Practical MECHANICS

JANUARY 1961

1'6

DREADNOUGHT Britain's First Nuclear Submarine

ALSO

EQUIPPING A JEWELLERS' WORKSHOP

LIVE STEAMER FOR GAUGE-O

A 30/- EXPOSURE METER

MAKING A STROBOSCOPE

ANNOUNCING . . .

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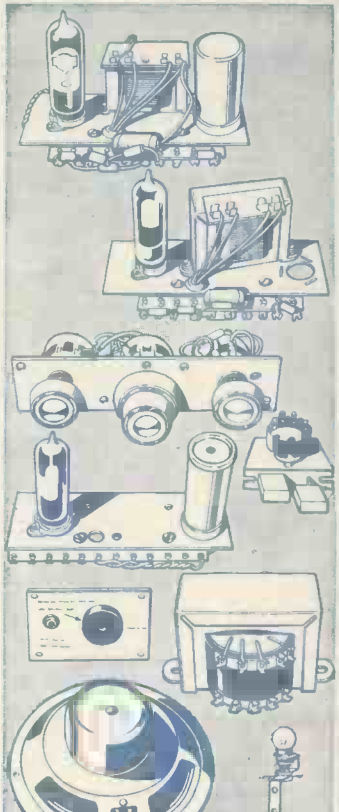
THE KIT COMPRISES . . .



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CONTENTS

FAIR COMMENT

WHERE NEXT?

THERE are two sides to space research. The side the public sees comprises little more than occasional rocket launchings, successful and unsuccessful, either by Russia or America, with long periods of silence in between. The picture the rocket scientist and technician sees is very different; it is one of continuous research and experiment with fuels, metals, instruments and now human beings. The last spectacular news in the race for space was, from the Russians, the firing into and recovery from orbit of a space capsule containing animals: from the United States it was the successful launching of a weather satellite. What will the next big news be?

Both the Americans and Russians are working full pressure on the problems of getting a man into space and, of course, bringing him safely back to earth again, but it is not likely to be achieved in the immediate future. What is more likely is that the Russians may try to follow up their initial success in firing a rocket on to the moon by landing instruments and transmitters there. This step is certainly figured in the American programme as is the setting up of a manned space laboratory, but the date envisaged at the moment is somewhere in the region of 1969 or 1970.

Most of the future U.S. space plans are being based on their newest rocket, Saturn. This is still in its pre-launching trials stage. It will be about twice the size of the Jupiter-C rocket and will tower some 185ft. from base to nose cone. Its diameter will be 22ft. America's rocket scientists produced this giant by tying together groups of smaller rockets and then gambling on a new propellent—a combination of liquid oxygen and liquid hydrogen.

Jupiter and Thor Rocketdyne engines, specially modified are to be used. The multi-engine cluster offers a number of advantages. One of these is, in the event of a failure of several engines during the launching, the rocket can be guided to a safe crash area by means of the remaining motors. A minor failure of one or two motors need not necessarily spell failure of the whole project; the rocket could be re-routed on a journey which comes within its restricted range or perhaps by diverting the fuel from the idle engines to those working properly, the rocket may still reach its destination at a slower speed.

The race continues and although we can perhaps forecast what the next steps in the American programme might be, Russian activities can only be assessed by guesswork. One thing, however, is certain, the sky is no longer the limit!

YOUR WORKSHOP

Most workshops start off as a collection of tools—a screwdriver, a hammer, a saw, then a hacksaw and perhaps a drill. The back step or the kitchen table usually serves as a bench. These few tools are used to do the odd jobs around the house and as new jobs are found, the number and range of tools increase. The purchase of a car adds another range of tools and finally the erection of a bench in the garage or the building of a shed make the construction of a workshop a necessity.

All workshops must grow in slightly different ways and vary according to the interests of their owners. It occurs to us that those just beginning to acquire a few tools could pick up a lot of tips from reading details of established workshops, so we invite readers to send in details of theirs, including, if possible a photograph. Let us know why the workshop is arranged as it is and what type of work is usually carried out. We shall, of course, pay for all material published.

The February, 1961, issue will be published on Jan. 31st. Order it now!

H.M.S. DREADNOUGHT

BRITAIN'S FIRST NUCLEAR SUBMARINE

HER MAJESTY THE QUEEN launched the *Dreadnought*, the Royal Navy's first nuclear submarine, at the Barrow-in-Furness shipyard of Vickers-Armstrongs (Shipbuilders) Ltd., on Friday, October 21st last year.

As originally planned, the *Dreadnought* was to have been fitted with a British designed and built nuclear reactor, but in 1958 an agreement was concluded with the U.S. Government for the purchase of a complete set of propulsion machinery of the type fitted in the U.S.S. *Skipjack*. This agreement has enabled the submarine to be launched far earlier than would have otherwise been possible. The supply of this machinery is being made under a contract between the Westinghouse Electric Corporation and Messrs. Rolls-Royce.

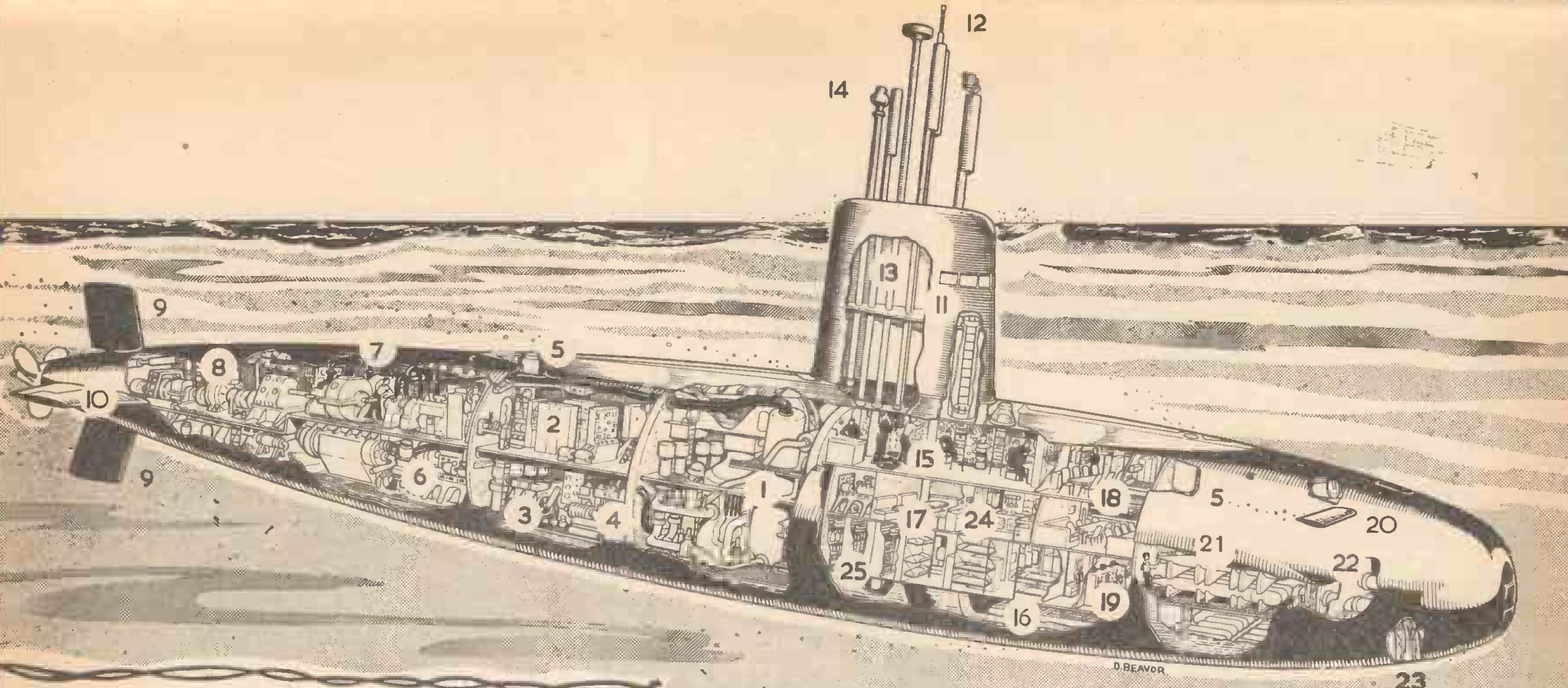
With a length of 266ft., a beam of 32ft. and a surface displacement of about 3,500 tons, the *Dreadnought* will have a hull of British design both as regards structural strength and hydrodynamic features, although the latter is based on the pioneering work of the U.S. Navy in the *Skipjack* and *Albacore*. From about midships aft, the hull lines will closely resemble the *Skipjack* class so as to accommodate the propulsion machinery. The forward end of the boat is wholly British in concept. In the Control Room and the Attack Centre the instruments are fitted into consoles.

The Nuclear Reactor

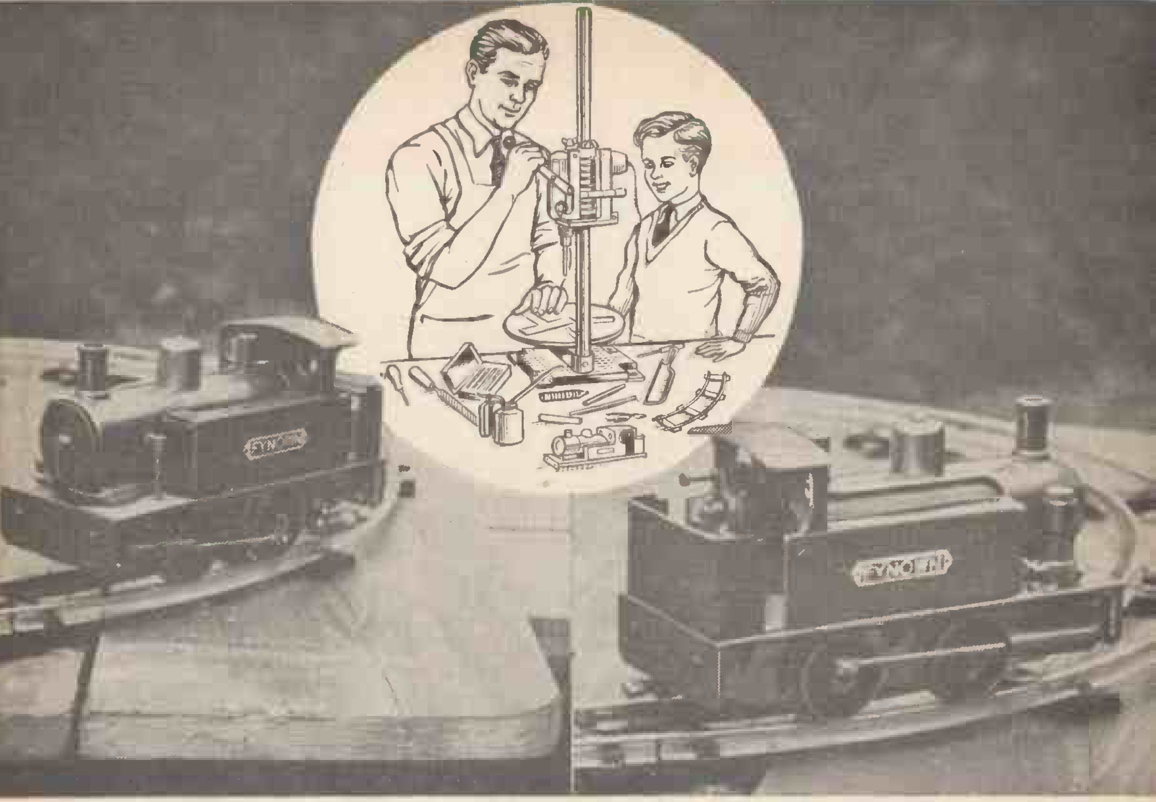
This is a pressurised water type, which will drive a single shaft through steam turbines. Almost every electrical and mechanical part of the propulsion machinery is installed in duplicate so as to minimise the inconvenience of breakdowns. In addition, every control feature of the power plant and of the boat has been duplicated. These innovations will ensure an extremely high standard of reliability which, combined with the need to refuel at only very long intervals, will give her the ability like other nuclear submarines to undertake patrols of particularly long endurance at continuous high underwater speeds.

Accommodation for her complement of 11 officers and 77 ratings will be of a standard which it has been impossible to attain in any previous submarine. The improved water distilling plant will for the first time provide unlimited fresh water for shower baths and for the washing machines in the fully equipped laundry. Separate mess spaces will be provided for senior and junior ratings, arranged on either side of a large galley, which is equipped for serving meals on the cafeteria system. Particular attention has been paid to the decoration and furnishings of the living quarters and to the recreational facilities.

Dreadnought will be fitted with an inertial navigation system and with means of measuring her depth below ice. Her primary role is as a submarine hunter-killer.



Key:
- 1 Reactor compartment
- 2 Reactor control compartment
- 3 Auxiliary machinery
- 4 Diesel generator
- 5 Escape hatch
- 6 Main condenser
- 7 Main turbines
- 8 Electric propulsion motor (alternative drive)
- 9 Rudders
- 10 After hydroplane
- 11 Surface navigating bridge
- 12 Periscope
- 13 Radar and radio aerials
- 14 Snort
- 15 Control room
- 16 Electric batteries
- 17 Crew's quarters
- 18 Officers' quarters
- 19 Electric space
- 20 Forward hydroplane
- 21 Torpedo space
- 22 Torpedo tubes
- 23 Stowed anchor
- 24 Galley
- 25 Stores rooms and refrigeration space



A LIVE STEAMER

Described by N. DEANE

THIS diminutive live steamer was built almost entirely from scrap, without any machining and with an accuracy not normally found except in machined work. There are some novel features both in the finished article and in the methods of construction. The engine represents an 0-4-0 side tank that can be seen around docks or a steelworks. The deep buffer beams enable such engines to sometimes push narrow gauge stock and are often solid slabs of steel which provide greater adhesive weight. A close inspection shows that the model is really a 2-2-0, but a few liberties have been taken. See photographs and Figs. 7 and 8.

The Cylinders

The " waggler " cylinders are made of hard brass tube, silver soldered on to the port faces. The pistons and connecting rods are of silver steel. The wheels, taken from a toy construction kit, were modified by knocking out the bosses and replacing them inside the tread; i.e., on the outside of the engine the bosses were silver soldered in position. The driving wheels are tapped 2 B.A. to suit the $\frac{3}{16}$in. dia. axle and located by thin locknuts after quartering.

The leading wheels are free to revolve on their axle which is $\frac{5}{32}$in. dia. held on by locknuts, the axle afterwards being riveted over. The leading axle passes through a brass block which in turn is pivoted through the frame stay. Although it is not sprung the engine has " independent front suspension."

The Frames

These are made of bright M.S. plate bent into $1\frac{1}{4}$in. × $\frac{7}{8}$in. × $\frac{1}{16}$in. angle. The deep flanges are drilled for wheels, cylinders and frame stays, whilst the narrow top flanges are drilled to suit the deck fittings. To ensure greater accuracy when mating parts, especially by hand drilling, a template and jigs can be made. (See Fig. 6.) The template can be made from scrap 16G. M.S. The shape of the frame is marked on it and all the holes in the flanges marked out and drilled $\frac{1}{64}$in. undersize. Three holes are selected for locating; these are the wheel centres and the cylinder pivot pin. The location holes together with the frame outline are sketched on both frame members and the holes centre-popped and drilled. The template is bolted to one frame and all the holes drilled from it. The other frame is then drilled in the same way.

The template for the buffer beams is a piece of 1in. × 1in. × $\frac{1}{8}$in. angle with the appropriate holes in it.

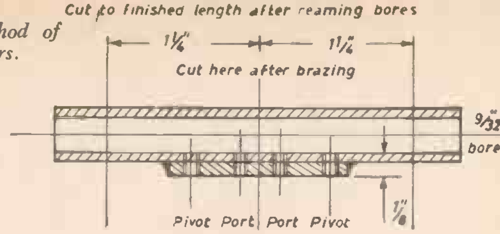
Next the frame assembly jig is made. This is a shallow channel 4in. × $\frac{1}{2}$in. × $\frac{1}{16}$in. M.S. 9in. long. The outlines of the tops of the frames are carefully marked out, location holes drilled and the top flanges of the frames bolted down to the jig. The buffer beam template is fixed to one end. This serves to hold the buffer beam in position whilst the holes in the gussets are marked out from the frames and from the beams. One hole is drilled in each gusset and the gusset bolted up whilst the remaining holes are drilled from the frame and from the buffer beams.

The Frame Stays

Although these seem elaborate for gauge O, they are quite easy to make. They started as a piece of

Fig. 1. (Right)—A front view of the completed steamer.

Fig. 2.—The method of making cylinders.



16 s.w.g. plate bent around an $\frac{11}{16}$in. wide steel block to form a channel section $\frac{13}{16}$in. wide × $\frac{5}{16}$in. deep. The flanges of this are notched and bent to shape, then finally filed to size. They should be a nice push fit between the jigged-up frames and will stay put for drilling with the frames lightly clamped in the vice.

When all the holes are drilled they are opened out to a push fit for 8 B.A. screws. Both buffer beams are fitted in the same way. The frames are finished perfectly square and the buffer beams perpendicular.

Although more drilling is involved by the method described here, the marking out is cut considerably and much greater accuracy is obtained. In addition the cylinders and wheels can be erected on the template to determine the accuracy of the port spacing; the port blocks were in fact drilled from the frame template. Also if any mistakes are made on the template they can be easily rectified simply by making an extra template just for the offending holes.

The driving axlebox is a piece of ¼in. o.d. ($\frac{3}{16}$in. i.d.) brass tube passing through ¼in. holes in the frames. It is surrounded by a piece of ⅜in. o.d. tube, $\frac{13}{16}$in. long, and the ends of the ¼in. tube are riveted over outside the frames.

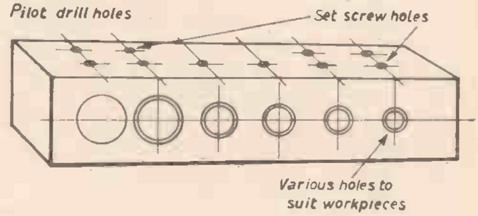


Fig. 3.—(Above) A useful jig.

