be offered with optional 4wd.

AMC also plans to begin building its own four-cylinder engine next spring for use in its '83 Jeeps and rwd small cars. Derived from the company's existing six-cylinder, the new four should be about the same size as the Pontiac 2.5-liter unit it has been using for several years. Phasing out the Pontiac engine will make AMC more self-sufficient and will free up more of the popular 2.5-liter Fours for use in GM's own cars. **PM**

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Chrysler's 1983 Rampage mini-pickup

If this shape looks familiar, it's because the Rampage will be built on Chrysler's current TC3/024 front-drive sport coupes. Our covert operatives in Detroit not only took pictures, but actually got to drive one with the 2.2-liter Four. Impressive, they say. The performance was quite good and the handling very untrucklike. Will the Japanese sport pickups finally get some real competition? Stay tuned.

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CAR CLINIC

SOLUTIONS FOR MECHANICAL HEADACHES

BY MORT SCHULTZ



Heatproof

I'm happy to see the end of warm weather so I can use my 1979 Datsun 280ZX without worrying. But I'm already dreading next year. Around here in summer, temperatures hit between 110° and 120° F. After driving at 60 to 65 mph on the interstate for a while with the air conditioner on, the first stop sees the temperature gauge of my Datsun topping out and the coolant boiling over. All the dealer does is tighten hose clamps. Is there a service bulletin he doesn't know about?—W.J. Mansir, Highland, Calif.

No there's no service bulletin. In fact, yours is the first complaint I've gotten about the Datsun cooling system.

Possibilities I see for overheating of this engine are: 1. you've placed something, such as a bug screen, in front of the car and it's blocking air; 2. you've installed an aftermarket air conditioner, which is less efficient than the air conditioner you could have had installed by the factory; 3. the head gasket is damaged and hot exhaust gases are leaking into the cooling system.

Also, to help ward off trouble, you should service the cooling system every two years. Flush the radiator and engine, and refill them with a fresh ethylene glycol-water solution. Then, it's important to replace the thermostat and test the radiator pressure cap.

Obviously, 110° to 120° F. temperatures aren't comfortable for man or beast, but your 280ZX doesn't have sweat glands. High ambient temperature shouldn't bother it.

Avoid the greasy look

I recently bought a fine used 1979 Dodge Colt. The only problem I've encountered is an excessive amount of oil being drawn into the air cleaner. The dealer says it's normal. I can't believe that. What can I do to clean up this mess?—John Meredith, Milwaukee

A trace of oil in the air cleaner is normal, but not an excessive

amount. If you have a 1,400-cc engine and the car was built before October 1978, a new valve cover (part No. MD030274) has been issued to stop oil from leaking into the air cleaner. If you have a 1,600-cc engine, remove the valve cover and install a washer (part No. MD007746) under the camshaft front-bearing cap bolt. Then, install a new valve cover (part No. MD007496) and retaining screw (part No. MF100065). These repairs also apply to 1979 Plymouth Champs with 1,400- and 1,600-cc engines.

Mass confusion

I recently took my 1981 Dodge Aries to have the rear brakes adjusted (they aren't self-adjusting). The mechanic couldn't find openings in the brake flanges and had to remove wheels and drums to get at adjustment mechanisms. Yet, the service manual says to make the adjustment through access holes. I don't understand. Neither does the Dodge mechanic.—John L. Gotelli, San Francisco

Neither do I. Every K-car I've seen has an access hole in each brake backing plate. The hole is high up on the plate and a little off-center, just below the area of the wheel cylinder. Maybe your mechanic isn't looking in the right place. Also, access holes are covered by plastic plugs, which may be painted the

same color as the backing plates, making them hard to spot.

Just suppose, though, that by some fluke, access holes weren't cut into the backing plates at the factory. Your dealer is obliged to get you the right parts. These plates have to have access holes.

Once you straighten this out, show your dealer how sharp you are by giving him two new bits of information about the K-car brake adjustment that he may lack:

1. The parking brake should be released and the parking brake cable backed off, so there's plenty of slack in the cable. If there is the least bit of tension on the parking brake cable, the adjustment won't be made correctly.

2. Once shoes are against the drum, back off the star wheel six clicks—not 10, as the service manual states. Remember: Six clicks! The manual is not right.

After the adjustment is made, be sure that the mechanic replaces the plastic plugs. If he doesn't, dirt will creep into brake assemblies through the access holes.

Try to cool it

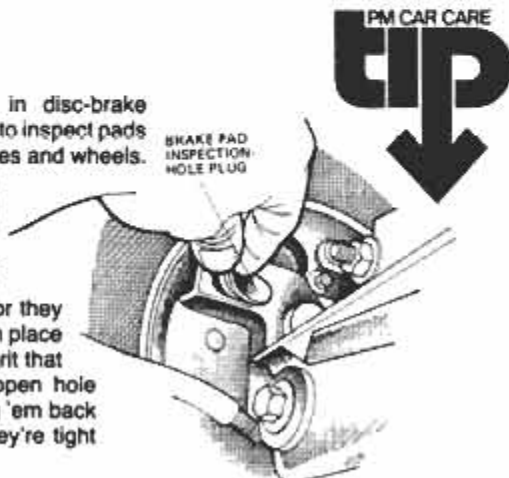
My 1979 Buick Regal, bought new, has the 3.8-liter (231-cu.-in.) V6 engine. Not since day one have I been able to get rid of pinging. I use the highest octane gas I can buy, and I've had all adjustments verified for accuracy, time after time. Several months ago I thought I had the answer when I read in your column that the sensor which controls the thermostatic air cleaner and the EGR valve may be at fault. This, too, proved to be a blind alley. Please, can you help me?—Al Murray, Falls Church, Va.

Perhaps you aren't using the right sparkplug. There has been a change since your car was built. The 1979 engine, except when equipped with

(Please turn to page 48)

A plug for a plug

Some manufacturers put rubber plugs in disc-brake assembly plates. You can pull out the plugs to inspect pads for wear, eliminating the need to remove tires and wheels. Most drum-brake assemblies are also equipped with pull-out plugs to let you adjust lining-to-drum clearance. Unfortunately, these useful plugs are often a problem, because some Saturday and professional mechanics forget to reinstall them, or they don't insert plugs securely enough to stay in place as wheels hit bumps. In either case, road grit that enters the brake assembly through the open hole causes a lot of expensive damage. So plug 'em back up again, friends—and make sure that they're tight enough!



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CAR CLINIC

(Continued from page 46)

turbochargers, came equipped with AC R46TSX plugs. Under some driving conditions, these are too hot for the engine and ignite the fuel mixture prematurely, creating a spark rap (ping).

General Motors has recommended replacing the AC R46TSX with cooler operating AC R45TSX plugs in all 1979 models equipped with the 3.8-liter nonturbocharged engine. Gap this plug to .060 in. Use AC R44TS plugs in the 3.8-liter engine with turbocharger. You should gap this plug to .040 in.

Lighting the way

Is it possible to convert an older type timing light into one of the newer type induction models?—William T. Gish, Kansas City, Mo.

It's possible. You would have to get the circuit board for the particular induction model you're interested in or that fits. You can then replace the guts of your old timing light, salvaging both the case and the tube.

However, before you get enthusiastic, let me tell you that several instrument manufacturers told me

that the cost of modifying an old timing light would equal—perhaps even surpass when postage for sending parts is added—the cost of buying a brand-new induction timing light.

Elementary, my dear Kozlowski

My two friends and I own 1980 AMC Concord station wagons with automatic transmissions and 258-cu.-in. engines with two-barrel carburetors.

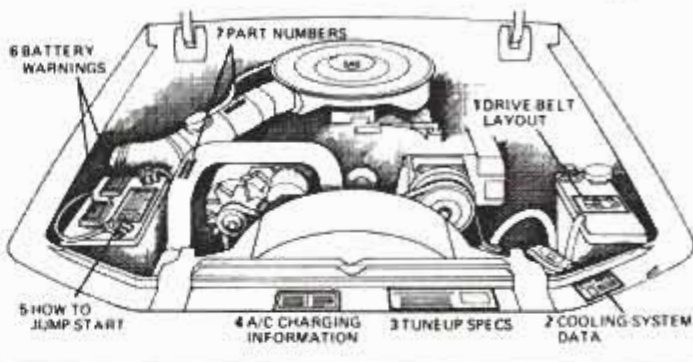
Oddly enough, we all have the same problem.

All three vehicles operate perfectly in city traffic. However, after driving on the highway at 50 mph for about one hour, all three stall at the first stop. They all start again, but they all stall at the next stop, and so on, and so on, and so on.

My friends have taken their Concorde to the dealer, who has tuned up the engines and overhauled the car-

Data processing

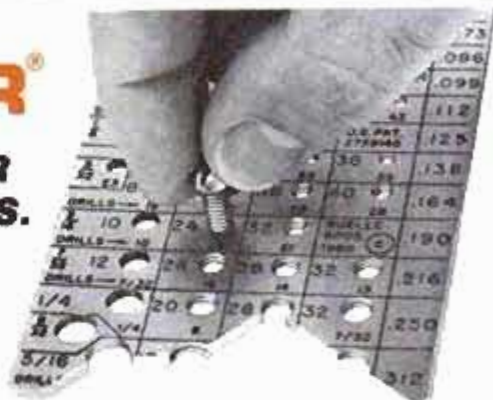
Are you aware of the useful information that may be printed on labels attached to your vehicle? Take a look in your engine compartment. Manufacturers are displaying more and more data that Saturday mechanics need. For example, under the hood of this 1981 Ford you will find: 1, a drive-belt installation diagram; 2, cooling-system fill requirements; 3, tune-up specifications; 4, airconditioning-system charging data; 5, how to jump-start an engine that has a dead battery; 6, important battery safety precautions, and 7, some numbers you can use when ordering replacement parts. We thank manufacturers for this, and hope that with each succeeding model year they will give us more of this type of useful data.



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3	1/4	48	56	45	.099
4	5/16	40	48	36	.112
5	3/8	32	40	28	.125
6	7/16	24	32	20	.138
7	1/2	18	24	15	.151
8	9/16	14	20	11	.164
9	5/8	11	16	8	.177
10	3/4	8	12	6	.190
11	7/8	7	10	5	.203
12	1	6	8	4	.216
13	1 1/8	5	7	3	.229
14	1 1/4	4	6	2	.242
15	1 3/8	3	5	1	.255
16	1 1/2	2	4	0	.268
17	1 5/8	2	3	0	.281
18	1 3/4	2	2	0	.294
19	1 7/8	2	1	0	.307
20	2	2	1	0	.320

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A&C GRENADIERS—THE TASTE LEADER

buretors. I work on my own car, and I've tuned the engine, overhauled the carburetor, changed filters and also checked all emissions controls. We're all ready to throw in the sponge, but thought we'd seek your advice first. What's happening and what can we do to correct it?—Stanley F. Kozlowski, Olney, Md.

Before I tell you what I think, let me say that there's no service bulletin relevant to this problem, which is very strange.

How is it possible that three owners of identical vehicles have an identical problem that has not been recognized by the company? It's time, I think, to try a little Sherlocking.

Could it be that the same adjustment is being made to all three cars and that all three are suffering the same malady because of it? If so, what adjustment?

This question leads me to conclude that the problem may be with the carburetor float adjustment. The cars act as if they are being afflicted by fuel starvation. Perhaps the floats of all three aren't being set high enough to satisfy the needs of the engine.

For example, if all three cars have Carter Model BBD two-venturi car-

buretors, the dry float-level adjustment is given in the service manual as .218 to .282 in. If float levels in all three cars are set on the low end of the specification (say, .218 in.), set them higher (say, at .250 in.) and see what happens. If nothing good happens, you should go all the way—to .282 in.

Perhaps, though, the correct specification range is not being used to adjust all three floats. This opens up still another possibility. In addition to the Carter Model BBD carburetor, two other two-barrel carburetors are used on AMC models—the Holley-Weber Model 5210 and the Motorcraft Model 2100. The service manual gives their dry float-level adjustment specifications as .380 to .460 in. and .287 to .329 in., respectively.

The solution then, may lie in making sure the specification each of you is using to set float levels is the right one for the carburetor on your cars.

GOT A PROBLEM WITH YOUR CAR?

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 published in the column.

SERVICE TIPS

■ Lack of warm air from the heater and cool air from the air conditioner in 1977 and 1978 Ford Granadas, Mercury Monarchs and Lincoln Versailles may be caused by an air leak where upper and lower cases of the blower housing meet. To seal this area, on the right of the blower as you sit in the car facing the blower, install a spring clip (part No. CODF-19A779-A). It will close the gap between cases.

■ Owners of 1981 Dodge Aries and Omni models, and Plymouth Reliant and Horizon models equipped with the 2.2-liter engine don't have to put up with rough idling. The trouble often is caused by an improperly adjusted low curb-idle speed setting made at the factory. Ask your dealer to adjust the setting as outlined in service bulletin 14-02-81.

■ There's been a sparkplug change for 1981 Chevrolet and GMC light trucks, pickups and vans equipped with 4.1-liter (250-cu.-in.) engines. Don't use AC R46TS plugs as recommended in owner and service manuals. You may get a spark knock. A cooler plug, the AC R45TS, is now recommended.

■ In case you haven't heard, GM is recalling about 105,000 early-production 1981 X-cars to replace electrical ground cables that may break, affecting headlight and windshield-wiper operation. You can wait for the recall notice or check your dealer to see if your car is affected. But if headlights dim or windshield-wiper action becomes sluggish, get the car back to the service department. **PM**

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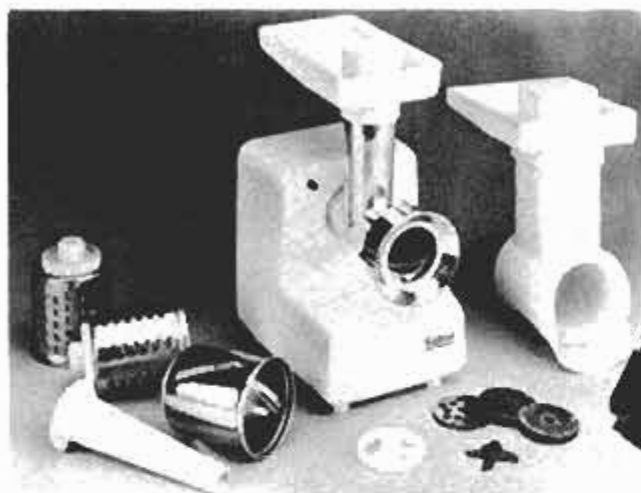
Plus it has the API-SF/CC rating required in most diesel cars.

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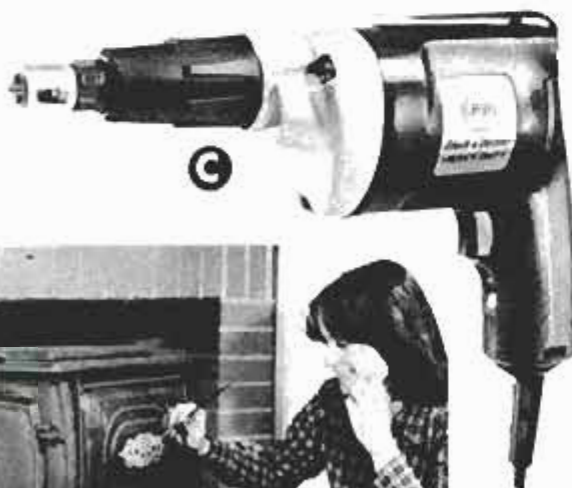


You can trust your car to the products with the Star.

NEW NOW for home and shop



B



D



A The Cafe Gold coffeemaker and the Food Machine food processor are two new products that represent innovations in the field, according to the manufacturer. Both are sold at department stores. The coffeemaker has a permanent, 24-karat-gold-plated filter and a control dial for adjusting the temperature of the hot plate. It costs \$95. The Food Machine (\$150) combines the versatility of a food processor with the capability of a heavy-duty meat grinder. The unit features three different-sized sieves that grind meat and three stainless-steel drums that slice, shred and grate other foods. A separate sausage-stuffing attachment is also included. Both appliances are made by Salton Inc., 1260 Zerega Ave., Bronx, N.Y. 10462.

B A small transistor radio which is designed to look like a Powerlock II tape measure is available through a special offer from Stanley Tools, Dept. PID, Box 1800, New Britain, Conn. 06050. When you buy any one of the following three tape measures you can mail in a card and get the radio, plus a 9-volt battery, for \$8 postpaid: 1 in. x 25 ft. (\$15.49); 1 in. x 16 ft. (\$13.49); and 3/4 in. x 12 ft. (\$10.69). The offer is good until Jan. 1, 1982 at hardware stores and home centers.

C The Industrial Construction Div. of Black & Decker Inc., Hampstead, Md. 21074, has introduced three redesigned Scruguns (Type II) for installing drywall. The 2,500- and 4,000-rpm variable-speed reversible units are \$102 each and the 4,000-rpm, on-off reversible unit is \$99. The manufacturer claims that by making these tools 6 oz. lighter and moving the center of gravity back, closer to the handle, user fatigue has been reduced. All three are available at lumberyards and tool-supply houses.

D The ThurmaloX Deco Kit is a set of seven 1-oz. bottles of heat-resistant paint, thinner and two brushes specifically designed for wood and coal-stove decoration. The kit has gold, silver, green, blue, brown, white and black colors and costs \$12.95 postpaid from the Dampney Co., Dept. DCR, 85 Paris St., Everett, Mass. 02149. Smaller, one-color accenter kits (gold or silver) are \$6.95; brushes, thinner and black touch-up paint are included.

APPLIANCE CLINIC

QUESTIONS ANSWERED

No-spin washer

We have a year-old Montgomery Ward heavy-duty clothes washer, Model AN 6419-82A, serial No. 87H105, that doesn't spin. The serviceman who fixed it about two months ago said that he moved the spring up a notch, like stretching a fan belt on a car. The washer worked fine for a month, but then it quit spinning.

We've stretched the spring to the last notch without success. Any suggestions as to what we should do now? We'd like to be able to do the wash. —Bill and Sue Bradle, Glencoe, Ill.

It sounds as if the washer has a stretched or broken internal drive belt. Replacing the belt on this machine is a fairly complicated process. The motor and motor pulley must be removed along with some hoses. It takes about half an hour for a professional serviceman to do the job. The approximate cost to replace the belt, parts and labor included, is \$30 in your area.

If you would like to tackle the job yourself, stop at a Montgomery Ward service department. Ask for manual No. CRS 85108 (Ward part number for the manual is No. 85207571). The price is \$4.50. You will also need supplement No. 1 (part

No. 85207563), priced at \$2.50. The drive belt itself is part No. Q000181625. It is priced at around \$7.

Short-lived defroster coil

I have an Admiral refrigerator, model No. KNT-160, serial No. 8024495. My problem is the life of the defrost coil. It lasts eight months almost to the day. The last time it went, I replaced it; but the time before that one, I had a serviceman do it. He checked the voltage and part, but couldn't find anything wrong. I was told the defrost timer could be at fault. The freezer is cold and the refrigerator holds a constant 38°F. What could be wrong?—Walter Martynow, Redford, Mich.

The defrost timer wouldn't cause this problem. We checked with Admiral, whose technicians see no reason for the defrost coil to fail within an eight-month period.

The area they suggest checking is at the connection where the defrost coil attaches to the wiring harness. Make sure there is good contact at this point. There is the possibility of moisture getting into the bullet connector. The constant freezing and thawing could force the connection apart. The wires would still remain

in the insulated sleeve and give the appearance of still being connected, even though an open circuit existed.

If you use a solderless connector for this hookup, Admiral suggests you put in a silicone sealer to seal the connector to the wires. This would ensure that no moisture could get inside.

The defrost coil, part No. 52763-1, should be a 400-w. heater with 30.9 ohms resistance.

Drum beat

I have a Frigidaire dryer model No. DCDN. As the dryer turns, I can hear a noise near the front of the drum. If I lift the front of the drum or push the load of clothes to the rear, the noise stops. Do you have any ideas as to what could be causing this?—Charles Warner, Lawton, Okla.

You could have a problem with the nylon drum slides that support the front of the drum. The two slides are riveted to the top of the port plate assembly. Over the years, lint may have built up on the surface of the slides or the slides may have worn down.

To inspect the drum slides, you must remove the port plate assembly from the dryer. Open the loading door and lift the round door seal. You'll see screws holding the port plate to the dryer. Remove screws, reach inside and support the drum while removing the assembly. It will come straight out.

Next, clean lint from the drum slides area. Inspect slides for wear or cracks. The slides should be about 1/4 in. high. Check carefully for loose or broken rivets.

If the slides look good after cleaning, just lubricate and reinstall the port in the dryer. If you need new slides, you can get them from Frigidaire.

The part number for the slides is 65-97854; total cost is about \$4.90. You get two nylon slides and four rivets. Order from Central Frigidaire Parts Center, Oklahoma City, Okla. 73125, or write Frigidaire, 3555 Kettering Blvd., Box 4900, Dayton, Ohio 45449. **PM**

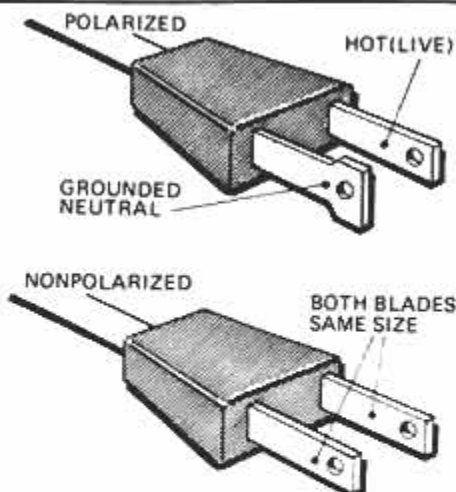
SERVICE TIP

Today most portable lamps and televisions are being sold with polarized plugs. One blade of such a plug is wider than the other. The plug can fit only one way into a polarized wall receptacle, which has one wider slot to accept the plug's larger blade.

Electricity in an appliance flows through two wires: the "hot" line which brings in the electric current and the "cool" (neutral) line which is connected to ground and returns the electricity to the power source. The wider (neutral) blade of a polarized plug fits only into the neutral side of a receptacle. Because of this, the switch in the lamp or television will always "turn off" the "hot" line.

When you use a nonpolarized plug, your chances are 50-50 that the plug will be inserted so the hot line remains hot, even when the switch is turned off. Under certain conditions you could receive a severe shock: for example, when you touch a water faucet and come in contact with an exposed "live" part of a lamp or television with an electrical defect.

Beginning in 1980, all lamps and televisions were required to have polarized plugs. Soon extension cords will also be required to have them. Polarized wall outlets have been universally used since 1932. Chances are the wall outlets in your home are polarized. If not, now is the time to change them.



The wider, neutral blade of a polarized plug (top) will fit only into the wider, neutral slot of a polarized receptacle. Both blades of a nonpolarized plug will fit the slots of polarized or nonpolarized wall receptacles.

Nonpolarized plugs will always work in polarized outlets, but don't force a polarized plug into a nonpolarized outlet. You should have the outlet changed to accept polarized plugs. Always look for the UL label when buying an electrical product.

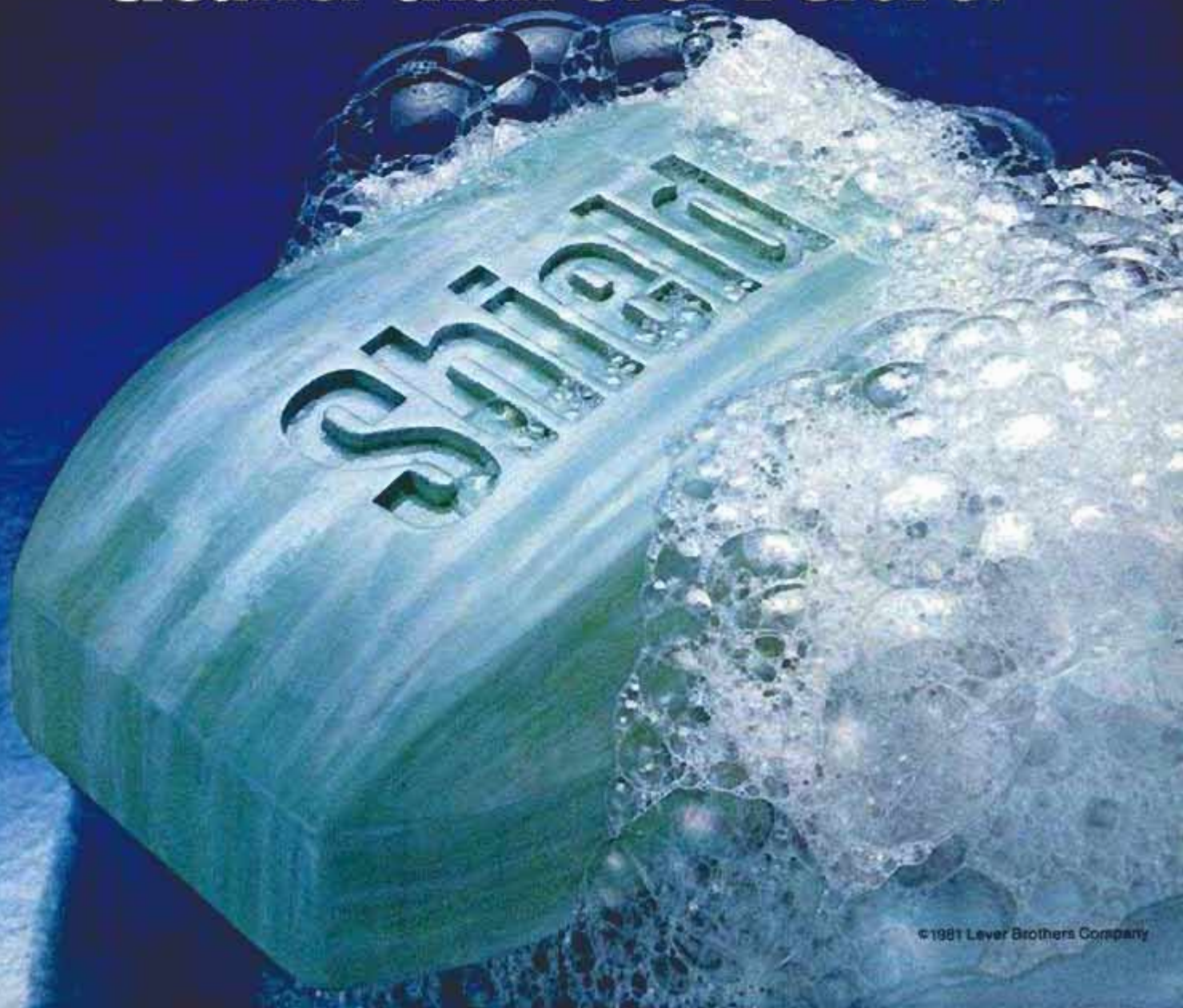
If you have a question about any appliance, send it, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

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HOMEOWNERS' CLINIC

QUESTIONS ANSWERED

Basement moisture

Our basement construction is part block below grade (five courses high) and 2x4 studs with plywood sheathing above grade. The exterior finish is aluminum siding. I have fiberglass insulation with no foil backing between the studs. In the winter months, when I look behind the insulation, the plywood is saturated with moisture. We have oil-fired hot-water heat and a wood-fired hot-water boiler. I'd like to finish the basement, but not if I'll have to replace rotted wood.—John Kowalczyk, Madera, Pa.

You'll have to replace it, John, if you don't stop that moisture from getting into the framing. "Mildew and Peeling Paint" (*Homeowners' Clinic*, page 52, Oct. '80) describes the problem and the cure. With a cold and impervious material such as aluminum on the exterior, it's all the more important to install a vapor barrier.

I suggest that a minimum of 4-mil-thick polyethylene be stapled to the face of the studs. Be sure to overlap the joints a minimum of 4 in.

Although the block is not giving you any trouble, I'd continue the vapor barrier down from a 1-in. fold at the ceiling, past the studs and block to a 1-in. fold at the floor. This would effectively seal the wall. Fasten the vapor barrier to the block with dabs of roofing cement.

Fungus-resistant shingles

The white paint on my roof eaves is turning black with mildew and fungus. Two roofers told me that my 17-year-old roof needs to be replaced. The mildew occurs only on the north and east ends of my house. Is there a cheaper way to go than replacing the roof?—Angelo Colavita, Manhattan Beach, Calif.

Angelo, 17 years is a pretty fair roof life. If you think your roof can survive longer, you can at least combat mildew on the roof eaves and other painted surfaces with a product called X-14 (see "Paint Additive," *Homeowners' Clinic*, page 42, March '81). Use this product when repainting.

When you replace the roof, you might consider installing mildew-resistant shingles. Several manufacturers produce them, but Celotex's FRS (fungus-resistant shingle) claims to be the only one warranted to stay fungus-free-white for the life

of the shingle. It is now manufactured on a tough fiberglass mat and carries a 20-year limited warranty. FRS shingles cost from 10 to 13 percent more than most standard-brand shingles.

Each shingle contains special porous zinc granules that destroy fungus spores chemically. Whenever it rains, this fungicide is slowly released and washed across the face of the shingle, much like a time-release capsule. The fungus-killing action



This test roof, shingled in 1967, has two rows of FRS (fungus resistant shingles) that stayed white. They also started to clean the mildewed shingles below them.

continues for the 20-year limited warranty life of the roof.

The photograph shows a roof conventionally shingled in 1967, with several white FRS shingles. Not only has the white remained white, but the action has started to clean the dirty (mildewed) shingles on the roof below.

Gas-to-electric light

The advertisement I've enclosed from your magazine shows a kit to convert a yard light from gas to electric, yet the light still looks like a gas one. I've never really done anything like this and plan on hiring an electrician. Do you have any suggestions?—Clyde Allard, Amarillo, Tex.

I hadn't converted a light either,

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 this column. For more home repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send order(s) to PM, Box 1014, Radio City Station, New York, N.Y. 10101.

so I called Yardlighting Systems, Inc., 1039 Charles Ave., Dept. 45, St. Paul, Minn. 55104, and asked them about their Relite. They said that the instructions packed with each one of their kits make installation very simple.

The only job that a pro must do is disconnect the gas line. Your gas company will probably do that for a nominal fee. Then cut the copper tubing at a point near the base of the pole.

The "low-voltage" conversion model, which is really a transformer plugged into an outlet in your basement, is suggested. You dig a small trench to bury the wire. Instructions explain the step-by-step procedure.

Cracked shower walls

Four years ago we installed a shower in our bathroom, and used Marlite on shower-stall walls. The material is starting to blister and crack. Is there something we can use to seal the panels? It would be difficult to remove and replace them.—August Buss, Sidney, Neb.

Marlite manufactures many different types of panels. What you describe leads me to believe that the type you used wasn't intended for shower-stall walls.

Marlite does, however, make a shower and/or tub kit (priced at about \$99). The material in the kit is ABS (acrylonitrile-butadiene styrene), a tough plastic used in making plastic pipe. Marlite claims that the material is impervious to moisture and will not support mold or retain odors. It can be installed over most existing surfaces, including ceramic tile.

If your local home center doesn't stock this item, write to: Marlite Products, Home Improvement Div., Box 830, Rock Falls, Ill. 61071, for the name of the nearest supplier serving your area. **PM**



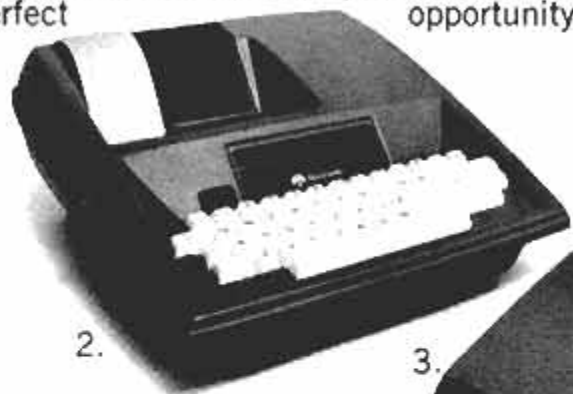
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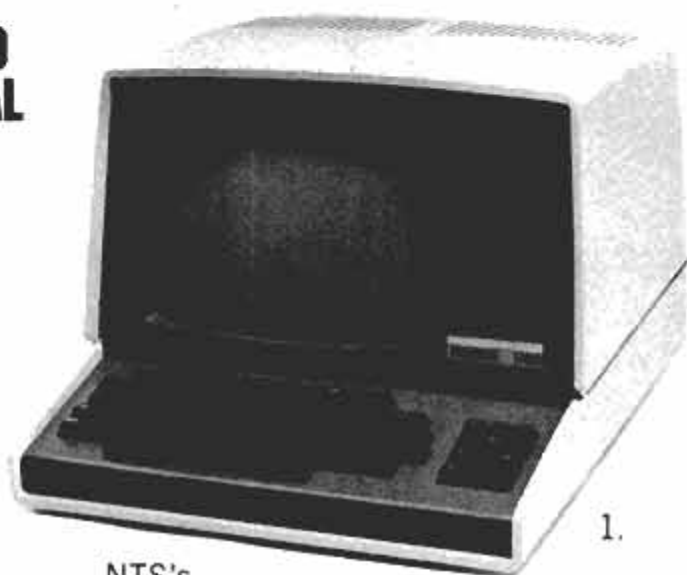
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The NTS/Rockwell AIM 65 Microcomputer (#2) is included in our Microprocessor Technology Course. It's a single board unit featuring an on-board 20 column alphanumeric printer with 20 character display. This 6502-based unit also has 4K RAM memory, expandable, 8K monitor ROM and 8K advanced BASIC interpreter on ROM.

And in NTS's Master Course in Electronics and Industrial Technology, you'll work with the NTS/KIM-1 Microcomputer (#3). This unit features a 6 digit LED display with an on-board 24 key hexadecimal calculator-type keyboard. It's a 6502-based microcomputer with 1K of RAM memory, expandable.

HOME ENTERTAINMENT ELECTRONICS

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SCIENCE WORLDWIDE

Animal tests and cancer

Scientists and nonscientists alike worry greatly about the condition of laboratory rats exposed to possible cancer-causing substances, because the response of rats may parallel the response of humans.

But according to a report from an American Medical Assn. council, some of the worry may be unnecessary.

The Council on Scientific Affairs suggests that there are several deficiencies in animal tests designed to yield conclusions about the safety of substances for humans. For one thing, researchers originated such tests to study how cancer developed, not to judge risks to humans. Doses were maximized to increase the possibility of cancer so its course could be studied. And these doses were not reduced when scientists turned to assessing risk of exposure to humans.

And there is a limit, the council argues, to information that can be drawn from such tests: "A substance can be carcinogenic for certain organs in one species, but relatively harmless in other organs or in other species."

The council repeated warnings, however, that exposure to asbestos fiber is related to lung cancer, and noted that a correlation seems to be emerging between intestinal cancer and diet.

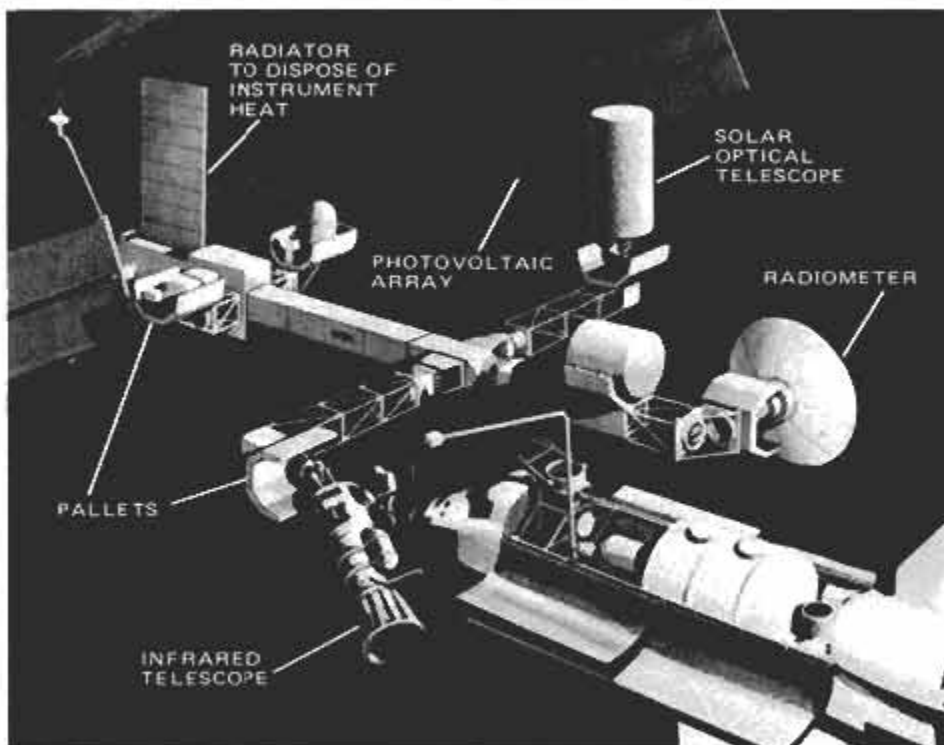
Fly fishing in a fake brook

Cornell University scientists haul a rich catch from the artificial babbling brook (below): thousands of blood-sucking black flies.

Successful breeding in the labora-



Cornell's brook: a home for black flies.



Shuttle orbiter would service platform, 255 miles high, every three to four months.

tory raises hope that researchers can come up with new repellents, vaccines and biological controls to keep the flies at bay.

The flies are more than a nuisance. In the United States, they cause black-fly fever; in tropical climates, they carry an infection which has blinded approximately 2 million persons.

Previous attempts to breed flies in captivity—to help researchers find ways to fight them—have failed. Cornell researchers succeeded by modifying a lobster tank, fortifying fast-flowing water with ground rabbit chow and attaching small obstacles to the inclined bottom to simulate conditions flies find hospitable for reproduction.

'Car-pooling' in space

The structure above is a kind of advanced car pool for space payloads. And its developers at McDonnell Douglas Astronautics Co. say it might be a forerunner of colonies of human space pioneers.

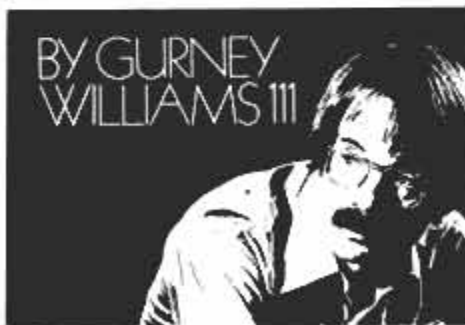
The free-flying platform, built largely of 2-inch-diameter graphite epoxy tubes, would offer up to six pallets—"beds" accommodating scientific instruments such as sun-watching telescopes. Power for these instruments would come from a 200-foot-long photovoltaic array, converting sunlight in space to 10 to 25 watts of electricity. This power

could also support a space shuttle, bringing crews to service the orbiting structure. The shuttle orbiter would ferry packages back and forth from the pallets in trips every few months. Meantime, the payloads would orbit together, about 255 miles above the Earth.

The rationale for the system, under development for NASA, is savings: "It's the difference between car-pooling and having your own sports car," says Fritz Runge of McDonnell Douglas. The platform achieves economy by combining the power system for the separate packages into one unit.

Runge told PM the first sections of the platform could be in orbit in six years, and the whole structure could orbit before the end of the decade. In later missions, the pallets will accommodate capsules with human crews, catching month-long rides in space.

PM



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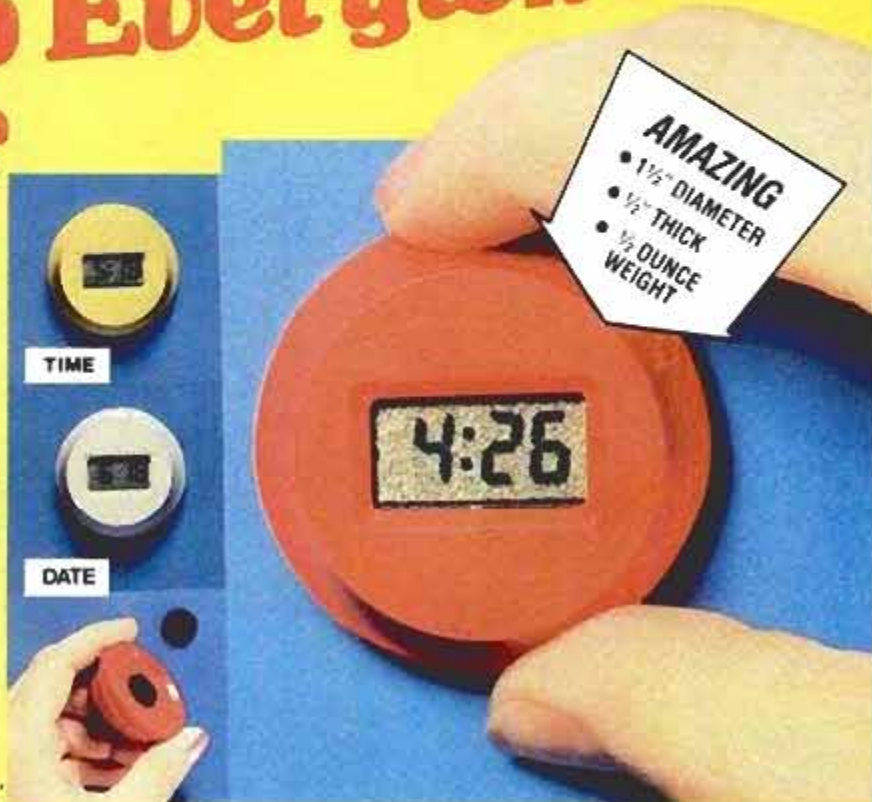
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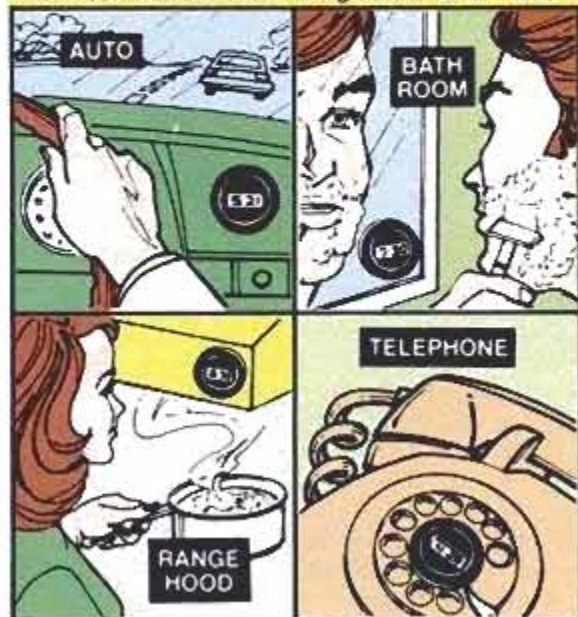
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CAPSULE REPORTS ON NEW AUTO PRODUCTS

Well heeled

Scuffed heels on your dress shoes can be avoided with Sendak International's Heel Gard.

The Heel Gard is a ¼-inch-thick, 5½ by 5-inch-square piece of soft carpet meant to be mounted to the gas pedal/brake area of your floor boards. Your right shoe's heel rides



Heel pad protects your shoe from scuffing and saves the carpet from premature wear.

on the Velcro-fastened pad and resists the usual scuffing.

The Heel Gard takes two minutes to install, resists road salt and is washable. It sells for \$2.98. Sendak International's address is Box 1606, North Springfield, Va. 22151.—G.W.

Dipstick wiper

Probably the greatest aggravation about checking your car's oil level is finding something handy to wipe the dipstick on. Hopkins Manufacturing Corp. helps make this chore a tad easier with the aid of its Dip Strip'R dipstick cleaning tool.

The Dip Strip'R consists of a "clam



Dipstick wiper has adhesive back which allows it to be stored under your hood.

shell"-type plastic case with sponge rubber inserts to wipe the dipstick. Just lay the dipstick across the wiper, squeeze the tool together and

draw the dipstick through. The re-useable wiper fits into a convenient holder that has a stick-on backing.

The Hopkins' Dip Strip'R retails for about \$1.30 at most auto-parts counters. The Hopkins Manufacturing Corp. is at 428 Peyton, Emporia, Kan. 66801.—M.L.

Tune-up kit

Motorcycle tune-ups are made easier thanks to Nippondenso's "Hot U" ignition-system service kits. The kit for my 1976 Kawasaki includes four of ND's U-grooved electrode sparkplugs, two sets of breaker points and a matched pair of condensers. ND offers kits for most bikes, from mopeds through big road burners.

My Kawasaki tune-up kit retails



Ignition-system service kit is available for virtually every two-wheeler made.

for \$20. A complete display of ND's sparkplugs, as well as tune-up kits, may be found at most motorcycle shops. Nippondenso's address is 857 East 230th Street, Carson, Calif. 90750.—Joel Breault

Springing ahead

Carburetor throttle-return springs, or any spring for that matter, can be a bear to remove and replace—espe-



Spring-removal/installation tool has T-handle and comes in a package of six.

cially without special tools. The Kesch Tool Co. comes to the rescue with its twist-of-the-wrist spring-removal tools. The Six-Pac I tested included a vinyl pouch of six, tempered-spring-steel shafts, each with a different tip, and a plastic handle. The tips are perfect for small springs such as those on outboard motor carbs, lawnmower carbs or frontseat adjusters, for instance.

The Kesch pocket Six-Pac is \$6.50 at auto-parts stores or write to Sauk Valley Equipment Co., Box 550A, Rock Falls, Ill. 61071.—T.A.

Coded kill switch

Here's a way I found to prevent unauthorized use of a favorite four-wheeler. It's called the Camtec V.P.S. II. This antitheft, or antiuse, device features a coded activation system for your car's ignition system. Until you punch in the special four-digit code, your engine will



Camtec antitheft device keeps the ignition disabled until you punch in your code.

crank, but won't start. The car sounds as if it is out of gas. The V.P.S. II is designed to be hidden from view and supplements the standard ignition key. Installation time is about an hour with standard tools. Instructions and a 90-day warranty are included in the \$59.95 retail price. Information on the Camtec V.P.S. II is available from the Cambridge Technology Corp., Box 4130, Spokane, Wash. 99202.

—Joel Breault



This solar water heater can supply at least 42 gallons of hot water on sunny days. Any handy person who can make good soldering joints on copper pipe can construct it.

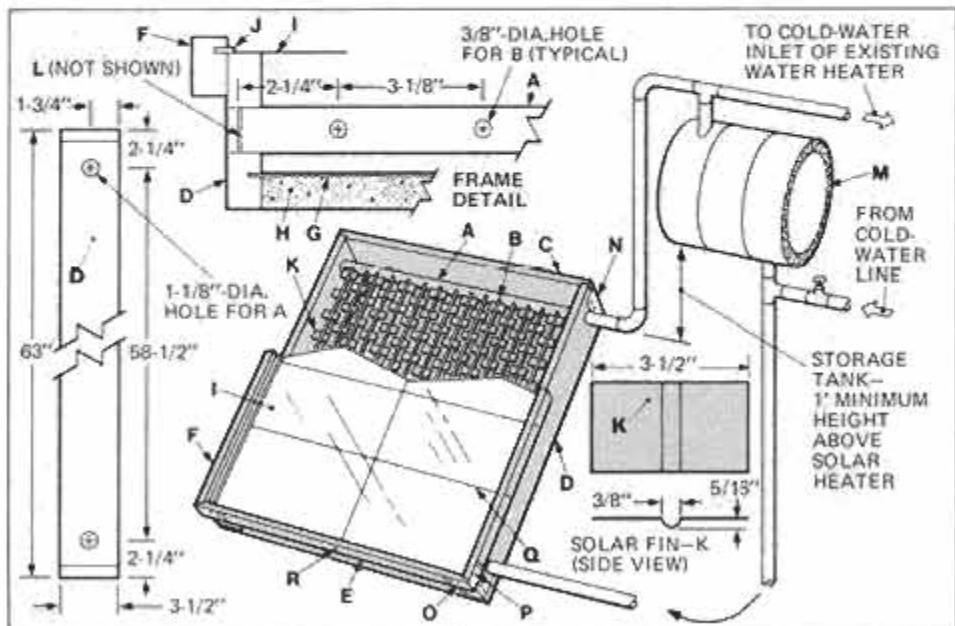
Build this solar water heater and lower your fuel bill

This solar water heater is an auxiliary to an existing water heater—electric or gas. It has cut our electric bill in Florida an average of 200 kw. hours per month.

A row of copper tubes is the basis of the solar water heater. Aluminum solar fins on the tubes conduct absorbed solar heat to water in the tubes. Water circulating by thermosiphon action keeps warm water rising to a 42-gal. insulated storage

tank above the panel. This water feeds to the existing water heater.

The solar water panel must face directly south. Its angle (degree of pitch) depends on its geographic location and latitude. The farther north, the steeper the angle must be. Note: In freezing climates, the solar heater must have a cold-water bypass that runs to the existing heater, because the solar-heating system must drain.



Building the heater

Begin heater construction by boring holes for the tubes in the headers and reaming them to exact size. Clean the ends of the tube with steel wool in order to assure good solder contact; solder all tubes to one header first. Solder the brass plugs in place.

The simple cover has a groove for wedges glued to secure the vinyl sheet. Fishing line passed over the vinyl, then passed through holes bored in the cover frame, with the ends wound around nails, helps hold the vinyl.

To insert the headers in the frame, elongate the frame holes and slide the headers in at an angle. Later, you can seal the holes with a wood filler.

