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JULY • 35c Monthly

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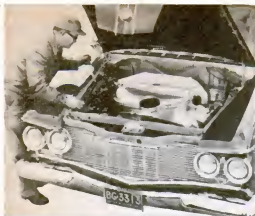
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Gas-turbine car: "Washtub"
engine powers it. P. 35



Air pioneer: The man who
gave the Navy wings. P. 84



Flying frogmen: Newest
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Cover photo by R. D. Borst

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Sun boat: Solar power turns its paddles. P. 119



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PS Readers

TALK BACK



Phony-Accident Racket

"BEWARE of Accident Fakers" [May] was well written and most timely. It should serve well the insurance-buying public throughout the country. Please congratulate author E. D. Fales Jr. for a job well done.

J. DEWEY DORSETT, Gen'l Mgr.
Ass'n of Casualty and Surety
Companies, NYC.

Is 70 M.P.H. Too Slow?

IN YOUR Lancer round-up [Mar.], which I enjoyed immensely, I was bemused by Martin Mann's comment that 70 m.p.h. is "not sufficient for turnpike driving." California now has a mandatory 65-m.p.h. speed limit (thank goodness) on all highways, and probably isn't alone in that regulation. You Eastern scorcher!

M. LOVELANDER, Santa Monica, Calif.

Mann, no scorcher, replies: "For 65-m.p.h. turnpikes, you want a car that can maintain a cruising speed of 65, even up hill—and still have some speed in reserve to take care of emergencies. It's dangerous to cruise at top speed. To provide 65-m.p.h. cruising, absolute top speed would have to be way over 70."

The Power of a Candle

THE Science and Mathematics Teaching Center of Michigan State University is conducting a Traveling Science Teacher Program under the sponsorship of the National Science Foundation.

To stimulate interest in science, one approach used is to demonstrate homemade apparatus and to encourage duplication of these teaching aids by students

and teachers. One of our Traveling Science Teachers suggests the PS article "A Homemade Radio Powered by a Candle" [Nov. '60] would be helpful in furthering our objectives. Could you supply copies for use by 15 teachers?

JOSEPH E. BOWLES

University of Michigan, E. Lansing.

Can do.

He Knows His Hot Rod

I ENJOYED "Cars That Detroit Never Built" [Apr.] and have a few additions and corrections. The Competition Roadster, bottom of page 104, has turned a respectable 125 m.p.h. in 11.05 seconds in 1/4 mile, and formerly held the 1/4-mile record for "C" class modified roadsters. The engine is a Chevy 283 C.I. with a



PS Editor Wins Award

THE bronze plaque shown above was recently presented to PS Senior Editor Devon Francis at the annual meeting of the Aviation/Space Writers Association. His award-winning article, "The Violent End of Flight 2511," was published in POPULAR SCIENCE in February, 1961.

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few modifications, not a Corvette; the estimated horsepower is 300, not 400.

This car was built by the Stratorods (I'm a proud member, but inactive due to location), a car club consisting of Air Force personnel from March Air Force Base, Calif.

A/lc J. B. GRUZEN, Cold Lake, Alberta.

34-Year Puzzler Gets Answer

BACK in 1927, eight of us at sea aboard an American freighter spent a total of more than 100 hours trying to solve a puzzle. We used up all the scraps of paper we could find aboard, but had no success. Through the years I have often wondered about the answer. Now I know.

I found it in PS Puzzlers [Mar.]: the "unicursal puzzle." The solution was kind of tricky, wasn't it?

C. H. HARDY, Whittier, Calif.



NOT a Hil-A-Vator

WE SAW the story and pictures of a hillside elevator installed at an unusual home in San Fernando Valley ["Toadstool House," Apr.] and noted particularly the use of the name "Hillavator" on the floor plan.

We are manufacturers of the Hil-A-Vator and we can only hope that readers will not associate our hillside elevator with the equipment shown. We are pioneers in this field and our trade name stands for a product whose quality and safety has been proved by its accident-free history and one acceptable under the American Standard Safety Code for Residential Elevators and under insurance-company safety requirements.

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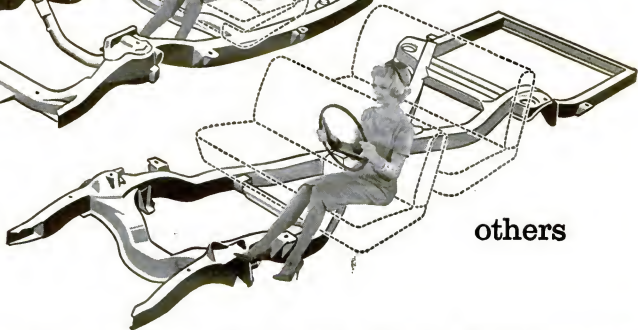
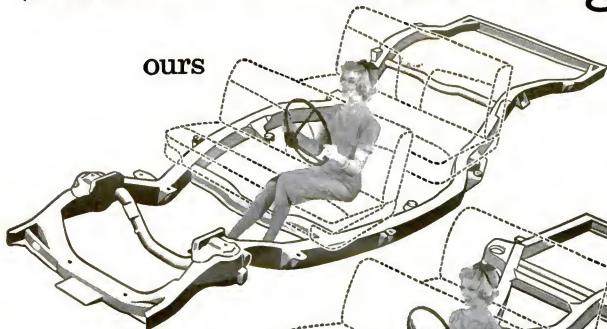
The floor plan to which you refer was supplied by the architect.

The Wrong Move

MOVING the heating thermostat to an outside wall [Letters, Apr.] may give you some of the advantages of an indoor-outdoor control, but watch it! The con-

Which frame is stronger?

ours



others

Guardrail construction in the 1961 Ford Family of Fine Cars has greater rigidity, offers the strength of strong side rails.

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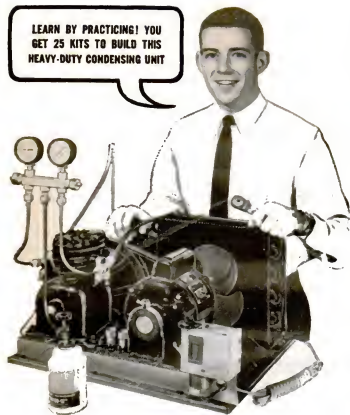
These are 4 of the many reasons we think you will find (upon comparing our cars with other cars) that Ford Motor Company builds better bodies.



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tractor who built our local post office located the thermostat on the south side. In the middle of the afternoon, inside temperature would go down to 65 degrees when the stat was set at 75. Next morning when we showed up for work, it was around 80 inside with the stat at 65.

The trouble with that setup was that the sun would heat up the wall during the day. After the sun went down the wall got cold. This meant the heater wouldn't put out in the middle of the day, and was forced to work overtime at night. I finally got it to work properly by relocating the thermostat on an inside wall.

PAUL G. OTTO, Wasco, Calif.

Like Rome, They Take Time

BACK in 1959, you had an article about "TV Tubes That Won't Burn Out." At the time, the tubes were being perfected and were expected to go on the market in 1960. What ever happened to these wonderful tubes?

JOSEPH TIRPAK, Moosic, Pa.

Tung-Sol Electric reports that the bulbs are still in the lab stage and will be for another year.

Any Old Mirrors to Lend?

THE amazing picture "In Front of a Shotgun Blast" [Mar. p. 110] shows the



photographing setup but still brings up some questions:

What was the distance of gun from mirror and mirror from camera? Was the speed light or amplifier connected to the camera? Was there daylight?

I'd like to try duplicating such a shot myself.

WILLIAM PARKER, Baton Rouge, La.

Distances, size of shotgun and shot do not matter. But mirrors cost—and you'd



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tires require on wet, slick or snow covered pavement . . . and it is *noise-treated* for quieter running. You'd expect to pay more, but the big news is this: *You can start running on Firestone Transport-100 tires now at no extra cost!* Available in nylon or Tyrex[®] rayon cord, tubed or tubeless, at your Firestone Dealer or Store. Always Specify Firestone Tires on New Trucks.

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need a good-size one. And you can use it only once! The photographer broke half a dozen before he got the shot just right. You can connect the amplifier to the camera to trigger the shutter or operate it by hand. The shot was taken in a studio, with all illumination from the two speed lights.

Just Pull the Fuse?

INSTEAD of trying to make safes crack-proof ["Legal Burglars Crack Safes for a Living," Mar.], why not protect them electrically? When a remote switch is turned on, jarring the safe would set off



an alarm on the roof of the building. All wiring would be under or within the safe and between the walls of the building, so a burglar couldn't cut the wires or disconnect the system.

J. P. BERGER, Uvalde, Tex.

For Scientific Chimney Sweeps

ABOUT that tip for chimney cleaners [Letters, March]: Any value derived from throwing old dry-cell batteries (always with the shells broken open) in a fireplace or furnace would come from the depolarizer manganese dioxide that is present. This powerful oxidizing agent would give a cleaner flame as well as a hotter one that would reduce soot and, perhaps, loosen any accumulation.

FLOYD WEED JR., Jefferson City, Tenn.

No More Vacations for Gus

GUS must have been looking the other way when that screen-door handle was mounted on a car dash ["Hints from the Model Garage," Mar.]. It might assist folks entering or leaving the car and help children to stand upright in a moving car, but with everybody—including your own writers—urging car makers to get rid of lethal protuberances on the dashboard, this hint is a step backward. So is the encouragement of children to ride standing up. They should be in their

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seats, preferably anchored there firmly by seat belts.

Young (and old) faces that have hit dashboards and windshields are not pretty to look at or work on.

S. G. GRUBB, D.D.S., Cleveland.

Now Hear This, IBM 704

THE report on sassy electric brains ["The Month in Science," Mar.] was ominous. Let's not have any machines that talk back, please!

Last summer after using some pungent prose on a balky washer-dryer, I turned my back. Suddenly I was startled to hear, "Hey, you," ring out loud and clear. I whirled, stared at the machine, and then with great relief saw my neighbor at the screen door. It took three cups of coffee and five cigarettes to calm my shattered nerves. My battle with machines still continues, but if they ever start talking back I'll quit.

I've recently heard that the most effective way to deal with an obstinate computer is to swear at it in Greek.

BONNIE WEBER, Castro Valley, Calif.

When You Survey . . .

THERE are many pitfalls the person who follows "How to Survey Your Lot" [Apr.] must watch out for. The fallacy in the instructions is the supposition that the house is square and that it is either parallel with the property line or perpendicular to it. It has been my experience that houses are none of these.

As an example, if the side of the building was 1 inch out of being perpendicular to the front of the lot, corner E in your example would be 5 inches in error; corner G as much as 9 inches. Do-it-yourself surveying is not accurate enough



to rely upon when erecting a fence or retaining wall—you need a licensed land surveyor.

You also say that a property owner may save a surveyor's mark by embed-

ding it firmly or by replacing it with a permanent marker. Such action will remove the responsibility of the surveyor for the accuracy of his work and, thus, he will no longer guarantee the survey. Surveyors' markers should never be removed or tampered with. When you have your lot surveyed, pay the surveyor a small additional fee to install iron pipe rather than wood stakes.

CARL F. WHEELER, Fords, N. J.

True, not all homes are parallel or perpendicular to a lot line. As the story points out, unless the do-it-yourself survey makes it possible to find corner stakes, the quality of the job is entirely dependent upon the accuracy of the lot survey plan. But building codes stipulate minimum distances from lot lines that walls and fences may be erected. These laws should compensate for considerable surveying error before encroachment on a neighboring property occurs.

Finally, as stated in the article, "... when you add to or sell your house ... you need a pro to pinpoint dimensions ..."

Banking in the Round

AFTER seeing the Geometric School ["PS Picture News," Apr. p. 100] we'd like to show you our new quarters, now nearing completion. The distinctive design was created by W. A. Sarmiento, originally of Peru, and shows modern Latin American architectural influence.

Uniquely, all the mechanical equipment for the building is on the seventh floor. The rectangular area contains the elevators, stairways, plumbing, and ducts for heating and air conditioning.

W. D. SAGER

Security Federal Savings & Loan Ass'n.
St. Petersburg, Fla.



Charge of the Horse Brigade

I WAS amused by the picture of the sergeant using a tumble-drum turned by the wheel of a truck ["Short Cuts and Tips," Mar.] to clean tire chains. A simi-

CONTINUED

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lar device was used in the horse artillery days, also for polishing chains. It was used at Fort Francis E. Warren, Wyo., when I was stationed there—and that was back in 1936. The drum contained bits of leather and each unit equipped with horses had made one.

H. E. BAILEY, Glenrock, Wyo.

Tip for Fussy Disk Spinners

I VIEW with alarm the padded slot contrivance for holding records, now being built into some stereo phonographs ["PS Picture News," Mar.]. I'd rather have a



few greasy fingerprints on my records than a large chunk broken off one side. The idea is good in principle, but a careless swipe of an arm or a stumble could break off the record in the slot.

There is a contrivance on the market that does the same job beautifully for the fussy. It's a pair of padded tweezers with which you grasp the record at the edge to place it on the turntable without touching the grooves. It's worth the \$5 cost to a serious collector.

F. C. BUZZELL, Spring Lake, Mich.

The Big Crackup

A FEW days after reading "The World's Biggest Auto Accident" [Apr.], I picked up a local paper to read of a 23-vehicle collision. It occurred on the New Jersey Turnpike; no smog, but rainy weather. Must be the second-biggest crash!

R. J. SHARP, Stratford, N. J.

... THE article was graphically written, but why lay all the blame on the two alleged "culprits" whose cars suffered no damage?

Driver A found himself unexpectedly in thick fog and slowed. What should he have done—gone on lickety-split? The driver following was either tailgating or paying less attention to the fog ahead, or both, and found himself confronted by "the sudden glow of tail lights, directly ahead and far too close." As a result he

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panicked, and instead of slowing to a safe speed and going ahead, as Driver A quite properly did, screamed to a crash stop and stayed motionless until the next car rammed him.

The blame on Driver B rests on somewhat sounder reasoning. But the author does mention that both cars following him had no difficulty stopping safely when B stopped to investigate. Besides, the pile-up in the southbound lanes would have happened whether he stopped or not.

Instead of pinning the blame on A and B, why not admit that the ones at fault were those who were traveling at speeds in excess of what was safe for the conditions prevailing. That is reckless driving, no matter how you try to rationalize it.

W. E. FOSTER, Fairport, N. Y.

Bringing the Sea to His Door

IMAGINE my surprise when I saw a picture of my handiwork in your Picture News ["Double-Take Garage Door," Apr., p. 132]. Here is another photo



showing the murals on the outside walls of my house. I am a marine machinist at the Long Beach Naval Shipyard, so seascapes are appropriate.

J. E. GUSTAVSON, Westminster, Calif.

Tuning In on the Old Days

FIRST thing to catch my eye on the April contents page was the blurb for the article "Restoring Antique Radios." My wife, her sister, and I engraved that set. I have a picture of my wife showing how the engraving was done.

The set—a No. 61, very powerful and with wonderful tone—was made by Federal T & T in Buffalo, N. Y. At the

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same address the original station WGR (World's Greatest Radio) was started. I was among the first 10 to broadcast from the roof of the building.

LEON BOISVERT, Arcade, N. Y.

... I HAVE more than 150 antique receivers, horns, power supplies, parts and hardware, including close to 1,500 antique tubes. Several years ago, I found there were many other collectors interested in buying, selling, and trading old-timers. To get these people together and to further the hobby, my wife and I formed a guild.

Our chief aim: to interest others in old-time radios, to preserve and restore those sets still around, and eventually to erect a museum to display them. We publish a monthly newsletter with hints on repairs, restoration, tube substitution; and listings of what members want or wish to offer in sets and parts.

JAMES H. STEGNER
 Antique Radio Guild
 RD 1, Mt. Zion, Clearfield, Pa.

For More Light

I HAVE the answer for the April letter writer who complains that light bulbs burn out faster these days: Use 130-volt bulbs instead of the 120s used in cities with low voltage. He can expect triple the life from these.

CHARLES BLOOMBERG, Portland, Ore.
But what dealer carries them?

He Knows the Key

ONE item in the May Detroit Report, "Year's Weirdest Coincidence," makes me take pen in hand. I find it amazing that anyone would find it amazing that a car ignition key would fit a home owner's front door. Such coincidences are commonplace. I would give even money on being able to name the make of lock involved. I'm a locksmith.

JIM BURTON, Rantoul, Ill.

A Not-So-New Idea

I OWN a 1957 De Soto Fireflite and it has a funnel-shaped lead-in for the ignition key. If Mr. Remy really wants this feature ["I'd Like to See Them Make," Mar.], tell him to try the used-car lots.

C. A. SECREST, Kansas City, Kans.

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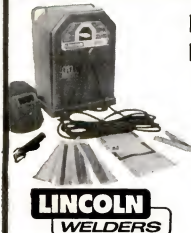
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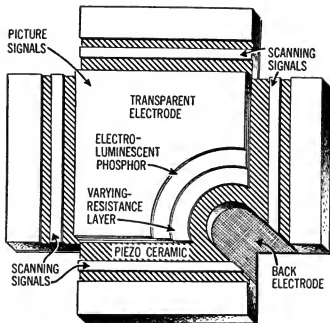
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The month in science

TV on the wall. It looks as if they have finally found a practical way to make a television picture screen flat enough to hang on your wall. Stephen Yando, a researcher for General Telephone, has invented a ceramic panel—sort of a complicated dinner plate—that converts video signals into moving pictures. It's flat, only half an inch thick, and solid—no vacuum. Though still experimental, it may eventually replace the bulky picture tubes now used.

Hanging the picture screen on the wall, separate from the controls, may appeal to some people. But more far-reaching advantages come with a solid screen. It means TV sets that are thin (proportioned like portable radios), light in weight, trouble-free (because components that produce heat, the chief villain, could be eliminated), and so parsimonious of power that cheap batteries would run them a long time. The main circuits of television receivers can already be made to such specifications with transistors (or, soon, tunnel diodes). The bottleneck has until now been the bottle: the big, heavy, fragile, power-hungry picture tube.



Ceramic panel promises flat, solid TV screen

Yando did not have to invent a new way to convert electricity into light; flat electroluminescent panels to do that have been on the market for nearly 10 years. The problem was scanning: how to switch individual points of the panel on and off very rapidly to build up the quick-changing light-and-dark pattern of the TV image. Mechanical switches are too slow and cumbersome; the only electronic switch had been an electron beam—which brings you right back to the standard TV picture tube. Yando solved the problem by pulling a very cute trick with piezoelectric crystals, which are old and long-used electric devices (for an up-to-date report on them, see p. 70).

Piezo crystals convert mechanical movement to electricity, or electricity to mechanical movement; they work either way. In the new spark pumps for one-lung engines, they generate a voltage from mechanical vibration. In sonar devices for submarine spotting, they make sound waves (a mechanical vibration) from a voltage. Yando's trick was to make a piezo crystal work both ways at the same time—convert electricity to motion, then motion to electricity—and combine that with an electroluminescent panel to get light.

The dinner-plate picture panel is a flat rectangle of piezo ceramic

(lead zirconate-titanate) coated with electroluminescent phosphor (a powder similar to fluorescent-lamp coating). Electrodes at the sides of the ceramic bring scanning voltages that determine which point will light up. Electrodes on the back and face of the panel bring TV picture-signal voltages that determine how bright the point will light up. (The face electrode has to be transparent so you can see the picture that is created.)



Five-inch-square panel has already been built

The scanning voltage causes a mechanical vibration to move across the ceramic in a line—like a long ocean wave. The vibration wave, in turn, generates a piezo voltage in the ceramic. So a line of voltage moves across the panel. But suppose you feed in two scanning voltages simultaneously, one to the top edge of the panel and one to a side edge. This gives you two moving lines of vibration waves and two moving lines of piezo voltage. Where the lines cross, you get a moving point of double piezo voltage.

You can control the course of this point—make it scan across the panel—by doing things with the circuits in the TV receiver.

The electroluminescent layer will light up wherever there is a voltage. But you don't want the moving lines to show at all, and even the moving spot must adjust its brightness to suit the TV picture signal. So a varying resistance cuts out all voltage at or below the double-strength piezo voltage—even the moving spot, unaided, won't light up. But the additional voltage supplied by the picture signal can make the moving spot glow, changing it from dim to bright to create the entire image.

First use of the solid picture panel will be to display numbers and symbols in military gear. General Telephone—one of the bigger manufacturers of conventional television receivers and picture tubes (Sylvania brand)—declines to guess when you might get a TV screen to hang on your wall.

You, too, may revive the dead. A new method for restarting stopped hearts should save many lives. It does not require a physician to cut open the chest, stick his hand inside, and massage the victim's heart directly (a difficult and often unsuccessful procedure). He just squeezes the heart from outside, pushing down hard on the patient's chest so that the heart is pressed between breastbone and spine.

The new technique was developed by Drs. J. R. Jude and W. B. Kouwenhoven, and G. Guy Knickerbocker of Johns Hopkins, and is now being taught to doctors (a movie produced by Smith Kline & French is spreading the word). Some experts think it is simple enough to be included in Boy Scout and Red Cross first-aid courses, the way artificial respiration is now (see p. 107).

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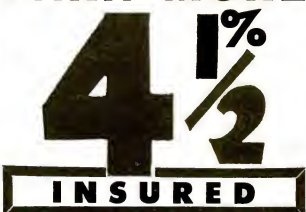
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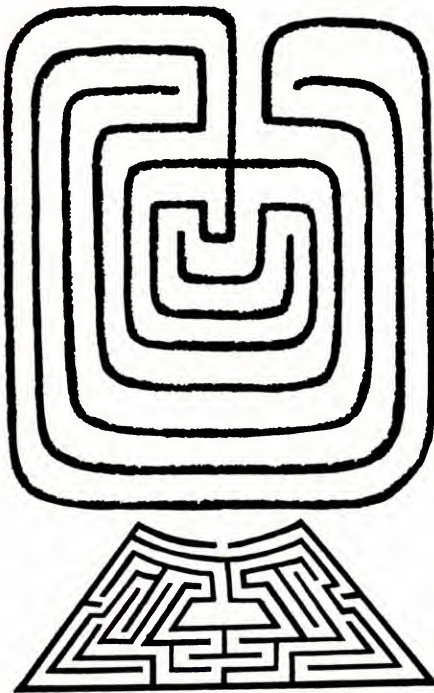
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PS Puzzlers By Joan Steen

Some July sparklers to inflame you . . . Answers on page 183

.....

This Way to the Minotaur



IN MOMENTS of frustration I content myself sometimes by drawing a maze. It's a particularly well-behaved maze, one that mathematicians call "universal": Once inside it, you have to trace all the pathways, but there are no blocks so that eventually you do get to the center. This particular maze is very old. It's been found on Mycenaean stone tablets that date back to 1200 B.C., Etruscan vase fragments of 700 B.C., and Roman coins. The legend goes that Theseus had to thread his way through this form of labyrinth in order to slay the Minotaur. I am indebted to John L. Heller, Professor of Classics at the University of Illinois, for showing the ingenious way to draw the maze—which I challenge you to discover. The trick was probably well-known in the ancient world and became a favorite doodle.

As for non-universal mazes I submit one example (left) for you to thread. This, too, is historical. The garden adjoining the royal palace at Hampton Court in England is laid out in this way. The dark lines are hedges.

.....

HOW calculating are you? As a start, write down the number eleven thousand, eleven hundred and eleven.

Catch you? No? All right, maybe we'll trip you with this old teaser: If a hen and a half lays an egg and a half in a day and a half, how many eggs can seven hens lay in six days?

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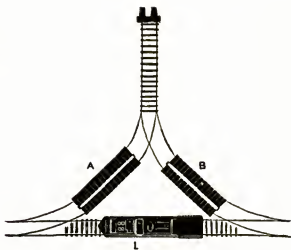
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PS Puzzlers continued

TWO boys were carrying bricks from the curb to the back yard. "If you give me one of yours I'll be carrying twice as much as you," said the bigger boy. "But if I give you one of mine," he added, "then we'll be carrying equal amounts." How many bricks did each boy carry?

THE impulse is strong but I shall spare you the many bad puns that might attend this train-shunting puzzle. (Like, are you sure you're on the right . . . oops. There I go. Sorry!)

Okay. There's a main track and two sidings with a common track area. The common part is long enough to hold either freight car A or B, but not both; nor can it hold the locomotive, L, which is on the main track. The problem: How would you use the locomotive to jockey the cars so that eventually A and B will have switched places?



Puzzle of the month



THE "Dutchmen's Wives" puzzle is an old one that I like because it's a nice mixture of logic and arithmetic. Sam Loyd says that it yields read-

ily to experimental puzzle methods.

Three Dutchmen and their wives go to market to buy hogs. The men's names are Hendrik, Claas, and Cornelius; the wives are Geertring, Catrun, and Anna—but they're not necessarily paired in that order. Each of the six buys as many hogs as he or she pays dollars for one hog. When they reckon up their purchases at the end of the day it turns out that Hendrik has bought 23 more hogs than Catrun, and Claas 11 more than Geertring. Each husband has spent exactly \$63 more than his wife. Now who's married to whom? (Answer next month)

Answer to last month's P-O-T-M: June's puzzle—to weigh all integral amounts from 1 to 40 pounds in a scale balance using a fixed number of weights—was discussed as early as 1556 by the Italian mathematician Tartaglia. Some 50 years later, a Frenchman, Claude Gaspar Bachet, enlarged upon it, allowing weights to be put in either pan. He reasoned:

To weigh one pound, you need a one-pound weight. To weigh two pounds, you need, in addition, a two- or three-pound weight. With the addition of a two-pound weight, you can weigh one, two, and three pounds; but with a three-pound weight you can weigh 1, (3-1), 3, and also (3+1) amounts. Add a nine-pound weight and you can weigh all weights from one to 13, while no lesser weight gives you that much. With that clue, Bachet went on to 27 pounds, and discovered that these

four were sufficient to weigh any number of amounts from one to 40 pounds. Furthermore, given weights of 1, 3, 3², 3³, . . . 3ⁿ⁻¹ pounds, you can weigh any integral number from 1 to (1+3+3²+ . . . +3ⁿ⁻¹) pounds. Later mathematicians worked out the solution algebraically and established that, for the 1-to-40 problem, the set 1, 3, 9, 27 is the minimal set necessary (allowing both sides of the scale to be used), and the only one in which all weights are unequal.

If you have any doubts about how it works, here are some examples:

Weight	Scale	
If unknown object x weighs	left	right
14 lb.	27	1, 3, 9, x
20 lb.	3, 27	1, 9, x
25 lb.	1, 27	3, x
38 lb.	3, 9, 27	1, x
40 lb.	1, 3, 9, 27	x

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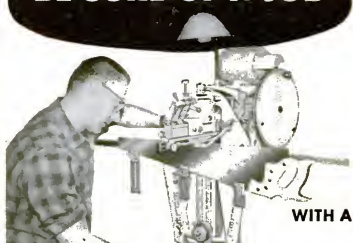
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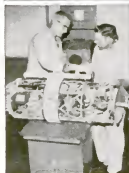
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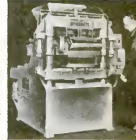
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DETROIT REPORT

By Devon Francis

Welcome Back the Wire Wheel

WIRE wheels, symbol of the sporting set up to three decades ago (and standard on such vehicles as the old Model A), are coming back on some of Detroit's 1962 cars. Like the bucket seats

on several compact cars early this year, wire wheels should be catnip for motorists shopping Automobile Row.

These things are fishing expeditions. The manufacturers are trying to find out what the public wants. For years they assumed they knew. Then came the debacle of the economy-car imports, and Detroit rushed frantically into the production of severely functional compacts. Now, to its amazement, the fancied-up, more expensive compacts are snapped up.

"People are determined to have economy," remarked one auto company official, "no matter what the cost."

Remember the Corsair? Names have been chosen for the 1962 Chevy and Ford medium-wheelbase cars—those of 114 and 115 inches. Chevy's, as we predicted last month, will be baptized Corsair, calling up shades of the defunct Edsel.

Ford's Canadian X, as it has been known, will borrow a name from the standard-size Ford—the Fairlane. Mercury's Canadian Y will be called the Meteor, a name long known on Canadian-produced Ford products.

Guess what Buick's doing to hp. For '62, Buick is going to upgrade its tidy, aluminum V-8 engine—introduced last year at 150 horsepower—to a whopping 250 hp. The thrust bearing will be moved up to the center main. Early production models of the aluminum V-8

—they never reached the public—pumped oil past the thrust bearing into the bell housing. Its location may have been the cause.

A temporary fix was made for 1961, but the final solution seems to be moving the bearing forward.

Open secret. A British manufacturer of steering gears has let a cat out of the bag. The subject: Ford's 99-inch-wheelbase Cardinal with the V-4 engine, scheduled for market next spring. The secret: The car's chassis components will be built largely in England and Germany.

The British company proudly announced they'd supply Cardinal steering

gears to Ford's plant in Cologne. Ford executives, who have been speaking of the car only in airy generalities, were appalled. They commented grimly that the Cardinal's steering gear was being redesigned. Latest Detroit rumor is that the Cardinal will not be called the Cardinal at all, but the Hummingbird (brackets nicely with Thunderbird).

Look: the '62 Mercury. Ford's Lincoln-Mercury division has come up with an adroit answer to a widely circulated rumor that its Mercury will be going the way of the Edsel. To issue a denial would tend to spread the rumor.

Instead, the executives in charge decided to reveal a feature of the 1962 Mercury. It's a new, one-piece, self-hinging accelerator pedal made of a flexible synthetic called polypropylene. The implication: Merc's here to stay.

This and that. Cornell Aeronautical Laboratory, Buffalo, N.Y.—which, despite its name, engages in much auto-safety research—reports that rain reduces a car's stopping ability by about half . . .

that concrete provides the best friction surface . . . and that a special method of painting unlighted asphalt roads makes them reflect 3½ times as much light from headlights as when unpainted.

ALMOST 80% OF THE LAST 34 INDIANAPOLIS "500" RACES HAVE BEEN WON WITH PERFECT CIRCLE EQUIPPED ENGINES, AS WELL AS MOST OTHER MAJOR USAC AND NASCAR RACES



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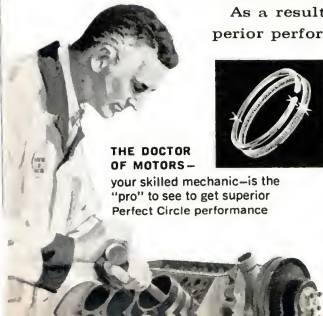
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Chrysler's Muscular 'Washtub' Engine 19 Miles a Gallon —on Kerosene!

By Devon Francis

ANY sharp-eared visitor to Detroit these days can spot a new kind of automobile cruising the streets. It out-accelerates most other cars. Except for road irregularities, it's practically vi-

GAS-TURBINE ENGINE cruises Detroit streets in a 1960 Plymouth body. Its weight is about half that of a comparable piston engine, or 450 pounds. Electrical system is standard 12-volt.

brationless. It emits only a faint whine.

The car is powered by Chrysler's third version, in seven years, of its gas-turbine engine.

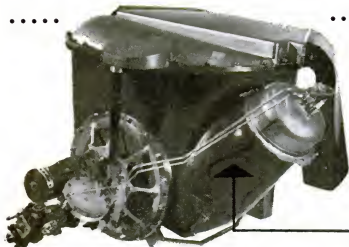
The gas turbine, the first great revolution in automobile power since the piston engine first propelled a vehicle three

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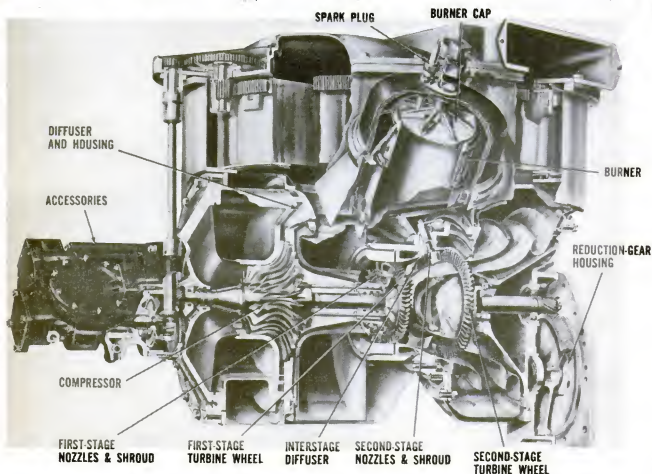
35



Engine is simple, smooth, and rugged



THE COMPLETE ENGINE (left), with projecting burner, is a yard long, 35 inches wide, and 27 high. Burner, burner cap, spark plug are pictured at right. Burner is 13 inches long and 5 inches in diameter.



ENGINE'S SIMPLICITY is reflected in cutaway. Compressor supplies air at four times atmospheric pressure. At reduction gear, 200 horsepower is reached at 4,570 r.p.m., maximum speed at 5,360 r.p.m. Turning ignition key causes solenoid to open fuel valve. It also en-

ergizes starting motor and fires spark plug. Turbines race from idle to full speed in less than three seconds. Engine fire is not self-sustaining under 18,000 r.p.m. Engine "fails safe"—if engine speed or turbine-inlet temperature gets too high, the fuel is cut off.



EXPLODED VIEW shows accessory case (oil, fuel, air pumps) at far left; compressor, turbine

wheels, gas diffusers, and housing for single reduction gear—8.53:1—at right.

quarters of a century ago, is here. It's already on fire trucks, and has been used experimentally in over-the-road trucks.

At cruising speeds the Chrysler gas turbine goes as far as, and in some instances farther than, a piston engine of equal horsepower on a gallon of fuel. In traffic it matches the piston engine in fuel economy. It will burn anything short of cordwood, including ordinary furnace oil.

When I rode in the gas-turbine car, I caught my breath at the acceleration—it topped 60 miles an hour from a standing start in less than 10 seconds. Its top speed is around 115 m.p.h.

No warm-up. The car drives like any other automobile. To spin the starter, you switch the key in the ignition slot. Geared up, the engine is turning at 20,000 r.p.m. in a few seconds. At that speed a single spark plug lights the fire in the burner. There's no need for a warm-up, regardless of weather.

On the instrument panel you find only a speedometer, ammeter, oil-pressure indicator, fuel gauge, and a tachometer. The tach is there for the engineers. Production cars won't have one.

At the left of the panel you see Chrysler's familiar buttons for the automatic transmission. Missing, though, is the N-for-neutral button. The gas-turbine car is always in gear. That's to put a load on the engine and keep it from overspeeding at idle—under 19,500 r.p.m. The other control buttons do the same job as those for a piston engine.

Your feet find the same pedals as those in any automatic-transmission car, a brake and an accelerator. To go, you press the gas pedal. If you press hard, hang on to your hat. You begin getting torque—lots of it—at 19,500 r.p.m. The

automatic drive upshifts twice before you hit high. To stop, you release the gas pedal and press the brake.

Automobiles powered by gas turbines could be produced tomorrow if Detroit's motor makers so willed it. They won't—not that soon. But, even so, it begins to look as though gas-turbine cars will begin appearing on production lines within five years.

The experimental Chrysler engine shares many qualities with the Boeing gas-turbine engine in San Francisco's and Seattle's fire trucks, described in **POPULAR SCIENCE** last February:

- It's simple: has only one-fifth the moving parts of a reciprocating engine.
- It's light: weighs only half as much as a piston engine of the same power.
- It's efficient: unburned fuel that comes out the tailpipe can hardly be



SINGLE SPARK PLUG is five inches long to extend into burner. Burner cap, which carries it, supplies both air and fuel to the burner. Extra compressor air is vital to turbine speed.



INSTRUMENTS, left to right: (1) amps, fuel gauge; (2) speedometer; (3) turbine speed as percentage of maximum, graduated in tens; (4) turbine inlet temperature in hundreds, oil pressure in tens. Accelerator governs fuel-pump r.p.m. Problem is turbine blade's low heat tolerance. Goal: 2,000 degrees—80 more hp.

measured. By comparison, piston engines are notorious for fouling the air.

- It's muscular at low speed: develops highest torque—push at the driving wheels when light turns green—at stall. Pistons peak at half speed.

- Its accessories requiring attention and repair are minimal: single spark plug, no distributor, no radiator.

- It's compact: At 36 inches, including speed-reduction gear and transmission, the Chrysler engine is shorter than the Boeing, but wider. It spans 27 inches, not including the burner, and is 27 high. This is a substantial improvement over the piston engine, and it's telling no tales out of school to say that width and height will be reduced.

Comparing gas turbines with piston engines is like trying to match apples and oranges. Both are "heat engines." They convert heat to mechanical motion—get their heat from burning a liquid fuel. But the turbine operates at a much lower temperature than the piston engine—from 1,600 degrees at the first-stage turbine to 400 degrees at the exhaust. This compares with a high of 3,800 degrees in the piston engine, a low of 1,500. The gas turbine uses up 75 percent of its heat; the piston engine only 60.

Gas turbines and drive trains lose energy in mechanical friction, but far less than piston engines. Escaping the energy-consuming and vibration-making reciprocation of the piston engine, the turbine just spins—up to 10 times as fast as a

piston engine's crankshaft, or 45,000 revolutions a minute. A gas turbine rated at 140 hp. on the test stand is deemed the equivalent of a piston rated at 200.

There's another difference. The gas turbine uses six times the air consumed by a piston engine for the same power output. In the Chrysler unit, that means 1,740 cubic feet a minute. But air used for combustion is about the same.

That excess air in the turbine, a miniature tornado, is there for a purpose—to drive the compressor and power turbines and cool the turbine blades.

If the gas turbine is so good, where's it been? That's a story!

In the wood-paneled, carpeted precincts of Chrysler's engineering division is a lean, handsome, intense man with smoke-gray hair—he's 50-year-old George John Huebner Jr.



TURBINE ENTHUSIAST Huebner holds variable nozzle plate for power turbine. It has 23 vanes that can rotate, automatically, 100 degrees.

Huebner is designated "Executive Engineer—Research." (The authoritative *Automotive News*, trade newspaper, calls him "easily the most dedicated gas-turbine engineer in the industry.") With Chrysler since 1931, he has had a starlit career. It was he who, in 1952, organized the company's missile program under government contract. This program spawned the highly successful Redstone-Jupiter missile systems.

He got interested in gas turbines as far back as 1934, and was pushing for automotive gas-turbine research as early as 1940. Then the war came.

After the war Huebner went to work

[Continued on page 172]

Missile room in Polaris submarine



MISSILES ARE LAUNCHED from a single panel in the submarine. Each has its own set of firing controls.

The central passageway in the nuclear submarine Theodore Roosevelt runs between 16 upright tubes that store and fire Polaris guided missiles. Armed with atomic warheads, the rockets pack more destructive power, the Navy says, than all aerial bombs dropped in World War II. They can be launched under or on the surface of the water, have a 1,100-mile range.

The Roosevelt and four other sister subs also carry torpedoes fired from regular tubes.



MAIN PASSAGE aft of Roosevelt's conning tower contains 16 vertical launching tubes—14 of them are shown here.



Electronic pacer

Japan's Olympic trackmen now practice behind an electronic pace setter. It's similar to the mechanical rabbit at a dog track, except that speed is set by magnetic tape. Changes can be made during a run by radio remote control. The pacer also contains a loudspeaker that broadcasts instructions from the coach.



Drive-in inoculation

Enlisted men at the Naval Air Station at Memphis, Tenn., are no longer required to stand in line to get their flu and other shots. Instead, an ambulance ramp has been converted into a drive-in dispensary. The sailors arrive with sleeves rolled up. Corpsmen on either side can handle as many as 700 an hour.



Italian compact

Reminiscent of a Rambler, this car is the new Italo-American-styled Fiat 1300. The four-door sedan is powered by a

79-cu.-in., 72-hp. engine, or an optional 80-hp. unit claimed capable of 93 m.p.h. Refinements include quad headlights, disk brakes on front wheels, reclining bucket seats, choke-on warning light.



Oxygen tent for pets

A veterinarian's cage for a sick dog, cat, or other small animal can be converted into an oxygen tent by attaching a transparent plastic panel to the door. Oxygen is fed in from a cylinder or piping system. The panel has an ice chamber for cooling the compartment. Medication, when required, can be sprayed in. Maker is National Cylinder Gas, Chicago.