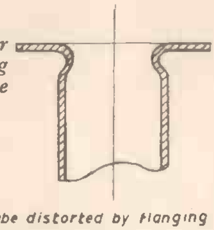


Fig. 4.—Over annealing should be avoided.

The Boiler

This is made from 1¼in. bore domestic water pipe 18 s.w.g. thick. Its heating surface is extended by means of 20 5 B.A. copper pins screwed into it and soft soldered. See Section AA, Fig. 7. These mop-up

FOR GAUGE "0"

much of the otherwise escaping heat from the spirit lamp. The boiler ends are $\frac{3}{16}$in. discs, 1⅛in. dia. They are expanded to a tight fit in the 1¼in. tube, by getting them red hot and spreading them by hammering. The front end is located by the chimney tube and the rear end by a copper ring brazed into the

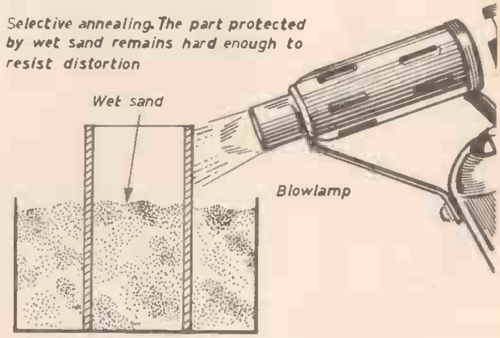
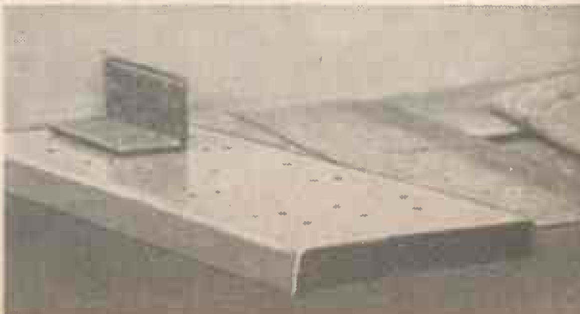


Fig. 5.—Selective annealing in process.

Fig. 6.—(Below) Two drilling jigs.



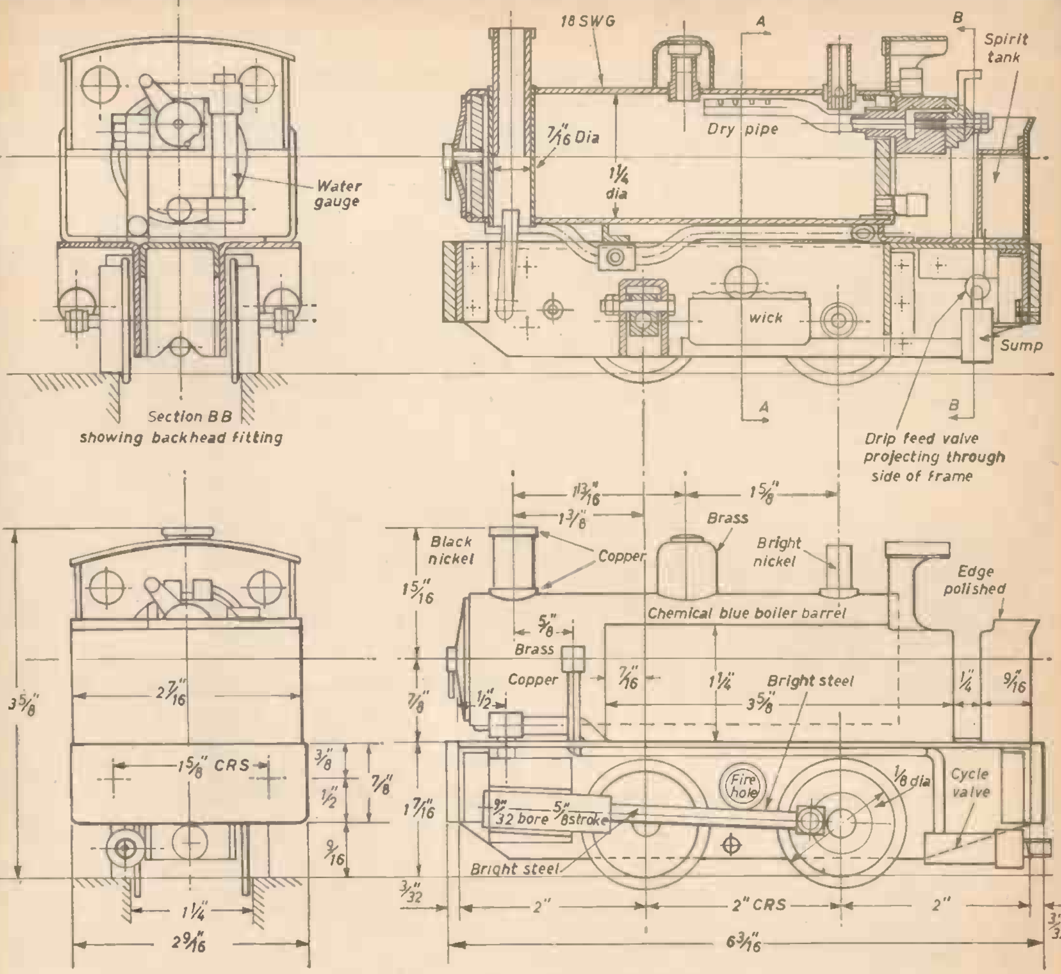


Fig. 7.—The general arrangement.

shell. The discs are set with the outer faces $\frac{1}{8}$in. inside the shell and brazed in, after which the ends of the shell are riveted over and the joints sealed with silver solder.

The bosses for the safety valve, dome plugs and check valve are of thick-walled copper tube screwed 26 T.P.I. brass, tapped into the shell and afterwards silver soldered in.

The Chimney

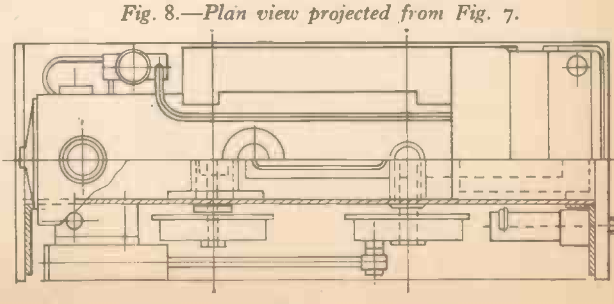
The chimney tube is of $\frac{7}{16}$in. bore × 20 s.w.g. copper. A piece of $\frac{7}{16}$in. o.d. nickel tube was driven in and brazed. A short piece of the copper tube was then brazed to the top of the $\frac{7}{16}$in. o.d. tube and afterwards filed down to a narrow ring. The result is an impressive looking stove-pipe with a nicely flared base. The smokebox door and handle are dummy and camouflage the unsightly boiler end.

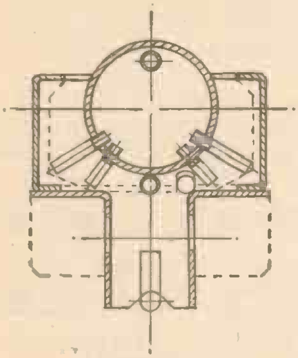
Two pieces of 18 s.w.g. brass were cut to form the ends of the tank and brazed to the boiler shell. Before brazing they were bolted to the jig. These formed the front of the tanks and the lower part of the cab front. With the boiler assembled on the frames the tank sides were cut and bent to shape, then drilled for 8 B.A. countersunk screws. The end plates were marked from these and drilled and tapped 8 B.A.

The Regulator Body

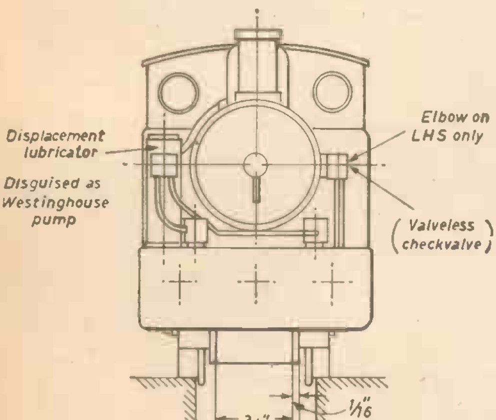
This is made from a piece of $\frac{9}{16}$in. sq. brass, $\frac{1}{2}$in. long. It is riddled with holes for steam ways and among other things provides a steam connection for the water gauge and the lubricator. The steam is fed into the regulator by a dry pipe made from $\frac{3}{16}$in. o.d. × 26 s.w.g. copper tube. This really does supply dry steam and any small drops of water carried into it, evaporate before going very far, owing to the large

Fig. 8.—Plan view projected from Fig. 7.





Section A A
Showing hedgehog spikes



bore. The valve disc is simply a $\frac{3}{32}$in. thick piece of brass with two holes drilled for ports and joined by filing a groove. The back is closed by brazing a disc of thin brass over it. The valve is then lapped on to the regulator face. A double coiled spring washer and a 6 B.A. screw hold them in close contact.

Pipe Connections

Steam pipe connections are made to the regulator body by banjo unions, the main steam pipe banjo bolt being 2 B.A. and the ones for water gauge and lubricator 4 B.A. The $\frac{3}{16}$in. dia. main steam pipe passes directly under the boiler shell to a brass block whence it divides into two. The branches are led to small stand pipes directly over the steam ports. The branch pipes and lubricator pipes are soldered into the stand pipe heads, but this is one of the final jobs. All other steam pipe joints are silver soldered.

The port blocks are cut from $\frac{5}{16}$in. thick hard brass and drilled for steam and exhaust pipes, etc., after being marked from the frame template. The pipes are thick-walled and screwed 2.B.A. Forty T.P.I. is more suitable if taps and dies are available.

The cylinders are made from brass tube, approximately $\frac{11}{32}$in. bore, $\frac{3}{8}$in. o.d. The piston material is $\frac{3}{32}$in. silver steel.

Take a 4in. length of cylinder tube and silver solder a length of $\frac{1}{8}$in. phosphor bronze to it at the centre (see Fig. 2). Build up a nice fillet and then cut the tube and plate at the centre. Hold one in a block of wood in the vice and open out the bore with a $\frac{3}{32}$in. drill held in a hand brace. Both cylinders can be done this way. Next make the pistons and mount them on the rods. After lapping out the cylinder bores with emery cloth, the pistons can be coaxed in. These are run-in in the cylinder until they fit easily and then anointed with molybdenum disulphide paste.

The Crossheads

These are old lampholder terminals already tapped 5 B.A. for piston rods and drilled $\frac{7}{64}$in. for crankpins. The crankpins are 6 B.A. bolts (switch cover screws) with a plain shank. Crankpin bosses are 4 B.A. bolts tapped into the wheels. Those used on the prototype were already tapped 6 B.A. and were taken from some old electrical fittings.

The commercial wheels, used on the original model are not ideal; turned wheels are far more suitable. The treads on these wheels are slightly coned the wrong way, but the engine still rides very nicely on a 1ft. radius track. An elastic band was fitted over the driving wheel treads and left on for two weeks. At the end of this time the rubber in contact with the brass had perished and a rough black deposit was left on the tread and until it eventually wore off, this added to the adhesion of the wheels a great deal. The payload was increased to the point where the engine just could not move it, but still the wheels did not spin. This tip might be usful for the efficiency trials so popular with enthusiasts.

Fig. 3 illustrates a very useful jig which was made for drilling the banjo bolts, boiler fittings and pistons. It is simply a piece of bright mild steel bar (key steel), with holes of varying sizes drilled in it. Some of the holes are drilled half way and continued by a smaller diameter, others drilled right through; some are tapped and some are plain. Other holes have a smaller hole drilled at right angles and breaking into the bore. These enable plain or screwed round bar to be held whilst holes are drilled axially or at right angles to the material. With this gadget it took about 5 minutes to drill a $\frac{1}{16}$in. hole down the centre of a 4 B.A. screw and another hole through the shank to break into the bore.

The " hedgehog " boiler has not been tested properly but during construction before the engine was assembled, a bunsen burner was placed under the unspiked "pot." It took exactly 1½ minutes to boil. After fitting the spikes the same experiment took less than ¾ minute. Also these spikes together with the asbestos linings of the side tanks help to save the paint.

Polishing

When the brazing has been done and the boiler cleaned up, all the copper, brass and nickel, the chimney, barrel and safety valve should be highly polished and then immersed in a boiling solution of:

Lead acetate	2 oz.
Sodium thiosulphate	4 oz.
Acetic acid	2 oz.
Water	½ gal.

The result of this treatment is that all parts acquire a rich deep blue colour, the nickel will in fact be black. Carefully rub the deposit off the chimney cap and base. The finished effect can be heightened by polishing the edges of cab and bunker and the insides of the spectacles.

(*Concluded on page 205*)

This device was built primarily to synchronise the camera shutter with the flash-bulbs when attempting to obtain flash-light studies of such nocturnal creatures as foxes, badgers, owls and so forth.

Synchronisation, however, opens up innumerable possibilities for pictures of other types which cannot be obtained by any other means.

Synchronised Flash Unit

By Trevor Holloway

THE whole device is controlled by a switch, which is electrically operated, and can therefore be at any reasonable distance from the synchroniser. When the switch is closed, the camera shutter is opened, the flash-bulbs fused, and the electrical circuit switched off—the whole sequence taking only a fraction of a second. Exposure time is governed by the duration of the flash (e.g. 1/40 sec. or 1/75 sec.)

The components are contained in a box measuring 9in. × 7in. × 2in., and are operated by a 4½V. cycle lamp battery. Two refinements have been fitted—an interior light controlled by a switch on the top of the box, and allowance made for switching a low-consumption lamp in series with the flash-bulb to indicate a complete circuit.

The Synchroniser

Referring to the sketch, the synchroniser is set by depressing the metal strip X, the end of which projects outside the box. This is prevented from returning to its normal position by a catch on the armature Y. On closing the operating switch, current flows through the two magnets, which attract armature Y, thereby releasing X which presses down the cable release, so operating the shutter.

The release of X also allows spring C to switch over from the main contact to the flash-bulb contact, so that the bulb is fused and the circuit from the battery broken.

The arm X consists of a metal strip about 8in. long and pivoted in the centre. Armature Y is made of soft iron, so that good attraction is obtained from the magnet bobbins, which can be obtained from an old electric bell.

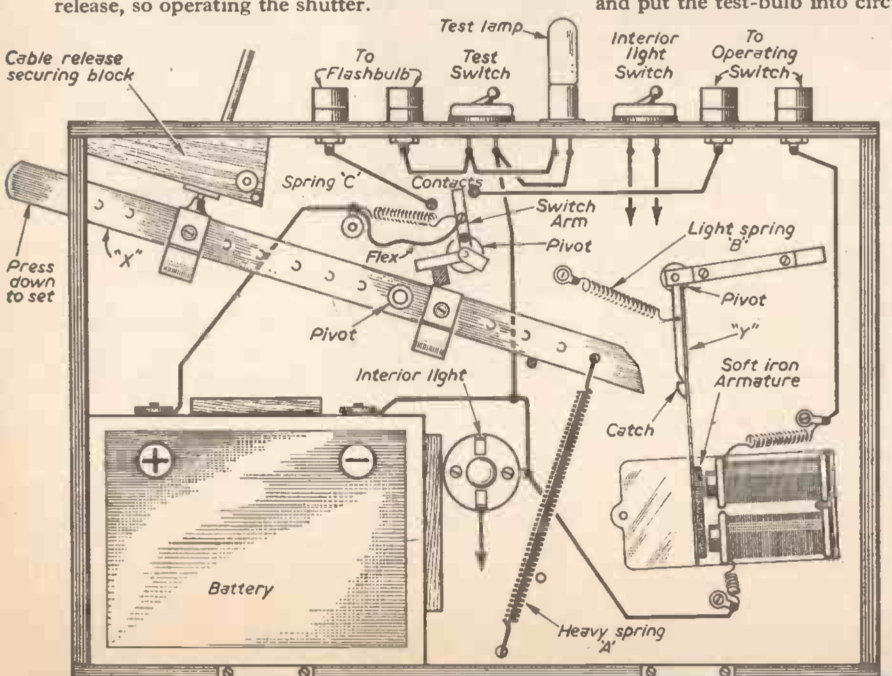
If the interior light is required, one contact of the switch should be connected to the positive terminal of the battery, the other to the lampholder. The remaining lampholder connection is already shown as connected to the negative battery terminal.

Adjustment and Testing

Fix the cable release in position and tighten spring A until it is strong enough to work the shutter. Then depress arm X until it is set in the catch, and arrange the magnet bobbins so that the pull is sufficient to release the arm. The arm should be only just set in the catch for the best results.

The interior switching mechanism for the flash-bulbs has now to be adusted. Connect up the bulbs and put the test-bulb into circuit. (N.B.—The test-bulb is incircuit when the contacts of the test-switch are *open*.) The arm X should now be slowly released by hand and the interior switch arranged so that the shutter opens *just* before the test-bulb lights.

The apparatus should be tested at least once before using, but do not forget to close the test switch before making the actual exposure, and also see that there are no acute bends in the cable release. A 10in. cable release will overcome any difficulty in this respect. The camera shutter should be set at 1/5 sec. or ½ sec. if either of these speeds is available, but the synchroniser will work quite efficiently at 1/25 sec. or less.



Published in response to readers' requests, this article tells you how to make a

STROBOSCOPE

for viewing and timing moving machinery

THIS device will provide "chopped light" of high intensity for the local viewing of moving machinery, and use in some photo-electric amplifying devices. The speed of "chopping" is variable between about 5 and 5,000 c.p.s. by means of a speed control knob and the use of various interchangeable discs. The parts are easily obtainable and one type only of many possible variations is explained.

Fig. 1 shows the apparatus viewing moving machinery in subdued light. Fig. 2 shows how the light is "chopped" after being beamed by the lens. The speed of the motor is variable by means of a knob (variable resistance) and the direction of rotation by a switch.