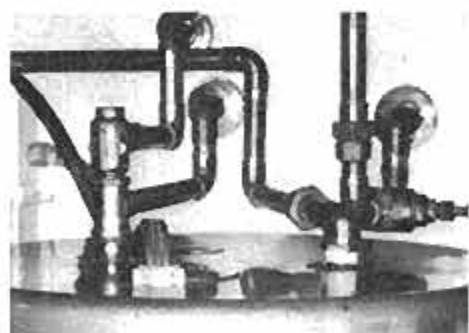
A simple die of a 2-in. oak cube helps shape the solar fins. Bore a 1 1/2-in.-dia. hole in the wood and cut through the hole lengthwise so that 1/16 in. of the diameter remains. Shape the fin to the block's contour with a 1/8-in.-dia. steel rod. Press-fit the fins on the underside of the tubes and spray-paint the metal black. Fasten the cover and install the panel securely.—Karl F. Frank

MATERIALS LIST—SOLAR HEATER

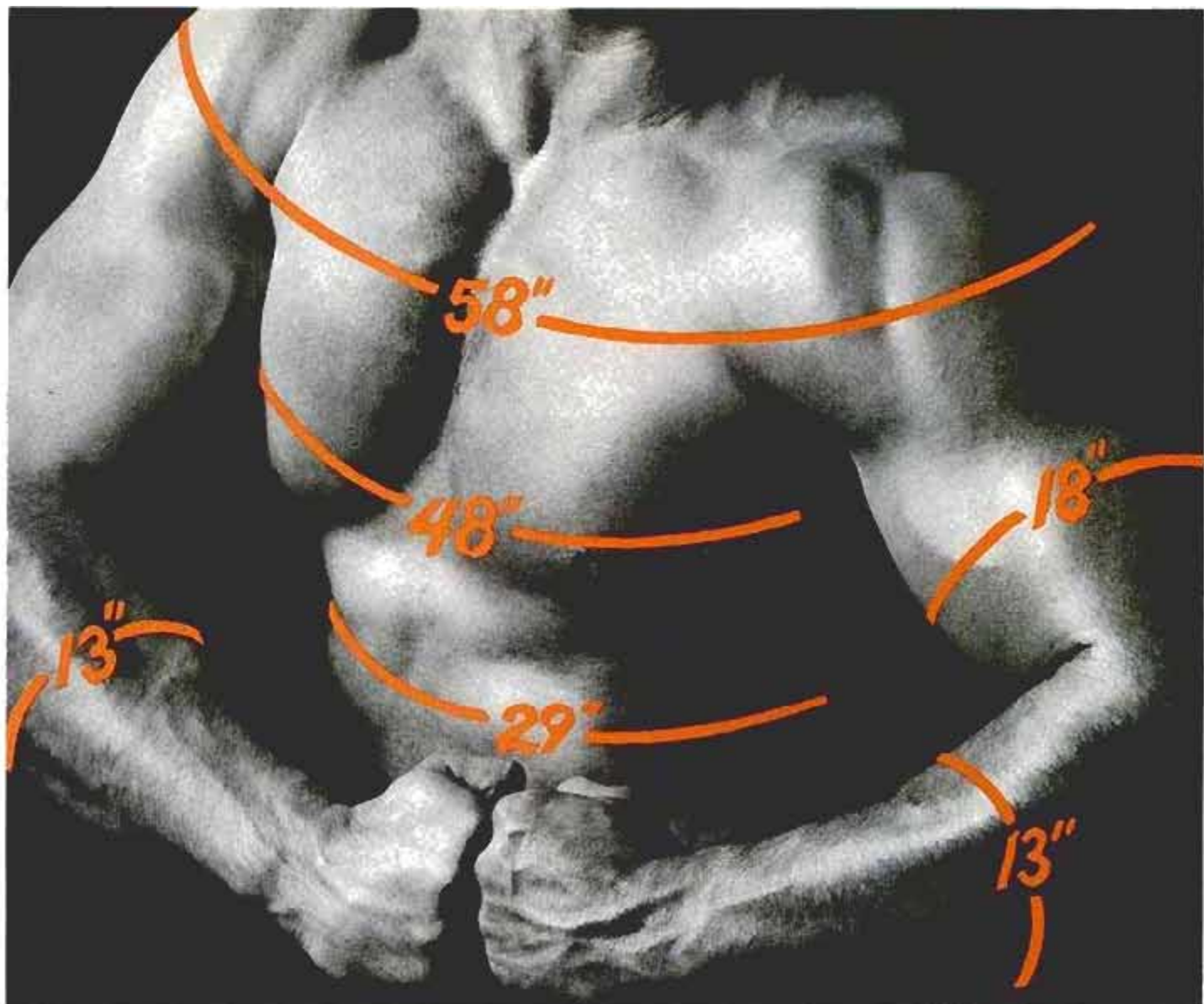
Key	No.	Size and description (use)
A	2"	1 1/8" o.d. x 53" type "L" copper tubing (headers)
B	15"	3/8" o.d. x 57 7/8" type "L" copper tubing
C	2"	3/4 x 3 1/2 x 49" redwood (frame)
D	2	3/4 x 3 1/2 x 63" redwood (frame)
E	2"	3/4 x 1 1/4 x 50 1/2" redwood (cover)
F	2	3/4 x 1 1/4 x 64 1/2" redwood (cover)
G	1"	1/8 x 48 x 62" hardboard (frame bottom)
H	1"	3/4 x 6 sq. ft. Styrofoam insulation sheeting
I	1	8-mil vinyl sheet, Sears catalog, No. 32KY42292C
J		1/8 x 3/8 x 20" redwood (wedges)
K	120"	2 x 4 3/2 x 22-ga. aluminum sheet, 10 sq. ft. (fins)
L	2	1/16 x 1.025"-dia. brass discs (end plugs)
M	1	42-gal. storage tank with insulation
N	4	3 x 4 x 4" sheet-metal angles (corner reinforcements)
O	4	1 x 4 x 4" sheet-metal angles (corner reinforcements)
P	48	3/4" No. 10 sheet-metal screws
Q	†	Braided steel fishing line (secure vinyl)
R	†	Nail to secure fishing line ends

Misc.: 1 1/2" No. 8 fh woodscrews, flat, black heat-resistant paint, solder, Elmer's professional cabinetmaker's contact cement.

†Increase by the number of increments that the unit will be enlarged. †As required.



Cold-water pipe with valve (right) bypasses electric water heater and leads to solar system. Pipe entering from left is hot-water return from solar storage tank.



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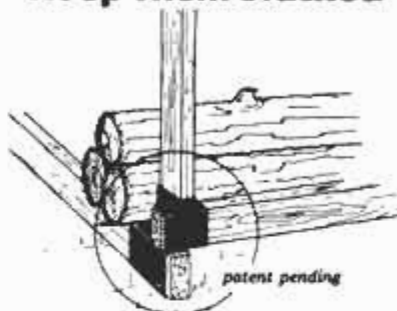
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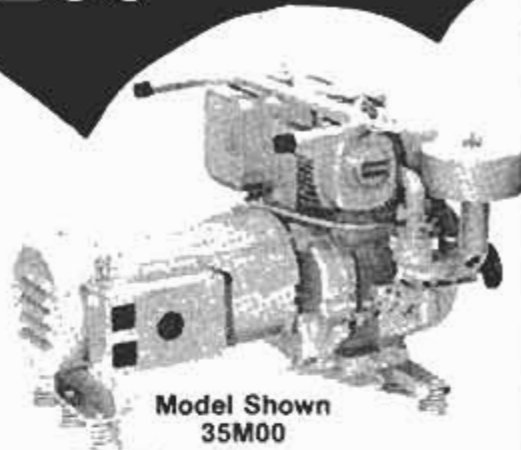
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50M00	5000	Manual	120/240	\$640.00
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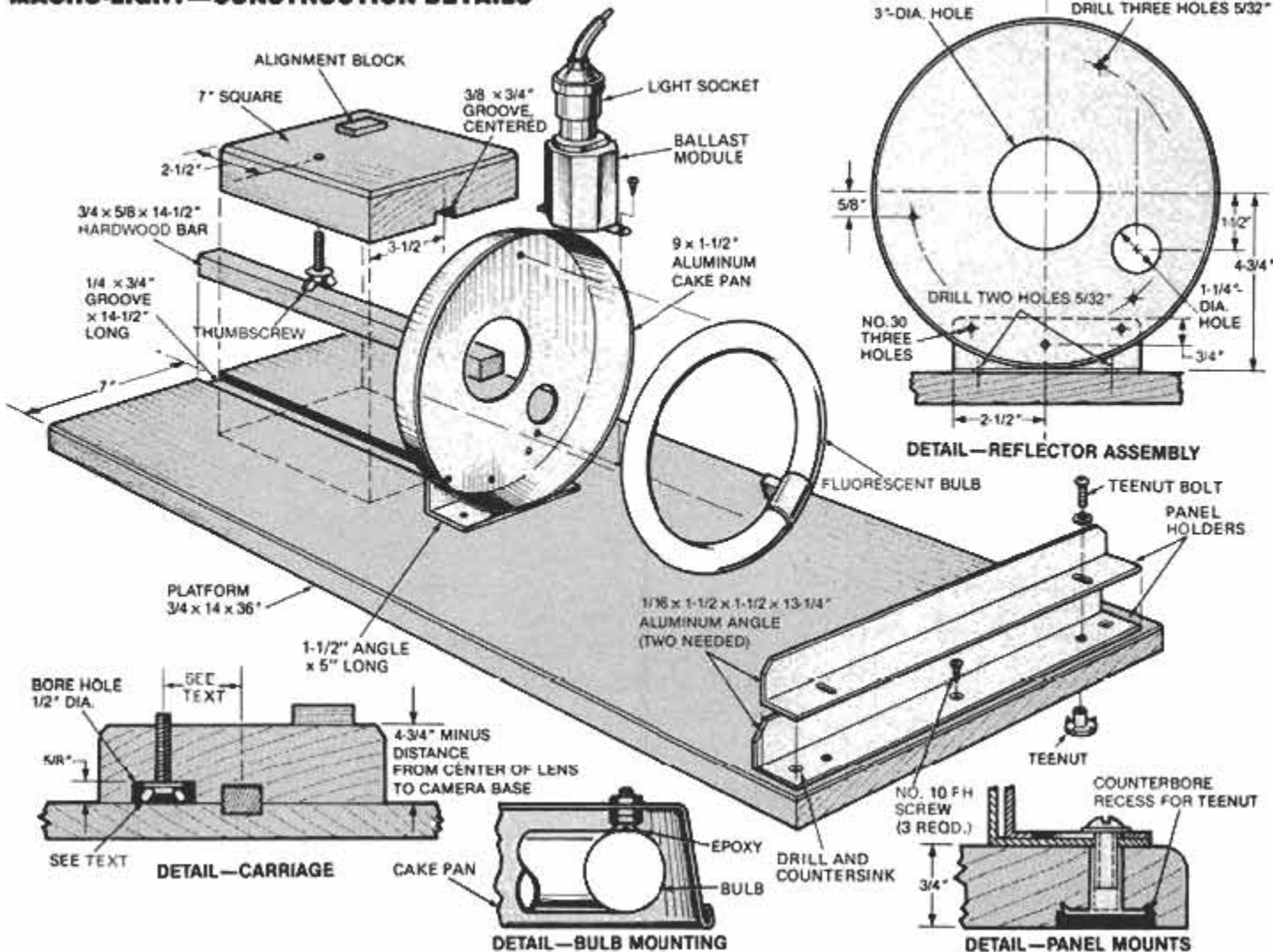
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MACRO-LIGHT—CONSTRUCTION DETAILS



LIGHT FOR CLOSE-UP PHOTOS

(Continued from page 25)

al thickness of the material used, the support will handle stock up to 1/2 in. thick.

MATERIALS LIST—MACRO-LIGHT

- | Amt. | Size and description (use) |
|------|---|
| 1 | Circular fluorescent bulb: part of Energy Saver Adapter, made by Lights of America, 204 Yellow Brick Rd., Walnut, Calif. 91789. Usually \$9 to \$10 |
| 1 | Ballast module: part of Energy Adapter |
| 1 | Replacement socket, rotary or pushbutton switch |
| 1 | Two-pronged electrical plug for fixture wire |
| 1 | Lamp cord, length to suit |
| 1 | Aluminum cake pan, 9 x 1 1/2" (reflector) |
| 2 | 1/8 x 1 1/2 x 1 1/2 x 13 1/4" aluminum angle (background-panel supports) |
| 1 | 1/8 x 1 1/2 x 1 1/2 x 5" aluminum angle (reflector support) |
| 1 | 3/4 x 14 x 36" plywood (base platform) |
| 1 | 3/4 x 5/8 x 14 1/2" hardwood (track bar) |
| 1 | 7" square wood block, thickness to be determined, built up from plywood or solid stock (carriage) |
| 1 | 1/2 x 1/2 x 1 1/2" wood (alignment block) |
| 1 | 1/4-20 thumbscrew (if unavailable in required length, see text for customization) |
| 2 | 10-24 Teenut |
| 2 | 10-24 x 3/4" rh bolt |
| 2 | No. 10 washer |
| 2 | No. 8 x 3/4" fh wood screws |
| 2 | No. 8-32 x 1" fh bolt |
| 4 | No. 8 x 3/4" rh wood screw |
| 3 | 1/8" short aluminum Pop rivet |
| 3 | No. 8-32 x 1/2" fh bolt |
| 9 | 8-32 hex nut |
- Misc.: Five-minute epoxy cement

With the lower angle installed, clamp the upper angle in place and drill two No. 10 holes through both angles and the platform. Remove the upper angle and file the slots as shown. Open up the No. 10 holes in the platform to 1/4-in. dia. for a minimum depth of 3/8 in. and countersink the underside of the platform. The 1/4-in. holes can run up to the lower angle, but not through it. Press in the 10-24 Teenuts, using the bolts to draw them tight while maintaining alignment. A dab of epoxy on the

nuts' exterior portions assures permanence.

Two 1/2-in. holes can now be drilled in the platform to match those drilled in the base of the reflector support and countersunk on the underside for No. 8 screws. The reflector support will be installed after you have assembled the reflector and bulb.

Position the ballast module as sketched and pilot-drill the platform for the two No. 8 mounting screws.

(Please turn to page 94)



The 22-w. fluorescent bulb described in the text is equivalent in light output to a 100-w. incandescent. Bulb comes with both a base and a ballast module, costs around \$10.



Underside of camera carriage shows thumb-screw arrangement. If you can't find a screw long enough, make your own from any 1/4-in. threaded rod—or long bolt.

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PM builds Heathkit's portable power system

A Heath-Watt can weather a blackout or light a campsite. PM built one and tested it on a ham radio Field Day.

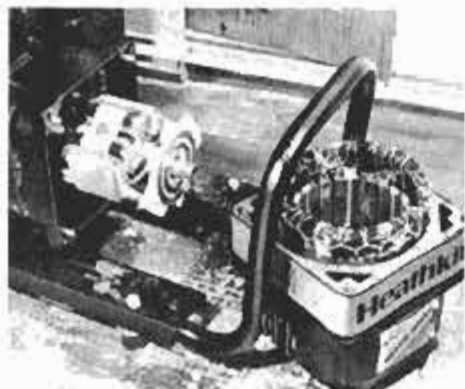
by Neil Shapiro, WB2KQI
ELECTRONICS EDITOR

The new Heath-Watt portable a.c. power system from Heathkit is not only handy and inexpensive (\$595 in kit form)—it's also an interesting kit to build from a learning standpoint. Often, when you put together an electronic kit, you wind up with no greater understanding of how the unit works than you had before beginning to build "by the numbers."

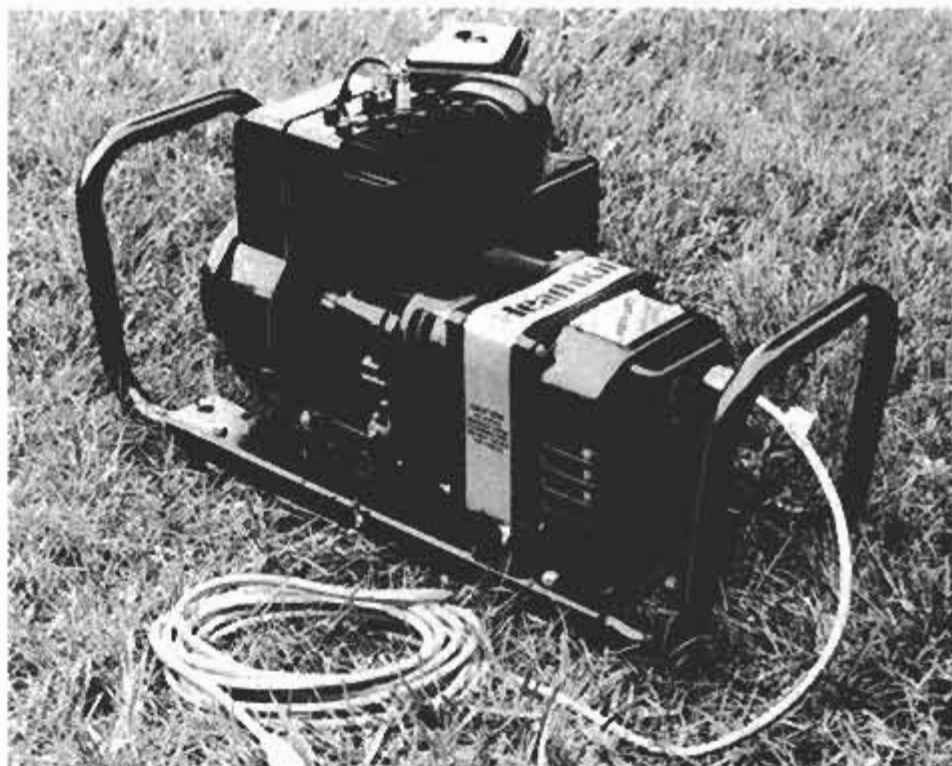
But after you assemble the Heath-Watt, you'll have gained more than just a 2,200-watt emergency power supply—you'll have acquired a "grounding" in the mechanical and electrical principles of power generation.

Putting it together

Unlike most electronic kits, when you unpack this one, you don't notice



The rotor magnet can be seen within magnet housing. Stator magnet lies disassembled on the tabletop. Rotor magnet spins within stator's interior magnetic fields.



Portable power of up to 2,200 watts can be yours with this new a.c. power generator from Heathkit. You should be able to build it in less than a week's worth of evenings.

how many parts there are, just how big the disassembled pieces seem. The rotor and stator magnets and the parts of the cradle—not to mention the factory-assembled 5-hp Briggs & Stratton engine—all add up to a finished weight of 84 pounds.

The kit went together in five evenings. I did it all myself, but a few times, wished I had asked a friend to help me steady some of the heavy parts. The only annoying building chore was pounding an end bearing into its tight-fitting housing.

Most of the assembly is mechanical; the little bit of wiring takes less than two hours.

Once it is all together, the final step is to "flash the field." You connect a lantern battery across the generator's brushes for about 15 seconds. This sets up a small amount of residual magnetism needed to start up the first time.

Hooking it up

Before you start things going, read the separate Briggs & Stratton manual. It will instruct you on the Heath-Watt's lawnmower-style engine.

The first time you run the unit, check that the a.c. current is correctly factory-set at 60 cycles per second. To do this, plug an electric clock into the running generator. The clock uses the frequency (cycles per second) of the a.c. current to time itself. So, if the clock runs slow, the engine must be speeded up; if it runs fast,

the generator must be slowed. This same technique may be used to check any generator's speed setting.

While the Heath-Watt is a strong little machine, it can't supply your entire household with emergency power. It will provide 2,200 watts of service, maximum. Trying to get more out of it will just burn out the windings on the magnets.

But 2,200 watts is enough to get you through a power blackout or to use on a camping trip. Odds are that you'll be able to run a refrigerator (about 500 watts for a conventional model, but more if it's a freezer-combination type), one electric-stove burner (about 1,200 watts per burner), some room lights and perhaps a few small appliances.

Heath includes a handy reference guide to typical power requirements. All you have to do is total the power requirements of everything you intend to use.

Bear in mind that this unit is designed to be used outdoors or in emergency situations. It should only be connected to your house wiring by an electrician who knows how to wire a manual transfer switch safely.

If you do decide to use this Heath-Watt generator on a camping trip, you should order the optional spark-arrest muffer. This type of muffer is required by law in many state and national parks to minimize the danger of the generator starting a brush fire.



Editor Shapiro mans his Field Day station, WB2KQI. Powered by Heath-Watt emergency generator, it consisted of Heath's

SB104A transceiver and SB line of accessories. More than 400 contacts were made with other hams working portable gear.

Emergency-powered ham radio

Amateur radio operators all over the country sat down at their microphones and code keys, the wind in their hair, the roar of their power generators competing with the static of the airwaves as the 1981 Field Day activities began. Every year, the American Radio Relay League (ARRL) sponsors this contest in which some "hams" set up their equipment outdoors or under emergency-power conditions, and other hams get points for talking with them. A 24-hour operation, Field Day is not only intense competition, but a prime test of the preparedness of this country's ham radio operators, who stand ready to set up emergency communications anytime and anywhere.

What better way, we thought, to test the new Heath-Watt power generator than to hook it to the Heath SB-104A ham radio transceiver and operate as an emergency-powered Field Day station.

Building both the Heath-Watt and SB-104A turned into a race against time, since Field Day was fast approaching. But thanks to Heath's modular construction techniques, the SB-104A proved an easy kit to assemble, despite its complexity.

The SB-104A operates on the five most popular ham bands of frequencies—the so-called 80-, 40-, 20-, 15- and 10-meter bands. The transceiver delivers about 100 watts of output in single-sideband (SSB) and continuous-wave (CW) Morse code.

We filled the Heath-Watt's gas tank; connected our extension cords; hooked up our station antenna to the transceiver. (We would be in the category of "Emergency Power with Home Station." Other hams would be "Emergency Portables," and still others would be normally powered at home. Bonuses would be given for emergency power, with

additional bonuses for being completely portable.) Then we waited for the 3:00 p.m. "bell."

At 3:00 (EDT), the bands came to raucous life as thousands of amateur radio operators sprang into action. Quick exchanges were made as hams in contact spoke in clipped voices giving their location and contest category.

By 10:00 p.m., I was beginning to weary of saying over and over again, "Your report is 1E—E for Edward—here on Long Island, New York." The 1E meant I was running emergency power at my usual location and I was the only operator. Many times I would speak with a club station that might have many operators. Then there were the logs to keep. I had to record each contact and keep an up-to-the-minute "dupe sheet" to avoid duplicating contacts.

The Heath-Watt was holding together nicely under this continuous operating pressure. A tank of gas (with the generator supplying less than half its rated wattage) was lasting 3 to 3.5 hours.

By this time, I had worked (spoken to) well over 400 stations from almost every state, including Alaska and Hawaii. For a while, I entertained heady thoughts of winning.

But at about this time, a friendly group of neighbors stopped by to inquire if I intended to run the Heath-Watt all night. Discretion seemed the better part of neighborliness (besides, they threatened to cancel their PM subscriptions), so I silently folded my ham radio for the rest of the evening.

By the next morning, when I got back on the air, the leaders had passed me by. But there's always next year. Already, I've made arrangements with a ham radio buddy to take the Heath-Watt and the SB-104A into the wilderness for the 1982 Field Day.—N.S.

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THE BRAIN VS. THE BURGLAR

Perim-A-Tron's™ central console, or "BRAIN", employs a microprocessor, making it the most advanced security system available for consumer use. With Perim-A-Tron™ on duty, small sensors monitor doors and windows ready to signal the "Brain" from as far as 250 feet, in the event of a break-in attempt. The "Brain" processes each signal instantaneously and sounds not only a self-contained 85db internal alarm, but also a second 95db remote siren to augment the inside alarm or for placement outside to alert neighbors and police.

The Perim-A-Tron™ is so easy to live with that pets can come and go through partly-open windows or sliding glass doors without triggering it, yet so vigilant that an intruder will set it off before he can enter.

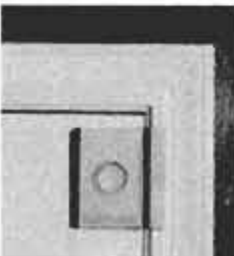
THOUSANDS OF OPTIONS

Perim-A-Tron's™ micro-computer lets you choose from thousands of three digit disarm codes. Only you know your code. But if your son's friend receives a "demonstration", you can easily change the code again...and again. You need no specially coded key which can be lost, misplaced, or stolen. The system even has two separate channels, each with its own distinct alarm sound. This feature allows you to zone your system. For example: Channel 1—house, Channel 2—garage, or Channel 1—doors, Channel 2—windows.

HOW IT WORKS

Operating the system is simplicity itself. When leaving, a light on the console tells you that you've armed the system properly, and have from 5 to 45 seconds to leave the house. This variable delay feature, not found on some expensive commercial systems, is selective so that it can apply only to frequently used doors. All other openings would be set for instant alarm. Upon returning home, you have ample time to turn the system off, thereby avoiding a false alarm.

If a break-in attempt occurs while you're away, an alarm memory light on the console tells you so. What's more, after sounding for



This photo shows a transmitter & magnet installed. If a break-in attempt occurs, the transmitter and magnet become separated triggering a wireless radio signal which activates the alarm. Installation takes only a few minutes and doesn't even require a screwdriver.



Perim-A-Tron's™ 20 button keyboard gives you protection a \$2,000 commercially installed system can't beat. Includes powerful remote horn.

10 minutes and scaring away the intruder, the system shuts off automatically and re-sets itself.

A CONSTANT GUARDIAN

Leave Perim-A-Tron™ in Test Mode during the day and it will signal when anyone leaves or enters. This thoughtful signal will not operate the remote horn but gives a 2½ second warning on the internal speaker only.

If power fails (or is cut-off), the console has a battery back-up. And each battery powered transmitter/sensor will signal at the console if the battery runs low.

The Perim-A-Tron™ system is highly resistant to false alarms because it is not sensitive to motion or sound. Pets can roam at will, curtains can blow in a breeze, you or your children can visit the kitchen for a midnight snack—all without setting off an alarm.

COMING HOME SAFELY

There is nothing more frightening than finding a prowler lurking near your house when you arrive home at night. Our system's EXTRA PROTECTION DESIGN lets you carry a transmitter in your pocket, purse or glove compartment (it's about the size of a cigarette pack). With simple modification, it serves as a PANIC device and will set off the alarm at the press of a button.

COMPARE IT

Hard-wired "commercial" burglar alarms can cost \$2,000 PLUS a monthly fee (and you still never own it). Motion and sound detectors cost up to \$200 per unit and cover only limited areas. Your home may require two or three of these units and, in most cases, no alarm will sound until AFTER a prowler is inside for 30 seconds or more. Perim-A-Tron™ combines pre-entry protection with micro-electronic circuitry to provide the most protection at the lowest cost.

U.L. LISTED

The Perim-A-Tron™ Home Security System is listed by Underwriters Laboratories as a burglary protection device, a rating which goes beyond electrical safety. To earn this listing our alarm was thoroughly tested for critical burglary protection functions such as transmitter range, sound volume, battery back-up, keyboard component life, battery failure warning, and test function. This tough-to-get U.L. listing resulted from the exacting standards engineered into the Perim-A-Tron™.

YOU BE THE JUDGE

We urge you to order just the basic Perim-A-Tron™ system (pictured above) for a 30-day trial period. Use it to protect your family while you sleep and to protect your home while you're away. Then if you're not convinced that the Perim-A-Tron™ is the most advanced, efficient security system available today, return it undamaged for a complete, no-quibble refund—including return postage. You are protected by a 90 day manufacturer's warranty as well as Shelburne's 25 year reputation for satisfied customers.

HERE'S HOW TO ORDER

To order simply send your check for \$199.95 plus \$5.65 for shipping and handling to the address below. Credit card holders can speed delivery of their system by using our toll-free number listed below. We will then promptly ship your Perim-A-Tron™ unit complete with easy-to-understand instructions and decals warning that the premises are protected. Additional transmitters are available for \$29.95 each, but one is not required for every door and window. Instead, magnetic contacts can be purchased and easily connected to the transmitter, allowing you to cover additional openings for as little as \$5 each. The instruction booklet is quite useful in helping you determine the correct combinations to protect your home or office at the lowest possible cost.

Give yourself some peace of mind—order a Perim-A-Tron™ today at no obligation.

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TECH LINES

New floor may save your life in air crash

Aviation

There are few things more frightening than stalling and losing control of a light airplane during flight. Dropping down, the plane rushes toward earth at speeds of 80 mph. Like facing a firing squad, you have little chance to get out alive.

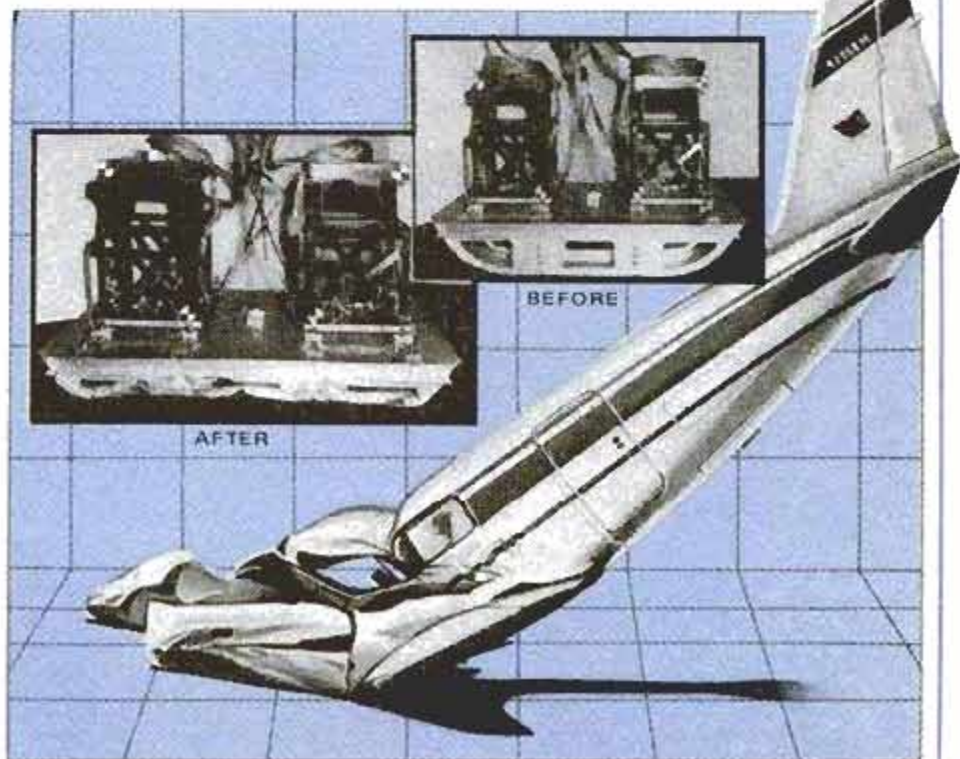
That grim picture is changing in your favor. Since PM's first report on research by the National Aeronautics and Space Administration into life-saving technology during light-plane crashes (*Target: A Safer Plane to Crash in*, page 83, Apr. '78), NASA has come out of the test laboratories with a floor structure that collapses to a predetermined level. The concept: a crushable floor system absorbs crash forces that otherwise would transmit instantly to the pilot and passenger(s). It's the same theory that a youngster employs when jumping from a barn loft: He cushions his fall with a pile of hay on the floor.

NASA researchers designed the floor system to match the thickness and contour of existing light-plane construction. The collapsible floor, which is 8 inches thick, is produced of standard airplane-gauge aluminum. It "somewhat resembles a honeycomb," according to NASA's Huey Carden, a member of the research team.

"We don't design airplanes," Carden explains. "All we can do is provide the advanced technology to manufacturers and permit these concepts to work their way into aircraft structure and save lives."

In 1980, according to a report from the National Transportation Safety Board, 1,375 Americans lost their lives in 3,799 general aviation accidents.

Full-scale plane tests of the new floor system will begin in March 1982—with dummies strapped aboard. Meantime, laboratory tests on seats and restraint systems continue under direction of a second NASA group. An energy-absorbing seat, anchored to a sturdy—yet collapsible—floor, takes a share of a crash jolt by "giving," to lower its occupant



Surviving a light-plane crash at 80 mph (normal stall speed) may soon be possible with the development of a shock-absorbing, crushable floor (lab-test photos, above).

more gently toward the floor. Various seat concepts are being considered by the NASA group at Langley Research Center, Hampton, Va., and by the FAA's Civil Air Medical Institute in Oklahoma City.

This research on crash dynamics is being expanded to jet transports. It will complement current NASA/FAA studies which are aimed at enhancing the chances of passenger survival in post-crash fires.

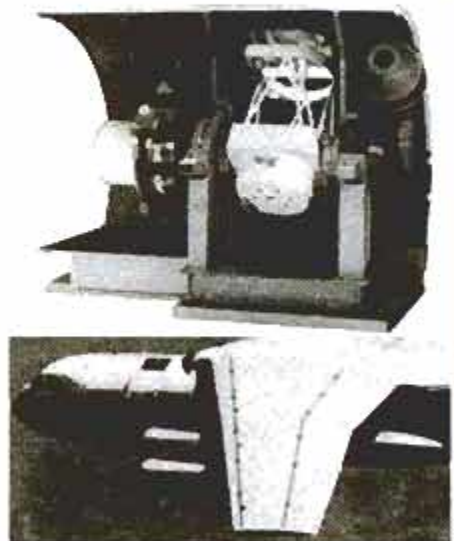
Troposphere sun study

Earthbound telescopes can't measure infrared wavelengths accurately because of atmospheric interference by water vapor. Solution: Spy the sun from above the atmosphere.

That's just what a group of scientists did during the July 31 eclipse. They mounted a 91-cm. infrared telescope on spherical air bearings in the bay of NASA's C-141 Kuiper Airborne Observatory.

Following the eclipse over the Pacific Ocean, the scientists collected data on the sun's chromosphere. This goal is best achieved during an eclipse and

from the jet's height of 13.7 kilometers (45,000 feet), which is in the Earth's troposphere, a region virtually free of water vapor. "It was a pace-setting flight," said a spokesman for the researchers.



Telescope (top) sights sun through open bay (bottom); sends data to a computer.

Energy

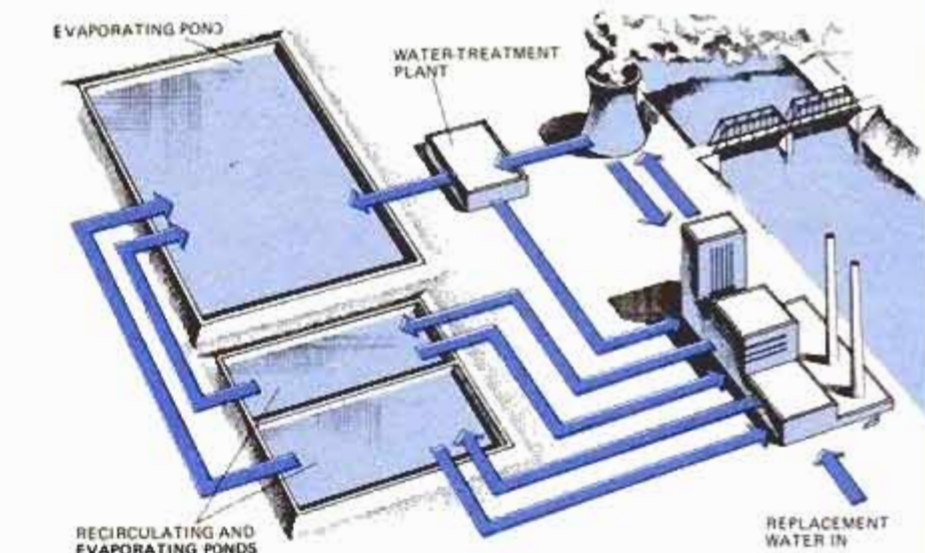
Water-saver utilities

Many an angry community has fought electric powerplants that dump tons of process water into local waterways. Western-state residents can be thankful for a small countertrend.

Driven by scarce water and strict environmental guidelines, more than 30 electric utilities there recycle most of their process water and evaporate what they can't use.

These new facilities are called zero-discharge powerplants, since they discharge no waste water into nearby lakes, rivers or streams. "Zero discharge also means the plants use less water in the first place," says John Muldich of the Electric Power Research Institute (EPRI), the joint research arm for U.S. utilities.

Muldich points out that zero-discharge plants are ideal for the thirsty West, but won't work in the rain-soaked eastern states. Evaporation ponds, exactly designed to handle plant water runoff, can't store rainfall as effectively. To build more clay-lined ponds would be expensive and would eat up precious land. And before very long, the ponds would fill up. Even in the hot, arid West, it takes



Worst water is sent to huge evaporation pond (upper left). Better water is stored in smaller ponds. Some is recirculated; some is treated. No water is sent to the river.

a full acre of pond surface one minute to evaporate about one gallon of water. After a time, residual gunk in the pond is cleaned out and buried.

Icy summer cooling

Cooling a house in summer with a huge reservoir of winter ice buried in the ground is an idea linked in the past with an electric heat pump (see *It's New Now*, page 58, Nov. '77). Now it's believed that winter ice alone is a rich source of energy for passive cooling of residences and commercial

buildings. So reports Anthony J. Gorski of Argonne National Laboratory, Argonne, Ill., after the first international workshop on ice-storage cooling, held at Argonne.

In one study presented, for example, cooling interior spaces with low-temperature air from stored ice proved an immediate saving over conventional airconditioning. Because air from ice coils is far less humid than airconditioner air, thermostat settings can be higher—and energy costs can be lower.

Electronics

Getting personal

The giant of computer firms has entered the arena of small-computer manufacturers in a big way. IBM's new personal computer is a direct challenge to such machines as the Apple II and TRS-80.

When rumors about the personal computer began, some predicted IBM would price itself out of the market. But the big company's stripped-down version sells for around \$1,500. You'll be able to buy it through IBM retail centers, Sears and J. C. Penney.

The new computer offers sound, color display and the ever-popular BASIC lan-

guage. The unit also features a detachable 83-key keyboard and automatic self-testing of its own componentry.

We watched IBM technicians put the new machine through its paces as a word processor, business-management tool and game referee. IBM will be releasing software, such as VisiCalc, Adventure and EasyWriter under its own label.

The new computer uses 8088 CPU (central processing unit) and is the first 16-bit personal computer (all others are 8-bit and operate at a slower rate). An IBM spokesman said the personal computer will be able to use up to 256K of optional memory (most other units offer a maximum memory allocation of 64K or less).



With an optional printer (left) and an 83-key keyboard, the new IBM personal computer becomes a word-processing center.

In its most inexpensive version, the IBM unit will hook up to the family TV and use cassette tape to store programs. For a larger investment, IBM will include disc drives and a printer.

Five plug-in slots are built into the new computer,

opening up the potential for future expansion using IBM peripherals and, perhaps, those of other makers.

PM plans to test this new entry into the personal computing field and report in a future issue. We'll let you know if the giant has reason to be jolly.

Inventions

Pinpoint search signal

Until now, enemy personnel could zero in on one of our downed fighter planes by listening to its radio distress signal. A new ranging system bamboozles the enemy, yet is so accurate the rescue craft can chart the downed plane to within 14 feet.

Developed by Edward J. Nessen, an RCA Government Systems Dept. engineer, the system (Patent 4,278,977) begins with a brief signal from the rescue craft. After a fixed delay, the pilot's radio responds. This time delay is converted to distance and the search-plane pilot plots it on his chart. Then he neither sends nor receives any more signals.

No more potholes?

Drivers may gain four advantages from a paving material being tested by the Connecticut Department of Transportation. A mix of asphalt and a cellulose derivative, the paver is an invention of York Research Co., Stamford, Conn. The gains:

- The mix appears to weather heat and icy cold better than existing materials.
- Cracks in an old road don't "telegraph" through a layer of the new material.

■ Impressively resilient, the stuff fills potholes without sinking under truck-load weights.

■ It costs about 17 percent less than conventional asphalt.

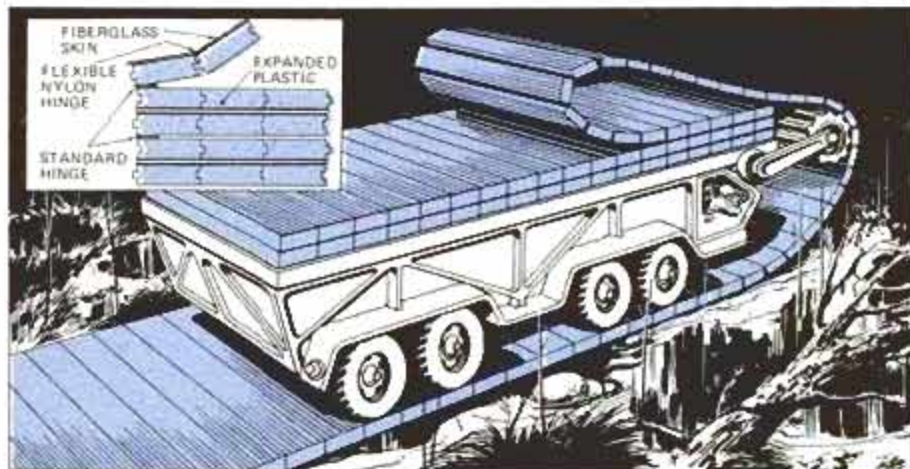
If tests follow the present schedule and are successful, the material will be available to municipalities by the fall of 1982.

Have road, will travel

Swampy land won't bog down Army transports—not even 70-ton tanks—when a tough, buoyant roadbed folds down over normally impenetrable land. Made with a steel skin to support the heaviest vehicles, this folding road

can also be made with a fiberglass or wood skin. A foamed plastic body keeps the road afloat on top of muck and mire. Standard hinges connect each layer of road atop the mobile carrier, while nylon hinges connect individual planks.

Designed by Army researcher William R. Abell, now retired, the roadway (Patent 4,277,201) is the solid-land-to-water link for an already-developed portable bridge. Into pilot production at Pacific Car & Foundry, the roll-off roadway could be in Army hands by late in this decade. Beyond that, the roadway may be adapted for commercial use if costs can be cut.



In swampy conditions, folding road rolls out in front of mobile carrier. Tongue-and-groove joints in plank (see inset) help to firm roadway under heavy Army vehicles.

Aerospace

Space assembly

How do you send a solar-energy-collecting platform as big as a football field into space? You don't. You send up parts, and astronauts in pressure suits assemble the pieces in space.

That's the practical solution technicians developed at NASA's Langley Research Center in Hampton, Va. Earth tests, such as the one at right, were completed in September. The next step is a try in space.

Astronauts will be working from a mobile station designed to fit inside the Space Shuttle Orbiter's

payload bay or fly free, operating near the Orbiter.

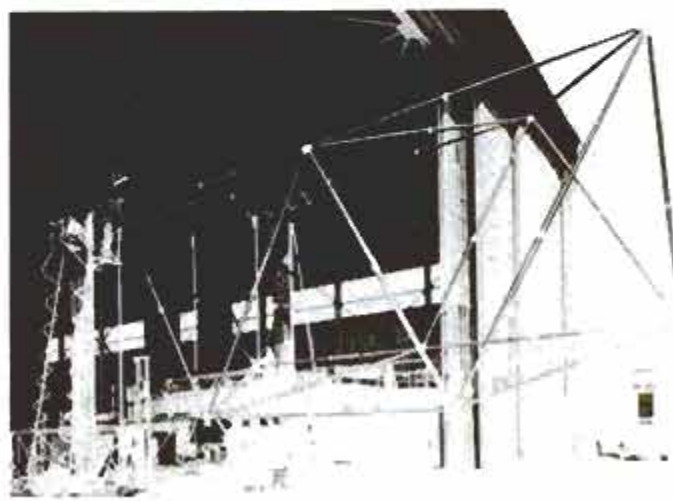
With foot restraints, two astronauts will attach them-

selves to the station, freeing their hands for assembly tasks. Work platforms, one on each side of the mobile station, would be electrical-

ly operated, either from the platform or from within the Orbiter's flight deck.

When a section of platform or antenna is completed, it will move along the "assembly line," at which point the astronauts would add more elements or equipment. Segments will be made from lightweight, graphite-epoxy conical tubes. These will stack compactly inside the Orbiter for transport into space.

Astronauts will assemble these struts into truss structures without using tools. The struts have quick-attachment cluster joints developed at Langley.



NASA tries out the space-frame assembly in a Langley hangar.

Editor: John H. Ingersoll

Contributors: Don Harris, Stacy V. Jones, Neil L. Shapiro, Gurney Williams, III

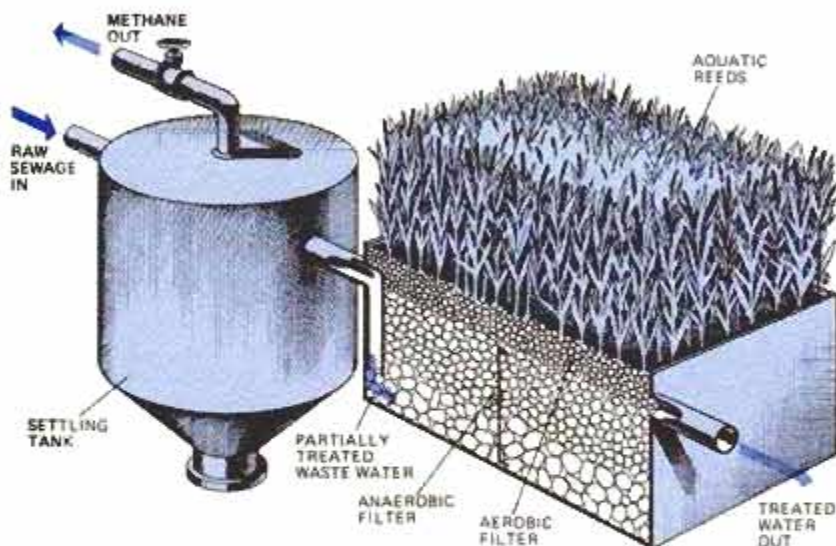
Environment

Space water treatment

Water is life. Since there are no spigots in space, astronauts have had to depend on a sophisticated recycling system that converts waste water to pure drinking water. Drawing on that technology, scientists at NASA's National Space Technology Laboratory in Bay Saint Louis, Miss., have developed a relatively inexpensive method for treating earthbound sewage.

Their system combines ancient know-how (a septic tank) with acquired data on the impurity-absorbing qualities of aquatic plants such as reeds or cattails.

Put it all together as in the sketch (right) and from the sealed settling tank (septic) comes a gaseous mix. This mixture is composed mostly of methane, a potential fuel, plus partially treated waste water.



First major test of NASA water-recycling system is planned for plant in Minden, La.

Water is drained into the base of a rock bed, where it filters up to an oxygenating pebble-and-root-system layer. According to NASA's Dr. B. C. Wolverton, the effluent (treated water) is well within safe bounds for return to streams, rivers or ocean.

With the right combination of filter,

plants and tank, this system can produce drinkable water, just as it does on space craft, for 21st century homes.

Aquatic plants not only remove normal impurities, but also have the capacity to leach out any toxic substances.

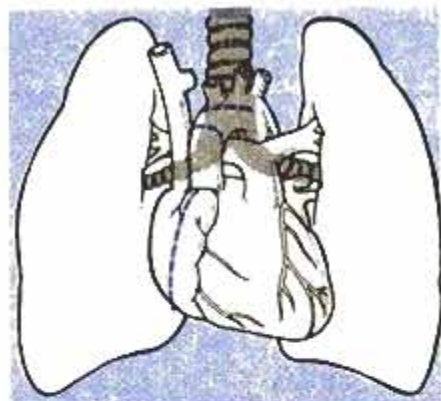
Medicine

Heart-to-heart check

Potential or present heart-related problems show up instantly for doctors using IBM's new electrocardiographic system. Your present EKG chart is compared with previous records, stored in the system on a floppy disc. The physician spots even slight variations and can interpret their significance for you.



Nurse with an IBM cart that takes and stores EKG record for later match-up with newer data. A less costly unit (in the foreground) records data and delivers printout.



Incisions are made in the right chamber of heart (lower left), aorta and windpipe.

Heart-lung transplant

Last July, 28-year-old Karen Wilson of Mill Valley, Calif., became the third person ever to receive a successful combined heart-lung transplant. Performed at the Stanford University Medical Center, Palo Alto, Calif., the six-hour operation corrected a congenital heart flaw that had impaired her lungs.

According to team physician Dr. Bruce A. Reitz, it will be many years before this still-experimental operation becomes routine. Stanford is currently planning four such operations a year.

Products

Mini-stargazer

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If you've ever tried to build anything more complicated than a birdhouse, you know you need more than a couple of simple tools. To give a professional look to those money-saving, money-making projects, like your own home repairs and remodeling jobs or building furniture and cabinets, you need a table saw, a vertical drill press, a lathe, a boring machine, and a disc sander.

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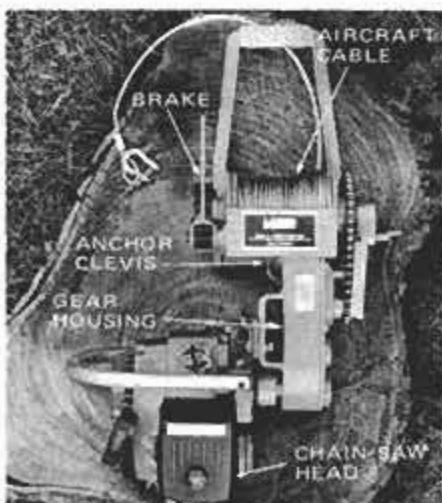
PM LOOKS AT WINCH POWERED BY CHAIN SAW



Winch, powered by chain saw, pulled these two 16-ft. logs 150 ft. up a ravine.



Before use, chain is fastened to winch clevis (Inset) and secured to a tree.



Unit holds 150 ft. of 3/8-in.-dia. aircraft cable or 250 ft. of 1/2-in. cable.

It's quite a feeling to be able to haul up to 8,000 pounds by pulling the trigger of a chain saw. That's what you can do with this winch designed to be powered by a chain-saw head. I tried out the unit on two 8-in.-diameter, 16-ft.-long logs. The winch pulled them over some rough terrain and through dense underbrush with no problems.

Such a tool is ideal for hauling firewood from places where your truck won't go. It would also be invaluable for stream or pond cleanup, dragging elk or deer out of a canyon, pulling a truck out of mud or a ditch, tightening fences, pulling machinery onto trailers, and so on.

Connecting the winch to a chain-saw head takes only a few minutes.—R. Joseph

SPECIFICATIONS—CHAIN-SAW WINCH

Construction: Tenzalloy aluminum
Capacity: 8,000 lbs. with snatch block
Weight: 20 lbs.
Prices: Winch with fair-lead and choice of cable (3/8 in. or 1/2 in.), \$365; snatch block, \$15.95; 1/2-in. x 250-ft. cable, \$48; 3/8-in. x 150-ft. cable, \$42
Manufacturer: Fred A. Lewis Co., 40 Belknap Rd., Medford, Ore. 97501



Chain at end of cable is looped and secured around log that is to be moved.



The winch can be used only with a chain saw having an accessible drive sprocket.

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ADJUSTABLE BEVEL CUTTER cuts 45° bevels from 1/32" to 5/16" wide

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Now you can drill perfect exact depth holes quickly, easily and automatically. Just slip the "Stop" on your drill bit and twist to tighten for desired depth. Eliminates guesswork, avoids costly errors. Use with Twist Drills & Masonry Bits. 2-PIECE SET has small & large "Stops" for 1/16" to 1/2" bits. No. 1500M **\$455** ONLY



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Instantly Magnetizes or Demagnetizes small tools—screwdrivers, wrenches, etc. Lifetime Magnet
Speeds up repair and assembly work. Can be used as a "retriever" by magnetizing end of long steel rod
To magnetize, tool is inserted into Magnetizer several times. Magnetizer is removed and tool is now magnetized
Magnetizer can be left on tool if desired
To demagnetize, tool is pulled over rounded side of Magnetizer core. No. 1532—ONLY **\$395**

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Fits any Electric Drill. 5" Diam. hollow surface has 400 sharp teeth for smooth finishes. Cuts wood, wallboard, plastics. Quality-made in U.S.A. of hardened tool steel. Never clogs or needs sharpening. Arbor has 1/4" shank. No. 1255M & "Best Buy" at **\$265**

SAVE! Get above Disc Rasp PLUS TWO EXTRA DISCS. No. 1255M only **\$5.25**

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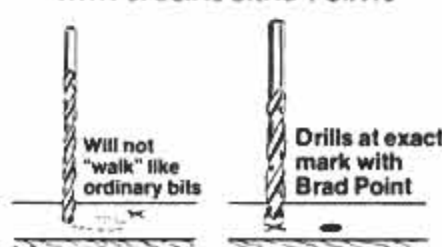


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Drills feature: Brad Points that dig into workpiece to lock bit for drilling at exact point desired. Prevents bit from "walking" off mark. 2 Cutting Flutes start & shape perfectly round holes. Super Sharp Flutes shave wood to a smooth, polished finish. No. 1960—ONLY **\$1595**

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Set of 8 Centers, 2 each: 1/4", 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1 1/4". Drill holes in piece of wood to be joined & insert Centers. Press other piece of wood against Centers & tap. Tap resulting punch marks for drilling opposite dowel holes. No. 584 **\$200**

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Build PM's power meter and stylus timer



PM's power meter (right, above) will show just how many watts are getting to your speakers. The stylus timer (pictured atop

the turntable) will meter out the hours your stylus has been tracking the grooves so that you will know when to replace it.

These handy add-ons can each be built in an evening and can save you from worn records or blown speakers.

by Jeff Sandler

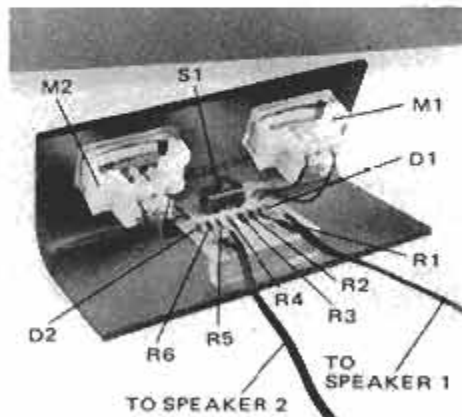
If you have an expensive stereo set, the most crucial and easily damaged components are the largest and the smallest—your speakers and your stylus. Here are two projects, a power meter and a stylus timer, that can be added to most stereo systems.

So don't worry about frying your speakers or playing worn records—just get out your soldering iron and build our two reliable audio policemen.

The power meter

A power meter, even a three-range one like ours, is a very simple circuit. Essentially, it's a resistor, a

diode and a meter in a series circuit. Its function is to measure the voltage going into the speakers. The more voltage, the more power the speakers use. The nonlinear meter scale converts this into the customary units of power—watts.