Tightrope rider

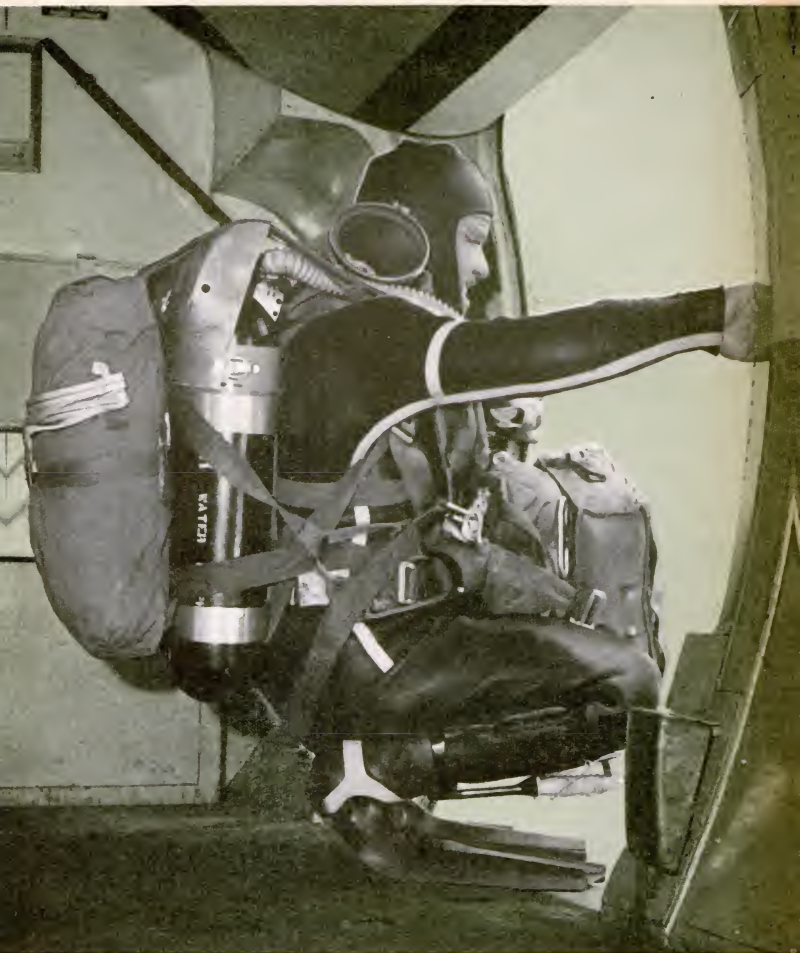
Flanged hubs on the wheels of a four-wheel-drive Land Rover enable it to run on two taut wires at Fort Tregantle, England. British army engineers are testing the technique for possible use on primitive bridges spanning ravines and rivers in trackless jungle country.



Heartbeat wrist watch

This watch won't tell you the time, but it will let you know how often your heart beats while you are at work, running a race, or driving your automobile. For "works" it contains a tiny battery-operated amplifier, attached by wires through your sleeve to electrodes taped to your chest. It was developed by Lockheed for San Francisco heart specialists.

Meet the USAF's Jack-of-All-Rescues...



Turn the page to see him in action

Frogman with an Umbrella

By Frank Harvey PS PHOTOS BY W. W. MORRIS

NEWEST guy on the Air Force team is the para-diver. Equipped with parachute, aqualung, and nerves of high-carbon steel, he combines the skills of paratrooper and frogman.

Loaded like pack mules and trained for trouble, para-divers are flown wherever they're needed, in transport planes, flying boats, or helicopters. Here are some of the chores they can perform:

- Go to the aid of passengers and crew of a ditched plane (or a still-airborne potential ditching).
- Help a submarine in trouble on the bottom—before slower, conventional surface divers could arrive.
- Assist in identification and recovery of sunken planes or ships.
- In wartime, airdrop into heavily defended areas to blow up harbor installations, ships, or large dams.

Motto of the paradivers: "We get there fastest, dive deepest, stay down longest." They do, too.



FIRST STEP as Sergeant Nick Klimis starts suiting up is into heavy soft-rubber outfit that will insulate him from the cold—while he's working under polar ice, for example.



ABOUT TO GET THEIR FEET WET, two paradivers of the 48th Air Rescue Squadron, Eglin Air Proving Ground, Fla., hit the gulf on a practice jump. These men leave the plane at a very low altitude and must perform many complex operations in mid-air to deploy their gear.



AN INSTANT AFTER LANDING, their work is cut out for them: (1) recovering their breath—knocked out by the impact, (2) getting their aqualungs plugged in to feed their own lungs before they sink,



RAZOR-SHARP KNIFE for the unexpected is strapped to one of Nick's sturdy legs. The knife may be used only once in 100 jumps—but then it may be a matter of life or death.



NICK GETS A LITTLE HELP from another ARS sergeant as he puts on his special lightweight "jump tanks." The hinged aluminum shield on top protects the air valves on impact.



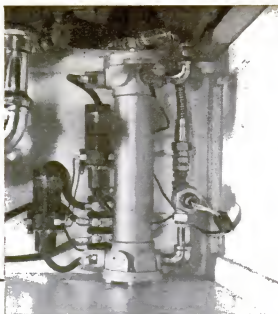
PARADIVER IN FULL GEAR and ready for anything on land, sea, or in the air. He is carrying on his back—and front—roughly 150 pounds of equipment. And he can still smile!



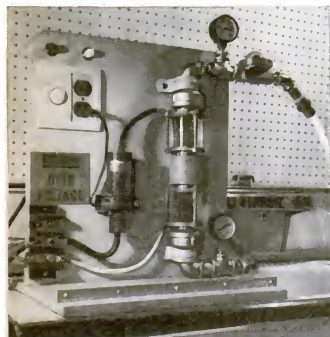
and (3) freeing their canopies before the billowing nylon sails them over the horizon. Now they're ready to go down hundreds of feet beneath the surface, if necessary, to tackle their underwater job.



DUMMY SPACE CAPSULE—a steel mockup of the one used by Mercury astronauts—is here used by the par divers as a rescue problem in their training program. Big inflated collar they have just fastened around the capsule was adapted from a standard GI 20-man lift raft.



ENTIRE HOT-WATER SYSTEM—including pushbutton controls—is contained in this unit. Model demonstrates manual-lever faucet while turning on automatic drain.



LABORATORY TEST MODEL has glass sections to show 9" ribbon of carbonized cloth heating water as it flows up tube at 2 gallons per min. Water enters at 50 degrees (lower gauge) and reaches nozzle at 110 degrees. Varying rate of flow raises or lowers the temperature.

New electronic boiler gives an inexhaustible supply—without a tank. The secret: hot cloth

RIGHT away, you notice something peculiar. Only one water pipe feeds the sink. There are no faucet valves on the rim of the basin—only a few pushbuttons mounted on the splash panel.

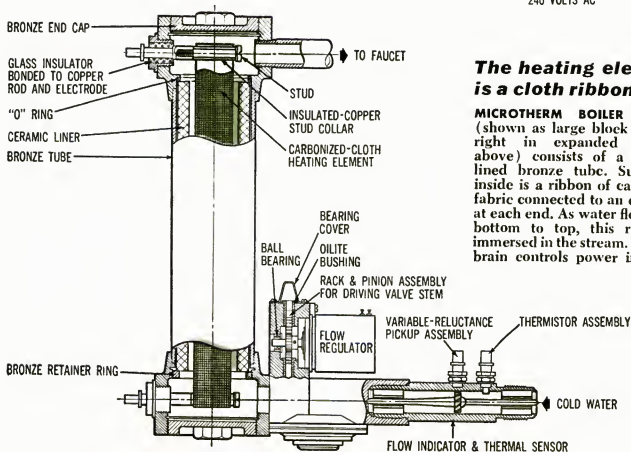
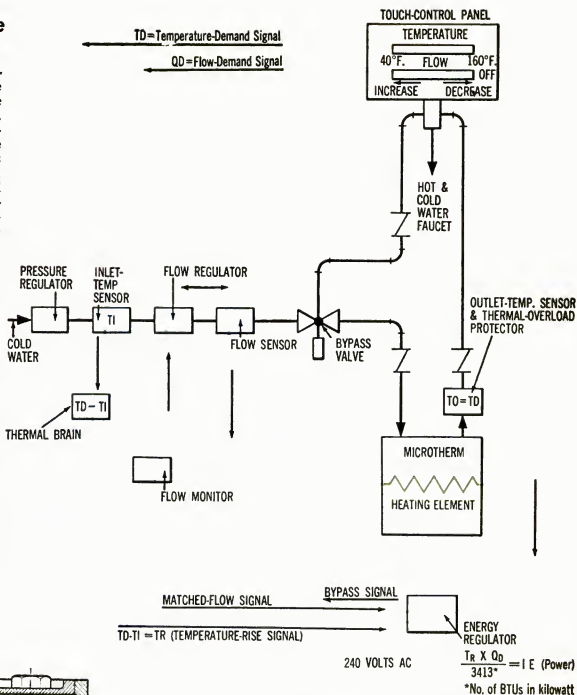
Touch the buttons marked "Hot" and "Flow" and steaming water gushes forth. (The rate of flow depends on how many times you tap.) Touch a different combination and the stream runs cold.

All from one pipe? Sceptically, you slide back the cabinet door to see who's playing tricks. Inside, next to the drain trap, is an upright, foot-long bronze tube. Though it's supplied by only a standard cold-water line, this tube sends forth an instantaneous and limitless supply of water at any temperature you specify. The

CONTINUED

Here's the route the water takes

UNIT'S FLOW and temperature demands are automatically set at the touch panel (top right). A thermal brain subtracts the temperature of the water as it enters the house (left) from the temperature desired at the faucet, to determine how much increase is needed. The brain then computes the amount of electrical energy required to heat water at that flow to the desired temperature. This signal is transmitted to the energy regulator (bottom), where gating and phase shifting supply the proper amount to the heating element. Feedback circuits throughout the system monitor the commands and make necessary adjustments in flow rate and energy supplied. One loop stops electrical input if water fails to flow. A thermal overload loop shuts off the power, should the energy regulator not function. When cold water is desired, bypass valve (center) simply cuts out the detour through the boiler.



The heating element is a cloth ribbon

MICROTHERM BOILER at left (shown as large block at lower right in expanded diagram above) consists of a ceramic-lined bronze tube. Suspended inside is a ribbon of carbonized fabric connected to an electrode at each end. As water flows from bottom to top, this ribbon is immersed in the stream. Thermal brain controls power input.

unit is Microtherm—an electronic water heater that could revolutionize residential plumbing.

Suspended within the tube's ceramic core is a remarkable new heating element—carbonized cloth. It's a fabric woven from organic fibers and baked at 5,400 degrees. Though the carbon atoms left behind are arranged in the crystal form characteristic of graphite, the tensile strength of these fibers is a hundred times greater than that of ordinary graphite. When immersed in water, the cloth can release over 1,000 watts per square inch—and it is chemically resistant to liming.

Carbonized cloth, a product of missile research, was developed by National Carbon as reinforcing for plastics exposed to hot, erosive rocket gases. When it became commercially available two years ago, it solved the problem that had stymied the Thermotronics Corp. in its efforts to create a small electronic water heater.

How to please all the people. Any domestic hot-water system must cater to a wide range of preference in temperature and flow. One man's cozy bath is another man's lobster pot—or still another's glacial lake. Some like to shower at a mild flow of a gallon or so per minute, while others prefer to step under a cataract. In creating a unit that would heat water instantly, Thermotronics Corp. had to devise a means of integrating these two factors. At the same time, they wanted to keep the unit so compact that it could be located at the fixture—if possible, right in the sink cabinet.

The purpose of this was to avoid the heat losses involved in long pipe runs. A 90-foot run of $\frac{3}{4}$ " pipe holds $2\frac{1}{2}$ gallons. If that trapped water were at 115 degrees when you stopped the flow, an hour later, when you reopened the faucet, it would have cooled to a tepid, useless 70. In a 12-hour period, where cycling may occur at least 10 times, such a run

would waste 25 gallons of hot water—about a quarter of a small family's daily requirement. And even after you'd drained away this water in order to draw a fresh, hot supply from the tank, the new water would lose heat to the cold pipe. If it's traveling at a rate of $2\frac{1}{2}$ gallons a minute, it's likely to lose more than 8 percent of its heat during that 90-foot run.

The advantage, then, of placing the hot-water supply near the outlet is obvious. But few kitchens or bathrooms have space for a big storage tank. Besides, the tank itself is inefficient; maintaining a large, stand-by supply of hot water night and day is basically unsound. Whenever water is run from the average tank for more than five minutes, several hours are required to replenish the supply. And then it must be kept hot—for many hours perhaps—while it waits to be used.

The solution to all these problems is to dispense with storage

entirely, devising a compact unit that's able to heat water economically on its way to the faucet. Previous heaters have been capable of an electrical input of only 100 watts per square inch. The number of square inches required for instant heating of water would have made the heater too large.

Thermotronics, meet National Carbon. That was where carbonized cloth came in. It permits construction of a unit so compact that it will fit into any sink cabinet—and that weighs only 16 pounds. A new pilot model, shown above, is still smaller: The carbon ribbon is doubled back (putting both terminals at one end), and the energy regulator is now a tiny, solid-state-matter, silicon-controlled rectifier. It, and all other components, plug in so that repairs are as simple as replacing a radio tube.

The heaters are made in several amperages. You can install one 100-amp

[Continued on page 182]



MINIATURIZATION shrinks newer model to half size. Hand is holding electronic brain that translates signals from flow and temperature sensors to control current from the rectifier.

Switcher rides on or off rails

On rubber tires, the railroad trackmobile at right is a truck for use on the highways or in the yards. Retract them, and flanged wheels poking out at the sides in top photo fit on the tracks, as at lower right, where the vehicle runs sideways like a crab to switch or spot rail cars.

Its large, eight-ply, 7:50-by-17 tires can be driven over exposed tracks without damage. For rail travel, a hydraulic coupler transfers part of heavy freight-car weight to the wheels of the truck for better traction. The vehicle is manufactured by the Whiting Corp., of Harvey, Ill.



Its truck wheels down, the trackmobile hauls yard dummies.



Truck wheels up and riding sideways, it's a switch engine.



"Spacious small car," as it's advertised, seats four comfortably. It has 62-m.p.h. top speed.

New baby Citroen

The new Citroen AMI 6 is not much bigger than the homely 2CV, but there the resemblance ends. The tiny four-door has a sleek, low-drag body with reverse-sloping rear window like the Ford Anglia, sculptured sides, contour seats, and luxurious upholstery. Rectangular headlights give four-eye penetration and spread; extra-deep reflectors flatten and concentrate the beam. A flat-twin engine, displacing 36.6 cu. in. and developing 18 hp., drives the front wheels. All-independent suspension is much like the 2CV's. Gas economy of up to 42 m.p.g. is claimed.



Beetle-browed front sports wide headlights.

Camera Rides Balloon to Shoot 'Impossible' Pix




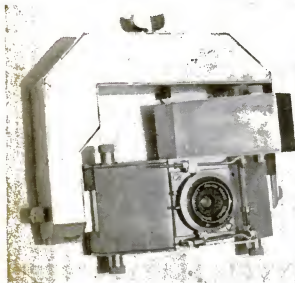
USING a 16-foot, hydrogen-filled balloon as a sky hook for his camera, Conrad Nockolds, an ex-Royal Air Force officer, has created a profitable commercial-photo business.

With his balloon tethered at 400 feet or lower, Nockolds shoots low-level aerial photos where planes and helicopters are not allowed to fly below 2,000 feet. His company, Aero Stills, Ltd., operates a fleet of six balloons stationed at strategic points around Britain.

One of his biggest assignments was photographing 25 chain-store units under construction, as a visual progress report for the executives. Nockolds photographs factories for company reports, country homes for real-estate agents, views from the

 **Miniature copy of World War II barrage balloon . . .**

. . . anchored by winch-cranking, shutter-clicking 
Conrad Nockolds . . .



. . . carries a remote-controlled camera like this . . .



. . . and takes low-level aerial photos

"windows" of planned skyscrapers to show to prospective tenants.

The U.N. Food and Agricultural Organization even hired his equipment for anti-locust research in the Sahara.

The camera, attached to a bicycle wheel suspended from the balloon, is pre-positioned for height, downward angle, and wind direction before it is sent up. A newer type now under test (close-up on facing page) is fully remote-controlled from the ground. Two tiny electric motors, running at 10,000 r.p.m., swivel and tilt the unit while a third one fires and resets the shutter and advances the film.

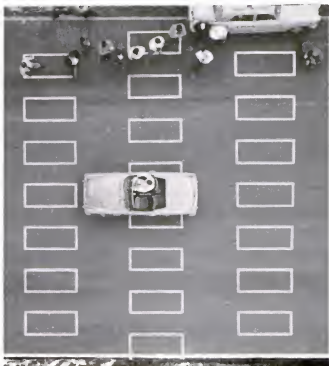
Nockolds anchors the balloon with his own weight. He reels it in and out with a simple, hand-cranked winch that carries 400 feet of steel cable marked off in 25-foot sections to indicate height.



ALUMINUM TRAILER, towed by panel truck, serves as a mobile hangar to transport the balloon to the assignment area.



CAMERA SUPPORT is a bike wheel with spokes removed and rim drilled to keep weight to minimum. Most photos are shot with wide-angle 80-deg. lens at $f/16$, $1/500$ sec., medium-fast film.



BIRD'S-EYE VIEW—a publicity shot of a Sunbeam Alpine on starting grid at a race track.



UNUSUAL LOOK AT LONDON. Camera is level with gilded cross on dome of St. Paul's Cathedral, 365 feet above the street. Thames River is in the background, and the newspaper area around Fleet Street is off to the right.

like these 



1. COPTER HOVERS 10 feet off ground while crew attaches ropes from 32-foot steeple.



2. STEEPLE ALOFT makes pass at tower frame. Third try nicks top, does no damage.



3. STILL FLYING BLIND, pilot successfully drops steeple in place on his fourth attempt.

Church steeple takes to the air

A 32-foot aluminum steeple flew heavenward to cap the framework spire on a new church in Clearwater, Fla. Lacking a crane with a high enough reach to do the job from the ground, the contractor called on a helicopter pilot for help. The pilot, flying blind when over his target, was

directed by spotters stationed on the church roof. After four passes, the steeple came down snugly over the wooden framework. Corner guide ropes were cut loose so the pilot could fly away.

"Cheaper and quicker than bringing in a crane," was the contractor's verdict.



Purring catfish dotes on petting

Felix the Catfish, a recent arrival at New York's Coney Island Aquarium, thinks he's a cat.

He must be stroked by a tankman (left) before he will eat, and insists on being hand fed. A gorgeously colored, rare South American specimen, Felix arches his back when his tank is approached and wiggles near the surface, itching to be scratched.



New English sports car

Making its debut in the U.S. is the GSM Delta, a brand-new fiber-glass-bodied two-seater sports car. It's equipped with a Ford Anglia engine that is available in three modifications, with horsepowers ranging from 61 to 86. A 103-m.p.h. top speed and 40-m.p.g. fuel consumption are claimed. The British roadster's basic price, \$2,767, includes soft top, removable hard top, and tonneau cover.



Two-story trailer

If you go on outings in style, you'll dig this new French trailer. It has an upstairs room for the maid. Called the Digue, the plush camper was introduced at an outdoor-living show in Paris.



As a kid he built this cycle car . . . and a weird bike run by jounces



THE amiable Dutchman shown beaming above should help counter any impression that Holland is the place where people do nothing but wear wooden shoes and grow tulips for a living.

His name is Dr. Hubert ("Hub") van

Doorne, and his career is a classic rags-to-riches story. It is also an account of how one creative mind has helped put his country on the technological map.

Born in 1900 in a poor home, Hub quit school at 10 when his blacksmith father died. He went to work in his father's

DAF-FY INVENTOR continued

forge in an effort to support his family. The smithy soon went broke, for young Hub didn't have the muscles to wield a hammer. He became an apprentice for a machinery manufacturer.

Hub's lifelong craze for wheels flowered in early boyhood. A homemade pedal car and a bicycle powered by jouncing were juvenile inventions. By the time he had reached his twenties, he was a self-taught

engineer and had climbed the company ladder to be plant manager.

In 1928 he joined with his brother Wim to found their own firm. They began with a handful of borrowed money and a tiny workshop in Eindhoven that soon grew into Van Doorne's Trailer Factory. Here Hub's unconventional ideas on couplings, wheel suspension, and braking systems mushroomed into reality.



Rocking-Beam Rear Axle

FOR quick conversion of civilian trucks to military six-wheelers, van Doorne designed this rocking-beam bogie in 1935. Crown gears splined to the half-shafts drove the tandem wheels through opposed pinions. The freely pivoted beams gave

good traction on rough ground. Adaptations included a Ford V-8 scout car (just above) and a six-wheeled armored car (top) in 1938. The latter used a driven front axle and no-chassis construction, advanced ideas for the time. The small idler wheels in front were to help roll the car up very steep banks.

Automatic Hitch and Winch

HITCH for truck-drawn artillery combines with a winch having an automatic cutoff. On hard climbs, the gun can be released, while the truck advances, and then winched in. This 1936 idea is still in widespread use today.



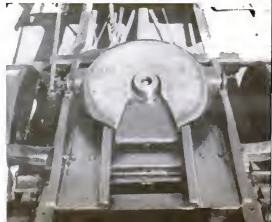
Odd-Ball Four-Wheel Truck Drive

UNUSUAL front-drive conversion for trucks put differential in middle with individual prop shafts to the wheels. Splines and U-joints took care of suspension and steering movements. Drive at wheel used pinion and crown gear. A 1938 idea.



Automatic Coupler for Semis

THIS 1935 coupler eased life for truckers. V-guides aligned pin as tractor backed. Air and electric lines were automatically connected by coaxial fittings. And the trailer undercarriage automatically tucked itself up.



During the late Thirties, when Holland was threatened by Nazi Germany, he turned his fertile mind to military inventions. Some were fanciful, some of real value. But because of the swiftness with which the German Blitzkrieg rolled over the Low Countries, few ever saw action.

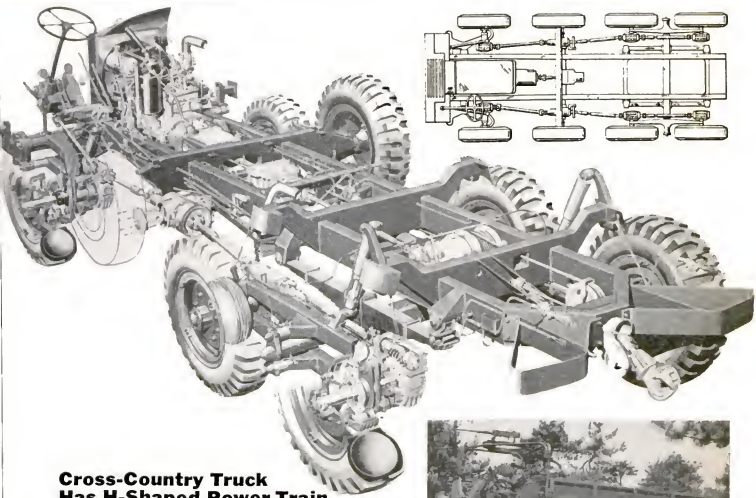
After the war, Van Doorne's resumed expansion. It grew by 1950 into the large DAF truck factory. In 1958 came the in-

roduction of the DAF car, with its trans-axle and its automatic transmission using variable-diameter pulleys. Hub was launched into the big-time auto business. His new plant, as spotless as a Dutch kitchen, is tooled with ultramodern equipment to turn out 200 of the small cars a day. Trucks, trailers, and airport tankers are also manufactured by the firm.—David Scott.



Swiveling Dual Wheels

REAR wheels on heavy DAF trailers could swivel to balance the load on uneven surfaces in this 1932 patent. An extra advantage: To change an inside flat, you just jacked the chassis and flopped the whole dual assembly over.



Cross-Country Truck Has H-Shaped Power Train

Now used by NATO forces in Europe, this military truck has six driven wheels. The spares, just behind front mudguards, are free to roll when the truck crests a bank, protecting transmission and preventing hang-ups. Power is transmitted by an unusual H-shaped shaft layout. It permits exceptional wheel deflection and



gives a whopping 16½-inch ground clearance, because of the absence of the conventional low-hanging differentials. Off-the-road ability is thus unusually good.



Tank-Trap Ice Slicer

THIS converted truck sliced tank traps in Holland's frozen waterways in 1939. Circular saws replaced wheels on the rear of rocking-beam bogies. Jack and cables forced saws downward, and a six-foot strip of ice was cut free as truck was driven forward. An amphibious vehicle followed to break up ice strip. On roads, jack tilted bogies so that saws cleared the ground. But ingenious device didn't help; the Germans conquered the country in days, after the ice had melted.



Jet Tanker Is Double Ellipse

THE compound-elliptical shape of this airport tanker is not just van Doorne whimsey. Problem was to provide 10,000-gallon capacity within a reasonable envelope. Vertical ellipse in back nested neatly between wheels. Horizontal ellipse in front fitted neatly over tractor turntable without excess height. High-speed refueling pumps were tucked within the tractor body.

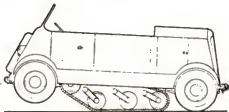
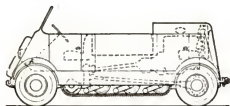
Tanker Booms Fuel Fighter

A PAIR of overhead booms speeds refueling of jet fighters in this van Doorne idea. Booms swivel for filling either fuselage or wing tanks at a rate of 750 gallons a minute. Introduced in 1949, this rig is used by some USAF units stationed at European bases.



Some van Doorne Ideas Proved Duds

THREE notions van Doorne admits were turkeys: Siamesed tanks, joined by a swiveling trunk (above), fizzled out on paper. So did scout car meant to convert to a half-track in rough going (below). Wire-failing, tethered helicopter to snare planes (right) was tested, but engineers feared it might kill more Dutchmen than Nazis.

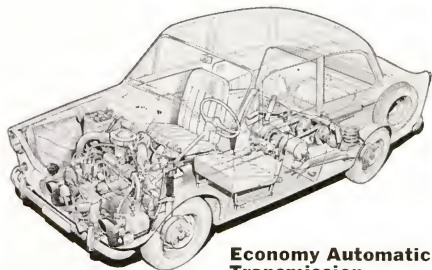




Push-Me-Pull-You Amphibian

THIS double-ended amphibian could do almost everything. A central engine drove all four wheels. Either set could

be steered when the other pair was locked straight. In the water, the doorless hull floated high. A three-bladed prop could be locked on a stub shaft and the steered wheels used as rudders.



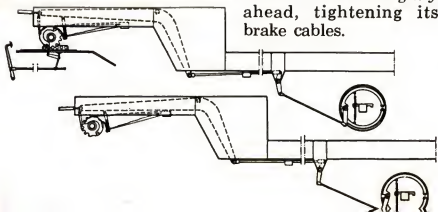
Economy Automatic Transmission

THE van Doorne invention best known in U.S. is the V-belt automatic drive in the DAF car. It uses pairs of variable-diameter pulleys. Effective diameters are controlled by a combination of springs, weights, and engine vacuum. The effect is of a continuously variable ratio between low and overdrive. Car has an air-cooled two-cylinder engine of 600-cc. displacement.

Early Hitch Gave Automatic Braking



BACK in 1932, before air brakes came in, van Doorne cooked up this semitrailer hitch. A rack on the tractor engaged a sector on the semi. When tractor brakes went on, the semi lurched slightly ahead, tightening its brake cables.



Pull-Out Power Plant

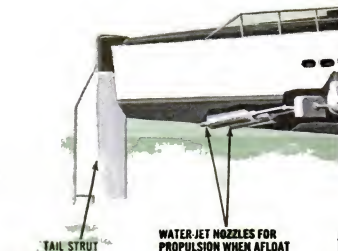
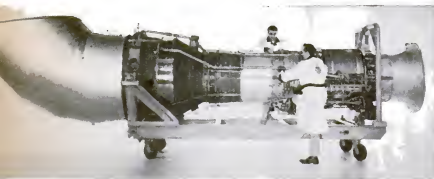
FLIP two clamping handles and the complete engine of this 1947 bus rolls out for servicing. No other preparation is necessary, since fuel and electrical lines are extendible and the drive train separates at a conical dog clutch. It's still in use.



Self-Loading Containers

THOUGH fairly new here, container trucks were built by van Doorne as early as 1936. An auxiliary frame could be power-tilted for loading or unloading. It could also be extended horizontally to reach flatcars or loading docks at plants. ■ ■

HS DENISON, 80-ton hydrofoil test ship, will skim ocean this summer at 60 knots. If fitted as passenger vessel, for coming trial in commercial service, she can carry 80 in airplane-type seats as in cutaway drawing at right.



The U. S. is launching

MIGHTY ENGINE of Denison, this 20,000-hp. gas turbine just completed for her by General Electric packs tremendous power in compact and lightweight 6,600-pound machine. Drive shaft will pierce big exhaust duct at left, as in drawing of ship.

By Alden P. Armagnac

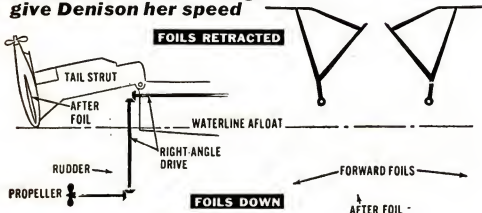
TWO new U. S. vessels with underwater wings may mark the greatest advance in marine design since steam replaced sail. The world's first hydrofoil ships designed for the high seas, they will inaugurate ocean travel at speeds up to 60 knots, or 70 m.p.h.

This summer will see the completion of

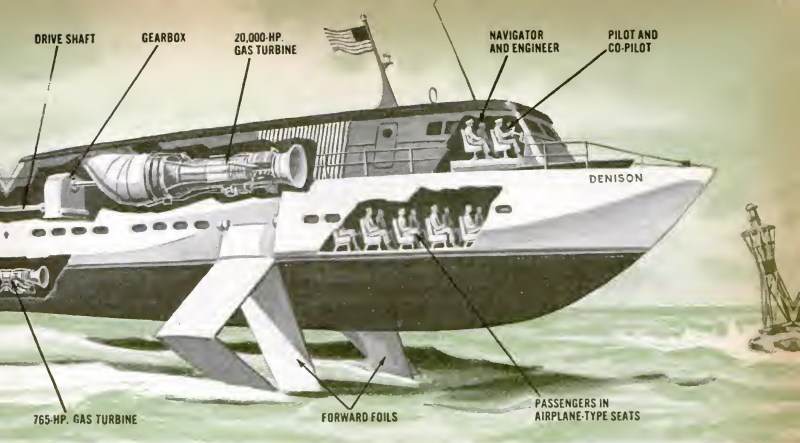
the HS (Hydrofoil Ship) Denison for the Maritime Administration at an Oyster Bay, N. Y., shipyard. Its 80-ton size ties the record for foillborne vessels, and it will be the first ocean-going one. And the keel has been laid for the biggest hydrofoil ever built—the seagoing 110-ton sub-chaser PC(H)-1, due to join the Navy next year.

Hydrofoil craft like these will bridge

These underwater "wings" will give Denison her speed



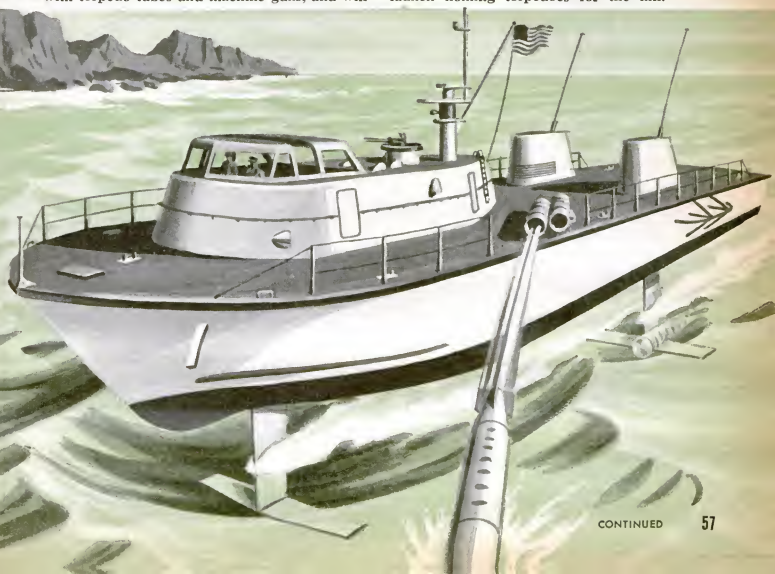
SHIP "FLIES" five feet above water on surface-piercing foils forward (left), and submerged foil aft (far left) attached to pod that also carries propeller. Automatic controls operate trailing flaps on forward foils, and vary inclination of tail foil, to check heaving, pitching, and rolling in heavy sea. For docking, retractable foils are raised from water, as shown.



the world's first ocean vessels to speed on underwater wings

NAVY'S PC(H)-1, 110-ton subchaser due for completion next year, will be its first hydrofoil fighting ship. Combat-ready craft will be armed with torpedo tubes and machine guns, and will

have latest in sub-detecting sonar gear. At foil-borne speed of 40 to 50 knots, it will dash to location of a detected enemy submarine, and launch homing torpedoes for the kill.



Early and modern hydrofoils in American waters



ONE OF FIRST successful hydrofoils, built by Alexander Graham Bell, had trout above in 1919. It bettered 70 m.p.h. and set a world speed record for all watercraft of its day.



TEARDROP-SHAPED Lantern, Dr. Vannevar Bush's submerged-foil craft of early Fifties, showed stability as passenger rode erect standing. Foil-control system was ahead of its time.



FLYING DUCK, foilborne amphibian vehicle with wheels, was tried out last year by U. S. Army. The 13-ton craft, with submerged foils and gas turbine, skims the water at 35 m.p.h.



FIRST PASSENGER HYDROFOIL in U. S., beginning operation this summer between Bellingham, Wash., and Victoria, B. C., is foreign-built Flying Fish—a 60-passenger, 27-ton vessel.

the gap between the speeds of today's ships and planes.

Slashing through the water, winglike foils beneath their hulls exert lift, as a plane's wings do in air—and raise the hull clear of the surface. So foilborne vessels, freed of most of the wave-making and frictional drag that limits ordinary ships' speed, can go twice as fast or more.

That speed can carry voyagers faster than by conventional ships, more economically than by plane. It can bring

perishable cargoes, like bananas from Central America, so quickly that costly refrigerating plants won't be needed. In warfare it can effect a swift amphibious landing, and can counter fast new submarines with still faster subkillers.

Abroad, hydrofoil boats ranging up to more than 50-ton size have carried hundreds of thousands of passengers over inland waters. America awaited its first hydrofoil service until only a few weeks ago—when a foreign-built vessel, the 27-

U. S. NAVY'S postwar hydrofoil program has produced series of novel craft. Largest so far, 15-ton Halobates, tested long-armed "feelers" at bow to control its submerged foils.

FASTEST HYDROFOIL of all, Navy's ladder-foiled XCH-4, hit 78 knots (90 m.p.h.). Two aircraft piston



ton, 60-passenger Flying Fish, was scheduled to begin 40-knot ferry runs between Bellingham, Wash., and Victoria, B. C. But now the U. S., which never built any large hydrofoil vessels before, has suddenly leaptfrogged into world leadership in their development.

Recent American breakthroughs are responsible: new-shaped propellers for high speed, tremendously powerful and lightweight gas turbines to whirl them, electronic foil-control systems to defy ocean waves. Our big new foilborne ships will be showcases of these advances.

A gleaming white ship, blue-striped along her water line, the Denison will "fly" five feet above the sea. Well within her range of 855 nautical miles at top 60-knot speed, a New York-Bermuda run is expected to be one of her first trials.

Built by Grumman Aircraft Engineering Corp. and its affiliate, Dynamic Developments, Inc., the \$5,000,000 Denison will serve the Maritime Administration as a test ship—a working model to try out plans for projected hydrofoil ocean liners of 500 to 1,000 tons.

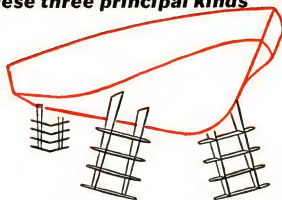
For practical trials, MarAd will put the Denison in actual commercial service early next year. If used as a passenger ship, she will accommodate about 80 in airplane-type seats below deck.

By far the world's most powerful hydrofoil vessel, the funnel-less Denison will be driven by a gas turbine rated at up to 20,000 hp.—more than propels a conventional Mariner-type merchantman of 22,600 tons. Through an over-the-stern drive, the mighty engine spins a 36-inch propeller developing 25,000 pounds of thrust, virtually as much as a satellite-launching rocket.

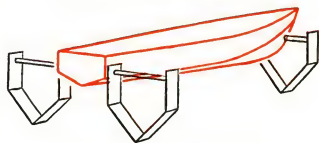
The Denison flies on three foils—two forward ones, piercing the surface, and a submerged foil aft.

Secret of her seagoing ability is a newly developed foil-control system, per-

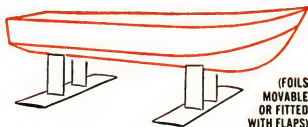
Hydrofoil craft "fly" on foils of these three principal kinds



Surface-piercing: ladder type



Surface-piercing: V or U type



Submerged (with movable elements)

fect in sea trials of a 17-foot model of the Denison. For near-level flight over waves, the automatic controls actuate lift-regulating flaps on the forward foils to check heaving or rolling. They vary the inclination of the after foil to counteract pitching.

Flaps hinged to each side of the tail strut form the Denison's novel rudder. Opening either flap steers her that way. She turns in 1,000-foot radius.

In port she lifts her retractable foils above the surface—and propels herself

[\[Continued on page 187\]](#)

engines, totaling 1,260 hp., drove air propellers of this 8-ton, 54-foot craft designed by William Carl.

MOST ADVANCED despite small size, Navy's gas-turbine-driven XCH-6 has propeller and foils of new "supercavitating" design—a recent breakthrough in research toward higher speed.





RECTANGULAR steering wheel saves kneecaps and gives short drivers better visibility. Grab-

bing air when turning it is a habit that's quickly overcome. Its small size gives better handling.

Survival Car Lets You Walk Away from Crash

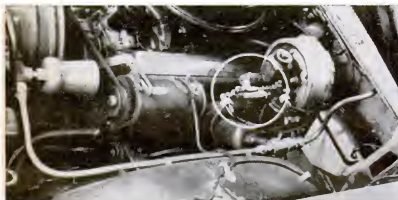
IF SPECIAL packaging prevents damage to fragile goods during shipping, why not package more precious cargo—people—in a similar way to practically eliminate traffic deaths and injuries?

The knotty problem of how to do it was tackled eight years ago by the Liberty Mutual Insurance Co. Accidents were painstakingly reconstructed, statistics were analyzed, and a "survival car" began to shape up. The result, recently completed, is a modified 1960 Chevrolet in which, the designers say, it's almost

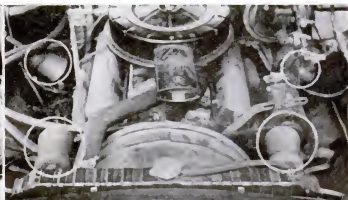
impossible for riders to be hurt seriously.

Accident files disclosed that the major safety consideration is keeping driver and passengers in their seats during a collision. The worst injuries were found to result from being thrown against the windshield, dashboard, steering wheel and column, or out the door. To remedy these hazards, the "survival car" has:

- Oversize bucket seats, seat belts, and shoulder harnesses.
- A laminated windshield with a double-weight filler for greater penetration



IN-THE-LINE BRAKE DEVICE (circle) is a tee-shaped cut-off that closes up either front- or rear-wheel sections of the brake system if a line ruptures, thus retaining brake fluid and allowing two-wheel braking. Made by the Alex Mfg. Corp., Jamaica, N. Y., the device connects master cylinder to front and rear brake lines.



ENGINE-COMPARTMENT FIRE is automatically smothered by a CO₂ bomb set off by Kidde fire-protection system. Four circles mark gas nozzles. In case of the system's failure, manual dash control releases the gas.



WEBBED STRAPS behind rear-seat passengers' heads prevent whiplash injury, and armrest stops sliding during a lateral collision. Belts and harnesses give added protection.



PADDED HEADREST atop front seat will hold the head under a 5,000-pound blow from a rear-end crash, but it never touches the head during normal driving. Tubular roll bar within pad prevents car roof from crushing occupant in case of a rollover.