Mounting the Components

A square biscuit tin makes a suitable container and two pieces of ¾in. × 3in. deal the width of the tin (usually 9in.) are required. One of these is slightly hollowed out to take the motor (Fig. 2). Other motors may be used if the mounting is modified; it must, however, be very firm and rigid. Be careful not to bend the rather delicate shaft of the motor. This motor support beam is then temporarily mounted in position across the centre of the tin, leaving 4¼in. above and below the beam with the axle tip (of the motor) 2½in. from the nearest side of the tin. The approximate position of the beam is shown in Fig. 4. It is fixed with wood screws at each end.

Lens Mount and Focusing Components

The other piece of deal has a 1⅞in. hole cut in it to take the lens. This is mounted by cutting a piece of tinplate 2½in. square with a 1⅜in. hole in it and fixing it on one side of the hole in the beam (see Fig. 4). Small panel pins are then used to hold the lens firmly in place.

Two small threaded rods, or long screws about 4in. in length are then fixed either side of the lens as shown in Fig. 4 and a small piece of plywood or hardboard drilled to fit on to the threaded rods. A motor car type double-pole metal lampholder is then mounted on the hardboard. The lamp must be exactly in line with the centre of the lens, as in Fig. 4. Plug in a lamp, connect up to a battery and make sure the filament can be focused to a bright patch of light on a wall about 3ft. away. Using extra nuts fix the lamp in this position.

The lens holder may now be mounted so that the centre of the lens is *exactly* 2½in. above the motor axle and the front of the lens lying above the front of the motor and well behind the tip of the shaft. The front of the lens will then be about 4in. from the nearest side of the tin. A hole is now cut in the tin side immediately in front of and nearest to the lens; 1¾in. dia. is suitable and a Perspex or glass cover is fitted to prevent anything getting in to foul the mechanism.

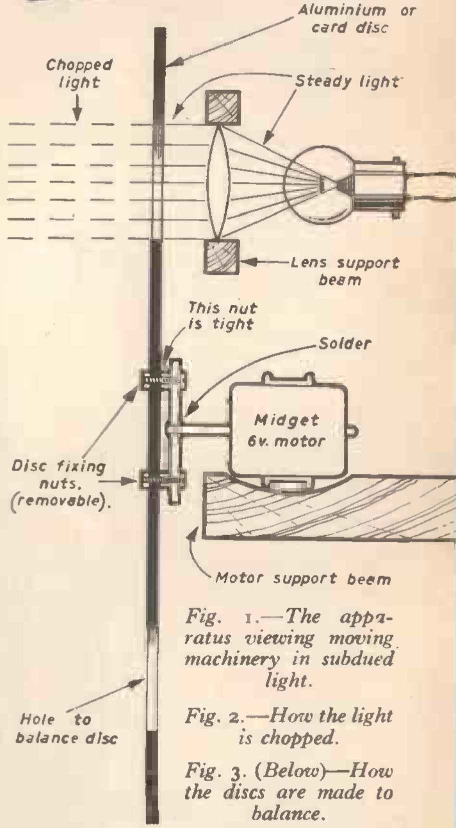
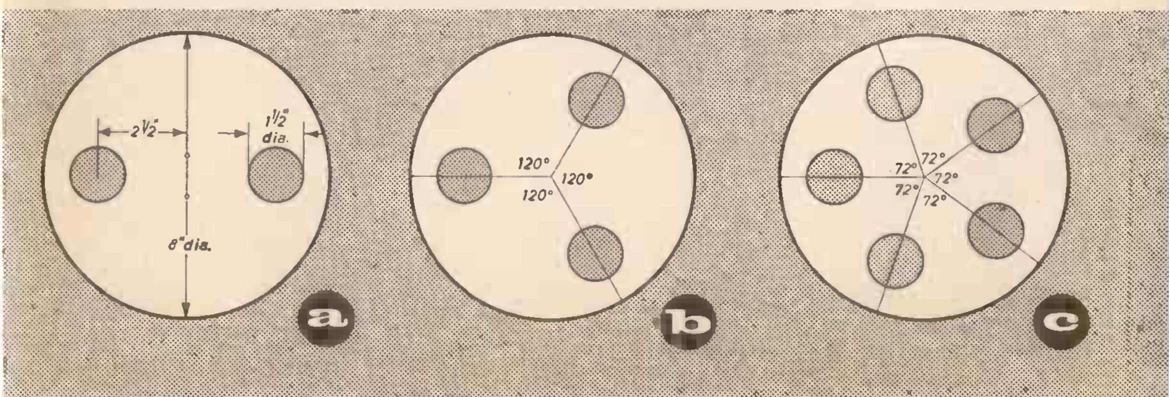


Fig. 1.—The apparatus viewing moving machinery in subdued light.

Fig. 2.—How the light is chopped.

Fig. 3. (Below)—How the discs are made to balance.



The Controls

The controls are now mounted on the side opposite to that with a hole in it. Switches S1 and S4 are mounted with the small keyway at the top and if a S98a potentiometer (from Messrs. Milligans) is used, as in the prototype, it must be mounted externally with three screws and no S1 is required since there is an " off " position when the knob is turned fully anticlockwise. A lead-out hole for power is drilled and fitted with a rubber grommet.

The Discs and Disc Mounting

The discs may be cut from cardboard or light aluminium sheet. They should be balanced. If the holes are marked out with the aid of a protractor, as shown in Fig. 3, balance will not be upset. If one hole only is required, a bolt and nut of a suitable weight (found by trial and error) must be fixed on the opposite side to create a balance. It is important that the disc centre to the centre of the holes should be *exactly* 2½in.

A small piece of brass (about 1¼in. × $\frac{1}{16}$in. × ½in.) is now drilled with three holes. One in the centre to just take the motor axle and two others equidistant each side as in Fig. 2.

Small B.A. nuts and bolts are fitted to the outer holes and must be done up tight. Holes are cut in any discs made to coincide with these bolts.

The motor beam is now removed and the brass

PARTS REQUIRED (Car battery operation)

A full size biscuit tin or similar container, either of wood or metal

S1, S2 and S4. Arcolectric S600 toggle obtainable from Messrs. Arcolectric (Switches Ltd.), Central Avenue, West Molesey, Surrey.

S3. Arcolectric T630.

Warning Lamp Assembly. complete, Arcolectric SL86.

Main Lamp. " En-Fo " 24/24W., double contact 6V. head lamp, or similar from any garage.

Lamp Holder. S.B.C. D.C. *metal* (London Wholesale Warehouse).

VR1. 35 Ω (or similar) variable resistor, must be able to take 1A. at " zero " resistance.

S98a obtainable from Messrs. Milligans, 2 Harford St., Liverpool 3 was used in the prototype.

Bulgin I.V.C. 4 would probably suit, being very slightly overloaded.

Motor. Model Control type. Prototype used " Volta " P.M. 6V. measuring 1⅛in. × 1$\frac{1}{16}$in. × 1in. with a $\frac{3}{32}$in. dia. shaft protruding ⅜in. Obtainable from Messrs. Annakin, 25, Ashfield Place, Otley, Yorks.

Lens. Any magnifying type lens of short focal length. Prototype uses No. 24, but No. 65 would do, obtainable from Messrs. H. English, Rayleigh Rd., Hutton, Brentwood, Essex.

A few odds and ends, nuts, bolts, Perspex etc.

For mains operation these additional parts are required.

MR1. Metal rectifier, full wave, bridge type, 6V. 1A. No.1010 from Messrs. H. English will suit.

Tr.1. Transformer to deliver 4A. (single filament lamp only) or 8A. (double filament lamp) at just over 6V.

C1. 6V. 1000μF or 3,000μF electrolytic condenser. Radio Supply Co., 29, Moorfield Road, Leeds 12.

R1. See text.

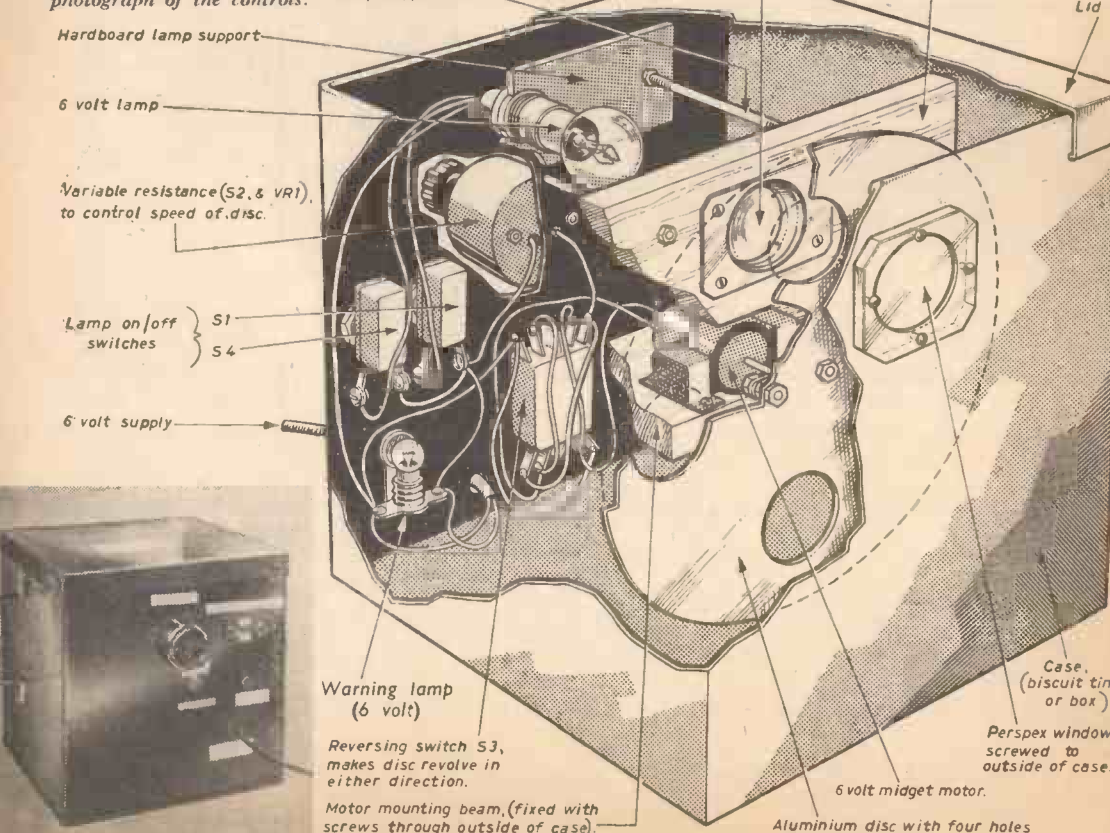


Fig. 4.—A cutaway perspective view showing general arrangement and a photograph of the controls.

strip *quickly* but carefully soldered in place on the motor shaft. Acid flux should be used sparingly, and washed off afterwards. Mount the motor and disc.

The inside of the tinplate disc should now be given a coat of black paint to prevent unwanted reflections.

The Circuit

The prototype worked off a 6V. car battery and used the circuit shown in Fig. 7. The experienced reader may build to this diagram, soldering wires with cored solder only.

Those with less experience should build to Fig. 5 first, and then if they wish to Fig. 6. The dotted line in Fig. 7 shows an optional additional light which can be employed when using a double filament headlamp bulb.

Wiring in Fig. 5

Wire the battery leads to warning lamp and test. Take the positive side of the warning lamp to S1 and S1 to main lamp filament. Take the negative side of the warning lamp to main lamp filament. If a single filament lamp is used wiring is easier; if double take this latter wire to the metal casing of the bulb holder. Test out.

If a double filament lamp is used, wire the positive side of the warning lamp to S4, and S4 to the other filament. Test out.

Wire the negative side of the warning lamp to the motor. The other side of the motor is wired to the variable resistance. The variable resistance is then coupled to the positive side of the warning lamp. In the prototype S2 is omitted as previously explained the lead going straight through. Test out the motor. It should only just revolve with all the resistance in circuit and do about 2,000 r.p.m. with none in.

The Reversing Switch

This is not necessary but better results are sometimes obtained with the motor revolving one way rather than the other. Generally it is best to have the disc moving across the lens in the same direction as the machinery to be observed, but this does not always seem to be the case.

The wiring looks rather complicated, but if Fig. 6 is copied, all that needs to be done is to disconnect the motor from "X" and "Y" of Fig. 5 and connect it to S3 as in Fig. 6. Leads "X" and "Y" of Fig. 6 are then connected to the points where the motor previously went to in Fig. 5. *Never* put the reversing switch in another position until the motor has been stopped by use of S2 or VR1.

Using the Stroboscope

Hold as in Fig. 1, with the machinery to be observed in poor light. The motor speed is then slowly increased until the machinery observed appears to come to a stop. The performance of the machinery under various conditions can then be observed. Slow moving machinery will require slow rotation of the motor and only one hole in the disc, whereas very fast mechanism will require high r.p.m. of disc together with many holes (these must have a fair degree of separation).

Models may be made up to work from flashlamp batteries, or from the mains as in Fig. 8. When using on mains it is not necessary to rectify the heavy current required by the lamp, the slight 50 c.p.s. effect of the filament will not matter if a good voltage is used.

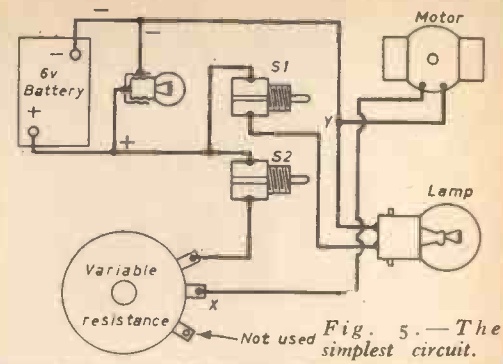
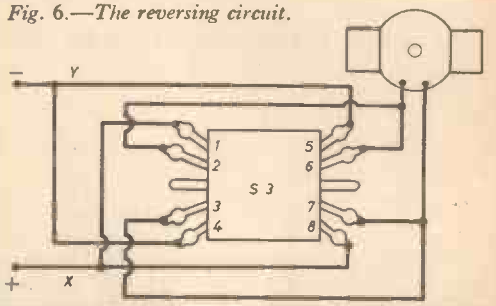


Fig. 5.—The simplest circuit.

Fig. 6.—The reversing circuit.



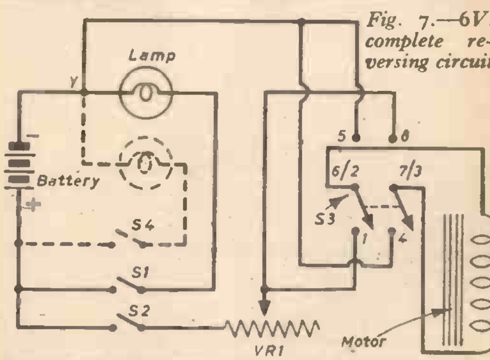


Fig. 7.—6V. complete reversing circuit

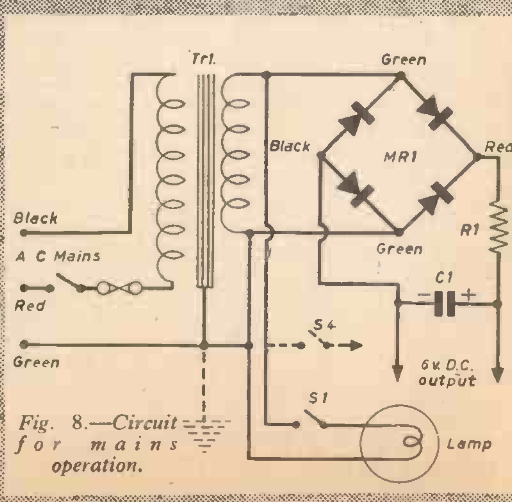


Fig. 8.—Circuit for mains operation.

A Thirty Bob EXPOSURE METER

By D. D. Smith

Fig. 1.—Size of the meter.

For the Photographer or the Ciné Enthusiast

ALTHOUGH this exposure was designed for use with a ciné camera and is therefore calibrated in f. numbers (assuming a speed of 16 frames per second and a shutter speed of a nominal 1/35 sec.) the scale also carries a calibration in light units and conversion scales are incorporated. The meter, therefore, is equally useful for still photography. It can be seen in Fig. 1.

The meter is based on a micro-ammeter and selenium cell supplied by Messrs. G. R. Products, 22, Runnymead Avenue, Bristol 4. This firm will supply the meter, cell and shunt resistor at an inclusive price of 30s., post paid, the required types being sent if this article is quoted for reference.

Making the Case

The case is made from $\frac{1}{32}$in. sheet copper, a material chosen because it is easy to work and solder. Three pieces are required, one 6in. × 2in., and two $2\frac{1}{2}$in. × 1in. Fig. 2 gives the dimensions for cutting and marking out the largest piece. It is important that the window is accurately cut out as it has to correspond with the meter scale after assembly. A tension file made for holding in a hacksaw frame is the best tool to use although, of course, it could be drilled and filed to shape. Although the required holes are marked out at this stage, drilling is left until later, so that any discrepancies occurring in making other parts may be catered for. Drilling of the case may be undertaken as each component part is completed. Right angle bends are made on the appropriate (broken) lines. The inside edges of the case are removed by filing, as are the edges of the side pieces, so that when these are fitted together a "V" groove is formed to take a fillet of solder for jointing. (Fig. 3.) Tinning of the chamfered edges before assembly will ensure that the solder runs into the "V" grooves.

Scale Window

Any thin transparent material is suitable for this. The writer used the transparent Polystyrene top from a box of cream cheese segments of well-known make. The material is cut to a size of $1\frac{3}{4}$in. × $1\frac{1}{4}$in. and fixed on the inside of the case by three 8 B.A. roundhead screws. It is important that these latter be cut so that they do not protrude further than the nuts on the inside of the case, otherwise they may foul the meter movement when it is being fitted.