Power meter contains two circuits that are mirror images of each other—one power-measuring circuit with two meters, one for each of your speakers.

In the circuit, each resistor limits the voltage going into the sensitive meter and also determines the range of 1, 10 or 100 watts. Since there are three ranges, you need three resistors and a switch to select the desired range. The diode rectifies the a.c. voltage to the speakers into d.c. voltage that the meter can display.

But you need two independent meters, one for each stereo channel. The solution is to duplicate the circuit—so that you have six resistors, two diodes and one double-pole, double-throw switch.

In the construction, you solder these parts onto a printed-circuit board, along with the clips that will hold the speaker leads, or use point-to-point wiring. We supply a plastic holder (see parts list on page 86) or you can use your own design. Using hookup wire, connect the M1+ pad on the circuit board to the plus meter terminal. Likewise, the M1- pad goes to the minus meter terminal. This is repeated for the second meter, using the M2+ and M2- pads on the circuit board.

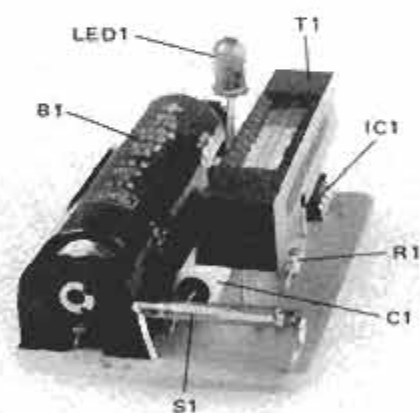
Next, glue the circuit board to the clear-plastic support rails. Set the board so you get a good view of it through the smoked plastic. Finally, connect the speaker wires to the circuit-board clips. One channel goes to the two clips on one side of the circuit board and the other channel goes to the other side.

Now you can test your system. On the 1-watt scale, even at very low volume, the meters will bounce in synchronization with the loudness. Of course, as you increase the volume, the deflection becomes greater.

You should switch over to the 10- or 100-watt range when the meter needles reach the end of the lower scale.

As you move up to the higher

(Please turn to page 86)



Stylus timer uses a unique mercury-plating device to measure the passage of time. When "used up," just reverse contacts and meter is reusable, as detailed in text.

POWER METER AND STYLUS TIMER

(Continued from page 85)

wattage scales, you may be surprised that the sound level you hear doesn't seem to increase nearly as fast as the meters indicate. In other words, 100 watts doesn't sound 10 times louder than 10 watts, but perhaps only twice as loud.

There's nothing wrong with the meters—your own ears' logarithmic response cuts down loud sounds and builds up soft ones. It's the only way you can make sense of the range of sound levels you hear in a typical day—where the loudest can be a billion times stronger than the softest.

But if you have a high-powered amplifier, the "compressing" effect of your ears makes it easy to fry a pair of speakers. They won't warn you that you're letting the volume get too high. Some systems can put out 100 watts (think how hot a 100-watt light bulb gets). So keep an eye on the power meters when you start cranking up the sound.

The stylus timer

The stylus tip on your record player leads a very harsh life indeed. While being crushed by up to 33 tons of pressure per square inch, it's dragged over two-thirds of a mile of hard plastic per hour. If that's not enough, it's whipped from side to side in the groove with accelerations of more than 100 Gs, up to 20,000 times per second!

Even a diamond, the hardest substance in the world, can't hold up indefinitely under these conditions. The result—a chipped, raspy tip abrading two-thirds of a mile of your valuable record groove per hour—is certainly something you would like to avoid. Unfortunately, you can't stop the steady erosion of the tip, but if you keep track of playing time, you can insert a new tip before your record player turns into a record shredder.

And keeping track of time is just what the PM stylus timer does. As

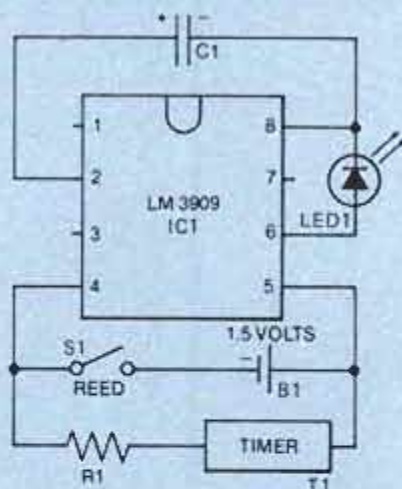
PARTS LIST—STYLUS TIMER

B1: AA-size battery, 1.5 v.
 IC1: LM3909 LED flasher integrated circuit
 LED1: Light-emitting diode
 R1: 430K carbon resistor
 S1: Reed switch
 T1: Mercury tube timer (Curtis Instruments)
 PCB: Drilled, etched and labeled printed-circuit board.
 Misc.: Drilled and machined aluminum case, small bar magnet.

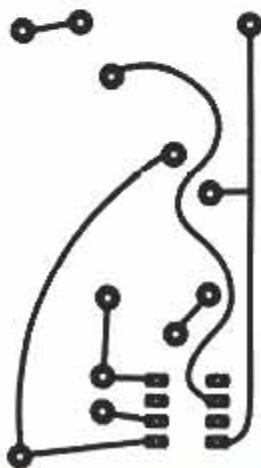
PARTS LIST—POWER METER

D1, D2: Germanium diodes (LN34A or equivalent)
 M1, M2: Meter with power scale
 R1, R6: 56K carbon resistors, 1/4 w.
 R2, R3: 24K carbon resistors, 1/4 w.
 R4, R5: 5.1K carbon resistors, 1/4 w.
 S1: d.p.d.t. slide switch
 PCB: Drilled, etched and labeled printed-circuit board.
 Misc.: Formed, machined, smoked Plexiglas holder, wire, solder, printed-circuit-board connection clips.

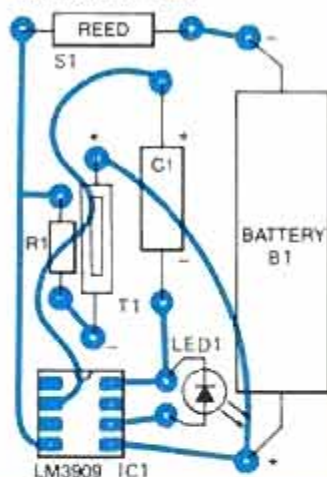
PM's STYLUS TIMER



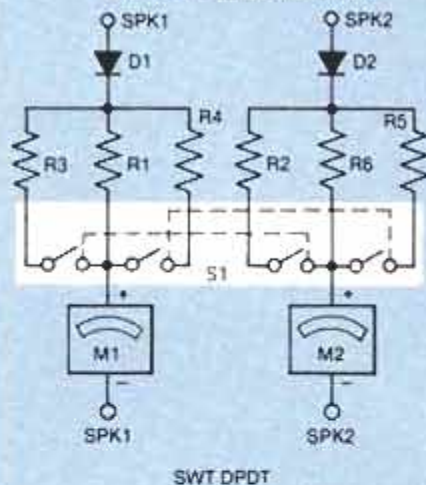
FOIL SIDE



COMPONENT SIDE

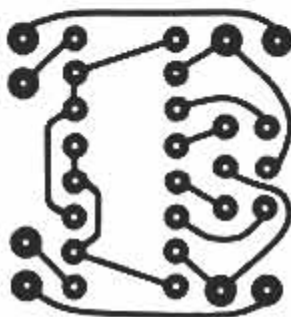


PM's POWER METER

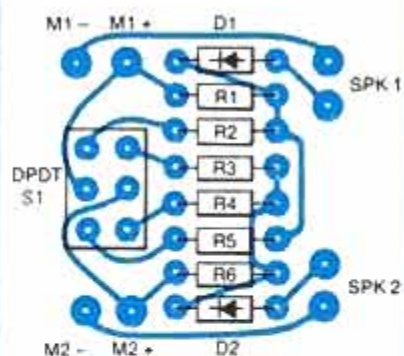


SWT DPDT

FOIL SIDE



COMPONENT SIDE



The stylus timer's foil-side template may be used to make the board. This component-side view shows you where the parts go.

soon as your records start spinning, the timer's LED starts to flash, and the elapsed-time meter moves down its 0 to 1,000-hour scale.

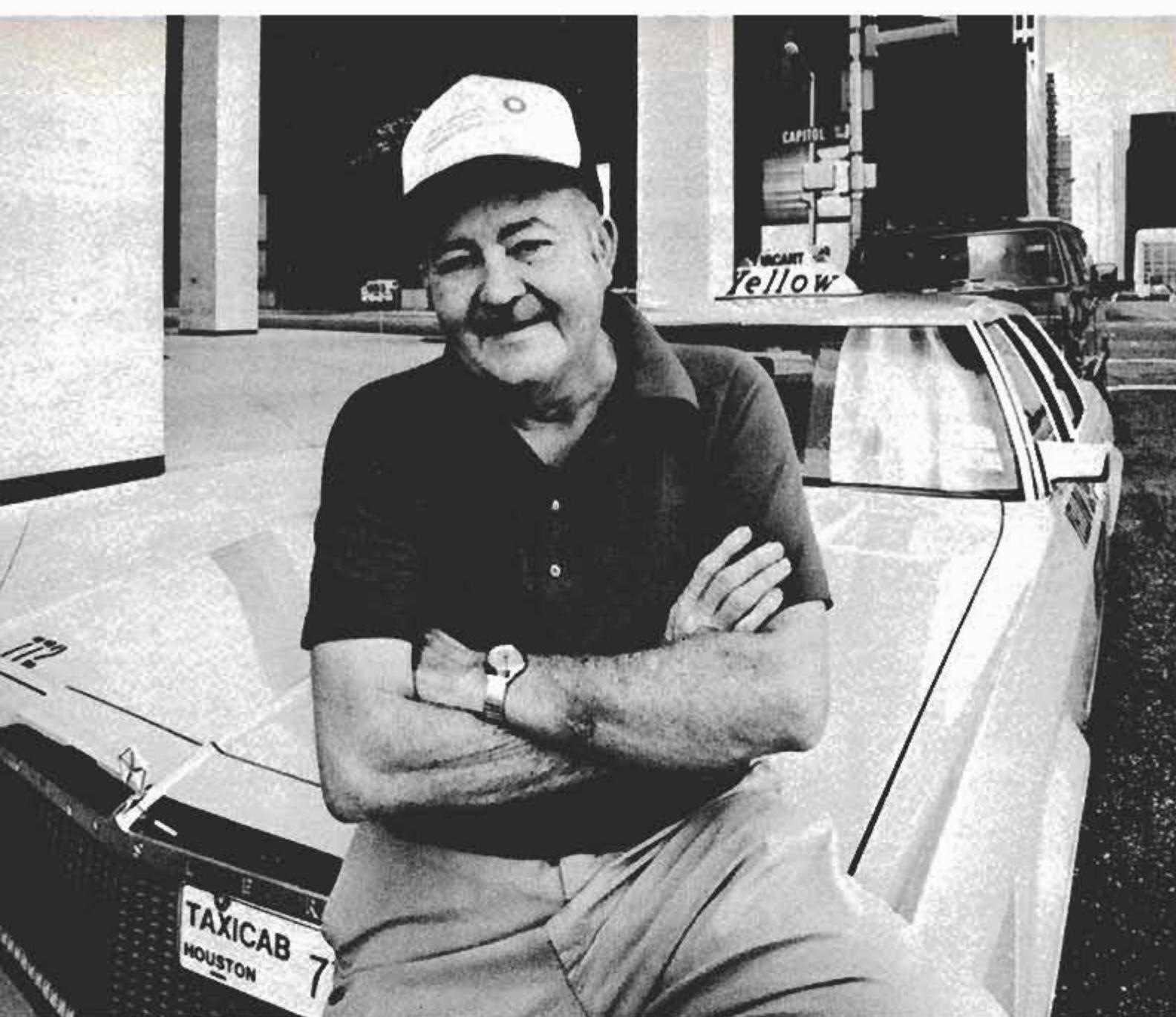
Actually, nailing down the exact stylus playing time isn't quite as simple as it first appears. Where do you tap into your system so that the timer is activated only when records are being played? For example, the

Foil and component views for the power meter show how to make a printed circuit. Or use schematic for your own layout.

ON-OFF switch is "on" when the radio or tape deck is used—neither of which wears out styluses. Applying the same logic eliminates such tie-in points as speaker outputs, switched outlets, preamp outputs and so forth.

But every time you play a record, you move the play lever, and when

(Please turn to page 89)



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Look for all three Exxon motor oils where you shop for oil.

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104-Page

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POWER METER AND STYLUS TIMER

(Continued from page 86)

the record is done, the lever snaps back on its own. So here is where the stylus timer records playing time with a magnetically activated reed switch. This way, you avoid the difficult task of "hard-wiring" into your system. (Our timer will work only on turntables that have such a lever.)

Inside the stylus timer case is an interesting combination of old and new technology. The flashing LED, which lets you know the stylus timer is "timing," is driven by a modern IC developed only a few years ago. This IC is so efficient, it can flash the LED for more than 3,000 hours on a single alkaline penlight cell.

The elapsed-time meter relies on the old and seemingly inappropriate technology of electroplating—plating one metal on another using electric current. During electroplating, the amount of metal which is plated is only a function of the current multiplied by the time the current is flowing. If you keep the current constant, then the plating becomes only a function of time, which is the variable we want to determine. But to determine the actual time, you have

to determine the exact amount of metal plated—not an easy task.

Enter a clever idea—so clever, in fact, that it was patented recently. Instead of plating solid metals, why not use a liquid metal—mercury? Put it in a small-diameter glass tube with a liquid electrolyte "gap" in the mercury column.

Changing sides

When the current is passed through the tube, the mercury on one side is plated onto the mercury on the other side of the gap. As the mercury changes sides, so to speak, the gap travels down the tube. The elapsed time is shown by the location of the gap on the printed time scale next to the tube.

In the circuit—as you might expect—the tube current starts when the reed switch closes (play lever on). The 430K (430,000-ohm) resistor sets the current so the gap takes 1,000 hours to go down the scale. Different resistors give other scales.

And the stylus timer can be reused. When the gap reaches the end of the scale, you reset it to zero by reversing the tube holder.

The function of the LM3909 IC and the capacitor is to flash the LED. They are powered through the reed

switch to give you a fail-safe indication that the timer is operating.

To use the stylus timer effectively, check how long the manufacturer recommends you should go between stylus changes. Typically, for diamond styluses, it's 800 hours.

But deviations from ideal playing conditions can cut this time considerably. Dirty records can knock 30 percent off the figure. Even more critical is the tracking force—the weight that holds the needle in the groove. The ideal force for good systems is around 1½ grams. Up at 3 grams, stylus life can be cut in half. Too little tracking force, however, is worse than too much: An underweight stylus "chatters" and chews out the sides of the groove.

So evaluate your record-playing system, and figure how long your stylus should last... then watch the timer.

PM

WHERE TO BUY PARTS

The following are available from Circuit Craft Inc., 10 Idell Rd., Valley Stream, N.Y. 11580. Prices include postage and handling.

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\$9.95—kit of power meter parts (less case).

\$16.95—kit of power meter parts including machined, formed, smoked Plexiglas case.

\$19.95—completely assembled, ready-to-use power meter.

Stylus Timer:

\$19.95—kit of stylus timer parts, including case.

\$24.95—completely assembled stylus timer.

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Small-bore, blown and beautiful: Riding Honda's CX500 Turbo



by Joel Breault

If you're a doodler, as I am, you've probably sketched more than your share of dream bikes. Mine usually have racing fairings, mag wheels, trick suspensions and plenty of horsepower. Evidently, the designers at Honda Motors in Japan have been looking over my shoulder, because they've just built my dream bike—the CX500 Turbo—the first turbocharged production motorcy-



Trim dimensions make this bike easy to handle when switched off, but also make it cramped for riders over 6 feet tall.

Ample ground clearance and monoshock rear suspension give the Turbo super handling.

cle in the world. From headlight to taillight, it incorporates every breakthrough that's occurred in the bike world in the last five years. And on top of that, it's a beautiful machine.

This bike is rolling sculpture. It has a wind-tunnel-designed aerodynamic fairing, gold-anodized Com-Star mag wheels, monoshock rear suspension, a computer-controlled fuel-injection system, a turbo, water cooling, shaft drive and enough space-age components to make Buck Rogers want to strap on his protective helmet, zip up his leather jacket and head for the most squiggly road in the county.

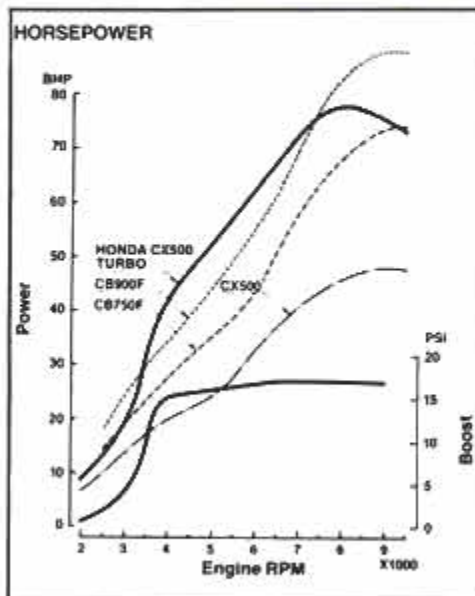
Power or reliability

Turbocharged bikes have been around for about six years in the aftermarket. The turbos are bolt-on items, borrowed from the car world. Most are like a light switch—when they're on, they're on; when they're off, they're off.

Bikes with bolt-on turbos spin out gobs of horsepower, but most can be ridden only in a straight line. Turbos are notorious for mid-range stumble

and lag time before the boost comes on. Sometimes, there's no boost until very high rpm—making it totally useless for anything but all-out drag racing. Detonation can be another

(Please turn to page 92)



Comparison of horsepower figures shows Turbo has more beans than a 750-cc engine. Boost is full on at 4,000 rpm.

Pocket Concert Hall PRICE SLASHED

Was \$199, then \$179—We cut it to only \$118
NOW JUST \$69

Cybernet has a problem. They built over 100,000 of these fabulous Pocket Concert Halls. They built them to be better than the Sony Walkman, but by the time they got them here, the price had already come down on the Walkman (it's now as low as \$139 in some areas) and lots of cheap Hong Kong made recorders have hit the market.

The Cybernet was built to sell for \$200 and wholesale for \$119. It has a very sophisticated dual flywheel tape drive system and superb electronics. To test a portable, shake it while you play music. If the music wows badly, or even stops, you have a cheap unit.

Both Sony's and Cybernet's can pass this test. Not many others can. So, if you want the best sound and the most stable unit, Cybernet has 35,000 left. And, at only \$69 (\$2.50 P&H) Order No. 9192, it's an incredible bargain. Remember this is a \$200 retail unit, and the January 1981 wholesale price sheet shows dealer cost at \$119.97. We'll be glad to send you a copy if you'd like to see it. You get DAK's 30 day risk free trial & Cybernet's 1 year warranty described below.

EXTRA HOME BONUS—We've made a special matching cable system so you can plug the Pocket Concert Hall into any line (aux) inputs in your home stereo. Now you can make copies of cassettes by playing them on the Pocket Concert Hall and recording on your main cassette deck, or just listen to your favorite cassettes through your home stereo. The sound is fabulous. Just \$4 (1 P&H) Order No. 9200.

First there was silence. Then from nowhere, there explodes an awesome kaleidoscope of sound. Violins from the left, trumpets from the right, while the sounds of a vocalist seem to come from somewhere above.

You've just experienced a breathtaking experience in sound. It's better than sitting in the middle of a full symphony orchestra.

As you take off the almost weightless 1½ ounce headphones and tentatively look around for the orchestra, the realization of the experience sinks in.

Now you can enjoy more beautiful sound from your cassettes while you are jogging or washing the car than when you are sitting in front of your stereo.

SOMERSAULTS AND CARTWHEELS
If you were on a diet yesterday, you probably lost more weight than the trifling 16 oz. of the Pocket Concert Hall.

The Concert Hall goes where you go with a protective leatherette case that easily hangs on your belt or rides comfortably in your pocket. It also comes with an adjustable shoulder strap.

Whether you're into gymnastics, long walks, or just mowing the lawn, you'll enjoy the unbelievably rich stereo sound of the Pocket Concert Hall. And, to prove our point, we offer you a 30 day risk free trial.

ENGINEERED FOR STRESS

Most fine stereo equipment is designed to be lovingly placed on a shelf and never moved. Obviously, this isn't a practical way to listen when you're walking your dog or riding a bike.

The Pocket Concert Hall incorporates a special dual flywheel tape movement system with a unique anti-rolling mechanism resembling a fine clock. It keeps the music smooth and stable, even when you're doing cartwheels.

The Pocket Concert Hall is specifically designed for rough treatment. Other machines are really redesigned dictation recorders. The Pocket Concert Hall is designed to provide superb stereo music while you're on the move.

You can expect years of enjoyment from this finely crafted revolutionary new sound machine.



MUSIC AT YOUR COMMAND

You won't be 'roughing it' when you leave home. You can play all your cassettes since there is an equalization switch for Metal/Chrome or standard.

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There are convenient lock-in fast forward and rewind buttons, plus cue and review. If you want to listen to a song again, just press the review button without ever leaving play.



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Cybernet is an extremely large Japanese Company with a large presence here in the U.S. They manufacture component systems valued in the thousands of dollars and sophisticated wireless transmission systems.

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WE'RE SOLD ON QUALITY.

RIDING HONDA'S CX500 TURBO (Continued from page 90)



The wind-tunnel-designed fairing keeps the rider well out of the slipstream at speed. Flaps in the fairing allow the heat from the engine to warm the rider in cool weather.

problem as can extreme internal heat from the increased horsepower. Also, unless the moving parts are designed from scratch for turbo-stress, they will eventually self-destruct.

Honda engineers have overcome the turbo objections. First, a special Honda-designed miniturno was manufactured by IHI (Ishikawajima Harima Industries). The impeller is the trick here. Its tiny, 48-mm diameter allows it to develop boost as low as 3,000 rpm. The impeller itself spends most of its time spinning at 180,000 rpm with a maximum full-boost speed of an incredible 240,000 rpm.

The turbo is located in front of the motor and as close to the exhaust ports as possible. Because the 80°, V-Twin produces intermittent induction demands and exhaust impulses (compared to a four-cylinder motor), a special resonance chamber was designed for low-speed operation and a surge tank was built for smooth, high-speed running.

The integral wastegate bleeds off excess boost pressure above 18 pounds per square inch (p.s.i.), its boost limit. Consider the fact that most auto applications run between 3 and 7 pounds, while drag racing bikes may run as much as 24 pounds.

The CXT spins out 78 hp at 8,000 rpm—a 63-percent increase over a stock CX500's 48 hp. The large amount of heat generated by this mill is dispersed by a radiator and water jackets around the cylinders. To eliminate the detonation problem, forged pistons are used and compression ratio is reduced from

10.0 to 1 in the normally aspirated CX500 to 7.2 to 1 for the turbo. The crank bearings have been made stronger, the clutch diameter increased, and the transmission is beefed up to handle the extra load. The oil sump is larger and features an integral oil cooler located under the motor. The four valves per cylinder allow the little CXT plenty of breathing room at high rpm (9,000 rpm redline).

This motorcycle allows Honda engineers to meet their design goals for the '80s—more horsepower from a small motor (78 hp), less weight (499 pounds), mileage (over 50 mpg) and futuristic but functional styling.

Digital computer

The turbo isn't the only trick feature on this spaceship. Computerized fuel injection (CFI), controlled by a digital computer system in the aft section of the seat, monitors fuel needs.

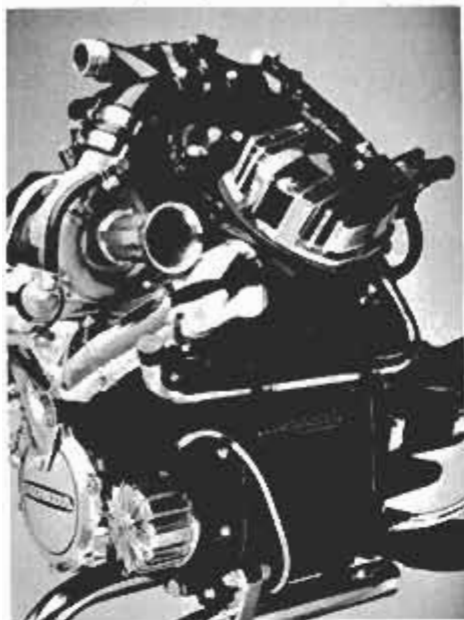
Various sensors check rpm, boost pressure, throttle opening, engine temperature and altitude and feed a constant flow of information to the computer. It determines the precise amount of fuel needed at any given moment for maximum fuel efficiency. The digital computer condenses all the input from the sensors, then two computer programs, called "maps," process the information.

One map works the low-speed fuel demands and the other map takes care of the high-speed fuel needs. The dual-map computer, built by Nippondenso, can withstand cold, heat, rain, dirt, vibration, microwave interference and other inher-

ent motorcycle problems. The system diagnoses any problems with the sensors and corrects them as necessary.

How well does all this technowizardry work on the road? Like it should. You punch the electric-start button on the right control pod and the motor comes to life instantly. The choke and start enrichment are controlled by the computer. Pull in the clutch, tap down on the shifter for first, ease out the clutch, add throttle and you're off.

The only way to test a bike like



The heart of the beast is the V-twin, water-cooled 500-cc engine. The tiny turbo is mounted between the cylinders, as close as possible to the exhaust ports.

this is on the local racer road. On an early production test bike, we headed east for the Angeles Crest Highway, 30 miles from the clogged freeways of Los Angeles and above the smog level. The bike's Pro-Link progressive monoshock smoothed out the freeway expansion joints.

At cruising speed, the CXT requires virtually no boost, as indicated by the turbo boost gauge located in the center of the instrument cluster. Other gauges monitor fuel level and engine temperature.

To ride this CXT fast, you have to shift quickly, like a motocross bike. This isn't always so easy to do, though. On a few occasions, the bike was running right on redline in the apex of a sweeper—and that's not the ideal moment for a gear change! Other times, I found myself running in a higher gear, down on rpm and falling off boost. This meant there wasn't enough drive out of the corners. A quick fanning of the clutch got the revs and boost back in line.

The suspension works well on both esses and high-speed sweepers—as it should. The bike sticks in the cor-

ners, holds your chosen line and is easy to pitch back and forth in the switchbacks. I got the CXT to twitch or wallow only a few times, and you can make adjustments to the monoshock Pro-Link system to correct this. Air-supported springs keep the front end from nosediving under hard braking. This is accomplished with a light touch on the hydraulic dual discs with double-piston caliper front stoppers and an equally light touch on the rear disc brake lever. Although the brakes never seemed to fade, the rear unit locks up very easily.

Honda has put the best into the CXT, including shaft drive, a fully transistorized high-energy ignition system, a sticky Bridgestone 3.50-18 on the front and a 120/90 x 17-inch rear tire, both V-rated for continuous speeds above 130 mph. The bike has a dry weight of 499 pounds.

My favorite feature is the futuristic and aerodynamic fairing. The windshield is positioned just right for my six-foot frame, as is the seat height, the foot-peg location and the 1-inch-rise handlebars. My knees just fit behind the 5.29-gallon fuel tank. A taller person might have trouble here.

The fairing-mounted turn-signal lenses were wind-tunnel tested and shaped to deflect the wind stream around the rider's hands on the handlebar grips. The fairing-mounted mirrors looked good, but had somewhat fuzzy images, depending on speed and vibration. The lower part of the fairing has vents and ducting to channel cooling air directly to the CXT's radiator. Internal and adjustable ducting allows the rider to use the engine's heat on a cold day or vent it to the outside. The fairing, constructed of hand-laminated fiberglass, is easy to repair in the event of a sidestand tip over. This should change to compression-molded 'glass for production models.

In the vanguard

The CX500 Turbo points the way for 1980s moto-technology. It's an incredible piece of complex machinery—perhaps too complex for the average owner who likes to do his own work. Techno-overkill has its price, and you'll probably pay it when the time comes for repair and replacement parts. (The price of the CXT has not yet been set, but it will be around \$5,000.) Still, when you flick the CXT into third, turn on the boost and let the revs climb like an ICBM, you can't help but form a smile that stretches from one side of your helmet to the other. You'll know that you've finally found your sketch-pad dream bike, too. **PM**

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

LIGHT FOR CLOSE-UP PHOTOS

(Continued from page 68)

This, too, will be installed at a later time.

To install the bulb, run two 8-32 nuts firmly onto each of the three flathead bolts to space the bulb from the reflector for maximum reflectance. Set them into the reflector and finger-tighten the holding nuts. (Particularly after the bulb is installed, these nuts should never be wrench-tightened, as the force may shear the epoxy bond—or break the glass.) Thoroughly clean the bulb and boltheads with acetone, lacquer thinner or alcohol and place a generous drop of epoxy on each bolthead. Being careful to keep adhesion-robbing fingerprints off the contact areas, center the bulb in the reflector with the electrical connector aligned with the 1/4-in.-dia. hole and set it on top of the bolts. After the epoxy cures, it's a worthwhile precaution to remove the bulb until final assembly. While the epoxy is curing, work can begin on the camera carriage.

Optical correction

Measure the distance from your camera lens centerline to the cam-

A man in a red cap and plaid shirt is shown in profile, smoking a cigarette. He is holding a large roll of blueprints. The background shows a construction site with wooden framing and a mountain range under a blue sky.

The first ultra

era base or motor drive. Subtract this measurement from 4 1/4 in. (centerline of reflector to platform) to determine the carriage height. More than likely, the carriage will have to be laminated from several layers of plywood or solid stock to achieve the required height.

After dadoing or routing the track slot to a slide fit with the track bar, align the camera on the carriage with the lens barrel parallel to the track and mark the location of the tripod socket. Should it fall close enough to center to interfere with the track, use a deeper counterbore for the thumbscrew. With the thumbscrew installed and the camera realigned, set the alignment block against the camera's back and epoxy it to the carriage.

If a sufficiently long thumbscrew isn't available, one can be made as illustrated, using either a piece of threaded rod or a bolt shank. Don't let the thumbscrew project more than 1/4 in. above the carriage or the camera body may be damaged by overzealous tightening.

Allowing for the maximum anticipated working distance from an elec-

trical outlet, wire a length of lamp cord to a replacement light socket that includes a switch. Assemble a plug to the other end. Screw the socket onto the ballast module and then install the module on the platform with the switch projecting away from the reflector.

Finishing touches

Other than painting the components, the sole remaining chore is cutting a background panel from plywood or cardboard. One panel with white and black opposing sides will contrast with nearly any subject matter—yet will be far enough behind the subject to preclude shadows at the anticipated depths of field.

Should a ring strobe also be used to capture live subjects monitored under the fluorescent, the reflector's aperture will have to be enlarged to accept the strobe, or the strobe mounted after the lens is inserted through the aperture. If other than flat illumination is desired, the camera can be pivoted on the carriage without the thumbscrew. In this case, an overbalanced

camera may require temporary support.

Another means of achieving biased light is to screw the track bar in place in lieu of gluing; this permits its removal to allow the carriage/camera assembly to be turned to shoot at an angle to the light plane (ordinarily, the camera is simply moved by sliding the carriage until object is in focus). A third method, although it reduces total light intensity, is to mask a sector of the bulb with cardboard taped to the reflector.

If a particular setup doesn't illuminate the white background sufficiently, a small spot can be directed to the panel, or a sheet of translucent glass or plastic can be substituted and illuminated from the back. Of course, meter readings will be taken directly from the subject, or a gray card placed at exactly the same range. When working with color film, a correction filter will compensate for the fluorescent illumination.

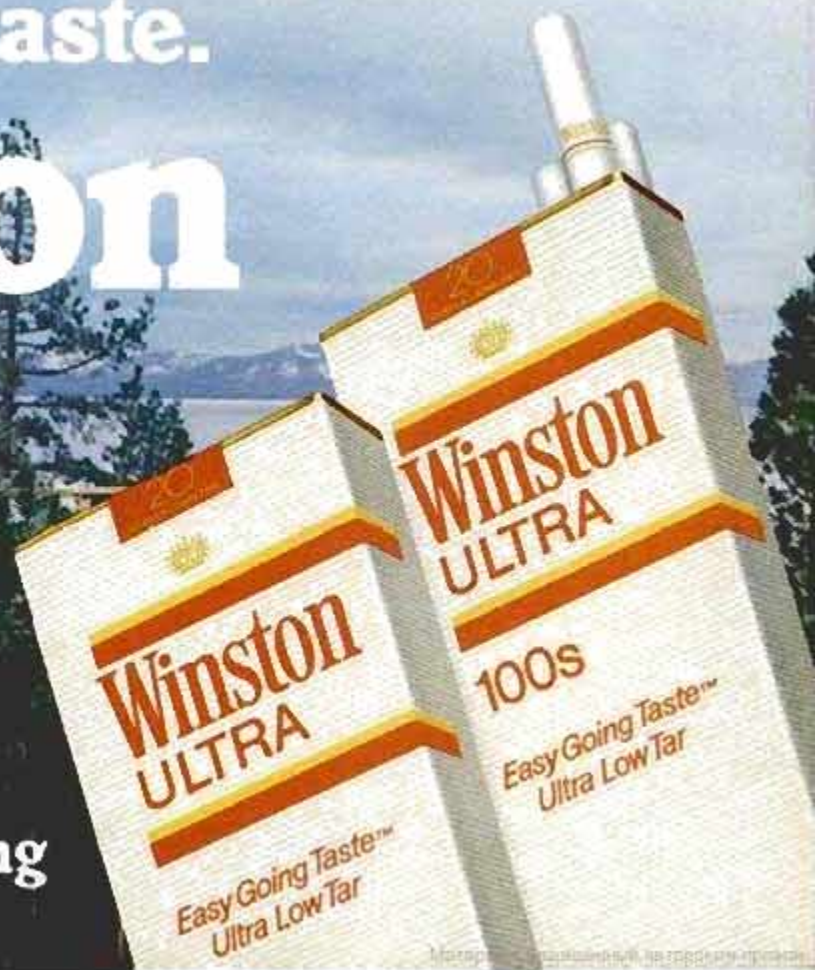
Now you can rack out the bellows, stack up extension rings and reverse lenses—and enjoy macro-photography. **PM**

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FINALLY, THE 'BUCK ROGERS' WEAPON

A 540-foot linear accelerator being built in California will tell us whether electrons are any good as bullets. If they are, the nation will have fired its first ray-gun prototype.

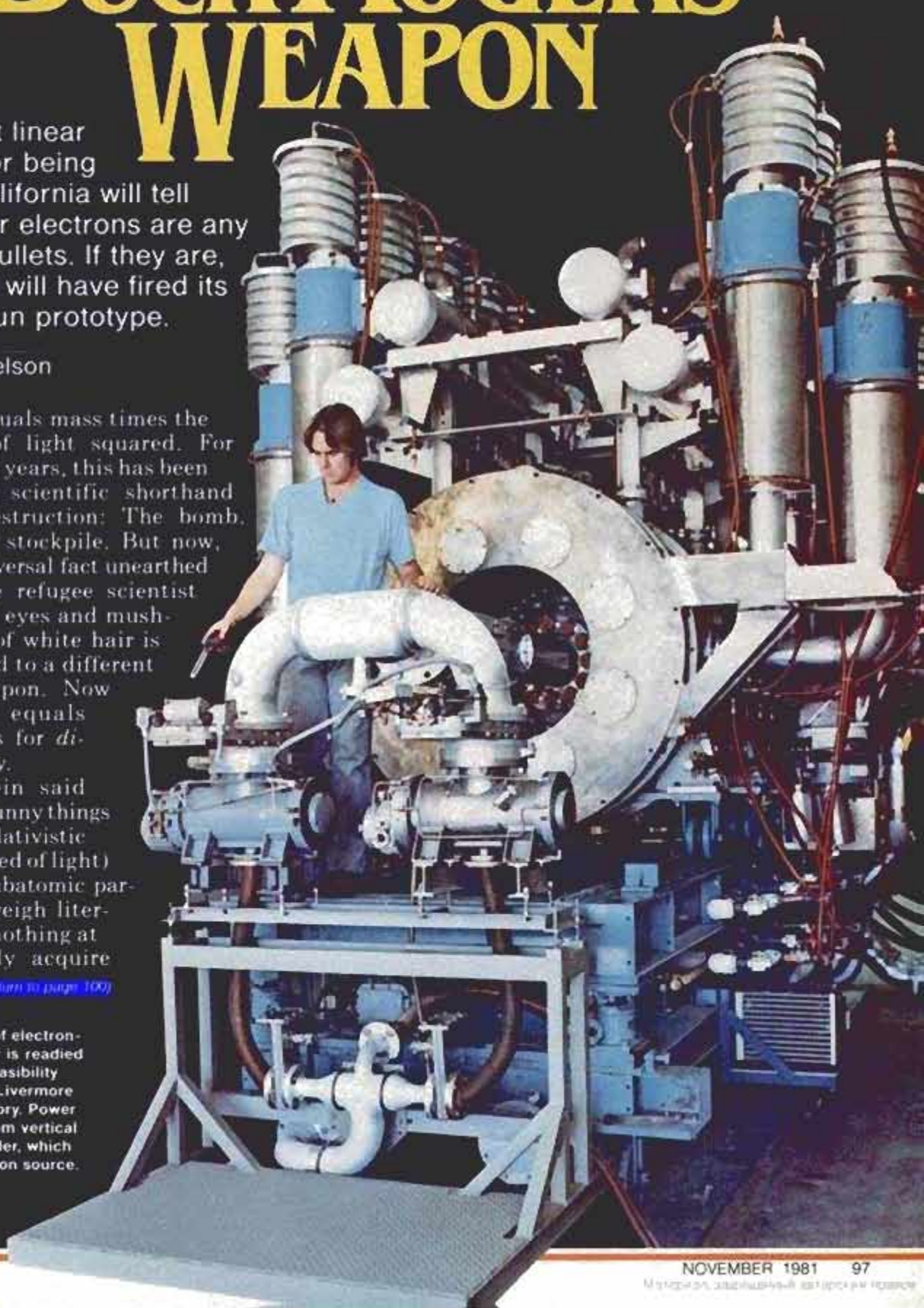
by Robin Nelson

Energy equals mass times the speed of light squared. For more than 35 years, this has been regarded as scientific shorthand for mass destruction: The bomb. The nuclear stockpile. But now, the great universal fact unearthed by the little refugee scientist with the sad eyes and mushroom cloud of white hair is being applied to a different kind of weapon. Now the E that equals $m(c^2)$ stands for *directed* energy.

As Einstein said they would, funny things happen at relativistic (near the speed of light) velocities. Subatomic particles that weigh literally next to nothing at rest suddenly acquire

(Please turn to page 100)

Injector section of electron-beam accelerator is readied to test weapon feasibility at the Lawrence Livermore National Laboratory. Power pulses are fed from vertical columns to cylinder, which houses the electron source.



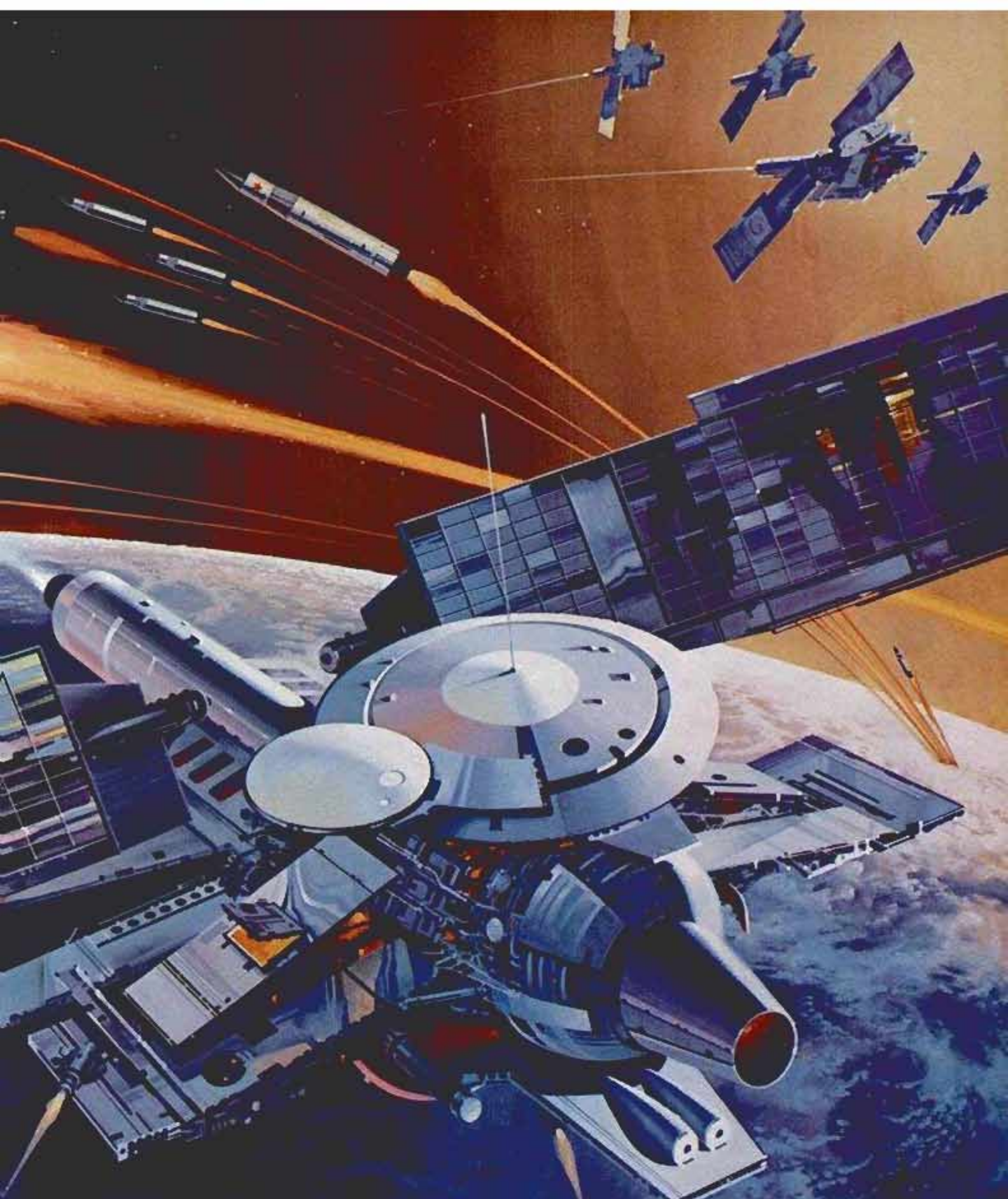


QUANTUM WAR: BEAM WEAPONS IN ORBIT!

Scenarios built upon the eerie, soundless violence of combat in space are no longer found exclusively in science fiction. In the '80s, we are printing them in the defense budget. Artist Paul Alexander's version here, of course, far outleaps current technology, but the basic elements are evolved from what is well known. ICBMs near the end of boost phase are being destroyed by orbit-

ing, directed-energy artillery units. Some missiles seem to fly on undamaged, but their guidance systems have been permanently disabled by huge jolts of energy delivered deep within the functional core.

Winglike panels contain some synthetic solar cells to supplement the reactor-powered electrical system of the beam weapon. But a major function of the array is to trap hydrogen ions from the solar



wind—these are the "bullets" with which the system reloads itself. Accelerated to nearly the speed of light in an electrical field along the barrel, the hydrogen ions are stripped of an electron—neutralized—as they depart. (In space, charged particles such as protons and electrons would scatter harmlessly due to mutual repulsion.) AWACS-type radar provides target data.—R.N.



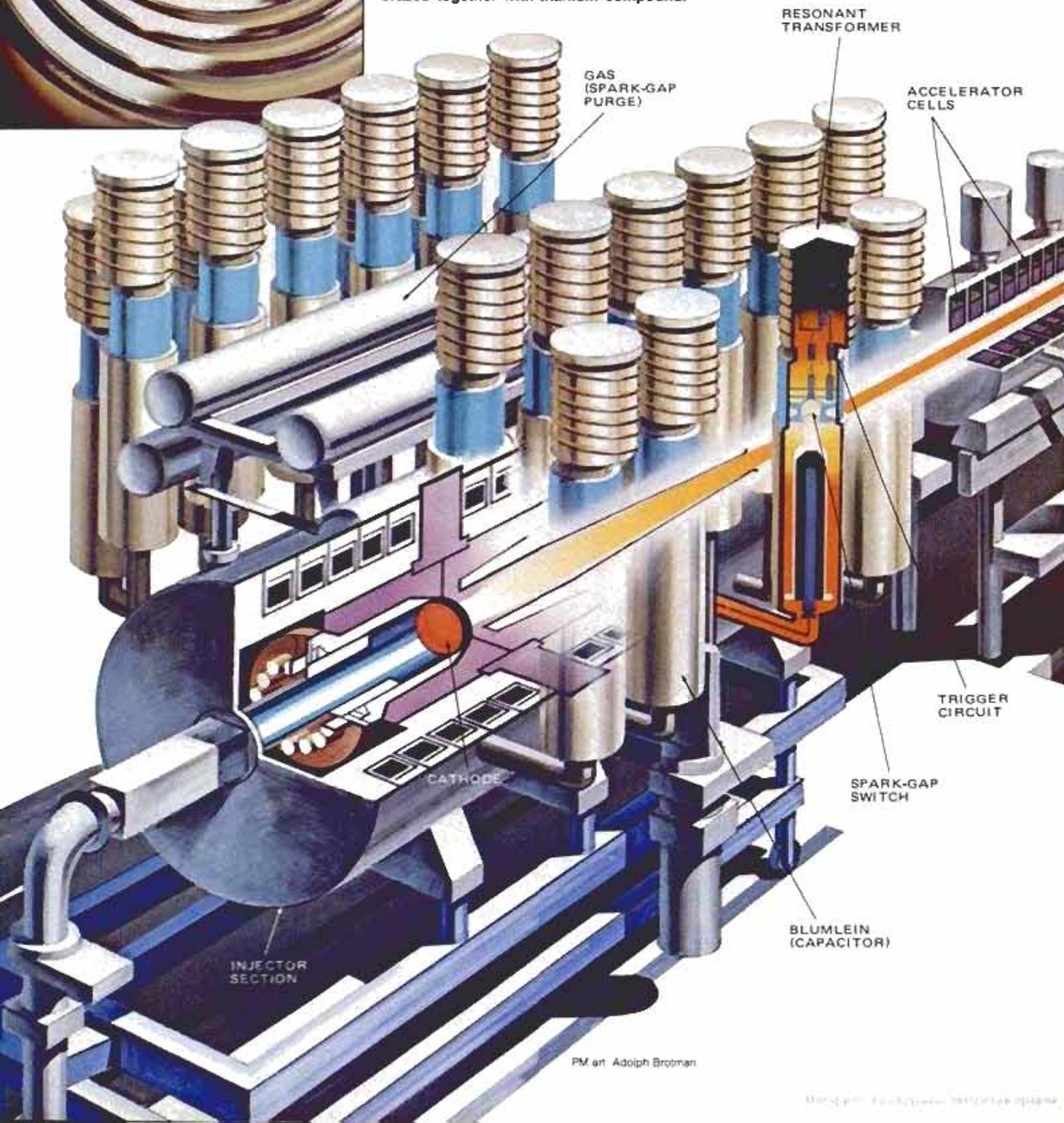
significant mass. But the actual speed of light is involved only as a limiting factor, by which Einstein predicted the total energy available in the destruction of matter—as in a nuclear reaction. The kinetic energy of any moving object, from a dandelion tuft to a falling safe, can be found by taking its mass times the square of its velocity.

This is why military technologists can get excited about a machine that

will accelerate the lightest discrete particle ever weighed—an electron—up to .999 times the speed of light. Electrons exiting this accelerator will effectively weigh 100 times more than they did on entry, 500 feet back in the system.

These numbers, however, tell only part of the story, since the behavior of the electrons upon contacting a target is what counts. The mass acquired in the accelerator is imme-

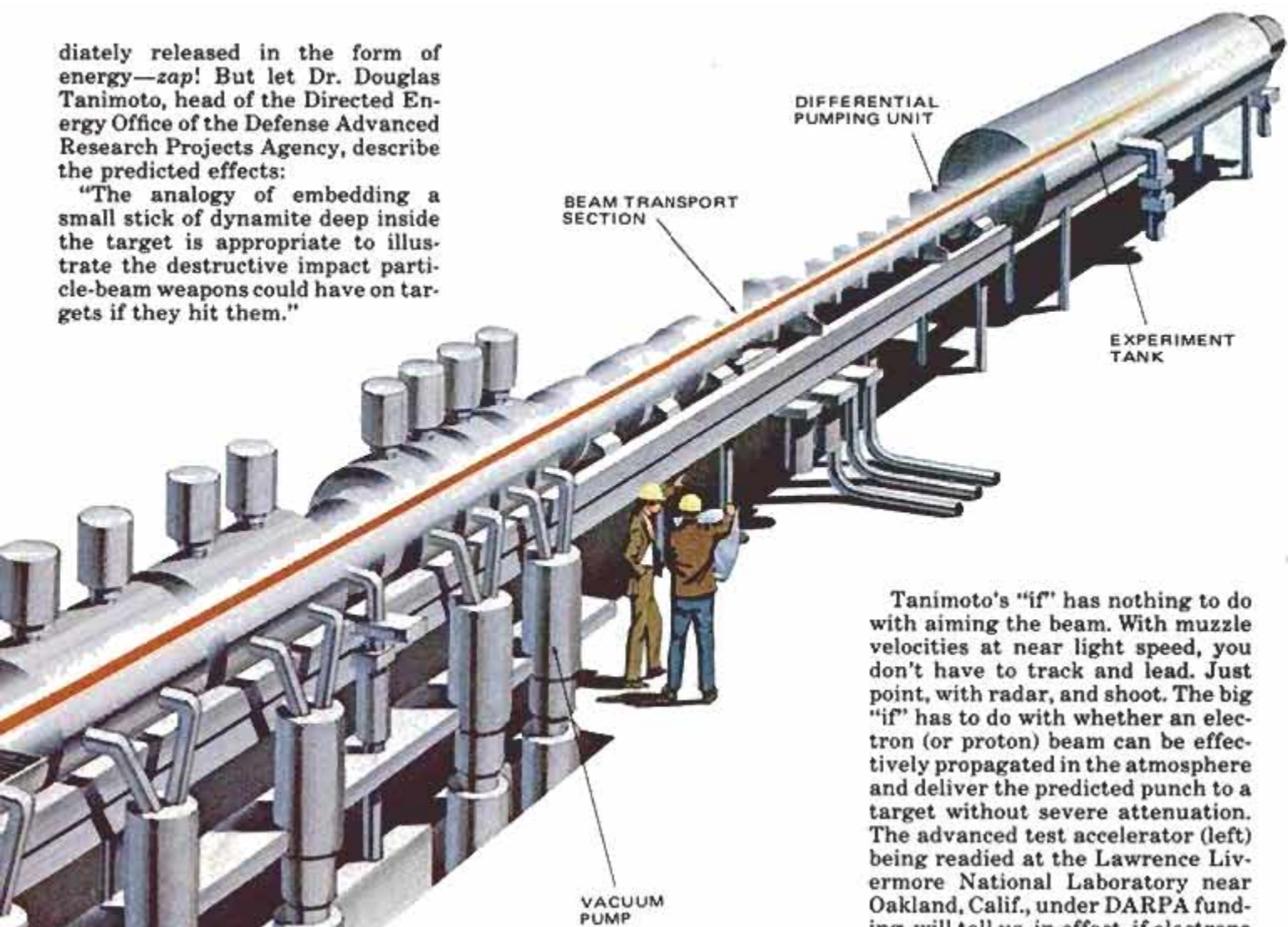
Outer shell of an accelerator cell is an airtight cylinder of copper and porcelain rings brazed together with titanium compound.



PM art Adolph Brotman

diately released in the form of energy—zap! But let Dr. Douglas Tanimoto, head of the Directed Energy Office of the Defense Advanced Research Projects Agency, describe the predicted effects:

"The analogy of embedding a small stick of dynamite deep inside the target is appropriate to illustrate the destructive impact particle-beam weapons could have on targets if they hit them."