CAPSULE CHAIRS swivel 360 degrees for easy entry and exit. The flick of a single buckle latch instantaneously releases the lightweight lap belt and both shoulder straps.

resistance; the windshield keeps out 95 percent of ultraviolet rays as well.

- A collapsible steering column to prevent chest injuries and a small, rectangular steering wheel to protect the driver's kneecaps.

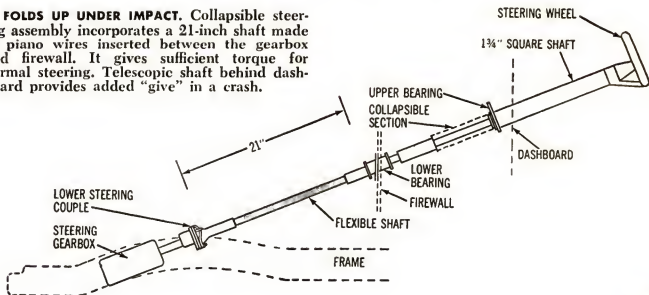
- Headrests to prevent whiplash neck and spine injuries in a rear-end crash.

The car takes care of three blood-chillers, too. Should one of the hydraulic brake lines fail, an automatic piston device cuts off the line to provide two-wheel brake operation. A fire-extinguishing sys-

tem in the engine compartment is triggered by abnormal temperature increase. A no-dozing device keeps drivers awake by periodically flashing a red light and, if not switched off, blowing the horn. If still ignored, it turns off the ignition.

The car has been road-tested for 5,000 "extremely comfortable" miles. But what's more important is the firm belief of its engineers that these few modifications in your own stock car would allow you to walk away from a 40-m.p.h. head-on collision.—*Alex Markovich.*

IT FOLDS UP UNDER IMPACT. Collapsible steering assembly incorporates a 21-inch shaft made of piano wires inserted between the gearbox and firewall. It gives sufficient torque for normal steering. Telescopic shaft behind dashboard provides added "give" in a crash.



Minuteman

Our Ace in the Hole

The first solid-fuel intercontinental rocket, as ready as a rifle bullet, goes on guard next year, to stand at alert in blastproof silos

By Wesley S. Griswold

ON THE morning of last February 1st, a day of historic significance, a tall, slim missile that looked like a huge rifle bullet leaped from its pad at Cape Canaveral and roared southeastward.

"There goes the missile gap!" shouted a rocket engineer.

Minuteman, our first solid-fuel ICBM, was off to a perfect start. Compared to Atlas or Titan, which lift off the pad like a fat man getting out of an easy chair, Minuteman shot up like a skyrocket. Its booster roared from ignition to full 170,000-pound thrust in a quarter of a second.

The flight was a socko success. All three stages of the 58-foot missile worked precisely. In less than 20 minutes, the nose cone plunked its dummy half-megaton warhead straight into the target area, 4,600 miles downrange. This wasn't as far as it will go—6,300 miles—when Minuteman is ready to fight, but it was as far as it was supposed to go.

Minuteman's initial flight was extraordinary for three reasons:

- Solid fuel, which looks like dirty-gray eraser material and bounces, but makes an ICBM a pushbutton weapon, had given its most dazzling demonstration of efficiency to date. Minuteman's booster, 24 feet long and 5½ feet in diameter, is the biggest solid-fuel engine ever built.

- A major missile, for the first time, had made its debut with all its parts present. Always before, the first launch was only a partial trial. But Minuteman had behaved so well in its incubator—making 8 tethered hops out of a hole at Edwards Air Force Base—that 10 scheduled preliminary tests were canceled. This meant a juicy saving of \$10,000,000 and a big hunk of development time. When the missile first thundered into the air, it was a full-fledged bird, under the control of its own self-contained guidance system.

- Most significantly, Minuteman had proved to be such a star performer that the Air Force was able to schedule it for the firing line in defense of the nation by July 1962, a year earlier than anyone had dared hope.

Holes in the hills. The firing line will consist of as many as 150 holes in the ground in northwestern Montana. The holes will be 85 feet deep and 12 feet in diameter, walled with reinforced concrete. They will spread over three big counties, perforating a 115-square-mile expanse of wheatland and hills. By 1965, there are to be 600 of them, scattered about Montana, southwestern South Dakota, and possibly



The big rocket rides to its silo in a supertruck

A 275-hp. V-12 engine powers this transporter, 63 feet long and nearly 10 feet wide. At its secret hole in the ground, truck erects its huge body and gently lowers the rocket. Both cab and body are air-conditioned.



New Hampshire, depending on Congressional appropriations.

Each hole will be centered in a two-acre circle, fenced and guarded by electronic sensors, and capped with a ground-flush, 80-ton sliding door of reinforced concrete. At a signal, an explosive charge in a gas generator will shove this door aside on tracks.

Beneath the massive hard hats, Minutemen will stand at the ready, in air-conditioned comfort, for a command that may never have to be given. The rockets can stand without deteriorating for "several years." Air conditioning and humidity control are requisites of life for the moisture-sensitive solid-fuel ICBM. The necessary environmental controls, plus ground checkout equipment and an emergency power system, will be lodged in a narrow, two-story chamber girdling each silo.

One-second takeoff. Each missile will stand inside a steel liner, resting on a ring-shaped steel platform 22 feet tall. The plate on which it rests will take the full 6,000-degree blast of fire and gas from Minuteman's booster. Tests have shown that the missile's bellows won't shake it perilously in the instant that it is confined in the hole.

For every 10 missiles, comprising a flight, there is to be an underground control center. It will be a domed, circular room, shock-mounted to protect its vital equipment and personnel from the earth-cracking smash of an H-bomb hit above.

Buried cables will link control centers and silos in the first three Minutemen squadrons. But this is a gold-plated way to communicate. Future squadrons will use buried radio networks. Transmitted signals will travel up to the earth's surface, across it, and down to receivers.

The command to fire. Elaborate precautions will make certain that no Minuteman can be launched unless the Strategic Air Command orders it. A code word from SAC headquarters in Omaha, changed daily, will be the command. Two or more control centers must get the word, and compare notes, before either can launch a missile. Moreover, two men in each center must make parallel moves at twin consoles before any Minuteman can take off. Nobody will man the missile silos. Each Minuteman's digital computer will make that unnecessary.

Checkout by computer. Periodically it will check up on the Minuteman's readiness for flight, like a man feeling to make sure his shirt is buttoned, and report to the silo's ground-checkout equipment. This, in turn, will signal the missile's control center.

If the computer finds anything wrong, it will report the area of trouble. Then a repair crew can be sent to the site by truck or helicopter to pinpoint the fault. No major repairs will be made there, however. If such are needed, orders will go out to yank the ailing missile and put in a fresh one.

Work cage lets men attend a bird on alert



Suspended from a circular monorail, work cages can be lowered into the silos to permit technicians to make minor adjustments. But if the automatic checkout circuits report that rocket needs major work, it will be plucked out and replaced with a functioning one.

The solid-fuel ICBM is so much simpler than its liquid-fuel predecessors, and so thoroughly tended by electronic aids, that it can almost get along without people. A squadron of 500 Air Force men can handle 55 Minutemen, whereas it takes 600 to look after only 9 of the Atlas liquid-fueled intercontinental missiles.

Installed by supertruck. The tricky job of placing each 66,000-pound Minuteman in its hole (or lifting it out again if necessary) has called into being a wonderful truck, the transporter-erector.

Its role is to carry the missile from the nearest assembly point to its silo and lower it in launch position. For this task, it has a 275-horsepower, V-12 engine, a range of 500 miles on its 120 gallons of gasoline, a top speed of 40 miles an hour. It can climb 17-percent grades, and has a 50-ton hoist, weighing less than 2,000 pounds.

The truck consists of a four-axle tractor and a three-axle trailer. The missile container, 63 feet long and built of aluminum and magnesium, lies across tractor and trailer like a recumbent grain elevator. It forms the only connection between the two halves of the truck, except for an umbilical cord of electrical and hydraulic lines, contained in a metal raceway bolted to the bottom of the container. When the truck reaches its destination, this raceway is unbolted while the container is erected.

The 12-wheel tractor has tandem steerable axles. Its cab, only 6 feet high but nearly 10 feet wide, straddles the nose of the engine. In fact, the engine, well insulated and soundproofed, fills most of the cab.

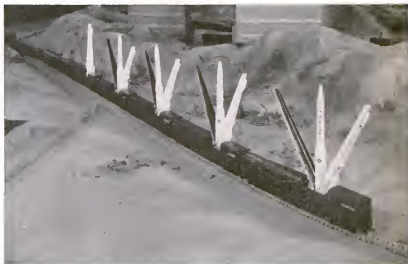
Keeping a missile cozy. A Cadillac air-conditioner keeps the cab comfortable and at the same time makes sure that the container has a temperature that suits the missile (60-100 degrees). In cold weather, an auxiliary heater keeps the missile cozy and free of condensation.

The forward end of the container, where the hoist is located, is tapered to clear the cab and provide the driver with an adequate upward view. A signal board of colored lights hangs from its tip, facing the cab. This keeps the driver informed of environmental conditions in the container, and warns him if the missile is getting too much road shock. This is unlikely, because

Missile trains, free to roam the rails, are a counterpunch



Traveling rails to secret destinations, or just orbiting on irregular courses, Minuteman trains will be likely to survive even the most devastating sneak attack. A "strongback" will protect rocket in travel, open up before launch.



[Continued on page 184]



Delivery by air gun

Ira Bearden has built a business out of putting circulars on the doorsteps of homes in Houston, Tex.—at the rate of 8,000 a day. He rolls them into pointed tubes, has an assistant on the back seat fire them from a double-barreled carbon dioxide gun with a barrel out each side. Even when fired on the move, they can hit a target up to 80 feet away. Raising or lowering the windows adjusts elevation.



Thumper sounds for oil

A 6,000-pound slab of battleship plate drops nine feet from the rig on the truck above to give the earth a resounding wallop. Resultant shock waves are picked up on seismic instruments by a crew nearby, and the data is used for mapping the area geologically in hunting oil. The method is cheaper and faster than underground dynamite charges. The dangling ropes warn onlookers away.



Mini-car for Vespa

Best known as a scooter manufacturer, Vespa of Augsburg, West Germany, has added a tiny car, the 400, to its line. Its two-cylinder, two-cycle, 13-hp. engine does 55 m.p.h. and squeezes 50 miles from a gallon of gas. The four-wheeler is 112 inches long and seats two adults and two children. The right seat is hinged to conceal the spare. The car has hydraulic brakes and a 12-volt system.

Blowtorch insulation



This "blanket" is so impervious to heat that it will keep a blowtorch from burning your hand. Thermosorb contains 90 percent water in material resembling cellulose felt. It was developed by Chance Vought space scientists, who say that it boils so slowly that an alcohol flame reduces thickness only $\frac{1}{8}$ inch in 20 minutes. It's used for insulation in space re-entry vehicles, between rocket nozzles and instruments, and in more earthly firewalls and protective clothing.

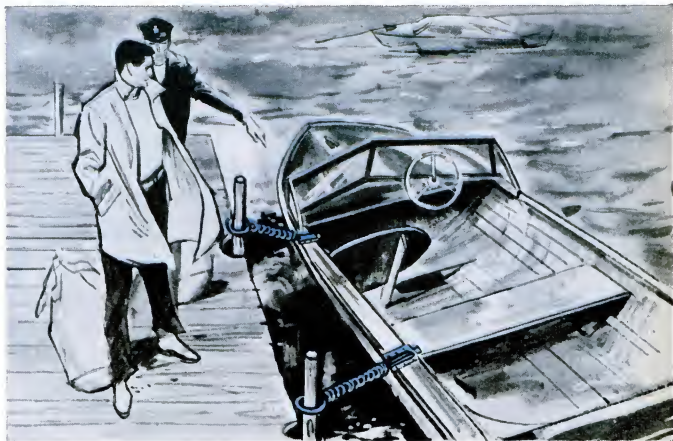


Fan-driven mosquito boat

An aircraft motor drives this boat (shown here on a trailer)—one of several used by New Jersey mosquito exterminators to spray breeding grounds in marshes and the swampy Jersey Meadows. The boat navigates in two inches of water. The prop, being topside, doesn't foul in underwater vegetation. Insecticide can be sprayed from nozzles at the sides or introduced in the slipstream.

New Ideas from the Inventors

.....



Flexible Hitch Moors Boat. A spring with a ring at one end and a screw-down bracket at the other might simplify docking and launching while allowing a boat

to ride with winds and tides. This recently patented hitch would moor a boat to a free-standing anchor post; a pair would keep a boat from banging a dock.

Rod Radio Keeps Angler Posted. A fisherman could listen to music, news, or weather reports on this radio without disturbing other fishermen—or fish. A compact receiver and batteries would fit into the handle and play through an ear-phone; signals would be picked up by the rod, which forms a natural whip antenna.

Bracket Holds Spectacles. An eyeglass wearer wouldn't have to perch his specs on the edge of a basin before washing his face if he had a wall fixture like the one below to keep them safe, dry, and smudgefree. In a home bathroom, the bracket could be styled to match the soap dish and toothbrush holder.



More Inventors' Ideas



Carton Keeps Drinks Cold. Your picnic preparations might be simplified if beverages were sold in leakproof carry-cartons like these. Cardboard spacers and a tray-handle insert in each carton would keep cans or bottles from rattling; they'd also leave space for ice cubes, which you'd put in before leaving home.

Sprinkler Sprays Lawn Corners. Instead of watering only the center circle of a lawn, this sprinkler would reach for the corners. As water pressure rotated the



Pillow Bag Forms Sunshade. This combination beach bag would protect a girl's complexion from the sun and her hair-do from the sand. Cushioned to serve as a headrest, the bag would have a zippered pocket for towels and other swimming accessories. The fanlike handle would open out, as shown above, into a sunshade.

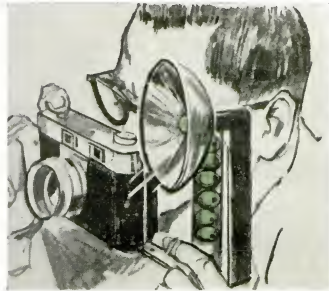
spray head, cams would intermittently restrict the flow. By alternately increasing and diminishing pressure, they'd square the spray pattern to fit your lawn.





Polish Pads Keep Fingers Clean. You could clean your shoes without dirtying your hands if polish came beaded, like this, on a roll of tear-off applicator pads. A hard wax would be used so it wouldn't smear until you applied pressure. The inventor suggests that a polishing cloth be tied around the roll.

Strip Feeds Flash Bulbs Faster. You'd miss out on fewer pictures if you could reload a flash gun by advancing a new bulb out of a magazine. The bulbs would be made in a continuous strip; wire contacts extending from each shell would bear against clips in the gun, connecting to the battery and camera shutter. Without bases, they'd cost less, too.

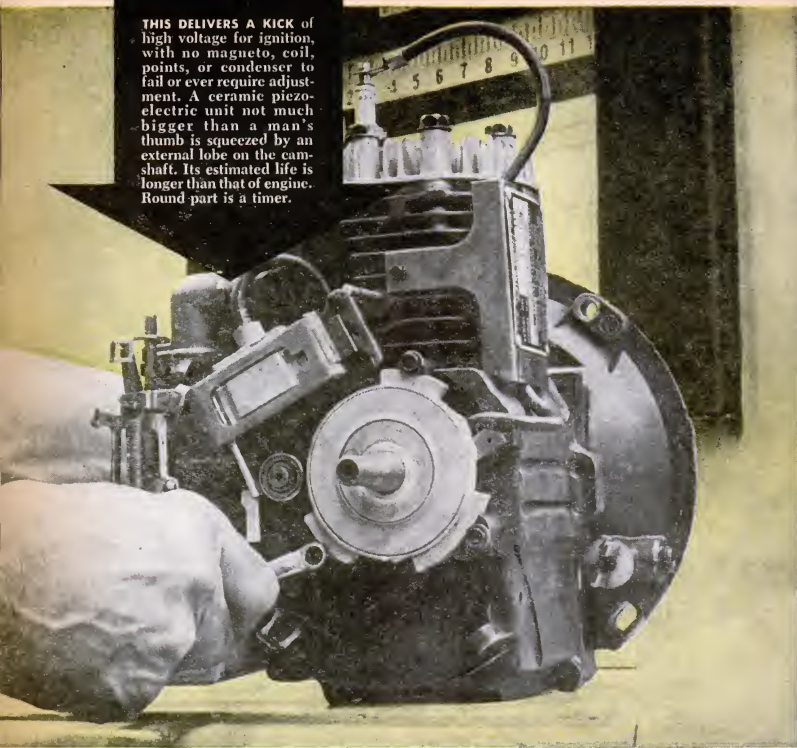


Soda Machine Refunds Deposit. You'd have to leave a few cents extra for the bottle when you bought soda out of this dispenser. But you'd get the deposit back when you popped the empty bottle down a chute. Sensing "fingers" would make sure it was the right kind, and unbroken.

The following patents have been issued on these inventions:
 Boat hitch—No. 2,912,953 to H. Olsen, Alpena, Mich.;
 Rod radio—No. 2,927,995 to J. Francis, Weirton, W. Va.;
 Bracket—No. 2,884,220 to M. Monley, NYC;
 Carrier—No. 2,844,299 to D. Kessler, Cincinnati, and T. Hauj, Milwaukee;
 Beach bag—No. 2,932,833 to K. Fombach, Philadelphia;
 Sprinkler—No. 2,839,064 to S. Nelson, Fredericksburg, Va.;
 Polisher—No. 2,839,774 to R. Rond, Minneapolis;
 Flash bulb—No. 2,844,018 to M. Schwartz and W. Castedello, Plainville, Conn.;
 Soda machine—No. 2,954,111 to B. Garrard, Atlanta, Ga.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each. To write to an inventor, if the address given above is insufficient, you may address him (by name and patent number) in care of the Commissioner of Patents.

THIS DELIVERS A KICK of high voltage for ignition, with no magneto, coil, points, or condenser to fail or ever require adjustment. A ceramic piezoelectric unit not much bigger than a man's thumb is squeezed by an external lobe on the camshaft. Its estimated life is longer than that of engine. Round part is a timer.



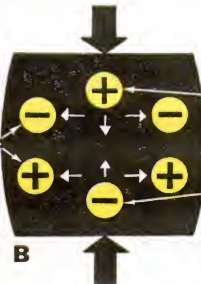
How pressure on a crystal can generate electric charges

IONS
UNIFORMLY
SPACED
CRYSTAL
ELECTRICALLY
NEUTRAL



A

OUTWARD
MOVEMENTS
OF UNLIKE
IONS
CREATE NO
VOLTAGE



OPPOSITE
MOVEMENTS
OF UNLIKE
IONS
GENERATE
CHARGES
ON TOP AND
BOTTOM

B

No coil, no points, no condenser:

Spark Pump Fires Engine

By Robert Gannon

BEHIND a factory fence in Cleveland, 36 one-lung engines have been roaring night and day for months. They're the same kind you see on lawn mowers, with one big difference: Among the whole lot there is not a single magneto, coil, point, or condenser.

Inside the Clevite Corporation's test lab nearby, a six-cylinder Chevrolet engine runs day after day. It has no standard ignition parts except spark plugs.

What fires these engines? A tiny ceramic cylinder little larger than a cigarette filter is squeezed by a cam. This instantly produces a 20,000-volt potential—enough to hop a half-inch air gap with ease. The ceramic isn't delicate; tests indicate it will outlast small engines five to one or more.

Connected through nothing more than a simple timer, this piezoelectric spark (piezo from the Greek for "press") will blast a spark across any but the most befouled plug. Cranking speed has little to do with the voltage produced. A one-lunger with this kind of spark generator (Clevite calls it a Spark Pump) will start with a minimum of yanking. It won't be

prone to kickback, or balk if cold or wet.

Such engines with optional spark-pump ignition (\$12 extra) have been marketed in test areas in the South and West for some time. Clinton Engines Corp., Clinton, Mich., is selling them, at ratings of 2¾ to 6 hp., all over the country. Other manufacturers will probably join the switch to piezo ignition next year.

Typical of engineering enthusiasm is this statement by Clinton's Martin Glenday, a magneto engineer for 15 years,



SQUEEZING A LEVER rigged to work this piezoelectric spark pump creates a half-inch flash of electricity. The ceramic is compressed only slightly—1½ thousandths of an inch.

Piezoelectric crystals have an orderly arrangement of atoms somewhat like that shown at A at the left, with half the atoms having a positive and half having a negative charge.

Because there is an equal number of the two kinds of charged atoms, or ions, the structure is electrically neutral and the ions are uniformly spaced.

Apply sudden pressure on opposite faces as at B, and the ions at right and left are driven outward toward the side faces. But movements of opposite charges in the same direction cancel out, leaving these faces still electrically neutral.

A different situation exists between the top and bottom ions. Downward movement of the positive one creates an electric cur-

rent downward. Upward movement of the negative ion—a reverse movement of an opposite charge—also generates a downward current.

The two add up; one face becomes negative (has an excess of electrons) and the other positive (with a deficiency of electrons). Connect them through a circuit, and the excess will rush to supply the deficiency, doing the work.

Nothing is used up; the next squeeze pumps electrons around again. The effect is momentary, a burst of current when the squeeze is on, a brief reverse flow when pressure is relieved. Steady pressure produces no electricity, but trip-hammer blows or intermittent squeezes generate alternating current.

with three patents to his credit: "When I first got involved with piezo ignition, I decided to hang up my hat as far as magneto engineering is concerned. Conventional ignition systems are doomed. Piezoelectricity will eventually replace them—and not only in single-cylinder engines."

Your car engine, too? Right now, auto-research labs are testing piezo systems. One company working with Clevite predicts an operational one for cars within two years. Clevite engineers say that's optimistic.

But eventually a car owner may forget all about defective coils; open or shorted condensers; maladjusted, burned, or pitted points. Cold-weather starts won't be hampered because ignition juice has to come from the same half-dead battery that drags around a chilled engine.

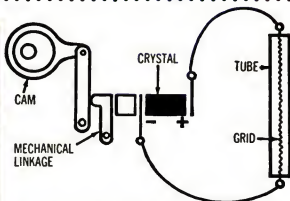
At high engine speeds, coil ignition falls off because there isn't time between

spark demands for the coil's magnetic field to build up to full strength. Crystal spark generators have no such time lag; they'll deliver as hot a jolt as at lower speeds.

But engineers must still decide whether to use a single ceramic for a multi-cylinder engine (with a distributor to apportion the spark), or a separate spark generator for each cylinder. This would also require a third cam for each, and raises the question of how—if you have a gang of generators (or two for a V-8)—to manage the prickly problem of automatic spark advance.

Already a grandpappy. Electricity from crystals was known 80 years ago. Pierre Curie (of the famous radium family) found that when he squeezed quartz a voltage was generated across the crystal. But it was only momentary, and except for lab purposes as useless as a

[Continued on page 174]



NEW SPEEDOMETER has a cam driven from the transmission. This nudges a piezo ceramic wired to a neonlike tube on the dash. Light glides along a grid in the tube in proportion to current, which varies as the square of the frequency of squeezes. Tube is calibrated in miles per hour.

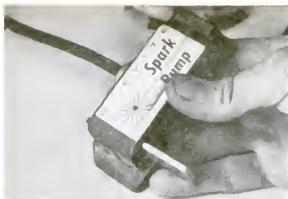
Coming: piezoelectric speedometers, scales, and strobe lights

As you tool along the highway, a traveling glow in a glass tube shows the speed of your car—though nothing moves behind the dash. Home again, you shower, step on a scale—and read your weight on a dial on the wall before you. These are two new piezoelectric devices, developed by the Jerome Murray Corp. of New York.

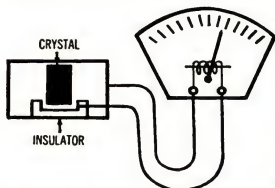
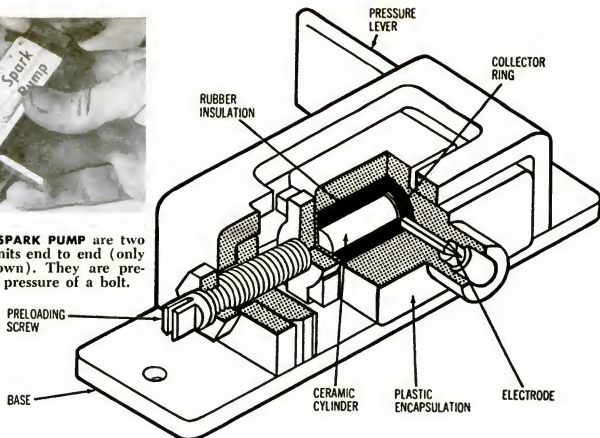
Jerome Murray is a tall, sharp-eyed professional inventor to whom a speedometer manufacturer brought a problem: The Tempest's road-jounced transaxle

gave cable-driven speedometers the fidgets, making them inaccurate. Could Murray design a speedometer immune to this trouble?

Recalling that piezo units were used in missile acceleration recorders, and aware that the current from a spool of PZT varies with the square of the frequency at which it is squeezed, Murray took off from there. He replaced speedometer takeoff gears with a simple cam. This squeezes a PZT ceramic connected to a neonlike tube on the instrument



INSIDE A SPARK PUMP are two ceramic units end to end (only one is shown). They are preloaded by pressure of a bolt.



SPRINGLESS SCALE has no levers and is very accurate. Stepping on it compresses a piezo ceramic, but meter responds only to return pulse of opposite polarity as load comes to rest. Voltmeter is calibrated in pounds. Needle holds the reading until the user presses a button on the case.



panel. The higher the road speed, the greater the current—and the longer a line of light, in the tube.

A piezoelectric scale with no springs or levers shows weight on a voltmeter with high accuracy.

Also on the docket at the Murray plant is a new, cheaper electrostatic air filter. The present ones use a transformer, rectifier, and capacitors to charge the screens. Murray's will do it with a cam on the fan shaft to keep bumping a piezo crystal that generates 15,000 volts.

His pocket photo strobe stores current in a condenser when you squeeze a

ceramic crystal three times with a hand lever. It explodes into light with an energy of 200 watt seconds, weighs about six ounces, and may sell at an amazingly low price—about \$15.

An old hand at inventing, Murray dreamed up a wind-driven electric generator as a boy. A manufacturer spotting it coined money making such generators. Murray still smarts from that.

He got even, in part, by devising the rain switch that raises a convertible's top when the clouds get drizzly. Murray sold that idea, for real money, to General Motors.—*Devon Francis.*

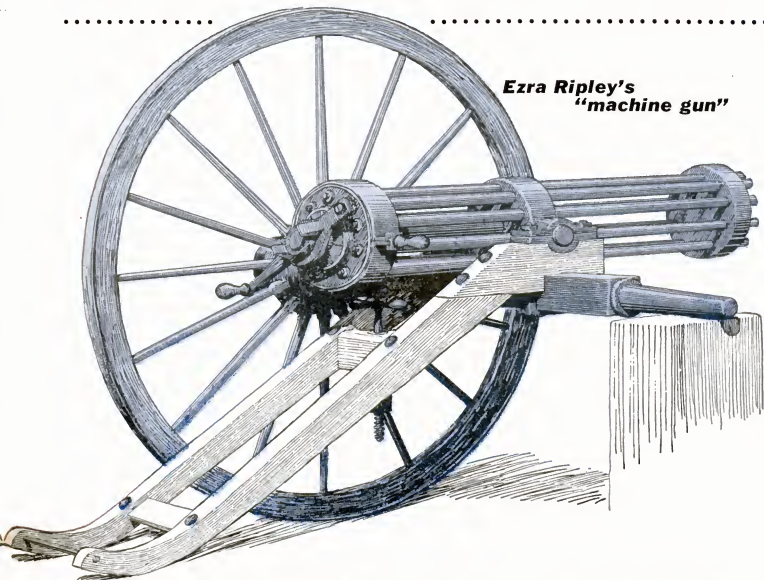
Text and drawings by **Edwin Tunis** Author of *Weapons: A Pictorial History*

PEOPLE casually call these weapons machine guns. They certainly were the forebears of the Lewis and the Browning, but a true machine gun is automatic—hold its trigger and it will shoot itself out of ammunition, using its own

power to load, fire, and eject. No Civil War gun did that. They all operated by the power of a man's arm—usually turning a crank.

Only a breechloader is practical for continuous firing. It might be thought,

**Ezra Ripley's
"machine gun"**



A GUN WITH NINE FIXED BARRELS arranged cylindrically was patented by Ezra Ripley of Troy, N. Y., in 1861. A drum-shaped breechblock locked into place behind the barrels. It, too, stood still. This block was bored with nine chambers, each aligned with a barrel, each preloaded with a regulation .58-caliber paper cartridge, and each primed in advance with a percussion cap fitted to a cone on the back face of the block. Around this face a crank moved an arm carrying a spring-loaded firing pin. A cam cocked the pin and tripped it at the right points to fire each barrel in succession. The explosions took place in the breech-

block and not in the gun barrels themselves.

After nine shots, the gunner slid the whole firing assembly back a few inches, snatched out the empty breechblock, threw in a fresh one—and thus, in a few seconds, was ready for nine more shots. Since the crank wouldn't turn until it had locked the breechblock in place, accidental firing with the breech open was impossible. The gun was light and nearly foolproof. But when the Chief of Ordnance delivered his stony refusal, Ezra took his plans and injured feelings home to Troy. Probably he never built a working model, but others put his ideas to good use.

Guns *Third in a series of articles on the arms used in the War Between the States a century ago*

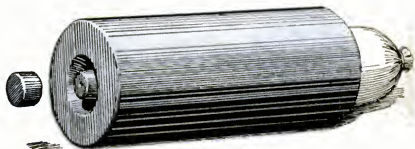
too, that a metal cartridge rigid enough for easy mechanical handling would also be necessary for quick fire. But inventors found ways to use cartridges of paper, linen, and pig intestines, impregnating them with saltpeter to make them burn up completely inside the barrel of the gun.

Hundreds of ideas for quick-firing mechanisms failed dismally. Sir Henry Bessemer, who also blasted iron into steel, built a "self-acting" gun in 1854. Its operator had to get up steam on a boiler before he could shoot, but Sir Henry made the gun's recoil action open the steam valve, anticipating Hiram

Union Repeating Rifle, known as the Coffee Mill



WILSON AGER invented the Union Repeating Rifle, which no one ever called anything but the Coffee Mill. It used regulation .58-caliber paper ammunition loaded into hollow steel chargers that also served as breechblocks and explosion chambers. These cylinders, loaded and primed, were fed down and to the right by gravity from a baffled hopper mounted above and behind the breech. Centered below the breech was a revolving carrier. Fundamentally it was drum-shaped, though six concave troughs, cut into it lengthwise, left only narrow strips of the original surface of the drum. As each trough moved toward the top position it accepted a charger, which it carried down to line up with the gun barrel. At that point, rotation was mechanically interrupted for the instant it took a cam to wedge the charger forward against the breech and release a striker to hit the priming cap. After firing, the cam at once relaxed its pressure, permitting the carrier to move the empty charger out of the way of the next round. The used charger fell out of its trough, rolled down a chute,



Charger and its percussion cap

and dropped into a box. It was about as simple as it could be.

The rate of fire was geared down to 120 rounds a minute because of the way the Coffee Mill's barrel heated up: In continuous fire, it sometimes dripped melted lead from its muzzle. Ager cooled later models with fans and housings, and provided quick-change spare barrels. But wedging the chargers against the breech never made a gas-tight seal, and the Coffee Mills, especially the sloppily built early ones, tended to spit fireworks at that point. Nevertheless they were effective guns up to a thousand yards.

Early model of the Gatling Gun

RICHARD GATLING built a good gun. It owed something to the Barnes and Ripley guns as well as to the Coffee Mill, but it also owed much to Dr. Gatling. Its first version, which is illustrated here, used a hopper and steel

chargers like the Coffee Mill's to fire regulation paper cartridges. The Gatling hopper delivered its chargers from the left side to six carriers, each of which was part of the bolt of one barrel. The crank rotated bolts

Maxim by 30 years. Another Englishman, Thomas E. Linden, foreshadowed the Browning machine gun by 40 years with a blowback piston to open the chamber and load. Unfortunately, his gunner had to cock the gun by hand and fit a percussion cap onto each round. This procedure slowed the rate of fire somewhat.

The Union Army could have had a practical quick-firing gun from the very beginning of the war if it had taken the trouble to make tests of either of two guns offered it.

Cranking out the shots. As far back as 1856, C. E. Barnes of Lowell, Mass., had patented a crank-operated quick-firing cannon of small caliber. He made cartridges of linen, stiffened for ready handling, and fed them to the gun by gravity from a tray to the left of the barrel. Turning the crank opened the breech, mechanically placed a cap on a priming cone, loaded the cartridge, closed the breech with a toggle arrangement much like that of the later Henry rifle, and released a spring-loaded piston to fire the round. The linen burned completely in the chamber, so there was no ejection problem. Blowback through the

hole in the priming cone recocked the Barnes gun.

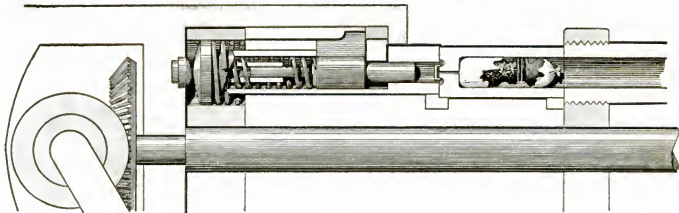
Its rate of fire? How fast could a man turn a crank? No soldier ever had a chance to find out.

Ezra Ripley's gun, patented five years after Barnes's, is pictured and described on the first page of this article.

Flintlocks and the Coffee Mill. Barnes and Ripley were ingenious mechanics but they would "take no for an answer" and they went down before that master no-sayer, General James W. Ripley, the Army's Chief of Ordnance (no kin of the gun inventor as far as is known). Back in the 1840s General Winfield Scott, furiously sure that the Army's new percussion cap was worthless, equipped a regiment with Revolutionary flintlocks at his own expense. James Ripley would have understood. When President Lincoln urged consideration of the Union Repeating Gun, which he nicknamed the "Coffee Mill," the General seemed not to hear him. Abraham Lincoln then personally ordered 10 of the guns and ultimately bought 60.

This was the first quick-firing gun used in combat. The occasion was a minor scrimmage at Middleburg, Va., on March

One bolt of the 1862 Gatling at the point of firing



and barrels together around a central shaft. As they moved from station to station each bolt performed a different operation: It accepted a charger from the hopper, cocked its striker by hitting a fixed cam on the front wall of the casing, pressed its charger forward against the breech by means of a cam on the rear wall, slipped off the front cam to release the striker and fire the cap, relaxed the squeeze on the charger, and, ejecting it down a chute on the left side, moved into position for the next round.

The first Gatling was subject to the usual gas-leakage trouble. The Doctor's effort to

overcome it with a wedge interfered with smooth operation and quickly wore out parts. He had the good sense to quit trying and change over at once to a firing pin and a copper-cased rimfire cartridge. This sealed the breech tight by expanding, when it was fired, to press its case hard against the wall of the chamber. The change required the addition of a mechanism to shove the cartridge into the breech and to pull its case out again after the gun fired. Dr. Gatling continued improvements after the war. With a motor and 10 barrels he eventually achieved an astonishing rate of fire—3,000 rounds a minute.

29, 1862. A witness reported a single Coffee Mill cutting cavalry to pieces at 800 yards. But Colonel John W. Geary, who officered the Union side of the scrap, decided the gun was inefficient and dangerous to operate. The Colonel returned his two grinders to the Army Ordnance Department.

It's true that the first Coffee Mills were badly made and leaked a lot of hot gas; it's true that one of them made war even more hellish for General Sherman by nipping a sliver of lead sideways into his leg; and it's true that the Coffee Mill acquired a bad name that it doesn't seem to have deserved. The overheating of its single barrel, which troubled the experts, was largely due to excessively long bursts fired by inexperienced soldiers, mostly raw recruits.

Actually, war wasn't ready for rapid fire. Nobody knew how to use it. Most of the Coffee Mills ended up guarding covered bridges.

The famous Gatling. When Richard Jordan Gatling, M. D., brought forth his famous quick-firing gun (most of its fame is post-Civil War) he told Lincoln that this was no Coffee Mill—but it *was* in some features. General Ripley, of course,

refused to consider it, but other officers liked it. Its multiple barrels never overheated, since each fired only one shot in six.

Gatling was a promoter. After Ripley turned him down, he hired civilians to demonstrate his gun in actual combat, where ranking line officers could see it operate. He sold Ben Butler 12 Gatlings, which the General took to Petersburg in 1864, mounting 10 of them on gunboats and two on standard carriages. The whole dozen of these revolving guns vanished and nobody has ever found out what happened to them.

Dr. Gatling worked against heavy resistance—the Army held well-founded suspicions of his loyalty to the Union. He was raised in North Carolina and was an active member of the secret Order of American Knights, devoted to the sabotage of the Northern war effort. It was believed that he started making his guns at Cincinnati because it was a good spot from which to sell both North and South, or to stage a convenient Rebel raid on the factory.

These surmises can't be proved, of course, because the plant burned down before it produced many of the guns. ■■

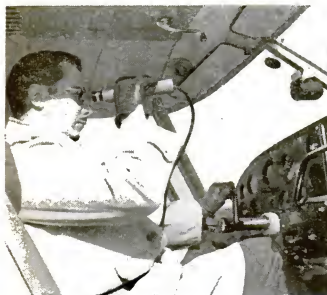
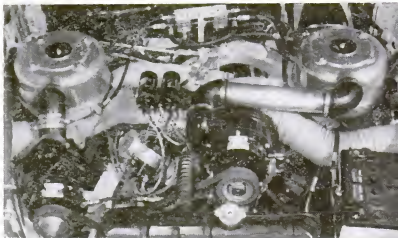


AFTER RECORD RUN for the flying mile, Granatelli grins beside his 300F. Hornlike projections replacing two headlights duct air to the superchargers.

EACH BLOWER (below) delivers 17 pounds' boost and runs on a separate belt. Matched manifold and head ports, hot camshaft contribute to 120-percent power increase.

Chrysler 300F sets speed record

World's fastest fully equipped sedan, Anthony Granatelli's 1960 Chrysler 300F blasted through the Daytona Beach flying mile at 179.472 m.p.h. Stock-displacement engine develops a mighty 813 hp., thanks to two Paxton superchargers and other modifications. The 5,600-pound car is docile enough to be used daily for commuting.



Midget small-plane radar

A miniature radar and viewing screen have been built into a 20-ounce telescope case for pilots of private aircraft and small boats. The screen is a .6-inch cathode-ray tube enlarged 10 times through a magnifying eyepiece.

Westinghouse designed the Private Eye so its separate transceiver could be located in another part of the ship for best weight distribution.



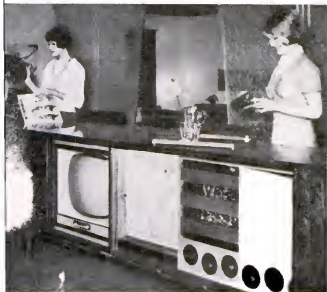
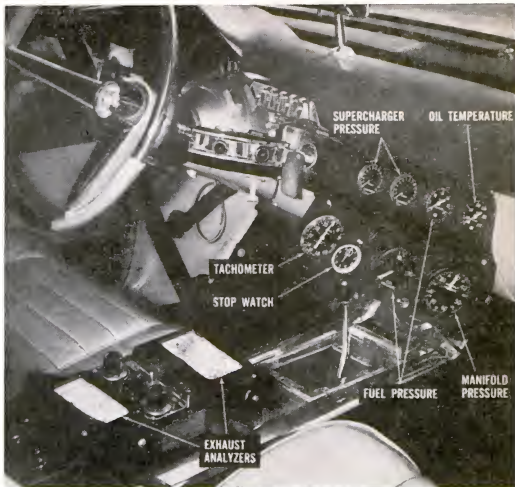
Lumber supermarket

Carts that hold lumber, plywood panels, and other building supplies enable customers to carry purchases to checkout counters at a shopping center in Mayfield Heights, near Cleveland. Other departments in the 100-by-330-foot Forest City Material Co. branch sell paint, hardware, power tools, plumbing supplies, and housewares. Shoppers in them use regulation supermarket carts.