The Cell Assembly

Whilst this is under construction, it must always be remembered that heat (from a soldering iron, for example) or any cellulose cements or acetate solvents will destroy the selenium cell. The two contact surfaces of the cell are the sprayed metal rectangle on the back and the two metallic strips on the active surface. The back surface makes contact with the case, the latter acting as one conductor to the meter, and copper foil about 0·005in. thick is used to contact the front surface. Perspex of $\frac{1}{8}$in. thickness, frosted by sand-

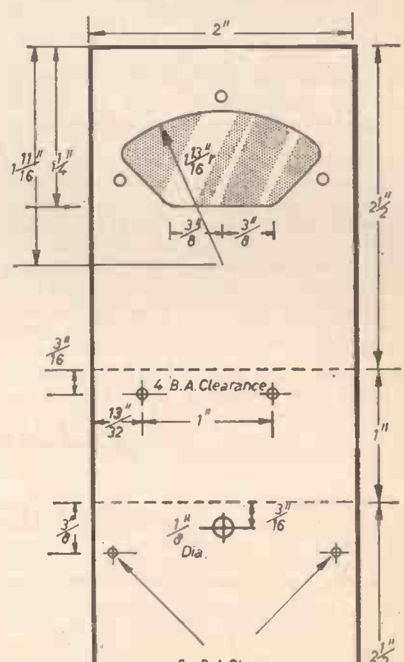


Fig. 2.—Dimensions for marking out case.

papering on the face nearest the cell, is used for the window. Cardboard of a thickness equal to that of the cell, is used as a frame and spacer for it. The exploded view (Fig. 4) shows the general arrangement of the parts. The copper foil contact has a thin flexible wire soldered to it as shown which passes through a clearance hole in the card frame and a corresponding one in the case. A small "dimple" must be drilled in the Perspex to take the end of the wire which protrudes through the copper foil. The dimensions of the frame, copper foil and Perspex are all equal to that of the length and width of the case, i.e. 2½in. × 2in. The holes in the copper foil through which the 8 B.A. × ½in. fixing screws pass must give ample clearance to avoid a short circuit.

Care must be taken to ensure that the window in the foil through which the light passes to reach the cell is exactly 50mm. × 30mm. otherwise a false reading will be given. The material may be cut easily if it is laid on a hard smooth surface and a sharp blade is used. Before assembly it is essential to make sure that the contacting faces of the copper foil and the copper case are grease free. To achieve good contact between the cell and the case, a few layers of aluminium foil from a cigarette packet are sandwiched between them.

At this stage the instrument may be tested by holding the frame of the meter firmly on the case and touching the wire from the active surface contact on the cell to the contact at the rear (opposite side to the pointer) of the meter. If light is falling on the cell, the pointer should kick to the left and remain steady. If this movement does not take place, check to see that there is no short circuit from the screws to the copper foil.

Two Scales

To avoid cramping at one end of the scale, two separate scales are used. One is for when the light intensity is low, i.e. artificial light; the other is used for high intensity light conditions outdoors. For the first condition, the meter only is connected to the cell; in the second case, a shunt resistor is incorporated in the circuit, parallel to the meter coil. The resistor and associated switch are on the top of the case, which is made from Perspex.

The Perspex is cut and filed to fit inside the top of the case leaving a lip on each of the short sides as shown in Fig. 4. It is next frosted on the inner face, as was the cell window. Fixing holes are drilled and tapped 6 B.A. to a depth of approximately ⅜in. to register with 6 B.A. clearance holes drilled in the case sides and finally holes for fixing the resistor and for the press button are drilled at the centres shown in Fig. 5. The resistor is normally in circuit and can be disconnected by pressing the button of the switch. A sectional view, which more clearly illustrates the construction of the switch mechanism is given in Fig. 6. The contact, which is made of spring brass taken from an old torch battery is dimensioned in Fig. 6A. To it is soldered a ¾in. length of brass or steel rod, $\frac{3}{16}$in. dia.

Calibration

The movement had, originally, an edge-reading scale and therefore has the end of the pointer at right-angles to the meter frame. Now that a front-reading scale is being used the aluminium pointer

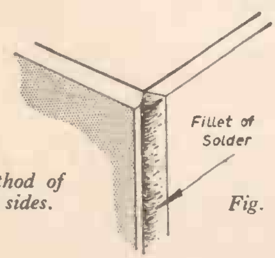


Fig. 3.—Method of jointing case sides.

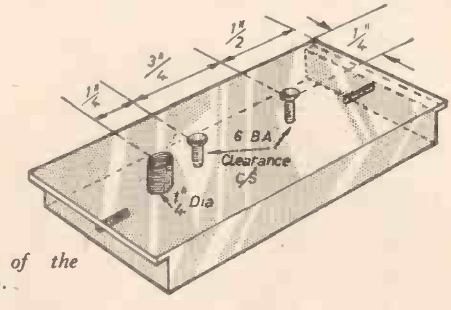


Fig. 5.—Details of the Perspex top.

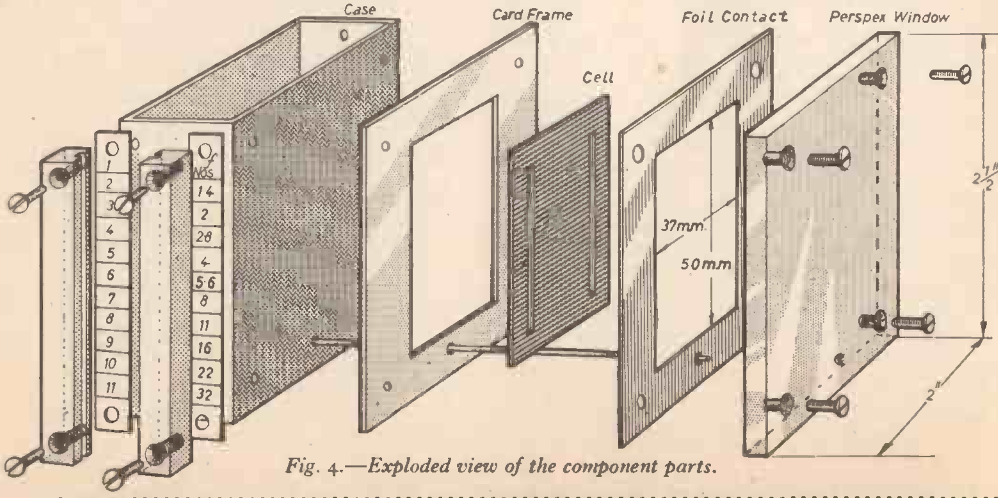


Fig. 4.—Exploded view of the component parts.

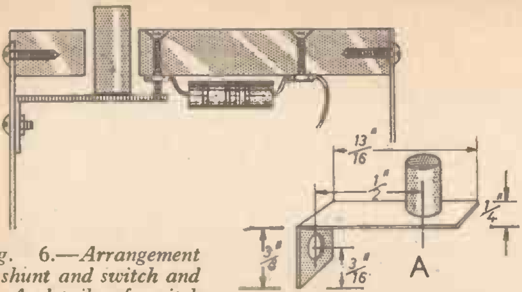


Fig. 6.—Arrangement of shunt and switch and at A details of switch blade.

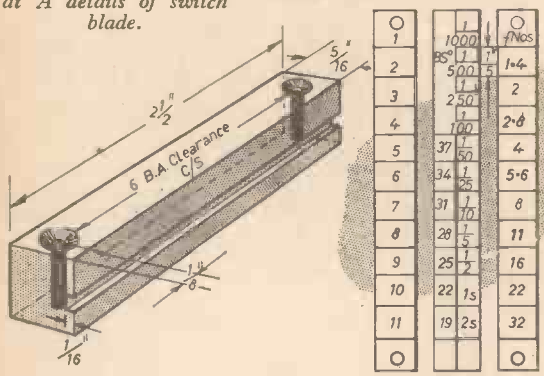


Fig. 7.—Scales and scale cover details.

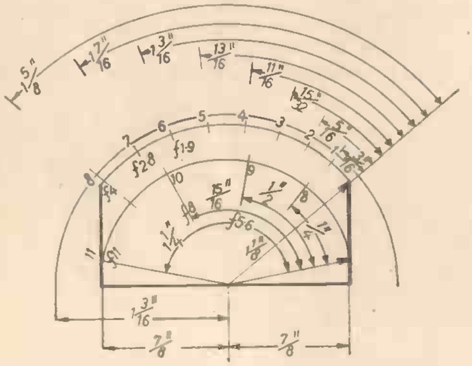


Fig. 8.—Scale markings. All measurements from o to numbers are made with dividers.

shank is used as the indicator. The original luminous end must not be removed, however, as this would upset the balance of the movement.

The scale is made from thin white card marked to the dimensions given in Fig. 8. It is, of course, important that these measurements are followed accurately. Markings can be made in Indian ink. If the meter is not needed for ciné photography, the "f" numbers may be omitted and light units only marked in. It will be noticed that the exposure meter in the illustrations has a black ground with white figures. This was obtained by using artist's scraper board instead of card and scratching the ciphers in. On completion the scale is fixed to the meter frame with impact adhesive. This must be done carefully so that the meter movement is not disturbed. The pointer is finally zeroed by means of the adjusters.

Conversion Scales

Before final assembly, the conversion scales are

Fig. 9.—A view showing the scales.

made. These consist of two fixed and one moving component. The outer, fixed components are made from ¼in. thick Perspex, grooved to take the third, moving scale. Dimensions are given in Fig. 7, with the exception of the width of the groove, which is made to take whatever thickness of transparent material is used for the sliding part. The actual scales are printed on thin card. The one having light value numbers is on the left hand side and that for apertures on the right. The sliding scale has on it film speeds and shutter speeds. The fixed cards are held between the Perspex covers and the case. The moving scale is fixed with clear cement to the transparent plastic which is cut to slide smoothly but firmly in its grooves.

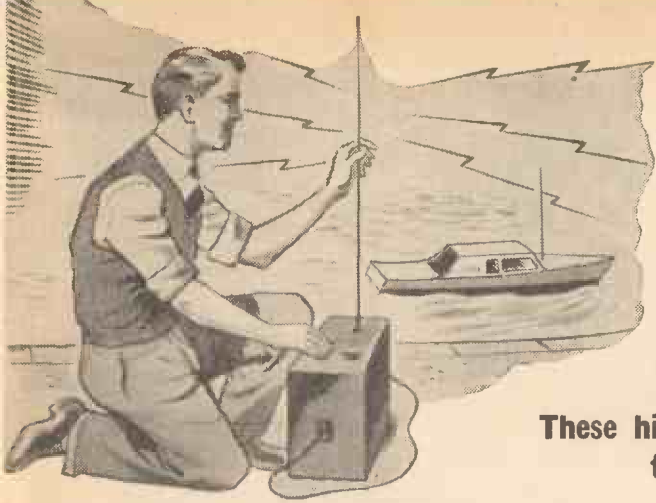
Assembly

Firstly, because of the difficulty of holding the nuts whilst the movement holding screws are inserted, the 6 B.A. nuts are soldered to the lugs on the meter frame. The covering of Vynide or similar material is now fixed to the case with impact adhesive. Again, it is most important that the aperture to the sensitive surface of the cell is exactly 50mm. × 30mm. After this the conversion scales and covers are fixed with 6 B.A. × ⅜in. countersunk screws and nuts.

The wire from the cell is soldered to the rear terminal of the meter together with an extension wire which later goes to the shunt resistor. This wire should be the thinnest stranded flex available. Bell wire is suitable. The meter may now be lowered carefully into the case and fastened at the base with two 6 B.A. × ¼in. cheese-head screws, the extension wire being led down the side.

It will be found necessary to remove a small amount of Perspex from the top at the edge where the nuts holding the scales come through the case. Before the top is screwed down, the push-button switch is fixed to the case side with an 8 B.A. × ¼in. round head screw and nut, and the extension wire connected to the screw holding the resistor.

To use the meter, the cell is pointed at the subject and the light reading noted. If the needle moves only fractionally, the push-button is depressed to cut out the shunt. The centre slide is moved until the speed number of the film in use coincides with the number indicated by the meter needle. The two right hand scales now show the aperture to be used with the chosen shutter speed.



MODEL CONTROL AERIAL EFFICIENCY

By F. G. Rayer

These hints may be quite a revelation to the radio control enthusiast

INEFFICIENT aerials are frequently used with a model control transmitter. It is, in fact, quite usual to join up almost any random length of aerial, and to take no steps at all to discover its efficiency as a radiator. In this way much of the output of the transmitter may be lost. The actual advantages of using an effective transmitting aerial will prove worth while—the stronger signal makes receiver and relay easier to adjust, a smaller aerial may be used on the receiver, and more reliable control can be maintained over a greater distance. If greater range is not required, economies may be introduced at the transmitter. For example, a single valve transmitter, correctly coupled and loaded to a good aerial, can give a better signal than a 2-valve transmitter incorrectly coupled to an inefficient aerial.

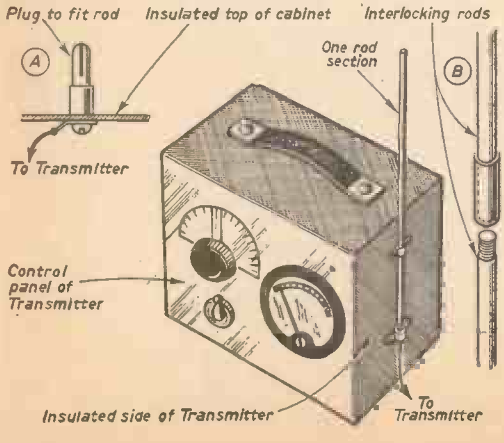
The methods involved in trying to obtain good radiation are, of course, similar to those employed by amateur transmitting stations.

Aerial Length

A model control transmitter aerial is usually vertical, as this avoids directive lobes which could be a nuisance as the model moves about. Such an aerial also gives a vertically polarised signal. The actual aerial is frequently made from interlocking rods, or some type of telescopic aerial which is easy to transport.

Surplus 12in. interlocking rods are popular, as any reasonable length can be made up. For a short aerial, it is only necessary to fix a suitable plug to an insulated panel on top of the transmitter, as at "A" in Fig. 1.

Fig. 1. (Below)—Vertical aerial arrangements.



This plug should fit the bottom rod. Additional rods can then be added, to make up the aerial.

When the aerial is fairly long, additional support is needed, and clips fitted to the side of the transmitter as at "B" will then serve to hold one rod permanently in place. Other rods can be added, as necessary, and quite a long aerial can be erected, except in strong winds.

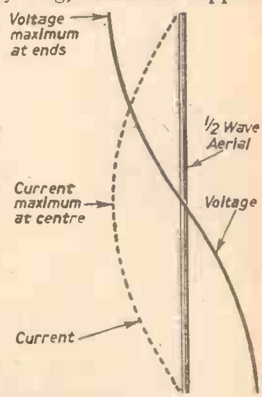


Fig. 2.—Current and voltage in a ½-wave aerial.

Usually, the longer the aerial, the more powerful will be the radiated signal. However, this does not mean that extremely long aerials are required. This is not so, partly because the frequency of the 27Mc/s model control band helps to make very long aerials unnecessary.

If the influence of aerial length is to be understood, it is necessary to consider the distribution of voltage and current in a simple aerial. For model control purposes there is no need to go into this theory very deeply.

Fig. 2 shows a ½-wave aerial operating at its correct frequency. Current is at a maximum in the middle, falling to approximately zero at each end. Voltage, on the other hand, is at maximum at each end, and zero in the middle.

A model control aerial will usually be only *part* of a ½-wave. As a result, the way in which it is current or voltage operated will vary widely. As example, assume that the aerial were nearly as long as the ½-wave in Fig. 2. If fed at the bottom end, it would take extremely low current, but would accept a high voltage. That is, it would act as a high impedance. Again, assume it were only one-half the length in Fig. 2 (that is, ¼-wave), it would then be fed at a point where current is near maximum, but voltage near minimum. It would then provide a low impedance load. Between these extremes will be found a wide range of possible current and voltage points, voltage rising as current falls. For maximum efficiency, the aerial should be fed with voltage, or current, or the correct proportion of both, according to its length. Fortunately this is easily arranged, in practice, by means of an aerial tuner.

The approximate length of a ½-wave aerial, for the 27Mc/s band, would be 17ft. 6 in. For a ¼-wave, the length is about 8ft. 9in. The exact length depends on the particular frequency used, aerial diameter, length of lead from transmitter to aerial, and other factors, and for these reasons performance is best checked by measuring the power radiated from the aerial. One means of doing this is to connect a fairly sensitive R.F. meter (0-300mA is suitable) at the bottom of the aerial. Another way, extremely useful in practice, is to employ a field strength meter to check how much energy is being radiated.

Field Strength Meter

This is the same as a frequency meter (such as used for checking frequency) with a short aerial added. Alternatively, the instrument can be built for field strength tests, and used as a frequency meter by removing the aerial.

A convenient circuit is shown in Fig. 3. The tuning condenser is a small short wave type, its exact capacity being unimportant. Any coil of efficient design, tunable to 27Mc/s (about 11·1 metres) is satisfactory. About ten turns of 20 S.W.G. or similar wire, on a ¾in. dia. former, may be used.

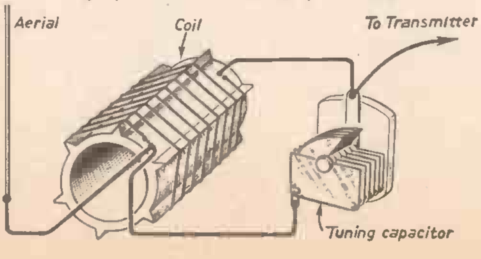
The meter, upon which field strength is read, should be of sensitive type. A 100μA movement is excellent, but other meters may be employed. As there is no need for actual current to be known, surplus indicator units of various kinds can be used, with a scale so that readings can be noted.

If the instrument is to be used as a frequency meter, all construction must be rigid, and a suitable pointer knob or dial is needed on the tuning condenser. For field strength tests, this is less important. The aerial may consist of one or more 12in. rods, according to the sensitivity required. The actual length need not be known, but it is best to keep to one particular aerial, if comparative tests are made over a period.

The field strength meter is placed at a convenient distance from the transmitter. If the 100μA or similar movement has a clear pointer, this may be seen at some 10yd. or so distance. Failing this, a helper is required, to call out readings. For easy work over longer range, binoculars supported by a tripod will be handy for reading the meter. The distance between transmitter and meter is unimportant, but should not be too small. For comparative tests, measure this distance, so that results can be duplicated if required.

All modifications to the transmitter aerial or coupling are directed towards securing the maximum possible pointer deflection on the field strength meter, which will be an indication of the power being radiated.

Fig. 4.—Bottom loading of an aerial.