Tanimoto's "if" has nothing to do with aiming the beam. With muzzle velocities at near light speed, you don't have to track and lead. Just point, with radar, and shoot. The big "if" has to do with whether an electron (or proton) beam can be effectively propagated in the atmosphere and deliver the predicted punch to a target without severe attenuation. The advanced test accelerator (left) being readied at the Lawrence Livermore National Laboratory near Oakland, Calif., under DARPA funding, will tell us, in effect, if electrons are any good as bullets.

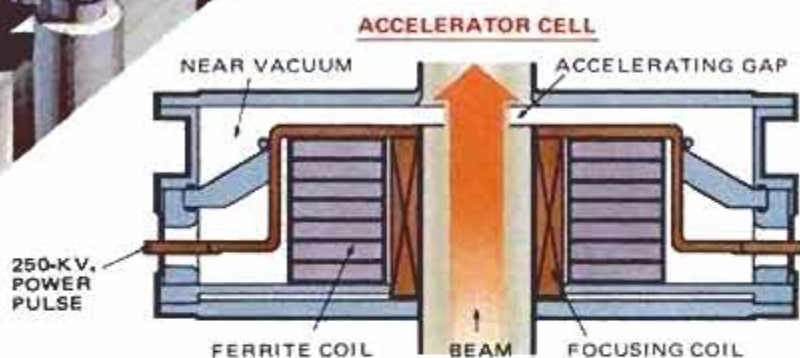
Up to now, particle-beam development has been a very small part of directed-energy weapons research.

Almost \$2 billion has been spent on high-energy laser research, and this continues at the rate of \$200 million per year. Yet even a working laser weapon could be thwarted by rotating targets at high speed, or ablative-type shielding. A laser has to chew its way from outside in. But in the case of a particle beam, "deep deposition of the energetic particles in the target," as Dr. Tanimoto points out, "provides a very high probability of catastrophic kill and makes shielding very difficult."

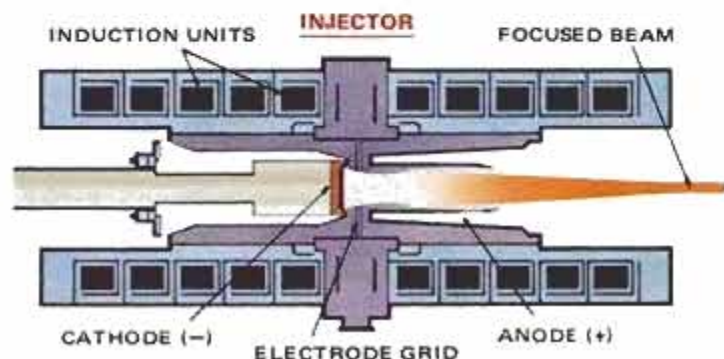
Soviets have the jump

Another reason particle-beam development will get more attention is that the Soviet Union is believed to be well ahead in testing weapons-grade beam technology. A facility has been identified near the Sino-Soviet border which apparently has an array of explosive-flux (Pavlovski) generators of the type associated with pulse-power for beam accelerator work. These relatively light units use explosives to collapse conductors around a strong magnetic

(Please turn to page 141)



Cathode (below) is a hot metal plate releasing electrons into an electric field; cone-shaped anode begins to form beam. Accelerator cell (above) uses timed power pulses to magnetically speed up electron beam and compress it as it passes.



Secrets of towing with your compact car

Combine the latest in hitches with good rig balance and driving techniques.

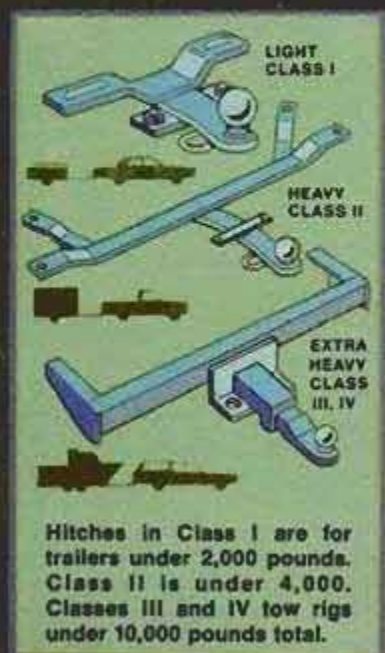
by Bill McKeown OUTDOORS EDITOR

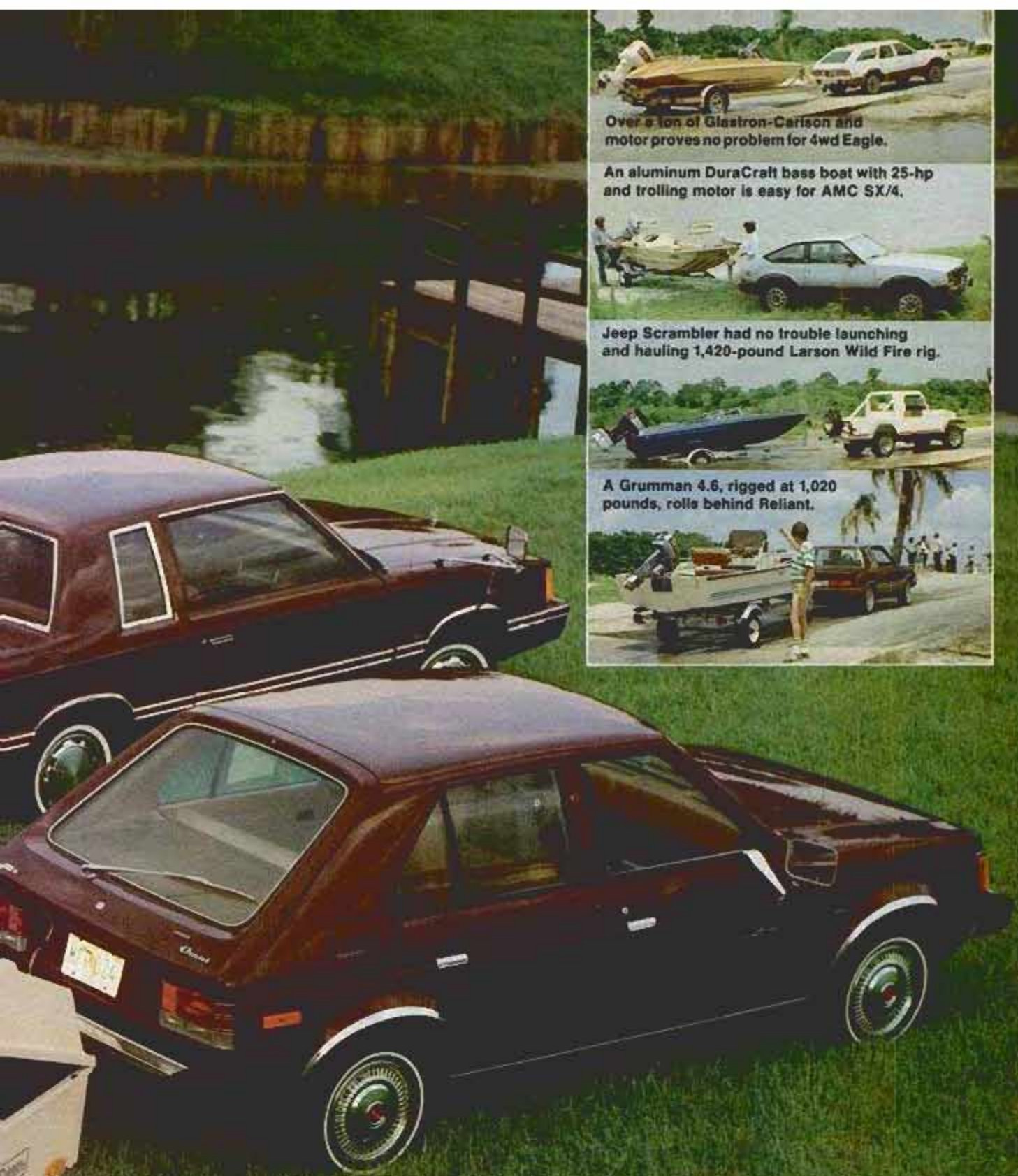
When small cars and big gas bills arrived several years ago, there was fear that trailering was going to be a casualty. Then it looked as if towing a camper to the hills, or a runabout to the lake, might become

just a pleasant memory. But now we are learning compact cars can be recreation vehicles, too—with an important difference.

Recently, we tested an interesting assortment of small cars pulling

Coleman camper, with canoe and motor, is easily towed behind a Plymouth Reliant. Dodge Omni pulls a full VersaTrailer.





Over a ton of Glastron-Carlson and motor proves no problem for 4wd Eagle.



An aluminum DuraCraft bass boat with 25-hp and trolling motor is easy for AMC SX/4.



Jeep Scrambler had no trouble launching and hauling 1,420-pound Larson Wild Fire rig.



A Grumman 4.6, rigged at 1,020 pounds, rolls behind Reliant.



Aluminum scores again as a 680-pound Fisher 15 rig climbs a steep ramp with Ford Escort.

New options and accessories can make the difference between safe and scary trailering

various trailered boats. The good word is that every rig worked well—because we paid special attention to details: Safety factors, load matching and performance features must be considered more carefully.

We checked out 10 cars from Detroit manufacturers.

From American Motors we had an Eagle wagon, SX/4 and Jeep CJ5. All three vehicles had the 4.2-liter Six under the hood.

From Chevrolet we used two Citations, one with 2.5-liter Four and the other with 2.8-liter V6 and towing package. A third Chevy was a Chevette with 1.6-liter Four.

From Ford there was a Fairmont with 3.3-liter Six and an Escort with the 1.6-liter Four.

From Chrysler we had a Plymouth Reliant with 2.6-liter Four and a Dodge Omni with 2.2-liter Four.

We tried the cars with a number of boats of various sizes.

We packed a Zodiac inflatable and 7.5-hp Evinrude into a Coleman VersaTrailer. That combo weighs in at about 500 pounds.

We tried a 15-foot aluminum Fisher—with 15-hp Johnson mounted—on a Gator trailer—680 pounds.

On the heavy end, we went to 3,540 pounds with a Cobia Odyssey cruiser, powered by an OMC sterndrive. That one we hitched to the four-wheel-drive AMC Eagle.

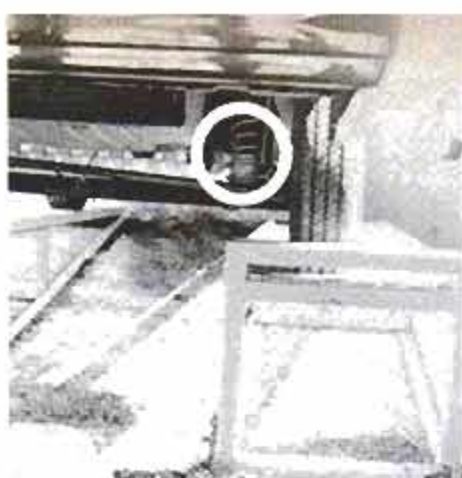
We had no trouble driving at speed, or muscling the boats up and down launching ramps. Trouble-free towing is easy when you understand the following rules:

■ Match of tow load to car and driving conditions comes first. It should be figured out before you buy your rig, and must be more exact than ever before.

The weight a compact can handle is determined by size, power and type of car, plus the routes that you will drive. It is also estimated by the manufacturer, and you'd better find out what he allows before you void your warranty.

So, go by the book. Refer to the owner's manual, and check with the manufacturer if you don't think the manual gives you the answers. You need to work out those details before you buy the car, take delivery and hitch up.

■ The type of driving you do and the routes you follow are going to be important. Frequent hauling of a heavy trailer at maximum speeds over hills and deserts to a steep launching ramp can strain your compact, overheat it and possibly wreck it. Offroad running across rugged terrain may punch away at springs and shocks. Lugging up steep slopes and spinning wheels in sandy spots could cook your engine and transmission oil and put added



Air Lift inflated inside rear coil spring of a compact car helps to prevent sagging.

burdens on drivetrain and brakes. Bucking whipsaw gusts from passing trucks and pushing through strong winds can make steering difficult and dangerous with a heavy-weight in tow.

Hitting the road for an occasional easy run over flat roads to a level campsite or launching hoist is a different towing matter. Though your car dealer and manufacturer aren't likely to admit it, a certain amount of safety factor is usually figured into their rules for towing. But the smaller your car, the more critical the limits can be. You can possibly get away with occasional overloading, but the days of casually hooking up a trailer to a makeshift bumper hitch disappeared with the arrival of smaller cars and engines.

■ A car manufacturer's "tow package" used to be a possible option. Now it should be considered essential, if available. Again, ask before

Even a sterndrive cruiser—nearly two tons with trailer—can be towed by a car with equalizing hitch and four-wheel drive like the Eagle.





Once lifted and bolted into place, the load-distributing arms of the equalizing hitch level the load to both front and back wheels.



In addition to the load-leveling of the hitch, sway bars secured below the trailer tongue will prevent the rig from fishtailing.

buying. Not many "RPOs" (regular production options) can be added later on without difficulty and considerable expense.

If you have a choice, consider a large engine, a high engine-to-wheel axle ratio, automatic transmission, heavy-duty suspension and radiator, power brakes and steering, heavy-duty battery and generator, equalizing hitch and platform mount and a trailer-wiring harness. You might also think about how much time you'll spend on the road and opt for tinted glass, cruise control, luggage rack, dash instruments, tilting steering wheel, reclining seats, spotlights and high-intensity running lights, air conditioner, CB radio and the rest.

With trailer in tow, you may find driving much easier and more comfortable at lower (and more economical) speeds. That will make trips longer, and you're likely to appreciate how much less tiring it is, for example, to drive with closed windows shutting out traffic noise and wind buffeting, as you can with air-conditioning.

Your transmission will often heat up during heavy driving with a trailer in tow. An extra radiator to cool it is not usually a predelivery option, but is an important aftermarket item to consider, and can be installed by your dealer, at a garage, or at home if you are a good mechanic. Side mirrors and other trailer

accessories are easy do-it-yourself installations. Only the attachment of hydraulic trailer brakes that are cut into your car's brake lines should be left to the experts.

■ Balance and level ride is particularly important for your smaller car. Weight on the rear of a light car tends to lift the front wheels, endangering steering control for any vehicle and reducing traction for the popular models with front-wheel drive. Choice of the proper load-balancing hitch, plus rear spring booster or air shocks will help. Supplies and luggage stored in the back of the car and in the boat or trailer behind can also ruin level balance and cause a rear sag.

Tongue weight on the hitch ball should be 10 percent of the trailer load, and total weight of loaded car and trailer should be checked on a truck loading scale. Luggage, passengers and gear in the car and trailer can make the total weight soar. Never level an overloaded trailer by moving gear back to lighten the tongue weight. This is dangerous.

■ The equalizing hitch is engineered to lever weight forward through the chassis and distribute the trailer load to the front wheels as well as the rear. Trailers of any weight can use it, and those of 2,000 pounds and up (Class II and above) should always use it. Sway bars can be added to help reduce fishtailing. Reese, Draw Tite, Eaz-Lift and Val-



Small car towing a light aluminum boat needs Class I hitch (under 2,000 pounds).



Compact's cargo capacity can expand with Le Trunk of U.S. Trailer, Livonia, Mich.

ley Tow-Rite are among the makers of these clever devices, with custom models for most small cars. You can fit them on or they can be installed by trailer dealers like Hitch World, a new U-Haul division with over 1,000 branches around the United States and Canada. Accessories such as wiring harnesses and transmission coolers are also available.

■ Trailer brakes are essential for small-car towing of larger rigs, and some compacts require their use. Surge brakes are the simplest; they automatically slow the trailer as the car decelerates. Electric brakes fitted to a trailer allow control by the car driver.

Acceleration with a small car is going to be slower and passing will be trickier, but using a small car to tow a lightweight trailer or boat need not cramp your style. **FPM**



Use of truck scales is the only accurate way to figure the weight of car, rig and gear.

Tune in on

Satellite TV, flat screens, larger-

by Hans Fantel



Sony Profeel
(component TV)



The two TVs shown here—Zenith's Video Hi-Tech and Sony's Profeel—can do much more than simply receive television transmissions via antenna. They hook up easily to all of the devices pictured around them. You can connect a laserdisc or a home computer, since these televisions have both direct and antenna-video inputs. The Sony Profeel features a separate tuner and two speakers, while the Zenith has a built-in tuner along with its two outboard speakers. These are the first of the TVs you will be seeing that can do it all—handle the whole spectrum of the world of video.



Sony CC100
(video camera)

Mattel Intellivision (video game)



Sony SL-5400
(videotape recorder)



PM photo: Peter Johansky

PHOTOGRAPHS BY PETER JOHANSKY FOR PM

tomorrow's television!

than-ever projection sets—all these and more are just over the horizon.



Pioneer LaserDisc (videodisc)



Atari 800 (home computer)

While you were in the kitchen, escaping commercials and getting a snack, the video future sneaked up on you:

- Network TV is being challenged by satellites beaming programs directly into your home from outer space.
- High-tech cable services are providing two-way communications and direct access to data banks.

And before too many more commercial breaks, you'll find that:

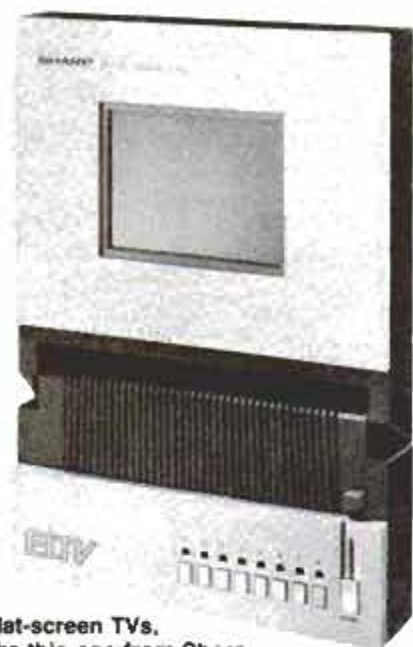
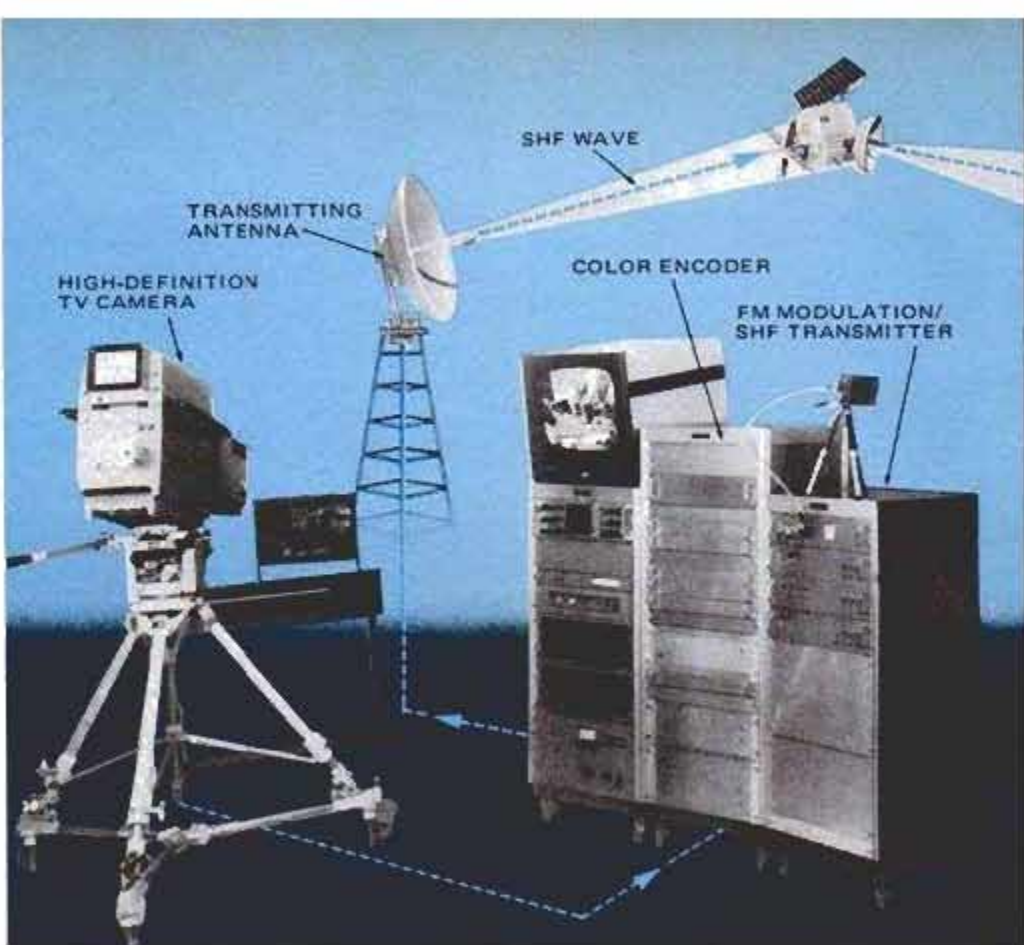
- The trusty old TV set has given way to component video with high-definition pictures and stereo sound.
- Wide-band video transmission is providing sharper detail, so images can be projected on large screens without loss of clarity.
- Film and photography may be replaced by



Zenith Video Hi-Tech (direct-input TV)

Sharpest TV picture

A television picture as clear and detailed as a 35-mm slide may be on the way. Matsushita (Panasonic's parent company) recently demonstrated its new system of satellite, high-resolution TV. The quality of the image was little short of fantastic. With over 1,000 scanning lines, this high-resolution technology runs video circles around present-day pictures. Matsushita envisions using the system as part of a direct-satellite broadcasting system. As shown here, such a system would send pictures taken with a high-definition TV camera, and specially encoded and modulated, up to a satellite at super high frequencies (SHF). A customer's home, equipped with a rooftop antenna, would receive these signals from the satellite. Signals from the antenna would first go to a down-converter which would translate the SHF signals to the ultrahigh-frequency (UHF) range that the TV set uses. These high-definition signals, because of their improved resolution, would be ideal for wide-screen TV. This would eliminate fuzziness on big-screen sets.



Flat-screen TVs, like this one from Sharp Electronics, should be appearing on the market within the next few years.

instant-playback video camera/recorder combos.

The cathode-ray tube—key to conventional TV—is making way for the flat "picture wall," consisting of liquid-crystal light emitters.

The impact of these developments will ultimately affect almost every phase of your home life and leisure. But first, let's look at what you can get *right now*.

Component video

Component video is to ordinary TV sets as component stereo is to ordi-

nary radios. Sony and Zenith are pointing the way. Instead of putting all the works in a single box, they designed video systems like audio components, made up of interconnected functional units.

Sony's new Profeel Series, for example, features a separate monitor screen—available in either 19- or 25-inch size) whose image resolution matches that of professional broadcast monitors. It contains elaborate circuits which automatically adjust contrast levels between bright and dark areas of the picture, control color balance, prevent color spill and suppress the visual noise that normally shows up as "snow" or "confetti."

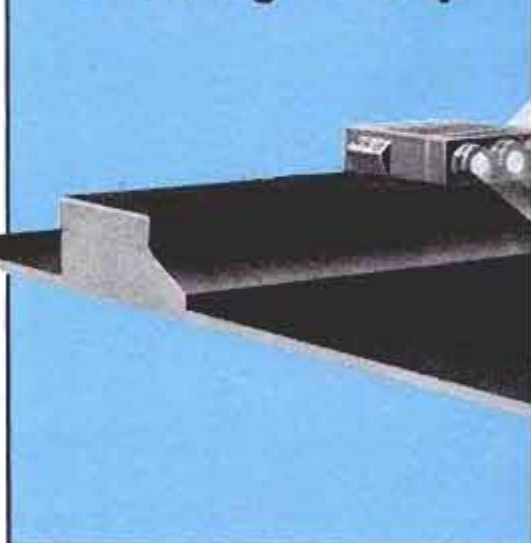
Linked to this monitor is a separate, cable-ready, frequency-synthesized tuner with wide-band video circuits. This works like wide-band frequency response in audio: The wider bandwidth lets you put more information through the circuit. In the case of audio, it means greater sonic fidelity. In video, it means sharper picture detail. In short, this approach yields a kind of "high-fidelity" video.

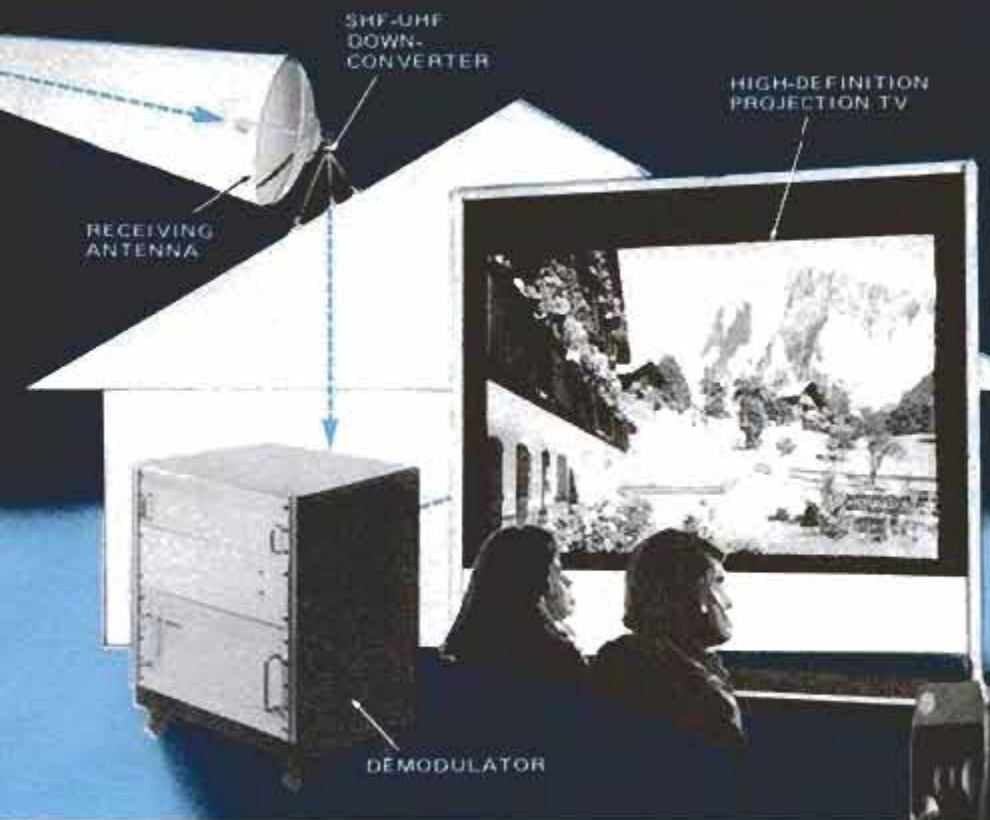
The tuner also has separate inputs for VCRs, videodiscs, home computers, video games—even converters for coded broadcasts. Thanks to these separate inputs, these external signal sources no longer have to be attached to the antenna terminals, so they bypass the radio-frequency (RF) stage entirely. This eliminates the noise and

distortion inherent in the demodulation of RF signals. For added convenience, the tuner also operates in a scan mode, sampling on-the-air programs as well as cable presentations in a given area.

The audio section of this component video system is equally remarkable. For one thing, it's ready for stereo and will be able to receive stereo TV as soon as this type of broadcasting is authorized by the Federal Communications Commission. The audio section can also handle the stereo sound on the latest laser videodiscs and from the more

Big-screen video takes a giant step





with its new Video Hi-Tech designs, which also use a monitor-type screen and direct inputs for external program sources. The component approach, says Zenith executive Walter Fisher, "makes the TV receiver an integral part of a home-communications system."

Expanded program capability

Many of the latest television sets can receive more than 100 channels (including the new superband cable spectrum) without outboard converter boxes. Surprisingly, all this extra channel capacity is filling up fast. A growing number of special-interest programs—anything from

(Please turn to page 160)

venturesome cable systems, which are beginning to offer stereo programs.

In keeping with the component concept, the audio amplifier and the two speakers are also separate. This provides a cost-saving advantage if you already own a stereo sound system. Then you don't have to buy the audio section at all. You can feed the audio signal from the video tuner directly to your stereo amplifier and speakers.

No doubt, Sony's bold move will prove to be a trend setter. Zenith has already followed Sony's lead

Prototype unit from Sony is a combination videotape recorder and video camera.

This one-piece unit is just as portable as home-movie equipment and such units are directed at competing in that marketplace. Other makers, like Hitachi, have shown similar prototypes.

As soon as video editing equipment and accessories are available at consumer prices, camera/recorder setups like these should prove to be quite popular.



Big-screen TV has gone truly gigantic, and may get even larger. Matsushita has demonstrated a new, large-screen system that keeps a picture bright enough to be seen at large diagonal measurements. The prototype system delivers a picture of 170 in. measured diagonally. The unit which projects the picture uses three 13-in. cathode-ray tubes (CRTs). The CRTs may be positioned to project onto the flat, plastic screen from the front or rear. And the compact projection unit measures just 42 x 23 x 33 in. Matsushita expects that this system will be used almost exclusively for large audiences. So, while many things in electronics get smaller, look for larger TV pictures. They represent the video handwriting on—literally—the wall.

Build the \$900 PM airplane anyone can fly

This 145-pound ultralight gives you all the thrills of real flying—and you don't need a pilot's license. You can make it from PM plans.

by Sheldon M. Gallager

Rolling gracefully into a steep turn, PM Woodhopper shows off sweeping wingspan—at 32 feet, only a foot shorter than that of a J-3 Cub. Large wing area, providing high lift, is secret of plane's ability to fly well on low power. At same time, wing is designed with a constant chord—uniform width throughout its length—for ease of construction (all ribs are identical in size and shape).

PM photos: Dave Gustafson



PM reporter Shel Gallager checks the Woodhopper's yoke-and-stick controls.

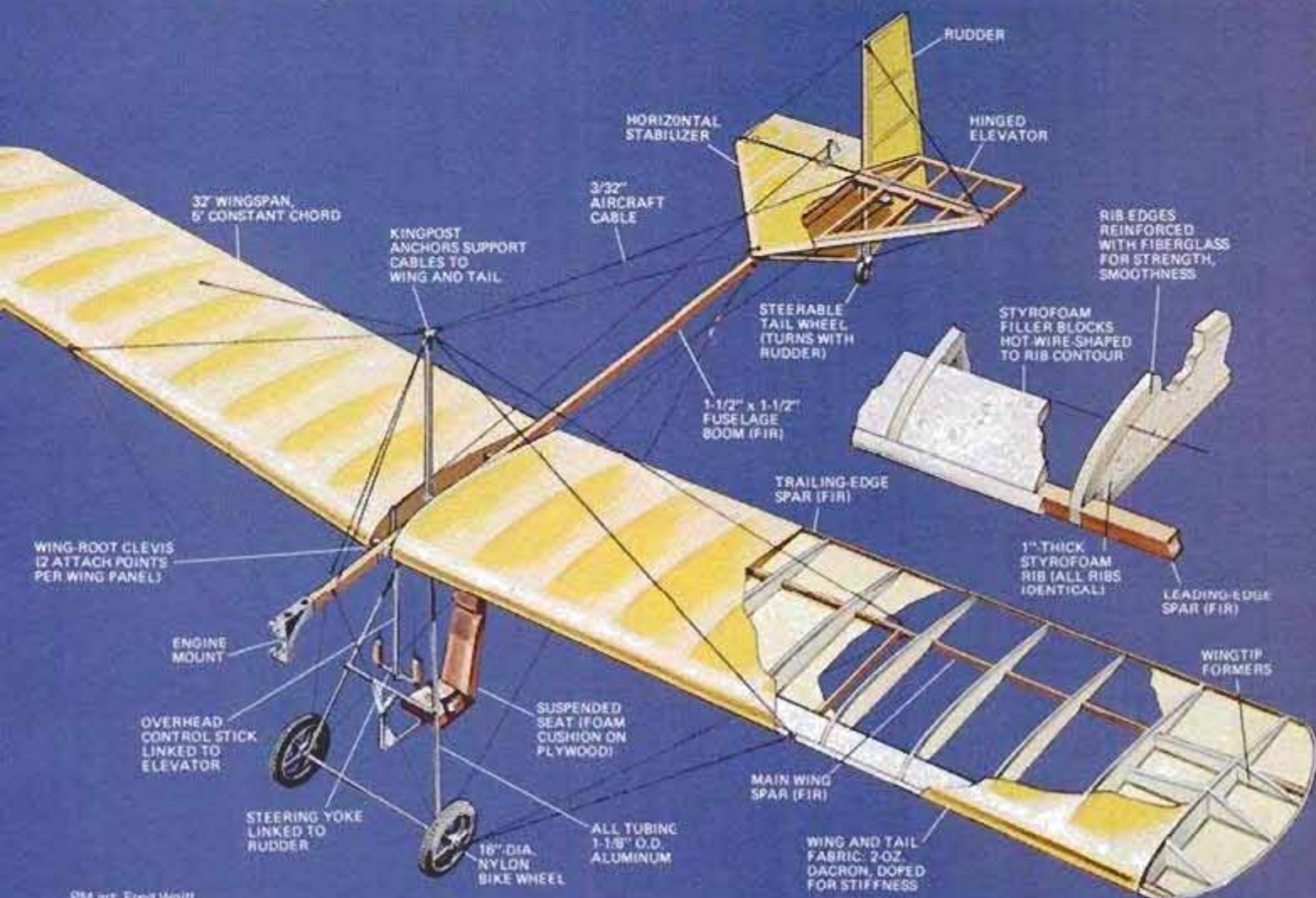
It was a blistering-hot day when we rolled out the PM Woodhopper for her first test flight. Our field was at an elevation of 4,500 feet, and the temperature was in the high 90s. That meant we were actually operating at a density altitude of around 9,000 feet (the altitude equivalent of

our heat-thinned air). Little swirling dust devils danced across the runway, warning of possible turbulence.

Pilots learn to be wary of such conditions. Thin air lengthens your takeoff run and sharply reduces your ability to climb. Altogether, it was not an ideal day to be flying a

wispy, 145-pound, 30-hp ultralight, especially an untried design that, only an hour earlier, had been a pile of parts on a hangar floor. It would be a severe test.

Our colorful new creation was developed for PM by noted ultralight designer John Chotia, president of



PM art: Fred Wolff



Classic taildragger configuration saves weight and simplifies construction. Bonus: Tail wheel turns with rudder, affording easy, one-control steering on the ground or in the air.

WOODHOPPER SPECIFICATIONS

Wingspan	32 ft.
Wing area	157 sq. ft.
Length	17½ ft.
Weight, empty	145 lbs.
Maximum pilot weight	200 lbs.
Cruise speed	35 mph
Redline speed	45 mph
Stall speed	20 to 21 mph
Landing speed (approach)	25 mph
Takeoff speed	27 mph
Climb speed	26 to 27 mph
Range (with 1-gal. tank)	30 to 35 mi.
Stress limit	+3½ Gs
Power	15 to 30 hp
Takeoff run	80 ft. or less
Landing roll (on grass)	50 to 60 ft.
Ceiling	10,000+ ft.
L/D (glide ratio)	9:1
Climb rate	250 to 450 f.p.m.*
Sink rate	250 f.p.m.
Cost to build	\$700 to \$1,500†
Construction time	250-300 hrs.

*Varies with engine choice, pilot weight, weather conditions.
†Varies with engine choice (see text).



Woodhopper is so light and free-rolling, one person can walk it to and from the field. Hand-cranking prop to start engine is easier with a helper, but can be done by yourself.

Weedhopper of Utah and maker of the popular kit-built Weedhopper, one of today's best-selling ultralight sports planes (see photo below). We told Chotia we wanted an airplane that PM readers could build in a basement, using common shop tools and readily available materials. It had to be low in cost and simple in design. Most important, it had to be safe and easy to fly—without requiring a pilot's license.

The result is the Woodhopper, a light, easy-to-build, stick-and-fabric aircraft capable of providing all the fun and thrills of ultralight flying at about one-quarter the cost of ready-made commercial models. It's tech-

nically foot-launchable—although you don't really have to use your feet—so it qualifies for unlicensed operation under current FAA regulations. At 145 pounds, it's also well under the recently proposed 155-pound weight limit that the FAA

may impose in place of foot-launchability. So, either way, you won't need a license to fly it.

Complete plans for building the Woodhopper are available for \$50 from Weedhopper of Utah (see ordering information below). A free fact sheet will also be supplied by Weedhopper (send a stamped, self-addressed envelope). For those interested in learning to fly an ultralight, Weedhopper's new flight-training program (see report below) will be open to PM readers who purchase the Woodhopper plans.

Exciting first flight

To be on hand for the Woodhopper's maiden flight, we went to Weedhopper's new 20-acre flight-testing facility near Ogden, Utah. Here, the 10,000-foot peaks of the Wasatch Mountains loom awesomely to the east, and mammoth Great Salt Lake stretches majestically

(Please turn to page 147)

Ultralight school: From novice to solo in safe, easy lessons



Author (in right-hand seat above) gets check ride in two-place Weedhopper trainer.

As the nose came up and the ground fell away, I noted that the runway seemed awfully narrow. Though plenty long—1,500 feet—it was less than the width of the average driveway. Getting back down on it might be tricky.

I needn't have worried. I was flying the Weedhopper Two, a special, two-seat, dual-control trainer used to introduce first-time students to the sensations of ultralight flight. My instructor was Weedhopper president John Chotia, a superb pilot and patient teacher. Our field was Weedhopper's new 20-acre flight-training center located near Ogden, Utah.

I soon learned why the runway is so narrow—it's on purpose. You start off by doing a series of fast taxi runs, deliberately swerving from side to side. The idea is to learn how to control the plane on the ground without going off the slim strip of pavement. When you can do that, you can cope with any squirrely take-off or landing you may encounter. Since take-offs and landings are basically high-speed taxi runs, this is an essential skill to master.

I also discovered that it doesn't really matter if you *don't* stay on the runway. On several landings, Chotia intentionally plopped us into a patch of soft, churned-up dirt at the end of the pavement. We settled in gently with a surprisingly smooth, short roll. We also practiced crosswind landings, coming in at an

angle. I had visions of cartwheeling or ground looping, but we didn't. At the last instant before touchdown, you just crank the rudder over, straighten out and ease it on. It's beautiful.

"One of the great things about flying an ultralight," says Chotia, "is that everything happens so slowly. You have a lot of time to think."

Weedhopper's new training center is a model for others that are being set up at Weedhopper dealerships across the country. The object is to teach prospective Weedhopper pilots how to fly correctly and carefully, something Chotia believes is vital to safe, enjoyable ultralight flying.

Each dealer will have a practice field, a classroom for ground instruction and both single- and two-place Weedhoppers for students' use. The course, which will cost about \$300, is open to Weedhopper customers and to PM readers who purchase plans for the Woodhopper.

A typical program will consist of two evening ground-school classes and two Saturday-morning sessions for hands-on flying. But there's no limit on how long you can take. "Some students learn faster than others," says Chotia. "Some airline captains take longer to get the hang of it than people who've never flown anything before." So don't be discouraged; there's hope for us all.—S.G.

New one-day Weedhopper kit



For those eager to get airborne literally overnight, the new Model C Weedhopper (above) comes ready to assemble and fly. All parts are pre-cut, pre-bent and pre-drilled. You just bolt them together, slip on the colorful fabric, mount the engine and you're set for takeoff. Assembly time is six to eight hours. Wingspan is 28 feet; cruise speed, 30 mph; pilot weight, 220 pounds. Price, with 30-hp 460-C engine, is \$3,795. As with PM's Woodhopper, you do not need a license to fly it.

HOW TO ORDER PLANS

Complete plans for building the PM Woodhopper, including full-size cutting patterns and an illustrated instruction manual, are \$50 postpaid. Send your check or money order to PM Woodhopper, Weedhopper of Utah, Box 2253, Ogden, Utah 84404. Please make payable to Weedhopper of Utah. For a free fact sheet, send a stamped, self-addressed envelope to the address above.



Celica Supra is powered by a dohc fuel-injected Six that produces 145 hp. Pop-up lights distinguish Supra from the other models.

FIRSTHAND REPORT

by Gary Witzenburg
DETROIT AUTO EDITOR



Toyota built its first double-overhead-camshaft (dohc) engine for its beautiful prototype 2000GT sports car in 1965 and began selling twin-cam Sixes and Fours in production cars two years later. Since that time, some 400,000 of the exotic Toyota engines have been produced for both street and racing cars.

Latest in the series, a fuel-injected, 145-hp, 2.8-liter dohc Six,

Driving the 1982 Toyota Celicas

comes to the United States as standard equipment in Toyota's all-new Celica Supra. And that's just one of the high-zoot features in this Camaro-class Nipponese flyer.

Toyota's Celica, a perfectly adequate and well-built sporty coupe at a reasonable price, has been around since the early 1970s. The mid-'70s brought the original liftback, which looked like an old Mustang fastback, and then the cleanly restyled next-generation coupe and liftback.

This year, the four-cylinder Celica sports all-new sheet metal and a host of new features and refinements. It's a half-inch longer, an inch wider and over an inch taller,

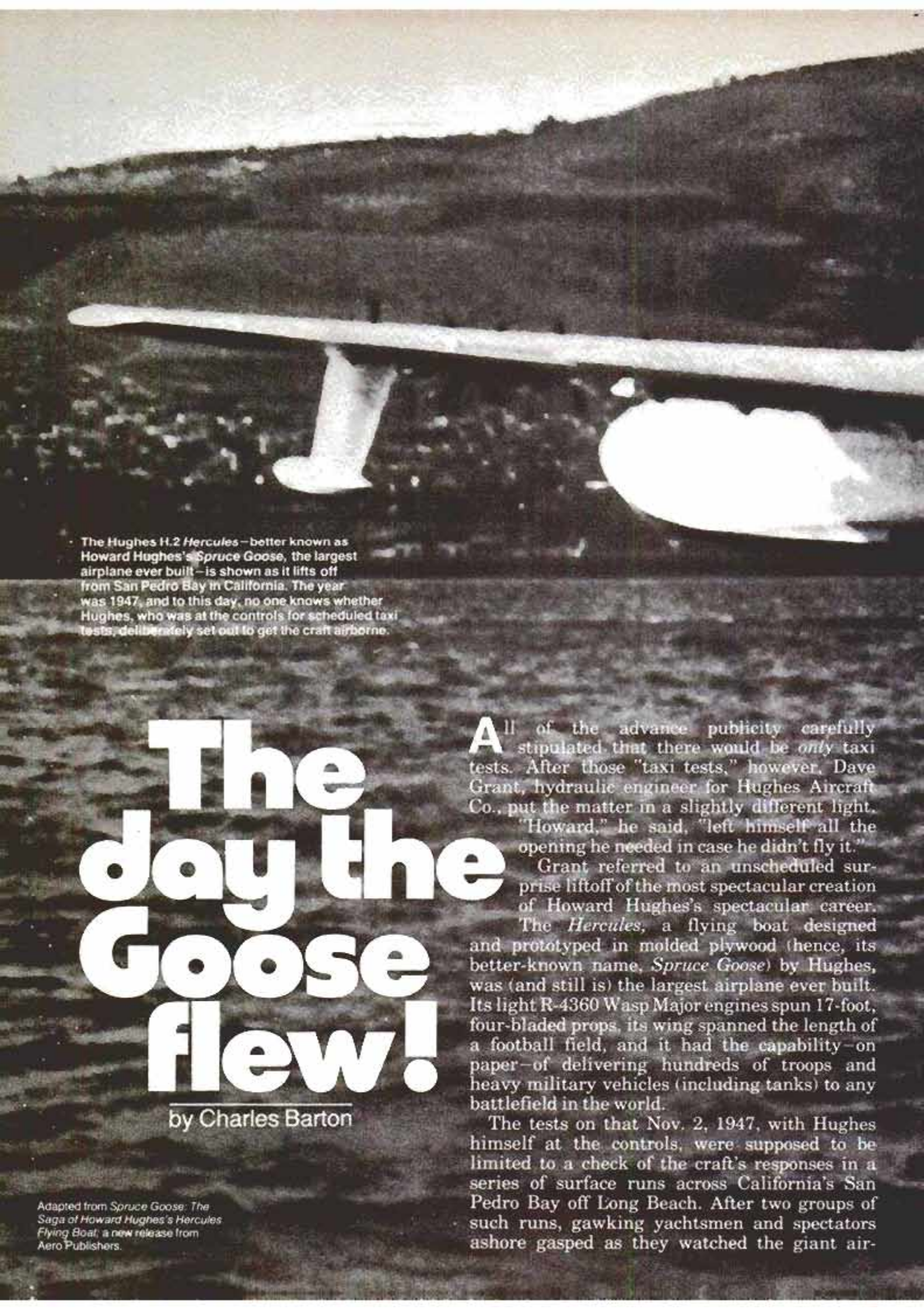
has wider tread front and rear, and a bit more front leg- and headroom. Rack-and-pinion steering replaces the former recirculating ball; there are vented front disc brakes vs. the previous solid discs, headlamps that flip up to vertical from their normal, aerodynamically angled positions, and slick new formal coupe and liftback body shapes—the latter of which splits Japanese wind-tunnel air with an impressive 0.34 coefficient of drag (Cd), which is equal to that of the Porsche 924.

But the new Supra is a whole different ball game. In addition to the new, electronically injected, twin-

(Please turn to page 138)

Standard Celicas, available in both notchback and fastback bodies, are equipped with a 2.4-liter, sohc Four which yields 96 hp.





The Hughes H.2 Hercules—better known as Howard Hughes's Spruce Goose, the largest airplane ever built—is shown as it lifts off from San Pedro Bay in California. The year was 1947, and to this day, no one knows whether Hughes, who was at the controls for scheduled taxi tests, deliberately set out to get the craft airborne.

The day the Goose flew!

by Charles Barton

All of the advance publicity carefully stipulated that there would be *only* taxi tests. After those "taxi tests," however, Dave Grant, hydraulic engineer for Hughes Aircraft Co., put the matter in a slightly different light. "Howard," he said, "left himself all the opening he needed in case he didn't fly it."

Grant referred to an unscheduled surprise liftoff of the most spectacular creation of Howard Hughes's spectacular career. The *Hercules*, a flying boat designed and prototyped in molded plywood (hence, its better-known name, *Spruce Goose*) by Hughes, was (and still is) the largest airplane ever built. Its light R-4360 Wasp Major engines spun 17-foot, four-bladed props, its wing spanned the length of a football field, and it had the capability—on paper—of delivering hundreds of troops and heavy military vehicles (including tanks) to any battlefield in the world.

The tests on that Nov. 2, 1947, with Hughes himself at the controls, were supposed to be limited to a check of the craft's responses in a series of surface runs across California's San Pedro Bay off Long Beach. After two groups of such runs, gawking yachtsmen and spectators ashore gasped as they watched the giant air-



plane actually leave the water and take to the air.

Did Hughes deliberately take off? Or did the huge craft accidentally raise itself off the wave-tops at a hair above its designed stall speed? Until his death, Hughes hid the answer behind an enigmatic smile. The question still is debated among experts, many of whom were on board during the historic flight. Today, more facts about the run and the events leading up to it are known. While few can be said to provide concrete evidence one way or another, many of these facts shed interesting new light on the circumstances. All of the known facts, as well as verbal and written reports about the *Spruce Goose's* unprecedented "hop," are presented in the account that follows. If you are among the many curious aviation buffs who have long wondered about that flight, read on — then make up your own mind about what you think really happened.

Saturday morning, Nov. 1, dawned gloomily along the California coast that year. Storm warnings were hoisted from Point Conception to Newport Harbor. Brisk winds stirred choppy seas in the outer harbor at Long Beach. Howard Hughes himself anxiously checked the weather and then headed for Terminal Island, where his giant plywood creation was berthed.

By the time Hughes arrived, his crew had cleared all scaffolding and movable obstructions away from the flying boat, and opened inlet valves allowing harbor water to gush into the drydocks. Sturdy rubber bags called "airjacks" cushioned the hull as it floated in the dock. Hughes checked these preparations, then walked out on the jetty along one side of the channel through which the great plane would pass for its first taste of salt water. The sea breeze whipped the fabric of his gray slacks. He decided momentarily that tests were off for that day, but they would continue the launching so they'd be ready when the weather improved.

By mid-morning, crews hoisted the small cofferdams from the ends of the wingtip float docks, and opened the massive gate sealing the main hulldock. A large crowd of onlookers, including Paramount and Movietone newsreel cameramen, gathered at the site. People were standing all around the aircraft, most on the two jetties that formed the sheltered channel to the bay.

All cameras were on Hughes as he walked past the spectators clustered forward of the right wing. He smiled dutifully, then walked to the gangplank leading to the flight-deck hatch in the nose, beneath the copilot's side window. He put

"The plane could have lifted off easily if I'd pulled back on the control."

one hand on each of the wooden posts flanking the gangplank entrance and, with arms stiff, flung both feet up onto the gangplank—like Tom Sawyer showing off to Becky Thatcher while pretending he didn't know she was watching. He stooped and entered the hatch under the printed label "EXPERIMENTAL."

Inside, he climbed the ladder leading to the top of the hull. Here an elevator platform had been hand-cranked to its raised position, where it served as a vantage point for directing launching and docking operations. Jack Jerman, production chief, joined him on the platform.

Hughes carefully checked everything over, then made walkie-talkie contact with Harold Tegart, the launch engineer, who would direct winch operation. Four tractors tended the lines that would keep the tail from swinging during launch. Everything looked good.

"Start easing her out," he said.

Winches growled, winding in the lines that ran from the bow through harbor bottom pulleys some 300 feet off shore. As the big bird moved into the channel, a freshening wind pushed against the towering tail. The fore and aft restraining lines tended by D-6 and D-8 Cats tightened.

Everything went smoothly. The bird cleared the jetty ends and was fastened to a mooring bridle until next day. Early Sunday morning, Nov. 2, Glenn Odekirk, one of Hughes's pilots, picked him up in *Bel Air*.

"How's the weather at Long Beach?" Hughes asked.

"Not good, but better," Odekirk said. Later he recalled the following dialogue. Hughes said, "Odie, you don't mind if you're not aboard while I'm doin' my taxi tests, do yuh?"

"Oh, come on," said Odekirk. "Don't give me that. I know if it feels right, you're going to hop it."

Hughes just smiled.

Odekirk knew Hughes didn't want another pilot aboard. He didn't want anyone to be able to say, "Oh, he didn't fly it. The other guy did."

At Terminal Island, chief engineer Rae Hopper cautioned Hughes before they boarded the flying boat.

"We found a stress error in the aileron-operating mechanism," he said. "It's small and easy to fix, but it would be better not to fly until we repair it. If you want to go ahead and fly it, don't go over 140 mph."

"Don't worry, I won't," Hughes replied. (For Hopper's account of the flight see *Spruce Goose: Pterodactyl of World War II*, page 83, Nov. '77.)

About midday, Hughes invited reporters to board the plane for its maiden taxi test—a 3-mile run up the bay and back. Hughes's own fleet of small boats ferried them out to the aircraft.

As they came aboard, Howard cautioned them not to expect too much. "We'll reach speeds of only about 40 mph," he said. "The water is too choppy for anything else."

He climbed to his topside platform to supervise positioning of two "sea mules" for towing, then returned to

the flight deck. About 30 passenger seats had been installed behind the cockpit.

Engine man Harry Kaiser was on the flight deck with flight engineers Don Smith and Joe Petralli, electrical-panel operator Merle Coffee and other crew members. Howard removed his hat and two-tone sport jacket.

"Hi, Dave," he greeted his 30-year-old "copilot" as he jackknifed his tall frame into the pilot's seat. Grant's excitement showed in his eyes and ruddy face. That his hydraulic engineer, Dave Grant—who was not a pilot—should be designated "copilot" was a uniquely Hughesian idea. Howard didn't want a regular copilot, as Odekirk had noted. Furthermore, Grant was the designer of the hydraulic flight-control system, the most critical part of the airplane at that point. So in Hughes's opinion, it was fitting that Dave share a seat at the controls.