MOVIE CAMERA securely mounted to roll bar (above) accurately records readings of 10 instruments and allows the driver to keep his eyes on the race course.

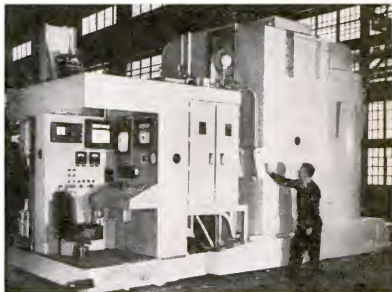
ACCESSORY PANELS (right) keep Granatelli informed of everything going on under the hood. Rare fourspeed gearbox mates to heavy-duty clutch.



Music and Martinis

Stereo hi-fi, two speakers, a 21-inch television set, a tape recorder, cocktail bar, refrigerator, and drink locker are all contained in this 14-foot mahogany cabinet. The piece was exhibited at this year's furniture show in London's Earls Court.

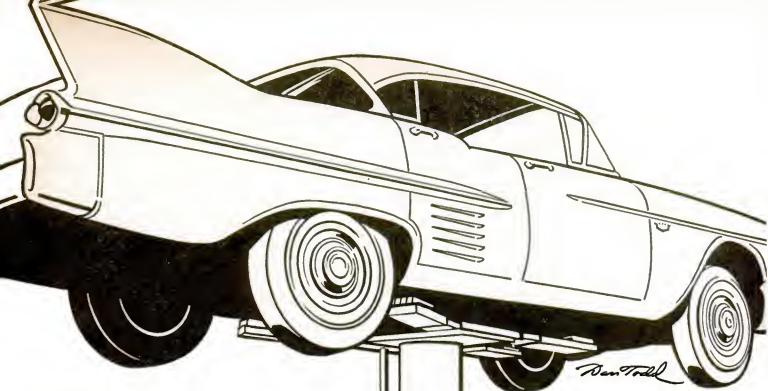
Feel like a party? You can have it for a mere \$4,500.



Fuel truck for atomic plant

A \$700,000 self-propelled 200-ton vehicle carries radioactive fuel elements to and from the reactor at the Enrico Fermi atomic power plant nearing completion near Detroit.

Riding on rails, it stops over a trap door covering the underfloor fuel chamber, removes spent elements, and reloads by remote control operated from a panel in the "cab." Waste is stored in a shielded compartment for disposal. The "transfer cas! car" was built by Baldwin-Lima-Hamilton.

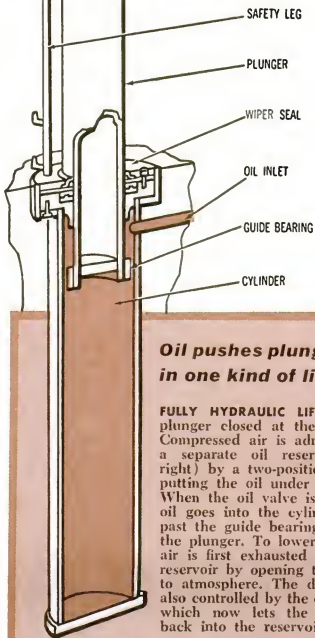


How a Hydraulic Car Lift Works

IT'S electricity, acting through air or oil, that raises your car for repair or lubrication. The supporting column of a car lift is an elongated piston, or plunger, working in an equally long cylinder set in the ground.

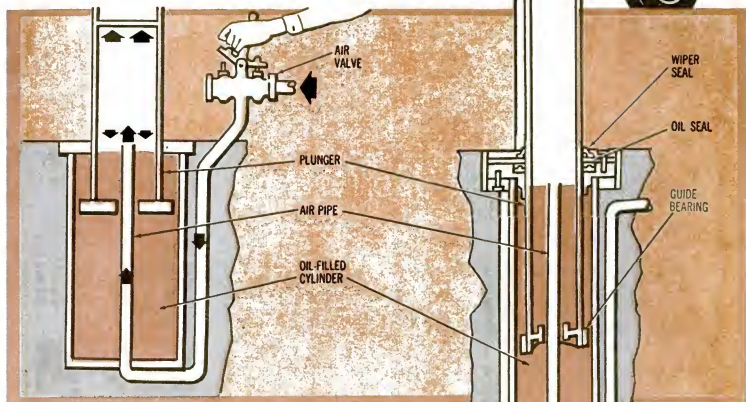
At its lower end, the plunger has a bearing that rides the cylinder wall to keep the column from wobbling under an off-center load. At the top of the cylinder, a wiper seal leaves only a thin film of oil on the rising plunger, and keeps out water and dirt.

The fully hydraulic system at right affords very precise control but requires a separate reservoir and two valves. The more common semi-hydraulic system at the far right uses a standing oil supply to seal in working air. As air is compressible, this type coasts slightly after the valve is shut. Both kinds shown, as well as mechanical lifts, are made by the Globe Hoist Company, Philadelphia.

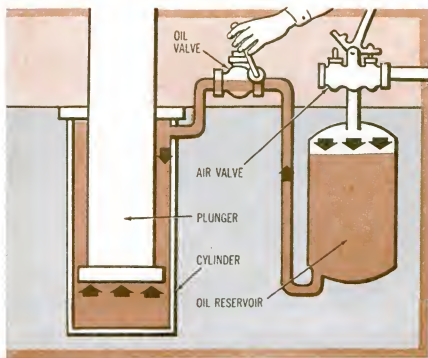


Oil pushes plunger up in one kind of lift

FULLY HYDRAULIC LIFT has a plunger closed at the bottom. Compressed air is admitted to a separate oil reservoir (at right) by a two-position valve, putting the oil under pressure. When the oil valve is opened, oil goes into the cylinder and past the guide bearing, raising the plunger. To lower the car, air is first exhausted from the reservoir by opening the valve to atmosphere. The descent is also controlled by the oil valve, which now lets the oil flow back into the reservoir.



Air bears on oil cushion in semi-hydraulic lift



AN AIR PIPE runs through the bottom of the plunger up to the top of the cylinder in this type of lift. Oil flows freely into the plunger and between its outer wall and the cylinder proper. An air valve is the only control. When it is held open to admit air from the compressor line, pressure builds up between the closed upper end of the plunger and the oil beneath, raising the plunger. When the air is shut off, the plunger is held at that height. To lower it, the valve is opened on the side to the atmosphere, letting the air in the plunger bleed off slowly.

Raising the roof to lower it

Why move a two-story house through city streets with lots of overhead wires when you want a ranch house on the new site anyway? By slicing it in two, a Three Rivers, Mich., man hauled this one over an easier route and had what he wanted when he got there.

A Wellsaw with a 16-inch blade separated the two stories in 30 minutes. Double studs at corners were left intact to support the roof until twin cranes could lift it off. Waste was trimmed and the halves joined at the new site.



1. SAW POKES NOSE THROUGH, near one corner (circle). Its wielder is inside second story.



3. CRANES MOVE FORWARD and lower attic and roof section onto body of flatbed trailer.



4. UNROOFED FIRST FLOOR, with part of second story also gone, is moved in conventional way.



Folded container bolts to floor of plane cabin.



Opened, each box fits into space of three seats.

Collapsible cargo hold

There's no waste space on Pan American's ocean-hopping jets. If no passengers occupy the rear seats on a flight,

close to 500 pounds of letters and small packages go aboard instead. The seats are removed and the mail rides in boxes bolted in their place. The boxes, of aluminum and fiber-glass, fold for storage.



2. TWIN CRANES lift off roof. Chains secured to beams passed through wall holes held it.



5. NOW A BUNGALOW, with second-floor waste trimmed off, house rests on new foundation.



Logs get a lift

This aerial tramway brings out heavy logs from otherwise inaccessible areas in British Columbia.

The four-ton carriage, run by a 100-hp. diesel engine, rides on a two-inch steel cable. Its operation is controlled from the ground by radio.

Camera captures unknown ape

This is Ufiti (African for ghost), just a six-foot-tall tale until recently. She was first seen by road workers on the edge of Nyasaland's forest—1,000 miles from the haunts of known anthropoids. She is believed to be a type of chimpanzee, but her face is flatter and darker, and she has the power of a gorilla. Her ears are rounded and her long feet, with four toes and "thumb," more human than chimp.

Experts hope to penetrate deeper into the rain forest to find out if there is a group of the apes and perhaps other unidentified animals.



The Man Who Pinned Wings on the Navy

Just 50 years ago, naval aviation was born—fathered by Glenn Curtiss, inspired mechanic, inventor, and U. S. pilot No. 1

By Gardner Soule

THE man at the controls of the plane pictured at right will be much in the news this summer.

His name—Glenn Hammond Curtiss—was on the No. 1 air-pilot license issued by the U.S. He died 31 years ago. Why is he making headlines in 1961? Partly on account of the unique plane he's shown in—but mainly because he was the father of naval aviation.

Naval aviation is 50 years old this year, and the U.S. Navy is staging a handsome array of celebration events.

The plane that Curtiss is maneuvering in the photo was the U.S. Navy's No. A-1, the first airplane the Navy ever owned, the first of the hundreds of thousands that were to influence the course of two world wars and to spread Navy wings over the globe.

The photo was made in July, 1911, exactly 50 years ago, a few days before



A Hunger for Speed Curtiss was born at Hammondsport, in New York's Finger Lakes country, on May 21, 1878. A dominant theme of his life appeared early: He loved speed. He made a skate-sail to turn himself into a one-boy ice boat on frozen Lake Keuka. He also liked to tinker. Out of a cigar box, he made a camera; with spools, nails, tin, and wire, a telegraph set.



Glenn Powers a Bicycle One day Curtiss met a man pedaling a bike uphill. "Glenn," he said, "I'm going to give the thing up until they get something to push it." A few small gasoline engines were appearing. Curtiss contrived one for a bike. The carburetor was a tomato can. Going to the post office the motor wouldn't start; he pedaled. Coming back, it worked.



Curtiss, who had built the A-1, delivered his craft to the Navy.

The A-1, also called the Triad, was the first plane to be at home in the air, on the water (she's on Lake Keuka, New York, here), and on land. Notice the landing wheels tucked under the wings.

The man next to Curtiss will also receive attention this year. He is Lieutenant T. G. (Spuds) Ellyson, USN, who flew with Curtiss to become the first naval observer in the air and also, tu-

tored by Curtiss, naval aviator No. 1.

To help celebrate, the Institute of Aeronautical Science is building, with the Navy's assistance, two replicas of the A-1. One will fly at the convention of the Institute at San Diego, Calif., in August.

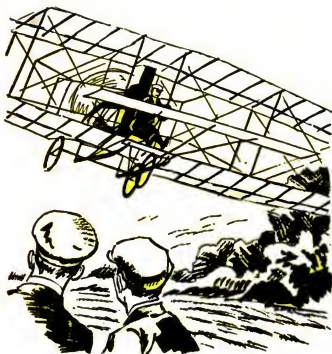
The life of Glenn Curtiss, how he pinned wings on the Navy, and what happened to him afterwards are depicted in the drawings that follow here and on the next two pages.



He Takes to the Air Townsfolk in Hammondsport chipped in so Curtiss, in his 20s, could build a motorcycle factory. Curtiss always demonstrated his own products: He won races, hill climbs. Thomas S. Baldwin, frustrated because he had no engines for his dirigibles, bought some from Curtiss. With no training, Curtiss went up alone in a dirigible and landed it—his first trip aloft.



Fastest Human Curtiss built a 40-hp., 8-cylinder engine for a dirigible, decided to try it on a monster motorcycle with an auto tire on the rear wheel. At Ormond Beach, Fla., on January 24, 1907, he opened it up over a two-mile run, whizzed over a mile course at 137 m.p.h. Record was not official; engine was "too big" for a motorcycle. But Curtiss was now the "fastest man on earth."



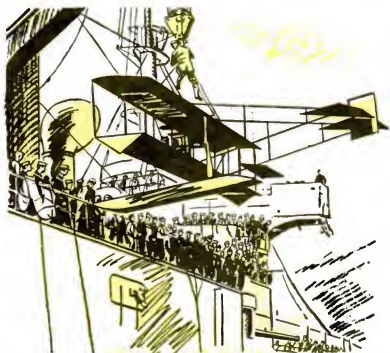
His First Plane Trip Alexander Graham Bell, who had invented the telephone, thought that heavier-than-air craft might fly from Boston to New York. He had Curtiss add engines to gliderlike planes made of wire, cotton cloth, and sticks. On May 22, 1908, in the White Wing, Curtiss first went up in a plane: "I flew 1,017 feet in 19 seconds, and landed without damage in a plowed field."



First Try at Seaplane Most early planes landed and took off on runners (not wheels). Crackups were common. Curtiss added a tricycle landing gear. But he had another idea: Why not take off and land on water? To a plane named the Loon, he added canoe-like pontoons. "We made many attempts to rise from the water," he said. But the Loon could never taxi fast enough.



First Hydroplane At San Diego, Curtiss struggled to develop a plane that would rise from and land on water. Fabre of France had taken off, but he'd cracked up on landing. Curtiss tried 50 changes in shape and position of pontoons. On Jan. 26, 1911, while taxiing, he found himself racing for shore. He jerked the stick, took off, landed. His helpers turned handsprings for joy.



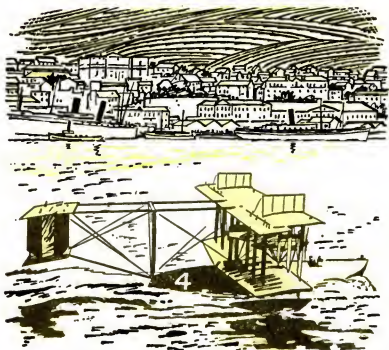
Navy Gets Air Arm The Secretary of the Navy had told Curtiss he'd be interested in a plane that could alight on water and be hoisted aboard a ship. On Feb. 17, 1911, Curtiss flew across San Diego bay, landed beside the U.S.S. Pennsylvania, and was lifted aboard by ship's crane. A few minutes later, plane was lowered and he took off. Payoff: The Navy ordered Curtiss planes.



Fastest Aloft First International Aviation meet was at Rheims, France, in 1909. Curtiss hurried together a plane with a 50-hp. engine. He had no chance to try it out, got it to Rheims packed in boxes as hand baggage. He flew 20 kilometers at 46.5 m.p.h., beating Bleriot (who had just flown the English channel), won Gordon Bennett trophy, was hailed as "fastest man on earth and skies."



He Scrounges Gasoline The *New York World* offered \$10,000 for the first flight between Albany and New York—152 miles. On May 30, 1910, Curtiss started down Hudson River in a plane with wheels plus pontoon—in case of forced river landing. He set down en route and borrowed gas from a motorist, then flew on to New York, making first U.S. intercity flight.



Over the Ocean On May 8, 1919, Curtiss watched from the beach at Roekaway Point, N.Y., as three four-engine flying boats, the NC-1, 3, and 4 (NC stood for Navy-Curtiss) took off to try hopping the Atlantic. The 1 and 3 were forced down at sea, unable to continue flight. NC-4 landed at the Azores, flew on to Lisbon. An airplane had flown across an ocean for the first time.



Wings for the Navy In May, 1930, 20 years to the day after his Albany-New York flight, Glenn H. Curtiss piloted a 20-passenger Curtiss-Wright plane over the same route. At three a.m. July 23, 1930, he died peacefully. He was buried in his home town of Hammondsport. Had he lived till today, reaching 83, he would have seen Navy wings routinely fly over every ocean. ■



Summer Living Room in Garage

You can convert your garage into a summer-weather playroom by hanging this fiber-glass screen in the door opening. The Reel Screen rolls up like a window shade to let guests in or out. It is sealed against insects at the sides by

close-fitting slides that zip shut, at the bottom by a vinyl cushion that conforms to the contour of the apron. Four sizes, 8 to 16 feet wide, \$49.50 to \$99.50. Barberton Aluminum Specialties, 324 Wooster Rd. N., Barberton, Ohio.



TRIM TABS are adjustable planes hinged to a boat's stern. They're controlled by switches on the instrument panel, operating reversible motors and screw jacks. The tabs trim laterally as well as longitudinally, level a boat even with all passengers on one side. Maker claims fuel savings plus 10 percent increased speed. \$240 to \$340. Bennett Marine, 14845 Plymouth Rd., Detroit.



POWER BLOCK PLANE does all scrub-to-fit jobs easier and faster than nonpower tools. You hold it in one hand and make repeated passes until the wood is dressed to a pencil line. Depth of cut is fixed by adjusting the blade flush with the surface of the rear baseplate. With edge-planing fence and adaptor for rabbet and bevel cuts, \$54.50. Porter-Cable Machine Co., Syracuse, N.Y.



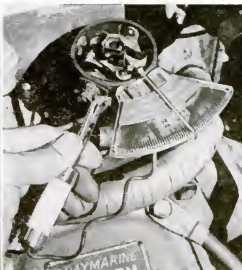
TORCH KITS contain all tools you need for home plumbing and soldering, craftwork, and paint and putty removal. Included in heavy-duty toolbox are instruction booklets that simplify jobs. Bernz-O-Matic plumbing kit sells for \$13.95; craft kit, \$11.95; paint kit, \$11.49. Otto Bernz Co., Rochester, N.Y.



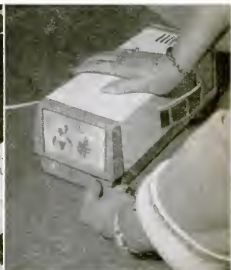
SWIMMING-POOL ELEVATOR rises on pressure from a garden hose. Your weight on a step operates it. When you walk off onto skidproof platform at top, water discharges into pool and gravity lowers ladder for next user. Mermaid Lift costs \$440 plus freight. Zehnder Corp., Box 331, Fort Worth.



ZOOM BINOCULAR has lenses that adjust from 7 to 12 power with intermediate magnifications. You can focus on a wide field, then set the eyepieces for close-up viewing. It sells for \$49.50. Compass Instrument & Optical Co., 104 E. 25 St., NYC.



POINT INDICATOR has battery that activates mechanism and illuminates dial to let you test and reset distributor when away from an electric outlet. Cam-Dwell Indicator, in hip-pocket steel case, \$4.95. Arnold Mfg. Co., 610 E. North Ave., Westfield, N.J.



35-MM. ENLARGER extends use of 10-second Rollaprint daylight printer [PS, Apr. '61]. You view negative on ground glass, project on 3¼-by-4¼-inch paper, roll through printer to develop. \$37.50. U.S. Photo Supply, 6478 Sligo Mill Rd., Washington, D.C.



Tent Rides on Pickup

This folding camper mounts for the road on top of any pickup truck. There's room under it for luggage, with access from the tailgate and one side.

The tent folds out on a stand-up-height aluminum frame, making it a one-man, one-minute setup job. An off-the-ground double bed remains on the truck, or the vehicle can be driven out from under, and a canvas skirt dropped around legs for the bed.

Pickup Camper costs \$385 f.o.b. Heilite Trailers, Box 480, Lodi, Calif.



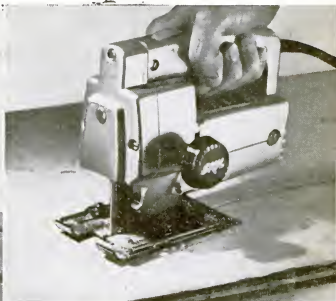
CORDLESS POWER DRILL operates on a nickel-cadmium battery that can be recharged 400 times before you need to replace it. Charger has two adjustments: for quick, five-hour boost; and for full overnight rejuvenation. One charge lets you drill 175 or more $\frac{1}{2}$ -inch holes in $\frac{3}{4}$ -inch stock. Available this fall for about \$50; charger around \$10 extra. Black & Decker, Towson, Md.



LABEL PRINTER embosses sharp, white block letters on pressure-sensitive black or colored vinyl tape. You dial the letter wanted, as on a child's typewriter, and press the handle. A built-in cutoff blade trims to desired length. Dymo Mite Tapewriter sells for \$34.95; chrome-plated, \$41.95. Extra tape, \$1.65 for a 12-foot roll. Dymo Industries, Inc., 2725 10th St., Berkeley, Calif.



PAINT SPRAYER fastens to the open top of standard quart can. You then clamp it to the hose of a canister or tank vacuum cleaner, with hose attached at exhaust end. Interchangeable nozzles take light or heavy paint. Spray Painter has no moving parts, is easy to take apart and clean. Price, \$12.95. Hyde Mfg. Co., Southbridge, Mass.



TWO-SPEED JIGSAW can be set at 3,200 strokes per minute for cutting wood, plastic, or composition; at 2,600 for metal. It handles 2½-inch wood and ¼-inch steel. You can adjust a three-position foot to cut plywood without splintering or to make bevel cuts. With four blades and a rip fence, \$99.50. Skil Corp., 5033 Elston Ave., Chicago.



ACOUSTIC TILE has a vinyl face that won't let dirt and grease penetrate to its fiberboard base, can be washed clean with a sponge dampened in detergent. In three embossed patterns at 33 to 35 cents per tile. Barrett Div.-Allied Chemical, 40 Rector St., NYC.



COOLER CHEST for station wagons and boats has removable plastic ice tray that holds 25 pounds. Pushbutton faucet supplies ice water or allows drainage. Sliding shelf stores eggs and meat; bottles and cans fit in bottom. \$32.95. Coleman Co., Wichita, Kan.



DRIPLESS PAINT is an acrylic emulsion that comes from the can as a thick, creamlike substance that needs no stirring. Friction of brush makes it flow smoothly. You can use it in blobs from the can lid. Cost: about \$7.45 a gallon. Du Pont, Wilmington, Del.

From a Shocking New Book:

Facts and Fallacies of World War III

None of us likes to think of atomic war. It is too horrible. Yet the awful perils of the 1960s won't go away just because we don't want to think about them. The safest course must be decided by rational thought. And, in the end, it is up to all of us—not just the experts—to decide what that course should be.

A thought-provoking new book—"On Thermonuclear War," by Herman Kahn—is turning topsy-turvy many long-held theories about atomic war and how it might be averted—or won. Some of its proposals have now been adopted as official U. S. defense policy.

You may disagree violently with its prescriptions (many experts do). You may be shocked by its blunt discussion of ghastly catastrophe. Yet its ideas are so brilliantly fresh, many of its conclusions so impressive, that the editors of POPULAR SCIENCE consider the following article, which summarizes salient points from the book, one of the most important this magazine has ever published.

YOU are President of the United States. A white-faced assistant bursts in: Leningrad has been wiped out. Somehow it got a missile from West Germany. Accident? Sabotage? Soviet trick? Who knows?

In strides the Russian ambassador. He lays it on the line:

The situation is intolerable. Europe must disarm totally and submit to Soviet domination. Also Asia and Africa. Within 24 hours!

To prove they are not bluffing, the Russians are destroying Frankfurt and Rome.

The phone jangles. Frankfurt and Rome are gone.

What would you do if you were the President?

This awesome problem—hypothetical yet possible—is typical of the tough look at modern war in Herman Kahn's book,

*On Thermonuclear War**. His thick treatise has been hailed as "the most lucid analysis yet presented" and damned as "evil . . . a tract on mass murder."

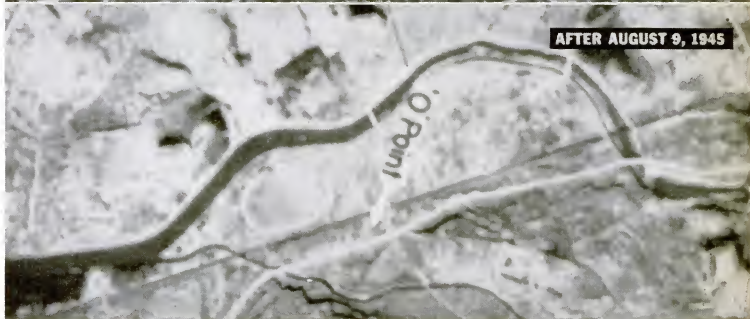
Kahn, a hard-headed mathematician who is an important adviser to the U. S. Government, calmly weighs questions that others fear to consider. His conclusions are often shocking. He claims: (1) H-bombs may not scare away war; (2) all-out atomic war is not impossible; (3) a prepared nation might bounce back from such a cataclysm.

Kahn spares no grisly detail—Doomsday Machines that could destroy the earth, pistols that shoot atomic bullets, an America staggered by the loss of 50 cities and 40,000,000 people. But by puncturing the fallacies of slogan-induced smugness, he shows how bold and intelligent action

*Princeton University Press, Princeton, N. J., \$10.



**GROUND ZERO AT NAGASAKI
BEFORE AUGUST 9, 1945**



AFTER AUGUST 9, 1945

“Model T” A-bomb did this. Bombs now are thousands of times more destructive.

could help to maintain peace (not *guarantee* to maintain peace, just help).

International blackmail— how to face it?

The catastrophe posed in the opening paragraphs is what Kahn calls 24-Hour Blackmail. How might it work out?

Your first impulse (as President) is to Push the Button—order immediate all-out atomic war. You are sworn to defend the freedom of our allies and they have been brutally attacked.

Your mind races over the morning's briefing. Now suppose that estimate of the military balance of power had gone like this:

U. S. forces could wipe out every Russian city, killing almost every Russian civilian. This threat was enough to deter

them from attacking America (and indeed they had not attacked our homeland, nor did they seem ready to).

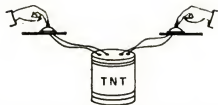
But . . . there was an awful but. Some Soviet military forces would survive the hardest U. S. blow. They could retaliate against America itself. And they would be powerful enough to kill practically every man, woman, and child in the entire country. (This is *not* possible now, but might be in the future.)

What would you do then? No man, given time to think, could order total annihilation of his own people. You would declare war, you would fight bitterly with nonatomic weapons. But the one thing you would not do was the very thing you counted on doing: retaliate with all-out H-bomb attack.

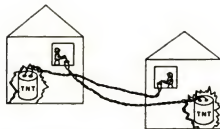
Rough? That's only a sample. Herman Kahn's view of life in the second half of

THE MILITARY DILEMMA:

Five Games of Deterrence . . . Which Should We Play?



1 You and your enemy are locked in a room. Each has a pushbutton attached to a keg of TNT. You commit yourself to mutual suicide if the other guy steps out of line. If your opponent is rational, he also commits himself. If both of you really believe that the other is willing to commit suicide, you will live out your lives peacefully with only a slight twitch now and then and regular fees to a psychoanalyst.



2 You have wired your opponent's house so that you could blow him up. He has wired your house. (This game pays a tremendous premium to the man who goes first.) There can be two elements of stability: (1) uncertainty—maybe his house is stronger than expected or your TNT weaker; (2) morality—murder is forbidden. In any case the situation is not very stable, and this game does not have a future.

the Twentieth Century is very rough. Here are some eye-openers.

Is all-out atomic war unthinkable?

High-placed Americans (including one President) have said flatly that war is "preposterous." Kahn argues that it is not. Many situations could ignite Big War. Consider just this one:

In 1956 the Soviets were rocked by the Freedom Fighter revolt in Hungary, and near-revolt in Poland and East Germany. We backed off. But suppose we had jumped to support the Freedom Fighters (with nonatomic weapons, as we did in Korea).

Now put yourself in the Kremlin. A bad time in the satellites could trigger

revolt at home. (Russian leaders are ultrasensitive to this fear, understandably.) There would be terrible pressure to Push the Button—before the satellite battles got out of hand, before trouble boiled over at home, before U. S. attacks hurt hard. Atomic war, even at the cost of shocking destruction from retaliation, might seem a reasonable choice.

That's how limited police action could "escalate" into all-out H-war. If the stakes were very high, the losing side might feel that anything was better than defeat. Unfortunately, escalation is not the only way the unthinkable war could happen. Among the others:

- **Miscalculation.** Suppose one side insists on having its own way, confident that the other side will back down. But the other side doesn't back down.

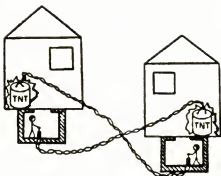


The Man Who Thinks About Atomic War

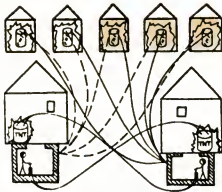
It is an unfortunate fact that, on a lecture platform, Herman Kahn looks like the mad scientist in an old horror movie. He is a half-bald 39-year-old bulgedome wearing thick-lensed spectacles, tall and decidedly plump, usually grim-faced.

Many people think he is a mad scientist. Others—including high officials of our Government—consider him one of the few sane men in a mad world.

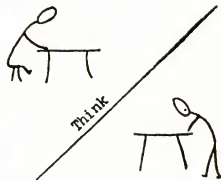
Kahn is a hired thinker: research physicist at the Rand Corporation, an outfit set up in business by the Air Force solely to do high-level, scientific thinking. His specialty is applying mathematics to strategic questions—civil defense, atomic attack—the real problems of life or death that cannot even be stated precisely, yet require choices for an uncertain future. He is also a consultant to committees and corporations, a lecturer at universities, and a much sought-after "briefer." He is a witty, earthy talker with a



3 You have a reinforced cellar in which a member of your family sits day and night. His job is to press the button that blows up your neighbor's house. Two problems: (1) You need some warning—the whole family can't live in the cellar 24 hours; (2) neither side is really sure of the strength of the cellars. They look strong enough—so you can't use the threat of blowing your opponent up for minor policing actions.



4 Other people on the block take sides. All their houses are wired so that either side can blow them up, but they have neither buttons nor cellars. Your opponent can make threats and force them to add their resources to his own. If, however, you have a cellar that will hold your entire family, you can present an ultimatum if he indulges in very reckless behavior. The existence of the cellar makes an ultimatum credible.



5 Now both players are trying to develop better bombs and cellars. If one gets a substantial lead—his bomb is certain to wreck his enemy's cellar, making it impossible for the enemy to retaliate—the game will change drastically. It behooves both players to have large research programs. (These pictures and captions are excerpted directly from Rand report P-1166, July 1957, by Herman Kahn and Irwin Mann.)

• Accident. With everybody looking over his shoulder for sneak attacks, a purely defensive alert could easily be mistaken for all-out aggression. For example: We get a false alarm, launch our SAC bombers but don't order a strike. They see our SAC and launch theirs, also without strike orders. We see their SAC, conclude the alarm is real and tell our SAC . . . You get the idea.

• Provocation. The worst danger of all, however, is believing that all-out war is "unthinkable." Once you convince your opponent that you believe this, he can run wild, confident that you won't interfere. Finally he may provoke you so outrageously that you will be forced into war, unwilling and unprepared. This is precisely how World War II started. To Britain and France in the 1930s war was

unthinkable. So Hitler grabbed the Rhineland, then Austria and Czechoslovakia, without opposition. Not until he invaded Poland did the Allies begin to fight—at a grave disadvantage.

Will all-out atomic war bring the end of the world?

A Doomsday Machine is possible. Kahn estimates it would take about 10 years and \$100,000,000,000 to develop one. It might work by breaking the earth apart, or burning the earth in fire storms, or changing the climate drastically, or destroying all life with tremendous doses of radioactivity.

The Doomsday Machine is not likely to be built because it is not controllable,

[Continued on page 178]

talent for parables. Here are a few sample Kahnologies:

Weapon stockpiles: "You have enough hands in the world to strangle everybody—each man has two hands and one neck."

Arms-control treaties: "Two men are fighting to the death with blowtorches in a warehouse filled with dynamite. They might agree to keep the lights on."

The U. S. Defense Department: "This business makes its money on a sale day every decade or two at a time unknown to the management. The management does have a signal that *this is the day*: Leading competitors come into the store, break all the equipment, and shoot the help."

The Pentagon analogy may stem from an after-school job as a youngster that Kahn considers most influential—clerking in his aunt's grocery store. He was born in New Jersey but educated in the Los Angeles area (Fairfax High School, UCLA, Caltech), where he now lives with his wife Jane and children (Debbie, 7, David, 3) in the last house along a winding road over Beverly Glen Canyon.

He is known by no nickname—his friends call him Herman (strangers call him Dr. Kahn, although he is not a Ph.D.). Relaxation? One associate says: "Amidst a varied social life, he works at his occupation 24 hours a day."



Amphibious Mudsucker.

The East German dredge at left churns up the bottom of shallow streams with a spinning cutter, then sucks up watery mud with a turbopump that spews it onto the bank at a rate of 100 cubic yards an hour. A pivoting arm dips six feet, swings on a 60-degree arc, while the pontoon boat is pulled by drag wires.

A 20-hp. diesel provides power. Detachable wheels make the vehicle roadable. An alternate head loosens sand with water jets.

What's New Behind the Iron Curtain

New Look for Skoda. Latest version of the Skoda Felicia (right) boasts a restyled tail section, bucket seats, a short stick-shift lever, and a cockpit for the gas-filler lid.

The Czech roadster is available with detachable hardtop that can be mounted without removing the folded canvas hood. Speed, with 53-hp. engine: 87 m.p.h.



ANTI-SEISMIC HOUSE is said to be able to resist 36-hour shock. Most quakes last seconds.



STEEL-SPRING FOUNDATION under all walls prevents upward spread of earthquake shocks.

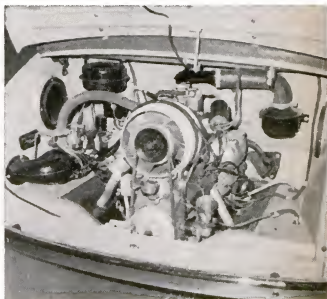
Bouncing Building. The rooming house above, in Turkmen, U.S.S.R., is mounted on springs instead of a solid foundation. Reason: Earthquakes are common there, and shock waves, absorbed by the springs,

can't crack the walls. Even the utility pipes have built-in flexible knees to prevent breaks during a jolt. Construction costs, increased 25 percent by the method, may be cut by mass production.



Vents above rear wheels supply air for cooling ZAZ engine. The car's top speed is 55 m.p.h.

Red "Volkswagen." The new Zaporozhets ZAZ-965, slated to become Russia's first mass-produced car, has a compact rear-mounted V-4 engine whose 45 cubic inches deliver 23 hp. Engineers are still trying to eliminate such bugs as excessive oil temperature and gas consumption at high speed and a noisy four-speed gearbox that has earned the nickname, "music box of Melitopol." Production plans call for 10,000 of the small cars to be built this year and 150,000 yearly thereafter.



BLOWER built around the generator sucks air past the cowed engine and out the lid's exhaust louvers. A gas heater provides plenty of warmth for Russia's arctic winters.

Sunshine Concentrate.

A patient is treated at right in a sun-following machine installed on the lawn of the Ordjonikidze sanatorium at Sochi - Matsestinsk, U.S.S.R. Rays collected in the multimirrored reflector at far right are thrown on the patient's back.

Turning the mechanism is a nurse. She pushes the device around a circular track to keep it facing the sun.





For Open-Air Commissars. Russia's new ZIL-111 convertible is derived from the eight-seater limousine whose 20-foot body rolls on a 12-foot wheelbase. The engine is a 220-hp. V-8 driven through an automatic transmission. Power steering, brakes, and windows are standard. Styling shows swipes from Buick, Packard, and Cadillac models of a few years back.

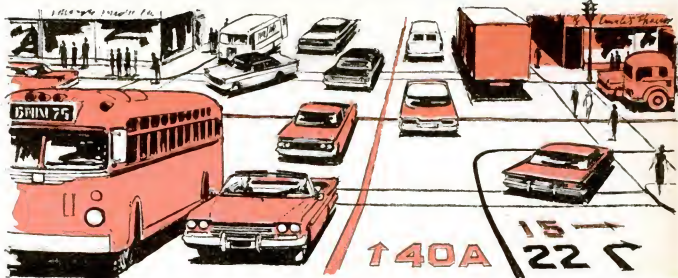


Elevator Cab for Big Crane. An East German building crane (left) has a control cab that rides up and down an elevator, saving the operator a climb and enabling him to view the work he's doing from the best height. Power, control, and phone cables loop from the top of the tower to the cab floor. The self-propelled, 200-foot crane is mounted on rails.

Volga Boatmen Go Modern. Twin hulls, with a separate engine in each, combine stability and speed with greater load capacity for the Russian freighter below. The 600-ton catamaran has an uncluttered deck for easy access to holds and a broad cargo area above its hatch covers. Controls and crew quarters are in the rear deckhouse. The vessel, built on the Volga, will do up to 15 knots. ■ ■



"I'd like to see them make..."

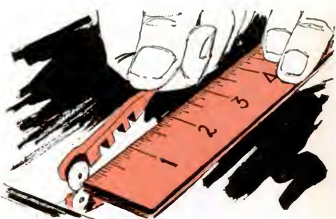


HIGHWAY DIVIDER STRIPES colored to tie in with route numbers. How easy then for a driver

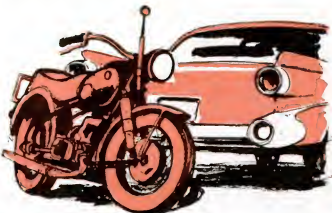
to follow his color line through a maze of city streets!—*Lloyd Smith, Elmira, N.Y.*



ABRASIVE TAPE backed with a pressure-sensitive adhesive. You could wrap it around a rod or any other handy object to sand those hard-to-manage pieces.—*John Lubin, NYC.*



GLASS-CUTTER WHEELS mounted in a notch instead of a fork, and bevel-edged on one side only. Then you wouldn't have to allow for offset of the cut.—*A. Vena, Philadelphia.*



MOTORCYCLE MARKERS to warn car-backing drivers who might not see a cycle. Reflector-topped, telescoping wands, they'd be raised in parking lots.—*L. D. Hull, Oakland, Calif.*



SUPERMARKET CASH REGISTERS with an additional window at right angles to the keys so the customer in a checkout line could see her items being rung up.—*J. Kelly, Albany, N.Y.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay \$5 for each one published. Please use Government postcards

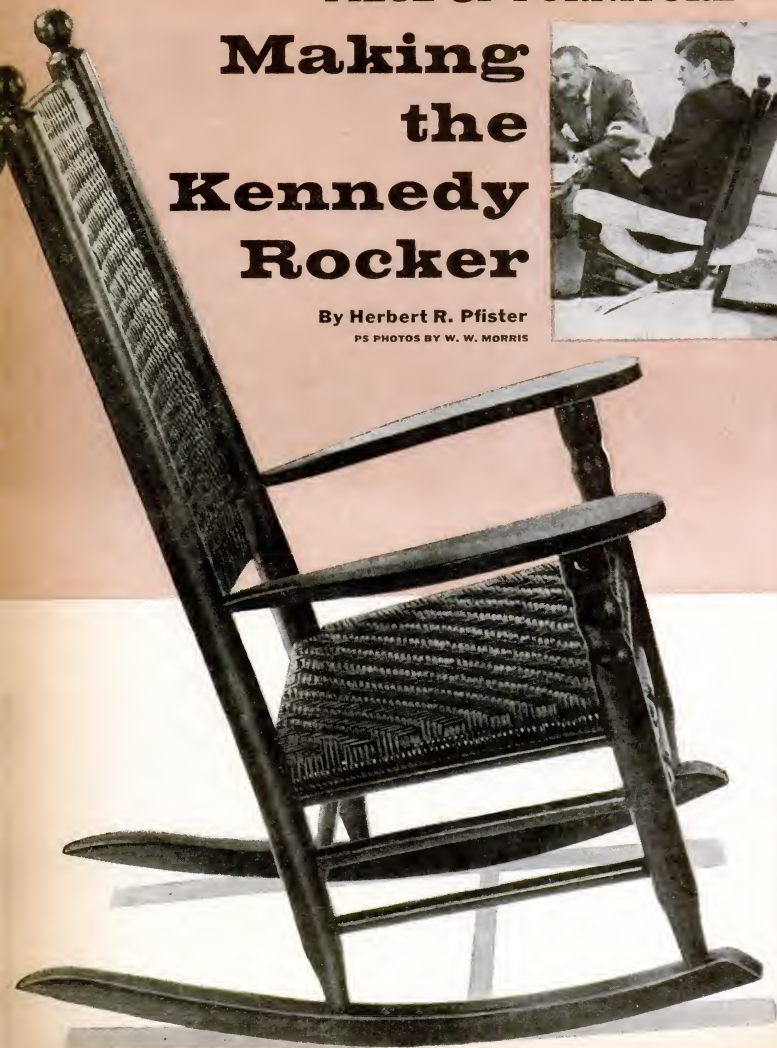
only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 17. Write your name and address clearly. Contributions cannot be acknowledged or returned.