Loading and Coupling

For general purposes, a self-supporting rod aerial cannot very well be longer than ¼-wave (about 8ft. 9in.), though longer aerials are feasible on windless days, or with the more rigid type of rods. A coupling loop is often provided in the transmitter, and this may (or may not) suit the aerial length. A simple way of securing better results may thus be found in changing the number of turns on this loop.

The loop should only be changed a turn at a time. After each change, assure that the transmitter is tuned on frequency, and that it and the field strength meter are tuned to the same frequency (that is, for maximum meter reading). A number of turns will be found at which the field strength reading is best, and this number can be adopted for the aerial used.

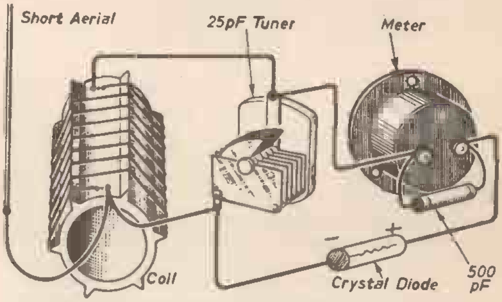


Fig. 3.—Field strength meter for aerial testing.

If the actual aerial is to be made resonant by itself, the approximate length for ¼-wave or ½-wave working will be as given. The aerial should then be made a few inches shorter, but have one overlapping or sliding section, so that it can be adjusted in length until the field strength meter gives the greatest possible indication. The exact length is not critical.

Referring to Fig. 2, it will be noted that the ½-wave aerial will be voltage fed (since the connection will normally be at the bottom). That is, there is high voltage, but low current. But if the length is near a ¼-wave, there will be high current but low voltage. In effect, the additional ¼-wave (required to make up the ½-wave) will be provided by the earth. Therefore the earth resistance, or effective resistance of the counterpoise earth provided by the transmitter, batteries, etc., will be extremely important. When the aerial is predominantly current fed, the losses in a given earth resistance will be much greater than if the aerial were voltage fed. For this reason, it will often be convenient to feed the aerial in such a way as to avoid any need for a high earth current. This may be done with a tuner, which is a compact means of making up the extra length which is not available in the actual aerial; or which enables an aerial to be resonated against ground, when the earth return is good.

Bottom Loading

Fig. 4 shows a short aerial with a tuner, the latter making up the effective aerial length so that the whole resonates in the same way as a ½-wave aerial. The best position for the tuner is not necessarily at the bottom of the aerial, but this is usually most convenient. With such an arrangement, the aerial length may be disregarded, and the tuner adjusted for maximum signal strength.

A tuner may be constructed as shown in Fig. 5. An air-spaced or short wave tuning condenser, of 100pF or 150pF capacity, is satisfactory. The coil can best have spaced turns, so that small clips can be easily attached. For a 1in. or 1¼in. dia. ribbed former, some eight to ten turns of 20 S.W.G. or similar wire, with turns spaced nearly ⅛in. (so that clips can be inserted without shorting) will be satisfactory. Tinned copper wire will allow good contact to be made easily.

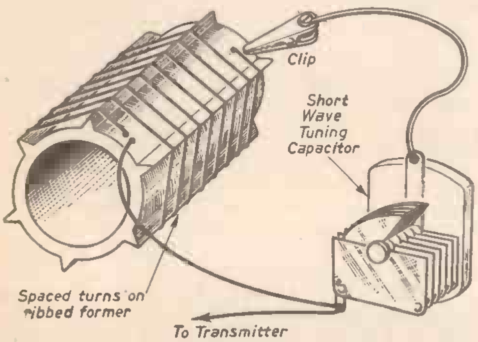


Fig. 5.—A multi-purpose aerial tuner.

The tuner is joined between the transmitter aerial terminal and the actual aerial, and is adjusted to obtain the highest possible reading on the field strength meter. If the aerial circuit of the transmitter is connected to earth, to avoid H.T. voltages here, it will be quite safe to adjust the clips or aerial, even with the transmitter working.

Fig. 6 shows some of the ways of connecting the tuner. In No. 1, only part of the coil is required to obtain resonance, but some turns in series with the bottom of the aerial help to secure best loading. With No. 2, the same tapping serves for both aerial and tuning condenser. With No. 3, the aerial requires more current, at less voltage, so it is tapped down the coil, and the whole coil is used to resonate the circuit. No. 4 is a series-tuned acceptor, aerial, part of the coil, and condenser forming a circuit tuned to the transmitter frequency, and thus drawing current. In Fig. 5, the aerial is tuned against ground, and link coupled. The coupling winding at the tuner can have the same number of turns as that inside the transmitter, and the two coupling windings are joined with twin flex.

Various other methods of coupling exist. The procedure is simply to try various systems, and adjust tappings and tuning, until the highest possible reading is obtained on the field strength meter.

Transmitter Output

Battery valves are often used in model control transmitters, and care is necessary to avoid increasing aerial coupling and loading to such an extent that the anode current rating is exceeded. This can easily be watched by inserting a meter in one H.T. lead. If the anode current tends to be too high, it is usually satisfactory to increase the value of the valve grid resistor somewhat. This will reduce H.T. current, but may actually increase radio frequency output, as shown by a rise in field strength readings.

With self-driven oscillators, such as are employed in popular 1- and 2-valve transmitters, the valve develops its own drive voltage across the tuning coil. With such circuits, an efficient coil is justified. A good degree of aerial loading will then give best possible output.

If it is remembered that all adjustments are directed towards obtaining as high a reading as possible on the field strength meter, the result of any changes will easily be seen. The effective radio frequency output of different circuits or transmitters can readily be compared, in this way. So can changes in the length or height above ground of the aerial, or variations in battery voltage, substitution of valves, etc.

Receiver Aerials

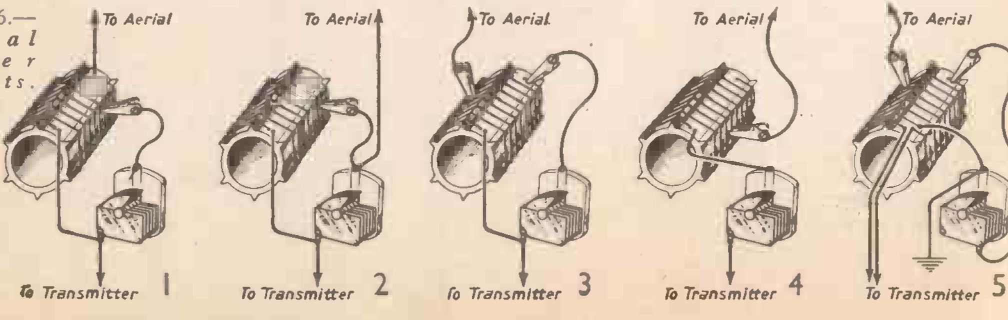
These are so often dictated by the model, that little change may be possible. However, it is usually feasible to have quite an effective aerial. For maximum signal pick up, it should be reasonably long, and well insulated from the model. Both the aerial and lead to the receiver should not move about, or tuning will be erratic. With regenerative receivers this can be very serious, though it is less important with flatly-tuned receivers.

The aerial can usually be vertical, and this also gives best effective height. It is, however, not essential to have a vertical aerial, and in some models the aerial may thus be a small scale replica of that supported horizontally between masts.

Some receivers are much influenced by the aerial, and unnecessary changes are best avoided. Generally speaking, simple receivers such as diode detectors followed by transistor amplifiers will operate best with a fairly long aerial. But with a super-regenerative receiver aerial loading is important, and a long receiver aerial may prevent regeneration.

The receiver aerial is best tested with a weak signal, so that the effect of receiver adjustments can be readily found. This can be arranged by temporarily removing the transmitter aerial, and running the transmitter at low power.

Fig. 6.—Aerial tuner circuits.



Silver soldering with mouth blowpipe and home-made spirit lamp.

A Home Jewellery Workshop

This will assist you to carry on a profitable hobby

By Peter Wix

SILVER, and even gold, and semi-precious stones, are not expensive when one considers the small quantities needed for jewellery. With equipment it is much the same, the expense being no more than for most other crafts. Many tools can be home-made for next to nothing, and most small metalwork tools already in the home workshop will be found useful.

The Bench

Fig. 1 shows a solid and easily constructed bench. Its height should bring the top about 9in. below your chin when you are comfortably seated. The *pin* is normally made of beech and costs about 9d. to buy, but it could be made of some other hardwood. It is screwed, or, preferably, bolted, to project from the centre of the semi-circle. The notch is an aid to sawing sheet metal, and nicks and grooves can be made as the need arises to hold some awkward job for sawing or filing.

Stakes and Mandrels

One flat, steel stake is essential, and it pays to have two so that one can be kept highly polished for work where both hammered and supported surfaces must remain free of scratches. An old type domestic flat-iron makes an excellent stake. It can be supported on a block which is cut to take the handle, or, better, the handle can be sawn off with a hacksaw. The working surface should be trued if necessary with a very sharp file, followed by successively finer grades of emery cloth.

The shaped stakes used for art-metalwork are seldom needed for jewellery, but the ball ends of ball-pein hammers of various weights make useful round stakes if they are polished and kept in good condition. The hammer head is best clamped in a vice when being used as a stake.

Mandrels

These are the formers, round which you can bend by hand or shape with mallet or hammer, metal strip, wire, etc. Short pieces of heavy steel tube and solid steel and brass bar could be collected in a range of diameters up to, say, 2in. Give emery treatment if necessary. A slowly tapering mandrel will obviously save a number of separate rods, and anyone with a lathe may find it worth while turning one. Old steel cotton spindles make good mandrels. The smallest mandrels are used mostly as formers for coiling wire for decorative work, or for making jump-rings. The handles of needle files can sometimes be used, and those very strong steel knitting needles are perfect.

Mallets

If you decide to make your own, use either boxwood or apple. An apple bough that has lain long enough to season but not to rot may provide material for a range of mallets. Fig. 2A and B show the most useful types. A lathe is not necessary: they can be shaped with a chisel, a "Surform" type file, and finished with fine sandpaper. Handles are best of ash or bamboo. The horn mallet in Fig. 2C is useful, but you can dispense with it and have another wooden mallet of smaller size.

Cork Mats

Old table mats of fairly thick cork are excellent, used with a bossing mallet for doming thin sheet metal. The leather sandbag used by art-metalworkers will allow a deeper impression.

Pitch Pan and Bowl

Cheap and easy to make, these are really essential for repoussé work and chasing. You can use a small cake tin, about 1in. deep, filled with a mixture of prepared chaser's pitch. The pitch is very cheap and it hardly pays to prepare your own.

The pitch bowl is a refinement of the pitch pan. It is supported on a tough leather ring, and the hemispherical bowl can be tilted to any angle when working on your metal with the punches. (See Fig. 3.) You could perhaps make one from an old

A polishing bench, showing the ½ h.p. motor which drives the polishing head, etc.

Part of a jeweller's bench showing some of the more important tools.

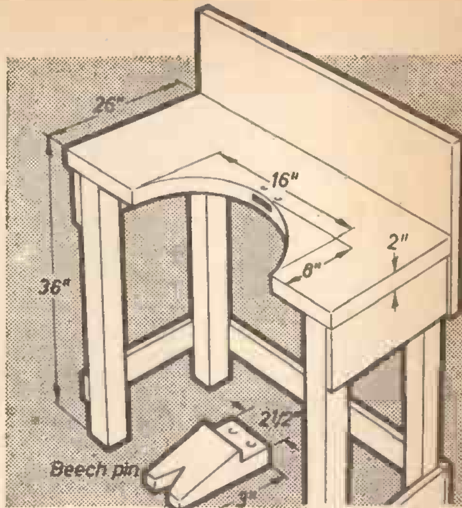


Fig. 1.—A solid and easily constructed bench.

colander of suitable shape, the inside lined with kraft paper or heavy brown paper before the pitch is melted and poured in. A shoe repairer will supply leather for the ring.

Repoussé, Chasing and Matting Punches

An assortment can be made from round and square tool steel or silver steel rod. Fig. 4 illustrates a few shapes, and each shape should be available in at least two sizes. Other patterns will suggest themselves as you become more experienced. Cut off lengths of about $3\frac{1}{2}$in. from your steel rod and grind the ends to shape. Polish the surfaces with emery to the best finish you can manage. Harden the end, and then temper to a dark straw colour, finishing with a final polish. The straight *tracer* for example (Fig. 4a) is made from $\frac{3}{16}$in. square rod, tapered to give a working face of $\frac{3}{16}$in. × $\frac{1}{16}$in. Other tools can be made from round or square rod of $\frac{1}{4}$in. or $\frac{3}{8}$in. Edges should, as a general rule, be slightly rounded off to prevent the tool digging in as it is tapped and at the same time moved over the design.

Matting punches have their working surface given a " tooth " or pattern, which gives a certain texture to the punched metal. One type can be made by bringing the end of the punch to bright red heat and driving it against the teeth of a file laid flat on the bench. Hardening and tempering follow in the usual way.

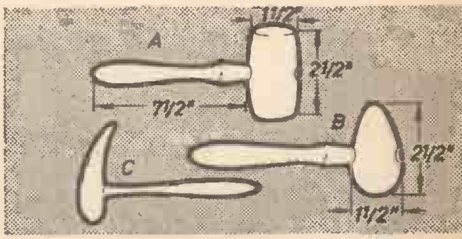


Fig. 2.—Three types of mallet.

Fig. 3.—(Below) The pitch bowl.

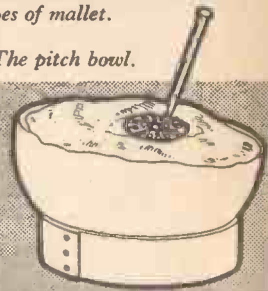


Fig. 4.—Various shaped tracers.

Doming Punches

For making perfect hemispheres or very accurate domed shapes, you will need a doming block (Fig. 5B) as well as the set of punches which fit the depressions. But a lead block is nearly as good, and Fig. 5A, shows a way of making extremely good punches. To solder a ball bearing to the end of a tube, invert them on an asbestos mat, heat ball and end of tube, and drop snippets of solder down the tube.

An ingenious alternative is to use strongly magnetised tubes of suitable steel. One tube may hold two or three sizes of ball bearing, but do not expect a very small tube to hold a large bearing. The magnetism can be retained in the case of the tubes by arranging them all head-to-tail when not in use. The lead block can be cast from scrap into a wooden mould, your ball bearings will punch various sized holes in it, and you can always re-cast the block when it has suffered badly from long use.

Hammers

Two hammers suffice for most jewellery work: a jeweller's hammer with 2oz. head (Fig. 6A) and a small ball-pein hammer of the same weight (Fig. 6C). Where repoussé work is intended, it will pay to have a repoussé hammer (Fig. 6B) with a 4oz. head. This has a large face and specially sprung handle. But most small hammers are useful if the faces are filed or ground to remove marks, and then polished.

Holding Tools

The hand vice shown in Fig. 7A is a very useful tool; it has jaws

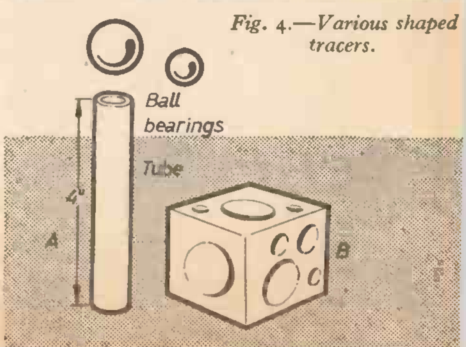


Fig. 5.—(Right) Doming block and home-made punches.

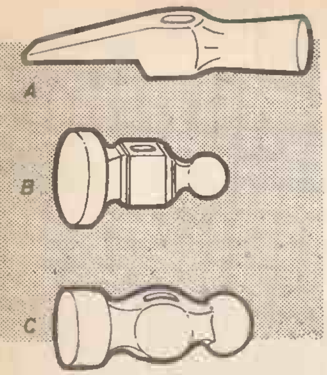


Fig. 6.—Three suitable types of hammer.

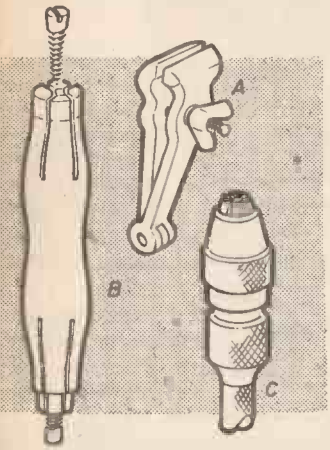


Fig. 7.—Details of a hand vice and ring clamp.

about 1½in. wide, patterned for extra grip. Brass or copper inserts could be fitted to save marking delicate work.

The ring clamp shown in Fig. 8 is really intended for holding a ring by its shank, but the leather-lined jaws will grip almost anything, and afford good protection. It is easily made from something like a piece of old chair leg of about 1½in. or 2in. dia., sawn down the middle, and shouldered to take the leather (shoe leather, or an old thick strap). It is held by a metal band around the middle, the band being secured from slipping by two half-tightened wood screws. The hardwood wedge is pushed or tapped gently in from the bottom.

Fig. 7B shows an alternative ring clamp. Turn or file down a large boxwood file handle to the shape indicated, and between 4½in. and 6in. long, drill the ends and fit a large wood screw to go in easily to half its length. Then make the saw cuts, saw the heads off the two screws, and cut slots in their tops. Its method of holding a ring by the expansion of the wood will be obvious.

The pin chuck is a small tool which will hold a brooch pin or piece of wire for filing or other treatment, and also serves as a tool holder for the tiny reaming blades known as broachers. The chuck itself is also used with the drillstock described later.

Cutting Tools

The saw frame, most frequently used of all jeweller's tools, is capable of astonishingly fine work. The best type has an adjustable frame, but a cheaper non-adjustable version is available. The best length of blade to buy is 3in., as this provides good rigidity for a given tooth size. Blades are numbered, 2, 1, 0, 2/0 and so on up to the finest you will ever need, which is 8/0. Stock two sizes at first: 0 and 4/0. A light fretsaw frame could be used (4in. blades are available), but the depth of frame makes it a little unwieldy for very fine work.

Small tin shears can be used as snippers, if they are really sharp. Curved blades are also very useful. Straight type should have 5in. handles and blades about 1¼in. long. A good strong pair of nail scissors will also cut thin sheet silver, gold, copper, etc.