Chuck Jucker, the crew chief, positioned himself between the two of them, belted himself to a stool that was secured to the deck, and adjusted his interphone headset. He was Howard's link with the rest of the crew throughout the ship. Chief engineer Rae Hopper and program manager Bill Berry were behind Hughes on the flight deck.

Further aft, systems mechanic David Van Storm was on the flight deck, but he would be in the cargo compartment when the plane took off. Electrical mechanics Jack Jacobson and Ben Jimenez manned stations forward on the starboard and port sides. Hydraulic mechanic Bill Noggle moved about, checking flight controls. Powerplant mechanic Al Geverink was in the right wing behind the engines, and Phil Thibadeau in the left wing behind the number two engine.

Nearly a dozen other crew members and observers on board included special engineers and mechanics, as well as George W. Haldeman, an observer for the Civil Aeronautics Assn. (CAA).

Hughes had a couple of walkie-talkies on his lap for communicating with press boats, sea mules and other craft in his fleet. When everyone was on board, he instructed the two sea mules to take the *Goose* in tow. Mooring lines were cast off. At the last moment, the ship-to-shore intercom line was unhooked and the sea mules gingerly maneuvered them toward the outer-harbor test area. At the harbor opening, a crowd of spectators lined the breakwater, waving and cheering. The outer harbor was swarmed with water taxis and pleasure craft that had gathered for the event.

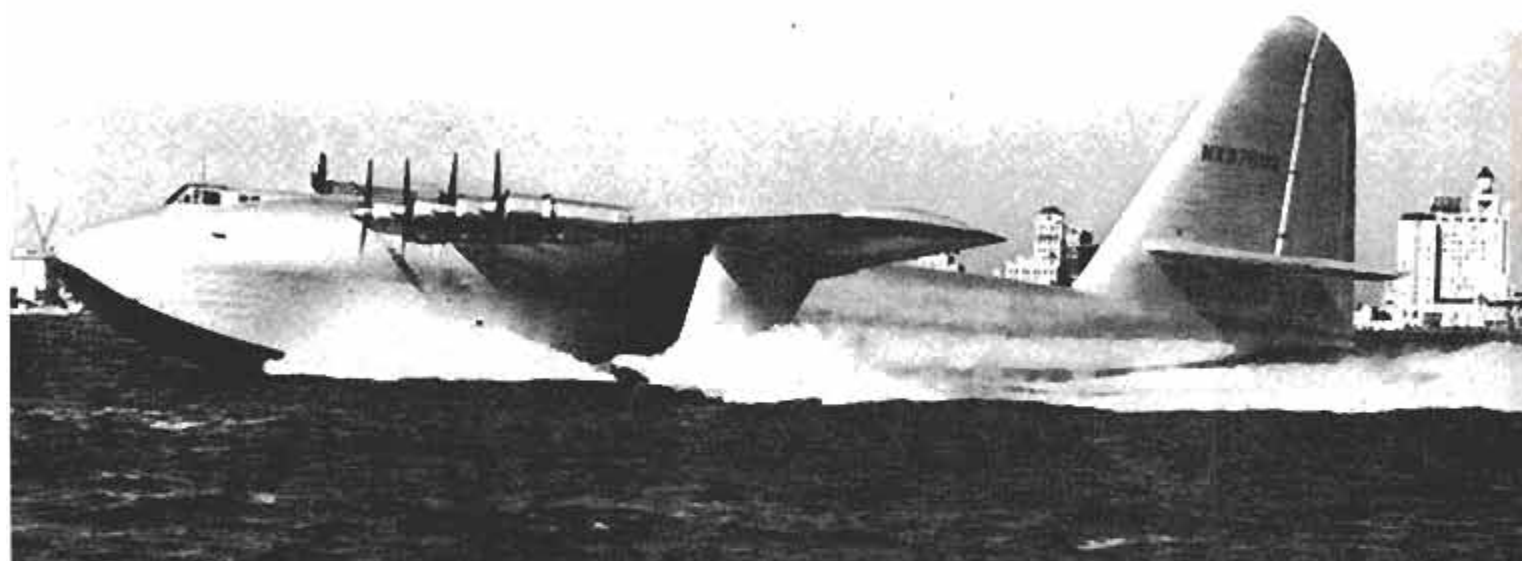
Dave Grant felt isolated. There was no interphone headset at his seat. He had asked for one when he came aboard, but his request had either been forgotten or ignored.

At the test area, Hughes and his engineers started the eight engines, one by one. The sea mules cast off and retreated.

After warming the engines and seeing that Petralli and Smith were satisfied with their instrument readings, Howard lined up the plane. Typically, he used no



After the surprise hop, Hughes, in a new hat, could hardly keep from strutting ashore.



After two initial runs in which the plane did not leave the water, most of the press got off—and missed the bigger story.

written checklists, but operated solely from memory.

Seeing the way clear ahead, he advanced his four throttles, each of which controlled adjacent pairs of engines.

The first run down the bay was actually a series of about three short taxi runs in which he accelerated to about 40 knots and then decelerated, feeling the plane out. At the far end of the bay, he throttled back and swung the aircraft around. It handled well on the water, responding quickly to rudder and engines.

Howard made no effort to have his passengers strapped in during these runs. All of the reporters were free to move about the flight deck.

In position for the second run, Howard advanced the four throttles again, while his left hand steadied the wheel on the control column. The eight Wasp Majors roared as the plane surged ahead and climbed rapidly to 75 knots. The hull spanned only the tops of the waves. Throughout the run, despite the chop, the hull spray fell away well below propeller line.

At the end of the bay, Hughes closed the throttles with satisfaction. As the plane weathercocked into the wind, engines idling, he answered reporters' questions.

Yes, he was satisfied with the ship's performance. Yes, according to plans, he would try one more taxi run. Yes, he felt that the 7 million dollars of his own money, which he'd plowed into the plane, were well spent.

The United Press correspondent asked another question. "Howard, are you going to fly the boat today?"

"Of course not," replied Hughes. "It will be March or April before we're ready to fly it."

"In that case," said the reporter, "is there a possibility of going ashore to file my story?"

"Certainly," Hughes said. He picked up his walkie-talkie to call for a boat. "A few fellas want off. Have a boat come alongside," he ordered.

As the boat charged into the test area, bow waves curling white and spray flying, Hughes eyed it narrowly. "Come up alongside from the rear," he said.

He was as protective of his new bird as an old mother hen, and he kept up a running stream of instructions and cautions.

The UP reporter triggered an exodus—no one wanted to be "scooped." Hughes, accompanied by Van Storm, went down to the cargo deck to see them off.

Two or three magazine writers, who had no deadlines, some five other reporters and a few photogra-



Questioned closely, Hughes chose to remain ambiguous, thereby creating the Spruce Goose mystery which may never be solved.

phers elected to stay aboard. James C. McNamara, news editor of independent Los Angeles radio station, KLAC, and the "broadcast pooler" for all the radio newsmen, had no alternative but to stay. He had waited for the third run to record his story, because he thought that would give him a more intelligent approach. He had failed to anticipate that his press colleagues would scuttle him by leaving early. With heavy heart, he watched them go, sure he'd been scooped.

About this time, Dave Grant sent Bill Noggle back to check the control-system actuators, control valves and plumbing in the tail. Hughes was unaware of this, nor did he check to see that crew and passengers were in their places before the next run.

Hughes restarted all engines and taxied further downwind to get in position. The final run would be westward toward San Pedro, parallel with the shore.

McNamara, by this time, had moved up behind crew chief Chuck Jucker—a good vantage point from which to record his view of what was about to happen.

He began his award-winning broadcast by saying: "This is James McNamara, speaking to you from aboard the Howard Hughes 200-ton flying boat, the world's largest aircraft. At this moment, as we speak to you from the spacious flight deck, this mighty monster of the skies is slowly cruising along a northwest course in the outer Los Angeles Harbor."

After commentary about the ship and its creator, he leaned forward and spoke in Hughes's ear: "Howard,

(Please turn to page 174)



How to master fine wood joinery

Two experts show how to create the joints that you'll use more than 90 percent of the time.

by Rosario Capotosto and Harry Wicks HOME AND SHOP EDITOR

PART 1

There are a number of important steps in every woodworking project—from purchasing the stock through planning, cutting, sanding and finishing. But it's safe to say that quality of the joints is as important as any other phase of woodworking.

You may be a master of fine finishes, but a beautiful, hand-rubbed look will not conceal sloppy joinery. Nor will it strengthen the piece. The fact is, poor joinery is the major reason for failure (deterioration) of homebuilt (and commercially manufactured) furniture.

Though there are countless joints to suit every conceivable joinery problem, the plain truth is that you will probably use five joints most of the time. The most commonly used joints include:

- Butt.

PM photos: color, August Latta
black and white: the authors

Neat joints are the unmistakable mark of a competent craftsman. Even the simple butt joint shouldn't be sold short; it's often used in such projects as this antique toolbox reproduction. (Plans for the toolbox begin on page 128.)



- Rabbits and dados.
- Dowel.
- Lap.
- Dovetail.

We will cover all of these joints in the next few issues of *Popular Mechanics*. In Part 1, this month, we start with the very basics of joinery—butt and rabbit joints.

Mastering joinery

In simplest terms, professionals learn by practice. And practice is the quickest route to craftsmanship for you, as well. You can use scrap materials to perfect your skills with the more advanced joints—those that call for deft work with a chisel, for example. If you work at joints only when you're faced with making one for a project, mastering joinery will take you time, at best, and it

may elude you completely, at worst.

Take advantage of the professional tricks offered on these pages. As every craftsman knows, they are mastered by experience and by working with other skilled woodworkers.

Here are a couple of basic points to remember:

- The butting members of a joint should be smooth. The very smoothness of mating pieces increases the resistance to pull apart. Think of the last time you tried to separate two pieces of glass. Chances are you had to *slide* one off the other—you couldn't *pull* them apart.

- Never load a joint with glue. Students are always shocked when we demonstrate just how little glue a professional uses in a joint. Apply the glue to both surfaces, then

spread it thin with a clean stick, dowel, or brush. Excessive glue will *not* make the joint stronger. In fact, it can actually result in a weaker joint.

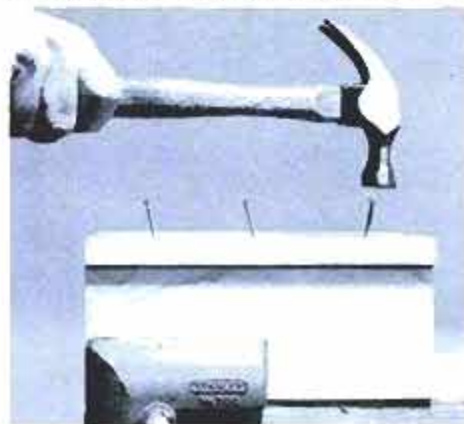
Too much glue also ensures considerable glue squeezeout, which is sure to ruin the looks of your handiwork.

About butt joints

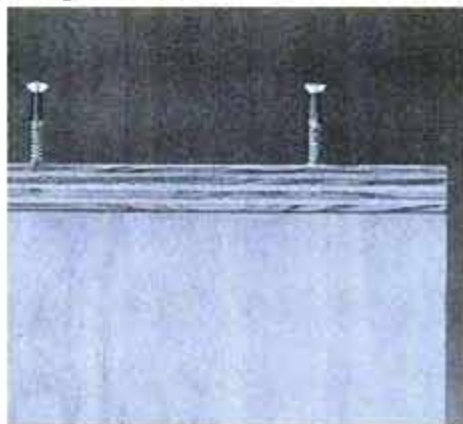
Because the butt joint is the simplest of all, many beginning woodworkers sell this type of joint short. There are times when a butt joint is quite adequate.

For example, in cabinetmaking, cases are often joined using reinforced butt joints (see photograph on facing page). And butt joints are extremely common in household carpentry as long as they are exe-

How to make better butt joints



This is a typical butt joint, with one member simply abutting the other. Here, one piece is placed to project slightly (i.e., overhang) to give an architectural shadowline. The nails are driven at an angle to ensure maximum nailholding strength. Use of glue in a butt joint is an absolute must.



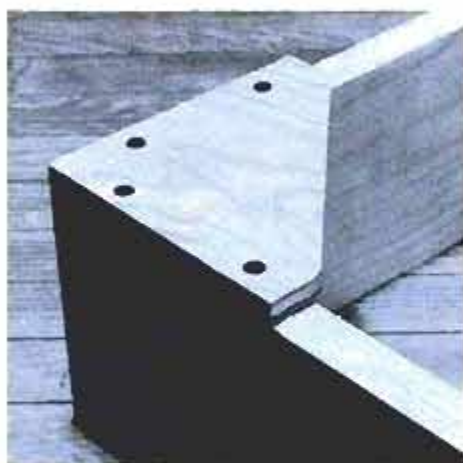
Screws give an even stronger butt joint than nails—but glue is still used. When you use screws, the wood members are temporarily tack-joined while pilot holes are bored. To hide screwheads, counterbore holes to accept dowels. If looks don't matter, turn screws into countersunk holes.



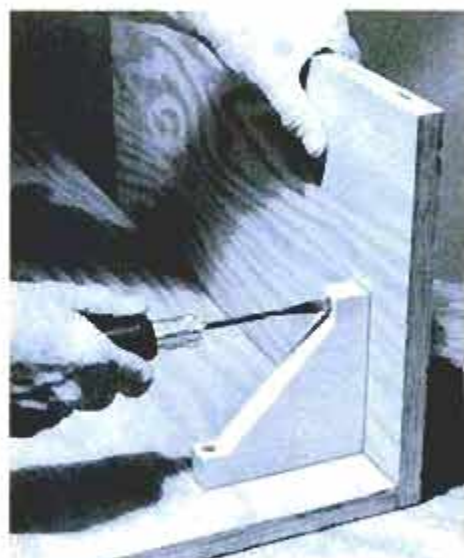
Screws into end grain, as here, provide minimal holding power. When fasteners must penetrate an end grain, insert a dowel as shown (partially installed here for clarity) to eliminate any chance of the screws pulling out of the joint.



There are many methods—plus commercial hardware—for strengthening a butt joint. A shopmade block such as this one does the job well. It is installed using either nails or screws through predrilled holes. Or you can use metal corner braces or irons (not shown), which come in several sizes.



You can use a plywood gusset on a butted corner if appearance is inconsequential and its surface mounting won't interfere with function of the case. As with the corner block, outside edges must be perfectly square (90°), and aligned with abutted pieces to ensure a square finished product. Use glue and ringed nails to install it.

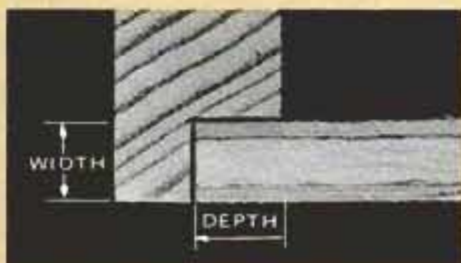


Another version of a wooden corner block: Because this one has longer legs, it gives even greater stability. Its shape allows easy installation with a pair of screws.

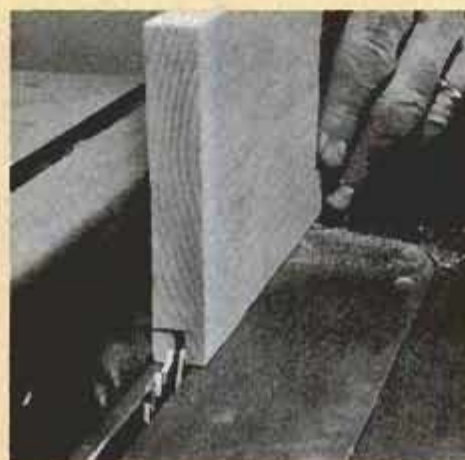
Making rabbets and dados



To make a dado with hand tools, you first cut the width lines to the desired depth with a fine backsaw. Then use a sharp chisel to clean out the interior portion.



A rabbet joint is a form of butt joint, but its L-shape gives the joint greater strength. The edge rabbet width is equal to the thickness of the stock to be inserted into the rabbet; the depth can be anywhere from one-third to three-quarters of the stock which is being rabbeted. The usual rule is to halve the board, as shown. Thus, in order to join the $\frac{1}{2}$ -in.-thick plywood to the $\frac{3}{4}$ -in. stock in this case, the rabbet was cut $\frac{1}{2}$ in. wide by $\frac{3}{8}$ in. deep.



To cut a rabbet on the table saw, always make the edge cut first. This way you'll have maximum support for workpiece.

cuted precisely in craftsmanlike fashion.

A case can be made against butt joints, of course; the biggest disadvantages are:

- Because of the minimal contact area (glue surface) between members, a butt joint is one of the weakest joints in woodworking.

- Because a butt joint leaves end grain exposed, it is not the best looking option in joinery.

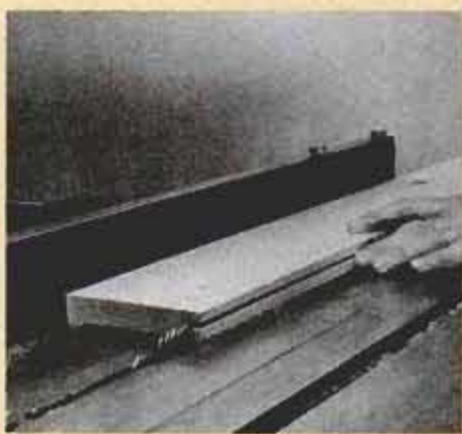
Thus, it is obvious that the woodworker must consider the pros and cons of a joint on every project he tackles. You would not, for instance, use a butt joint and leave end grain exposed on a fine piece of walnut furniture. On the other hand, you will often use butt joints when recreating early American furniture, especially the primitive type created by the settlers.

Making butt joints work

- In almost every case, you should beef up a butt joint by adding a corner strengthener. You can make adequate wooden braces or you can use commercial corner braces.

- An end butt joint is the weakest of all because one of the joining pieces is end grain (as in the toolbox on page 119). One good stunt is to thin your carpenter's glue slightly with water and to precoat the end grain. The wood will suck up the thinned glue like a blotter. When it's dry, you can proceed with the joint, using the glue as it comes from the bottle.

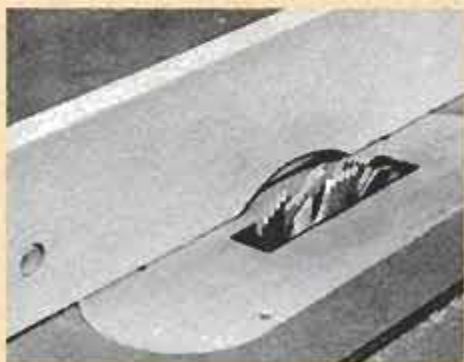
- Though edge-joining (gluing up two or more narrow boards to create a wide one) is usually done using dowels into the edges, there are times when the dowels can be eliminated. If the wide board will be contained on all four sides in a rabbet, for example, you can frequently do



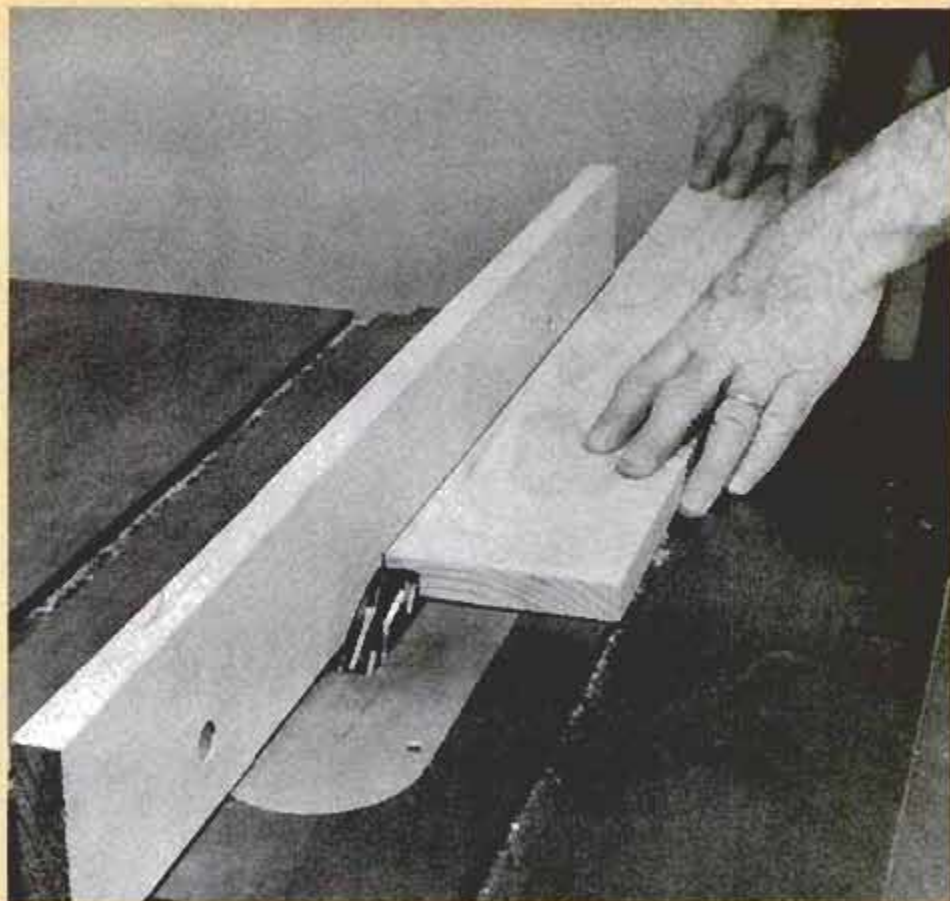
Make the second cut with the rabbet edge away from the fence, as shown here. For both cuts, the blade should be elevated just to clean out corner of cut, and no more.



You can cut a rabbet in one pass by mounting your dado head set on a table saw. For safety, add a wooden auxiliary fence, as here, to the rip fence. Position it with no more than half of the wood over the lowered cutters. Start the saw and slowly raise the head of the dado until you have cut a semi-circular notch in the wooden fence.



With fence moved away from the blade, the saw notch is clearly visible. This stunt lets you "bury" part of the dado head in the "fence" when you produce a rabbet.



With this method of making a rabbet in one pass, the work is fully supported and hands are away from the cutters. Use a pusher stick to complete the cut. For photo clarity, the blade guard is removed from saw in these pictures. For safety, leave yours on.

an adequate job by using corrugated fasteners or Skotch Connectors.

The usual technique, after spreading a scant amount of glue on the mating surfaces, is to align the boards and hold them rigid with a number of bar clamps until the glue dries. Next day, the clamps are removed and the glued-up board is placed on a solid, flat surface, hidden side up. The corrugated fasteners are driven into the board to span the joint and close it permanently.

If the board ends will be concealed in a rabbet, it's also a good idea to drive in a corrugated fastener at

each end—into the end grain—spanning the joint. *Note:* This trick was done on the oak legs for the jardiniere stand in the October issue of PM (*2 Turn-of-the-Century Plant Stands You Can Build*, page 104).

The important rule to remember is that corrugated fasteners should be used only where they will not be seen. Don't think that the resultant joint is as strong as a doweled joint; it isn't.

Study the pictures on page 119 showing six typical butt joint applications. The rules depicted are basic for butt joints and should be added

to your woodworking techniques. Remember that a nail driven at an angle, for example, holds better than one driven straight in. Also remember that, generally, you should bore lead (pilot) holes to avoid splitting, even in softwoods, because you are usually working near the end of a board.

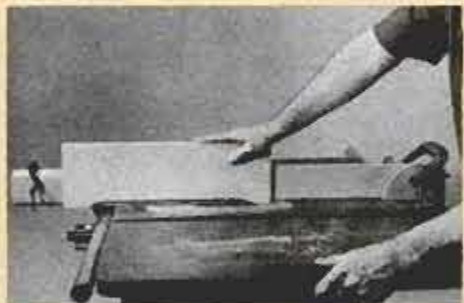
About glue blocks

A glue block of one type or another should be used to reinforce a butt joint's glue line whenever possible. For thick stock the glue block can be

(Please turn to page 180)



To cut a blind (stopped) rabbet you must add a wooden auxiliary fence with a pair of start and stop blocks clamped to it; notice the shape of the start block. By rounding off the front corner, you automatically create an aid to help you lower the workpiece (arrow) onto the spinning blade. See text for details on how to make this cut.



The board is pushed through until it comes to rest against a stop block that's clamped to the fence at the far end. At this point, you should either turn off the saw and wait for the blade to stop spinning or back the workpiece up a few inches and carefully lift it off. Don't attempt to lift board off the table the same way it was lowered on to spinning blade, as this could prove dangerous.



Using a router and a rabbet-cutting bit is the fast and easy way to make a rabbet. Make certain cutter is sharp, and don't try to take the full depth in one pass. In soft woods you should make at least two passes; make the first pass with the cutter set for half depth. On hardwood, cut the rabbet in approximately three or four passes with the cutter set for one-quarter depth on the first pass.

5 shop-storage ideas from PM's master craftsmen

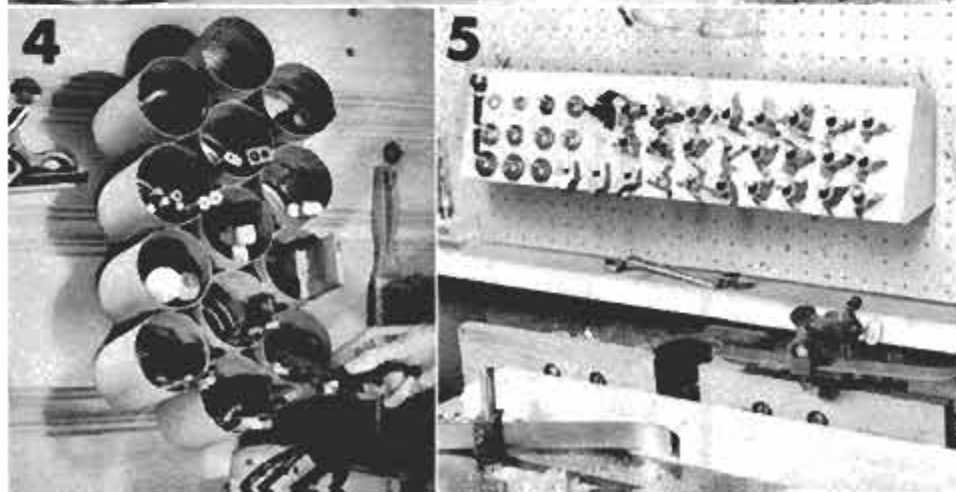
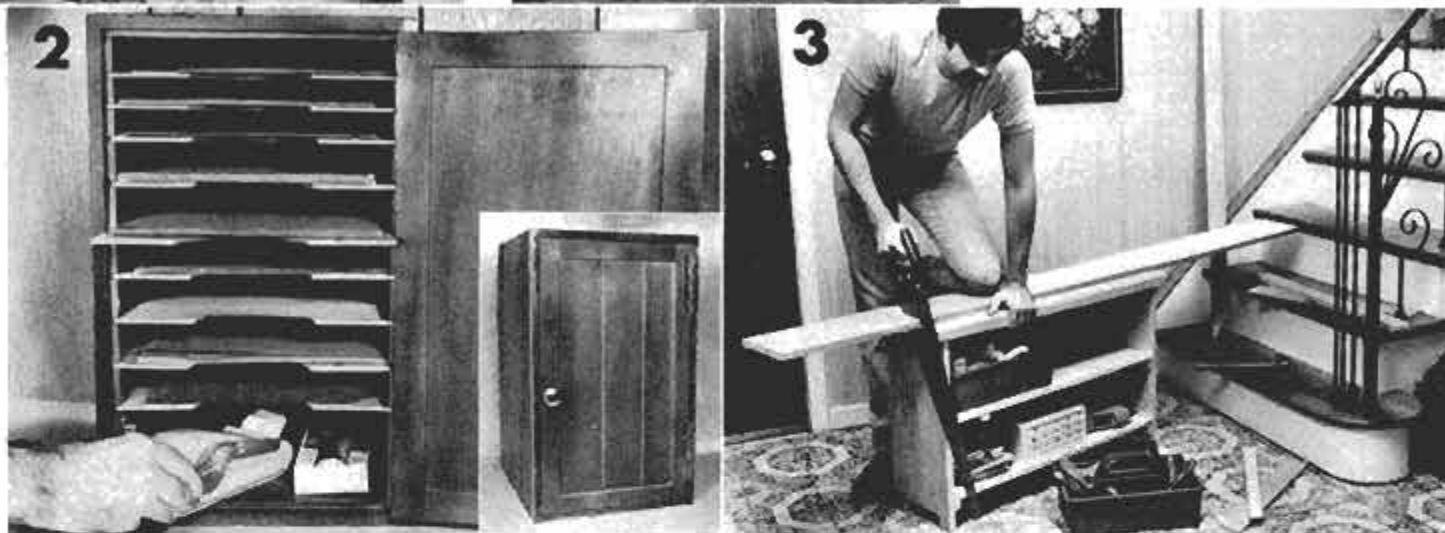
Busy shops are always short of storage space. Here's what some professionals do to ease their shop-clutter problems.



Efficient organization of tools and materials is one of the benchmarks of the professional-quality shop, and something that all shop workers should strive for. Experienced craftsmen know how much time can be wasted looking for a misplaced tool or rummaging through a poorly tended lumber rack. Perhaps these "bad memories" are why we received such an enthusiastic response when we solicited shop-storage ideas from four PM master craftsmen.

The five projects presented were chosen because they represent a wide range of storage techniques and require an equally wide range of shop skills. They do, however, have one thing in common: All designs are straightforward and can be easily adapted to your particular needs.

Complete plans and instructions for each project appear on the following pages.



1 This lumber rack saves space, also provides extra shop wall room on its back side for shelves and tools.

2 Mark of a professional craftsman is obvious in this attractive sandpaper storage cabinet. It's easy to duplicate.

3 Open-shelf toolbox hauls tools around house, yet keeps them handy in shop. Wide top is good work surface.

4 Recycling tin cans in this ingenious way provides various-sized small-parts bins for stationing throughout shop.

5 Tool rack can accommodate shaper cutters, spacers and wrench, as well as table-saw molding-head cutters.

1 Lumber rack

Storing new lumber and leftover scraps for future use can eat up a lot of valuable shop space. This is unavoidable. But if your shop is in the garage, like mine, and you have two overhead garage doors, you might want to try this design. I find that it works very well.

Begin by checking the vertical and horizontal dimensions for this rack against the actual measurements in your garage. (These might vary, depending on how your garage door is installed.) The minimum clearances shown on the drawing must be maintained if the door is to operate properly. Make any necessary adjustments to the rack size before you start construction.

Frame the shop-side wall first with 2 x 3s as shown. Install the blocking, then stand the wall, position it and nail it to the concrete floor with cut nails or masonry nails. Protective glasses or goggles should be worn when driving these hardened nails because they can chip or break if hit off center. Plumb the wall and nail it to the common wall between the house and garage using 16d nails.

Now, plumb the open end of the wall and install the upper brace by driving two flathead wood screws through the door track and into the plywood. (On most door tracks, holes will be available that can be used for this purpose. If not, drill your own.)

Be sure to use the flathead screws which won't protrude and interfere with the rollers when the door is operated.

Attach the bottom wall-to-track brace in a similar manner. Then cut and apply the plywood wall paneling to the shop side of the wall.

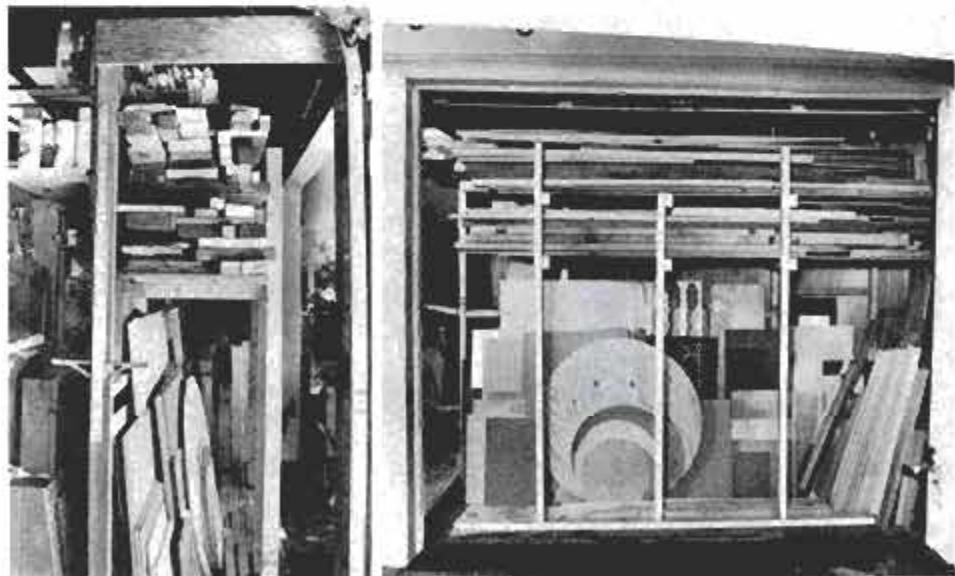
Next, position the bottom plate for the door side of the rack and nail it to the floor. Toenail the vertical supports to this plate, then install the horizontal supports that tie both sides of the rack together. Level these front to back. Then, using the

level again, position the two shelf support blocks on the house wall and nail them in place.

Nail on the shelving, beginning on the house side and working your way across to the open end of the rack, plumbing each vertical support as you go.

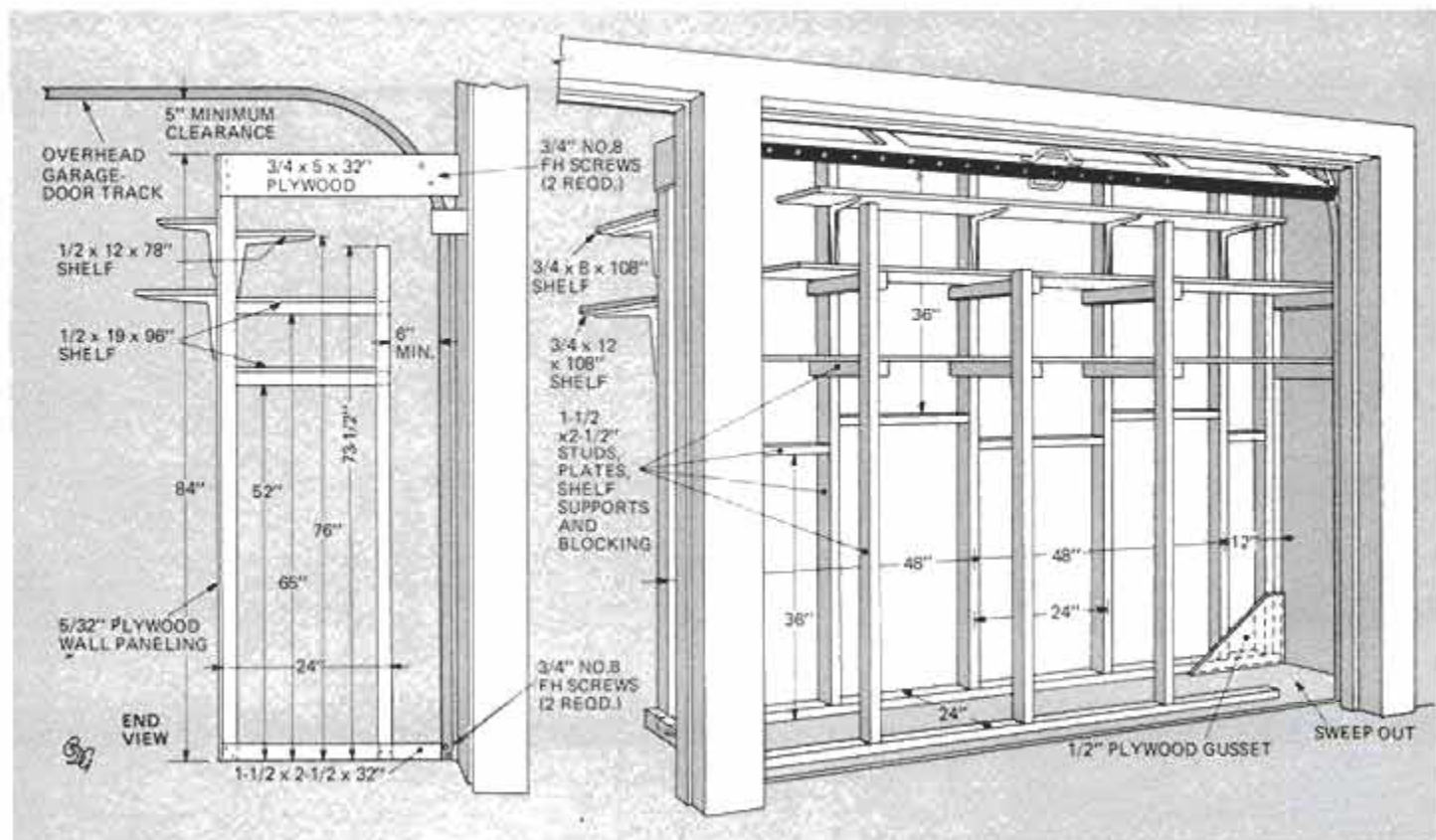
The metal shelf brackets for both sides of the paneled wall are installed on the studs, and the shelving they support is screwed to them. Finally, load up the shelves and the rack and you're done.

—Rosario Capotosto



Overhead garage door allows free access to full lumber rack without disturbing ongoing shop work (right), while open end (left)

provides access from within the shop. Marking ends of boards makes for quick reference when you're restocking.



2 Wall cabinet

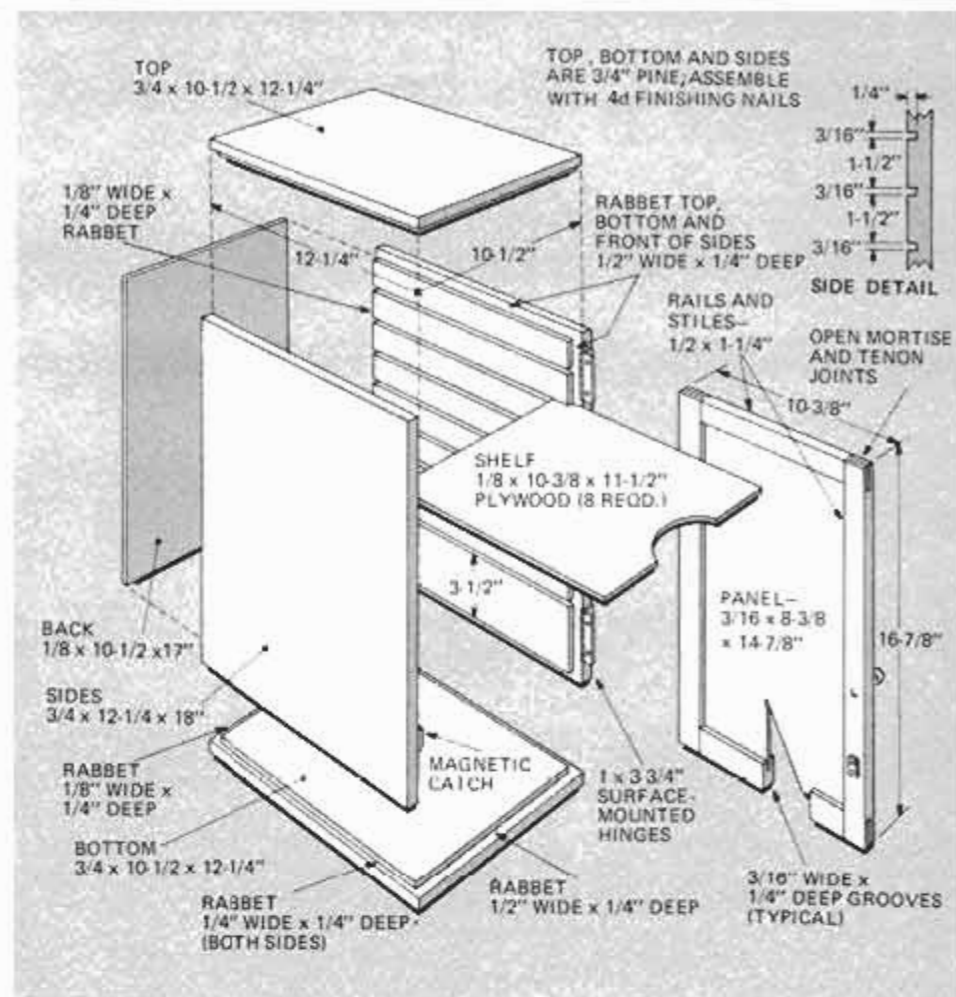
Busy shops go through a lot of sandpaper. This small, wall-hung cabinet is a convenient place to store abrasive by grit, and it also lets me see at a glance if I am running low on any particular kind. It isn't difficult to build and, though I used pine, $\frac{1}{4}$ -in. plywood could be substituted for the sides, bottom and top.

Start by cutting the back, sides, top and bottom to size, then cut all rabbets as shown. Use either a router or dado head in your radial-arm or table saw. Next, carefully lay out the dados for the shelves and cut them.

Before you assemble these parts, sand all edges slightly to provide a good glue surface. Then glue and nail them together. Install the back last after having carefully cut it square. This will keep the cabinet square while the glue is drying and will also reduce the chance of your having trouble fitting the door later.

Cut the door rails and stiles to size and cut the panel grooves and open mortises in them. Next, cut the tenons and door panel and assemble all door parts dry to check for fit. The panel should have a little play so it can expand and contract with the moisture content in the air, without causing the rails and stiles to come apart.

Make any necessary adjustments, then assemble all five pieces at once. Glue only the rails and stiles together. Do not glue the panel; it should



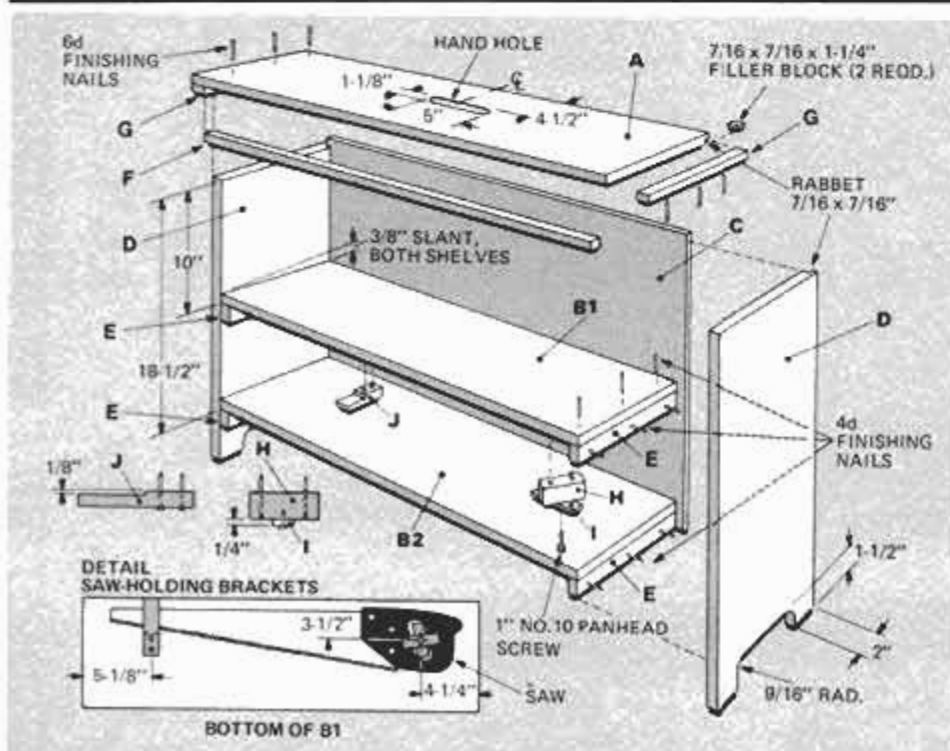
be allowed to "float." Clamp the assembly so it is square and flat, and allow it to dry overnight.

The door is hung using surface-mounted hinges. Any minor adjustment in fit can be made at this point using a block plane. Finally, cut,

sand and install the shelves and finish-sand the whole cabinet. Attach the door pull and magnetic catch.

Stain and varnish can be applied to the outside of the cabinet if you choose.

—C.E. Banister



3 Open toolbox

The shelves, sides and top of this toolbox are made with 1×12 -in. pine shelving stock that is butt-joined, glued and nailed with 4d finishing nails. Begin by ripping these pieces to width and cutting them to length.

Next, bore the $1\frac{1}{8}$ -in.-dia. holes in the top for the hand hole and cut out the waste between with a sabre saw.



Underside of upper shelf holds saw. Turn the block (right bracket) to free handle.

Note that this hole is not centered—it favors the back. This was done to provide better balance when carrying. Shape the “legs” at the bottom of the sides in the same way as the hand hole, then finish-sand all curved surfaces.

Cut the rabbets on the sides and top, running them the entire length of all boards. The voids left on the corners of the top can be plugged easily later with small blocks of wood, as shown in the drawing.

The cleats are cut to size and attached to both sides with glue and nails on a $\frac{3}{8}$ -in.-deep decline from front to back. This prevents the contents from sliding out when you're carrying the toolbox.

Next, attach the sides to the shelves and add the top. Glue and nail the $\frac{3}{8}$ -in. fir-plywood back into the rabbets and nail it onto the back of the shelves. For a good appearance, $\frac{3}{4} \times \frac{3}{4}$ -in. strips are glued to the underside of the top front and ends.

Two saw-holding brackets are attached to the bottom of the upper shelf as shown. The dimensions are suitable for saws like the Stanley Handyman, but other saws can be accommodated by simply altering the positioning to suit your needs.

Finish-sand the box and you're done. If you want, outfit the unit with plastic tool totes (trays) that are available at most hardware and department stores.—*R.F. Harker*

MATERIALS LIST—TOOLBOX

Key	No.	Size and description (use)
A	1	$\frac{3}{4} \times 11\frac{1}{4} \times 36$ " pine (top)
B	2	$\frac{3}{4} \times 10 \times 32$ " pine (shelves)
C	1	$\frac{3}{8} \times 20\frac{1}{2} \times 32\frac{7}{8}$ " plywood (back)
D	2	$\frac{3}{4} \times 10\frac{1}{2} \times 22$ " pine (sides)
E	4	$\frac{3}{4} \times 1\frac{1}{8} \times 10$ " pine (cleats)
F	1	$\frac{3}{4} \times \frac{3}{4} \times 33\frac{1}{2}$ " pine (apron)
G	2	$\frac{3}{4} \times 1\frac{1}{4} \times 11\frac{1}{4}$ " pine (apron)
H	1	$\frac{3}{4} \times 1\frac{1}{4} \times 3$ " pine (handle bracket)
I	1	$\frac{1}{4} \times \frac{3}{4} \times 3$ " pine (handle bracket)
J	1	$\frac{3}{4} \times 1\frac{1}{8} \times 5$ " pine (blade bracket)

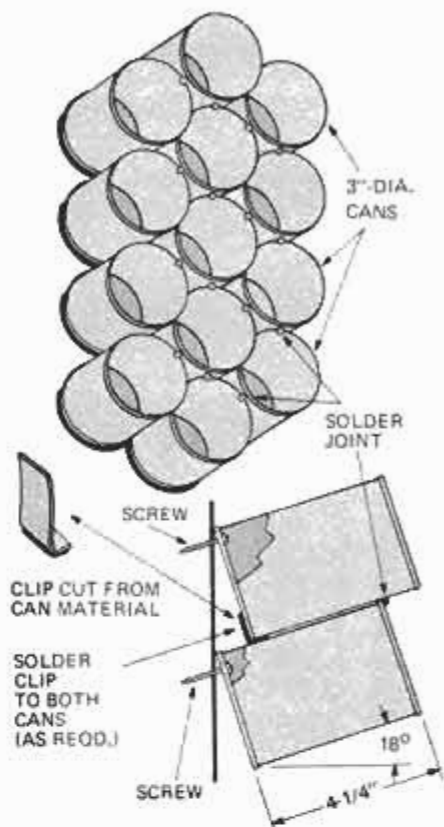
Misc.: Glue, 4d and 6d finishing nails, 1" No. 10 panhead sheet-metal screw.

4 Tin-can bins

I have used pigeonhole racks, made from empty fruit and vegetable cans, for shop storage for more than 40 years. They can hold an amazing variety of small tools and other parts. The rack shown here was made from 3-in.-dia. cans, $4\frac{1}{4}$ in. deep. Any size can be used.

The center vertical row of five cans is assembled first, using a soft wire solder made of tin and lead; some flux is helpful if the cans aren't absolutely clean. A uniform upward tilt of 18° is maintained with spring clips or snap clothespins. Remaining cans are added one at a time.

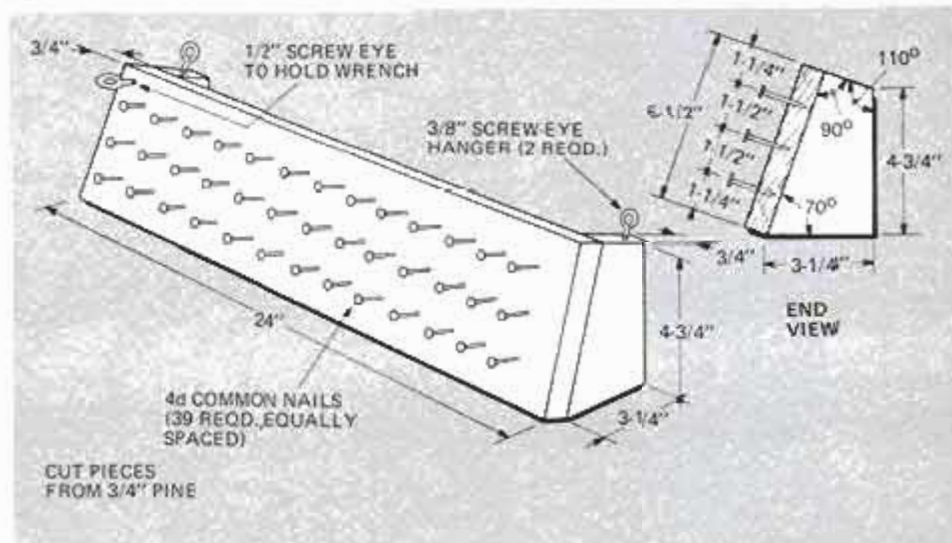
If the open ends don't make good contact, squeezing the cans slightly out of round should do the trick. But missshapen bottoms are not so easily joined. To reinforce some bottom joints that were too wide to solder, I made small clips of tin-can material and soldered these to the cans, as shown. When assembled, the rack can be spray-painted. Attach it to the wall with roundhead wood screws driven through the bottoms of the cans.—*Walter E. Burton*



After center row is soldered, spring clamps or clothespins hold cans in place on sides.