THE INSIDE STORY OF A FAMOUS
PIECE OF FURNITURE

Making the Kennedy Rocker

By Herbert R. Pfister

PS PHOTOS BY W. W. MORRIS



**Here's how a Carolina plant
builds that famous JFK rocker—
a rocker you, too, can make**

THE most-publicized rocking chair in the world today hasn't changed a bit in the past 35 years. It's a fine example of classic craftsmanship.

The chair is the Carolina Rocker, made by the P & P Chair Co. in Asheboro, N.C. The company's 71-year-old president, William C. Page, has been a chairmaker since 1912. In 1926, he went into business on his own, manufacturing a line of chairs that included the rocker that since has rocked its way to fame with President Kennedy.

"That was a mighty busy day in '26," Mr. Page told me, "and I'll always remember it because Bill Jr. was born the day I opened the plant." Today, Bill and his brother Tuck help run the plant. Bill handles the paperwork, and Tuck keeps the production line moving. Many of the employees have worked in the plant since it opened, and a family atmosphere prevails.

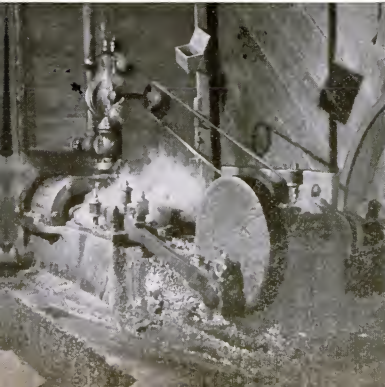
Because of her belief in the therapeutic value of "a really good rocker," Dr. Janet G. Travell, now the White House physician, has been recommending P & P rockers to patients for more than 10 years. President Kennedy bought his

Mechanics and Handicraft SECTION



1. OAK LOGS, cut within 50 miles of the chair factory, are trimmed of bark and sliced into slabs on this huge 40-inch rip saw. In the old motion-picture melodramas, the villain lashed the heroine to a saw similar to this one.

2. SPUNKY DONKEY ENGINE, driven by steam generated in boilers fueled only by sawdust, chips, and wood scraps from factory, powers the sawmill and some machinery. Boilers also provide heat, and steam for bending chair parts.



3. BACK-KNIFE LATHE, as old as the factory, turns 2"-square oak into chair posts as fast as operator can load it. Lead screw drives compound to rough out post; formed knife then moves down to shear it to finished shape.





4. HOW REAR POSTS ARE BENT: All are steamed in a barrel for 30 minutes (at left above). Then the ends of each pair are set in a jig. Pressure on a foot treadle forces a tongs-like clamp together on the post ends, and a wood



saddle is slipped over the ends to hold them in position. Bent posts (above) are stacked in a heated room for 24 hours for the bend to set. A slight spring-back on release has been calculated in the precise design of the jig.



7. BORING JIG locates holes in rocker runners and bores them at proper angle to receive front and rear posts. Runners are bandsawed one at a time by an adroit operator who follows a pencil line traced on the wood.



8. CANEWARK is meticulously hand-woven over back-rest assemblies and seat frames in a loft away from machine-shop clatter. The cane is presoftened in water, but even then splinters often keep a worker's all 10 fingers bandaged.

rocker in 1955, when he was a senator. At that time, Dr. Travell was treating Mr. Kennedy for a back ailment, and he found an identical rocking chair in her office exceedingly comfortable.

The secret of the chair's success is in the carefully bent back posts that slope away from the seat. Without this bend, the back would be too straight and it would push the sitter forward. Also, the armrests are about two inches lower than those on similar rockers. This permits the sitter's arms to drop naturally to a comfortable position at the sides of

the body. The seat and curved back of canework, woven by hand, provide firm, well-distributed support.

This canework is bottlenecking the company's output of rockers. It takes an expert about an hour to patiently weave the cane into an over-and-under pattern for the back and a herringbone pattern for the seat. No machine has yet been invented to replace hand-weaving.

Yet there *is* efficiency in the whole plant operation; P & P can turn out 250 of these chairs in a day of full-blast operation.



5. MORTISING MACHINE can rout up to three mortises simultaneously. Here two router heads oscillate rapidly from side to side on a carriage, while the operator feeds the post toward them until the required depth is reached.



6. SIMPLE SETUP above resembles a pencil sharpener in its operation. Square end of band-sawed armrest is placed in a guide and pressed into a spinning cutter head that rounds and tapers it to fit hole bored in rear post.



9. ASSEMBLY LINE GOES INTO ACTION whenever a supply of seats and back rests comes down from the weavers. This horizontal screw press forces posts onto back rest and rungs, while

operator encourages fit with mallet. A spot nailer then drives headless nails into the rungs and stretcher tenons to secure the assembly. Snug-fitting joints hold without glue.



10. TEAMWORK PAYS OFF on awkward job of joining the six side rungs to front and rear posts. Man at right in photo above aligns the rungs with holes on the left side of chair while his partner taps them in. Partner then holds

rungs on right side while first man starts them. Finally, both men sit up and pound the rungs home. Ends of the rungs are dipped into water just before assembly so they'll swell after being driven into the holes.



11. SEAT IS NAILED to the top rungs. Curved cutouts in each corner of the seat frame fit snugly against front and rear posts. Then, farther along, armrests are driven into holes in rear posts, nailed to top of front posts.

12. COMPLETE EXCEPT FOR RUNNERS (which are left off for shipment), chairs are dipped in clear lacquer. This was the standard finish for them until the Presidential rocker was refinished in a dark tone. This finish is sprayed on.



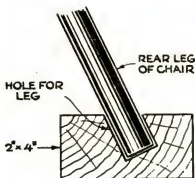
NEXT MONTH: How
You Can Make
the JFK
Rocker

AN ARTICLE in the August issue of **POPULAR SCIENCE** will give full dimensions and instructions for building the Presidential chair in a home workshop. You'll also learn canework.



Short Cuts and Tips

FROM PS READERS



Neatly Anchored Chair Legs

THESE barbershop chairs were always awry, until the owner anchored their rear legs in a wood strip against the wall. The

legs slip into sockets drilled at an angle, holding the chairs in a neat, straight row. The same idea might make sofas or wall benches behave in a home.—*J. C. Miller, Falls Church, Va.*

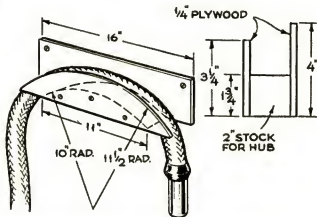
▶▶▶ I SAVE empty squirt cans of the type you buy charcoal lighter fluid in. They make handy containers for various types of oil, especially cutting and cooling oils. The plastic nozzles give a longer, finer, more continuous stream than you can get with ordinary oilcans. And with the screw-on caps, you can carry them on their sides in a toolbox without spillage.—*John Mihalick, East Liverpool, Ohio.*

▶▶▶ IF YOU don't have the exact size wire gauge you need, you can make your own by stretching a slightly larger piece of soft copper, brass, or steel wire to the correct diameter. Clamp one end in a vise and pull the other with pliers, miking the wire until the desired size is reached. The wire can be drawn uniformly, its size controlled to within .001".—*Sgt. Joseph Cholak, Beaufort, S. C.*



Ball-Point Pen Feeds Solder

HERE'S a handy way to store thin wire solder. Remove the refill stem from an old ball-point pen and coil the solder around it, then discard the stem and slip the coil into the pen. The solder can be pulled out of the point as it's needed.—*Kent Williams, Buffalo, N.Y.*



Hanging a Vacuum Hose

THIS hanger keeps a vacuum-cleaner hose handy and prevents its bending and wearing. Make it from thin plywood and a hub of 2" stock. Saw the hub on a 10" radius. The hanger can be mounted in a closet or on the back of a door.—*E. R. Chaffee, Sterling, Colo.*

Short Cuts and Tips

FROM PS READERS

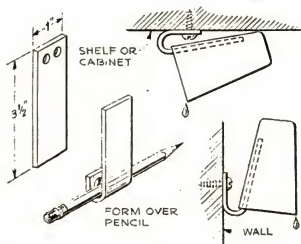
"Wheelbarrow" from Sheet Plastic

A GOOD "wheelbarrow" for spreading sand, soil, or gravel is a piece of heavy polyethylene film of the type used as a vapor barrier under concrete slabs. It slides easily on the ground and can be loaded and unloaded faster than a conventional wheelbarrow. To dump it, you just roll the film back over itself and spill the contents.—*Harvey Versteeg, Inkster, Mich.*



▶▶▶ WHEN doing small spray-paint jobs on a car, windows and chrome can be masked by wiping on kitchen cleanser, which leaves a powdery film. The film, along with any overspray, can then be wiped off.—*Ken Murray, Colon, Mich.*

▶▶▶ WORKSHOPPERS are always getting holes in their pockets from carrying tools and other sharp objects. The pockets can be quickly patched with iron-on tape or, in an emergency, ordinary adhesive tape.—*G. Allen Burrows, Burt, N. Y.*



Upside-Down Glass Stays Clean

THE usual drinking-glass holder in a bathroom or kitchen stores the glass right-side-up so that it can't drain and lets dust fall in. A hook to hold the glass upside down can be made from a strip of stainless steel or aluminum about 1" wide and 3 1/2" long. Screw the upper end to the wall, then bend the free end up around a pencil to form a hook. The hook can also be mounted under a cabinet or shelf to hold a water glass on its side.



Fast-Grinding a Lathe Bit

GRINDING away more than three-quarters of the width of a lathe bit to make an offset cutter can be a tedious, time-consuming job. It's much quicker to rough out the offset by slicing out a corner of the bit with a thin abrasive cutoff wheel. The partly formed bit pictured above at right shows how the cuts are made. The bit can then be brought to its final shape in minutes on the grinder.—*Floyd McGuckin, Ridgewood, N. J.*

You Can Save a Life

when breathing has stopped
in cases of **DROWNING**
ELECTRIC SHOCK
ASPHYXIATION
CHOKING
POISONING

YOUR PERSONAL
POCKET GUIDE TO

POPULAR SCIENCE
REG. U. S. PAT. OFF. *Monthly*

Artificial Respiration



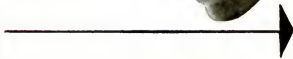
Techniques taught in **AMERICAN RED CROSS**
courses of instruction

New!

**a Popular Science
fold-it-yourself
booklet**



**FOR FOLDING INSTRUCTIONS,
PLEASE TURN THE PAGE**



Artificial Respiration

This booklet reprints an American Red Cross *Supplement on Artificial Respiration*, issued to supersede material on pages 117-125 in the Red Cross *First Aid* textbook (4th edition, 1957); and the technical instructions for administering artificial respiration included within pages 220-235 in the Red Cross *Life Saving and Water Safety* textbook (1956 printing).

The related background information on the subject is still authoritative in each of the respective Red Cross texts.

2

Normally, recovery should be rapid, except in electric shock, drug poisoning, or carbon monoxide poisoning cases. In these instances, nerves and muscles controlling the breathing system are paralyzed or deeply depressed, or the carbon monoxide has displaced oxygen in the blood stream over a period of time. When these cases are encountered, artificial respiration must often be carried on for long periods.

When a victim is revived, he should be kept as quiet as possible until he is breathing regularly. He should be kept covered and otherwise treated for shock until suitable transportation is available, if he must be moved.

Artificial respiration should be continued until the victim begins to breathe for himself, or until a physician pronounces the victim dead, or until the person appears to be dead beyond any doubt.

A doctor's care is necessary during the recovery period, as respiratory and other disturbances may develop as an aftermath.

19

Putting the booklet together: Just cut, fold, and staple



1. PLACE A RULER under the three sheets containing this booklet. With a razor blade against it, cut the sheets out.



2. MAKE A SECOND CUT across the three sheets, following the dotted line on the title page. Keep the sheets aligned.

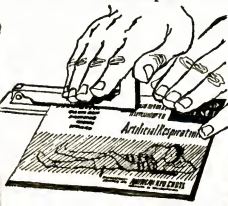


3. DISCARD the half sheet you now are reading, the part that gives you instructions for folding and assembling the booklet.

4. SLIP THE BOTTOM BUNDLE of sliced-apart sheets under (or behind) the top bundle. Make sure that pages are in order.



5. ALIGN THE SHEETS neatly, corner to corner, and staple them together at the center fold with two or three staples.



6. NOW FOLD THE BOOKLET along the centerline and it's complete—ready for your pocket and for use in an emergency.



victim swallowing varying quantities of water. This water, along with food remaining in the stomach, could, if regurgitated, obstruct the air passages and interfere with the efforts of the rescuer. The possibility of obstruction must be recognized by the rescuer and immediate steps taken to relieve it if it occurs.

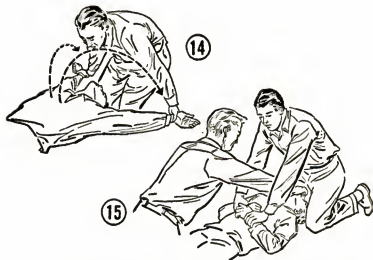
Evaporation of water from the victim's skin will result in lowering still further a body temperature that may already be dangerously low. It is imperative, therefore, to keep the victim from becoming chilled.

Related information for all methods

Time your efforts to coincide with the victim's first attempt to breathe for himself.

If vomiting occurs, quickly turn the victim on his side, wipe out the mouth, and then reposition him.

18



4. Repeat this cycle about 12 times per minute, checking the mouth frequently for obstructions.

When the victim is in a face-up position, there is always danger of aspiration of vomitus, blood, or blood clots. This hazard can be reduced by keeping the head extended and turned to one side. If possible, the head should be a little lower than the trunk.

If a second rescuer is available, have him hold the victim's head so that the jaw is jutting out (Fig. 15). The helper should be

14

Some form of artificial respiration should be started at the earliest possible moment.

Any procedure that will obtain and maintain an open-air passageway from the lungs to the mouth and provide for an alternate increase and decrease in the size of the chest, internally or externally, will move air in and out of a non-breathing person.

3

If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or with a cloth wrapped around your fingers.

1. Tilt the head back so the chin is pointing upward (Fig. 1). Pull or push the jaw into a jutting-out position (Fig. 2 and Fig. 3). These maneuvers should relieve obstruction of the airway by moving the base of the tongue away from the back of the throat.

2. Open your mouth wide and place it tightly over the victim's mouth. At the same time pinch the victim's nostrils shut (Fig. 4) or close the victim's nostrils with your cheek (Fig. 5). Or close the victim's mouth and place your mouth over the nose (Fig. 6). Blow into the victim's mouth or nose. (Air may be blown through the victim's teeth, even though they may be clenched.) The first blowing efforts should determine whether or not obstruction exists.

3. Remove your mouth, turn your head to the side, and listen for the return rush of air that indicates air exchange. Repeat the blowing effort.

7



The National Academy of Sciences-National Research Council Ad Hoc Committee on Artificial Respiration, in its meeting on Nov. 3, 1958, unanimously agreed that the mouth-to-mouth (or mouth-to-nose) technique of artificial respiration is the most practical method for emergency ventilation of an individual of any age who has stopped breathing, in the absence of equipment or of help from a second person, regardless of the cause of cessation of breathing.

The technique has the advantage of pro-

4

17

Artificial respiration for water cases

Individuals who die as a result of a water accident usually die from the lack of air, and not because of water in the lungs or stomach.

A drowning victim may be either active or passive. Unless unconscious, the drowning victim usually struggles to remain on the surface or to regain the surface, in order to secure air. These efforts are energy-consuming and may result in the

of Artificial Respiration

It has already been pointed out that the base of the tongue tends to press against and block the air passage when a person is unconscious and not breathing. *This action of the tongue can occur whether the victim is in a face-down or face-up position.*

(Silvester) method

1. Place the victim in a face-up position and put something under his shoulders to raise them and allow the head to drop backward (Fig. 12).

2. Kneel at the victim's head, grasp his arms and wrists, cross them, and press them over the lower chest (Fig. 13). This should cause air to flow out.

3. Immediately release this pressure and pull the arms outward and upward over his head and backward as far as possible (Fig. 14). This should cause air to rush in.

13

4



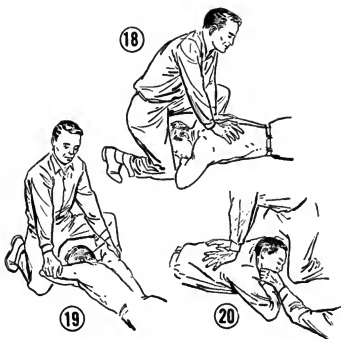
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6



8



3. Rock forward until the arms are approximately vertical and allow the weight of the upper part of your body to exert steady, even pressure downward upon the hands (Fig. 18).

4. Immediately draw his arms upward and toward you, applying enough lift to

16

Manual Methods

Rescuers who cannot, or will not, use mouth-to-mouth or mouth-to-nose techniques, should use a manual method. The rescuer should not be limited to the use of a single manual method for all cases, since the nature of the injury in any given case may prevent the use of one method, while favoring another.

The chest-pressure arm lift

If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or with a cloth wrapped around your fingers.



12

Mouth-to-Mouth

(mouth-to-nose)

Method of Artificial Respiration

viding pressure to inflate the victim's lungs immediately. It also enables the rescuer to obtain more accurate information on the volume, pressure, and timing of efforts needed to inflate the victim's lungs than are afforded by other methods.

When a person is unconscious and not breathing, the base of the tongue tends to press against and block the upper air passageway. The procedures that follow should provide for an open air passageway when a lone rescuer must perform artificial respiration.

5

For an adult, blow vigorously at the rate of about 12 breaths per minute. For a child, take relatively shallow breaths appropriate for the child's size, at the rate of about 20 per minute.

4. If you are not getting air exchange, recheck the head and jaw position (Fig. 1 or Fig. 2 and Fig. 3). If you still do not get air exchange, quickly turn the victim on his side and administer several sharp blows between the shoulder blades in the hope of dislodging foreign matter (Fig. 7). Again sweep your fingers through the victim's mouth to remove foreign matter.

Those who do not wish to come in contact with the person may hold a cloth over the victim's mouth or nose and breathe through it. The cloth does not greatly affect the exchange of air.



9

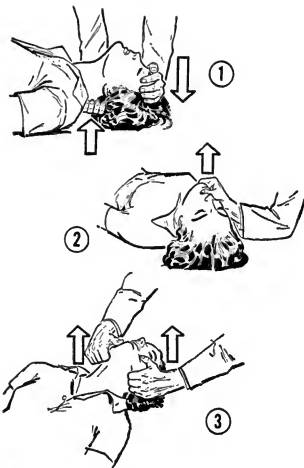
alert to detect the presence of any stomach contents in the mouth and keep the mouth as clean as possible at all times.

The back-pressure arm lift (Holger-Nielsen) method

If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or with a cloth wrapped around your fingers.

1. Place the victim face-down, bend his elbows and place his hands one upon the other, turn his head slightly to one side and extend it as far as possible, making sure that the chin is jutting out (Fig. 16).

2. Kneel at the head of the victim. Place your hands on the flat of the victim's back so that the palms lie just below an imaginary line running between the armpits (Fig. 17).



6



15

Mouth-to-mouth techniques for infants and small children

If foreign matter is visible in the mouth, clean it out quickly as described previously.

1. Place the child on his back and use the fingers of both hands to lift the lower jaw from beneath and behind, so that it juts out (Fig. 8).

2. Place your mouth over the child's mouth and nose, making a relatively leak-proof seal, and breathe into the child, using shallow puffs of air (Fig. 9). The breathing rate should be about 20 per minute.

If you meet resistance in your blowing efforts, recheck the position of the jaw. If the air passages are still blocked, the child should be suspended momentarily by the ankles (Fig. 10) or inverted over one arm (Fig. 11) and given two or three sharp pats between the shoulder blades, in the hope of dislodging obstructing matter.



10

11



PICNIC BASKET: Load the bottom with ice cubes, cover with sheet plastic—and a lunch on top will remain cool for hours.



SPILLPROOF BASKET: When a wastebasket is used where it's likely to be overturned, pour $\frac{1}{2}$ " of concrete in the bottom, after driving screws up through the bottom to anchor it.

UMBRELLA STAND: A wet umbrella will dry faster if drained while partially open. A basket makes a fine catch basin. Fold the umbrella when dry and use the basket as a hall stand.

NONSLIP TREATMENT: Next time you apply skidproofing to the underside of throw rugs, brush some on the bottom of wastebaskets to anchor 'em on slick floors.



KINDLING TOTER: Divide a bright-colored basket into two compartments with a plywood divider to make a holder for kindling and newspapers at the fire-side. Cut a finger hole in the partition for easy carrying, and secure it by driving brads through the sides.



TOY BOX: Using colored tape, print TOYS on the outside of a basket. It's especially good for tall items—bows, bats, toy rifles and the like.



PLANTER: It's ideal for large patio plants or dwarfed trees. Puncture it for good drainage.



DUSTBIN: Place one inside a power-tool table to collect sawdust. If there's a chute, cut a hole in the side of the basket, $\frac{1}{8}$ " smaller than the chute's beaded opening. Tape will keep the bin in place until it needs emptying.

CORD TIED BETWEEN GROMMET AND SCREW EYE AT ALL THREE CORNERS

1" SQUARES



LEECH HEM



DOUBLE-LAPPED SEAM

SEAM PARALLELS LEECH

PULLEY AND EYEBOLT

MAINSHEET

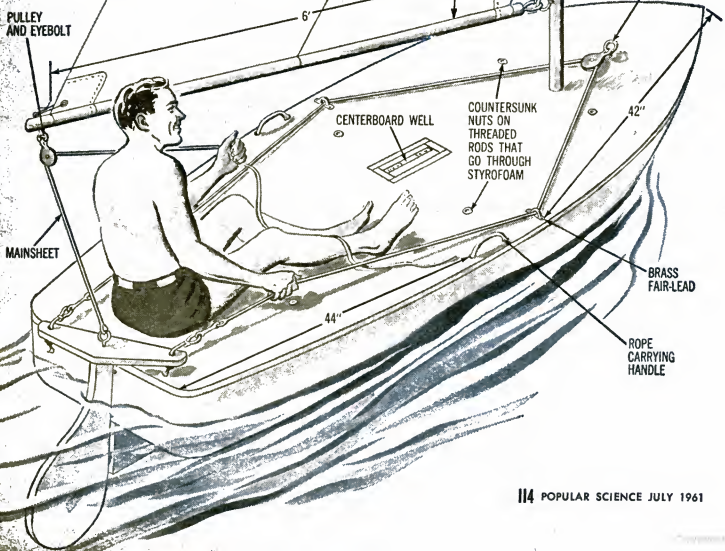
CENTERBOARD WELL

COUNTERSUNK NUTS ON THREADED RODS THAT GO THROUGH STYROFOAM

PULLEY AND SCREW EYE

BRASS FAIR-LEAD

ROPE CARRYING HANDLE



In just two evenings, here's
how you can build—

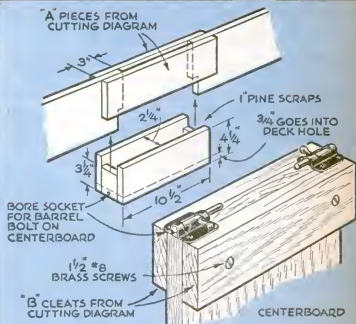
A Sailing Surfboard for \$50... or Less

By Jim Purves

SPEND next weekend on the water. Here's a boat that all but builds itself. The secret of its quick construction is the Styrofoam hull. You just carve it to shape without any worries about watertight joints or complicated framing. The plywood deck and keel provide support and protection for the foam when you haul the boat ashore or come alongside a dock.

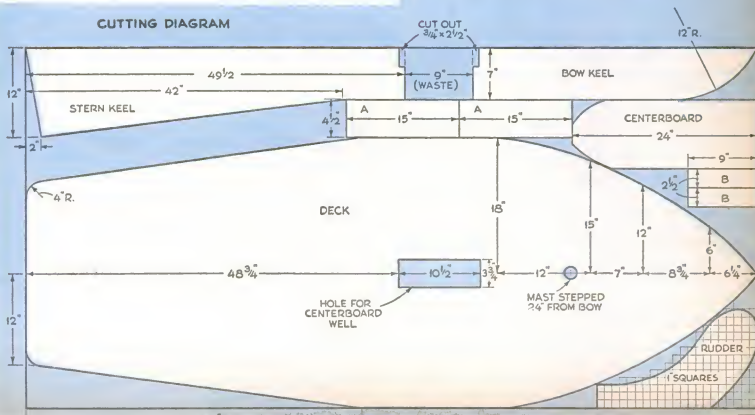
I call my boat Funfish—because ease of construction isn't the only virtue. It's a great boat for kids, and for adults who enjoy sailing most when they can forget about jibs, mizzens, spankers—the whole rigging ritual that can be so exasperating to a land-lubber. The Funfish is stripped to essentials. It's light for easy launching. You can tie it on top of the car or tuck it in a station

CONTINUED



REMOVABLE CENTERBOARD slips through deck from top, and down through gap in keel that separates flotation blocks. Cleats seat in well, aligning bolts and sockets. Waterproof glue and brass screws fasten well in deck hole, flush with top surface.

CUTTING DIAGRAM



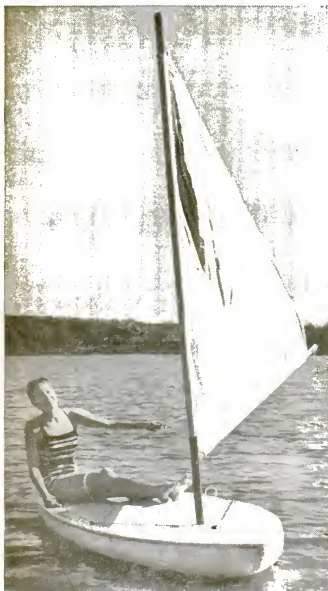
The hull is solid Styrofoam, cemented to the deck's underside



TRACE DECK OUTLINE on billet, after fitting it snugly to keel. Flip it over and use handsaw to slice off waste with series of straight cuts. Finish one half, shape the other to match.



FINAL SHAPING is done after billet is fastened with glue and hardboard washers on threaded rods. Trim with serrated bread knife and smooth with a rasp or plane; leave the bottom flat.



wagon when you head for the beach. The hull is amazingly stable—and so buoyant that it would take over 800 pounds to sink it. Any breeze sends it scooting.

Materials for the Funfish aren't expensive. Your biggest costs will be for a 4'-by-8' sheet of $\frac{3}{4}$ " AD-grade exterior plywood (around \$9), and two Dow Buoyancy Billets (about \$13 each). These rough planks of Styrofoam are sold by building-supply dealers as flotation material for docks, piers, and boat hulls. Buy ones that measure about 7"-by-20" and are a little over 9' long. They cost less than the precisely dimensioned Styrofoam used for insulation.

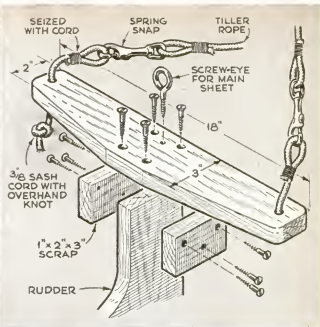
First, the woodworking. To lay out the bow curve, make the four measurements from the center line, shown on the cutting pattern. Drive nails at these points and bend a lath against them to establish the curve. For the mast, I used a 10' length of $1\frac{3}{4}$ " stair rail. The boom is $1\frac{1}{8}$ " closet pole, $6\frac{1}{2}$ ' long.

The mast step consists of a $1\frac{3}{4}$ "-by-4" pipe nipple, with a floor flange on one end and a pipe cap on the other. Position this assembly over the mast hole, on the

WHETHER YOU SIT OR SPRAWL, the tiller rope's within reach. Should boat capsize, just slip mast from step, right the hull, climb aboard, restep mast—you're off again!



RUDDER ASSEMBLY PIVOTS on back edge of keel by means of screw-eyes. Bottom one drops onto L hook; top three are locked together by pin attached to rudder with short chain.



YOKE AND BLOCKS are cut from 1" pine, assembled with 1/4"-by-8" brass screws. Spring snaps permit removal for transport. Rudder and centerboard are attached after launching.

underside of the deck, and attach with 3/8"-by-1 1/2" brass bolts. Use the round-head type and put the heads topside, with brass washers.

You'll have to cut a notch to accommodate this protruding step before you fasten the keel to the deck (with waterproof glue and 1 3/4" No. 8 flathead brass screws, countersunk into the deck). Counterbore, too, for the nuts on the threaded rods that pierce the Styrofoam.

Give boat, rudder, and centerboard two coats of marine enamel. A quart should do it (one coat's enough on the underside of the deck, if you run short).

Fitting the hull. You'll have to square one edge of each billet for a snug fit against the keel. Use a regular handsaw (rip or crosscut) with long, slow strokes. Lay the billet on the underside of the deck with this edge along the keel. With a sharp knife or pistol-grip hacksaw, notch the Styrofoam to make it fit around the centerboard well and mast step. When the billet fits snugly against the keel, trace along the edge of the deck with a grease pencil. Saw the billet to rough shape and attach it to the keel and deck with counter-top cement.

If you end up with a bad fit, you can fill in with tapered scraps. Save your largest hull trimmings for this—and to replace any chunks of the hull torn away

by accidents afloat. If patching is necessary, just square up the sides of the damaged area and fit in a scrap coated with leftover counter-top cement.

Turn a nut tight on one end of each rod and lock it in place by center-punching the rod. Push the other end through the deck, billet, and tempered-hardboard washer. Run nuts snug against these washers, saw off the rods, and center-punch again.

For the sail. You'll need five yards of denim, sailcloth, or light canvas. Cut two Funfish emblems at once from iron-on denim patches placed back-to-back. After applying one, hold the sail up to the light to position the second.

To join the boom to the mast, insert a large screw-eye in one end; heat and spread an eyebolt to link it into the screw-eye. Position the eyebolt in the mast by slipping the sail onto both mast and boom, tying it through the corner grommets. Use fairly long cords so you'll be able to shorten them if the sail stretches. Pull the sail down the mast until it's taut, and mark the eyebolt position. Also bore a hole through the boom, for the eyebolt that holds the mainsheet pulley. Remove the sail and give both mast and boom two coats of spar varnish.

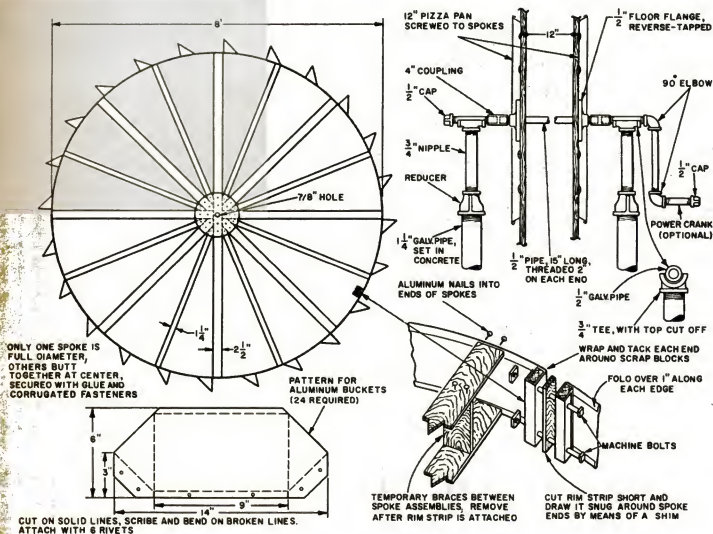
You'll need about 50' of 3/8" sash cord to rig the tiller rope and mainsheet. ■ ■

HOW I BUILT

My Back-Yard Water Wheel

A BROOK trickles across my lot and down an embankment, creating a perfect setting for a water wheel. I built one 8' in diameter, using $\frac{3}{4}$ " redwood for the spokes, a 50' roll of 14"-wide aluminum for the rim, and pipe for the axle and support brackets. I channeled the water into the lower buckets with an aluminum gutter.

My water wheel turns at 10 revolutions a minute. Not only is it ornamental, but I found a use for it—to turn a tumbling drum for polishing amethysts, agates, and other semiprecious stones. This process, using progressively finer abrasives, takes many months—for which the economy of water power is ideal. By replacing the drive pulley with a power crank, I also can operate animated cutouts on the lawn. The wheel, weighing under 50 pounds, is easy to lift into the pipe bearings.—*W. C. Robinson Jr.*



Solar cells at a new low price now make possible this and other exciting home-built projects


By Howard G. McEntee

SHINE the sun's rays or an ordinary lightbulb on this little stern-wheeler and her paddle wheel mysteriously begins to churn. No batteries, boilers, or other forms of power are hidden inside. Her tiny electric motor is driven entirely by the energy of light rays falling on three small solar cells mounted on her pilot-house roof.

These amazing sun batteries—now used to power U.S. space satellites—convert the sun's energy directly into electric current. They never run down or wear out like ordinary batteries. The model steamboat shown here will run all day, day after day, virtually forever, with nothing else to add.

New fun with sun batteries. Sun cells have been around for many years, but until now they have been too costly and low-powered for generating real electric power. Newer cells, using silicon instead of the earlier selenium, are up to 20 times

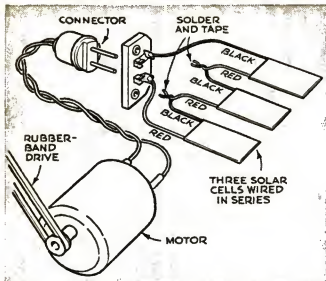
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The Boat That Runs on Sunlight



How three sun cells run the boat



CELLS ARE WIRED IN SERIES for maximum power by interconnecting their red and black leads, as shown above. The two end leads, one red and one black, then go to the motor through a small two-prong connector. Handle the cells carefully—they're thin and can break easily.

more powerful and are now being mass-produced to cut cost. You can buy them for a few dollars.

These beefed-up cells, in combination with tiny, powerful electric motors now available, are opening up a whole new world of wonders powered by sun energy alone. You can build ever-running mod-

A rubber band turns the paddles

SUN BOAT'S PADDLE WHEEL is light and free-spinning to conserve power. The rubber-band belt must be just tight enough to avoid slipping—any tighter will cause drag. Rotate the motor—its off-center pulley will give or take up slack to adjust proper belt tension.



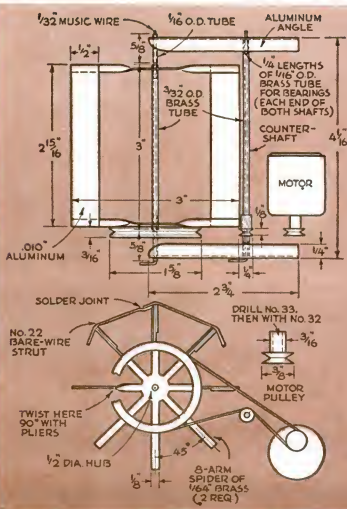
els, electronic devices triggered by the sun's rays, fire alarms, light-beam signals, even such intriguing things as a solar-powered scarecrow or other yard devices operated by the sun.

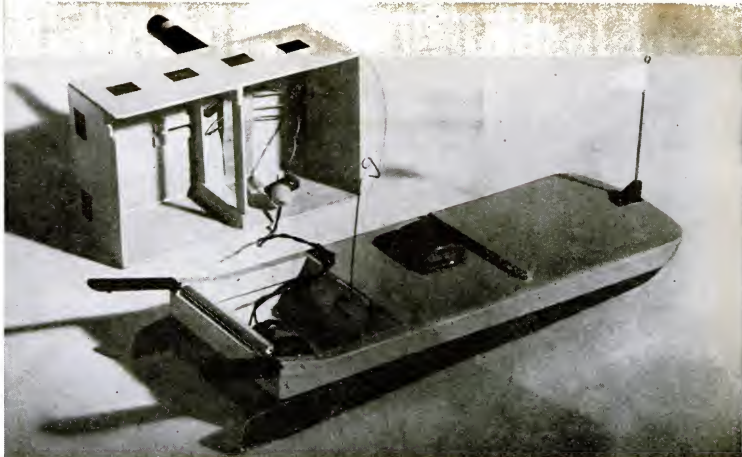
The model river boat was chosen by POPULAR SCIENCE as a fascinating way of trying out the new sun batteries because it requires so little power that you can get lively, exciting action with only a few of the cells. It runs briskly on three cells but can operate on only two.

Under the boat's normal load, the cells each put out about .4 volts, giving better than a full volt when wired in series. This is enough to turn the paddle wheel at a snappy 50 r.p.m.

Building the stern-wheeler. To save weight and get maximum speed, the hull and cabin are built up hollow from thin balsa sheet. The bow is given a smart deck overhang and an upward-sweeping keel to relieve the "mud scow" look.

The power plant is a Swiss-made Escap, one of several new miniature electric motors that give high power on very low voltage. No bigger around than a 25-cent piece, it has built-in reduction gears with a 4:1 ratio. This, combined

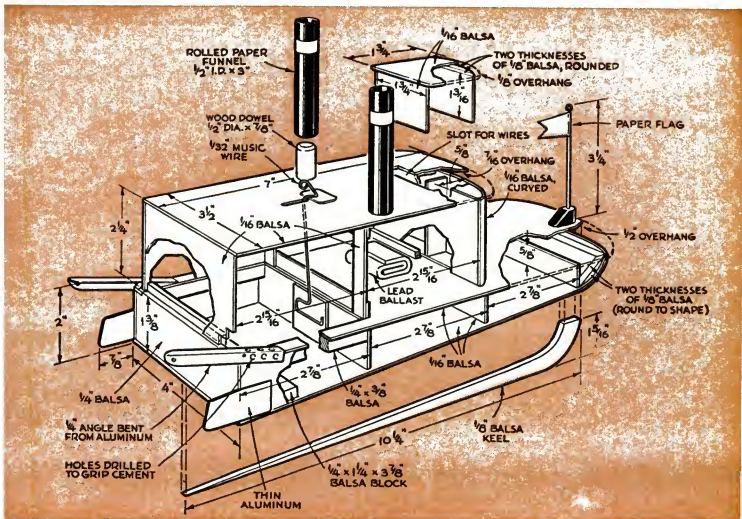




How the hull is built up

LIFT-OFF CABIN makes it easy to get at motor and wire the sun cells. While hull could be

solid balsa, it's best to make it hollow to save weight. The bent-wire hook shown at the center of the boat passes through a slot in the cabin roof to hold the cabin in place.

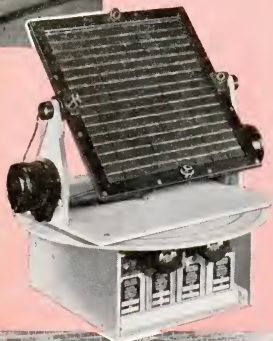


CONTINUED

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Sun cells have many weird and wonderful uses

TOY CAR zips along on 15 roof-top sun cells. Rotating solar tracker below follows the sun all day by using some cells to sense its position, other cells to drive tiny motors to turn it.



FIRST REAL SOLAR-POWERED CAR, restored 1912 Baker Electric runs on energy from 10,640 sun cells mounted on a roof panel. The cells charge storage batteries so car can run when there's no sun. International Rectifier devised the demonstration.

with a large pulley on the paddle wheel, gives the paddles plenty of push.

The Escap motor costs \$7.95 from G. M. Hobby Specialties, Box 67, Wantagh, N. Y. A similar motor is the Micro-Mo V, available for \$10.65 from Micro-Mo Electronics, 3379 East Blvd., Cleveland, Ohio. This has a higher built-in gear ratio and could thus use a slightly smaller pulley on the paddle wheel.

The three solar cells are cemented to the pilot-house roof with their leads passing down through the cabin to the motor. They must be placed dark side up—that's the light-sensitive face—and are wired as shown in the sketch. No switch is needed—the motor is automatically off when no light is on the cells.

The paddle wheel is the fussiest job, but comes out looking like a delicate jewel. The blade supports are two eight-armed spiders cut from 1/64" sheet brass. This can be obtained at hobby shops or as shim brass from auto stores.

The arms of the spiders are bent at right angles to each hub, and the hubs are soldered to a 3/32" o.d. brass tube for a shaft. The thin-aluminum paddle blades are bent around the arms and cemented. Cut the paddles with a razor blade against a straightedge to avoid buckling them with shears. The blades are braced by a wire strut cemented around each spider at the tips of the arms.