Side or end-cutters are definitely useful, but the cutters on certain pliers will do if very sharp.

Drill Stock and Drills

A small hand drill is sometimes useful—mainly for twisting strands of wire together in decorative wire work. The wires are held at one end in the vice, the other held in the chuck, or looped on a screw eye, with its threaded portion held in the drill chuck.

Fig. 8 shows you how to make a real jeweller's drill, the pattern of which has not changed in several thousand years. In use, it leaves you with one hand completely free, and it cuts quickly and accurately. To the $\frac{3}{16}$in. dia. mild steel rod is soldered the bob-weight which acts as a flywheel, then the threaded sleeve. This sleeve must accept the two components from your pin chuck. The handle is made from any piece of hardwood, and it pays to have a metal bush pressed into the centre where it has to travel up and down on the rotating spindle. Spear-point drills are used for their double cutting action, and these are quite cheaply bought in a set. In use, the string is wound up to bring the handle half way up the spindle, the handle is depressed firmly, then allowed to rewind itself.

Broachers are available in a set covering a wide range of hole sizes, and are essential if you want to enlarge the hole of a brooch pin or joint for example. The pin chuck can be used as a holder for the smaller broachers.

Files

Some at least are essential, and, generally speaking, the more the better. The smaller engineer's and toolmaker's files in the finer cuts are all useful. Needle files are essential for small jewellery, but, fortunately, they are very cheap. They have a smooth shaft and need no handle, and are available from 12cm. to 18cm. in length. Best not to have them with too fine a cut, but somewhere in the middle of the range. Fig. 9 shows a selection of needle file shapes. A warding, half-round, three-square and square would be best for a start. One or two small rifflers, with their ability to get into awkward places will also be useful sooner or later.

Triangular Scraper

This is easily made by grinding the teeth off an old three-square file and bringing the end to a point. Sharpen the edges by rubbing the flats on an oil-stone.

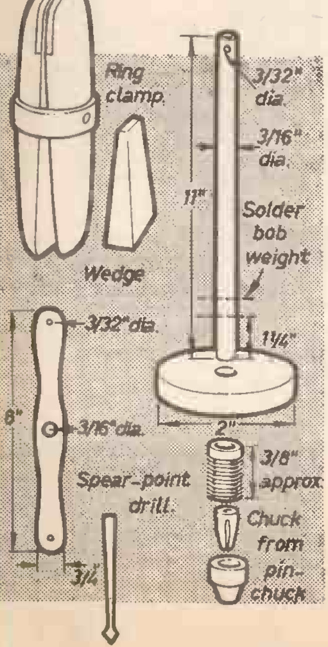


Fig. 8.—Another type of ring clamp and constructional details for a jeweller's drill.

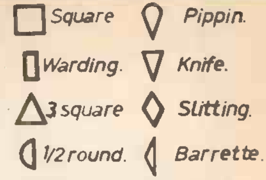


Fig. 9.—Various needle file shapes.

At least two pairs of pliers are essential for a start. One could be a round nosed pair 6in. long, with one nose treated as in Fig. 10A. A pair of 5in. flat pliers are necessary, and third choice would be a 4in. snipe-nose pair. You may like to convert another pair to that shown in Fig. 10B, filing back the jaws and sweat-soldering brass facings using tinman's solder and holding the jaw in a suitable flame. If one facing is made half-round, you have an excellent tool for bending a ring shank without marking it. Radio and other types of pliers may of course be used for some work.

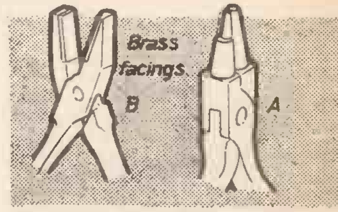


Fig. 10.—Pliers can be made more useful by converting them as shown.

Stone Setting Tools

If you have a leather modelling tool of hard steel like that in Fig. 11A this will serve well as a burnisher. Alternatively you can forge one that shape from tool steel (perhaps an old file), afterwards hardening, tempering to pale straw, and polishing the surfaces very bright. The straight type, which will serve for all rub-over settings is simpler to make, as it needs only grinding from a piece of tool steel. (Fig. 11B.)

Scorpers and Gravers are essential for engraving and for some kinds of settings. Three should suffice: a lozenge graver, a flat-bottomed scorper, and a spitsticker. These strange names indicate the tool's section. The flat scorper is also useful for cutting thin wires or filigree on the lead block; it cuts cleaner than snips or side cutters. Gravers and scorpers need extremely careful sharpening. An " India " or " Aloxite " stone will grind rapidly, and a fine " Hard Arkansas " produces a polished cutting edge.

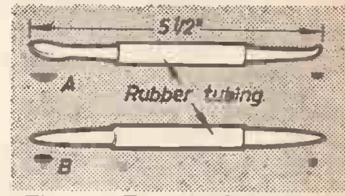


Fig. 11.—Two suitable burnishers

Soldering Equipment

All high-grade jewellery is hard soldered, i.e. joined with an alloy of the metal being used, this alloy melting at a slightly lower temperature than the work. If you have a gas supply, the " French " blowpipe is best, and certainly the easiest to use (Fig. 12A). You can provide air by the time-honoured method of blowing, or by using a small compressor. A pumped-up inner tube from a car or motor cycle, fitted with an additional outlet valve, less valve core would also be suitable. (Fig. 12B). This will supply air for a surprisingly long time on one filling. A bunsen burner and mouth blowpipe is another alternative (Fig. 12C), or the proper jeweller's swivelling gas jet screwed to the bench, and which is, in effect, a bunsen burner on its side. A spirit lamp will also provide a good hot flame, and the type shown in Fig. 13, was designed specially to allow the flame to come as close as possible to the work. Some commercial types have such a bulbous base that you have to blow the flame a long way to the adjacent charcoal block. This one is made from a tin with push-on lid, a piece of tube being soldered on to take the ⅜in. dia. wick.

Solid " Meta " fuel is another possibility, if you care to experiment. The tablets could be placed on the charcoal block, an appropriate distance from the work.

Borax has long been the standard flux, though some advantages are claimed for special fluxes supplied by the makers of silver and gold solders. Borax is used in lump or " cone " form, rubbed on a piece of ordinary slate with a little water.

Fine-pointed brass or steel tweezers are essential for laying small snippets of solder on the fluxed joints. Brass tweezers will also serve for dipping work into the acid pickle. Steel must not enter the bath.

Acid pickle, a 10 per cent. solution of sulphuric acid is used for silver, copper, or gilding-metal. A 25 per cent. hydrochloric solution is better for gold. If contained in a copper " boiling out pan " or Pyrex container, the acid can be warmed with the work in it, and this speeds up the pickling process. Beware of splashes and fumes, especially if hot work is dropped straight in the acid.

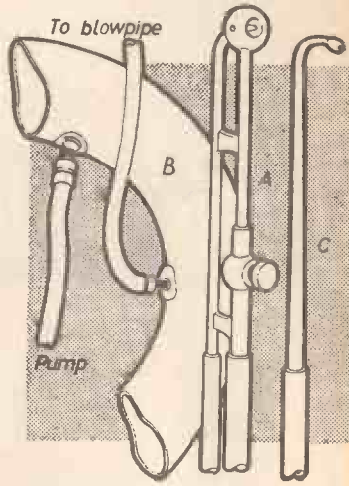


Fig. 12.—(A) a French blowpipe; (B) an improvised air supply and (C) a mouth blowpipe.

The Charcoal Block

A specially prepared block of compressed charcoal costs about 1s. 6d. and lasts a long time. Grooves and dents in the surface assist in placing work for soldering. Pins and wires may be stuck in to form jigs and other pieces of charcoal arranged around the work can help to build up heat.

A thick, soft asbestos mat gives a clean soldering surface, and a tin lid full of small asbestos lumps or snippings will hold awkwardly shaped work for soldering. If you have to repair a gem-set ring, a tobacco tin of wet silver sand will give some protection to stones, though it is best not to try these tricks on precious rings without considerable practice.

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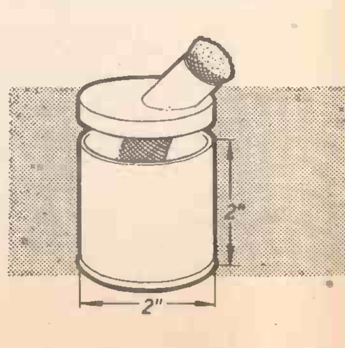


Fig. 13.—A suitable spirit lamp.

This design was originated by J. W. Tomlinson

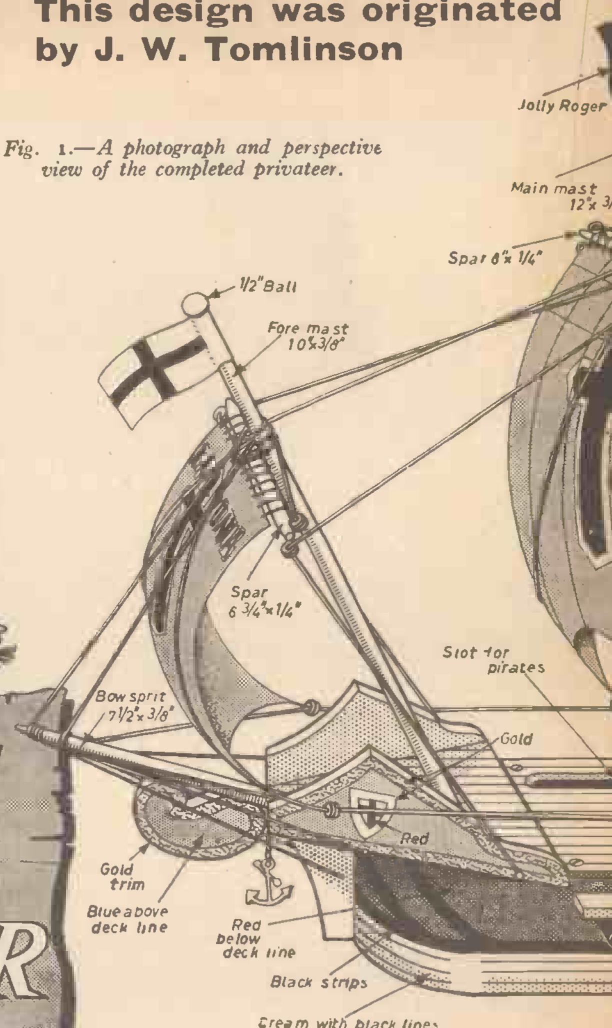
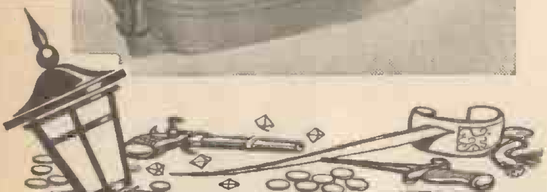


Fig. 1.—A photograph and perspective view of the completed privateer.



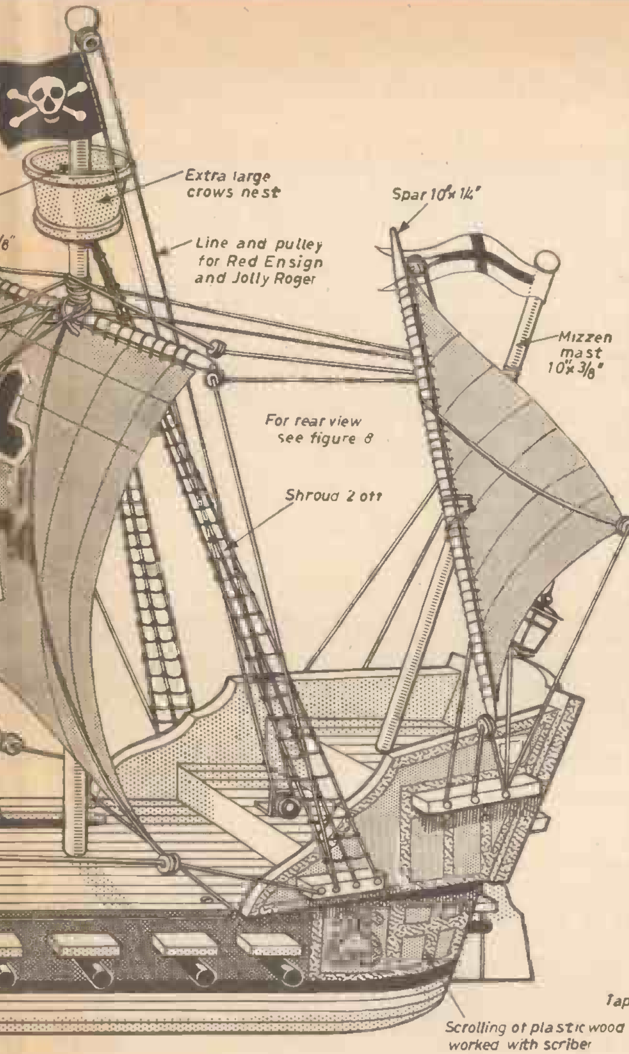
Build for the Boy A Hearth-Rug PRIVATEER

THIS toy is copied from an authentic model of the " La Bona Esperanza " which sailed the high seas in the year 1546. However, to satisfy the desire of a youngster to play with the model, a toy one was made, with modifications to include a flat bottom, a hold from which pirates would spring, and a Jolly Roger that could be hoisted in place of the red ensign, prior to making a kill. Instructions for making the toy are as follows, noting that since it is only a toy, the details are not critical and the dimensions are given only as a guide. Fig. 1 shows the completed vessel.

Hull and Fittings

The hull can be made from a piece of 3in. × 3in. soft wood, shaped with saw and chisel as in Fig. 2. Drill and chisel out the hold to accommodate the pirates, a slot 1in. wide will do for the three pirates or the whole of the hold can be chiselled out to accommodate the rest of the pirates. Cut, slot, and drill the cover for the hold and, referring to Fig. 2, make the other pieces that form the deck sides, the poop, rudder, bow pieces and gun covers. The two risers for the poop are cut from ½in. and 1in. thick wood. When assembled, these are made to overhang the hull, see Figs. 1 and 2.

Secure the deck fittings with glue and panel pins and drill the holes for the masts. Note that the holes for the fore and mizzen masts are at an angle pointing outwards front and rear. Drill the holes for the guns and the pirate operating rod. Fit the guns and covers and, from a piece of cardboard, cut the black strips for the sides of the hull. Glue these in position. Assemble the rudder and bow pieces. Whether or not one adds the scrolling is a matter of choice. It is easy to apply and looks very effective. Any suitable plastic will do, provided it will adhere to wood and the scrolls are made by just twirling a scriber or meat skewer through the plastic before it sets.



Making the Pirates

The deck pirates are cut from plywood and mounted on a suitable piece of wood, see Fig. 4. Two guide pins are fitted to the wood, lining them up with the holes in the hold cover. A thin piece of metal is then fixed under the pirates to form a slot for the clock spring to slide in. Cut a length of ¼in. dowel, notch it as in Fig. 5, insert it in the rear of the hull and fit the length of clock spring. Fit the piece of spring wire for the locking device as in Fig. 5.

The members of the crew are picked from the past and they can include such characters as Long John Silver, etc. These are all cut out in plywood and each glued to a small mounting piece, see Fig. 3. Finally they are gaily painted.

The masts and bowsprit are cut from ⅜in. dowelling with the top ends tapered. Turn or buy three ½in. wooden balls; drill and glue these to the top of the masts. Glue the masts into the hull and secure the bowsprit with two panel pins. Cut the spars from ¼in. dowelling to the dimensions in Fig. 2, taper and sandpaper the ends.

Cut the sails and flags from parchment paper and decorate

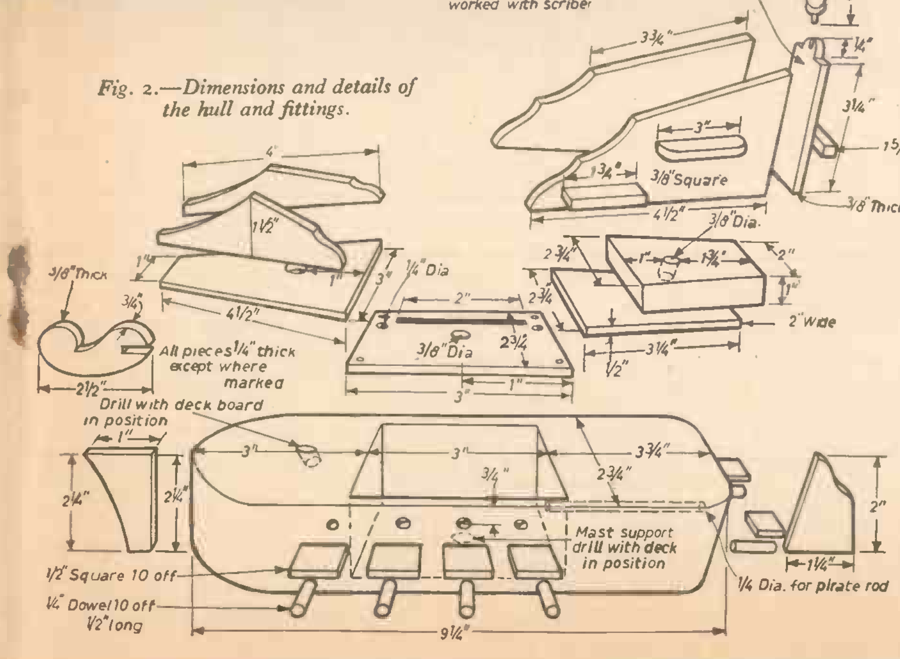


Fig. 2.—Dimensions and details of the hull and fittings.

Fig. 3.—Members of the crew.

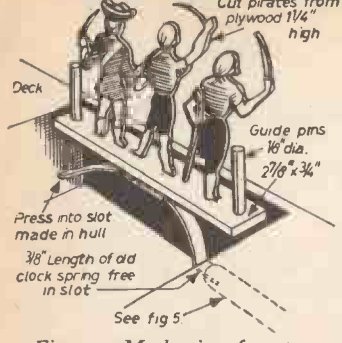


Fig. 4.—Mechanism for operating pirates.

Fig. 5.—(Below) Locking device for pirate rod.