5 Cutter rack

Over the years, I have accumulated many different cutters for my shaper and the spacers that go with them—a sizable investment. To protect the cutting edges from damage, I needed a sensible way to store them. This simple rack made of $\frac{3}{4}$ -in. pine filled the bill. After the front and sides are cut to size, lay out the grid for the cutter-holding nails on the front. Drive these 4d common nails perpendicular to the surface, then glue and nail the front to the sides with 4d finishing nails. Install screw eyes at both ends and the wrench-holding eye on the front. Paint and hang the rack over your shaper.—*Rosario Capotosto*





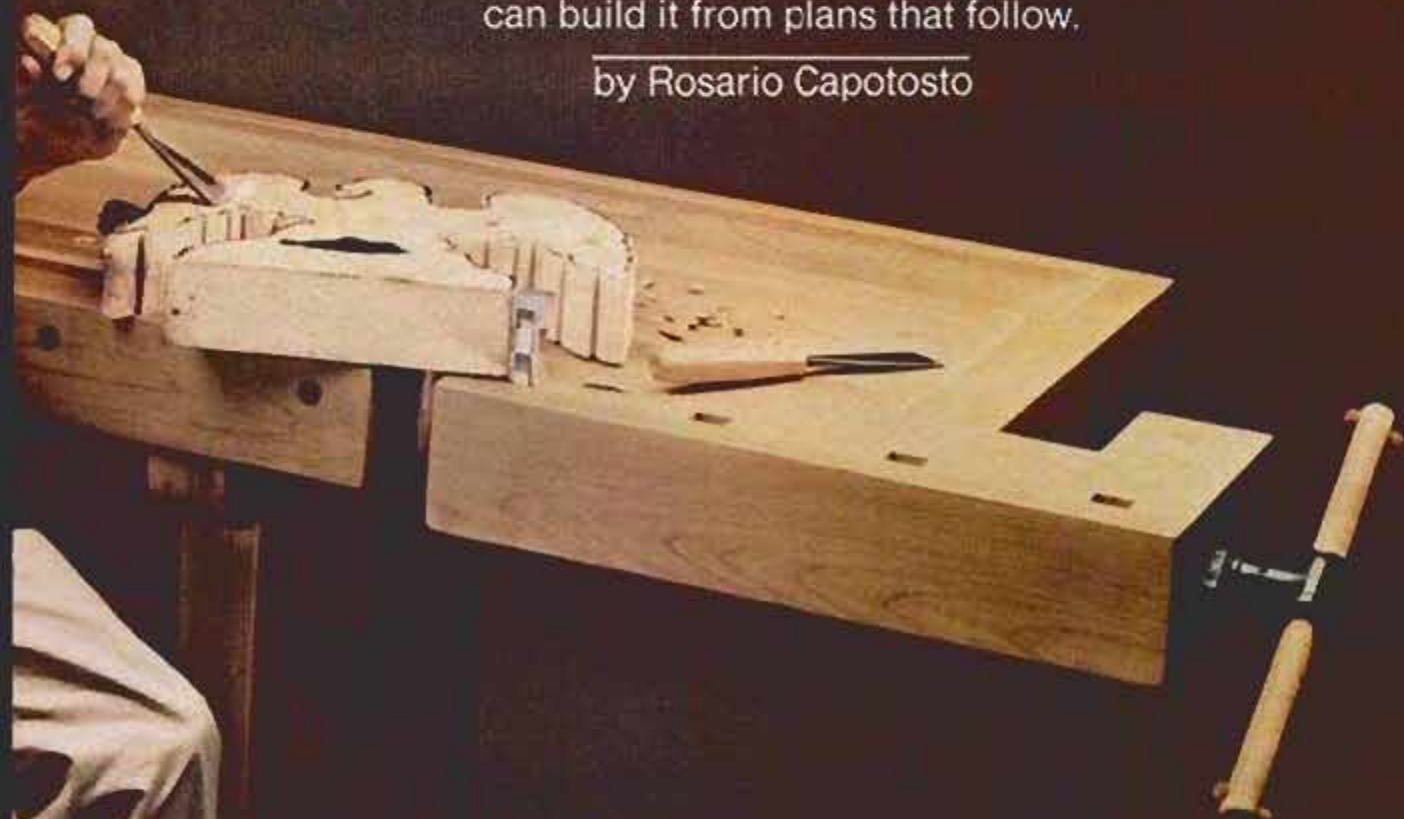
Using our plans, you can build this classic workbench for less than half the cost of a factory-made version. Ours is fashioned of maple to give a lifetime of use. The table's drawer (above right) slides freely on grooved runners. Dovetail joints give the drawer super resistance to racking. Detail (above left) shows stretcher on the back side mortised into workbench leg and reinforced with nut and bolt. Drawings on the following pages show how to make this joint.



Build the PM craftsman's workbench

Here's the classic European workbench every woodworker dreams of owning. You can build it from plans that follow.

by Rosario Capotosto



No matter what size your workshop, once you decide to make the move into serious woodworking, you'll know it is time to either buy or build a craftsman-quality workbench. You can find a simple workbench in lumberyards and home centers (that can't take the pounding) priced up to \$200. A conventional vise will add \$35 or more to the purchase price.

A classic European workbench like the one shown on these pages can be bought through craftsman-supply houses in the \$800 to \$1,000 range. Or, you can follow the PM plans and build our version—for under \$400.

The bench shown is the result of a joint venture between Popular Mechanics and Woodcraft Supply Corp. The table

Design: Popular Mechanics and Woodcraft Supply Corp.,
313 Montvale Ave., Woburn, Mass. 01801
Construction, black and white photos: the author
PM color photos: Dick Frank
Eagle pattern and carving block: Albert Constantine and
Son Inc., 2050 Eastchester Rd., Bronx, N.Y. 10461

2 classic toolboxes you can duplicate

You can use these beauties to hold your tools or as living-room furniture.

by Harry Wicks HOME AND SHOP EDITOR

A trip to an antique fair or shop is almost certain to turn up one or more old toolboxes. At least, that has been my experience during the past year. They are still around in a variety of shapes and forms—from the rare master craftsman's box like the one presented in the November '79 issue of *Popular Mechanics* (*Build PM's Tool Chest for a Master Craftsman*, page 132) to a simple carpenter's pine box like the one shown above right.

The majority of old toolboxes we were fortunate enough to find were obviously crafted by their owners. Typically, the design details were kept simple and the boxes



Our lidded reproduction is crafted of $\frac{1}{2}$ - and $\frac{3}{4}$ -in. cherry; we added a tray for chisels and such. With lid down, box can be used as a coffee table with storage.

were extremely functional. So it is with the boxes that we picked to reproduce.

The closed box is the more elaborate of the two; the original is made of $\frac{1}{2}$ - and $\frac{3}{4}$ -in. stock (pine and maple). We created the copy in the same thicknesses and, for sheer good looks, opted to use cherry for the case and mahogany for the tray.

The inside tray was missing from the original so we crafted our own version to accommodate our needs. The result is a tray sized to suit my collection of fine chisels. You can, of course, alter the members' shapes and locations to suit

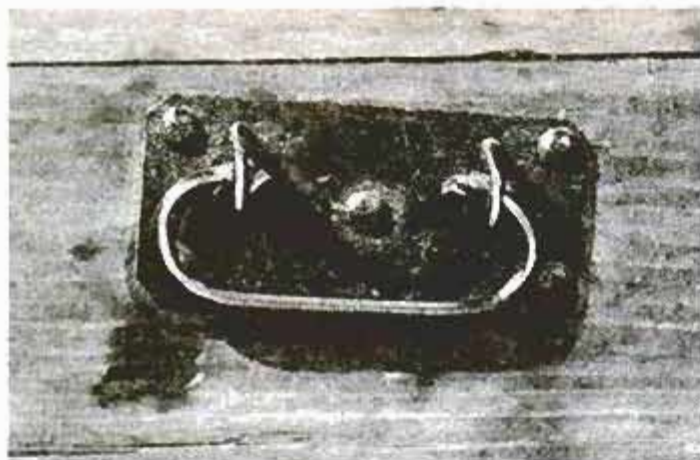


The open carpenter's toolbox is handy for conventional carpentry tools—hammer, small saws, and so on. Or, use it to display your *Popular Mechanics* and other fine magazines.

Construction: Harry Wicks and Steve Wilson
PM color photos: August Lotito
Technical art: Eugene Thompson



Both original toolboxes, found in Wheeling, W. Va., antique shops, are good examples of carpenter design—built by their owners.



The original handles (left) were probably handcrafted by the box's journeyman builder. A search of old hardware catalogs failed to turn up any that had the same look. We created our version (right)



using readily available hardware-store handles, and a backup plate fashioned from 28-gauge sheet metal. All metal parts are painted with flat-black latex and coated with varnish.

the tools that you plan to store in the tray. Or, if you choose to use the toolbox as a coffee table with storage, eliminate the small partitions completely so that the tray can be used as a server.

Making the box with the lid

The cherry for the box is available from The Woodworker's Store, Industrial Blvd., Rogers, Minn. 55374. Use our materials list to prepare your order. The hardware is hand-fashioned, using 28-gauge sheet metal as described later in the building instructions. All metal parts can be purchased at your local hardware store.

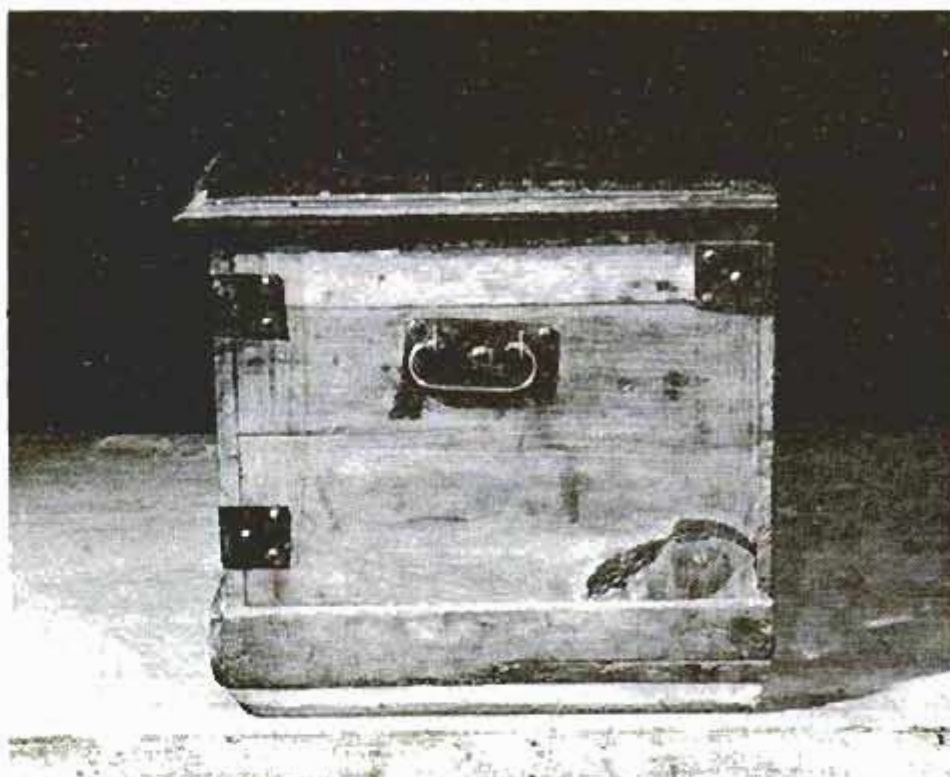
Start by laying out all parts according to the dimensions in the drawing. Use a square to ensure accurate cuts and cut all the parts to size. The wide boards for the top and bottom can be created by edge-joining narrow boards. For the original, the boards were joined using 1/4-in. dowels in the joint, and 1/2-in. corrugated fasteners into both ends across the joint.

Notice the decorative edging on the lid. This apparently was the journeyman's way of "showing off" his skills. The original moldings, in all likelihood, were fashioned using handtools. Though we did some of the shaping with power tools, we, too, had to resort to hand work to closely match the original molding shape.

Start by cutting the three molding pieces to width, depth and length. Then, set up your table saw with the molding cutterhead shown. You *must* use an auxiliary wooden fence to make the cut as shown in the drawing (see page 118, *How to Master Fine Wood Joinery*, for information on auxiliary wooden fences).

You should also use both a hold-down and a hold-in to avoid any chance of accident to yourself when making the moldings. Make the initial pass over the cutterheads to achieve the first stage. Finish shaping the molding by using a block plane with razor-sharp iron, files and sandpaper. (Note: You can substitute the Surform Shaver hand rasp for the block plane with great success.)

When the moldings are shaped and smoothed to your satisfaction, they can



This end view of the box shows the severe distressing that exists on the original. It's important that you resist the urge to overdo it when putting "antique" marks on your copy.

be installed on the three required edges (there is none along the back edge). To do it, predrill lead holes through the moldings or you will split them. Use 1-in. No. 18 brads and glue to affix the moldings.

Like the original, all joinery here is with nails and glue. To prevent any chance of splitting, predrill lead holes for the nails. You actually need two different-size holes for your nails. They should slide freely through the first piece, and then be driven into the leadholes in the second.

We used fewer nails than in the original because it is apparent that many of them were driven over the years to correct loose or split boards. (see photo above). You do want *some* nails to show; in these spots use 3d or 4d common nails. Set the heads slightly below the surface. The balance of the fastening is done with almost-invisible 4d finishing nails.

The tray

We used mahogany to fashion our tray and laid it out as shown to suit the author's tools. The interior members can be resized and reshaped to suit the use to which you will put the tray. Assemble the tray using glue and 4d finishing nails. Finish by locating and installing the shelf cleats on the case members.

Sand all parts before assembly, finishing up with 150-grit abrasive, and assemble the box. The next day, attach the lid to the case using the pair of 1-in. hinges set in mortises as shown.

The corner "irons" are, in reality, cut from 28-gauge sheet metal. You can cut and shape them at this time, but *do not* install them yet.

It is important that you notice that these pieces of "hardware" are *not* cut perfectly even. We copied the "off" sizes, shapes

and locations of the originals exactly. After cutting the pieces, file off any burrs and bore the holes for the escutcheon pins. After bending the corner pieces, paint them with flat black latex (after neutralizing the sheet metal with vinegar).

Finish shaping the escutcheon plate for the "keyhole" and temporarily position the plate on the box. Mark the wood for the keyhole, remove the plate and gouge out the keyhole. Since you won't actually install a lock, you needn't bore through for any hardware. Gouge it out with a small chisel or knife, and paint the hole black.

We made a look-alike handle by using a commercially available handle and cutting the backplate from 28-gauge sheet metal. The photographs on the facing page show how closely the reproduction resembles the original.

The box shown was finished by staining with Carver Tripp maple stain thinned about 50 percent with turpentine. After dusting off the piece, apply the stain with either brush or rag. Let the stain set several minutes, then wipe off all excess. Allow the box to dry overnight.

Next day, after wiping the box with a tack cloth, seal with a coat of clear (water

white) shellac thinned 50 percent with denatured alcohol. Allow the box to dry overnight. When dry, sand lightly with 180-grit paper wrapped around a cushioned sanding block. When it's smooth, dust off and wipe with a tack rag.

You can now attach the flat black "hardware." Fasten the corner braces and all three escutcheon plates using brass escutcheon pins. We used 3/4-in. pins, which we nipped to 3/8-in. length using a diagonal cutter. The escutcheon pin heads must also be touched up with the flat black latex paint.

Install the handles over the plates using the screws (that come in the package) into predrilled holes. When all the hardware is in place—and the black paint is absolutely dry—apply a coat of varnish to all parts as it comes from the can. Allow the piece to dry thoroughly before using.

Making the open box

The open box is easier to recreate. However, that doesn't mean sloppy work is acceptable. Do it the professional way: Start by rough-cutting the six boards to approximate, but slightly over, sizes.

When all parts are cut, you can lay out the angles accurately, using a bevel square. Start by laying out the angles for cutting the ends of the sides. Cut the ends of both sides at the same time, or use a clamped stop block on your radial-saw table so that both sides will be identical in length. Next, repeat the procedure to cut the miters on the ends of the endpieces. Again, cut both at one time or use a clamped stop block. Once the endpieces are cut, you can use your bevel square to transfer the angle so that the bottoms of the sides and ends will be ripped parallel to the bottom board.

At this stage, tack-fasten the boards together to check all bevel and miter cuts. Make adjustments if necessary; overall size, after all, is not critical.

Remember that you will need bevel cuts on all four edges of the bottom piece, and along the edges of the end boards where they butt the side pieces. These are easily determined with the pieces tack-joined. When sides, ends and bottom are fitted to your satisfaction, sand all boards smooth, finishing up with 150-grit abrasive paper.

Assemble the case, using carpenter's glue and 3d common nails. Again, do it professionally and first assemble the box using a bare minimum of 3d finishing nails and clamps. You will need a pair of mitered boards, for use as pads, with each clamp. These let you draw the boards tightly together. When the box is assembled and clamped, set it aside to dry. The next day, remove the clamps and add the 3d common nails. Set all nailheads slightly below the surface.

When the box is assembled, use your bevel square to lay out the centerboard (handle). Make a test cut in scrap and, when satisfied with the angle joint, lay out and cut the board itself. The hand-held cutout is centered on the board and can be made quickly by boring a 1-in.-dia. hole at each end and finishing the cut with either sabre or coping saw. Sand the board and install it in the case using carpenter's glue and 3d common nails.

The original box is quite battered and distressed. We deliberately held the distress marks on the reproduction to a minimum. Overdistressing is often the mark of a neophyte finisher. A few dents or bangs here and there with a ball-peen hammer, perhaps a gouge or two with a carver's chisel, the exposed nails, plus a few punctures with awl or file tang will do.

Dust the box off and wipe it with a tack rag. Then, to ensure an even stain finish, apply boiled linseed oil to all exposed end grains. Immediately apply the oil stain of your choice and wipe off excess.

Set the piece aside to dry overnight. Next day, sand lightly with 180-grit paper; dust off and wipe with a tack rag. Apply a coat of varnish thinned 50 percent with turpentine. Let the box dry 24 hours.

Next, using an artist's pointed brush, apply burnt umber pigment from a tube, thinned as needed with turpentine, to all nailheads and to small distress marks (punctures). The idea is to simulate years of accumulated dirt. Allow the umber to dry overnight, sand the piece lightly with 220-grit paper, dust and wipe with a tack rag.

Finish by applying a coat of varnish as it comes from the can.

To achieve a hand-rubbed, waxed look, we used Pratt and Lambert's satin finish varnish on the boxes shown. **PM**

MATERIALS LIST—OPEN TOOLBOX

Key	No.	Size and description (use)
A	2	1/2 x 6 x 23" pine (side)
B	2	1/2 x 5 1/4 x 12" pine (end)
C	1	3/4 x 9 1/4 x 21 1/4" pine (centerboard)
D	1	3/4 x 10 x 18 1/4" pine (bottom)

MATERIALS LIST—LIDDED TOOLBOX

Key	No.	Size and description (use)
A	1	1/2 x 13 1/8 x 22" cherry (lid)
B	1	1/2 x 13 1/8 x 22" cherry (bottom)
C	2	1/2 x 11 x 22" cherry (front/back)
D	2	1/2 x 11 x 12 1/8" cherry (side)
E	1	1/2 x 17 1/8 x 23" cherry (front trim)
F	2	1/2 x 17 1/8 x 13 1/8" cherry (side trim)
G	1	3/8 x 3/4 x 23 1/2" cherry (front molding)
H	2	3/8 x 3/4 x 13 7/8" cherry (side molding)
I	2	1/8 x 1/2 x 20" cherry (cleat)
J	2	1/2 x 1/2 x 12 1/8" cherry (side cleat)
K	2	3/8 x 1 x 13 1/8" cherry (skid)
L	1	1/2 x 11 3/8 x 20 1/4" mahogany (tray bottom)
M	2	1/2 x 2 1/2 x 20 1/4" mahogany (tray front/back)
N	2	1/2 x 2 1/2 x 11 3/8" mahogany (tray side)
O	2	1/2 x 2 x 10 7/8" mahogany (divider)
P	2	1/2 x 2 x 6 1/4" mahogany (divider)
Q	1	28-ga. x 3 x 4" sheet metal (escutcheon plate)
R	6	28-ga. x 1 1/2 x 4 3/4" sheet metal (corner plate)
S	2	28-ga. x 2 1/8 x 4 1/4" sheet metal (back plate)
T	2	1 3/4 x 3 1/2" Brauered No. 0234 chest handle
U	2	1 x 1 3/4" Brauered No. 6175 butt hinge
V		4d finishing nails
W		3/4" roundhead escutcheon pins cut to 3/8"

BUILD THE PM CRAFTSMAN'S WORKBENCH (Continued from page 127)

is based upon plans and vise hardware offered by that firm. The actual building of the craftsman's workbench was done in the PM shop.

Most European benches are constructed of either beech or ash, or a combination of the two woods. We weren't able to obtain either one locally in the dimensions needed for this project. So we substituted native maple. It's rock-hard and produces a bench that's as stable as any woodworker's table that I have ever used.

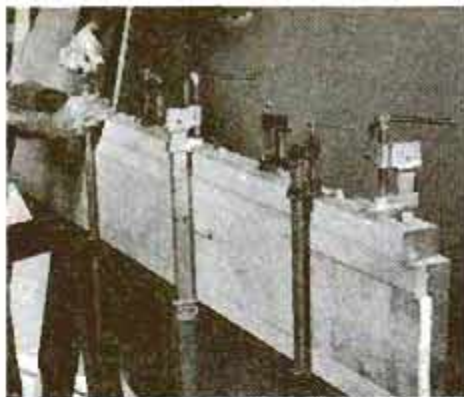
Construction procedure

Normally, hardwood comes surfaced two sides (S2S), so the first step is to true one edge of each piece of stock. Since the pieces are long and heavy, your best approach is to rip one edge true on a table saw rather than with the jointer. To do this, tack-nail a straight-edged strip of wood to the surface, allowing the edge to overhang the irregular edge of the stock. Run the true guide against the rip fence.

Rip the stock to dimension to make up

the main slab for the top, as indicated in the drawing. Use 3/8-in. dowels to reinforce the butt joints. Use the drill press to bore the through dowel holes in the outside pieces. Then clamp them to the wide board and continue the holes into the latter with a portable drill. Apply glue, drive in the dowels, then clamp.

The 2 1/2 x 12 1/4 x 79-in. slab is much too big and heavy to handle on a table saw, so a radial-arm saw is ideal for crosscutting the ends true, and to size. Support the workpiece firmly to make the end trim-



1 Make the bench top slab using edge-joined maple boards and $\frac{1}{4}$ -in. dowels; glue and clamp both sides. Kerf cuts (inside, near end) let you use warped board.



7 After dowel holes in inner front piece are bored through on a drill press, piece is clamped in position on slab, and boring is continued into slab with portable drill. Repeat step for front piece before gluing.

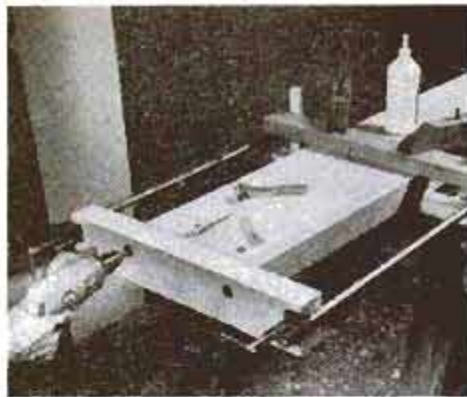
two 6-in. lagscrews, set into 1-in.-dia. counterbored holes and plugged. To bore the holes for the lags, bore the body holes in the end blocks on the drill press after drilling the larger hole for the lagscrew head and washer. Then, using the arrangement shown (photos above), clamp the piece(s) in place with bar clamps and continue the holes into the slab with a portable drill.

If you don't own a router-edge guide, a strip of wood clamped to the router base will guide the router to make the required groove in the edge of the slab. Measure the required offset from the edge of the straight router bit to the wood guide. Then make as many passes as necessary to obtain a groove of the required width, progressively repositioning the guide. Notice that the size and location of this groove is critical.

After the front members have been glued up, they are temporarily clamped together to make the truing crosscuts at the ends.

The notches for the bench dogs must be cut on the back surface of the front member before the final glue up. Note that the notches slant 2° toward the tail vise. The radial saw is ideal for this operation. Adjust the blade height so it cuts a kerf $\frac{1}{4}$ in. into the surface. Make repeated passes to cut a 1-in.-wide notch. Also make partial cuts to start shoulder cuts. Use a chisel to trim offset shoulders.

The two front assemblies are glued with



2 After slab has been crosscut to size, slab ends are attached with lagscrews and glue. You won't need 7-ft. bar clamps if you use this trick. Countersink all screws.



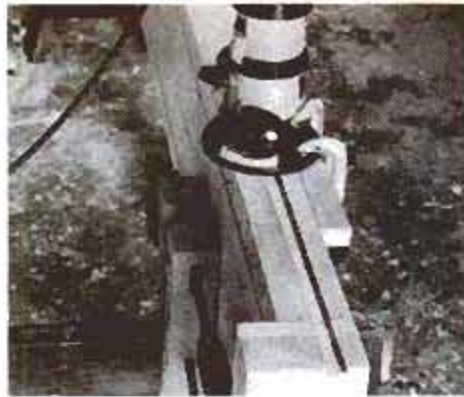
8 Ample supply of clamps used on both sides will ensure good joining of front pieces to slab. Note staggered dowel positions of the front pieces in drawing. Clean squeezed-out glue from all surfaces, particularly from bench-dog holes.

$\frac{3}{4}$ -in. dowel reinforcements. The best way to obtain true holes in alignment is to use the drill press and portable drill in combination. Bore the holes in the inner piece on the drill press. Clamp the piece to the slab, then continue the holes into the slab with the portable drill. Don't drive in dowels yet. Remove the clamps carefully. Without moving the piece, clamp on the outer piece which has also had its holes bored on the drill press. The second series of dowels is not in line with the first. Bore through again with the drill.

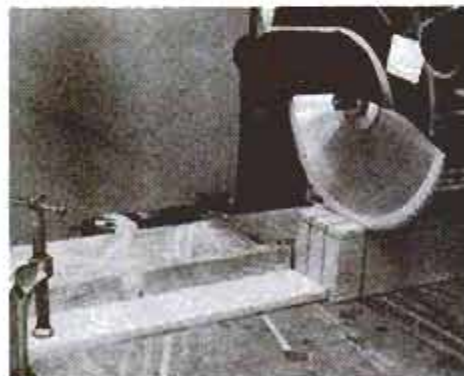
Apply glue and drive in the dowels, making sure they seat slightly below the surface. Add the second member, and drive in the dowels. The latter dowels should be slightly longer to allow flush sanding later. Before inserting the dowels, plane two slight flats on each side to give excess glue an escape path. Also sand a slight bevel on the lead ends so the dowels will slide in easily.

When applying the glue alongside the notches, don't overdo it. Allow the glue to set until it's no longer runny. Then use a chisel to clean out any glue on the insides of the slots.

When the slab is complete, cut a piece of stock for the shavings trough back. Use a dado head to cut a stopped groove $\frac{3}{8}$ in. deep to receive the base. Position the tail-vise back plate on the slab and mark it for drilling the attaching screw holes and the clearance hole for the vise nut. Put the slab aside while you work on the base.



3 Attach a guide to router as shown and rout a 20-in.-long groove to accommodate tail vise's upper guide plate. Rout groove before attaching front pieces to slab.



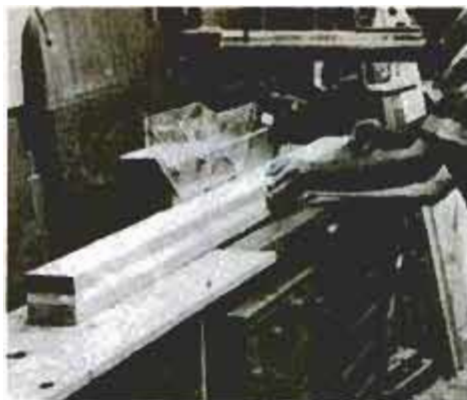
9 Using the radial-arm saw to make cross-cut kerfs is the first step in forming leg tenons. Use a clamped stop for uniformity.

The legs of the base are made with $1\frac{1}{4}$ stock ($2\frac{3}{4}$ in.), using mortise and tenon joints at the top and bottom. Rip the stock into squares, then crosscut the pieces to the required lengths. Mark the ends of the uprights for cutting the tenons. Use the radial-arm or table saw or a combination of both.

Start by making kerf cuts to form the shoulders. Set the blade height, and make all similar cuts on all the pieces before adjusting the blade for the second series of cuts. If you have a tenoning jig, use it on the table saw to make the end cuts to form the tenons. Or set up the radial-arm saw with the blade in the horizontal position to make the endwise cuts.

To make the mortises in the upper and lower leg members, first bore three overlapping 1-in.-dia. holes, $2\frac{1}{4}$ in. outside to outside and $1\frac{1}{4}$ in. deep. In addition, bore four $\frac{1}{8}$ -in.-dia. holes in each corner of the rectangle. Dress the holes to size with the chisel.

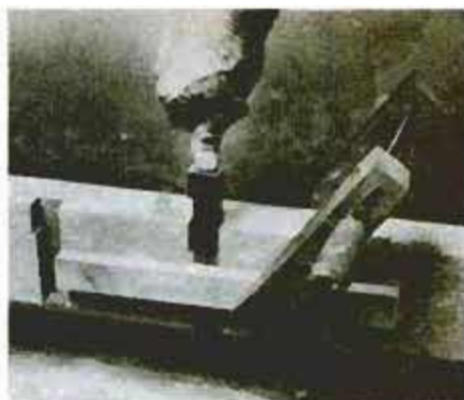
Mortises and tenons are also formed to join the stretchers to the leg sections. The stretchers are too bulky to handle with a tenoning jig, so they're formed as shown on the radial-arm saw. A series of eight $\frac{3}{4}$ -in.-dia. holes spaced $\frac{1}{2}$ in. apart from each end are made to rough form the mortises for the stretchers in the uprights. But before you bore these $\frac{3}{4}$ -in.-deep holes, locate the center of the mortise and bore a $\frac{1}{2}$ -in.-dia. through hole for the connecting bolt. Bore this hole on the drill



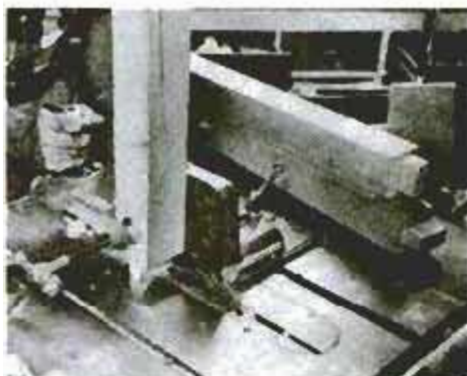
4 Inner front piece is supported on each side of jointer as it is run through the machine. Successful jointing requires this setup because the pieces are heavy.



5 Make $\frac{1}{8}$ -in.-deep kerf cuts in front piece with radial-arm saw. Chisel out slots for bench dogs. "Nick" on left of slot aids in cutting offset for dog shoulder.



6 Before gluing front piece, test-fit each bench-dog slot with a dog as shown. Fit should be snug, but you must be able to remove dog by hand easily.



10 A tenoning jig is used to complete the leg tenons on a table saw. A backsaw and guide may be used if working by hand.



11 Making mortises in the upper and lower leg members is easy with technique shown here. Bore three overlapping 1-in.-dia. holes in the center of the intended mortise and one $\frac{1}{8}$ -in.-dia. hole in each corner. Use a sharp chisel to complete job.



12 Use a portable drill to bore bolt holes into center stretchers. Holes in legs were previously bored through on a drill press. Clamps are used to test-assemble the legs and stretchers for proper fit.

MATERIALS LIST—WORKBENCH

Key	No.	Size and description (use)
TABLETOP		
A1	1	2 1/2" x 4" x 64" maple (outer front)
A2	1	2 1/2" x 4" x 24 1/4" maple (end)
A3	1	2 1/2" x 4" x 18 1/4" maple (end)
B	1	3 1/2" x 4" x 64" maple (inner front)
C	1	2 1/2" x 12 1/4" x 79" maple (top slab)
D	1	1" x 4" x 84" maple (back 1" trimmed from 5/4 stock)
LEGS, SUPPORTS AND DRAWER		
E	4	2 3/4" x 2 3/4" x 28 1/2" maple (legs)
F	4	2 3/4" x 2 3/4" x 24 1/2" maple (upper/lower members)
G	2	1 1/8" x 5" x 56 1/2" maple (stretcher)
H	1	1 1/2" x 2 3/4" x 12 1/4" maple (filler)
I	1	1 3/4" x 2" x 21" maple (vise filler)
J	1	1 1/2" x 1 1/2" x 12 1/4" maple (filler)
K	2	2" x 2" x 22 1/2" maple (drawer slide support)
L	1	2" x 2 1/2" x 12" maple (vise back support block)
M	1	3/4" x 2 1/2" x 16" maple (vise plate support block)
N	2	3/4" x 5" x 18 1/2" maple (side)
O	2	3/4" x 5" x 18 3/8" maple (front back)
P	2	3/4" x 3/4" x 15 3/8" maple (cleat, end)
Q	2	3/4" x 3/4" x 17 3/4" maple (cleat, side)
R	2	5/8" x 3/4" x 18 3/8" maple (slide)
S	1	1/4" x 1 1/4" x 2 1/4" maple (forward stop)
T	1	1/4" x 18 7/8" x 17 3/4" hardboard
U	1	3/4" x 5 1/4" x 6" maple (sweep out)
V	1	1/2" x 8 3/8" x 79" particleboard
W	1	1/2" x 2" x 79" pine (filler)
X	1	1/4" x 8 3/8" x 79" tempered hardboard
Y	1	3 1/2" x 6" x 20 3/4" laminated maple (front vise jaw)
TAIL VISE		
Z	1	2 3/8" x 4 1/8" x 22 1/2" maple (front piece)
AA	1	1 3/8" (6/4) x 3 1/8" x 22 1/2" maple (upper guide cover plate)
BB	1	1 3/8" (6/4) x 4" x 5 1/8" maple (upper guide cover plate)
CC	1	1 1/8" (5/4) x 3 1/8" x 22 1/2" maple
DD	2	1 1/8" (5/4) x 3 1/8" x 18 1/2" maple
EE	2	1 1/8" (5/4) x 4" x 8 1/2" maple
FF	1	1 1/8" (5/4) x 4" x 5 3/8" maple
DOWELS		
GG	2	1"-dia. x 16" dowel (vise handle)
HH	4	1"-dia. x 3/4" dowel plugs
II	7	3/4"-dia. x 5" dowels

press so that it's absolutely true. Then cut the mortises. Glue the top and bottom members to the uprights after cutting and sanding the curved-end profiles.

Don't glue the stretchers to the uprights; they are held with $\frac{1}{2}$ x 5-in. bolts. Assemble the legs and stretchers and clamp them together firmly. Adjust the clamps, if necessary, to get the assembly square. If long bar clamps are not available, use the short clamp trick again, as shown. Insert the portable drill into the predrilled holes in the uprights and bore into the stretcher ends.

Make the recess for the nut by drilling three overlapping $\frac{3}{4}$ -in. holes 1 in. deep into the back face of the stretcher. If you use a short point brad point bit, you will just make it without breaking through the



13 A $\frac{1}{8}$ -in.-deep slot is bored into back side of each stretcher end. This slot houses through-bolt nut and washer. Because slot is stopped, washer must be cut.

front face of the stretcher. Clean out the pips with a chisel. After the base is assembled, work on the tail vise.

The L-shaped tail vise is strengthened with offset, end butt joints. Construct the unit in three stages: the basic L, the upper guide plate cover, and the front with its bench-dog slots.

Start with the basic L. Cut the pieces to size, then glue the lower six pieces together. Use nails as pegs to keep the parts in place during gluing. Don't hammer the nails in; insert them into predrilled

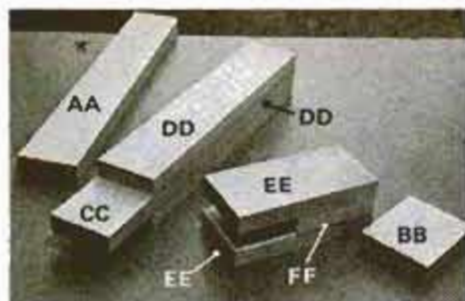
PLANS AVAILABLE

If you prefer to build this classic workbench from larger drawings, you can order a set of detailed PM plans with instructions printed on 14 x 22-in. sheets. Send \$5.95 to Classic Workbench, Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101.

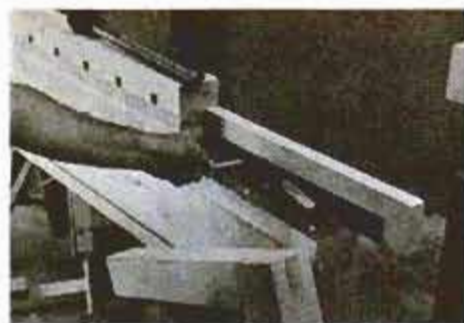
JJ	8	3/4"-dia. x 4" dowels
KK	4	1/2"-dia. x 1 3/4" vise handle stops
LL	14	3/8"-dia. x 3" dowels
HARDWARE		
MM	1	1/2" x 5" hexhead bolt and nut (4), washer (8)
NN	1	3/8" x 6" lagscrew and washer (4)
OO	1	1/2" x 5" lagscrew and washer (4)
PP	1	1/4" x 1 1/2" lagscrew
QQ	4	2 1/2" No. 12 fh screw
RR	6	1 1/4" No. 8 fh screw
SS	2	2" 6d common nail (rear drawer stops)
TT	1	1 1/4" finishing nails
UU	1	Woodcraft No. 17 DO4 - AW, \$111.40 postpaid (front vise)
VV	1	Woodcraft No. 17 DO2 - AW, \$107.80 postpaid (tail vise)

Misc.: Bench dogs, No. 16A71-6, \$21.80 pair, postpaid, from Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01801.

*The 1 1/8" (5/4) stock is actually slightly thicker than 1/8".



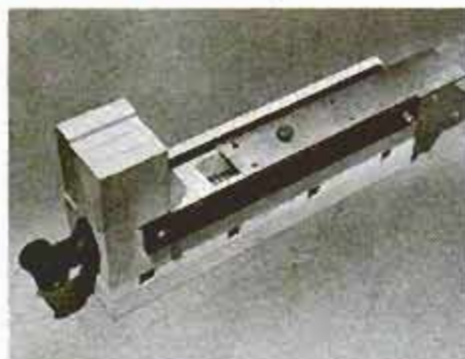
14 Wood members of tail vise are shown here with the first step in gluing the assembly completed. The two upper-plate-guide cover pieces (AA and BB) are attached to assembly separately. Letters refer to key in materials list and drawing.



15 After tail-vise back plate is attached to slab with a few screws, position the upper plate guide as shown and mark plate cover for screw holes. Note that guide plate is let into inside of the plate cover.



16 Upper guide plate and cover have been attached to tail-vise assembly, which is lying on the lower-guide-plate side. A recess in short piece of upper plate cover (far left) must be cut before this piece is attached to assembly. Back plate is test-fitted for free sliding action.



17 The tail vise is completely assembled. Note that lower guide plate is also let in.



18 Back plate has been removed from test assembly of tail vise and attached to slab. Slot by which vise moves over large nut is now visible. Place vise, add lower guide plate and tighten the two nuts.



19 Front vise base plate in foreground has been used as a template to mark and bore through-holes in vise support blocks. Use a bit in these holes to mark through-hole positions on intended vise jaw.



20 Front vise jaw is cut to size. Oversized through-holes have been bored.



21 Attach hardware as shown and scribe the perimeter of the guide rod collars on support blocks. Rout area for recessing collars, then attach with screws.



22 The final step in the front-vise assembly is attaching front plate to the vise jaw.



23 The nonracking drawer and guides are easily assembled. Bottom isn't yet in position, so drawer stop is revealed. Particleboard forms bottom of shaving trough.

holes. Set the four nails near the edges so they won't obstruct the hardware.

Next, make the recess for the vise screw and large nut. Bore a series of 22 overlapping 1½-in. holes to clear out most of the waste, then trim with a chisel. Bore the deep hole in the end for the vise screw.

Attach the lower guide plate to the bot-

tom of the assembly with two nuts. Set the upper guide plate into a rabbet with two wood screws. It becomes permanently secured when the wood cover pieces are glued into place. Insert two special flat-head carriage bolts through the plate before gluing. Test the assembly before gluing the cover pieces permanently. When bolted together, the grooves in the guide plates should be spaced so they will ride snugly over the back plate.

Construct the front piece as you did the front of the main bench top, with one exception. Make the holes for the bench dogs in reverse direction; they slant 2° toward the other holes.

The front vise

Glue in the vise back support block, then bore three holes in line with the vise bottom plate holes. Bore these holes about ¼ in. greater in diameter than those of the guide rods and vise screw. Temporarily attach the vise plate and insert the vise screw with the guide rod collars in

place. Trace around the collars to mark for cutting the recesses with a router.

To mark the jaw for drilling the large holes, remove the hardware, align it with the bench top and clamp it in place. Manually insert drill bit(s) through hole(s) in the back support block. Twist the drill bit so the point makes a center mark.

The curved profiles on the ends of the jaw are cut with the band saw. However, if you first make a kerf cut in the top with the table or radial saw, you will get a sharp, well-defined corner. A small belt sander is ideal for sanding out the band saw ripples, but protect the square shoulder by taping a thin strip of wood to it.

After installing both vises, use a large plane to true the surfaces. Stroke diagonally over the very rough spots, then work lengthwise, cutting with the grain. Finish truing with a large belt sander. The drawer can be easily assembled according to the drawing. Generally, a penetrating oil finish is used for workbenches. We used McCloskey Royal Danish Oil. **PM**

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Digital dash with a tachometer that simulates a torque curve is rather gimmicky, but we liked it. Among the other features are a trip computer and eight-way adjustable seats.

DRIVING THE 1982 TOYOTA CELICAS

(Continued from page 112)

cam engine, it boasts semi-trailing-arm independent rear suspension, variable-assist power rack-and-pinion steering, four-wheel ventilated disc brakes, a limited-slip differential, pop-up halogen headlamps and a choice of five-speed manual or four-speed lockup overdrive automatic transmission.

Inside are a space-age, eight-way adjustable driver's seat with an air-bladder lumbar adjuster, videogame-look digital/graphic instrumentation, a five-speaker home-quality stereo system and a super trip computer.

So special are these new cars to Toyota that the company brought us all the way to Japan to see and drive them, which we did at the Fuji Speedway road-racing course.

Home-grown design

The styling, though a bit controversial, tends to grow on you. Interestingly, the previous Celica, considered a design coup and very successful in America, was styled by *Americans* in Toyota's California Calt Design studio—and was not very successful in Japan.

This time around, they did it themselves, trying to please their own countrymen, as well as everyone else. The result is an aggressively handsome fastback shape somewhat spoiled by overdecoration and incongruity of detail at both ends, and a

clichéd, American-style, formal coupe. But at least the coupe doesn't come with a half-vinyl roof and coach lamps.

The Celica models

The Celica's shovel-nose front looks functional but seems a bit too radically sloped, and the "rock-forward" headlamps are too cute and gimmicky. The big front bumper is significantly changed. The 2.4-liter, overhead-cam, four-cylinder engine (which Toyota builds especially for the American market) puts out the same willing 96 hp at 4,800 rpm and the same 129 ft. lb. of torque at 2,800 rpm as it did before; the MacPherson-strut front and live-axle, coil-spring rear suspensions give about the same ride and handling; and the whole feeling is very familiar: competent and adequate, but less than thrilling.

There is better steering response from the new rack-and-pinion steering, and the cars seemed to corner better around the speedway than I expected—due partly to the increased tread width, but largely due to the better-than-stock tires fitted to our test cars. The interior, of course, is all-new and very nice, with a full set of gauges (attractive and functional) in the panel, tasteful decor and trim and a new heating system that allows left/right mixing so both driver and passenger are comfortable. There's also, at least, almost enough legroom for long-legged American drivers. The only two sour notes (for me) are the inverted "V" steering hub (I still think the spokes should be horizontal for proper driving) and a flip-up ashtray lid that interferes with the radio controls.

The Supra model

The Supra, on the other hand, has 25 percent more horsepower and 7

percent more torque than last year, a modified MacPherson-strut front suspension (offset spring for less friction and twice as much caster for improved on-center steering feel), variable-boost (less assist at higher speed) power rack-and-pinion steering replacing the old recirculating ball, and fully independent rear suspension instead of the previous live axle. The result is livelier performance and *tremendously* better handling, especially from the mean-looking, big-tired, flared-fendered version, which Toyota calls its Performance Pack.

There was no opportunity for straight-line acceleration testing, but Toyota says the Supra does 0 to 100 kph (62 mph) in 8.8 seconds and a quarter-mile from rest in 16.4 seconds. Subjectively, we felt the new Six's power was inadequate, particularly at off-the-line low rpm, considering the cost and the complexity of its dohc valve train. Another 15 or 20 hp would be very helpful in properly propelling the Supra's 2,900 pounds—especially that Performance Pack version. The five-speed manual transmission, however, is excellent, the four-speed lockup overdrive automatic is one of the industry's best, and the four-wheel disc brakes were exceptional in stopping power and fade-free stability.

Incredible eight-way driver's seat

The Supra's cockpit was basically the Celica's with more flash and gadgetry. Personally, we liked the Star Wars video dashboard. But it should have some sort of oil-pressure gauge and either ammeter or voltmeter. The incredible eight-way driver's seat sets a new industry standard for adjustability—fore/aft, recline, headrest vertical, headrest fore/aft, seat height, thigh support and adjustable air-bladder lumbar support for driving comfort. There's a little rubber squeeze pump to inflate the lumbar bladder and three buttons on the side bolster to exhaust air in just the right places to conform precisely to your shape and preference. Another gimmick, perhaps, but a darned clever one.

The radio, in recent Japanese fashion, is marvelous in its hi-tech look, sound and complexity. And there's a trip computer in the dash.

The neatest gadget of all, however, a Navicom computer-controlled electronic compass that graphically displays direction and distance to a pre-coded destination, is for the Japanese home market only. We understand they can't produce enough Navicom's this year to offer them in export cars. Or maybe they figure we wouldn't understand it yet. **FM**

SPECIFICATIONS: 1982 TOYOTA CELICA

	Liftback, coupe	Supra
Wheelbase (in.)	98.4	103.0
Length (in.)	176.6	183.5
Width (in.)	65.6	66.3
Height (in.)	52.0	52.0
Curb weight (lbs.)	2,559	2,910
Engine (cyl./type)	4 in-line	6 in-line
Valve train	sohc	dohc
Displacement	2.4 liters	2.8 liters
Horsepower/rpm	96/4,800 rpm	145/5,600 rpm
Torque ft.-lb.	129/2,800 rpm	155/4,400 rpm
Fuel cap. (gal.)	16.1	16.1

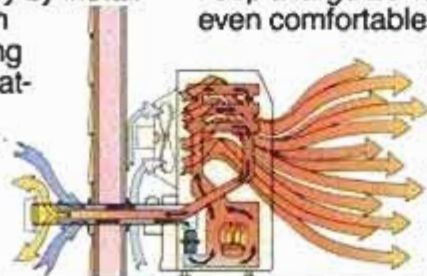
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HINTS FROM READERS

V-belt feet



You can make no-cost cushion feet for a storage box, small chest, or other article from sections of a discarded V-belt. Cut a rectangular notch about 1/2 in. long and half as deep as the belt thickness on the narrow side (belt bottom) of each section. With a leather punch, make a hole in the center of each notch area for a flathead mounting screw. Attach the foot with the narrow side outward. The feet shown in the photo are constructed of 1/2-in.-wide belting about 2 1/2 in. long.

—Walter E. Burton

Eyeglass cover

If you wear glasses, painting overhead can be a problem due to paint spatters. To protect your glasses, cover each lens with a circle of plastic kitchen wrap. The material won't obscure your vision until it becomes covered with paint spatters. Then you can simply peel it off and replace it with new plastic wrap. It's cheap, effective, and beats wearing goggles.

—Lane Olinghouse

Protecting caliper points



Straight point calipers and dividers are useless if they are dropped and the points are bent or damaged. To protect the points when not in use, cover them with rubber knitting-needle protectors which are available at a sewing- or knitting-supply shop.

—C. Boyd Pfeiffer

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'BUCK ROGERS' WEAPON

(Continued from page 101)

field, literally squeezing out bursts of incredible energy.

The Livermore facility will derive its power from a more conventional system, but one which involves complicated and precise technology. Electrons can easily be "boiled off"—induced to leave—a metal plate (cathode), heated to 850° C. in the accelerator's injector section. But in order to have a stable beam, which begins as a rarefied electron stream about 10 inches in diameter, the strong induction coils which move electrons from the cathode toward an oppositely charged cone (anode) must also accelerate them to .985 times the speed of light. This all happens within the 9-inch space between the cathode and anode. The beam's energy is then already rated at 2.5 million electron volts.

The entire remainder of the system is required to squeeze the beam down (because electrons repel each other) to about a 2-inch final diameter, while adding only 2,600 miles per second (m.p.s.) to the speed it carries out of the injector (183,000 m.p.s.).

Yet because of what Einstein taught the world to regard as relativistic effects, this tiny increment gives the beam a peak energy of 50 million electron volts—20 times the power it had leaving the injector. (This is consistent with the gain in mass by individual electrons, which are at six times rest mass leaving the injector and more than 100 times rest mass exiting the system.)

Because the beam is the product of pulsed current that builds, peaks and attenuates on a nanosecond scale, its best measurement is a technical approximation: It is figured at about 70 feet long during its existence in the accelerator for a period of 70 billionths of a second.

Once out of the injector, the beam passes sequentially through 190 accelerator cells. To keep the electrons from colliding with the gas molecules that would be present in a normal atmosphere, the tube is kept at a near vacuum.

Timed power pulses

The basic electrical power that makes all of this possible comes first from an electrical substation at the Livermore site. From a resonant transformer, it is pumped into storage devices known as Blumleins. The Blumleins feed both the injector's induction coils and the accelerator cells. When charged, they act much like capacitors—power that was built up over several microseconds is discharged 300 times faster,

through a high-speed, spark-gap switch.

The high-voltage output of the Blumleins acts on the beam through the accelerator cells. Precise timing of these voltage pulses to the cells in coordination with the arrival of the beam is critical to the process. In addition, solenoids and magnets focus and steer the beam throughout the accelerator stage.

The beam passes through a differential pumping unit following acceleration; this allows its unimpeded exit while keeping the near vacuum.

New test conditions

Up until now, the beam has been passed into an experimental tank to observe its interaction with various media or targets. The Livermore unit's beam will be tested for propagation through the atmosphere.

Perhaps it will be shown that a preliminary "hole" must be bored through the air—using a split-second laser or beam shot—in order for an electron beam to carry over any distance with lethal effect. Perhaps this prebored tunnel will contain the electrons in beam form, or maybe the electrons will disperse harmlessly in spite of it.

This is what Livermore's advanced accelerator will try to tell us. Beyond that, the accelerator's energy output will have to be doubled—to at least 100 million electron volts—before it even begins to approach the predicted threshold of weapons-grade effectiveness. And ways will have to be found to pack the vast power supply into a package that's mobile enough—even a battleship—to be used as an operational weapon.

Much of the preliminary research on electron beams was carried out under Navy funding in a program that began in the mid-70s in order to determine if the beam methodology offered a reasonable chance for "point" defense against antiship guided missiles. Such a system could well become the first practical "ray-gun" application.

Directed-energy defenses for space applications, on the other hand, must follow a different path, using neutral particles that do not disperse due to mutual repulsion. Experiments involving the acceleration of hydrogen ions—which are neutralized by stripping an electron as they leave the accelerator—are being scaled up in another DARPA program.

If the feasibility is there, the debut of real beam weapons is merely a matter of time, cost and our unwillingness to be a close second in their ultimate development. **PM**

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If you want to learn about wood carving, look into the Wood Carving School, 3056 Excelsior Blvd., Minneapolis, Minn. 55416. It offers five, intensive, five-day programs a year that cover carving design; proper care and use of tools; and the natural properties of woods. But it isn't all theory; much time is spent carving in the shop.

Enrollment for the one advanced and four beginner's courses is limited to people outside the Minneapolis area. The cost is \$195 excluding tools, wood and other supplies if you don't bring your own. For schedule information, write the school.—S.W.

Plug cutters

Three new plug cutters with a continuous self-ejection design have been introduced by General Hardware Mfg. Co. Inc., New York, N.Y. 10013. Made of high-carbon, tempered steel, these cutters make clean, smooth plugs up to $\frac{3}{8}$ in. long in both soft and hard woods, in $\frac{3}{16}$, $\frac{1}{2}$,



New plug cutters from General eject cut plug (arrow) when bit is lowered to cut next one.

and $\frac{3}{4}$ -in. diameters. Each cutter costs \$6 at hardware stores and home centers.

—S.W.

Make room on your bookshelf

Several particularly good and useful books have appeared recently, all of which will be welcome additions to a do-it-yourself's book shelf. Two of

them are Popular Mechanics books, published by Hearst Books.

The first, *500 Home and Shop Tips*, is a 160-page collection of good ideas that have worked for PM readers and professionals over the years. This compendium was collected and edited by PM's Home and Shop Editor, Harry Wicks. Priced at \$12.95,



Books include how-to tips for appliance repair (left) and home and shop work.

it's available at bookstores.