The large pulley on the paddle wheel is turned from aluminum, but could also be built up with a balsa disk for a hub and cardboard flanges. Cement holds it on the spider without solder.

Friction is kept low—a must with solar power—by cementing a short length of 1/16" o.d. brass tubing in each end of

[Continued on page 176]

NEWEST SUN CELL available is this plastic-encased type just introduced by International Rectifier. Each contains two separate cells sealed under a plastic light-collecting lens. Model boat runs well on one, even better on two of these.



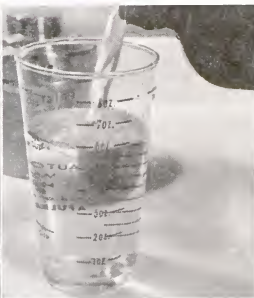
Darkroom Aids from the Kitchen



BLEACH BOTTLES are brown in color, tailor-made for storing light-sensitive chemicals.



PASTRY BRUSH is a fine tool for daubing stock developer on an area that's slow to come up.



MEASURING CUP from the kitchen is always useful, especially if it's graduated in ounces.



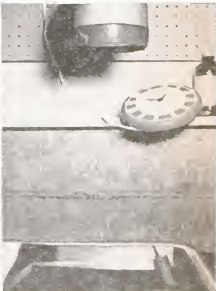
WIRE WHIP does a fast job of mixing developer, lessens chance of insufficient mixing.



CUP HOOKS make it easy to hang up film-developing reels for fast drying after they're used.

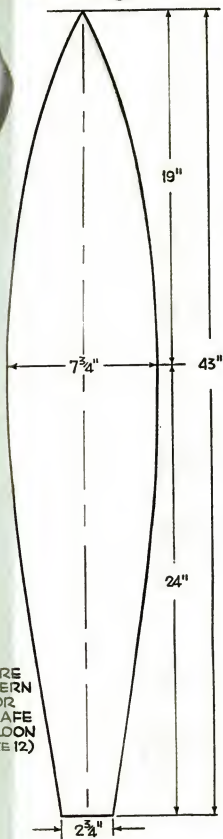


DISH MOP is useful in the darkroom for cleaning corners of sinks, trays, and tanks.



SECOND SWEEP on a kitchen clock is as good as a timer when you're developing prints.

They're



GORE
PATTERN
FOR
CARAFE
BALLOON
(MAKE 12)

INVERTED CARAFE, soaring over members of the Wingfoot Society (left), won last year's race. It's made of 12 identical segments, or gores. Pattern above is for smaller version—about 25" in diameter and 32" tall.

Bringing Back Hot Air Balloons

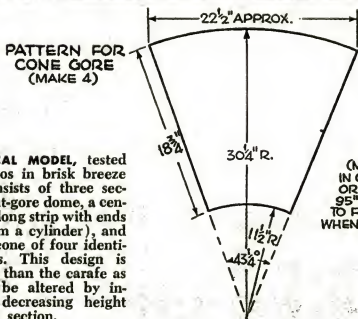
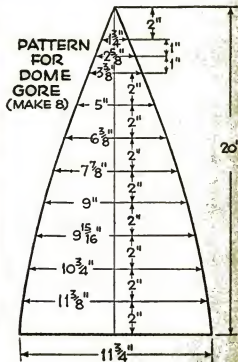
And you, too, can join in the fun. Here's how to build
and fly two tissue-paper models designed by an expert

By Walter E. Burton

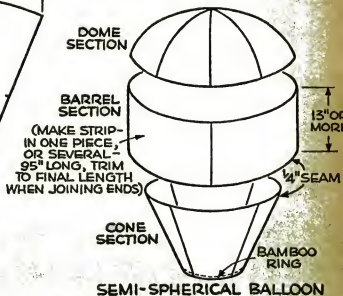
EARLY in this century, hot-air balloons were a familiar sight at county fairs. Folks squirmed impatiently through Fourth of July oratory while a crackling fire rippled air up into the gaping mouth of a big muslin bag.

Knickered lads itched with envy as they watched the barnstorming balloonist test his gondola ropes. At last, toward evening, it was time for the main event: the Death-Defying Balloon Ascension!

Those days will be recalled in Akron, Ohio, this month. The seventh annual picnic of the Wingfoot Lighter-Than-Air



SEMI-SPHERICAL MODEL, tested by Jim Contos in brisk breeze (above), consists of three sections: an eight-gore dome, a center barrel (a long strip with ends joined to form a cylinder), and a truncated cone of four identical segments. This design is more flexible than the carafe as volume can be altered by increasing or decreasing height of the barrel section.



Here are four steps in pasting up the semi-spherical model,



CARDBOARD TEMPLATES speed cutting of tissue-paper gores. Shape shown is for dome section. If knife is sharp, four gores can be cut at once, using hardboard as a cutting surface.



TO PASTE SEAMS, shift top gore on stack to expose $\frac{1}{4}$ " of edge on one beneath. Apply library paste thinly to exposed edge; fold up over top gore. Weights prevent shifting of tissues.

Society will feature a contest between member-built model balloons. Perhaps the kids at this picnic won't thrill to echoes of past glory—not in our era of space rockets and orbiting satellites. But it's certain they'll join their elders in the fun and challenge of getting the balloons inflated and launched—for this new modelmaker's hobby is one everybody can enjoy. That's one of the reasons why the Society (which started as an employee-activity group at Goodyear Aircraft) now mails its monthly bulletin to airship enthusiasts around the world.

The Society isn't a modelmaker's club, however. It is interested in all aspects of lighter-than-air activity, past and present, and many of its members have been aloft in full-size free balloons. Such a member is the Society's Historical Chairman, James A. Contos—one of the half-dozen licensed hot-air-balloon pilots in the U.S. Like the barnstorming heroes of the past, he makes his ascents in balloons he builds himself, but he's also an enthusiastic promoter of model-balloon flying. He's been making scaled-down balloons since he was a boy, numbering each design and keeping a log of its flights. Two of his favorite models are presented here.

What sends 'em up? The ancient principle of balloon flight couldn't be simpler. Hot air rises; when you wrap a volume of it in a bag with its opening weighted

[\[Continued on page 190\]](#)



HEAT BAMBOO STRIP over hotplate to make it pliable (don't scorch), then bend it around a bucket with 11"-to-12" diameter until it cools. Join ends as shown in sketch on facing page.

Now you're ready to inflate the

ALCOHOL-BURNING STOVE is made from two-gallon oil can set on asbestos pad and sheet-metal trivet to protect ground from scorching. Chimney is two bottomless cans placed over spout.



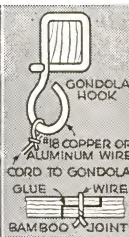
plus tips on making the mouth-ring and gondola



JOIN DOME HALVES after putting gores together in fours. Use the same type of seam, pressing with a putty knife to keep edge of top piece flat while bottom one is folded up over it.



AFTER ADDING BARREL to dome, attach the first of the four cone segments. They are seamed to bottom edge of barrel one at a time, then joined to each other. These are trickiest seams.



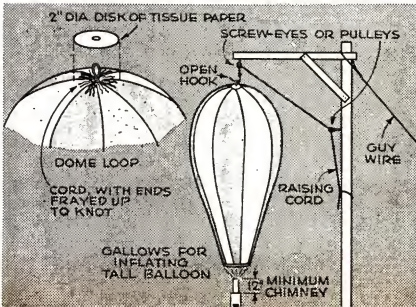
PASTE RING INSIDE MOUTH and reinforce seam with paper strip folded over it and lapped $\frac{1}{2}$ " over each side of balloon tissue. Before applying, attach hooks at 120-degree points.

PAPER-CUP GONDOLA may be necessary to keep inflated balloon upright. Three 18" strings suspend it from the ring hooks. Ballast sand can be added as needed after test launching.

balloon—the method depends on its size and the type of fuel

A DOME LOOP is necessary if you plan to use an inflating gallows, as shown. Keep balloon from lifting off hook until it's fully inflated. Loop's also handy for storing deflated bag.

PLAYING IT SAFE, these LTA fans fill their little pine-cone-shaped model at a 4'-high chimney. There's very little chance of the tissue paper igniting at this distance from the flame.



4 Designs for Weather Vanes

By

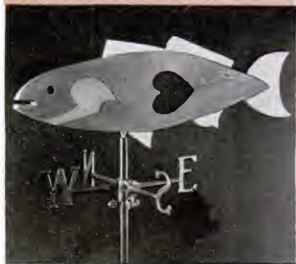
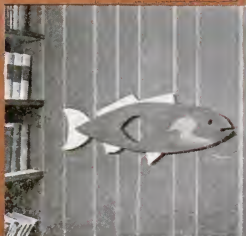
Steven Dohanos

Noted artist, illustrator, and instructor

EARLY-AMERICAN signs were often topped with scrollwork animals. Such creatures, now all but extinct, bring a high price in antique shops. Here are four original designs that capture the flavor of the past in contemporary terms.

One-inch squares will give you a pattern the right size for a weather vane; you can enlarge or reduce them for other uses. Finish the wood with stains or paints; for outdoor use apply preservative before finishing. All four plans are available for 50 cents from Stanley Tools, 111 Elm St., New Britain, Conn.

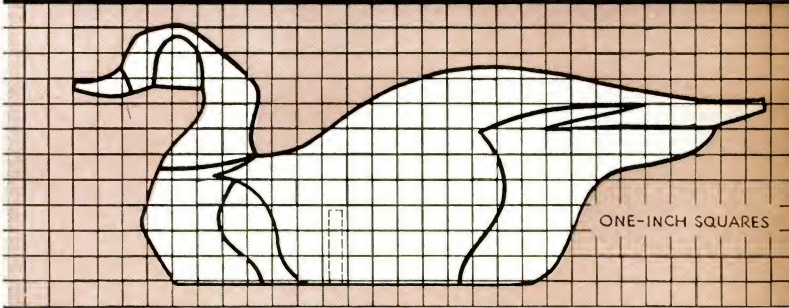
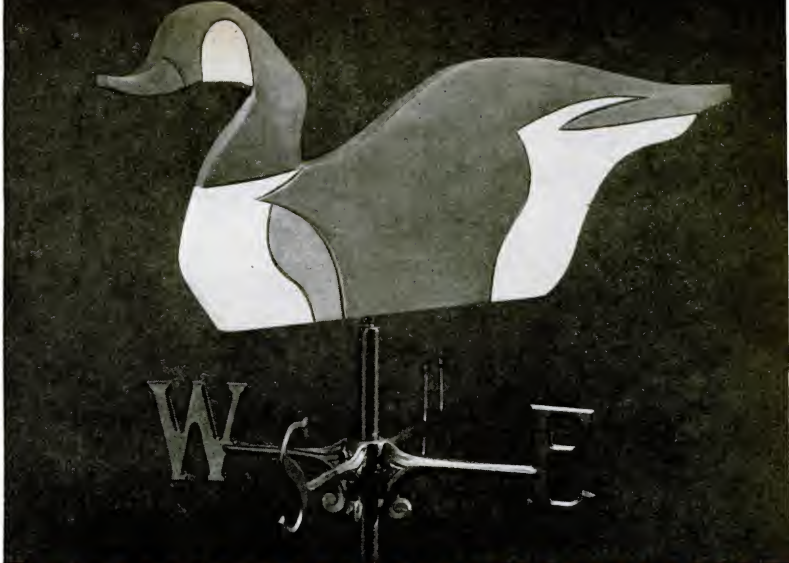
They don't have to go on the roof



Construction steps are

CUT THE OUTLINE, traced on the stock from enlarged pattern. A saber saw is the handiest tool for this. Dohanos chose 1" dressed cypress since it takes stains required for "inlay" designs.





similar for all four designs. Below, we form the goose

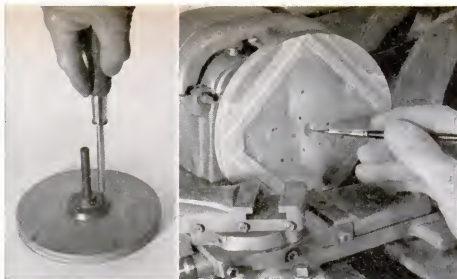
DIMENSIONAL EFFECT is easy with a bench plane. Taper the stock toward each end, leaving full thickness at center, where hole for standard is bored and lined with a metal sleeve.

FURTHER CONTOURING is done with a Surform file, or wood rasp. For filing and planing, work is anchored to the bench top with a C clamp, using a scrap block to pad the jaw.

QUICK FINAL SANDING can be done with drill-powered disk, as shown in photo. Interior lines of pattern are then traced on stock, incised with a carving tool to separate stain areas.



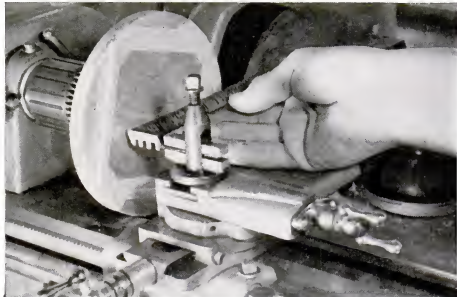
How to Cut Glass Disks in a Lathe



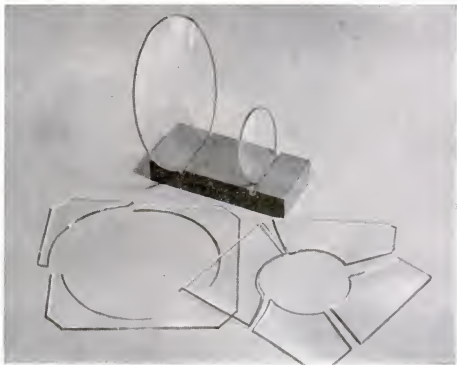
ASSEMBLE A HOMEMADE FACEPLATE with a shank that will fit head-stock chuck. Plywood disk must be big enough for square of glass, attached with masking tape. Apply center-dot of paint.

SCRIBING a circle with a glass cutter—freehand—is next to impossible. And it's almost as hard to trace around a circular template. Here's an easy way to cut clean, accurate glass disks of any size a lathe can handle.

Mount the $\frac{5}{8}$ "-plywood faceplate and true up the face before attaching the glass. Find the center by running the lathe at low speed and marking the spot with least circular motion. Saw the ball tip off an ordinary glass cutter so it can be mounted in the tool post. Lock the saddle and feed the cutter against the glass for one revolution, with the lathe running at lowest speed. (If you run a cutter over a previously scored line, you dull the blade.) Remove the glass and tap the back around the circumference before breaking.—*Gordon Douglas.*



FOR PRECISE SIZE, mount cutter in tool post, adjust to center height, and set proper radius.

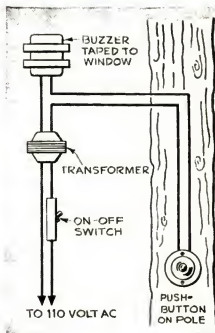


REMOVE SCORED GLASS from faceplate; make score marks from circle to edges to break off waste.



Short Cuts and Tips

FROM PS READERS



Long-Distance Doorbell

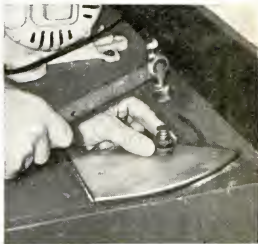
OUR five-year-old son needs help to cross a busy highway when he returns from school. His frantic calls for Mama often went unheard and disturbed the neighbors until we rigged up this long-

range "doorbell." It's connected by overhead wires to a pushbutton on a pole across the street and lets our son sound a buzzer in the house. Because of the voltage drop in the long wires, we taped the buzzer to the window for added volume.—*John B. Umhau, Chevy Chase, Md.*



Flathead Bolts from Roundheads

IF YOU suddenly find you need some seldom-used flathead bolts, you can forge your own from common roundheads this way. Drill a hole in a steel block to take the shank of a roundhead, and countersink the top of the opening. Heat the head red hot, drop the bolt into the hole, and pound the head flat. The slot will still be visible and can be enlarged to its original size with a hacksaw.—*Robert Micals, Freehold, N. J.*

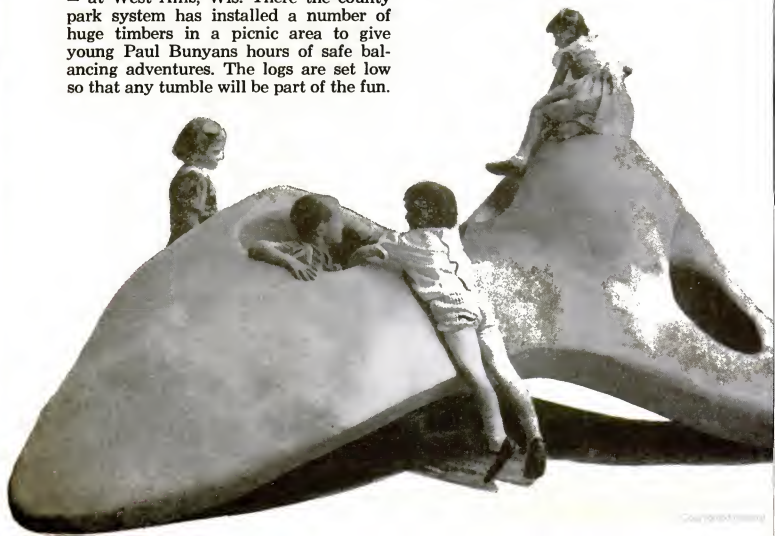


Pounding Block on Bench

STRIPPED of the heating element and other parts, the steel sole plate of a burned-out electric clothes iron makes a fine bench anvil. Drill and countersink two mounting holes. Mount the plate over a workbench leg for the most solid support.—*W. H. McClay, Pasadena, Calif.*

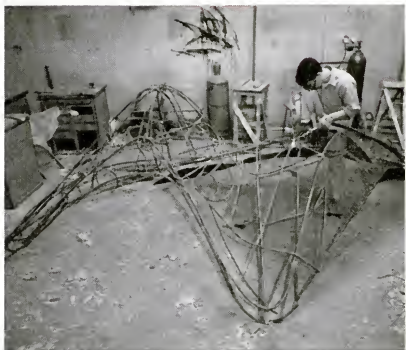


PLAY logs come big in Greenfield Park at West Allis, Wis. There the county park system has installed a number of huge timbers in a picnic area to give young Paul Bunyans hours of safe balancing adventures. The logs are set low so that any tumble will be part of the fun.





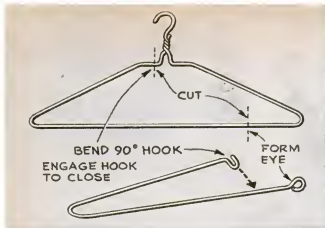
Offbeat Playground Equipment



A PIECE of play sculpture at the Putnam School playground in Athens, Ohio, gives youngsters a chance to explore caves and mountains; or slide, hide, and climb. It was designed and built by Dennis Dorogi, a sculptor. The cost: about \$150 for materials.

The framework consists of $\frac{1}{4}$ " metal

lath and $\frac{1}{2}$ " reinforcing iron, welded into the desired shape. Soil was mounded under this armature to form a mold for the under surface of the sculpture. Hardboard placed around the edges completed the mold for the concrete (a 1:3 mix of cement and sand), poured over the frame and troweled smooth.



Giant Pins Store Shop Parts

ONE look tells you whether a needed item is at hand when washers, hose clamps, eyebolts, or any parts with a hole are stacked on these big storage clips. Hung on the shop wall, they take up no drawer or shelf space.



Cut and bend wire clothes hangers as shown in the drawing above. Make the eye and the closing hook small enough so that the parts will slip over easily.—*Harry Walton, White Plains, N. Y.*

▶▶▶BEACH towels thrown over the car seats when you're coming home from a swim will stay in place better if you sew fishing sinkers in the towel corners. Eight-ounce weights will do the job nicely.—*John Langseder, Brooklyn, N. Y.*



"Extra Hand" for Soldering

LOOPING a coil of wire solder around a can of flux as shown above is almost like having a third hand when you're soldering connections. The coil of solder will sag after a time, but it's easily pulled back into position for the next job.—*W. H. McClay, Pasadena, Calif.*

Surgeon's Saw for Safer Shopwork

A PRECISION-BUILT electric surgical saw is now making a bid for home-workshop use. Don't get its manufacturer wrong. The Stryker Division of the Orthopedic Frame Co., Kalamazoo, Mich., doesn't want you dabbling in bone operations. On the contrary, their sales pitch is based on the fact that it's almost impossible to hurt yourself seriously with the saw. Yet its blade buzzes through wood, plastics, nonferrous metals, and even thin sheet steel. The action is moderately fast, and precise enough to suit the fussiest craftsman. The tool is versatile, too, thanks to a number of attachments.

Engineers at Stryker came up with this touch-sensitive Safety Saw more than 14 years ago. Old hands at designing surgical equipment, they were looking for a faster and neater way to remove casts after bones had mended. They knew that a portable circular saw would part the plaster in short order. But there was an equal chance of its putting a kerf in the patient underneath.

The secret: oscillation. Stryker's ingenious solution was a circular saw blade that didn't rotate. Instead, it oscillated just a fraction of an inch at very high speed. Result: Its double-edged teeth whizzed through the rigid plaster. But on striking flesh, they didn't cut; they simply joggled it back and forth. Then, as now, jittery patients usually yelled "Ouch!" at the moment of contact. That gave the doctors plenty of time to back off the blade.

An ingenious refinement in the 4" saw blade increased its usefulness, not only for splitting casts, but in bone-cutting operations. A pair of deep scallops divided the periphery into two sawing edges—one long for heavy work, the other short enough to cut between limits of less than an inch.

Two smaller and completely circular

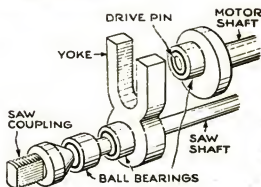


blades came along a bit later. One had very fine teeth for cutting and trimming metal and plastic pins; the other, a knife edge for slicing rubber, soft plastics, and textiles. This last, incidentally, is the only blade that can't be trifled with. Oscillating motion or no, it cuts like a razor on contact.

Rounding out the attachments is a gouge-shaped end cutter with a toothed edge. Using a shaft adaptor and blades premounted on special arbors, changeovers take less than 30 seconds.

The usefulness of the Safety Saw as a workshop tool is evidenced by an ever-increasing number of orders from big industrial outfits such as Westinghouse and G.E. Technicians, who probably spotted the saws in company clinics, wanted them for fine craftwork.

That's an important point. For conventional chores, the saw is only a fair substitute for an electric handsaw or saber saw. But you can't beat it for precision cutting, particularly in the tight spots—for feathering off edges of laminates without chipping, sawing holes for outlet boxes close to wall corners, trimming dowel pins, forming recesses for veneer inlays, grooving model parts to simulate



planking. And here's a neat trick: You can form a perfect hemispheric cavity by rotating a piece of workstock under the blade.

Easy to hold. The saw's certainty of control comes largely from its shape. Basically it resembles a hand grinder. But an extension of the shaft housing offers a firmer and more convenient grip close to the business end. At the same time, your hand is protected by the small box section containing the oscillating mechanism. For most sawing you can use a stroking motion.

The saw's one-amp universal motor is fitted with brushes designed to prevent arcing—a must for anesthetic-laden air. Ball bearings are used not only on the armature shaft but to cushion the off-center pin from the yoke that it rocks to produce the oscillation motion. The housing is heavy but comfortably balanced.

—Henry B. Comstock.

ONE-DAY PROJECT Fiber- Glass Patio Pool

By
John L. Parker



ATTRACTIVE GARDEN POOL can be made quickly by scooping a hollow in a flower bed and lining it with fiber-glass. Obtain fiber-glass matting, resin, and hardener from a marine-supply house.



LAY ONE-FOOT SQUARES of resin-soaked fiber-glass wet side up on bed of firmly packed sand. Overlap edges 1". Resin, with hardener added, is brushed onto squares on flat, clean surface.

AFTER EVERY FEW PIECES, blend in seams with additional resin to give appearance of single molded surface. Touch up any spots not fully saturated. Wear throw-away plastic gloves.

CASCADE CHANNELS can be formed by bridging resin-coated rocks with resinated fiber-glass strips. A 24-volt pump at pool's lowest point circulates water to spill down rocks (top photo).



**Your best bet for a
low-pitched roof:**

Half-Lap Roofing

FOR the very gently sloped roofs found on many modern homes today, your choice of roofing is limited:

- Where the roof pitch is 2" in 12" or less, you can't use shingles—wind and rain get under them and cause leaks.

- Built-up roofing is good, but costly and heavy, sometimes requiring a beefed-up roof to support it.

- That leaves half-lap roofing, made especially for the job. It's tough, economical, and easy to apply.

Half-lap—also known as duplex or salvage roofing—comes in the same long strips as standard coated-asphalt roll roofing. But here's the difference: Instead of overlapping only 2" at the edges, each course is lapped more than halfway over the one below it. This gives you double-layer coverage over the entire roof and triple coverage at seams. A combination of nailing and cementing keeps out wind and rain.

The exposed half of half-lap is surfaced with the same mineral granules as shingles and is available in most of the same colors. There's also a special narrow type designed to look like shingles.

You'll pay about \$3.25 for each roll of regular half-lap and \$4.25 a roll for the narrow shingle style. A roll of either covers 50 square feet.

The materials you'll need. For each roll of roofing, figure on one gallon of cold-application roof cement

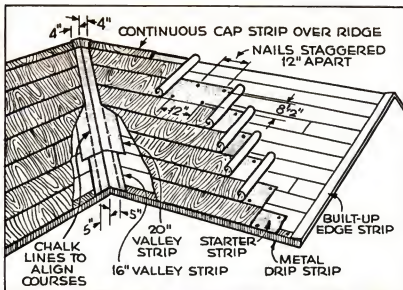


HALF-LAP GOES ON FAST when you use this trick. Nail the strips first, then roll back the free edges and brush on the cement all at one time, as above. Fold the strips down over the cement, as below, and walk back and forth over each several times to embed it firmly.





METAL DRIP STRIP, 8" wide, is first nailed along the roof edge to carry off water. Extend it $\frac{3}{8}$ " beyond the roof, bed it in cement, and stagger nails 4" apart, 1" from each edge.



ENDS OF ROOF must be built up slightly to direct water away. Nail down an 8"-wide strip of roofing or a redwood or cedar clapboard, thick edge outward, so it overhangs roof $\frac{3}{8}$ ".



WHERE STRIPS JOIN, overlap the ends 6". The underneath end is nailed, and top one is cemented over it to hide the nails. There should be one end joint every 20' to avoid buckling.

and 1 to $1\frac{1}{2}$ pounds of nails. Over bare sheathing boards, use nails $\frac{3}{4}$ " to $\frac{7}{8}$ " long. If there are rigid insulation panels over the sheathing, pick nails long enough to pass through the insulation and well into, but not through, the sheathing. Over old roofing, use nails 1" to $1\frac{1}{8}$ " long. The best kinds are galvanized threaded or aluminum screw-type roofing nails. These won't pop—the most common cause of roof leaks.

Put down asphalt-saturated felt first, if it's specified for the type of roofing you buy or by local building codes. Lap it 2" along the edges of the strips and 6" at the ends. Use just enough nails to hold it until the roofing is applied. Felt is cheap. A roll that will cover 432 square feet costs less than \$3.

How half-lap is applied. The first roofing strip is always started at the lower edge of the roof, and succeeding strips are laid upward toward the peak. This way, all overlapping edges point downward and shed water instead of catching it. A "starter strip," half the width of a

full strip, is put down first at the edge of the roof for extra protection. A metal "drip strip," consisting of an 8"-wide piece of flashing, is also nailed down along the edge of the roof under the starter strip to carry off water.

You nail only through the upper, concealed half of each strip, called the selva. The overlapping half of the next strip then covers the nailheads so that no holes are exposed to the weather. Nails are usually staggered about 12" apart along the horizontal and $8\frac{1}{2}$ " apart on the vertical, as shown in the drawing. Specifications may differ somewhat, however, according to the type of roofing you buy. Follow the manufacturer's recommendations.

The cold-application cement, in turn, is used only under the exposed, unnailed half of each strip. This seals down the free edges so that no nails are needed where they would be exposed. The cement requires no heating to soften it, but will flow more easily if you keep it stored in a warm place.

Before you start nailing, it's best to unroll the strips, cut them into the required lengths, and allow them to lie flat awhile. This permits them to expand first so they won't expand and buckle after they're fastened. On large roofs, the strips should also be cut and end-lapped every 20' to avoid long runs that cause buckling.

Valleys, hips, and ridges. When you come to a roof valley, you'll need an extra roll of standard 90-pound roll roofing in the same color as your half-lap. This is to line the valley and form a trough.

Cut the roll lengthwise into two strips, one 16" and one 20" wide. Run the 16" strip down the middle of the valley, granule side down, facing the roof. Cover this with the 20" strip centered over it with the granule side up. Nail both strips only enough to hold them in place. Some manufacturers recommend bedding the strips in roofing cement for good measure.

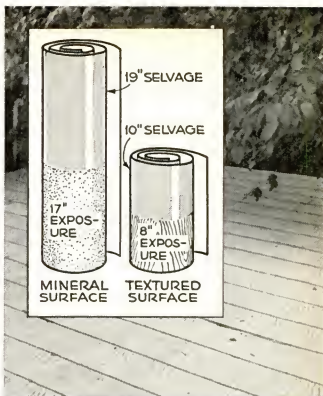
Snap a chalk line down each side of the valley, 4" from the center at the top and widening to 5" at the bottom. These are guides for lining up the ends of the horizontal roofing strips. For a snug fit, cut a 2"-sided triangular notch from the upper corner of each roofing strip where it meets the chalk line and bed the end in cement. Without the notches, you'd have a thick, triple-layer build-up at these points, making the ends hard to seal tight.

Hips are rarely found in low-pitched roofs, but if you do encounter one, cut the roofing into 12"-wide strips and bend them around the corner to cover it. Overlap the strips, nailing the upper selvage edges and cementing the lower exposed edges as you would with regular roofing strips.

The roof ridge is covered with a continuous cap strip after all other strips are on. For this, trim off the selvage and use only the granule-surfaced half. Run this lengthwise along the ridge, lapping it halfway down each side. Bed it in cement and use no nails.

Adding flashing. In new construction, use standard metal flashing around chimneys, vent stacks, and wherever the roofing meets the side of an adjoining structure.

In reroofing, carry the half-lap right



HALF-LAP COMES IN TWO WIDTHS, as shown in sketches. Standard type is 36" wide with 17" exposed. Narrow style, exposed only 8", is designed to look like regular shingles, as seen in photo. Called Ranch Roof, this shingle type is made by Bird & Son, East Walpole, Mass.



IF CEMENT OOZES OUT from under the laps, don't attempt to remove it—a tough job. Brush loose colored granules over it and they'll stick tightly, forming a perfect cover-up.

up over the existing flashing to a height of about 6". Place "cant strips"—triangular strips of wood—under the roofing where it curves upward to avoid a sharp, right-angle bend that might cause breaks. Bed the ends of the roofing in plastic roofing cement (this is thicker than the cold-application cement used elsewhere). Cap the upper edges of the roofing with an extra strip of roofing or metal flashing lapped over them. Where possible, tuck the edge of the cap strip into masonry joints or under siding boards. ■ ■

Restoring Brightness to Coated Metals

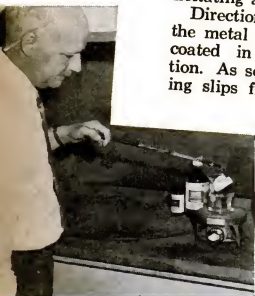
Coating-Remover Formula

1 cup ammonium hydroxide, 12% solution
1 tablespoon aniline

COMBINE in a heatproof-glass baking dish. Heat to almost boiling where a good draft of air will carry off irritating and toxic vapors.

Directions for use: Dip the metal object to be de-coated in the hot solution. As soon as the coating slips free, remove the

metal object with forceps. Rinse under a stream of cold water. The piece is now ready for working, testing, or refinishing. Coatings extremely difficult to remove may require scrubbing with a rubber spatula after treatment with the coating remover.



METALS SHINE BRIGHTLY after a quick dip in a powerful new coating remover, demonstrated here by its inventor, Charles H. Coleman.

removers take ages or won't work at all. It has no effect on the metal itself; other chemicals often pit or dissolve the surface.

The method is especially good for restoring the luster to knobs, hardware, and other brightwork where the lacquer has partially

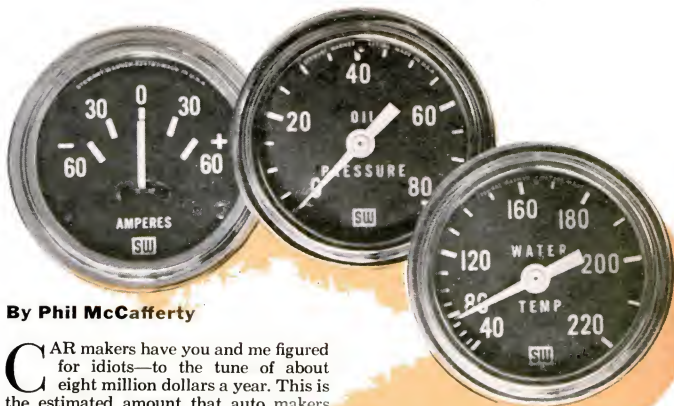
worn off, allowing the metal to tarnish. With the remover, you can take off all of the old lacquer quickly, polish the metal, then relacquer it for a good-as-new shine. Paint peels off where not even a wire brush could reach it.

Ordinary 3-percent household ammonia can be used, but a stronger 12-percent solution is recommended for faster action. This can be made by diluting standard 58-percent ammonium hydroxide. Mix one cupful to a quart of water and keep it stored in a tightly stoppered jug. The aniline is added just before you're ready to use the remover.

One caution: Both ammonia and aniline are toxic and can cause injuries. Work only in a well-ventilated area, wear rubber gloves, keep your eyes away from the chemicals, and don't breathe the fumes. If any liquid gets on your skin, wash immediately with soap and water, then rinse with vinegar.

EVER wished you could restore the sparkling brightness to metals that have become dull, grimy, or covered with paint? With a powerful new chemical remover, you can. It will take off any kind of paint, lacquer, even the toughest phenolic and epoxy resins, in a few minutes. Intricately shaped objects that can't be scraped clean, such as tools, metal buttons, jewelry, plaques, and decorative hardware, can be washed bare and shiny by simply dipping them in the chemical.

The special remover was devised by Charles H. Coleman, chief of the Testing Branch of the Military Subsistence Testing Laboratory in Chicago. Its patent rights have been assigned to the U.S. Government, but anyone can make and use it. It's a simple solution of ammonia and aniline—both readily available from drugstores and chemical-supply houses. It's said to work in minutes where other



By Phil McCafferty

CAR makers have you and me figured for idiots—to the tune of about eight million dollars a year. This is the estimated amount that auto makers save by selling us little blink-out bulbs—known to fervent nonbelievers as “idiot lights”—on five million new cars instead of fitting them out with more meaningful gauges.

Not everything about blink-outs is bad. They do give a conspicuous warning when something is seriously amiss. But they don't tell enough, or tell it soon enough, to be wholly reliable. That car buyers aren't happy is attested by the fact that gauge makers gleefully sell some quarter of a million accessory instruments a year to people who insist on knowing what's going on under their hoods.

A lot has happened since POPULAR SCIENCE first told its readers how to install “The Gauges Detroit Left Out” back in October, 1956. For one thing, some makers have whacked off another instrument—this time the water-temperature gauge.

One short-tempered driver dealt swiftly with this newest substitute blink-out when it had the brass to glow brightly, telling him his engine was “cold” after he'd nearly frozen his hands scraping ice and installing chains one sub-zero morning. He jerked open the hood and ripped out the wiring.

This latest device to save a buck is intended to douse one light when the engine warms up (presumably when it is safe to pour on the coal), then turn on a second light when the engine is about

Let's Bring Back the Missing Gauges

to have a heat stroke. But its designers have lost sight of such old-fashioned ills as leaking radiators, mountain-driving overheating, and freeze-ups.

There's little consolation in being told your engine has overheated *after* it's done it. With those wonderful old-time gauges, a climbing needle gave you warning *before* you got into trouble.

The basic blink-out principle is contrary to all rules of safety. Blink-outs do not “fail safe.” The system operates on the assurance that all is well when the lights are off. If a bulb burns out while you're traveling, you've lost your warning system.

Sure, most indicators remain on momentarily during starting, which makes it possible to check them for burnouts. But



New Gauge Kits simplify the buying and mounting of accessory instruments for your car. They include all hookup parts and attractive mounting panels, chromed or painted, designed for easy installation under the dash. Panels are available for one, two, or three gauges. You can also get bullet-shaped housings for on-the-dash mounting of single gauges.

One of the newest kits is the two-gauge type shown above, made by Stewart-Warner. It includes a handsome white plastic panel and a small behind-the-panel light that illuminates the instruments for night reading. Kits are available at auto-supply stores and mail-order houses, and some electronics-supply houses.

this has been known to have problems.

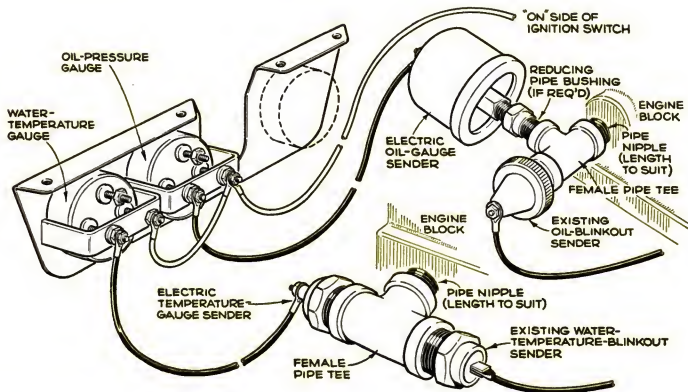
Consider the Midwestern husband who carefully lectured his young wife on the importance of watching gauges, then traded in the old car for a new blink-out model. Anxious to try it out, the wife

fired it up the minute it arrived without waiting for her husband to come home. Panicked by three glaring lights, she assumed the worst, threw open the hood, and was met by the smell of new engine paint burning. Without hesitation, she popped off the cap and filled the crankcase to the brim—with water.

The big blink-out gripe is that the lights fail to tell the *degree* of what is taking place. Most oil-pressure blink-outs turn off at about 10 to 15 pounds' pressure. Yet this is not nearly enough to lubricate an engine at 70 m.p.h.

The generator blink-out, unlike an ammeter, tells only whether or not the generator is producing current, not how much. You can be heading for a dead battery if you are using more current than the generator is producing. A battery can also be ruined by pouring an excessive charge into it, and over-production can kill a generator. Yet in all cases the generator is working, so the light is off.

The lights hide the secrets that a sinking, climbing, or fluctuating needle can reveal. Because of this, blink-outs are one of the greatest things that ever happened to a shady used-car dealer.

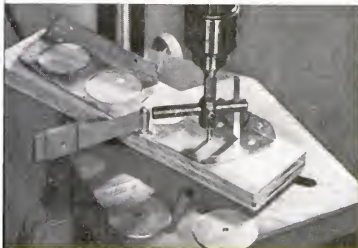


ELECTRICAL GAUGES need only to be wired to sending units in engine block. By substituting pipe tees for original blink-out senders, both

new and old senders can be attached to same engine-block openings. Use pipe fittings to match thread sizes of senders and engine.

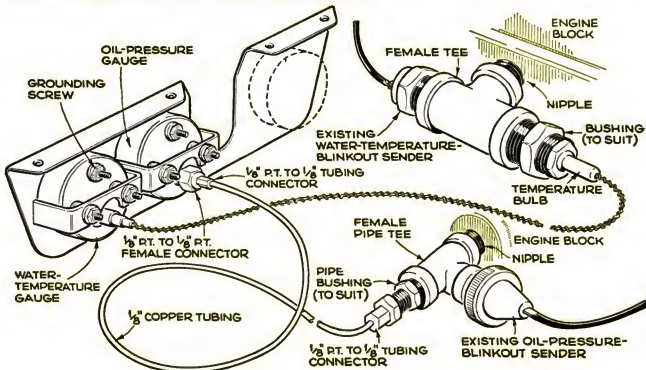
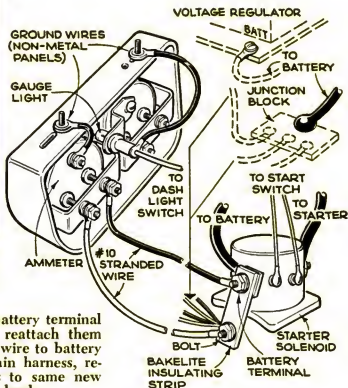
One shrewd used-car buyer headed straight home and installed an oil gauge and ammeter. It cost the dealer a set of main bearings to boost the mediocre oil pressure the gauge revealed. The ammeter also told a secret by wiggling its needle almost imperceptibly—a sure sign of worn-out generator brushes. The dealer paid the tab.