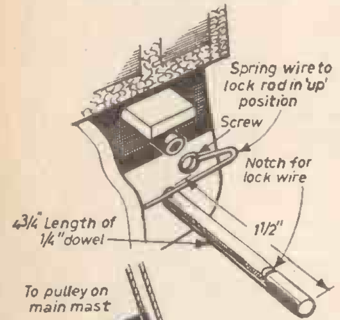


Fig. 6.—Details of the flag pulley.

as in Fig. 7. Make the " Jolly Roger " the same size as the main flag, see Fig. 6. The arrangement for hoisting the Jolly Roger is two pulleys, one wired to the mainmast and the other secured to the deck by a small bracket as in Fig. 6. The flag is of parchment paper and painted with white skull and cross bones on a black background. A loop of thin cord is then fitted to the pulleys with the red ensign attached to one end and the " Jolly Roger " to the other.

The shrouds can be made by first cutting a cardboard template, then nicking the edges with the scissors at the points where the cords cross. Assemble the cords to the nicks, using thinner cord for the cross pieces. Apply a spot of glue at each cross point, making sure that the cords are taut. When the glue is set remove the shrouds from the card and assemble to the main mast and deck.

The crows nest can be turned from a piece of round stock of not less than 1¼in. dia., keeping in mind that the lookout man will need standing room in his lofty perch. The anchor and lantern can be made from scraps or they can be bought from the model shop.

Assembling Sails and Rigging

Two sizes of cord should be used for the rigging, the thicker for supporting the masts and the thinner cord for the sails. Whether or not deadeyes are used will depend on how much detail one wants to include, they can be made or bought.

Using Fig. 1 as a guide, fit the main cords to support the masts. Lace the sails to the spars using thin cord and lash them to the masts. If deadeyes are not used, it is advisable to reinforce the bottom cord holes in the sails by gluing a parchment paper washer each side of the holes. The sails are bellied by the cords that pass over them being tightened and anchored to small nails driven into the sides of the deck pieces. Glue the flags to short pieces of thin cord and tie them to the masts.

Painting

The painting can be done in stages to the colours shown in Figs. 1 and 8. For instance, the shields and crown should be cut out of cardboard and painted before being glued into position. Bright showcard colours, followed by a spraying of clear lacquer will give excellent results. Keeping in mind that this is a toy, ageing effects should not be applied as these are for authentic models. For the youngsters, the brighter the colours the better. Fig. 8 is a rear view of the Privateer, giving details of the decorations and colour schemes.

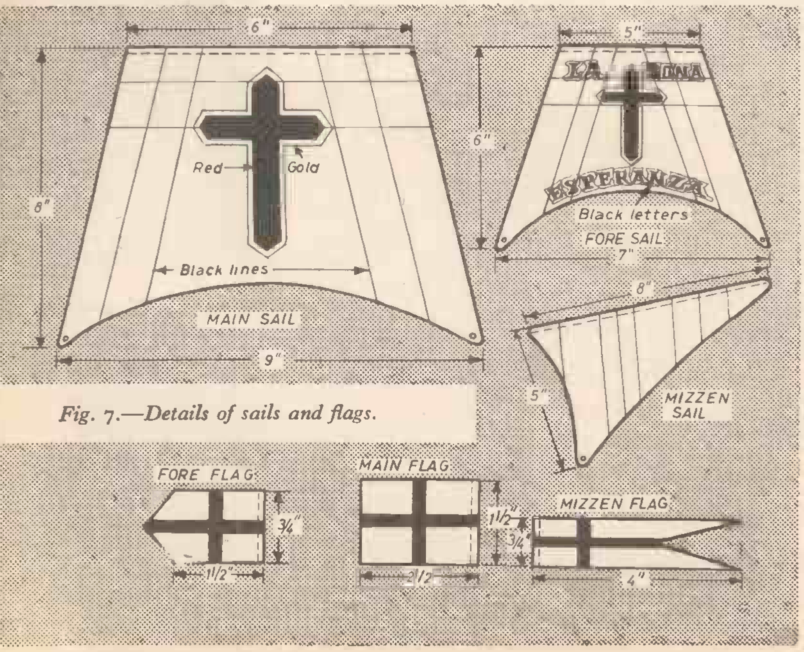


Fig. 7.—Details of sails and flags.

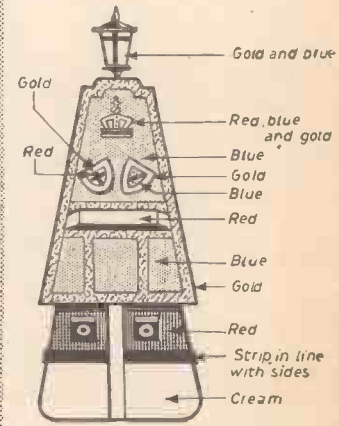


Fig. 8.—Rear view showing decorations and colour scheme.

Hover Scooter

THIS cross between a scooter and hovercraft has been developed by an American engineer at Long Ditton, Surrey. It rides at the height of 6 in. and is powered by a 250 cc. twin-cylinder, two-stroke motor cycle engine.

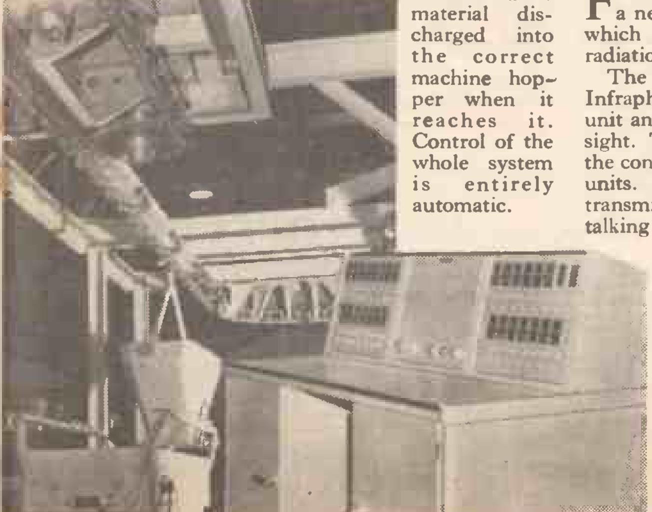
Walking on Water ?

NO, it is merely a member of the Royal Engineers walking along a partially inflated giant dracone during a recent military exercise. The nylon dracone is capable of carrying over 300 tons of oil fuel.

SCIENCE NOTES

Conveyor Automation

ELECTRONIC control techniques developed by the Elliott Automation group have now been successfully applied to a standard overhead conveyor system. In a typical application, 30 machines must be fed with any one of 70 different raw materials. Some machines use one material for several weeks, others change every few hours. A Webb overhead chain conveyor carrying 50 100-lb. capacity bottom-emptying buckets passes under 70 1-ton bunkers and over all 30 machines. Each machine has it own hopper fitted with a minimum level detector. When material is required a signal is sent to the control console. The first available empty bucket is filled at the appropriate bunker and the material discharged into the correct machine hopper when it reaches it. Control of the whole system is entirely automatic.



The Bombardier Muskeg

SPECIALLY designed for work in adverse conditions, this tractor can take mountain climbing, snow scraping and clearing, amphibious transportation and the carrying of industrial equipment in its stride. Made by Bombardier Snowmobile Ltd., Canada, the tractor is powered by a Perkins 88 b.h.p. industrial diesel engine. Two double rubber track bands reinforced with steel cable run each on eight wheels fitted with pneumatic nylon tyres. The all-steel welded chassis is waterproof up to the body platform and the ground pressure is as low as 1lb. per sq. in.

Infra-red Telephone

FROM America comes news of a new communicating system which uses invisible infra-red radiation as the voice carrier.

The hand-held, self-powered Infraphone is "aimed" at another unit anywhere within its line-of-sight. The invisible beam carries the conversation between the two units. Both phones are identical transmitter-receiver units, and talking and listening may be simultaneous, as with a telephone. In the photograph one "lens" is the infra-red source and the other, the infra-red receiver.

home-made CHEMICAL LABORATORY APPARATUS

Part 5

By K. Given

This instalment deals mainly with Tripods, Wire Gauzes and Sand Baths

A VERY strong solution of caustic soda when heated with zinc will give off hydrogen. The apparatus normally used is shown in Fig. 33, and should be fitted up well away from the front of the bench. All of it has been considered in past issues with the exception of the wire gauze, or sand bath, the tripod and the flask. Caustic soda should never be handled with bare hands and should always be kept tightly bottled.

The Tripod

Two tripods were made up by the author. Both are strong and will last a lifetime; no welding is required. They must be built of iron or steel. One was built using old bed framing and another using ¾in. mild steel angle. Any light engineering firm should be able to supply this.

Bed Iron Version

An old bed frame is dismantled or one bed iron bought at a secondhand shop for about 1s. With a hacksaw cut off one piece 27¼in. long and three pieces *exactly* 8¼in. long.

Taking the long piece and using a scriber or pencil mark off lengths of 8¼in. as in Fig. 34. Using these marks as a guide draw lines at 30 deg. on one edge. Six lines must be drawn. Cut out with a hacksaw the portions marked A, B, C and D in Fig. 34. You will then have one plain side and one with two 120 deg. gaps and altered ends.

The holes shown are placed 1¼in. approx. from each 8¼in. mark, and one extra one, ½in. from the right hand end. However, it is best to leave these until later.

The iron is now heated until each part marked " Bend " in the diagram is a bright red heat. Using a vice it is very easy to bend the strip gradually to the shape shown in Fig. 34B. Do not attempt to do any bending when the iron is not red and be careful to keep the top on one plane. Test for this on a flat piece of wood, concrete, etc. Any rectification of small errors must be made by heating again first. Very small errors may be put right with a file after making up the stand.

The legs are prepared by cutting the angle to the correct length, heating one end to a good bright red heat and compressing the heated end in a vice, or with the use of a largish hammer, until the angle is no longer 90 deg. but 60 deg. If there is any error make the angle acute rather than 60 deg. plus (Fig. 35).

Fitting the Legs

Each leg should now be tried for a fit *inside* the top already made. If necessary heat the legs again and adjust slightly with a hammer. Do not adjust the top once it has been made and tested on a plane surface.

Drill the holes shown in the top piece of Fig. 34, checking that, when drilled, the holes will be in such a position that they will capture the legs and at the same time not be too close to the acute angle or it will not be possible to get the bolt in or the nut on. With 1½in. sq. angle the centre of each hole should be 1¼in. from the outside tip of the acute angle. One such hole is marked in Fig. 34.

To bolt or rivet the legs to the top, mark the holes for drilling from the holes in the top. Use steel or iron nuts and bolts or rivets. An additional nut and bolt is put in the overlap on the top piece (Fig. 34). Alloy nuts and bolts from ex-Govt. aircraft equipment are not suitable. The finished tripod is shown in Fig. 36.

Tripod of ¾in. Angle Iron

Exactly the same system is used as for the use of bed iron. As there will be no odd holes in the iron

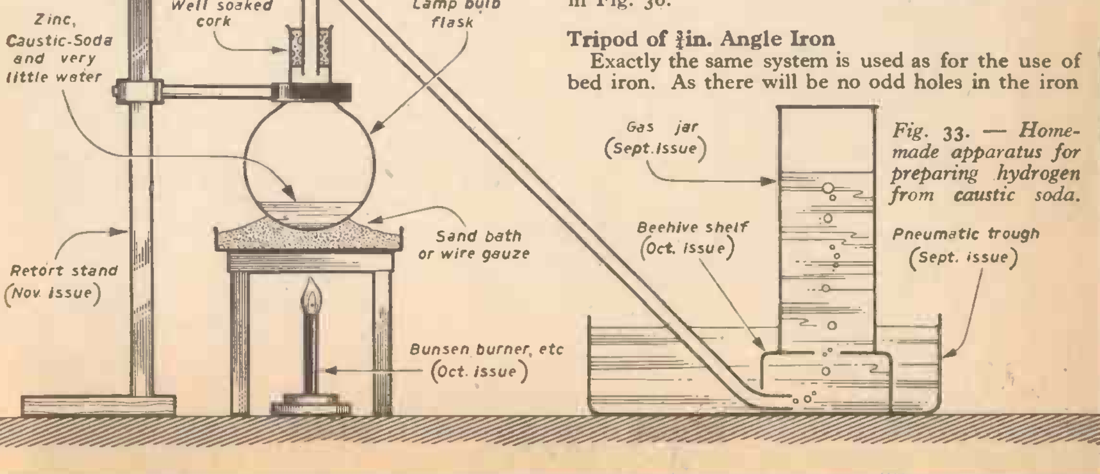


Fig. 33. — Home-made apparatus for preparing hydrogen from caustic soda.

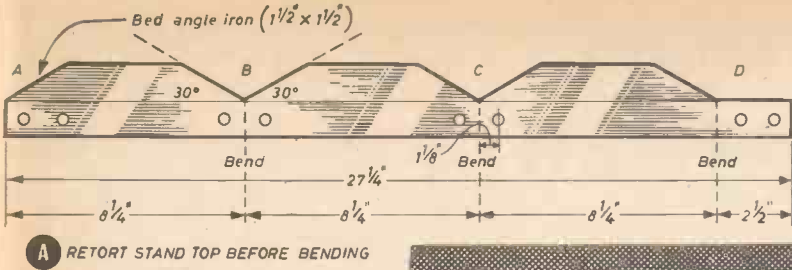
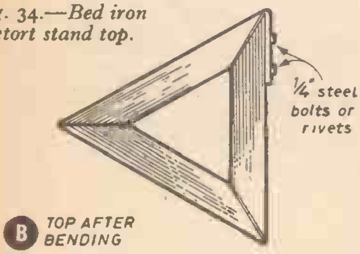


Fig. 34.—Bed iron retort stand top.



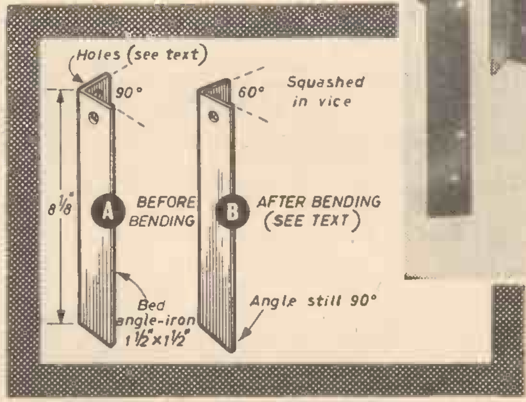


Fig. 35. (Right).—Retort stand legs.

Fig. 36. — Completed retort stand.

the finished job will be neater, more conventional, but less strong and robust. It is however stronger than the standard commercial cast iron tripods.

The measurements in Fig. 34 should read (when used with ¾in. angle) 5¾in., 5¾in., 5¾in., 1¾in. The angles are the same, the distance of the holes from the acute angle should be about ⅞in. The author used $\frac{3}{16}$in. Whit. nuts and bolts with ¾in. angle and ¼in. Whit. with the bed iron angle.

When finished the tripods should stand perfectly firm. It is dangerous to use a faulty tripod. If they are to be used on a polished surface the legs should be filed up to a roundish surface at the bottom. The joins in the top may be welded, preferably on the inside, but this was not done on the prototypes. The home-made tripods are somewhat heavier than those normally supplied; this is an advantage.

Wire Gauzes and Sand Baths

Some gauze used on government equipment (i.e. loudspeaker grills) is suitable. The gauze should be iron (nickel is even better) with about 30 meshes to the inch. Do not use a coarser mesh than this under any conditions or there will be danger of cracking the beakers etc.

Brass petrol filter gauze is suitable except for prolonged use at high temperature. Brass gauze is not suitable for use with heavy apparatus on large tripods.

The best alternative for the home experimenter is to make up a few sand baths. A large tin lid about 7in. dia. is filled with fine sand to a depth of about ¼in. The flask is placed in it, making sure that at least ¼in. sand lies beneath the flask (Fig. 37A). This is as good as a wire gauze except that it takes 5 to 6 mins. for the sand to warm up initially.

If chemicals are spilt on the sand it is best to throw it away or interaction may occur later with another chemical Remember hot sand *looks* like cold sand and burns from hot sand are very painful and difficult to get clean.

Silver sand (*not* lawn sand) is suitable and obtainable from any firm dealing in gardening materials. Fine building sand is also suitable as long as no stones are present in it.

Alternatives

It is quite possible to boil safe liquids in glass flasks with round bottoms without any gauze, etc. The flask must be supported in a clamp and a bunsen burner, adjusted to give a small blue flame, may be waved about under the flask. The flame must be kept moving and must not touch any part of the flask which contains no water. The home-made flasks to be described are not really strong enough for this method of support, but if a large flange is made on them they can be used.

Asbestos sheeting as used for ironing boards may be used in lieu of wire gauze, but it is slow to allow heat through and the thickness is not controllable. A sand bath is considered better. Wet asbestos sheeting can be explosive, so if you use some which has been left in the open, dry it slowly first in a warm place.

Asbestos cloth obtainable from some ironmongers and motor dealers may also be laid on a mild steel sheet or tin lid on a tripod.

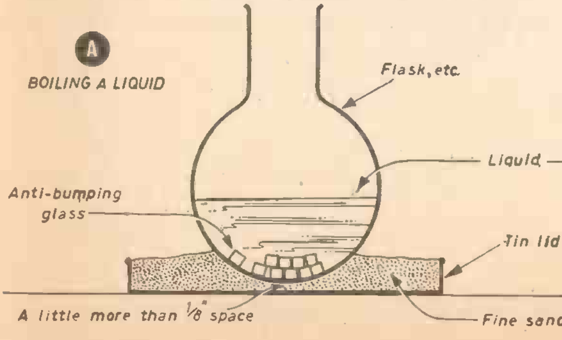
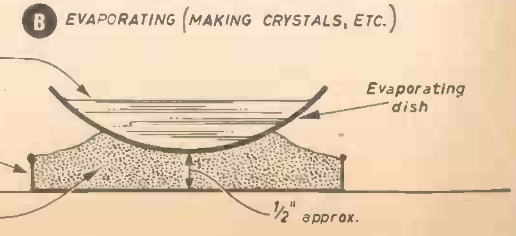


Fig. 37.—Tin lid sand baths in use.



Talking about the WEATHER...