Another gem in the PM collection is the brand-new *Home Appliance Repair Manual*. This 320-page book boasts easy-to-follow repair instructions for both large and small appliances, and contains an appendix, listing parts suppliers for both types. With more than 800 photographs and 200 diagrams, it sells for \$22.95 at bookstores.

Every serious—or would-be serious—woodworker should have a copy of *Making and Using Simple Jigs* in his shop. It is a roundup of jigs



Low-priced, 44-page pamphlet (left) is filled with photos and drawings (below) of easy-to-make jigs.



for use with your shaper, table saw, router, sander, radial-arm saw and more. It's a steal at \$2.75 postpaid,

from Armor Products, Box 290, Deer Park, N.Y. 11729.

Two goodies for home remodelers, *Century of Color* and *The Old-House Journal Catalog* are available from the Old-House Journal Bookshop, 69A Seventh Ave., Brooklyn, N.Y. 11217 for \$12 postpaid each. The first book has over 100 full-color illustrations showing authentic color combinations used for exterior decoration on homes between 1820-1920. "Affin-



Old-house restoration is aided by supplier catalog (left) and exterior colors book.

ity charts" which detail 200 more historically accurate combinations are also included. The second book gives up-to-date information on over 1,000 companies that provide products and services in the restoration field. According to the publisher, these companies have been carefully screened for integrity and professionalism.—H.W.

PM greenhouse fan

In our article *You Can Add This Deck and Greenhouse to Your Home* (page 142, Apr. '81), we showed a thermostat-activated exhaust fan. You can make one, using a Dayton fan model No. 2E634 (\$68.25) and a Dayton thermostat model No. 2E340 (\$21.50). For the nearest distributor write to W.W. Grainger Inc., 5959 Howard St., Chicago, Ill. 60648.

Which way is up?

The steps in the porch assembly drawing for the article, *This Dollhouse Is a Toy Box, Too* (page 94, June '81) should be shown with step Q-7 at the bottom leading up to Q-1 at the top. Inadvertently, the steps were labeled in reverse order. **PM**

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.

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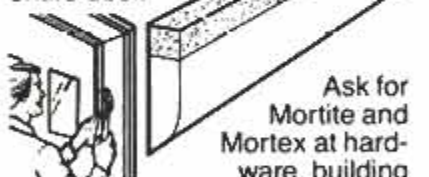


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HINTS FROM READERS

Drill bits from nails



When you must bore small holes in wood, but don't have the proper size bit, you often can use a small nail. Although nails don't bore as effortlessly as bits, you can use them in both electric and hand drills. Since nails are relatively soft steel, they dull quickly and should be replaced as needed.

—David W. Roberts

Knobs from toothpaste caps



Drawer knob is toothpaste cap. Parts for another knob are in the foreground.



Knobs and feet are toothpaste caps. Knobs are topped with colorful marbles.

Make a drawer knob from a toothpaste cap by inverting, preboring and attaching it with a 1/4-in., No. 5 screw. For a fancier knob, attach a cap and a metal disc with a No. 6-32 bolt, nut and washer. Secure a marble with epoxy resin to hide the bolt.

—J. Wallace and Walter E. Burton

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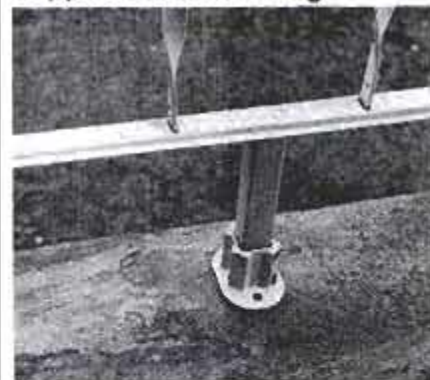
Tagging shop drawers



An effective way of tagging shop drawers to indicate their contents is to fasten on each drawer front a sample of the parts or tools that are in the drawer. Make the part highly visible by painting it with bright yellow, model-airplane lacquer. At times, some samples, such as the threading die in the photo, must be used for their original purpose. Fasten them so they can be removed and replaced easily. The die is hung on a roundhead screw. Apply lacquer where it doesn't interfere with normal use.

—Walter E. Burton

Support for iron railing



Iron railings usually run 4 or 6 ft. long between supporting posts. They have a tendency to sag if excessive weight is applied near the center, for example, if children climb or adults lean on them. You can prepare for this situation, or eliminate sag, by installing railing floor flanges at mid-points between posts with hardwood or metal uprights in the flanges supporting the lower rail. Shape the end of the upright to fit the rail channel. Paint the supports with an enamel matching the color of the railing.

—Ralph S. Wilkes

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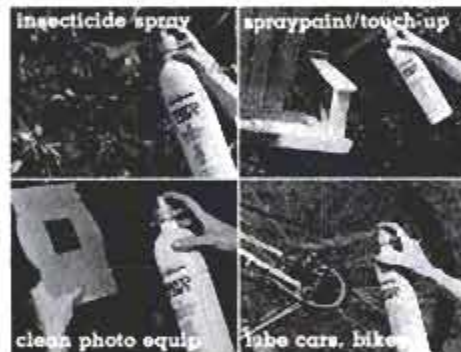
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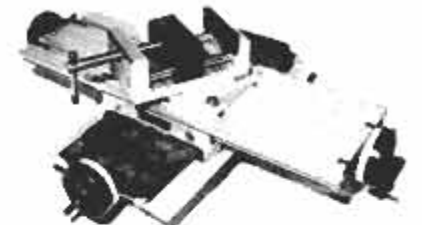
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urges that all builders obtain some form of pilot instruction before flying it. If you can't conveniently reach one of Weedhopper's flight-training centers, consider a few hours of basic dual instruction in a conventional airplane. It's fun, not too costly and doesn't commit you to the full course (typical cost: \$50 per hour). At the very least, be sure an experienced ultralight pilot is on hand to help you on your first few flights.

A strange bird

If you're new to taildraggers, you'll find they have a few eccentricities. All taildraggers are, by their nature, somewhat more wind-sensitive than tri-gear aircraft. In a crosswind takeoff or landing, the tail can swing sideways because there's no nose wheel to help keep it straight. The Woodhopper is no exception. Because of its large, high-lift wing, it may also tend to "float" during landing approaches when you get into ground effect—it just wants to keep flying and may not come down exactly where you expect.

Your takeoff technique is different, too. In a taildragger, you push the yoke forward as you reach flying speed to bring the tail up level, then you pull back to raise the nose and lift off. In a tri-gear plane, your tail is level to start with, and this two-step procedure isn't necessary.

Like all ultralights, the Woodhopper is a "calm-air airplane." Though not frail, it's simply too light to be flown in strong, gusty or turbulent air. At our first flight-test session, I asked where the windsock was.

"In the kind of air we fly in, a windsock would be hanging limp," they told me. "We watch those telltales instead."

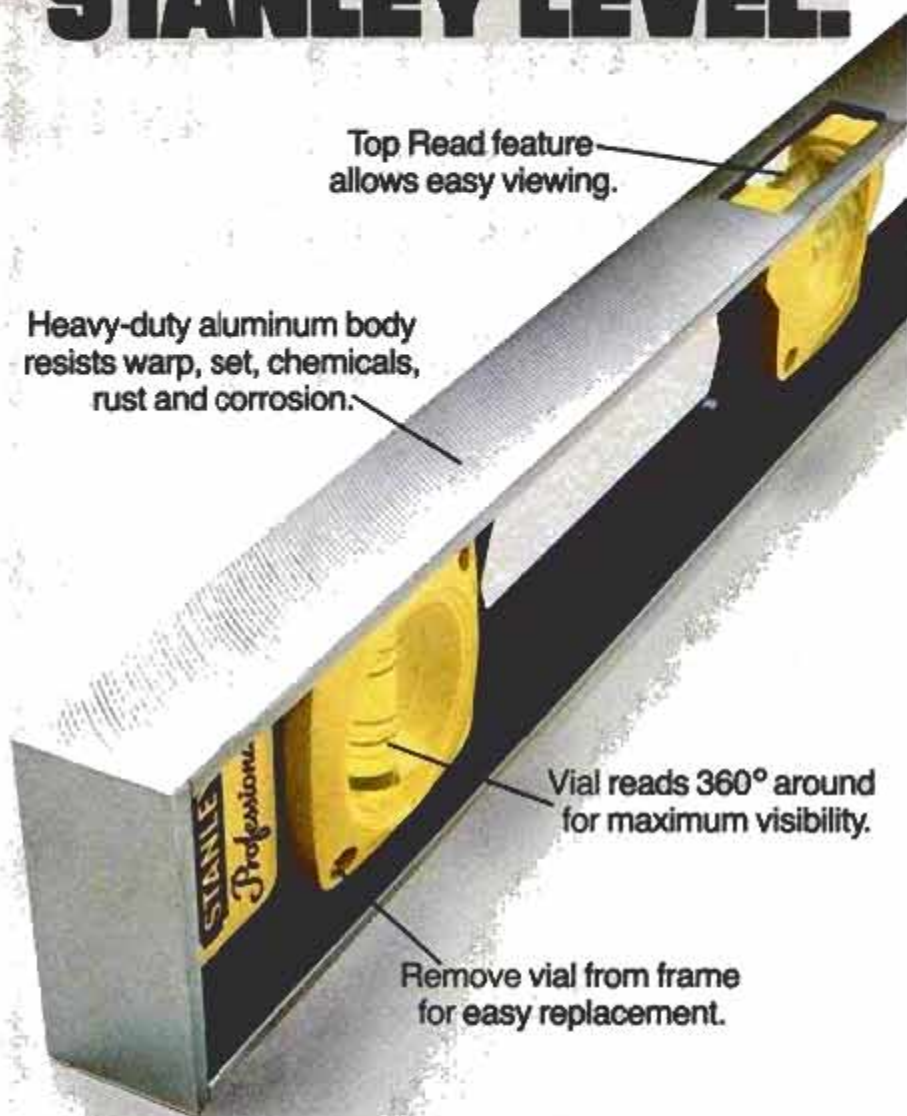
They pointed toward several thin, red streamers tied to poles. The streamers were standing straight out like they were made of wire. "That's enough crosswind to flip an ultralight if you're not careful," they warned. "A windsock wouldn't even be moving."

In general, the rule is never to fly in winds above 8 to 10 mph and to avoid even light crosswinds as much as possible.

None of these precautions need be a problem, but you should be aware of them. The Woodhopper is admittedly a minimal airplane, and it may even look a bit quaint. But it will get you up there and that's the idea. With care, you'll soon be enjoying what, to many, is the ultimate life experience—soaring aloft in a personal airplane you build and fly yourself.

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Now, whether you are cleaning up for final winter haul-out or are lucky and getting set for more boating on southern waters, this is a good time to repair blemishes and install accessories. A number of new add-ons and aids are available at marine-supply stores.

Scrubbing down comes first, and several new marine cleaners and polishes make this job easier.

For boats that sail in salt or brackish water, a coat of antifouling paint may be applied now, sealed with one of the bonding agents like Flying Fish Speedcote from Gulfstream Marine Coatings, Osprey, Fla.

Bonding agents are expensive—about \$50 a quart—but are claimed to cover four times the area of paint and cut skin drag up to 15 percent.

Dents and holes can be repaired with fiberglass and resin. Some new epoxies even work under water. Fibre Glass Evercoat dealers have a consumer product guide booklet describing uses. Aluminum boat-repair materials are available from Lumiweld, Box 517, De Land, Fla. 32720.



Shine for sailboats

Powercraft, too, can have their wood, plastic, leather, rubber and vinyl interior and exterior surfaces cleaned and restored with Marine Protector. It's manufactured by Star Brite, Coconut Grove, Fla. 33133.



Fill-her-up aids

Labeled water, gas or diesel and with locking or nonlocking tops, these new, \$19.60 Chromalex fills are made by Perko, Miami, Fla., the largest manufacturer of marine lights, hardware and accessories.



Scrubber-upper holder

Topsides, bottoms and swimming pools can all get the treatment with 3M's Marine & Pool Scrubber Holder. It's threaded for long broom handles and comes with fine, medium and coarse snap-on pads.



Blisterlike boat storage

With 6- to 8-mil polyethylene sheeting taped over a boat, a Shrinkfast 975 propane heat gun shrinks a protective cover over a winterized craft. The heat gun is from Gloucester Engineering, Gloucester, Mass. 01930.



Air for underwater

You can do bottom repairs and shallow treasure diving with Brownie's Third Lung. It's a floating compressor from Underwater Systems, 3511 Fairfax Dr., Fort Lauderdale, Fla. 33312.

(Please turn to page 152)



Off-season summer

For winter warmth aboard, this charcoal-burning, stainless-steel heater assembles quickly and stows easily. It costs \$400 from Transmar, Box 462, Highland Park, Ill. 60035. The heater is 12x15x9 inches ready to mount.



Electronic wind gauge

Apparent breezes of up to 99 nautical miles an hour are shown in direction and digital speed readout with the AW/WS-400 instrument for sailboats. It's from Kenyon, Box 308, Guilford, Conn. 06437.



Hub-cap helper

Wheel Bearing Protectors, from Dutton-Lainson, Hastings, Neb., shown in cut-away above, allow addition of grease to trailer wheels to keep out road dust or water during boat launching. They're approximately \$10 a pair.



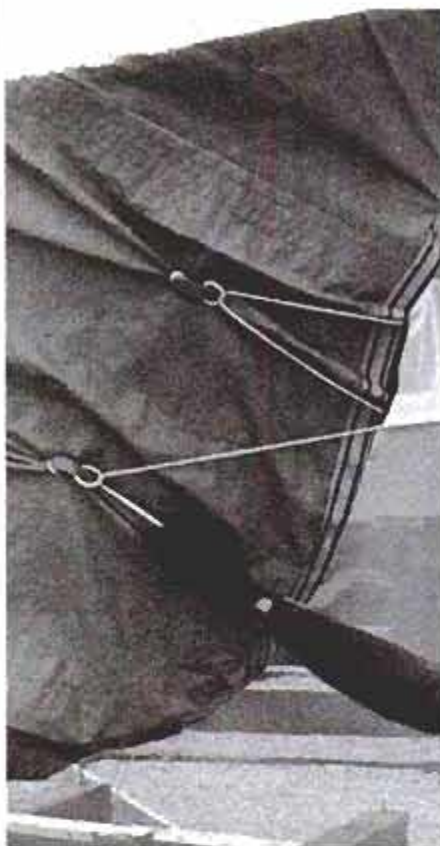
Compass replacement

Mechanical compasses will become obsolete, according to Wesmar, Seattle, Wash., with the introduction of its DC710 microprocessor-based digital model that is able to read out precise degrees.



No-bubble bilge pump

Clever engineering in the new bilge and live-well pumps from Attwood, of Lowell, Mich., clears airlocks and debris. Cut-away view of the through-transom 4105A model shows fins of the small 475-gph pump.



Cold-weather wraps

Movable grommets that can be reused for a tight custom fit are features of Weathermate Winter Boat Covers from Weathermate Marine Div. of Research Plastics, Shetland Park, Salem, Mass. 01970.



Stern treatment

Outboards and sterndrivers, like this Mercury MerCruiser, should have propeller shaft splines treated with manufacturer's anticorrosion grease. Zinc trim tabs should be replaced if they're corroded.

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Milwaukee, Wisconsin 53209

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COUGAR, 42 CUBIC FEET **19** EPA EST. MPG **26** EST. HWY.

LYNX, 28 CUBIC FEET **28** EPA EST. MPG **44** EST. HWY.

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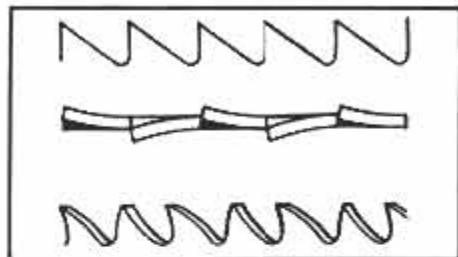


WORKSHOP MINICOURSE

THE RIPSAW

Since the rip saw is designed to cut with the grain, the tool meets far less resistance than a crosscut saw. For this reason, rip saws are designed with larger and fewer teeth than the crosscut saw. The typical rip saw has 5½ or 6 points per inch.

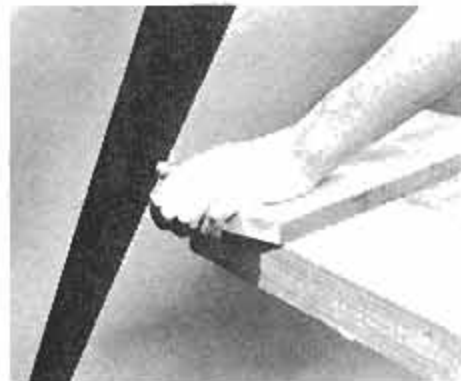
When you purchase any handsaw, make it your practice to go with a quality brand. Because of the way it is used, saw steel must be tough and hard in order to hold a cutting edge. An accurately tempered saw will ensure a long-lasting cutting edge, yet have the resilience to withstand buckling. The steel must permit filing and setting of the teeth.



Rip teeth are designed to cut with the grain. In this case, saw teeth actually cut like chisels (not like knives, as they do in crosscutting). Thus, the teeth are not beveled (top). In general, the teeth on a rip saw have a slightly wider set (center) and are larger with deeper gullets (above). Rip saws never have more than 7 points to the inch. The 5½-point rip saw is the version preferred by most craftsmen.



Before you buy a rip saw, there are several points to check out. To check a saw's tension, flex it slightly and place a straight-edge across the blade, as here. The saw blade should form a perfect arc.



To begin a rip cut, guide the blade with your thumb and use a couple of short up strokes. Once the groove is started, you should use smooth, full down strokes.

Today, most handsaws are taper-ground; that is, the entire blade is tapered from teeth to back (spine). This assures that the kerf (cut) made by the teeth is wide enough to accommodate the following blade easily.

If the saw didn't have such a wedge-like shape, the blade would bind or buckle—a common problem with many inexpensive saws.

Picking a good saw

When buying a saw, make sure you pick it up and heft it about. The handle must feel comfortable in your hand; you're the one who will be using it. And the handle should be designed to ensure that your sawing energy (i.e., your stroke) is directed straight to the cutting teeth—and not simply against the back of the saw. A well-designed and properly located handle means cutting will be a lot easier on your wrist.

When you examine the teeth of a rip saw you will discover that they



For ripping, the saw is held with its teeth at about a 60° angle to the work surface.

are slanted almost 90°, so that the wood fibers will be ripped as well as cut.

If you plan to use the saw most often on thick stock, choose one with coarse teeth. Conversely, for thin stock you should pick a saw with finer teeth.

Hold the saw at arm's length and check its teeth for uniform set. A poorly set saw will cause inaccurate cuts every time.

Also, check the saw's tension, as shown above at the right. A uniform arc is an indication of a well-balanced saw.

Using a rip saw

Always make certain that the board to be cut is well supported. To start the cut, brace your thumb against the saw, with the teeth positioned where you want to cut. Lightly draw the saw up two or three times to start a kerf, and then proceed with the cut.

Use full, even strokes and make



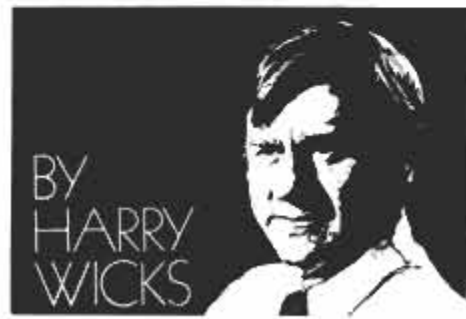
Take care of a good saw. Wipe the tool with an oily rag after each work session, especially when the saw has been handled with sweaty hands. The one shown has been in use for more than 50 years.

certain you hold the saw blade at 90°, perpendicular to the work surface—or you will produce a bevel edge. For maximum cutting ease, the teeth should be held at about 60° to the surface.

Clamp long boards

When making a rip cut in a long board, it is often wise to clamp the workpiece to either a sawhorse or workbench. This way, your noncutting hand will be free to support the cutoff piece as you near the end of the cut.

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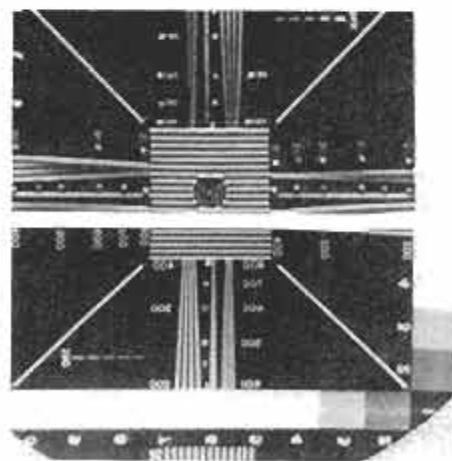
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TUNE IN ON TOMORROW'S TELEVISION (Continued from page 109)

grand opera to cooking lessons—are relayed by satellite for distribution via local cable systems. Some cable systems will link into entirely new satellite services, such as "Teletext." This service provides the viewer with selected information from computer data banks, displayed on the screen in letters or graphs. Since Teletext doesn't require a separate satellite channel, it can be offered very cheaply. It's already in wide use in England, Germany, France, Canada and Japan, and CBS is now experimenting with the Canadian version of the



Composite photo shows a normal TV image (left half) and Matsushita's high-resolution image (right) for comparison purposes.

system, hoping to introduce it in the United States on a nationwide basis.

Teletext and similar services will prove particularly useful when combined with two-way cable systems, like the Qube system already operating in Columbus, Ohio. By punching the proper call-up code into the touch pad of the two-way cable terminal, viewers will be able to "access" any kind of information they need from the central data bank.

Direct satellite broadcasting

A radical departure from conventional broadcasting, direct satellite broadcasting may eventually bring about the elimination of traditional radio and TV stations, as well as cable services. Instead, signals will be beamed into the home directly from satellites hovering in outer space. Since the "bird's" footprint spreads over the entire continent, there will be no such thing as fringe areas. That will be a real boon to the 1,400,000 American households which are now beyond the reach of TV transmitters or cable services.

Even now, growing numbers of viewers are putting up their own "earth stations," tuning in on all the

cable channels for free, including special pay services, such as Home Box Office, Bravo and the Movie Channel. The FCC says it's perfectly legal, as long as you're not making any commercial profit from what you pull from the sky.

But the price tag for the hardware is still pretty stiff. Complete earth stations—including dish antenna, a "down-converter" for amplifying the satellite signals and converting them to frequencies receivable by your TV set, plus the necessary controls—still exceed \$5,500. Scientific-Atlanta, National Microtech and SatFinder Systems are some of the main suppliers. The latest Heath catalog lists a complete earth station with a 9-foot dish supplied by Scientific-Atlanta for "as little as \$6,995."

Before long, the price of earth stations will come down to earth—partly because of growing competition and partly because of technical advances. By 1985, the Communications Satellite Corp. hopes to start a multichannel satellite broadcasting service at higher frequencies than those presently in use, and with more powerful transponders in the sky. This opens the way to smaller and lighter dish antennas—only 2½ feet in diameter—which could be mounted easily on rooftops. These would sell for about \$500, including the down-converter.

Other equally fascinating prospects loom within the next decade—high-definition video, big-screen video and video photography.

High-definition video

The quality of a TV picture is limited by the number of lines per frame. In the United States, this number is fixed by law at 525 lines. Most experts now feel that this standard is outmoded. By shifting transmitter frequencies into the ultra-high gigahertz range—produced easily with modern equipment—a broader bandwidth could be transmitted. This would accommodate more lines and provide better image detail. Both Matsushita and Sony have already built prototype video systems using 1,125 lines per frame. First seen at the Chicago Consumer Electronics Show last June, the Matsushita system produced an image so sharp that each strand of hair and every blade of grass was as sharp as on a fine photographic print.

Future plans—assuming assent from the FCC—call for special satellite channels set aside for nationwide, high-quality TV service of this type, naturally with stereo sound.

Big-screen video

Since high-definition video has roughly the same image resolution as 35-mm film, the system lends itself well to big-screen presentation in the home. And that screen might not be the face of a cathode-ray tube, nor might it rely on the triple-tube techniques now used to create big pictures in projection TV. Flat video screens—long a dream of solid-state designers—seem a step closer to realization. Small versions of such screens, measuring a few square inches, were demonstrated at the Chicago show by Sharp Electronics. They consist of tiny, liquid-crystal specks, corresponding to the dots of a conventional picture tube. Activated in sequence through a thin-wire matrix from the rim of the screen, they spell out the picture, point by point. Right now, nobody's going out on any limbs to predict a timetable for the development of larger screens. The greater picture area requires more image points and hence, a far more complex wiring matrix.

Video photography

Video engineers are confident that electronic techniques will eventually replace photographic film, both for home movies and still snapshots. Already in the works is a lightweight video camera with a built-in, miniaturized video cassette recorder. Prototypes have already been shown by Sony and Matsushita, and these battery-powered marvels of miniaturization are no bigger or heavier than present-day Super-8 movie gear.

As with all kinds of videotape recorders, the main advantage is instant playback—no developing necessary—and the camera/VCR combos are expected to be used like movie cameras. But they can also be used for stills.

Even the smallest microcassette would hold more than 10,000 separate frames—enough for a lifetime of still photographs. So you'd set aside one cassette for stills, and after you got home from taking pictures, you'd just stick the camera into an adapter and punch in the call-up code for the particular frame you want. Instantly, your still shot would appear on the video screen. The cost per picture would be far less than ordinary slides or prints.

All these developments are linked. Together, they spell out the shape of video for the rest of this century. And it all adds up to better ways of bringing more of the world into your living room.

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Mini-
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GREAT GIFTS TO MAKE

(Continued from page 32)

tions for the item that you plan to build. Also, study the drawing of it carefully. We have intentionally kept the construction details as simple as possible to make building the projects more fun. But we haven't sacrificed the craftsmanlike look that is desirable in projects of this nature.

Conventional cabinetmaking and carpentry techniques are used throughout. White glue is used for joinery and all set nailheads and other indents are filled with quality

1 Pen-and-pencil bookends

1. Start by carefully drawing the 1-in. squares on a scrap piece of 1/8-in. hardboard (or thick cardboard). Then draw the pen and pencil outline, using the drawing as your guide.

2. Cut out the template using band, scroll or sabre saw. File and sand edges where needed.

3. Hold the pattern in position on the 1/4-in. plywood and trace the outline around. Repeat for the second bookend, but flop the pattern 180° to create a mirror image. Note: Trace the outlines on the good (A) side of the plywood if cutting will be done with band or scroll saw; on the back (D) side if cutting will be done with sabre saw.

4. Next, cut the rabbets to receive the bases. Elevate your table-saw blade to 3/8 in. and set the fence to create the 1/8 x 3/8-in. rabbet.

5. Cut out the pen and pencil profiles using band, sabre or scroll saw.

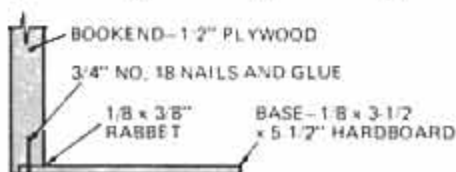
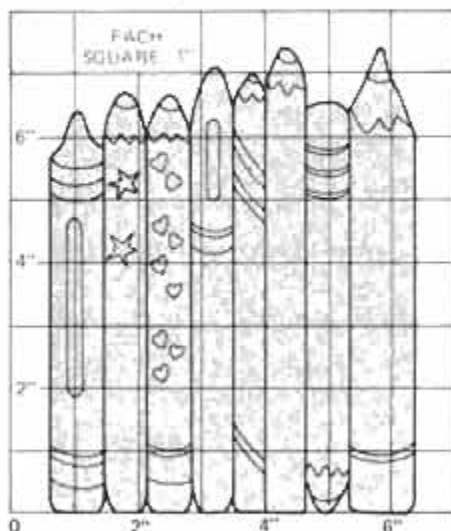
6. Fill any edge voids with a quality wood filler and sand the plywood smooth.

7. Because the bookends will contain relatively light books, we used 1/8-in. hardboard for the bases. Cut both to size and shape at the same time.

8. Assemble the bases to the bookends, using white glue and 3/4-in. brads as shown.

9. Allow glue to dry overnight. Then, dust the pieces and wipe off all particles using a tack cloth. Seal with a pigmented shellac.

1 BOOKENDS



wood filler, like UGL's Wood Patch.

In general, you should cut all parts for your project and then make a test assembly *without glue* to check dimensions and fit. Mark the parts as needed and disassemble the piece so parts can be shaped. Then, permanently reassemble with glue and nails (or screws).

All painted objects shown were sanded smooth, finishing up with 150-grit abrasive paper. After dusting and wiping with a tack rag, apply a sealer coat using a pigmented shellac such as Bin or Enamelac. Next day, sand lightly with 180-grit paper, dust, wipe with a tack rag and

10. You can use either latex paint or permanent felt-tip markers to color the pens and pencils. Start by drawing in the desired shapes lightly with a soft pencil. If you work with paints, you will need a No. 1 brush for

apply the finish colors to your gift.

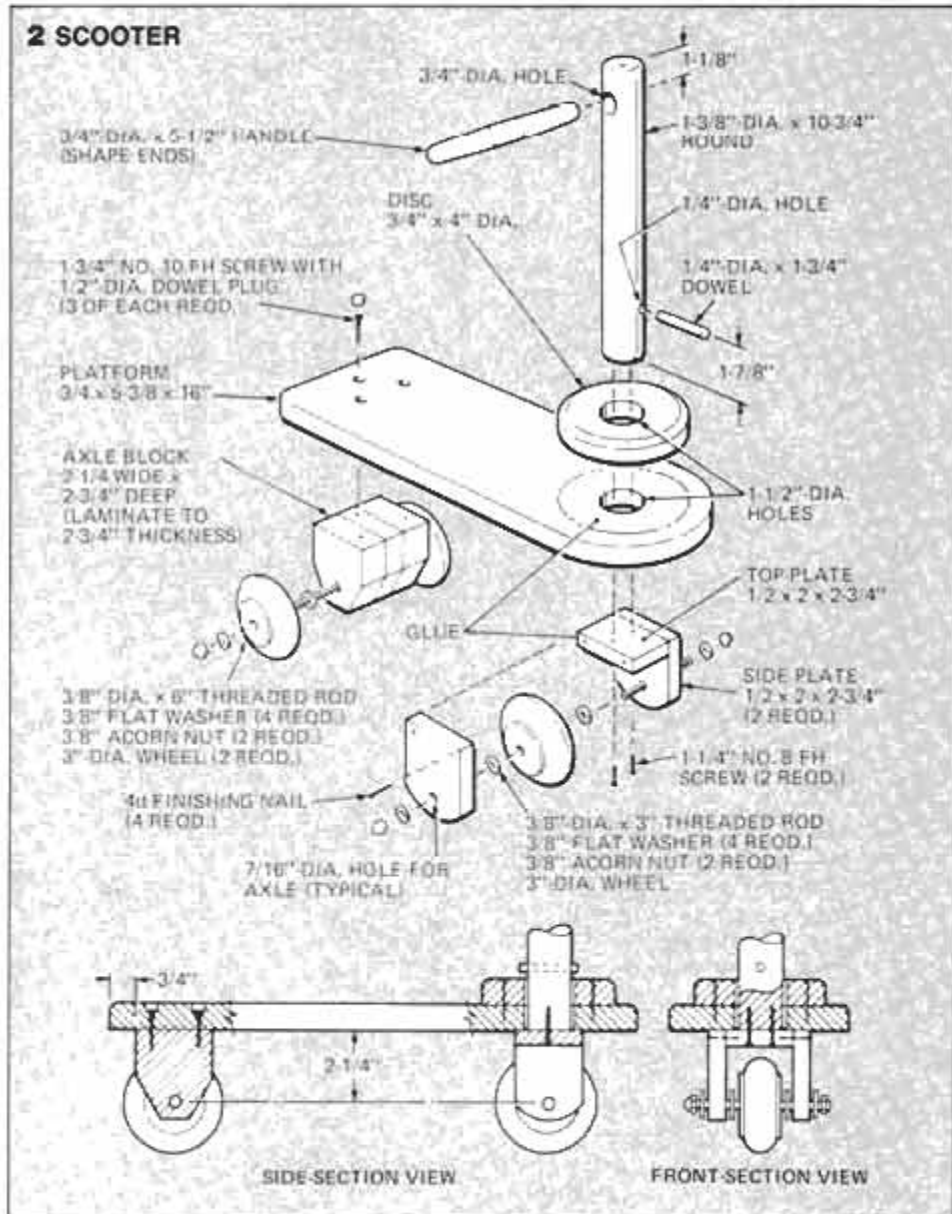
Use the color photos on these pages as a guide for painting your projects. If you use latex paints, you can protect the finish from finger marks by covering the paint with one coat of a satin-finish varnish.

The natural-finish projects—stool and shoeshine box—were stained with an oil-base stain. When dry, the stain can be rubbed lightly with 180-grit paper, dusted and wiped with a tack rag. You can seal the project using either shellac or varnish thinned 50 percent with turpentine. Next day, apply a coat of satin-finish varnish as it comes from the can.

outlines and a wider brush for filling in colored areas.

11. Protect the finish (when dry) by applying several spray coats of Krylon No. 1301 clear finish over all parts.

2 Toddler's scooter



1. Cut all parts to size and shape using the drawing as your guide.

2. Sand all parts smooth, finishing up with 150-grit abrasive paper. (Note: Bore the hole through the

piece that will be the steering-column disc before cutting the disc to shape.)

3. Bore the hole through the base for the steering (Please turn to page 164)

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GREAT GIFTS TO MAKE

(Continued from page 162)

column. Bore the axle hole through the rear axle block.

4. Test-assemble the parts with brads only, so you can accurately mark and cut the threaded rod axles to length. Do the front wheel first. Insert a washer and acorn nut on one end of the threaded rod, slip it through the U-shaped bracket, add the wheel and the washers as shown. Mark the rod for cutting using a felt-tip pen.

5. To cut the threaded rod without problems, run a pair of hex nuts on the rod and position them to straddle the cutting line. Clamp the work in a vise and make the cut, using a hacksaw with a relatively fine-tooth hacksaw blade. After completing the cut, run the nut off the rod to smooth the threads.

6. Repeat the procedure for marking and cutting the rear axle. (Note: The axle should fit snugly in the commercially purchased wheels, but turn in a slightly

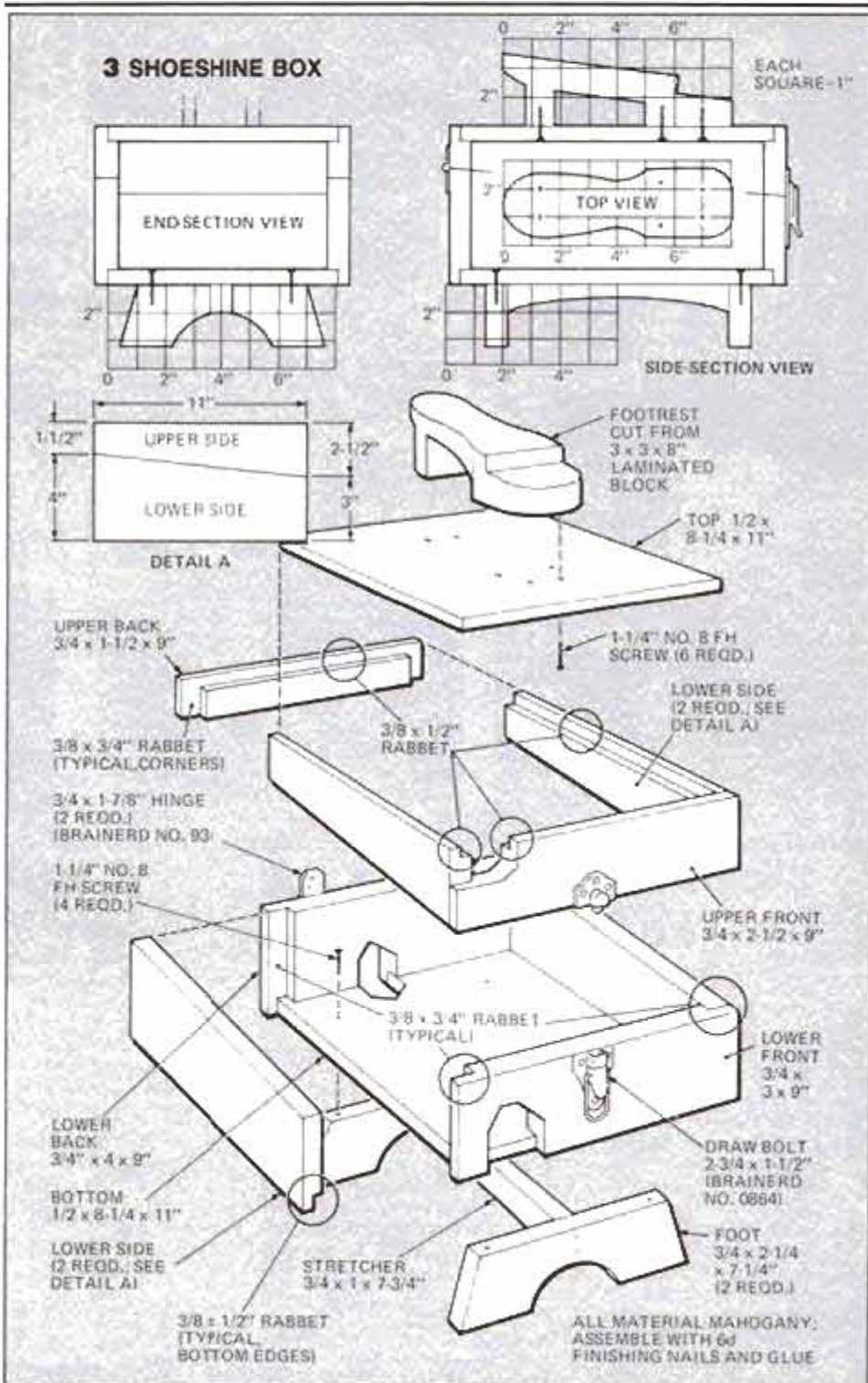
oversized hole bored through the hardwood block.)

7. Make certain that all parts are absolutely smooth, and all edges have been slightly rounded over to ensure a splinter-free toy. Then assemble the scooter using glue, screws and dowel plugs.

8. Seal the wood as described on page 162.

9. Paint the scooter using nontoxic latex paints. Choose a semigloss paint for its greater resistance to scuffs and marks. Because of the scooter's many colors you must use masking tape for good, clean color separation. Make certain that the tape edges are pressed tightly against the wood to prevent any paint from "bleeding" beneath. (Note: The scooter's designer sized the toy for use by toddlers aged 1 to 1½ years. Thus, for safety, it is built close to the ground and intended for riding, as shown in the photo on page 30. The scooter can be enlarged slightly by using slightly bigger wheels, if desired. But make sure it's not "tippy." The 3-in.-dia. wheels are available from Love-Built Toys & Crafts, 2907 Lake Forest Rd., Box 5459, Tahoe City, Calif. 95730.

(Please turn to page 170)



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"I worked in various industrial jobs for years, and always wondered if I could make money for someone else, why I couldn't do it for myself. So after losing my regular job, I opened my Foley sharpening shop in the basement of my home. I only had a minimum of cash to start with, but Foley financed the balance. My shop will gross over \$40,000 this year, and I like the feeling of running my own shop without answering to someone else."

William Wescott
Willoughby, Ohio 44094



**Husband and
wife have a
going spare
time shop**

"I'm a construction foreman, and my wife is a nurse's aide. Our Foley shop fits in nicely with our regular jobs, and we earn extra money. Our sons help out too, so ours is a real family business."

"I'm still too young to retire, but when I do I'll have a very good business built up. Foley equipment helps us to do good work and brings customers back with more jobs on a regular basis... we have a lot of repeat business the year around."

Victor Kosloski
Sturgis, Michigan 49091



**Glad he
chose Foley
for his saw
shop**

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Victor Johnson
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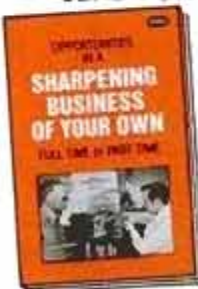
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VIC 20: A new and inexpensive home computer



This entry-level computer offers snazzy graphics and sound capabilities for just \$325. Here's what VIC can—and can't—do for you.

by Neil Shapiro
ELECTRONICS EDITOR

The new VIC 20 personal computer is Commodore Business Machines's latest offering in the field (Commodore is the manufacturer of the popular PET series of computers). The VIC 20 is an entry-level computer and will not compete with some of the more expensive systems. However, for the price of \$325 (list; some dealers offer it for \$299), it does have many features, some of which are not even found on the more expensive machines.



Keyboard of the VIC 20 (above) uses double- and even triple-purpose keys. Tops of the keys are labeled with typewriter-style numbers and letters. Fronts of the keys are labeled with special graphics characters and other control functions.

The VIC 20 is—to use computer-owners' slang—up and running minutes after unpacking. All you do is plug the power supply first into the VIC 20 and then into the wall socket. The VIC 20 then attaches to your color TV (a black-and-white TV could be used for a black-and-white display) via its antenna terminals in the same way as

(Please turn to page 168)



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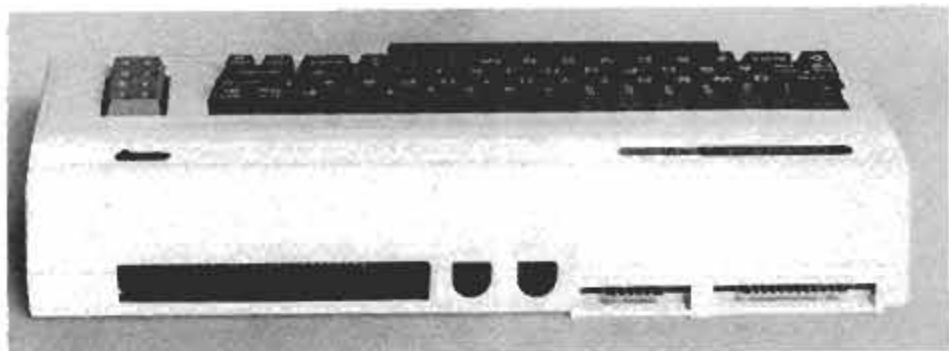
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Back of the VIC 20 shows Commodore has designed in many slots for future peripherals.

VIC 20: NEW, INEXPENSIVE HOME COMPUTER (Continued from page 166)

many of the popular video games.

In appearance, the little VIC 20 seems to be nothing more than a slim keyboard. But a closer inspection reveals that quite a bit of design has gone into it. Most of the alphabetic keys are engraved with not only a letter, but, on the front, two graphic symbols.

Easy graphics

One of the first things you'll want to do is try out the graphic symbols. By simply holding the shift key down, you can display any of the graphic characters on the right side of a keyfront; depress a key, along with a special key labeled with the Commodore logo to print the character on the left side of the keyfront. If you would prefer, you can switch to the all-text mode and lose half of the special characters, but have lower-case capability as you would on a typewriter.

These graphics characters were first made available on the popular PET computer. They're the same characters that are found on the PET, which means that many PET-style designs can be done on the VIC too. One of the best features of this style of graphics is that it's very simple to use. There's no complex programming required. You just add the shapes together, stack them atop one another and combine them in any way that suits your fancy.

The graphic characters available range from hearts and clubs to curves and straight lines. Many whole-screen pictures can be built up using these characters as building blocks.

Colorful keys

Colors are also easy to program on the VIC 20. The keys numbered 1 to 8 are dual-function. They have the usual numbers on top, but their fronts are labeled with the VIC's eight colors—black, white, red, cyan, purple, green, blue and yellow. So, to change the color in which either text or special characters will

print, all you have to do is hit, or program, a one-key command.

Because both text and graphics are available as keyboard characters, it is very easy to mix pictures and text on the VIC's colorful screen. It is quite simple, for example, to draw a blue box around a word written with green letters. Just program or type the word onto the screen while in the "green mode." Then use the straight-line and right-angle special characters—while in the "blue mode"—to draw in your box.

Advanced programmers can use commands to quickly display any character anywhere, in any color.

Besides the graphics and text on the screen, you can also change the color of the screen and the color of the border which surrounds it.

Adding sound

Musical notes, as well as sound effects, are easy to program using VIC's four-voice capability. Three of the VIC's voices can each sing any of 128 notes. The fourth voice is specially designed to vocalize only "noise," such as airplanes buzzing or motorboats chugging.

Each voice can be playing at a different volume. You can harmonize, synchronize or "cacophonize." Remember, the sound of beauty is in the ear of the programmer.

Pros and cons

The VIC 20 should not be considered a match for computers such as the Apple II or TRS-80 Model III. What it does, it does well; what it doesn't do, it was not designed for.

The VIC comes with 4K of memory (4,096 memory locations) and this is considered minuscule by many programmers. Commodore is planning expansion modules to bring VIC up to a possible full head of 32K, but there's no word yet as what these modules will cost.

The display, while fine for graphics, leaves a bit to be desired for text. It holds only 23 lines of 21 characters

each line. This means the VIC could not be used in most business or word-processing situations.

While the graphics are very good, they are limited to the character set provided. Computers, such as the Apple II or Atari 800/400, which can draw lines between points and store preplotted shapes in memory, are capable of smoother graphics.

A very nice feature: Commodore has included the same BASIC language as found in their more expensive machines. This is a full-featured BASIC language. Skills learned on the VIC can be quickly transferred to other BASIC-speaking computers. Besides speaking the same language as Commodore's larger machines, the VIC is able to share much of their software.

Software on hand

When most new computers come out, there is, for a while, not too much to do with them, because there is no software (prewritten programs) available. But since the VIC can use some of the older PET software, this may be less of a problem. (But the VIC is limited here by its limited display space. Some program displays that look great on the PET simply will not fit on the VIC screen.)

The instructions supplied with the VIC include one of the better manuals supplied with any computer. Its prose style is neither cloyingly cute nor too advanced for a beginner. Be assured that this is one computer you and your family will all be able to use.

VIC's future

Commodore has already come out with six new programs (on cassette tape) to support the VIC. The programs range from games to educational material. More are promised for release shortly.

A printer should be available by the time you read this. It will be able to print the VIC's graphics as well as text.

Plug-in cartridge programs, which will likely be more complex and expensive than the tape variety, are also planned. A master control panel will accept cartridges of either programs or additional memory. And there is even a floppy-disc drive planned for very quick access to programs and data. (Right now, programs and data may only be stored on tape.)

All in all, we think the VIC 20 is one of the most unusual and interesting of the lower priced computers. And for a price of around \$300, it's the only game in town that is more than just a game. **PM**

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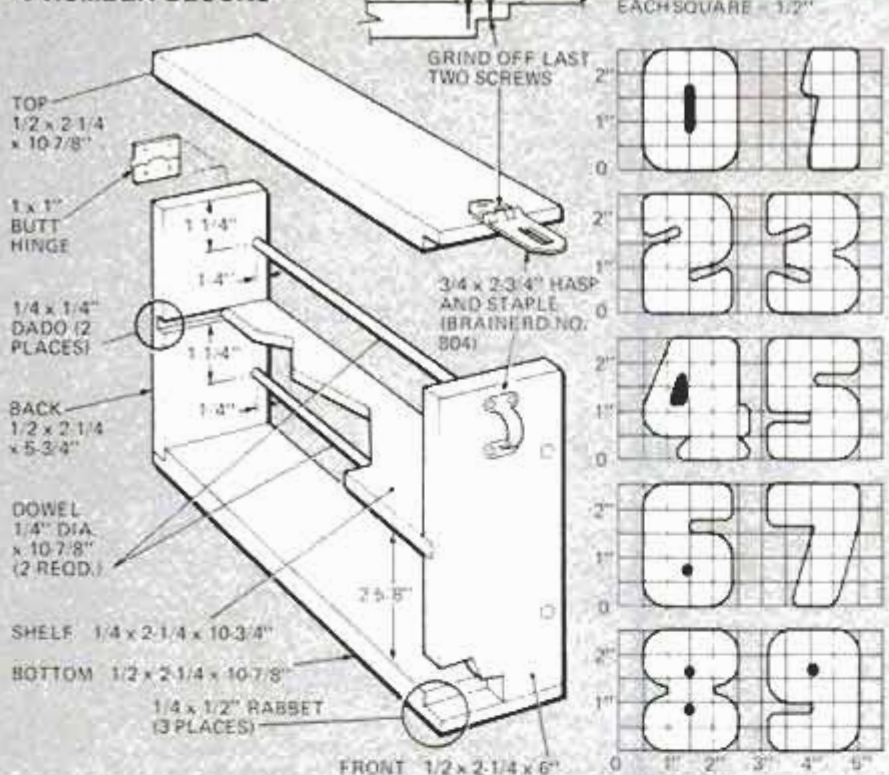
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4 NUMBER BLOCKS



CASE MATERIAL IS CLEAR PINE. ASSEMBLE WITH 4d FINISHING NAILS AND GLUE. NUMBERS ARE LAMINATED TO 1 3/4" THICKNESS.

GREAT GIFTS TO MAKE

(Continued from page 164)

3 Shoeshine box

For sheer elegance, the box shown is built of 3/4-in. mahogany. You can, of course, substitute pine if you prefer.

1. Start by cutting the parts to size and shape as detailed in the drawing. (Note: The old cabinetmaker's stunt of making a box, then cutting off the top to create a perfect matching lid should be used *only* if you have the equipment and knowledge for jiggling up to make a diagonal cut around a box such as this. Otherwise, for safety, cut all parts for the top and bottom and assemble them as described here.)
2. Glue up stock, if necessary, for the footrest. Clamp it and set aside to dry overnight.
3. Trace the footrest outline on the block and do the cutting with band or scroll saw.
4. Sand all parts smooth, finishing up with 150-grit paper.
5. Assemble the box, using white glue and 3d finishing nails and screws as shown.
6. Install the hinges and cabinet latch as detailed in the drawing. (Note: The catch shown comes packed two to a blister pack. This means that one—and its accompanying loose screws—must be tossed into your scrap box. If possible, buy your hardware from a store that offers such latches individually—and pocket the savings.)
7. With the box assembled, check all around for fit and tightness of the lid-box joint. Plane and sand where needed, then remove all hardware.
8. Using a pair of bar clamps, clamp the box so you can sand several sides with a belt sander and 120-grit paper followed by 150-grit paper in a pad sander. As you finish a side or sides, use a third clamp to start a

(Please turn to page 182)

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THE DAY THE GOOSE FLEW!

(Continued from page 117)

can you explain for our listeners what you're doing now?"

McNamara held the mike close to Hughes's lips to catch the reply.

"Yeah," said Hughes. "We're taxiing downwind very slowly to get into position for a run between the entrance to Long Beach Harbor and San Pedro. It's about a 3-mile stretch and we're gonna make a high-speed run. The wind is changeable—it's been changing all day—but it's not too serious..."

"Howard," said McNamara, "will you tell our listeners the speed you achieved on that last run?"

"That was around 90 mph. We were well up on the step and the airplane could have lifted off easily if I'd just pulled back on the control, I'm sure. But we have so many mechanical devices in this ship that I want to check a few of 'em out a bit before we try anything like that."

With that, Hughes turned his attention back to the cockpit. Looking straight at Grant he said, "Lower 15° of flaps." This was the recommended takeoff setting for the giant wing flaps.

Hughes, meanwhile, lined up in position, and asked Petrali and Smith if the engines were ready.

"All set," they replied.

Hughes hung up his mike and yelled to McNamara: "Hang on!" With the heel of his right hand, he eased all four paired throttles forward in one motion.

With a crescendo of sound, the giant plane surged forward. The nose of the plane came up slightly during initial acceleration until they were on the step.

McNamara called out the speeds in knots for the benefit of the radio audience. "It's 50 over a choppy sea. It's 55. More throttle. It's 60. It's about 65. It's 70."

Suddenly, just before McNamara called 75, it became very quiet. They were airborne! The plane had left the water shortly after reaching 70 knots (about 81 mph). Hughes pulled the throttles back and then pushed them forward again immediately.

With his right hand, he held power steady for a moment, then bit by bit, he pulled the throttles back, easing the ship to a power-on landing.