The accompanying drawings show how you can install your own missing gauges. Special hookups are used so you can add the gauges and still keep the original blink-out lights. Ammeters and oil-pressure and water-temperature gauges are available at auto-supply houses for \$5 to \$10 apiece, or in matched pairs for about \$15 a set.



CUSTOM-STYLED GAUGE PANEL can be made to suit your own car. Cut a cardboard template to fit under the dash and transfer this to sheet metal or plastic. Cut holes with a fly cutter.

TO CONNECT AMMETER, remove all wires from battery terminal on starter solenoid, except battery cable, and reattach them to new terminal on plastic strip, as at right. If wire to battery terminal on voltage regulator doesn't go to main harness, reconnect it and any other junction-block wires to same new terminal. If gauge shows "discharge," reverse its leads.



MECHANICAL GAUGES require direct connections to the engine block. Hookups are the same as for electrical gauges at left, except that tubing

must be run from the pipe tees to the gauges. If temperature bulb won't fit inside tee, use a larger tee with reducing adaptors.



NOW HEAR THIS: **Earphone Stereo**

For pure, no-bounce stereo, try phones. And with this \$13 amplifier, you can add stereo to a standard phonograph

By Steven Hahn

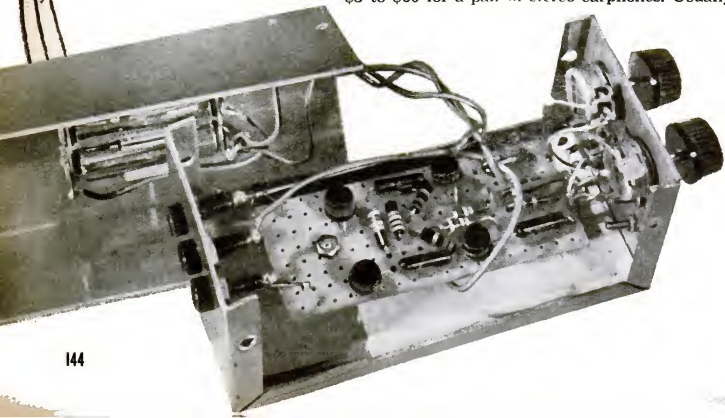
YOU won't believe your ears the first time you hear stereo sound with a pair of stereo earphones. The effects are unique—and exciting enough to cause growing numbers of record buffs to shut off their expensive dual-speaker systems in favor of the phones for their most dedicated listening.

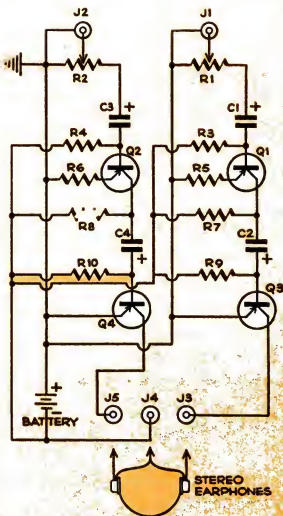
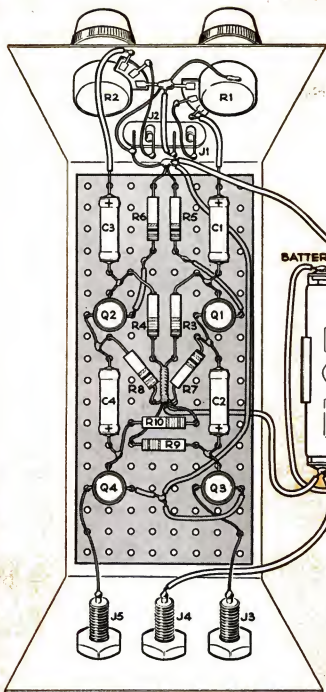
You can easily add stereo phones to any stereo player. Or you can get true stereo sound from an ordinary mono player for as little as \$15 to \$20. All you need is a simple transistor stereo amplifier you can build yourself, stereo headphones or standard phones modified for stereo, and a stereo pickup cartridge.

Stereo sound with earphones avoids a fundamental problem that always plagues loudspeaker stereo. With speakers, the stereo effect gets muddled as some of the sound intended for the right ear bounces around the room and reaches the left, and vice versa. With earphones, this can't happen. There is no intervening airspace to scramble the signals.

Stereo earphones. You can pay anywhere from \$3 to \$60 for a pair of stereo earphones. Usually

TRANSISTOR AMPLIFIER lets you convert any record player for stereo listening without altering the existing amplifier. Two pen cells, good for a month, furnish the power.

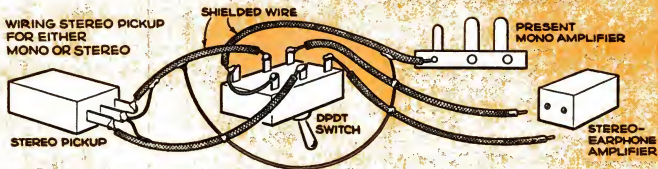




PARTS LIST

- R1, R2: 1/2-megohm potentiometer
- R3, R4, R9, R10: 470,000-ohm, 1/2-watt resistor
- R5, R6: 47-ohm, 1/2-watt resistor
- R7, R8: 6,800-ohm, 1/2-watt resistor
- C1, C2, C3, C4: 2 mfd., 6-volt, miniature electrolytic capacitor
- Q1, Q2, Q3, Q4: 2N324 transistor (G.E.)
- J1, J2: Double RCA-type phono jack
- J3, J4, J5: Insulated phone-tip jacks
- B: 2 Eveready #915 penlite cells
- Misc: Aluminum Minibox 2 1/4" x 2 1/4" x 5"; perforated circuit board, 3 1/4" x 1 1/2"; battery-mounting clip

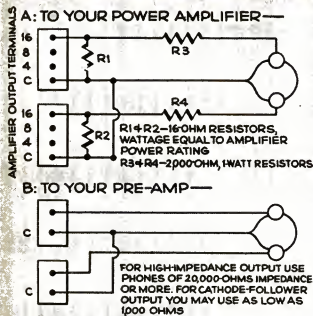
WIRING STEREO PICKUP FOR EITHER MONO OR STEREO



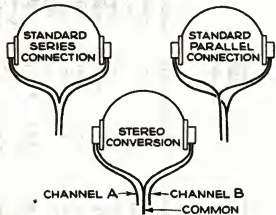
the cheapest is the standard magnetic type. Prices run from \$3 to \$15; impedance ranges from 1,000 to 10,000 ohms. They're simple, rugged instruments, but do not have as wide a frequency response as the crystal or dynamic types.

Crystal earphones use a piezoelectric crystal to convert electrical into acoustical energy—sort of a crystal phono pickup in reverse. High-frequency response is excellent and they are by far the most sensitive earphones available (they're

Connecting stereo earphones



How to convert standard earphones for stereo



quire the least electric power to produce sound).

They are, however, somewhat fragile to both mechanical and electrical shock. Avoid passing direct current through them. (A .1-mfd. blocking capacitor between the amplifier and earphones is the usual safeguard.) Prices vary between \$3 and \$25.

Dynamic earphones are actually miniature loudspeakers. They use the same moving-coil principle found in most speakers today. A frequency response of 20 to 20,000 cycles is claimed for the best of them—equal to that of the best loudspeakers available. The low-frequency response in particular will impress you if you are accustomed to the rather thin sound of ordinary earphones. A wide variety of impedances are available—six to several thousand ohms. Dynamic phones

are the most expensive; prices range from \$12 to about \$60.

The cheapest route to earphone stereo is to modify a pair of standard earphones you already own. A sketch shows you how.

Earphones naturally require far less power than speakers. If you are connecting phones to a power amplifier output, be sure to use the resistors as shown in the diagram.

Stereo pickup cartridges. To hear stereo from a standard mono record player, start by replacing the old pickup with a stereo cartridge. This won't interfere with playing mono records—in fact, your mono records will sound better than ever. The superior mechanical characteristics required of a stereo cartridge also make it better for mono. The diagram shows how to wire it using a D.P.D.T. switch to change from mono to stereo.

Transistor stereo amplifier. You need two separate amplifying channels for true stereo. Since earphones require very little power, you can do the whole job with a small battery-powered transistor amplifier and leave the amplifier in your record player undisturbed. Total cost of parts is less than \$13.

Mount the resistors, capacitors, and transistors on the perforated circuit board as shown in the diagrams and photos. Push wire leads through the holes in the board and solder connections underneath. Take care not to overheat the transistors when soldering them into the circuit.

Drill the cover of the utility box for the two volume controls and the input and output jacks. Mount these parts and the completed circuit board, and solder connecting leads. Mount the battery holder in the other half of the utility box and solder leads from battery to amplifier. You'll notice there's no switch. It's not needed since the amplifier draws practically no current when the earphones are disconnected.

Use shielded pickup wire from the pickup to the amplifier input. It should be no longer than 3' or 4'. The two volume controls allow you to balance the two signals. The earphones complete the electrical circuit of the final transistors so crystal earphones can't be used. Either dynamic or magnetic types will serve. Impedance should be between 1,000 and 5,000 ohms. ■ ■

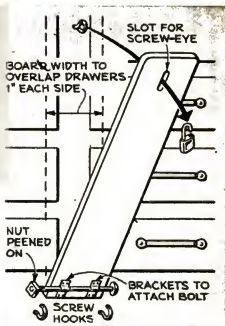


One Padlock Keeps 10 Drawers Safe

TOOL drawers needn't have individual locks. It's much easier and cheaper to lock them all with a hinged plate and one padlock. For short-term access to the drawers, the plate can simply be swung downward. For longer periods, it can be removed by lifting the hinged bolt free of the screw hooks.—*Hugh F. Williamson, Metairie, La.*

Short Cuts and Tips

FROM PS READERS



My Most Embarrassing Shop Moment

EVERY now and then I get a really brilliant idea. This time I talked my wife out of throwing away our old kitchen radio, explaining it would be a valuable source of spare parts for a new, similar set that I had just bought her.

Sure enough, the new set went dead one day, and a check showed the trouble to be a burned-out resistor. I removed the chassis from the cabinet, placed it beside the old chassis on my bench, and started probing for a resistor with the same color coding as the burned one.

About that time, our cat jumped up on the bench and began pawing at my hands for attention. I shooed her out and returned, a little irritably, to the radios. It was hard to see inside the chassis, so I just kept snipping out one part after another. I removed about two dozen resistors before I finally found the right one. Then I reached for the new set to install it.

You guessed it—distracted by the cat, I had mixed up the two sets and removed nearly all the insides from my wife's good



one. To make matters worse, a buddy from the plant where I work stopped in. When he managed to stop laughing, he dashed out to spread the word to all our friends.

I now have two old radios, my wife has a brand-new one that she won't let me touch, and I haven't laughed yet.—*Lyle Mace, Graham, Tex.*

7

Handsome Retaining Walls

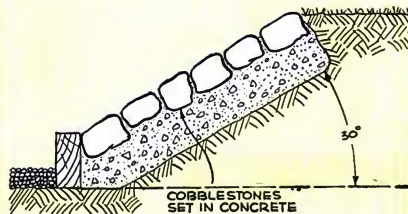
Sturdily built, they solve special earth-holding problems

A ROW OF IRRIGATION PIPES (right) makes an unusual retaining wall for M. L. Johnson of Ventura, Calif. Filled with soil, the concrete pipes have tremendous weight and form planters for bushes. Height can be varied to suit by sinking the pipes part way into the ground.



CURVED WALL FROM STRAIGHT BLOCKS is made by keeping bends gradual so sides look smooth. Used here by Harold D. Anderson of Hemet, Calif., it's a good way to break the monotony of a long wall. For maximum strength, as in top of photo above, take advantage of the arch effect by laying up the wall so that earth presses against the *outside* of the curve.

WALL THAT DOESN'T LOOK LIKE A WALL: The oversize planting boxes below add beauty, but their main function is to hold back the driveway on a hillside lot. Weight of earth inside them permits the use of ordinary brick without fear of its cracking. The stepped levels make maximum use of materials, prevent a massive look.



WALLS NEEDN'T BE VERTICAL to be good. This reclining type literally lies on top of the earth, holding it with very little weight and strength. Stones can be set in concrete, as they are here at the home of H. H. Jensen of Hemet, Calif., or they can be set in soil with a ground cover planted in the cracks to hold them in place. Best angle is about 30 degrees.



DOUBLE WALL FOR FOUR OR MORE COURSES

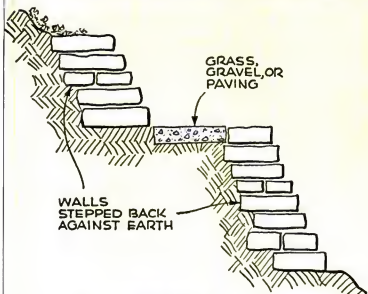


SINGLE WALL FOR THREE COURSES OR LESS

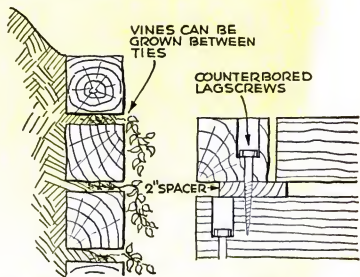


CIRCULAR TREE WALLS can save valuable plantings by holding soil around roots when surrounding land is graded lower. This one at the home of John Baker in Corona del Mar, Calif.,

is two bricks thick to support its five-brick height. For lower walls, a single row is adequate. Note the top row of edge-to-edge bricks used here for a pleasing finished appearance.



EVEN A STEEP SLOPE can be held in place and given useful level areas this way. By step terracing, walls are kept low and easy to build. These loosely stacked slabs, used by George M. Carter of Los Angeles, slant against the bank, relying on weight rather than strength to hold the soil. They'll give with frost but will settle back without falling, and need no footing.

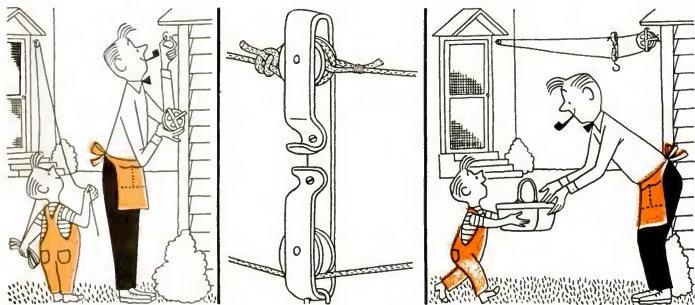
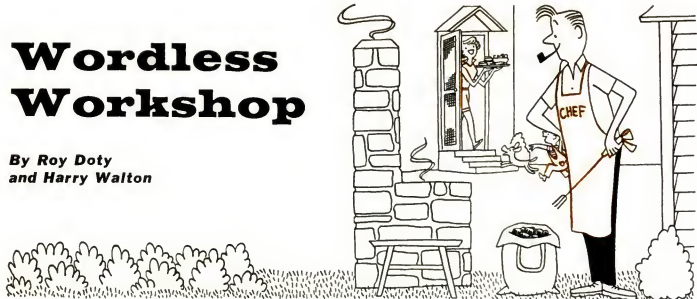


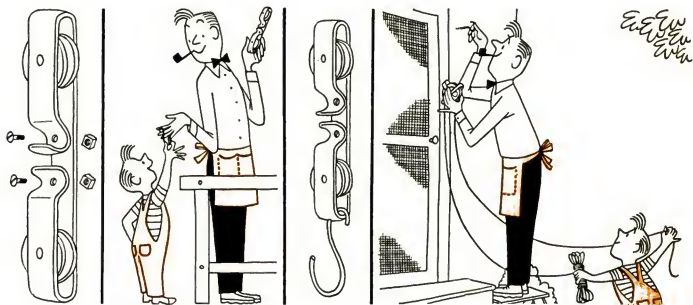
NEW TWIST FOR OLD RAILROAD TIES: Instead of being stacked solid, these timbers are separated by 2" spacer blocks. This gives good drainage and a more pleasing appearance. Discarded ties make a sturdy wall—and are often free. For extra strength, tie them together with large lagscrews. Exposed to air this way, they rot slowly and should last a lifetime.



Wordless Workshop

By Roy Doty
and Harry Walton







Here's how the pros go about—

Patching a Fiber-Glass Boat

By V. Lee Oertle

FIBER-GLASS and resin—the same materials used to make a fiber-glass boat—are used to patch it. With these tips from a pro, nicks, cracks, or even a hole staved in the hull can be repaired by the owner with scissors, paintbrush, and sandpaper.

Unlike wood, which splinters and caves inward over a large area on impact, fiber-glass, with its higher tensile strength,

usually fractures in longitudinal cracks. Such cracks are easily sealed, and hull strength restored, by covering them with a fine-weave fiber-glass cloth saturated with resin.

When a puncture does occur, a combination of cloth, resin, and filler material is used to close and reinforce it.

Extensive damage to the transom is best repaired by a professional. The motor puts a tremendous load on the stern, so the structural strength of the transom

CONTINUED

How to repair a hole in the side of a hull

SAND THE HULL around the hole to roughen the surface, and mask the area with tape and paper to protect the hull from resin spatters. Pick splinters and loose pieces out of the break.



CUT EIGHT-OUNCE FIBER-GLASS CLOTH to overlap the hole about 3" on all sides. This overlapping cloth, plus another laid on the inside later, will reinforce the hull at the break.

MIX RESIN PUTTY WITH CATALYST, and use putty knife to force it into the hardened depression in the cloth patch. Form slight mound with putty so it can be sanded flush when it sets.



APPLY RESIN around the hole, and press the patch in place while the resin is still tacky. Saturate the cloth with resin, press it into the hole, and brush out wrinkles and bubbles.

SAND THE PATCH SMOOTH after it has fully cured. Start with coarse paper and finish with wet-or-dry paper, feathering the edges of the patch carefully so that it blends with the hull.





FINAL COAT OF RESIN should be colored with resin pigment to match hull. Use a bit more catalyst in the mix to compensate for the retarding effect of the pigment on the curing time.



POWER BUFFING removes virtually all trace of the patch. Any pinholes or high spots will show up after buffing, so if you're very fussy, repeat the final coat to get perfection.

A second patch inside adds strength



AS A RESULT OF THE IMPACT, there will be a slight bulge on the inside of the hull. Sand the bulge flush, and cut an overlapping cloth patch as further reinforcement for the break.



INSIDE PATCH is applied in same manner as the one on the outside of the hull. After resin cures, apply putty and sand smooth. Finish with spatter paint to match interior of boat.

must be restored to the maximum. Punctures larger than 12" in diameter also require professional treatment, since a poorly applied patch can affect the performance of the boat.

How to buy materials. Most marine dealers carry patching materials. Measure the damage and buy enough fiber-glass cloth to overlap about 3" on all sides. Polyester resin is used for most repair jobs requiring a cloth patch. It can be applied over fiber-glass or bare wood,

and covers about 25 square feet per quart. One quart should be ample for several repairs, since you mix with the catalyst only what you need.

Scratches or small gouges can be filled with epoxy putty. Milled glass fibers can be mixed with resin to make a strong filler for deep gouges.

Handling the materials. Cut the cloth to size before mixing the resin, and have all tools ready for use. If the puncture is large enough to require temporary

Bottom patches can be applied only from the outside



TURN THE BOAT UPSIDE DOWN and sand the area around the break. Most fiber-glass boats have a double bottom, which makes it impossible to reinforce the patch from the inside.



CUT AN OVERLAPPING PIECE of fiber-glass cloth, center it over the puncture, and press it about $\frac{3}{8}$ " below the surface of the hull. Pour resin over the cloth to saturate it.



BRUSH OUT WRINKLES and bubbles, and press the saturated cloth into firm contact with the edges of the break. Flow resin at least 1" over edges of cloth to make feathering easier.



FOR EXTRA STRENGTH, mix resin with milled glass fibers, and pour the resulting batter into the depression after the cloth has hardened. Allow the mixture to cure thoroughly.



FINISH THE SAME AS A SIDE PATCH. Sand as near flush with the bottom as possible to eliminate bulge that could affect the performance of the boat, and apply final coat of resin.

backing up, coat cardboard with paste wax and tape it to the inside of the hull.

The best temperature for repairing is between 70 and 80 degrees. In this range, mixed resin will harden in about a half hour. An increase of 15 degrees will cause the resin to cure twice as fast, cutting down your working time, so avoid applying resin in the sunlight.

Mix resin and catalyst carefully in exact proportions recommended. Mix in clean, unwaxed containers. Rubber gloves

will protect your hands if resin tends to irritate your skin. Use expendable brushes or a cardboard squeegee to spread resin over flat areas.

Colored resin to match your boat can be applied for the final coat after sanding the patch smooth. When dry, it can be wet-sanded and buffed to blend with the surrounding area.

Unused resin and catalyst should be stored in a cool place, away from sunlight, to prolong shelf life. ■ ■

Short Cuts and Tips

FROM PS READERS

Trick for Cutting Plywood

WHEN plywood overhangs the saw table and can't be guided by the fence, move the saw. Set it parallel to, and the needed distance from, a wall, the front edge of your workbench, or any other smooth vertical surface. Press the end of the panel against this surface and maintain side pressure while you slide it along to guide the cut.—*Jackson Hand, Westport, Conn.*

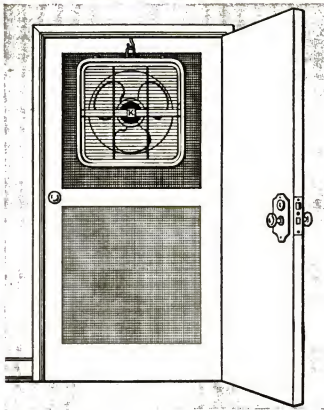


▶▶▶ A LAYER of gravel on top of the soil in a window box is a good idea. It will keep rain from spattering mud on the panes.—*M. Krucker, Davenport, Iowa.*



Sign Rolls Out to Work

GOT a large sign that you use in various locations, or only during certain seasons? Put it on wheels. Ray Brown of Bradley, Calif., rolls this one into the garage when he closes up his service station each evening. The sign is spring-mounted in a pipe frame attached to a dolly made from the frame and rear axle of a Model T. The front rests on a caster.—*E. V. Reyner, Salinas, Calif.*



Reversible Screen-Door Fan

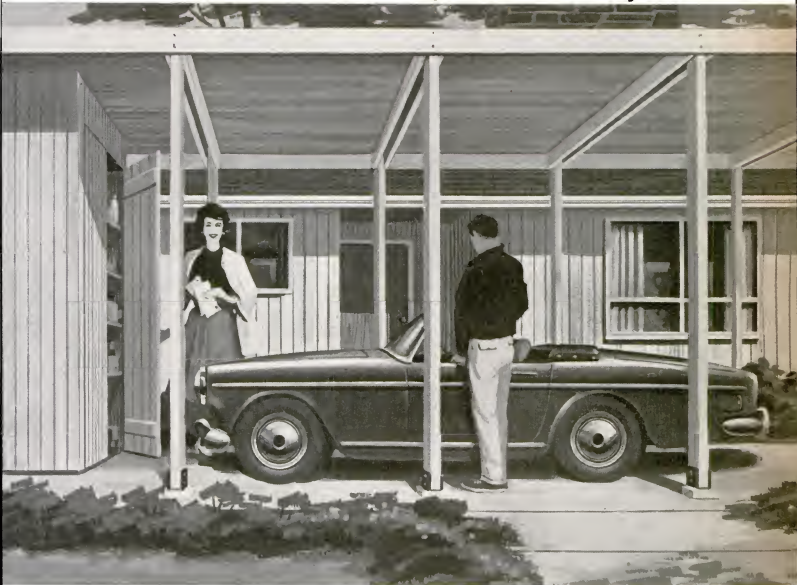
WHEN we moved to a new home, we took our 28"-square window fan with us, but none of the windows were wide enough for it. We now hang the unit from a hook driven into the top member of the doorway. This suspends the fan between the inside door and the screen door. Depending on which way we hang it, hot air is exhausted or cool air is drawn in.—*Paul Burch, Albany, N. Y.*

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New Ideas in Photography



BIG EASY-TOUCH EXPOSURE LEVER on front of Kodak Automatic 8 Movie Camera is handy when you grab the camera for a sudden picture opportunity. Camera is smart two-tone aqua color, weighs only 20 ounces.

Meet Kodak's Lowest-Priced Automatic Movie Camera!

Have you noticed how many people are taking *movies* this summer? One reason is the smart camera above—the new Kodak Automatic 8 Movie Camera. There's nothing to set, nothing to remember. Electric eye sets the lens opening for you—continuously, *automatically*. And the camera is always in focus.

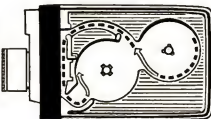
Result: Anyone can get sharp color movies from the very first. Priced at less than \$50, the Kodak Automatic 8 brings a top-notch

automatic movie camera within reach of almost every family. How about yours?

Check these facts about the Kodak Automatic 8 Movie Camera. They spell *quality*:

- Fast $f/1.6$ lens.
- Built-in "Type A" filter lets you use same roll of color film indoors and outdoors.
- Electric eye can be set for film-exposure indexes 10, 16, 25, and 40.

FILM-LOADING is fast and simple, thanks to recessed film channels and directional arrows.



Parallax correction
Indicator warns if light is too dim
Arrow tells when filter is in position

BRIGHT VIEWFINDER includes three important aids.

from Kodak

- Pre-stressed spring for even camera speed; positive cutoff at end of film run.
- Accepts Series 5 lens attachments directly.
- Bright finder for quick, easy aiming.
- Footage indicator shows amount of film remaining; resets automatically.
- Up to 40 average-length scenes on a single roll of 8mm film.
- Has sockets for light bar, tripod.

Right now is the best time for outdoor movie-making. See the Kodak Automatic 8 Movie Camera—and start taking movies *this* weekend!

Now—power film-wind keeps you "Always ready for the next shot"

Now fast-action picture sequences are as easy as single shots! A new Kodak 35mm camera—the Motormatic 35—has a spring-power film drive and automatic electric eye. They keep you always ready for the next shot—no pictures lost while winding film or setting exposures.

You can snap as many as 10 pictures in 10 seconds without even taking the camera from your eye. As soon as you shoot, the film zips forward to the next frame. If the light changes, the electric eye adjusts the lens opening automatically!

How power-wind works. The entire "power plant" is built into the baseplate of the camera, only about 5/16-inch deep. It consists of a powerful spring, gear train, and two speed-control governors—one a centrifugal brake, one aerodynamic.

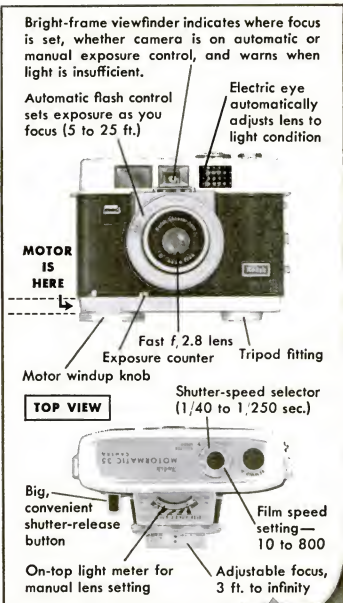
Turn the windup knob, and you store enough energy for ten pictures. Now press the shutter button. The shutter clicks; then the spring's power goes automatically through the gear train to advance the film exactly one frame—and cock the shutter for the next shot. The action takes only 3/5 of a second—with a smooth, steady pull that puts no strain on the film.

Automatic flash control assures good

exposure in flash shooting. Eliminates computing, thus makes it easier and quicker to change your distance. Just set the focus . . . 5 to 25 feet . . . and lens automatically sets to right opening.

Ideal family camera. Unlike most advanced-type cameras, the Kodak Motormatic 35 is especially easy for a beginner to use. Yet it lets him take pictures beyond the capability of most simple-to-use cameras. At the same time, the Kodak Motormatic 35 Camera offers the skilled picture-taker exciting new opportunities for fast-action shots. See *all* its features at your Kodak dealer's. Less than \$110.

Prices are subject to change without notice.



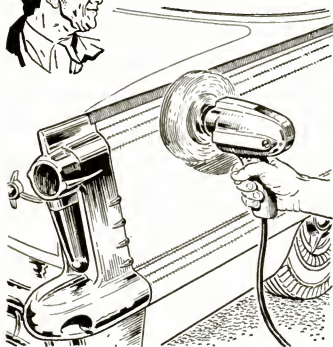
See your dealer for exact retail prices. Many dealers offer terms as low as 10% down

Kodak
TRADEMARK

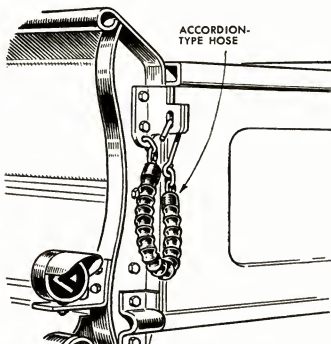
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

See Kodak's "The Ed Sullivan Show" and "The Adventures of Ozzie and Harriet!"

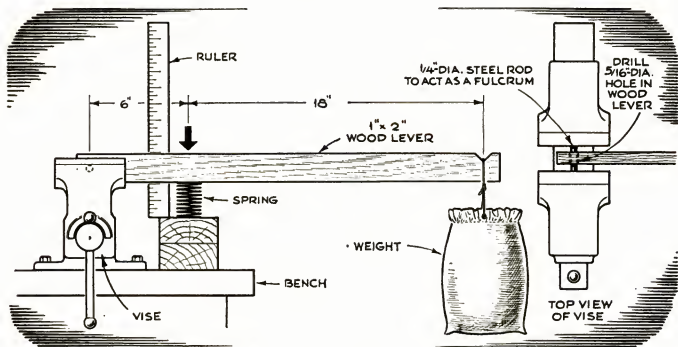
Hints from the Model Garage



When polishing a car with a power buffer, it's easy to wear through the paint on sharp edges like the rain gutters and ridges on the hood and fenders. To avoid this, cover the edges with masking tape and polish them later by hand.



Hush noisy tailgate chains by covering them with lengths of accordion-type rubber hose—the kind used in car heaters, skin-diving equipment, or old war-surplus gas masks. They'll save wear and tear on paint as well as your nerves.



Check valve and clutch springs for proper strength with a rig like this. Shop manuals list correct spring compression under a given load. If a spring compresses more, it should be replaced. To find the weight needed for the end of the

lever, multiply the desired load on the spring by the distance (here 6") from the fulcrum to the spring, and divide by the lever's total length (here 24"). The result is the required load in pounds. Measure spring compression with ruler.

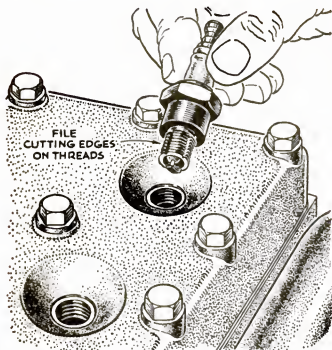


Above the new Astrojet (service mark of American Airlines Inc.)

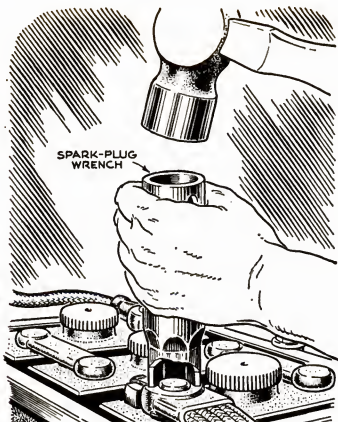
Every major U.S. airline
uses Champion spark plugs
—or Champion jet igniters—
because Champions give the
ultimate in dependability.
Why settle for less in your car?



More Hints from the Model Garage



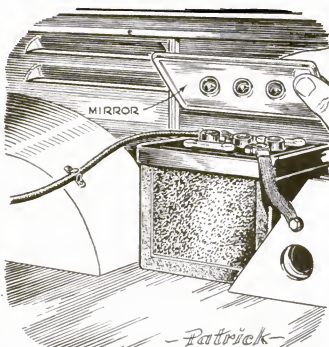
Clean engine threads when you're doing an overhaul by running dies on studs and taps into holes. An improvised tap for spark-plug holes can be made by filing notches across the threads on an old plug to give them a slight cutting edge.



To drive battery clamps straight and securely onto terminal posts, place a spark-plug wrench on top and tap it gently. The hollow wrench end drives the clamps on without cocking or deforming them, as direct hammering often does.



Need more work room in your garage? A car can be quickly shoved over this way to avoid repeated jockeying or in case the engine won't run. Place the jack on a wood block fitted with casters, raise the car 1" and push it sideways.



Check battery water with a mirror when you can't see easily into the cells, as in many foreign cars. It will save craning your neck and also eliminate the spill-over of damaging acid that can occur if you attempt to fill a battery by guess.

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FORD TRUCKS COST LESS

Gus Helps Land a Big Catch

By Martin Bunn

"**G**REAT fishing spot," said Gus Wilson between mouthfuls of grilled trout. "How did you happen to find it, Don?"

"A client of mine had a cottage up here," replied Don Holden, a slim man of 40 with sharp blue eyes and a dapper mustache. He lit a cigarette. "Say, Gus, would you mind if we called the trip off now?"

"Right now?" asked Gus, surprised at the suggestion.

Holden nodded. "It's been good to get away these three days. But I'm restless—got things on my mind."

"Okay," Gus agreed reluctantly. "I'll start packing."

The fishing jaunt had come as a surprise. Holden, once a fishing companion, had pulled up at the Model Garage in a jeep for a minor repair job—the first time since leaving his law practice to take a job in Washington. He'd invited Gus to come along "like old times."

Never had Gus known better sport. The country was ruggedly beautiful, the trout hungry, the frothing waters apparently reserved just for the two of them. But Holden wasn't the avid fisherman Gus remembered. Several times, while Gus was pulling them in, he'd driven off in the jeep without explanation.

SUNDOWN was a scant hour away when they started the jolting cross-country trek, Holden at the wheel. The terrain was unfamiliar to Gus.

"This isn't the way we came, is it?"

"No. Shorter, though," said Holden.



They were in a sparsely settled upstate area, remote from main roads. Gus estimated it was at least 20 miles to the highway. Suddenly he sat up.

"Look over there," he said, pointing. The jeep stopped abruptly, almost



As Gus watched helplessly, steel thudded on bone. Flesh ripped. Holden toppled to the ground.

slamming him against the windshield.

"What is it?" asked Holden.

"Thought I saw a road over there," explained Gus. "But you say we're miles from any road."

"We are," said Holden.

"Must be seeing things. I'd have sworn I saw a road."

The jeep lurched on, Holden silently intent on avoiding the worst hazards. A scant mile farther on they came upon a man standing beside a weather-beaten

black sedan, waving at them frantically to stop.

"Glad you showed up," he said as Holden braked. "Thought there was nobody around for miles."

"What are you doing here?" asked Holden, rather ungraciously, Gus thought.

"Same as you, I guess," said the man, pointing to the gear in the back of the jeep—"fishing." He was short and dark, his nose peeling with sunburn. Black eyes flicked from Holden to Gus. "My friend got sick this morning. Now our car's quit."

"Where's your friend?" asked Holden.

"In the back of the car. Now, if you'll give us a lift . . ."

Without waiting for an answer, he opened the sedan's door and helped out his hunched-up companion. Bent over, evidently in pain, the man, his white hair hatless, stumbled to the jeep.

"Get your friend in back," Holden said. "I'll sit with him. You drive, Gus."

Surprised — for Holden had done all the driving—Gus slid behind the wheel.

"Sure that car of yours can't be fixed?" he asked the short man.

"Maybe, mister, but it'll be dark soon and we'd better get out of here." He slid in next to Gus, stowing a big tackle box between them.

UNFAMILIAR with the country, Gus followed Holden's curt directions. As he swerved sharply to avoid a deep pothole, the stranger in back ordered him to stop. Thinking the man might be in acute pain, Gus braked, turned around to see what was wrong.

The sick man was sitting up tall and straight, holding an ugly .38 in one steady hand. With the other he reached

inside Holden's open jacket and pulled out a shoulder-holstered gun.

"Thanks for the jostling," he said, pocketing Holden's gun. "It threw me against that gun your pal was carrying. Nice tip-off for us that you're not just fishermen. Now, get out—with your hands up!"

"That means you," said the short man, nudging Gus and emphasizing his command with a steel-blue automatic. As

Gus backed out, he saw Holden and the "sick" man standing up in the back of the jeep.

"What's this all about?" asked Holden.

"I think we both know that," said the white-haired man. "Just get down there with your pal—and no tricks."

Holden backed, then ducked and made a lunge for his opponent's gun. He wasn't fast enough, but his attack threw the man off balance, and the bullet went wild as he fired. Gus, standing by helplessly, saw him swivel the gun in his hand, swing it up, and slash down. Steel thudded on bone. Flesh ripped. Holden

toppled to the ground.

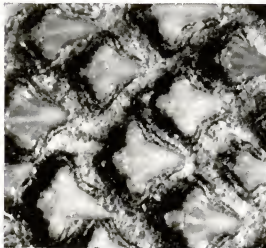
With lightning speed the tall man had his gun's business end forward again, pointing at the fallen Holden's belly.

Gus was getting ready to leap, do anything, when he heard the short man's voice. "No more shooting. Might be a security patrol around," he said, getting into the jeep and stepping on the starter. "Just make sure the other guy's clean and let's get out of here fast."

White-Hair frisked Gus expertly. Satisfied that Gus had no gun, he joined his companion in the jeep. "Let's go!"

The jeep roared off. As Gus shed his jacket to make a pillow for his unconscious friend, a flashlight dropped out of

What is this?



Can you identify what is shown in the photo above? Check your answer below

ANSWER: No, not cookies baking in a tin. It's a piece of sharkskin magnified many times. The odd-shaped protrances you see, minute in the natural skin, make an ideal abrasive for treating the fibers of high-quality felt hats, in a process called "pouncing."

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- no chimney draft needed

What is

VoluMetric Combustion?

It's an exclusive new method of oil firing that achieves 100% fuel combustion. Instrument tests show *no smoke or carbon residue*, even after a cold start. Thoroughly proved over a period of years. Now in use in thousands of homes and buildings—in many for as long as five years. *Users report savings up to one gallon out of three; some even more.*

Combustion Flow fan

Natural chimney draft is erratic, undependable. It is affected by the temperature of the chimney, the strength and direction of the wind, by nearby trees and buildings, and (most troublesome) by short modern chimneys. The Combustion Flow fan controls the air supply *accurately and automatically*. No more puffing fires or soot formation. CUSTOM Mark II units *create their own draft*. No chimney draft is needed. A vent pipe through the roof will do the job (local codes permitting).

Fuel and air injector

VoluMetric Combustion makes a clean fire *from the first split second of ignition*. At the start the combustion chamber is flooded with excess air to insure *100% fuel*

combustion. As the chamber warms up, the air supply is gradually diminished, maintaining maximum efficiency. A natural draft burner cannot make this adjustment. It must be regulated for top efficiency at operating temperature only. As a result it starts with an air-starved, smoky flame. With as many as 50 or more starts a day, about par in normal use, soot (which is nothing but unburned fuel), becomes a serious fuel waste.

A clean fire is more important than you think

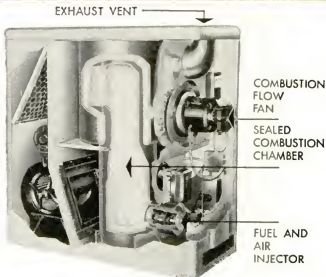
Smoke and soot are more than just a nuisance. At the end of the heating season your furnace or boiler has become far less efficient because an insulating layer of soot has gradually built up on the heating surfaces—the very surfaces you depend on to transmit heat into your home. Soot also causes about nine out of ten service calls, due to sooted flues, soot-fouled electrodes and car-

boned oil nozzles. CUSTOM Mark II VoluMetric Combustion reduces service troubles to almost nothing. No annual furnace and chimney cleaning is needed.

Conventional burners WASTE fuel AFTER THEY STOP

When the flame turns off, the chimney, flues and air ports remain wide open. Cold air passes freely through the furnace, carrying stored heat out the chimney. It's a *major* fuel waste. VoluMetric Combustion stops this "standby loss" in its tracks. First, the Combustion Flow fan, when it stops, becomes a damper that traps furnace heat. The heat goes into your home. Second, the sealed combustion system means that there is no infiltration of cold air through breather vents, draft regulator, observation port, or chinks around furnace doors. No other firing system has ever eliminated this serious fuel waste.

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a pocket. That gave him an idea. Maybe he could make his way back to the sedan they had left abandoned less than two miles back and make it run. But it was getting dark. He had to hurry.

WALKING fast, Gus flicked his light on and off, following back the unmistakable prints of jeep tires. The trail led him to his quarry—the drab, disabled sedan.

The key was in the ignition. Gus turned it and stepped on the starter. Nothing happened. He got out, raised the hood, and aimed his flash at the engine.

the bit of rubber between the breaker arm and the wall of the distributor case, wedging it behind the terminal. The arm now resisted finger pressure, snapped back against the cam.

Replacing rotor and cap, Gus got in and turned the key. The engine started.

AWAKE and rational, Holden slumped beside Gus in silence for a time.

"You have an explanation coming, Gus," he said.

"It'll wait till you're feeling better."

"I'm okay. Just get me to a phone."

Holden held his wallet in the glow of the dash light, letting Gus see the credentials of a government security agency.

"This really is an old fishing spot of mine, but now it's a top-secret defense setup. The road you spotted back there is part of it."

"So this vacation of yours is strictly business," Gus said.

Holden nodded. "There have been some leaks and I had a hunch that enemy agents were getting in here. The Defense Department agreed to let the two of us in. Any other 'fishermen' around this

area would have to be phonies."

"But why did you decide to leave all of a sudden today?"

"My hunch soured on me. I figured the leak must be at some other place."

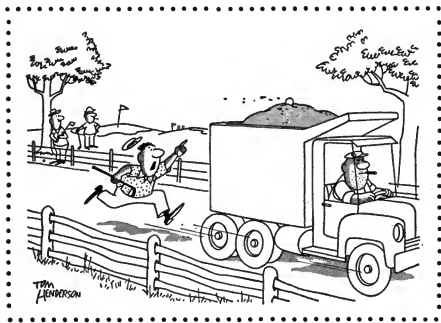
"Right now," Gus said, "I'm trying to figure how long a chunk of rubber will bounce if pinched 8,000 times a minute."

IT WAS still bouncing when Gus pulled into a highway gas station. Holden took over the phone. Ten minutes later a patrol car swept in, and soon after, Gus was sipping coffee in a hospital room.

"They got 'em Gus," said Holden, hanging up a bedside telephone. "That tackle box was loaded with telephoto cameras—and the film should send those two away for many years."

"Seems your kind of fishing landed a pretty good catch," said Gus.

"With your help, Gus. Without it, the big ones would have got away." ■ ■



The distributor cap dangled from its cables. But the rotor was in place.

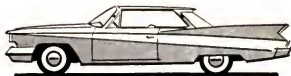
A closer look showed him that the spring on the movable breaker arm had snapped off, perhaps at an old kink or a rust spot. The copper bonding strip remained intact, but without the spring; the arm lay limp, the ignition points wide open.

Given pliers and a bit of spring steel, or even a bobby pin, Gus could have rigged a fix. The trunk held only a rusty jack and lug wrench. The glove compartment was empty. Gus's only tool was an old pocketknife, handy for camp chores but useless on steel.

He opened a door, felt the rubber seal strip. It was cracked and brittle with age. Turning to the engine, he yanked the windshield-wiper hose off the vacuum-booster pump. The rubber was lively.

He sliced off a short ring. In the last glimmer of his failing torch, he squeezed

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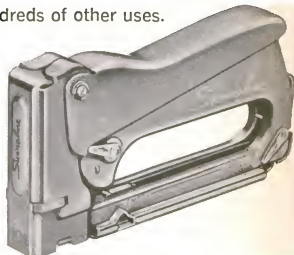


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19 Miles a Gallon—on Kerosene!

[Continued from page 38]

on his project. He gathered about him a tiny group of engineers who believed in the gas turbine. They labored in a sea of skeptics. It wasn't until 1954 that they came up with their first gas-turbine automobile.

Performance bettered. Nobody gave Huebner and his plans a second glance, however, until 1956, when he produced a turbine-powered car that averaged 14 miles to the gallon on a trip from New York to Los Angeles.

Persisting, he had so cleaned up his design by 1958 that he got 19.4 miles per gallon on a Detroit-New York trip. That was better than a standard Plymouth V-8.

When Huebner engine Number Three was announced early this year, it produced about the same gas mileage as in 1958, but Huebner had added spine-tingling acceleration and fine engine braking under no-throttle conditions.

Between 1958 and 1961, Huebner wrestled with three hefty problems. A gas turbine is, essentially, a constant-speed engine. Adapted to automobiles, it obviously couldn't run at one speed. Huebner was suffering from a lack of acceleration, an absence of engine braking, and a lag between depression of the accelerator and engine response.

With innumerable engine refinements and the addition of an automatic transmission, he got more acceleration. Then he put swiveling blades in his power turbine. That gave him even more acceleration plus engine braking plus instant response to the gas pedal.

The swiveling blades—Huebner calls them "variable nozzles"—are the unique addition to his engine. They swivel automatically through a control (a "brain") that reacts to gas temperature and pressure. These two depend on accelerator pressure and car speed.

The blades are tiny airfoils. They twist, root to tip, not only to gain efficiency but to minimize gas-compressibility effects from the turbine's high speed. At no-throttle the blades actually can reverse their "thrust." Then the kinetic energy of the car, through the drive wheels and drive train, makes a fan of the power turbine.

The fan, a sort of spigot turning off

19 Miles a Gallon—on Kerosene!

the flow of gases, stores their heat in the engine for use when the accelerator comes down again. Momentarily the engine interior becomes a heat reservoir. It's this reverse-blade position, using up the car's kinetic energy, that supplies the equivalent of the piston engine's compression braking.

One of the odd characteristics of the engine is that above 18,200 r.p.m. on the power turbine at a no-throttle condition, it "flames out." It's dead. No fuel flows. At exactly that speed the "brain" signals, "Hey, fuel, please!" Fuel flow resumes, the spark plug sparks, and instantly the engine is in business again.

With engine Number Three Huebner finally had a turbine that could range tirelessly over a speed spectrum of 18,000 to 45,000 r.p.m.

It is not perfect. Better fuel economy certainly is possible. To use an engineer's phrase, the Chrysler engine has finished its research phase and entered development. It has proved itself.

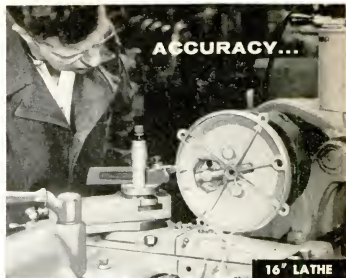
Fuel? On its latest publicized long-distance trip, from Detroit to Washington, D. C., the engine burned kerosene on the road and, in Washington, straight gasoline. On part of the return trip, it burned a mixture of diesel fuel dumped on top of gasoline. It will burn leaded, "premium" fuel, but only at the eventual expense of fouling the turbine blades.

Huebner is letting out just so much design information and no more. His regenerator, for instance, is off limits to reporters. Knowledgeable engineers with competitive companies say, however, that he uses a whirling plate in it to boost the heat transfer.

One of Huebner's problems in researching turbines has been the unwillingness of his staff engineers to wring out an engine to the point of failure. They flinch when one of their precious engines is abused. Their attitude is, let George Huebner do it. So George has to do it.

He has a fan club in one Midwestern city. Not long ago he got a letter signed by 150 teen-age car buffs when Chrysler got into production on gas-turbine cars, could they be first in line to buy them?

It would be a shrewd guess that they won't be much beyond voting age before they queue up. ■ ■



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Spark Pump Fires Engine (Continued from page 72)

spark jumping from a cat's rubbed back.

Today this hoary phenomenon of piezoelectricity (pronounced pie-ee-zo) is hard at work. Crystal or crystalline-ceramic phonograph pickups convert the mechanical jiggle of a record groove into minute electrical impulses. Piezo microphones convert sound into electrical pulsations.

A sort of reverse English is also put to use. If instead of squeezing a quartz crystal you run a current through it, the piece will expand along one axis. Switch poles and it contracts that way, to expand along another axis. Apply alternating current and the quartz vibrates at a frequency determined by its size and shape, so accurately that quartz-controlled clocks keep time within one second a year, and quartz crystals are used to hold the frequency of radio transmitters precisely on the nose.

But quartz is costly, hard to produce, has only a modest output, and is prone to crack. A sturdier and more powerful piezo generator was needed. It was found in the early Forties. A claylike mix of polycrystalline and ceramic materials, baked at about 500 degrees, was subjected to a whopping charge of electricity. This aligned the polarity of the internal crystals, making them capable of generating electricity when compressed.

Piezo in uniform. Such modern piezo ceramics led to a number of military applications: water-depth finders, submarine detectors, gauges that read the pressure in a gun barrel when a shot is fired, missile acceleration gauges, and sonar equipment.

It was while working on sonar that a Clevite research engineer bent a piece of ceramic in his fingers and got a whale of a shock. After an apt word or two, he said to himself: "Why not use this to fire a spark plug?"

In 1953, a patent assigned to the Briggs and Stratton Company described a piezo-ignition unit, of metallic titanate in a ceramic binder, to be mounted right in the spark-plug hole. It had sparking electrodes at the bottom. The ceramic was to be squeezed by mechanical or hydraulic action.

The mix: PZT. It was Clevite, however, that developed a lead zirconate-

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Spark Pump Fires Engine

titanate mix (PZT for short) capable of generating a jolt of electricity far greater than needed for spark plugs. Today Clevite is the leading producer of this type of piezo crystal. The next question was what shape to make it (ringlike for compression? a cantilever beam for excitation by bending?). And should it be activated by impact or squeeze?

The noise with impact activation was terrible. A cantilever element broke, if misadjusted, against the driving cam. A ring delivered too little current for its size.

Researchers finally settled on a pair of tiny cylinders placed end to end, with

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a contact in between and a common ground to both outer ends. In series mechanically, the two are in parallel electrically, giving double the output of a single one. A rubber jacket allows the ceramic to flex its muscles. Encased in plastic, the unit is next housed in metal.

To squeeze the PZT the necessary 1½ thousandths of an inch, a miniature crowbar is driven by a cam or eccentric on the engine. The complete Spark Pump weighs 8 ounces, occupies about 3½ cu. in. Here's what it does:

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- Works fine regardless of outside moisture, and in any temperature under 250 degrees F. (Above that there is some reduction of voltage.)

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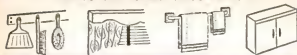


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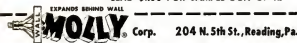


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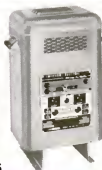
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The Boat That Runs on Sunlight

[Continued from page 122]

the paddle-wheel shaft for a bearing. A 1/32" music-wire axle is run through the paddle wheel so it touches the shaft only at the two small bearings, allowing the wheel to spin freely.

Rigging the drive. The small pulley on the motor can sometimes be obtained at hobby shops, or it can be turned from brass. To simplify mounting it, its center hole is bored for a press fit directly over the tiny gear that comes on the Escap motor. The exact-size hole can be made by boring first with a No. 33 drill, then reaming this hole with a No. 32 drill.

A rubber band about 4" long serves as the drive belt from the motor to the paddle wheel. With the motor set low in the deck well, a countershaft is required to carry the belt up and over the transom. This is made in the same way as the paddle-wheel shaft, with bearings cemented in the ends to cut friction.

If you prefer, the well can be decked over solid and the motor mounted on top, level with the paddle-wheel pulley. This eliminates the need for the countershaft and further reduces friction.

The motor is wired to the sun cells through a small two-prong connector, making it easy to disconnect the cells and also to reverse their polarity if the paddle wheel should rotate in the wrong direction. (The plug and socket connector used here consists of Lafayette Radio's No. MS 283 and No. MS 284.)

The boat must be well waterproofed with balsa filler and dope or enamel. A weight is added after the hull is ready for floating to make it ride level. This takes about 3 1/2 ounces of lead, placed forward and to one side of the motor to counterbalance it. The hull should float with the paddle blades no more than 1/4" in the water.

The two fixed rudders of thin aluminum provide good directional stability for straight runs, but can be bent slightly to give the ship a circular course. The funnels are just hollow tubes made by rolling strips of paper around a 1/2" dowel and gluing the ends. The tubes are then mounted on the cabin roof by slipping them over short pins cut from the same size dowel.

How you buy and use sun cells. The cells used here are one-by-two centi-

The Boat That Runs on Sunlight

meters (about $\frac{3}{8}$ " by $\frac{3}{4}$ "—the largest standard size made). They have an efficiency of six percent—not as high as some types, but fine for small jobs and cheaper. These cells are made by International Rectifier Corp. and are available for about \$2.65 apiece from its distributors or from mail-order electronics houses, such as Allied Radio, 100 N. Western Ave., Chicago, or Lafayette Radio, 165 Liberty Ave., Jamaica, N.Y.

Each tiny cell consists of a paper-thin layer of negatively charged silicon coated with a layer of positively charged boron. When photons of light strike the cell, they release electrons, creating a flow between the two layers. This sets up an electric current, just like the electron flow in an ordinary battery.

Two leads are soldered to each cell, one to the silicon and one to the boron, and these are wired to whatever you want to power, just as you would connect a battery. For a series hookup, the negative lead of one cell is wired to the positive lead of another. To increase amperage, the cells can be wired in parallel.

Storing solar energy. Any number of cells can be strung together—the U.S. weather satellite Tiros has 9,200 of them to catch sunlight from any direction. Since the cells' output is directly proportional to the intensity of the light striking them, they can also be used as delicate sensing and measuring instruments for photographic and other setups. For round-the-clock power, the cells can be used to charge batteries, which in turn can supply a steady current even when the sun isn't shining.

The cells work best in strong overhead sunlight. The slanting rays early and late in the day and in winter don't strike the cells as directly and thus produce less current. For bathtub trials of the model boat, a 100-watt bulb, held a few inches away, does fine. Be careful, though, not to let the cells get too hot—heat lowers their efficiency and may permanently damage them. For this reason, don't use high-intensity spotlights or photofloods.

For additional projects using sun batteries, an excellent 112-page booklet entitled "Solar Cell and Photocell Handbook" is available for \$2 from International Rectifier Corp., El Segundo, Calif.

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Facts and Fallacies of World War III

(Continued from page 95)

a drawback that unsettles the coldest-blooded militarists.

A war using present H-bombs would cause a ghastly catastrophe, but not total catastrophe. With modest preparation, we could come through—and rebuild.

Imagine that we are hit with 500 big bombs. This is enough to wipe out—totally destroy—every single one of our 53 major metropolitan areas (from New York and its suburbs to the New Britain-Bristol, Conn., complex). This is our A-Country, containing one-third of our total population, half our wealth, more than half our factories, and three-fourths of our war industry. Suppose it's all gone.

Would such an overwhelming disaster close the book on the United States of America? It should not. If our A-Country is gone, our B-Country remains: two-thirds the population, half the wealth, nearly half the factories. With luck, the B-Country could rebuild the A-Country inside of 10 years.

You don't believe it could be done? The Russians already have done it. World War II wiped out what amounted to the Soviet A-Country: 20,000,000 to 30,000,000 Russian people were killed, and one-third the national wealth was destroyed. The Russians bounced right back. Within six years, their total output (gross national product, in economists' lingo) had returned to the prewar level. (It's kept right on climbing since.)

Recovering from an attack would not be easy. Simply surviving to start recovery calls for protection from intense radioactivity immediately following the attack. This radiation would at first be strong enough to kill people, but would ease up gradually. For a 500-bomb attack, improvised shelters might do; for a bigger war you'd need very elaborate arrangements for protection and evacuation.

The grotesque evil of radiation adds new and odd complications to war and recovery from war. Practically everybody would need a meter of some kind. It would be more essential than a flashlight. You can't see or feel or smell radiation. Without a meter you couldn't tell if it was safe to go out of your cellar to hunt food or wash fallout off the roof. Without meters, you wouldn't even be able to tell who was seriously hurt. The only symp-

Facts and Fallacies of World War III
 tom of radiation injury is nausea—and after an attack just about everybody, exposed or not, would be nauseous for one reason or another.

Even the best preparations could not prevent appalling long-range harm from radiation. Its effect on heredity would increase—very substantially—the number of babies born dead or deformed in future generations. Some areas might be made uninhabitable for centuries. Yet this awful damage would probably not extinguish the human race, or the United States.

Are old-fashioned bombers obsolete?

If atomic war erupted next week, the shooting might be all over within two to 30 days. There would be no time to train men and convert industry to war production. The war would have to be fought with weapons drawn from the stockpiles. It can't be pushbutton war. Not yet.

Missiles might strike the first, hard blows. But victory or defeat would ride with pilots and bombardiers in manned airplanes, the B-47s, B-52s, and B-58s. There are several reasons:

- Both sides have a great many bombers on hand, but only a few missiles.
- Airplanes can carry bigger, more destructive bombs than missiles, and the man-operated bombsight is much more accurate than inertial guidance.
- Only a man can make a decision over the target—can look down to see whether the target is still there and requires another blow, or is already destroyed and should be passed by for an alternate.

But bombers fly slowly. There would be time for warning, for defense from anti-aircraft and fighters. The nation best equipped to ride out the initial devastation, duck or ward off the follow-up blows, and still strike back powerfully, would have the advantage. For blackmail, naked and vicious, would end this war: "Stop now and be reasonable, or we will hurt you more than you can hurt us."

Pushbutton war by 197X?

Horrible as war in the 1960s would be, the Seventies threaten worse. And that's

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Facts and Fallacies of World War III

without counting the Domsday Machine. The fantastic weapons of science-fiction are about to come true.

The oddest of future arms may be the Atomic Six-Shooter, firing californium bullets. Californium is a man-made element (now exceedingly rare and expensive). Its atoms can be split, like uranium's, but much more efficiently. Only a small amount of californium creates the "critical mass" that will ignite a chain reaction. A californium atomic bomb need be no bigger than a pistol bullet. You could build a hand-held six-shooter to fire bullets that would explode on contact with the force of 10 tons of TNT! (One complication: The ammunition has to be fresh, for californium is radioactive and decays into nonfissionable stuff very rapidly.)

And worse is possible. With really big bombs, you can play weatherman. Clean 20-megaton bombs (nonradioactive, but equivalent to 20 million tons of TNT each) might shift hurricanes. Smaller ones could blanket the stratosphere with dust, raising or lowering earth temperatures—a nasty trick to which the Russians (and Canadians) are particularly vulnerable. The Russians might retaliate by exploding a number of clean 10-megaton bombs in the ocean. If it did it right, this would load the troposphere with ice crystals, trap heat over the poles, and melt the icecaps—just enough to drown our coastal cities.

Germ warfare and chemical weapons also suggest very subtle yet effective ways to win battles. They could be more "acceptable" morally than bombs and bullets (one chemical weapon—tear gas—is already an acceptable "force" for subduing riots, much politer than machine guns). It would not be necessary to kill anyone. An international fight could be won by making the population of the opposing country good and sick, and keeping them sick until they gave in. Or a Miltonov gas might tranquilize an army so that the soldiers couldn't get mad enough to fight anybody.

Both weather control and chemical weapons lend themselves to Disguised War. A country could be laid low slowly and systematically by what would appear to be acts of nature—drought, unbearable heat, illness. Such a secretly assaulted

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Facts and Fallacies of World War III

people would have to give in to a strong opponent. They might never know they had been brought to their knees intentionally. (The future is grim indeed if everybody will be secretly hexing everybody else!)

It's a strange, sad fact that war may be triggered even by peaceable and desirable inventions. Think what very cheap—universally cheap—electric power (from tamed H-bombs) could bring. Cheap power means universally cheap food (the power makes fertilizer, irrigates deserts, pumps out swamps). We might give such power plants to underdeveloped countries, and show them how to run the things. Then they would no longer have to devote all their time and energy to producing food. They would have man-hours left over for other purposes (as we and the Russians do now). They might well use those newly freed man-hours to train armies, manufacture weapons, and pick on their neighbors.

Is war inevitable?

Both the United States and the Soviet Union have strong reasons—warmly human and coldly practical—for avoiding war. There are better things to do. War looks too hazardous, more hazardous than it has ever looked in the past. And the arms race might be picked up by other powers with dangerous ideas.

So there is a good chance that Something Will Be Done. It won't be world government; not yet. Total disarmament (which the Russians claim they want) is also out. It's just too easy to hide H-bombs. We'd never believe that they hadn't cached a whole flock of the awful things, and they'd never believe that we hadn't done the same.

Some agreement on arms control is possible. The ban on bomb testing has worked for three years now. Prohibition of bomb research might be next. Rules for warfare—outlawing the most terrible weapons—could be made up. (In recent times up until World War II, most nations did fight according to rules—no massacring civilians, for instance.)

Such limited, cautious concessions won't usher in the millennium. But they might just stave off Armageddon.—*Martin Mann.*



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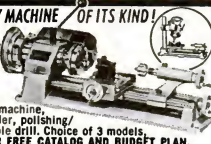
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Hot Water from Cold-Water Pipe

[Continued from page 46]

unit in the kitchen sink cabinet and run standard duplex piping to the bathroom. Or, if you want to avoid the heat loss and delay of that hot-water run, you put individual 60-amp units at each sink.

Pushbutton control. The Microtherm heater can be used with manual faucet valves, but it's most impressive when coupled with the accessory pushbutton control specially designed for it. Filling, mixing, shutoff, and rinse are all automatic with the Flow-Touch system. Thermotronics offers several different control setups, ranging from two on-off buttons for cold or hot water (for heaters with preset thermal and flow adjustments) to a capacitance panel offering a fully graduated range (temperature and flow rate are determined by the points along two control bands at which you place your fingertip). The systems can be regulated to shut off the flow when the basin is filled to a certain level. And, after you've touched the drain button, the basin automatically rinses itself as you turn and walk away.

If the unit is to be used with manual valve faucets, a thermostatic bleeder-valve control adds cold water when a slow rate of flow lets the water overheat. Whichever valve system you choose, faucet drip is eliminated. Since the supply shuts off at the heater, there's no pressure against vulnerable washers.

None of this is dream stuff for some world's fair "house of tomorrow." You can order a Microtherm system for your home right now. Thermotronics (27 Jericho Turnpike, Mineola, N. Y.) puts the cost of the unit (either amperage) at around \$150. Installation should be a quarter of that for a standard water heater, provided a 240-volt line exists.

It can heat your home, too. Since the heater is rated at 81,000 BTUs per hour, it can also double as a boiler for the hot-water heating system in a one-family home. When you want to draw hot water, a diverting solenoid valve temporarily cuts out the heating system—so one boiler serves both functions.

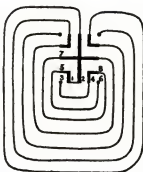
Considering that electric heating is expected to reach 5,000,000 homes by 1965, this application may become as significant as the revolutionary notion of one-pipe water lines.—*Alfred Wm. Lees.*

Answers to PS Puzzlers on 24 and 26

Mazes: To draw the labyrinth start with a cross, four corners, and four points:



Now connect the various points of the figure, starting with 1 and 2. Then connect 3 with 4 with a U-shaped line to start laying out the network. Continue working outward systematically, moving up one point at a time on the left, and coming down and around to connect with the next higher point on the right (5 and 6, 7 and 8, etc.)



Hampton Court: Follow the dotted lines.



Calculations: 12,111. 28 eggs.

The jobs? Look at the balance sheet:

	Job A	Job B
First year	\$2,500	\$2,500
	<u>2,500</u>	<u>2,750</u>
	\$5,000	\$5,250
Second year	\$3,000	\$3,000
	<u>3,000</u>	<u>3,250</u>
	\$6,000	\$6,250

Job B will always pay you \$250 more a year.

Bricks. 7 and 5. You did it in your head? Good. Algebraically it's easy, too:

If x = the larger amount, y the smaller, $x+1=2(y-1)$, and also $x-1=y+1$. Solve by subtracting and get $y=5$; then $x=7$.

Trains. 1) L pushes A into the common siding. 2) L returns to the main line, backs up, enters the right-hand siding, pushes B to A and then couples them. L then pulls them both out of the siding and back along the main track until they're centered there. 3) Car A is now uncoupled and L pulls B back along the main track and then up the right-hand siding, leaving it in the common area. 4) L comes back to the main track, pulls A to the right and then pushes it up into the right-hand siding into the spot where B used to stand. 5) L returns to the main track, moves left, backs up into the left-hand siding where it picks B out of the common track and leaves it where A used to be.



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Minuteman: Our Ace in the Hole

[Continued from page 65]

Minuteman rides trussed in harnesses that provide both torsion-bar suspension and shock absorbers, and its container is cushioned by the truck's air suspension. Altogether, the missile probably feels fewer jogs en route than a passenger in a Rolls-Royce.

No one need fear that a crash on the road might ignite the rocket engines. Air Force men have given them a hard time in tests—shooting bullets into them and building gasoline fires under them—without getting accidental ignition. And the warhead never rides the truck. It is added later, by other means.

The tractor has a five-speed main transmission and a three-speed auxiliary. A power takeoff from the auxiliary operates the hydraulic pump. It takes only 20 horsepower from the engine to raise the container to a vertical position and lower the missile into its silo.

The muscles that do the lifting are two powerful hydraulic arms at the sides of the container. Each has one end firmly anchored in a socket at the top of the huge box (when horizontal). The other end is rooted in a tie-down, bolted to concrete at the missile emplacement. These telescoping rams can extend 35 feet.

Once the container is standing straight up over the empty silo, the hydraulic hoist goes into action. With a total supply of 1,900 feet of 1/4-inch steel cable on four drums, it could lower a Minuteman 75 feet if it had to. It takes 12 minutes to stand the container on end, 7 minutes to swing the missile from its harness, and 35 minutes to let it down into the silo.

Coming: secret missile trains. Eventually, the nation's guard of Minutemen may number several thousand, a large percentage of them riding at random around the Midwest and Far West in camouflaged trains almost as hard for an enemy to find as Polaris submarines.

The Air Force originally planned to have more than 100 of these trains, each carrying from one to five missiles. Then President Kennedy asked Congress for three more buried squadrons of Minutemen in preference to the first three mobile ones. Though the trains, then, won't appear just yet, the first launch car has already been built. It will be used for

test shoots down the Pacific Missile Range from Vandenberg AF Base, Calif.

Minutemen, with warheads attached, will ride on their sides in 88-foot launch cars, resting in metal cocoons, called strongbacks. Inside, the missiles will be kept in their favorite atmospheric environment until within a few seconds of launch.

Wanderers by rail. Each train will be capable of roaming for several weeks at a time without taking on fresh provisions. The civilian train crews will live aboard with the 15-man Air Force missile crew. The men will be almost as isolated, except by radio, as a submarine crew. But it shouldn't be a dreary life. There'll be hi-fi music, TV shows, and movies in the diner, which will be quickly convertible into a lounge car or, during a strategic alert, a ready room.

Scores of secret sites. A train's primary launch sites will be selected sidings whose precise geographical locations have been plotted and already recorded on tape. (Minuteman's computer must be told by tape exactly where it is on earth before it can guide the missile to its assigned target.) But scores of secondary launch sites will also be surveyed. Ultimately, no train will ever be more than 10 miles from a suitable place to stop and shoot.

If Air Force Intelligence warns the train commander of a period of imminent danger, he'll order the train to the nearest primary launch site. There the car's trucks will be locked in place. Twelve hydraulic jacks, six to a side, will be lowered from the launch car to give it special stability, or, if necessary, lift one or both sides of the car to level it.

Then 45-foot clamshell doors will open in the roof, and a long hydraulic arm will push the Minuteman in its strongback to a vertical position. Flame-deflector doors, 10 feet square, will roll out beneath the erected missile.

And Minuteman will be ready to blast off on its deadly mission. ■ ■

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The September 1961 POPULAR SCIENCE Home Improvement Issue will be prized by every home owner.

The theme of the issue will be "Fall Building and Home Improvement Value Days" and will contain a wide variety of ideas for interior home improvement, plus special features on shell homes, garages, a home entertainment center and, of course, unusual ideas submitted by POPULAR SCIENCE readers in the last year's Home Improvement Holiday Contest . . . maybe even yours.

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Team up with your local Lumber or Hardware dealer who is always happy to serve you. Tell him you are a POPULAR SCIENCE reader . . . and watch the results.



SMALL WONDER. It's a miniature electric lamp, resting on a fingernail to show relative size. Developed by the Diamond Ordnance Fuze Laboratories, the light is 1/10 inch long, 35/1,000 inch in diameter. One use will be on control panels designed for missile research.



TRUCK DUMPER. A mobile elevator developed in East Germany can hoist a six-ton truck or trailer 11 feet in the air, then tilt it 35 degrees to discharge its bulk load into a railway car. With a cycle time of six minutes, 10 trucks can be unloaded in an hour. An electric motor powers the lift and tilt rams.

Hydrofoils Speed Over Waves

[Continued from page 59]

at eight m.p.h. with jets of water. An auxiliary gas turbine drives pumps that eject twin streams astern, from submerged nozzles. Vanes deflect the jets for steering and backing.

Except for alloy-steel foils and struts, the Denison is an all-aluminum ship. Hydrofoils are nearly as weight-conscious as airplanes, and so it takes airplane-style construction to give the Denison her 10-ton payload capacity.

Acting as pilot and co-pilot, her captain and first officer will sit side by side at steering wheels in the pilot house, with navigator and engineer behind them. An observer and a test engineer will complete her six-man crew for test runs.

Largest of hydrofoils, the Navy's sub-chaser PC(H)-1 will be a fully operational warship. Manned by an officer and 12 crewmen, it will be armed with torpedo tubes and machine guns, and will have the latest in sonar listening gear. Upon its completion by the Boeing Co. in 1962, it will introduce new tactics in antisubmarine warfare.

Playing a dual hunter-killer role, it will stalk subs by sitting quietly in the water and lowering its listening gear. On detecting an enemy sub it will leap into action. With twin gas turbines roaring, it will rise on its foils and dash in pursuit of the hostile craft, firing homing torpedoes for the kill.

Its 40-to-50-knot speed on foils will enable it to apply this "grasshopper" technique, alternately alighting and flying, and still keep up with an average ship formation. Designed to operate up to 250 miles offshore, it will have a range of 700 miles on foils—or 2,000 miles hullborne, using a diesel engine and extra propeller. It has an aluminum hull and stainless-steel foils of an advanced new "submerged" type.

The \$2,000,000 PC(H)-1 is only a start. By 1965 you'll see the first of a fleet of U. S. hydrofoil destroyers, predicts Capt. Bruce G. Kroger, a prominent and successful Navy campaigner for large hydrofoil fighting ships. The Navy has budgeted about \$17,000,000 to build a 300-ton experimental hydrofoil, for which it may award a contract this summer. Next it plans a 500-ton warship.

America's exciting new ships stem from

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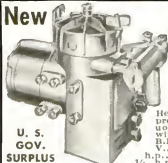


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a little-known Navy hydrofoil program that began in 1947. While hydrofoils were far from new at that time—Alexander Graham Bell had built a notably successful one nearly 30 years earlier—hardly any practical use had been made of them. The principal exception was a German blockade runner that had carried supplies between Sicily and Africa in World War II—an 80-ton, 105-foot, 43-knot diesel craft of 3,600 hp. designed by Baron Hans von Schertel.

At war's end, Russian forces overran the shipyard where von Schertel's craft was built, and got his plans; since then, sizable hydrofoils ply Russian rivers. In Switzerland, von Schertel himself organized the Supramar hydrofoil firm and designed a series of highly successful diesel-powered commercial hydrofoils, of which dozens have been built since 1953; the Flying Fish is one of them.

Meanwhile the U. S. Navy, starting with paper studies, progressed in the Fifties to testing radical new foilborne craft.

Driven by air propellers, the eight-ton XCH-4 raced over the sea at 78 knots, or 90 m.p.h. It set a speed record for hydrofoils that still stands.

Largest U. S.-built hydrofoil to date was the 15-ton landing craft Halobates, whimsically named after a water-walking bug. Two long float-tipped arms projected from its prow like feelers, which is exactly what they were. Sensing the boat's height above the water, they controlled its submerged foils accordingly.

How to do without feelers was shown by another submerged-foil craft, Dr. Vannevar Bush's teardrop-shaped Lantern. The Navy's 1957-built Sea Legs followed his scheme. An electric height-measuring probe, and a "black box" acting like an airplane autopilot, controlled its foils. The sensation was startling—even in rough water, the ride was so smooth as to give no feeling of speed.

These boats' all-underwater foils were new and revolutionary. The simple, fixed surface-piercing foils in common use were ideal for smooth water. But such a craft undulated up and down over waves—making the ride jolting, even dangerous, with high speed or high waves.

Submerged foils ignore waves. Suitably controlled, by varying their angle or

operating trailing flaps, they fly a rough-water craft level and true.

That is the Navy's plan for a seagoing hydrofoil. Sea Legs' successful submerged-foil system will be the model for the one built into the PC(H)-1. MarAd's Denison will test a later, rival solution—equipping surface-piercing foils themselves with control flaps.

Interested by the Navy's successes, the Maritime Administration—responsible for developing promising new kinds of merchant ships—came into the hydrofoil picture in the mid-Fifties. In close cooperation with the Navy, it launched its own commercial-hydrofoil program. In 1958 its research head, the late Col. Charles R. Denison, sponsored a \$75,000 study by Grumman to see if hydrofoil liners were feasible. They were, Grumman found. It recommended building a trial ship. The result was the Denison, named for the man who had started the project, and jointly financed by Government and industry. (MarAd will get her for a bargain \$1,500,000; Grumman and other firms are picking up the tab for the rest of her \$5,000,000 cost.)

Another breakthrough was introduced in the Navy's most recent experimental hydrofoil—the 23-foot, gas-turbined XCH-6, completed in 1959 by Dynamic Developments. It has propeller and foils of an advanced "supercavitating" profile, just discovered by Navy researchers.

Shaped like an axe with the sharp edge leading, these new propeller blades and foils promise unheard-of speeds. They work best above 65 or 70 knots.

Both the Denison and the PC(H)-1 have the new propellers. The Denison's three-bladed screw will be able to whirl at a fantastic 2,670 r.p.m., its blade tips traveling 400 m.p.h. The high-speed propellers and high-speed gas turbines make ideal mates for propelling a hydrofoil.

With the new foils still in an early stage of development, the Denison and PC(H)-1 will have foils of standard profile, like an airplane wing. But MarAd has commissioned Grumman-Dynamic to develop a set of the new supercavitating foils, which may go on the Denison later. Then she would hit an unprecedented 80 knots. In anticipation, her hull has been designed with the extra strength needed for this record speed. ■ ■

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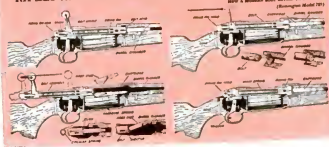
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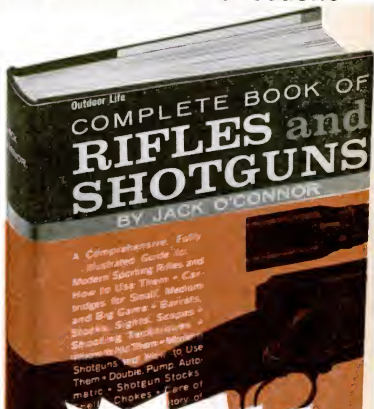
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Making Hot Air Ballons

[Continued from page 126]

so it can't tip up and spill—up she soars! The bag of a flying model can be made of paper. You can buy a special silk span or Japanese tissue, but a 25-cent package containing two dozen 20"-by-30" sheets of ordinary gift-wrap tissue will make a fine 3' balloon. Don't try crepe paper (too heavy and porous) or polyethylene bags (hot air may melt the plastic).

For the base ring, split a 36" length of bamboo, about 1/8" by 3/16", from a fishing pole—or buy a piece of matchstick bamboo used in curtains. The ring can also be made of 1/16" (or smaller) aluminum wire. If you don't attach a gondola, you can trim your balloon by clipping weights (such as bits of wire solder) to the ring. At Wingfoot picnics, the ladies often have to let their hair down because eager entrants solicit bobby pins for this same purpose.

Inflating the bag. Contos uses three types of fuel to generate hot air:

- Charcoal is efficient, but may produce sparks that will ignite the tissue paper. Contos never uses it for his indoor demonstration flights at banquets.

- Canned heat (Sterno) is the simplest fuel and is virtually free of sparks. A variation is the use of alcohol, in a burner made by stuffing cotton into a small metal can. Either can be used indoors. Contos' oil-can stove will accommodate several fuel cans, depending on the heat output desired.

- Bottled gas (LPG, propane) is useful for large balloons. A workshop propane torch can be rigged for inflating small models.

Paper balloons can ignite while being inflated. Don't hold the balloon too close to the stove, or let the bag be blown against it. A fireproofing treatment is possible, too. Just saturate the paper by flowing this solution over it:

Water	4 ounces
Borax	60 grains
Boric acid	28 grains
White glue	...3 or 4 drops	

If your experience with these models leaves you a victim of lighter-than-air fever, you can get further information about the Wingfoot Lighter-Than-Air Society by writing Jim Contos at 775 Sumner St., Akron 11, Ohio.

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Technician</p> <p><input type="checkbox"/> Elec. Light and Power</p> <p><input type="checkbox"/> Practical Electrician</p> <p><input type="checkbox"/> Practical Lineman</p> <p><input type="checkbox"/> Professional Engineer</p> <p>HIGH SCHOOL</p> <p><input type="checkbox"/> Good English</p> <p><input type="checkbox"/> High School Diploma</p> <p><input type="checkbox"/> High School General</p> <p><input type="checkbox"/> H. S. College Prep. (Eng 'g & Science)</p> <p><input type="checkbox"/> High School Math</p> <p><input type="checkbox"/> High School Science</p> <p><input type="checkbox"/> Short Story Writing</p> <p>LEADERSHIP</p> <p><input type="checkbox"/> Industrial Foremanship</p> <p><input type="checkbox"/> Industrial Supervision</p> <p><input type="checkbox"/> Personnel-Labor Relations</p> <p><input type="checkbox"/> Supervision</p> <p>MECHANICAL and SHOP</p> <p><input type="checkbox"/> Diesel Engines</p> <p><input type="checkbox"/> Gas-Elec. Welding</p> <p><input type="checkbox"/> Heating and Air Conditioning</p> <p><input type="checkbox"/> Industrial Engineering</p> <p><input type="checkbox"/> Industrial Instrumentation</p>	<p><input type="checkbox"/> Industrial Safety</p> <p><input type="checkbox"/> Machine Shop Practice</p> <p><input type="checkbox"/> Mechanical Engineering</p> <p><input type="checkbox"/> Plumbing and Heating</p> <p><input type="checkbox"/> Professional Engineer</p> <p><input type="checkbox"/> Quality Control</p> <p><input type="checkbox"/> Reading Shop Blueprints</p> <p><input type="checkbox"/> Refrigeration and Air Conditioning</p> <p><input type="checkbox"/> Tool Design</p> <p><input type="checkbox"/> Tool Making</p> <p>RADIO, TELEVISION</p> <p><input type="checkbox"/> General Electronics Tech.</p> <p><input type="checkbox"/> Industrial Electronics</p> <p><input type="checkbox"/> Refrigeration and TV Eng'g</p> <p><input type="checkbox"/> Radio-TV Servicing</p> <p><input type="checkbox"/> TV Technician</p> <p>RAILROAD</p> <p><input type="checkbox"/> General Railroad</p> <p>STEAM and DIESEL POWER</p> <p><input type="checkbox"/> Combustion Engineering</p> <p><input type="checkbox"/> Power Plant Engineer</p> <p><input type="checkbox"/> Stationary Diesel Engr.</p> <p><input type="checkbox"/> Stationary Steam Engines</p> <p>TEXTILE</p> <p><input type="checkbox"/> General</p>
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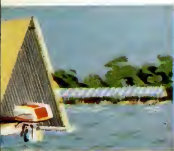


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