"He made the most perfect landing I've ever seen," said Grant. You couldn't even feel it hit the water."

No indications

Powerplant mechanic Al Geverink, in the right wing behind the engines, insists there were no indi-

(Please turn to page 176)

Goose flies again . . . and again!



Exact 1/20-scale model Spruce Goose soars near Orange, Calif., and is then eased to a perfect landing by her crew.



There it was, eight engines at takeoff power whipping the water below into a froth as the ponderous silver hull raised itself to a plane. Then, there it was in the air, circling majestically, with mountains behind it and water far below.

The year is 1981 and the Spruce Goose, in this instance, is an exquisitely finished model built by Californians Darrell and Merle Meyers. The two brothers invested more than \$8,000 and 2,500 hours in the exact 1/20-scale model of the Goose. It has a wingspan of 16 feet, and its takeoff weight for the maiden flight—photographed by Ray Hamilton near Orange, Calif.—was approximately 90 pounds.

Working for more than a year from Hughes Corp. blueprints, the Meyers' took more than a year to construct their Goose from plywood, balsa and Styrofoam, powering it with eight K&B en-

gines rated at 1.5 hp and displacing .61 cu. in. each.

As models go, it's about as critical to fly as the original was. The Meyers' acted as crew chiefs, each controlling a set of four engines with individual radio controls. An experienced R/C pilot, John Elliot, handled all flight controls (including operable flaps). Darrell Meyers figured the taxi run to be about 30 feet, by which time the Goose was hitting 28 mph.

In the air, the plane hit an estimated 85 mph. After performing stalls, pilot Elliot pulled off something Howard Hughes would have loved: a gigantic barrel-roll.

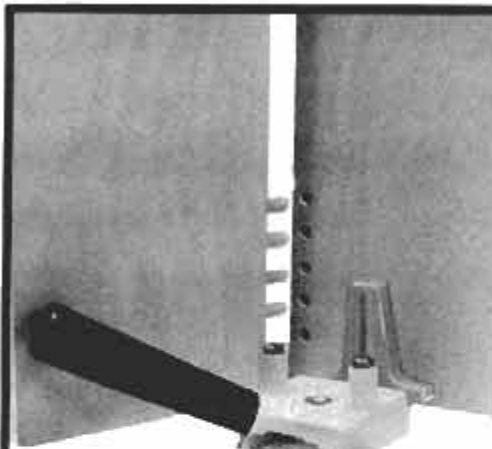
The Meyers brothers have flown the Goose since, but not often. "We're afraid," says Darrell, "some R/C model flyer nearby might turn on his unit and put us into a dive. It makes my knees shake."—R.N.



On special cradle after test hop, Goose draws a crowd of disbelieving admirers.



Before flight, engine controls are tested; two "engineers" each handle four props.



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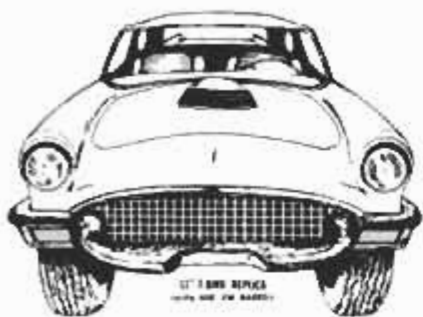
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THE DAY THE GOOSE FLEW! (Continued from page 174)

cations that Hughes planned to fly and that he, Geverink, was surprised to be airborne. "I think he intended to just pick it up a bit," he observes.

Ben Jiminez was surprised too. "I wasn't even thinking of going into the air. It's my opinion that he got on the step and it just took off. That's it. After it took off, Hughes just rode it out."

Flight engineer Don Smith agrees. "I'm sure it ballooned out of the water before he was ready. The thing that convinces me is that as soon as it came off the water, he yanked the throttles clear back."

Other crew members, however, claimed they sensed that Hughes would take off. Jack Jacobson said that before each run he cracked the forward door open enough to peek at the wing-flap position. Before the last run, the markings on the flap showed they were set to the takeoff position.

After the giant airplane had touched down smoothly, the CAA man, who was on Hughes's 65-foot surplus Navy PT boat in the harbor, put his arm on Odekirk's shoulder and said, "I knew he was going to do that."

Happy Hughes

After the landing, Hughes was elated. "Boy, those flaps really ballooned this thing," he told Grant.

McNamara asked, "Howard, did you expect that?"

"Exactly," said Hughes. "I like to make surprises."

McNamara, in summing up his impressions for the radio audience, said, "At one time, Howard said that if this ship did not fly, he would leave the country. Well, it certainly looks as though Howard Hughes will be around the United States for some time to come."

"Do you want to taxi again?" Hopper asked Hughes.

"Hell no," said Hughes and headed the plane toward Terminal Island. This time he didn't bother with sea mules. He taxied it in under its own power, right up to the buoys.

After the huge ship was fast to the buoys, Hughes left his seat, put on his jacket and a new, brown snap-brim hat. As he left the flight deck, he pushed back his hat, rubbed his brow and remarked to no one in particular, "She sure jumped off easy."

When he reached shore, Hughes couldn't keep from grinning and swaggering as he walked along the jetty, accepting congratulations from spectators.

"I think the airplane is going to be fairly successful," he said. "I hoped it would fly, but didn't want to predict it would for fear of disappointing people."

Hughes publicly congratulated his staff, then escorted a party of visitors aboard the plane.

Hughes explained that his plane was three times the size of the Martin Mars and seven times the size of the Douglas DC-6, the largest commercial airliner then operating. The Hughes boat could carry 700 passengers, he said.

At one point after the flight, Hopper asked Hughes point-blank: "Did you mean to take off on that run?"

"What do you think?" asked Hughes.

Dave Grant thinks the takeoff was both planned and inadvertent. "At the beginning," he said, "I think he really did plan to just taxi the aircraft. But he wanted to fly it and in his mind, the possibility was there. However, he probably didn't commit himself to it until after those first two runs."

"On previous runs we'd been at higher airspeeds without taking off. I think he didn't expect as much added lift as we got with only 15° of flaps. With the flaps at 15°, the airplane took off as soon as it got on the step. I think he expected to have to pull it off. That's what I mean by both inadvertent and on purpose."

Carl Babberger, Hughes's chief aerodynamicist, points out that all the factors were present for take-off—a slightly quartering high head wind, the 15° flap setting and a light load. "It probably got airborne before he expected it to, but on the other hand, being under fire from Sen. Brewster, he was probably prepared to gamble. If it took off, fine. If it didn't, fine."

Political pressure

The reference to Sen. Owen Brewster concerns that gentleman's 1947 investigation of Hughes's wartime military contracts and Brewster's references to the boat as a "flying lumberyard" that would never get off the water.

Those hearings may have had a bearing on the unprecedented flight. Grim-faced, Hughes had flown back to California, determined to test the plane before the hearings reconvened in November. Anger and hurt goaded him to superhuman efforts. Money was no object. He and his crews worked around the clock.

Hughes being Hughes, the motivation was certainly there for a real

(Please turn to page 178)

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- English-made 10-speed bikes. Regular \$295. We liquidated over 2000 at \$119.
- CB radios. We liquidated over 28,000 of 4 different brands at below dealer cost.

● Admiral 25" console color TV sets. We liquidated more than 2000 sets at below dealer cost.

● Shakespeare 15-ft. bass boats. Regular \$900. We liquidated over 1500 at \$388.

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● Pioneer chain saws. Regular \$539. We liquidated over \$3000 at only \$166.

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● Synthetic motor oil by Union Carbide. Regular \$4 a quart. We liquidated over 400,000 quarts at around \$1 a quart.

● Moulinex La Machine Petite food processor. Regular \$49.95. We liquidated many thousands at under \$19.

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HOW TO MASTER WOOD JOINERY

(Continued from page 121)

shaped like those shown on page 119, but for thin stock, it is generally better to use a strip of wood for the length of the joint (because the screws used are so short). A glue block can be used outside the joint, if placing one inside will interfere with the case's operation. For example, the joint between a cabinet side and an overhanging countertop could require an outside block. If the block were placed inside, it might interfere with drawer operation.

Finally, if more than two members are being butt-joined, it is often possible to create an interlocking joint by careful placement of the pieces. If three boards join to form a corner, the corner will be stronger if each board is joined to the other two.

About rabbets and dados

A rabbet is an L-shaped cut made in one board to receive another. Whether the rabbet runs with the grain or across the grain, it is called a rabbet.

Because a rabbet increases the gluing surface of the pieces being joined, the joint is considerably stronger than a butt joint. A typical-

ly good use for a rabbet joint is in mounting a cabinet's back panel.

Dadoes and grooves are U-shaped cuts made across the face of a board. If the cut is across the grain, it is called a dado; if with the grain, it is called a groove. As with the rabbet cut, the width of the cut matches the thickness of the piece being inserted into the dado. The depth is generally one-half the thickness of the piece being plowed. In some cases, the dado is cut deeper, but be aware that this can weaken the joint.

Though a dado gives a strong joint, the general criticism is that it isn't an attractive joint. Thus, when using dadoes in a cabinet, the usual practice is to add stiles and rails to hide the plowed joints. Dadoes and grooves, like rabbets, increase the strength of the joint because of the greater gluing surface.

Cutting a rabbet

When there are just one or two rabbets to cut, it is generally done using a combination blade on the table saw, and a two-step cut.

For safety reasons, it's important that you always follow the sequence shown in the photos on page 121. Done this way, the workpiece has maximum support and there is less

chance of an accident with the saw.

However, when you have a number of repetitive rabbets to cut, you can speed up the job considerably by installing your dado head set on the table saw. Make certain you add the wooden auxiliary fence, as shown, so the cut can be properly made (with the edge being cut next to the fence).

Most shops create such fences and install them on the saw fence, using flathead machine bolts and wing-nuts. The hardware is kept with the fence; the fence is stored on the wall when not in use.

Using hand tools on rabbets

A rabbet can be shaped using a handsaw with the workpiece clamped in the bench vise. In general, it is best to use a stiff-bladed backsaw for accuracy of cut.

Accuracy is a must, so also use a clamped-on guide for the saw to ride against. Make the first cut, then rotate the work in the vise to make another cut to clean out the rabbet.

Some craftsmen prefer to make the first cut with a saw, then clean out the waste with a razor-sharp chisel. No matter which way you choose to work, you must make all the cuts with great accuracy if you



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are to achieve craftsmanlike joints.

Similarly, dados can be cut using hand tools. Again, the width lines are cut to the desired depth using clamped-on guides; then, the waste is cleaned out with a chisel (see photo, page 120).

Stopped or blind rabbet

A stopped or blind rabbet joint is not visible at the ends. It can be done either of two ways:

■ You can make your rabbet cut through the board, then fill the ends with carefully cut filler strips, after the boards are joined.

■ You can make a stopped cut on your table saw, as shown in the photos on page 121. To do this, you must locate the start and stop points for the board being cut.

The easiest way to do so is to crank the blade to cutting height and hold a piece of scrap alongside the blade. You can see with fairly good accuracy just where the start block should be placed so the cut will start at the desired point, and where the stop block should be placed to stop the cut where wanted.

Position the blocks and clamp them securely to the fence. Make a test cut in scrap and adjust the blocks if necessary. When you're satisfied with locations, you can cut the actual workpieces.

The rounded portions left at the start and finish of the cut are then cleaned out (squared) with a chisel to suit the board entering the rabbet.

Tips for making stopped cuts

We have probably made thousands of blind rabbet cuts, but it wasn't until the photography session for this story that we came up with the idea of rounding over the start block, as can be seen in the photo. The rounded section makes it safer and easier to lower the board being cut.

To make the blind cut, start the saw and hold the workpiece firmly against both the fence and the start block with its outboard end held well above the blade. Keeping fingers away from the blade, slowly lower the workpiece into the spinning blade until it rests flat on the table-saw surface. When it does, slowly push the work forward until the far end contacts the stop block.

There are two methods for removing the cut piece: 1, You can back it up slightly with blade spinning, carefully raise the far end clear of the blade and lift it off, or 2, you can turn off the saw and wait until the blade stops before lifting it off.

Next month we will discuss reinforcing joints with dowels and other methods.

FM

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Woodsmith.

GREAT GIFTS TO MAKE

(Continued from page 170)

new clamp position, then move the second clamp to the same boards to prevent pivoting. Continue in this fashion until all sides are sanded.

9. Dust and wipe the pieces with a tack cloth.

10. The box shown was finished with varnish only to permit the mahogany grain to show through. Apply the first coat thinned 50 percent with turpentine. When the varnish is dry, sand lightly with 180-grit paper wrapped around a felt sanding block. Dust, wipe with a tack cloth and apply the second coat of varnish as it comes from the can.

4 Number blocks

1. Start by drawing a grid of 1-in. squares on $\frac{1}{8}$ -in. hardboard.

2. Draw in the number outlines. When you're satisfied with the shapes, cut them out on the scroll or band saw, using a relatively fine-tooth blade.

3. Using a file and sandpaper, smooth all edges and remove any saw marks.

4. Transfer the numbers to the thick pine stock

(glue up layers of $\frac{3}{4}$ -in. clear pine if you have no $\frac{3}{4}$ -in. stock in your scrap box). Again, cut out the numbers, using either band or scroll saw, or both.

5. Smooth all edges, using file and a flap-type sander in your drill press or portable drill.

6. Seal the numbers with a pigmented shellac; paint them using a nontoxic semigloss latex paint.

7. With numbers cut and available for measuring, you can lay out and cut the parts for the carrier.

8. Mark the endpieces for the dados and rabbets, and make these cuts on the table saw using a dado head set.

9. Clamp the ends together, mark for and bore the holes through both at one time to receive the dowels.

10. Assemble, using white glue and brads. Start by attaching the bottom and shelf to one end, then insert the dowels into the end. Next, add glue to the out-board mating surfaces and add the second end. Immediately wipe off all glue squeezeout.

11. Position the top on the box and install the hinges, then the hasp and staple. To prevent the top from swinging side to side, we used a pair of small hinges. If you have a small length of 1-in. continuous hinge in your scrap box, you can use this across the length of the joint.

12. Remove the hardware to paint the box. Use the

same type of paint that you used to paint the numbers.

5 Learning frames

1. Cut the parts for all four frames at one time.

2. You can assemble the frames using glue and 6d finishing nails through predrilled holes (as we did in the prototype), or you can use an open-mortise tenon joint at the corners as shown in the alternate corner-detail drawing.

3. Assemble frames, lay out for and bore holes through for the upholstery thread.

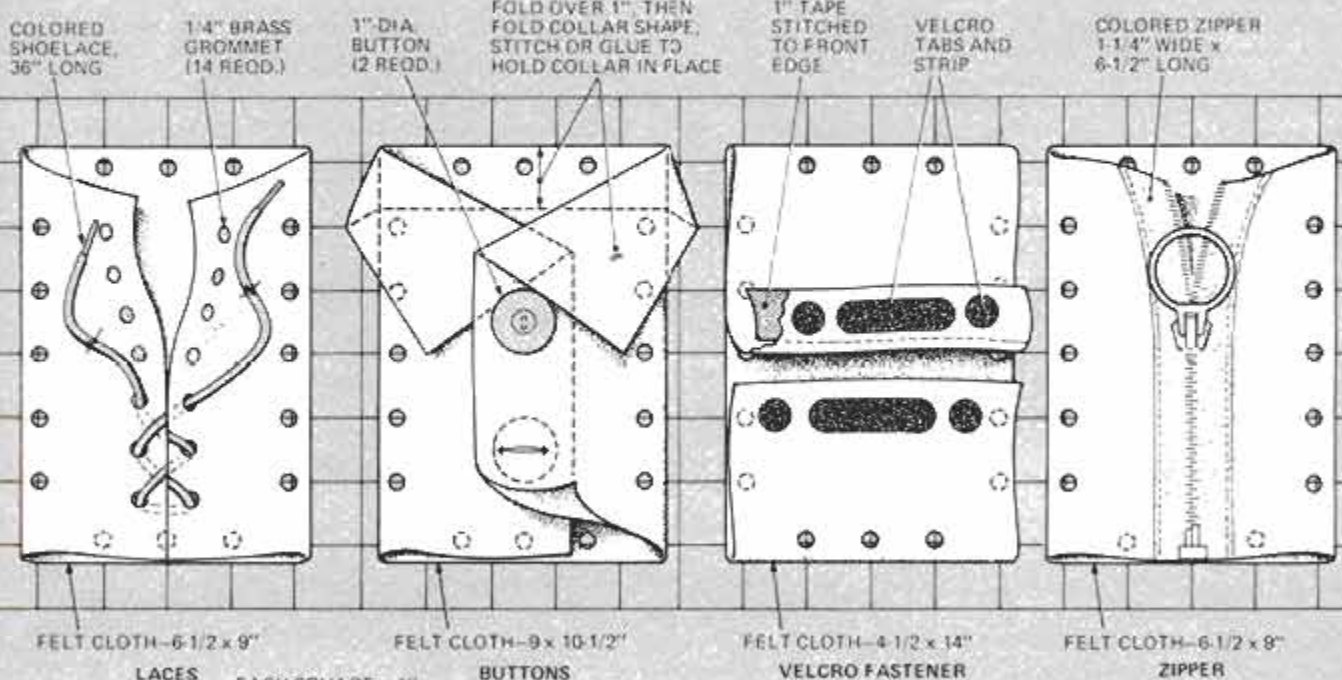
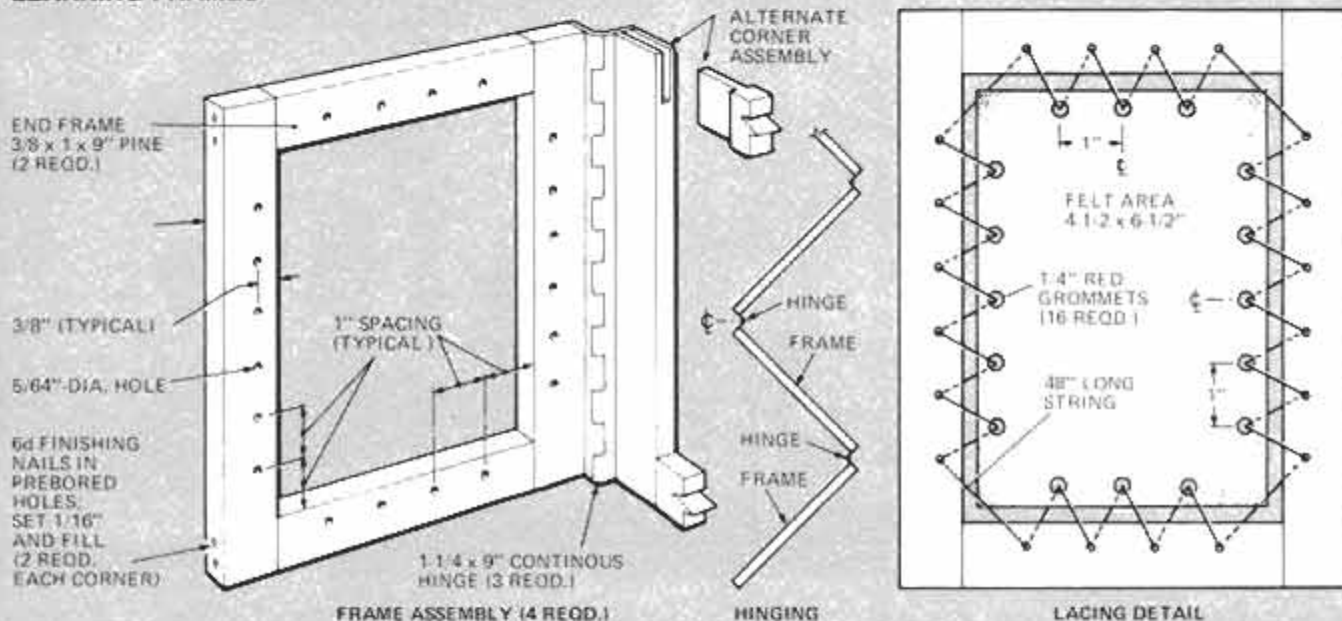
4. Join frame sections, using the continuous hinge as shown.

5. Protect the hinges from paint by covering them completely with masking tape. Paint the frames with a nontoxic primer and semigloss latex paint.

6. Assemble the frame panels, using No. 8 upholstery thread to hold the pieces to the frames. Upholstery thread is available at well-stocked sewing centers and from reupholstery dealers. Since painting the frames tends to clog the holes, use a needle to get the thread through.

(Please turn to page 184)

5 LEARNING FRAMES



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GREAT GIFTS TO MAKE

(Continued from page 182)

6 Ram swing

The prototype swing sports some parts built of cherry. You can use a hardwood to build yours, or you can hold down costs by using a softwood such as pine or fir. It's important that you use hardwood dowels throughout, however.

1. Make a full-size pattern of the head and the horns on cardboard (see the drawing below), and cut them out.

2. Cut the parts to size. Position and trace the patterns for the head and horns on the hardwood stock to make efficient use of the material. Cut two seats, the horizontal seat support and two vertical uprights. Cut the hand and leg supports of birch round. Cut birch attachment pegs.

3. Round all edges with a $\frac{3}{8}$ -in. rounding-over bit in a router. Or round the edges by hand with a rasp,

followed first by medium-grit and then fine-grit sandpaper.

4. Locate and bore holes for hand and leg supports in the uprights. Also bore a hole for the pivot (G). Don't bore holes for dowel pegs at this time; do that step after the supports are in place. Bore holes in the seat support for pivot (G).

5. Cut slots in the uprights to hold the ram head and the horizontal seat support. Use a table or portable saw to cut the slot in the front upright that supports the ram head. To do this, carefully make two parallel cuts to outline the notch width. Then cut the interior waste with a coping saw. Locate and cut the interior slots for the seat support in the front and back uprights. To do it, bore an entry hole and cut out the opening with a coping or scroll saw.

6. Sand all parts smooth, beginning with 60-grit sandpaper, followed by increasingly finer grits up to 120-grit. Dust the piece off between sandpaper changes.

7. Assemble parts with resorcinol glue in this manner:

a) Clamp and glue the horns to the head.

b) Glue the head in place; bore holes for the pegs that hold the head. Round the leading edges of the dowel and tap them in place gently with a wooden mallet.

c) Insert the hand and foot supports. Bore holes for dowel attachment pegs and insert them with glue in the manner described above.

d) Join the horizontal seat support and the uprights with pivot members (G) glued in place. Bore holes for attachment pegs (I) and insert with glue.

e) Position seats, bore holes for attachment pegs and glue them in place. Also bore hole for the tail rope that limits glider swing.

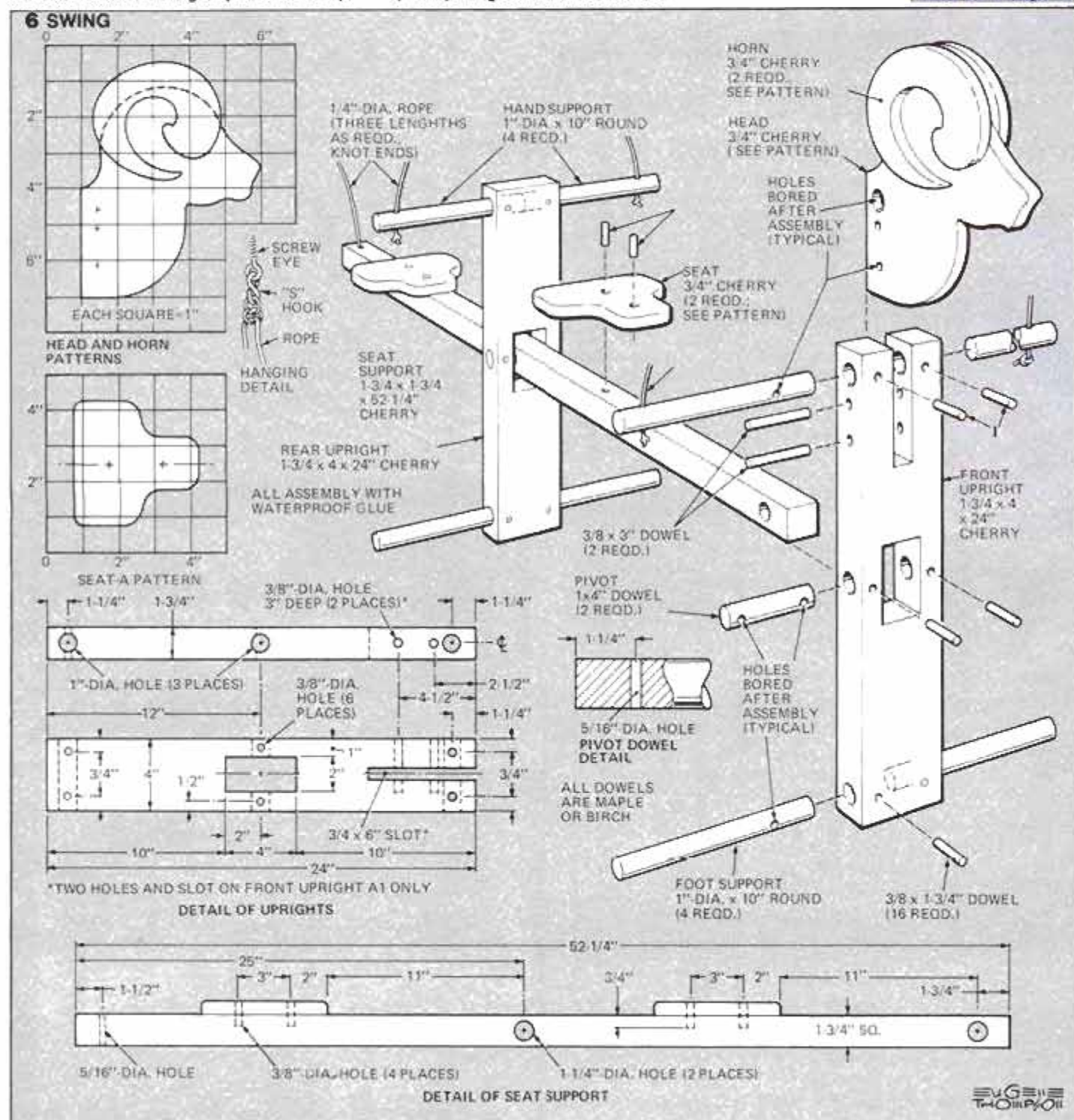
f) Bore holes for the glider's attachment rope in the hand supports at this point, to assure perfectly vertical holes.

8. Finish with a polyurethane varnish for wood used outdoors, such as Imperial ZAR.

9. String up with $\frac{1}{4}$ -in. nylon rope.

For a catalog of plans for small wood toys, by the designer, send \$1 to Cherry Tree Toys, 67131 Mills Rd., St. Clairsville, Ohio 43950.

(Please turn to page 188)



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*Based on R. L. Polk Co. registrations through July 1, 1980.

**Figures are for comparison. Your results may differ due to driving speed, weather conditions, and trip length. Actual highway mileage will be less. California mileage will be different.

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3. Before assembling, use either a small gouge or a knife to carve and shape the teeth. The teeth should be slightly recessed to increase the distance in the front planes between jaw and puppet head. Sand all parts smooth and assemble the head, jaw and dowels.

4. Assemble with glue.

5. Dust off, wipe with a tack cloth and seal with pigmented shellac.

6. Apply colors, using the photo on page 32 as a guide. Use acrylic paints and brushes, or permanent felt-tip markers to paint the clown.

7. Draw in outlines using a permanent black felt-tip marker.

8. When dry, seal the entire head by applying one coat of semigloss varnish. Take care to avoid getting any varnish in the pivot area or jaw movement will be inhibited.

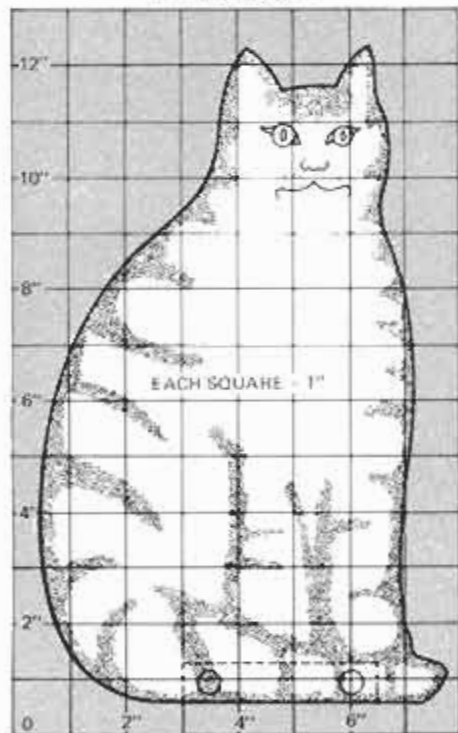
9 Cat doorstep

1. Carefully prepare a grid of 1-in. squares, then draw in the cat shape.

2. Cut out the cat, following the grid, using scroll or band saw.

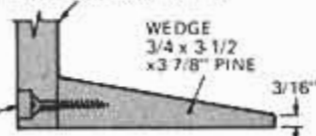
3. Remove all saw marks from the edge, using files and a flap-type sander in the drill press. Sand the cat surface smooth and set cat aside while you make the door-holding wedge.

9 DOORSTOP



CAT BODY—3/4 x 8 x 12" PINE

1-1/4" NO. 8
FH SCREW,
1/2"-DIA.
PLUG
(2 EACH)



WEDGE
3/4 x 3 1/2
x 3 7/8" PINE

4. Cut the wedge from 3/4-in. stock and attach it to the cat using screws and glue as shown. Conceal the screwheads by counterboring the screw holes and inserting dowels over the screwheads.

5. Dust off the cat, wipe with a tack cloth and apply pigmented shellac.

6. Next day, sand lightly with 180-grit paper, dust, wipe with a tack cloth and apply the colors. The cat shown was "painted" with permanent felt-tip markers.

7. Protect the finish by sealing the entire piece with one coat of semigloss varnish as it comes from the can.

(Please turn to page 190)

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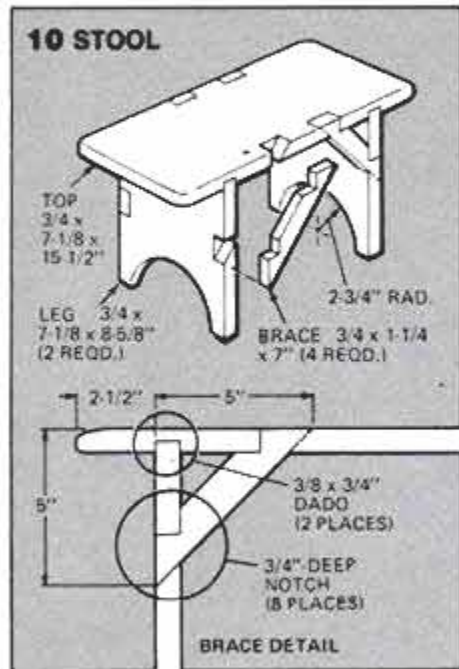
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10 Shaker stool

1. The stool gets its superior rigidity by the way it is joined. The diagonal braces are half let-into the legs



and top, creating, in effect, a shouldered angle lap—plus butted joint.

2. Start by cutting all parts to shape and size. Plow the dados in the underside of the top and temporarily assemble the top and legs using brads only.

3. Make certain that legs are square (90°) to the top.

4. Lay the stool on your workbench, and, one at a time, hold each mitered diagonal in place and mark the top and the leg for mortise. Make light matchmarks to ensure each piece going back to its mating mortise.

5. Disassemble the parts and cut the mortises using a dovetail saw and chisel. Then test-fit all of the pieces.

6. Assemble the stool using glue and 4d common nails. Set all nailheads, but do not fill.

7. "Antique" the piece by adding some nicks and bangs with a ball-peen hammer, awl and the like. Round over some "wear" points, near the joints, also.

Look carefully at the prototype in the photograph on page 32 and use it as a guide; the antiquing on it closely approximates the original Shaker stool from which it was copied.

8. Sand the entire piece smooth, finishing up with 150-grit abrasive paper. Dust, wipe with a tack cloth and apply oil stain of your choice following the directions on the can. Set the stool aside for a full 24 hours.

9. Next, seal the piece with 3-lb.-cut shellac thinned 50 percent with denatured alcohol. Set aside to dry.

10. Finish with one coat of satin-finish varnish, as it comes from the can. Don't wax the piece for at least three weeks (to allow the varnish to cure).

11 Toy village

The idea of this gift is to create simple versions of houses and buildings in your own neighborhood, which your youngster can identify with. The houses in the model shown on page 32 were created by cutting them from blocks of glued-up, 3/4-in., clear pine stock.

1. Start by deciding which houses you want to build, and glue up a block for each.

2. Shape the blocks using table, band, radial saws and belt sanders. In some cases, the shapes can be cut from a single block. In most cases, appendages—such as a simulated dormer—are glued on.

3. After cutting and assembling houses, sand them smooth and seal with pigmented shellac.

4. Apply colors, using acrylic or latex paints.

5. For easy application, 1-in.-wide Letraset plastic tape (available in art-supply stores) was used for windows, doors and other trim. Make certain you don't distort tape as you pull it from the roll because it will slowly return to its original shape and thus shrink on the project. Don't use cloth tape because you can't get a clean edge.

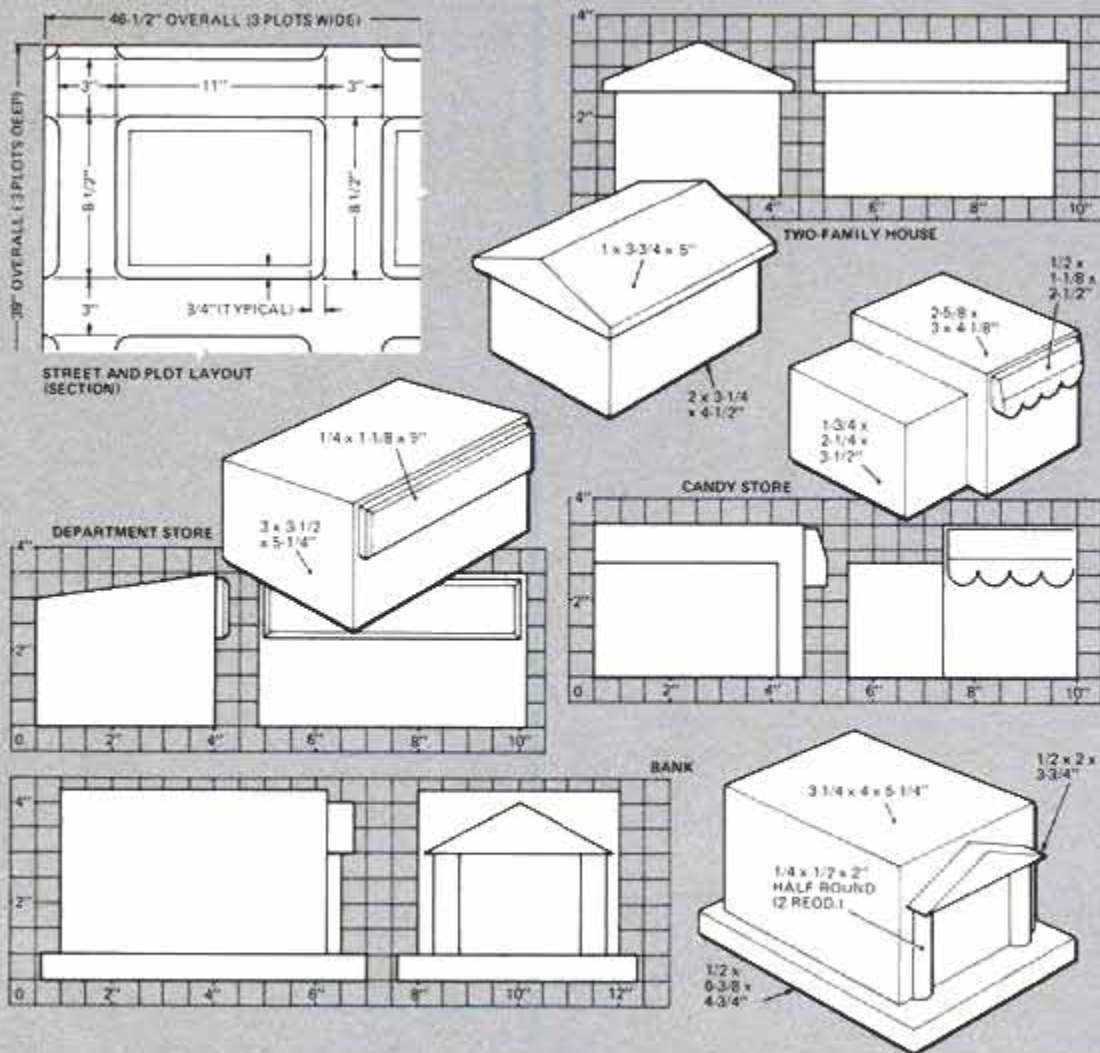
6. When all houses are painted, seal them with a clear coating such as Krylon No. 1301 clear spray.

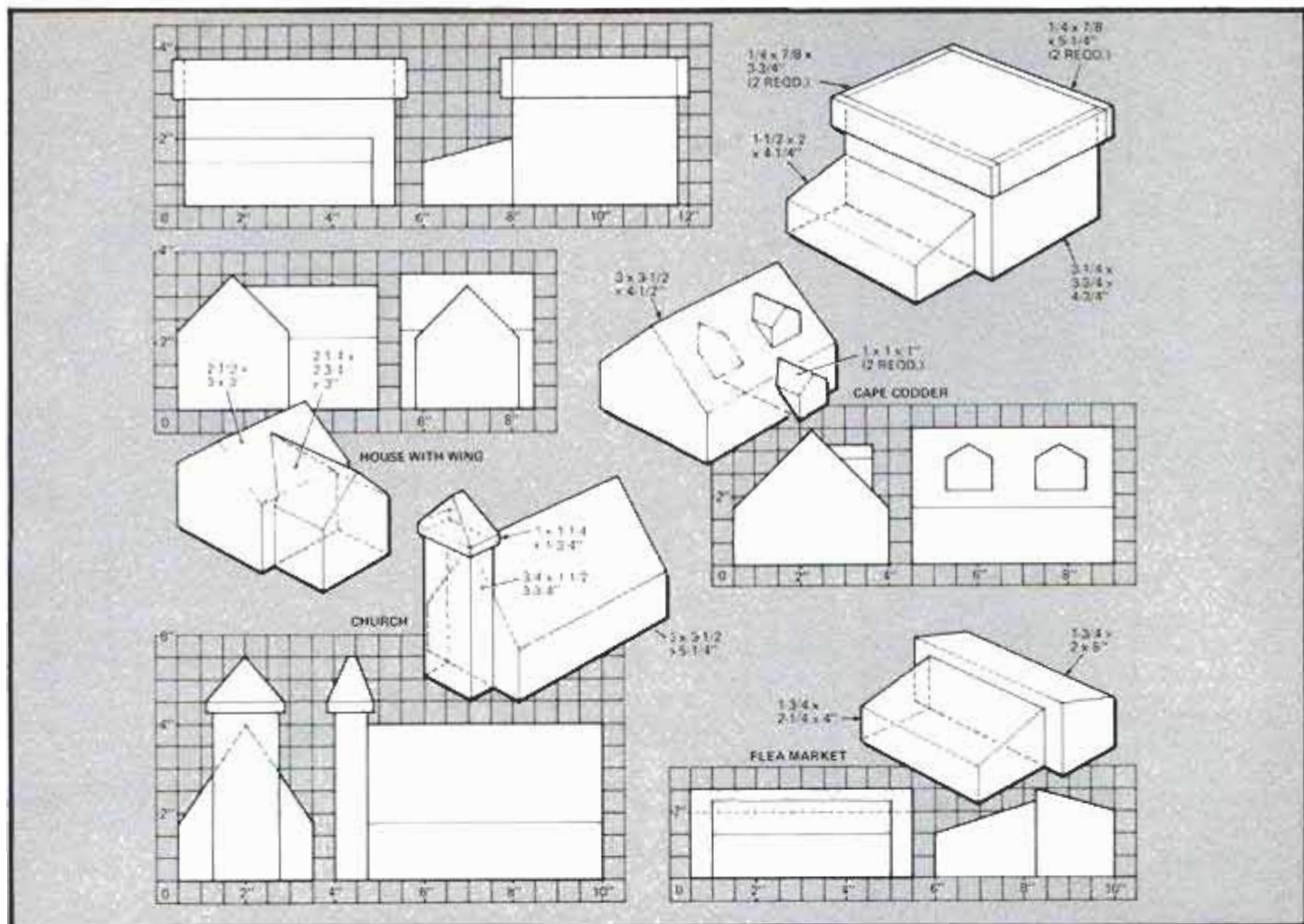
7. The streets are painted on a sheet of canvas cut from a 53-in.-wide painting canvas. (It's available at art-supply stores.) Do not use sails or other kinds of canvas because they're not treated for painting and won't hold the colors.

8. Lay out the street grid, using a soft pencil. Mask it, starting with the grass plots and working your way to the outside perimeter. Press masking tape down carefully so paint cannot run beneath the tape and cause "bleeding."

9. Use acrylic paints to paint the canvas. **FM**

11 VILLAGE





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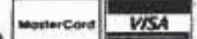
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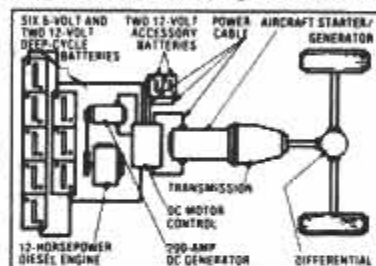
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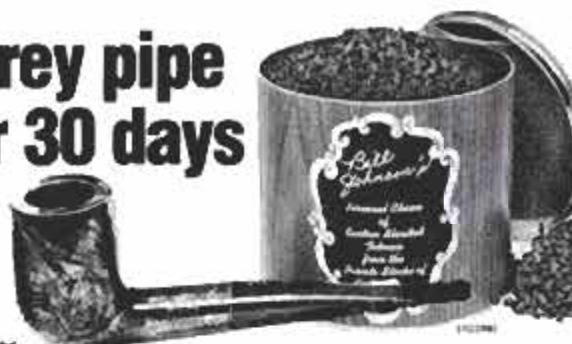
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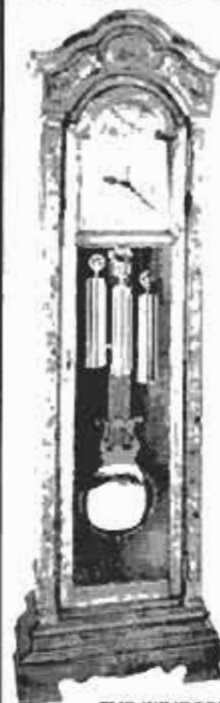
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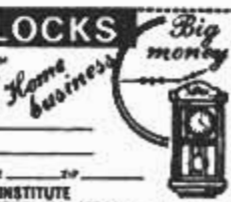
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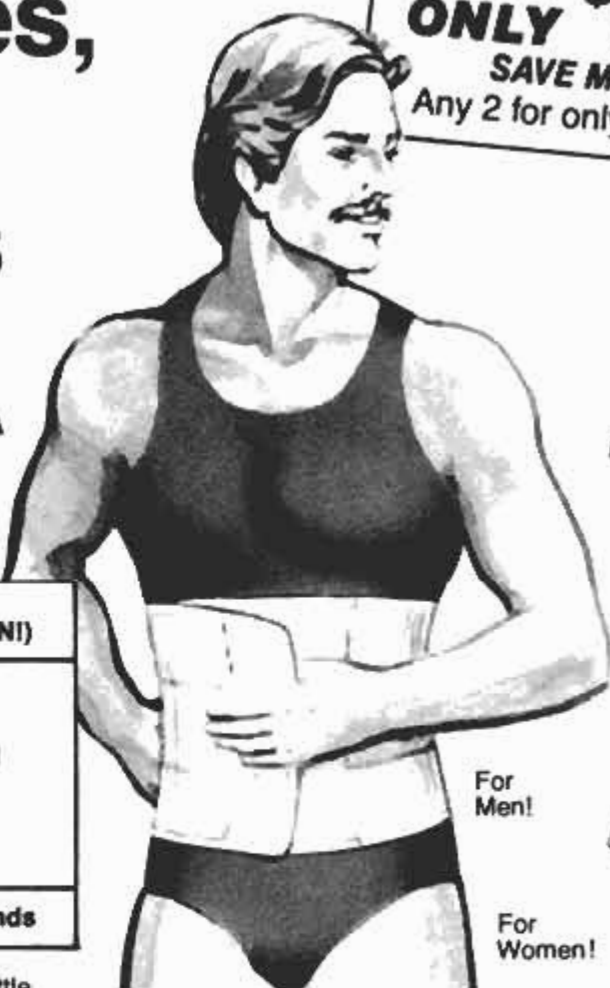
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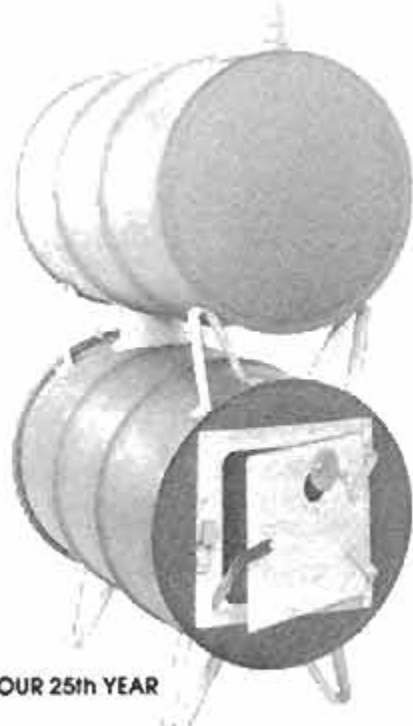
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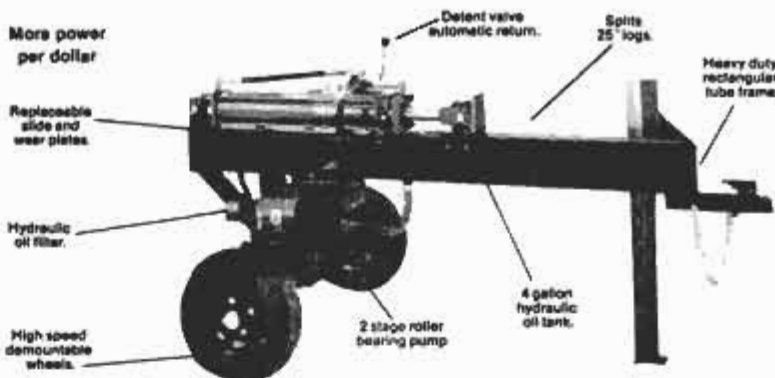
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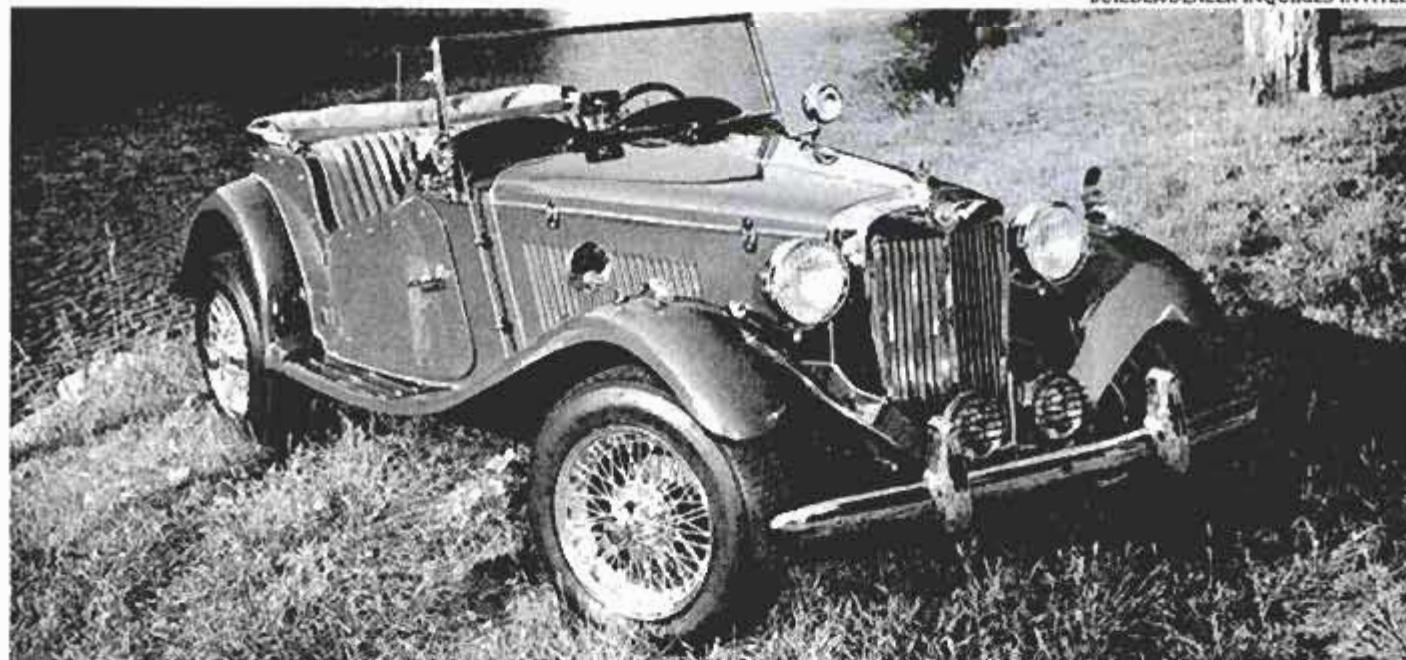
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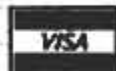
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EST
MPG

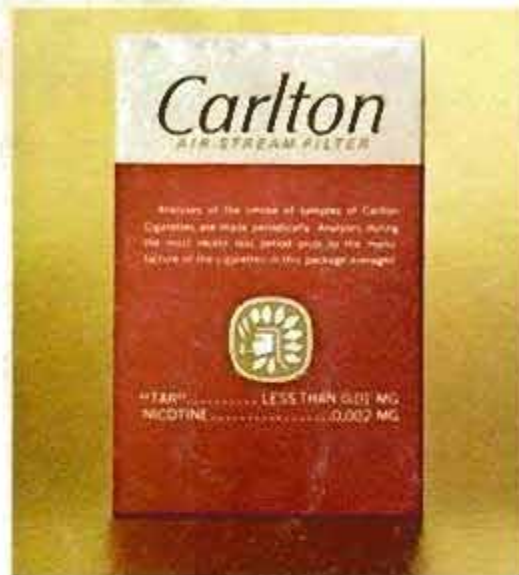
Optional 5 speed trim. Use these figures for comparison. Your mileage may vary due to speed, trip length, weather. Actual highway mileage will probably be less. California figure shown.

Ziebart is a registered trademark of Ziebart International Corporation.

1981 U.S. GOV'T REPORT: CARLTON LOWEST.

In the 17 U.S. Government Reports since 1970 no cigarette has ever been reported to be lower in tar than Carlton. Today's Carlton has even less tar than

the version tested for the Government's 1981 Report. Despite new low tar brands introduced since—**Carlton still lowest.**



10 packs of Carlton have less tar than 1 pack of...

	Tar Mg./Cig.	Nicotine Mg./Cig.
Benson & Hedges Light 100's	10	0.8
Kent	12	1.0
Marlboro Lights	11	0.8
Merit 100 Menthol	10	0.8
Salem Lights	9	0.7
Vantage 100's	9	0.9
Virginia Slims Lights	8	0.6
Winston Lights	11	0.9

Carlton is lowest.

Carlton Box—lowest of all brands.

Less than 0.01 mg. tar, 0.002 mg. nic. Carlton Menthol—Less than 1 mg. tar, 0.1 mg. nic.

Box: Less than 0.01 mg. "tar", 0.002 mg. nicotine av. per cigarette by FTC method.
Menthol: Less than 1 mg. "tar", 0.1 mg. nicotine;
Soft Pack: 1 mg. "tar", 0.1 mg. nicotine av. per cigarette, FTC Report May '81.

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