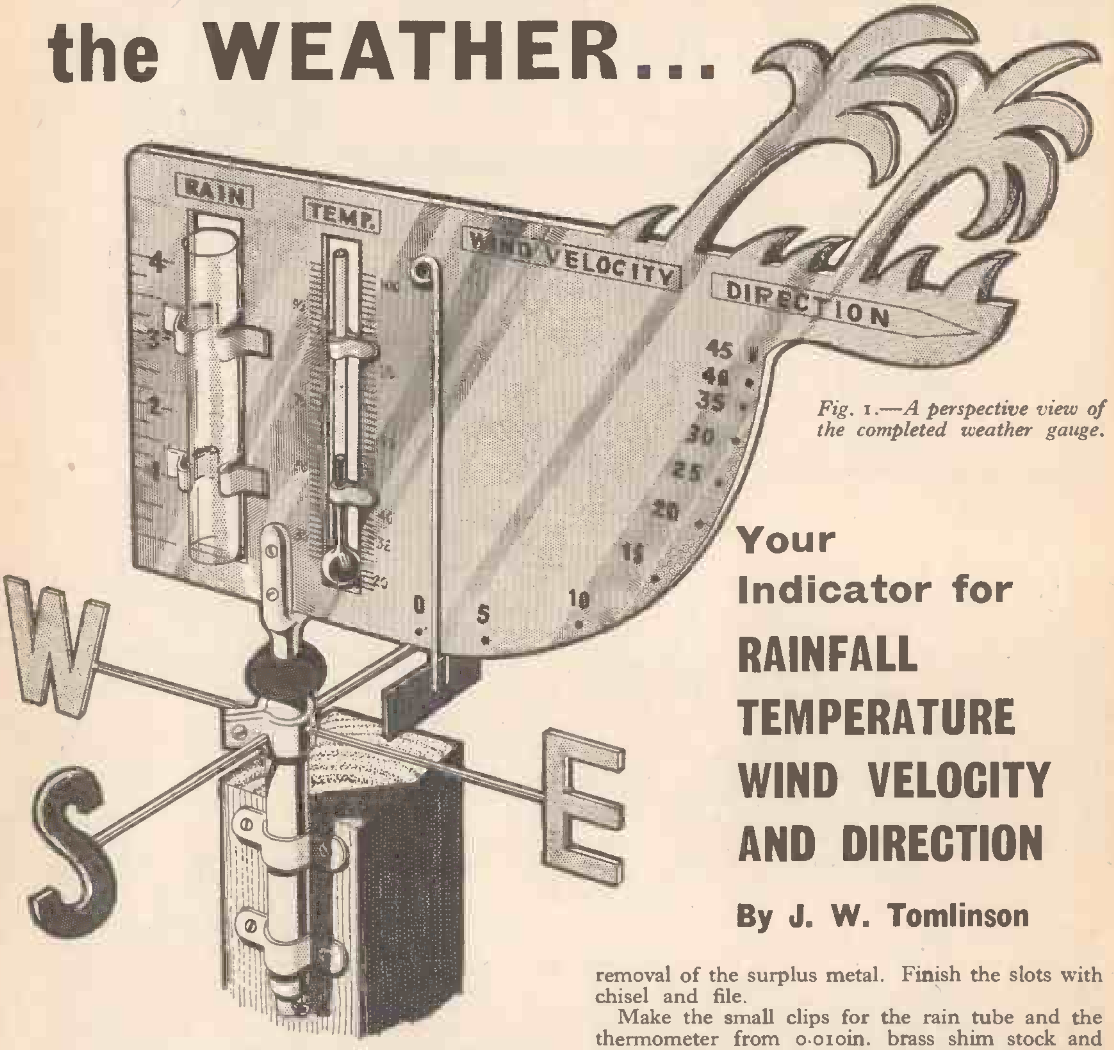


Fig. 1.—A perspective view of the completed weather gauge.

Your Indicator for RAINFALL TEMPERATURE WIND VELOCITY AND DIRECTION

By J. W. Tomlinson

THE weather is always a good starting topic when it comes to talking. In fact the weather goes further than that—it more or less rules our lives. Whatever line you are in, at work or at play, the weather is bound to affect you, one way or another.

If you want to check on the weatherman, or if you are a student of meteorology, or should you be just a guy who wants to stare out of the window on a wet and windy day, then this little gadget will be worth making.

Any sized gauge can be made. The dimensions given will produce a handy sized model, but they can be varied, provided the parts are kept in proportion so that they will fit together.

Construction

Mark out and cut the vane from a piece of 16 gauge tinned iron, using a saw, chisel and file. The palm tree decoration can be changed to suit the individual taste if necessary. Mark out the slots for the rain tube and the thermometer, and drill lines of holes just inside the slot marking out lines, to facilitate the removal of the surplus metal. Finish the slots with chisel and file.

Make the small clips for the rain tube and the thermometer from 0·010in. brass shim stock and after procuring a suitable glass tube, solder the clips in position on the vane, checking before the clips are permanently fixed that the tube can be removed for emptying. Fit the small clips to the thermometer and solder them to the vane, ensuring that the thermometer stem is central in the slot with the bulb resting on the bottom.

Thermometer Scale

The scale for the thermometer can be etched or stamped on to strips of brass shim and soldered in position, or marked straight on to the vane. In dealing with a thermometer of this nature, where most likely it will be viewed from a distance, perhaps through a window, it may be found that marking in 10 deg. steps will be sufficient, with an extra large mark for freezing. Before fixing the scale to the vane, tape a calibrated thermometer alongside the one in the vane and level up the scales. The calibration can be checked at extreme temperatures by placing the assembly first in the fridge and then in hot water.

Rain Tube Scale

The calibration for the rain tube can be done theoretically by working out the area of the tube and marking the vane accordingly, or in a practical way, by pouring water into the tube in stages from a vessel of known quantity. Make sure that the tube is resting on the bottom of the slot before calibrating the vane.

Wind Gauge

Make this from two lengths of 16 s.w.g. wire, preferably of brass or stainless steel, and solder them to a piece of sheet brass as in Fig. 2. Install the assembly to the vane and drill the hole for the rivet, making sure that the gauge can swing freely through its whole range.

Calibrating the Wind Gauge

An easy way of doing this is to compare it with a rotating scoop type of wind gauge. Readers who have access to laboratory equipment where compressed air can be released at known speeds should have little difficulty. Failing this, the gauge can be marked temporarily with sticky tape as winds of known velocity are blowing, until over a period, a full range is obtained. The speeds can be painted on to the vane. If one is not so much interested in the exact speed of the wind, the gauge can be marked LIGHT, FRESH, STRONG, GALE, which will prove quite satisfactory for general interest.

The Mounting

This comprises a shaft mounted in plain bearings and rotating in a fixed tube. Ball-bearings can be fitted if a super job is required. Make the rotating shaft from a length of $\frac{1}{4}$in. steel rod. Saw down one end and open out to form a fork. Drill the fork to take two $\frac{1}{8}$in. rivets and at the other end of the rod drill a hole for a $\frac{1}{8}$in. split pin. Sweat a $\frac{3}{16}$in. length of $\frac{1}{4}$in. bore tube to the shaft to form a bearing collar and rivet the shaft assembly to the vane.

The fixed tube assembly is made from a 3in. length of steel tube to which are fitted two plain brass bushes. Make the bushes from hard brass tubing and sweat them in position. To ensure that the shaft rotates freely, ream the bushes in line using a $\frac{1}{4}$in. reamer.

Make the clips for the fixed tube from $\frac{1}{16}$in. thick tinned iron. The clip which supports the direction letters N.S.E.W., should be made from $\frac{1}{8}$in. stuff, which is drilled and tapped 2BA to take the letter rods. The rods are $\frac{3}{16}$in. diameter and screwed 2BA both ends. The letters can be cut from sheet brass or bought ready made. Drill and tap them 2BA and assemble them to the rods and clip as shown in Fig. 2 or solder them in place as in Fig. 1.

Install the letter clip assembly to the fixed tube with the nut temporarily tightened. Fit the rubber weather shield to the shaft. If the hole in the rubber is cut undersize, the washer will take on a conical shape when assembled and keep the rain out of the tube. Apply grease to the two bushes and the shaft collar. Assemble the shaft and vane assembly to the tube and secure with the splitpin.

Finishing

Paint the assembly in colours to suit the surroundings and when dry, secure it in position with the two tube clips. Using a compass rotate the letter clip to the correct position and tighten the securing nut.

If the unit is mounted within a few feet of the living room window, and the readings can be seen from within, it can be a new interest for every member of the family on many a wet and windy day. Sc now let's talk about the weather. . . .

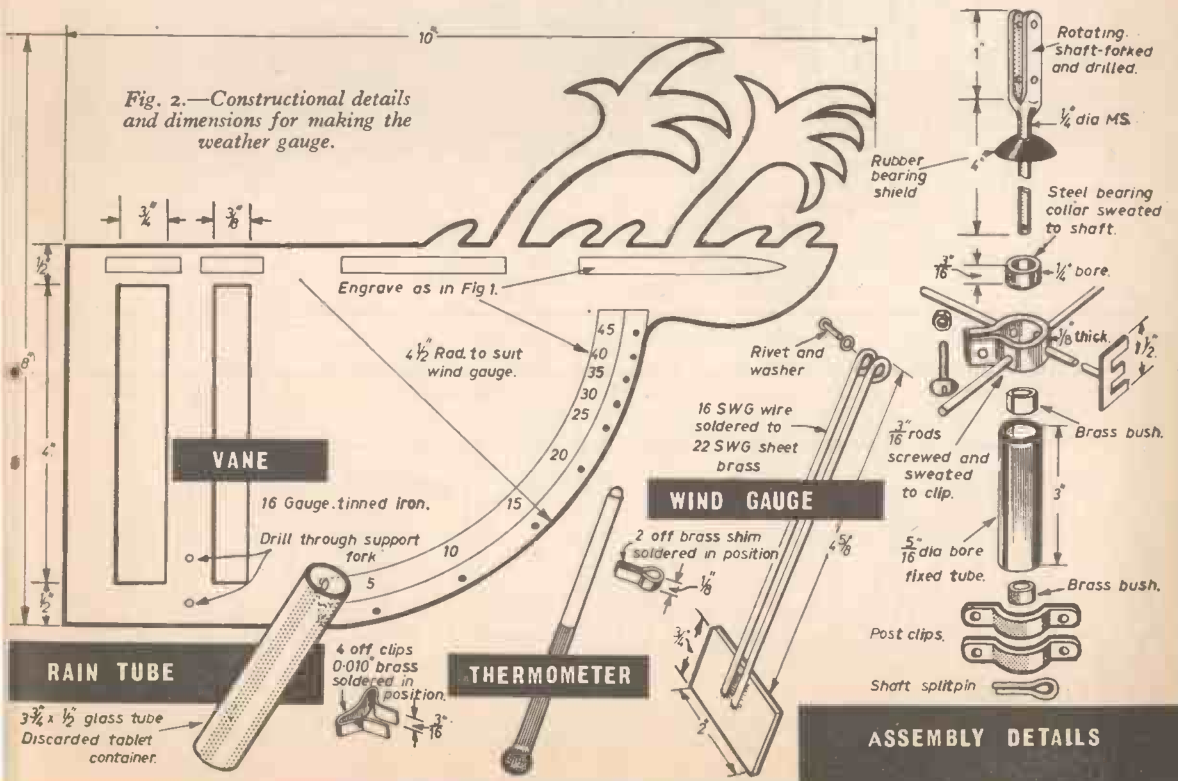


Fig. 2.—Constructional details and dimensions for making the weather gauge.

FUSES, CIRCUIT BREAKERS

By E. V. King

Part II of our

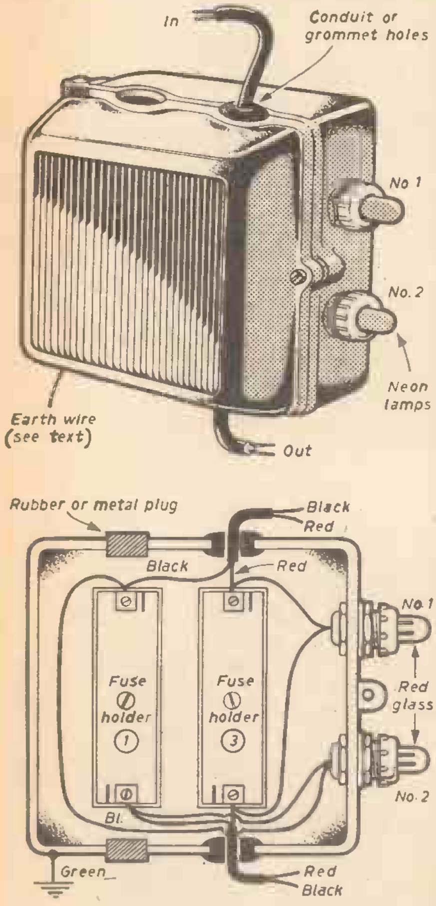


Fig. 91.—Exterior and interior views of a fuse box with neon warning system.

THE automatic home is largely operated by electricity and small circuits can be protected by the radio type fuses in glass tubes. Larger circuits need more bulky protection devices of which the overload cut out is the most convenient and up to date. All circuits should be fused to minimise fire risk and isolate a short to the apparatus actually involved. Fuse warning indicators are most helpful to locating a blown fuse, and may be used with all types of " cut out " as well as thermal fuses.

Neon Lamps as Fuse Indicators

Fig. 91 shows a small household lighting circuit fuse box fitted with tiny neon indicator lamps (Arcolectric S.L.160). If either or both fuses blow, the open circuit is shown by the neons glowing. In the ordinary way neither will be alight. When using this system, the circuit giving trouble should be left switched " on " while looking at the fuses.

In Fig. 91 the metal clad fuse holder has been drilled with ⅜in. clearance holes down one side and the two lamps screwed in with fixing nuts. The leads are already insulated but care must be taken in making the bends as a small resistor is incorporated in the leads and it must not be broken. Neon No. 1 is wired to either end of one fuse holder, and Neon No. 2 to the other in the same way.

Where there is not much room (as in Fig. 91) between the fuses and the side of the box an extra nut should be ordered with the lamps in lieu of the plastic domed nut, or for good appearance fit two nuts and the domed nut. Beware of fitting one lamp in such a place that it is broken by opening the door of the box. In the figures for instance the neon No. 2 could not be fitted on the left of the box due to the special way in which the lid hinges.

Using Pigmy Neons

The method given above is considered the best and lamps with internal resistances may not be allowed by supply authorities. The pigmy type lamps of the kind shown in Fig. 92a may be used, but for safety very good insulation is required and readers must devise their own arrangement according to the fuse boxes concerned. The wiring is shown in Fig. 92a. The lamps must be rated at the mains voltage or they will burn out unless a series resistor is fitted.

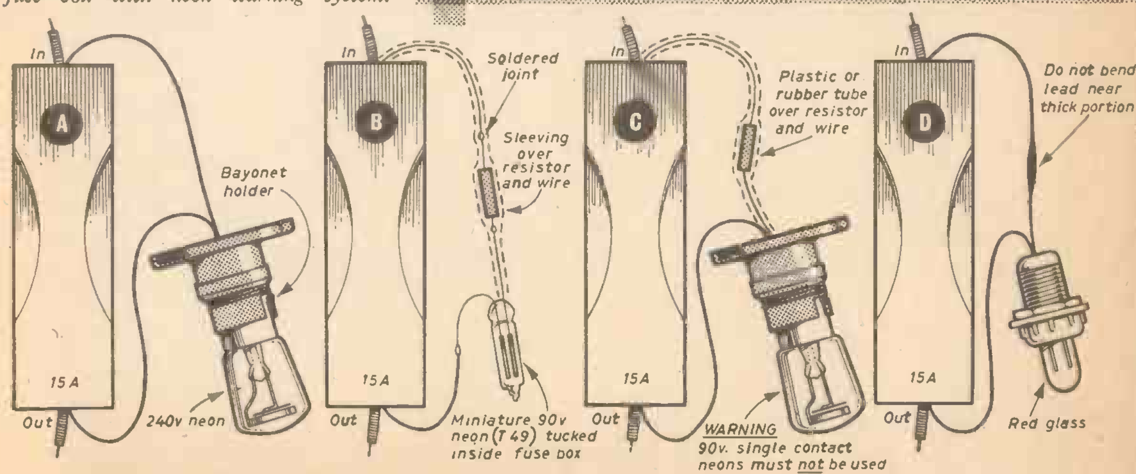


Fig. 92.—(A) Using pigmy neon lamp. (B) Using miniature 90V. neons. (C) Using 90V. pigmy lamp. (D) Using Arcolectric (SL78) neon.

AND FUSE WARNING SYSTEMS

Using 90V. Miniature Neons

The T.49 Arcolectric neon and many others may be wired with a series $\frac{1}{4}$W. resistor of 100KΩ or 180KΩ; the former will give a brighter light but the life of the lamp is limited to 4,000 hours working instead of 12,000 hours.

The leads would need a plastic sleeve and the neon could be tucked down beside the fuse holder. To find a blown fuse all that would be necessary would be to open the boxes in turn until a glow was seen (see Fig. 92b).

Using Surplus 90V. Neons

These must be wired in the same way as the T.49 and similar resistor values will suit. If the glow does not seem to be great enough to fill the inter-electrode space, decrease the value of resistor, but keep to $\frac{1}{4}$W. types for safety (see Fig. 92b).

Single centre contact neons, freely available as Govt. surplus, are not suitable unless special methods of insulation are used. The arrangement for double contact neons is shown in Fig. 92c.

Marking Fuses

Whether warning indicators are fitted or not it is a good and time saving idea to mark the circuits controlled by all fuses in the automatic home.

An upstairs and downstairs plan of the house is drawn and all lights and sockets numbered. The lights are all put on and lamps plugged into the sockets. Each fuse is withdrawn in turn and the numbers controlled are noted down either on the fuse box cover or a suitable place nearby. When a circuit is faulty it is then only a moment's job to check the fuse concerned.

Overload Cutouts

These may be fitted instead of fuses. Modern ones of the miniature type are neat, take little space, and are easily fitted in lieu of the thermal type fuses. Many new homes are being fitted with them as standard equipment.

Fig 93 (1-4) shows various circuit breakers which with advantage can be used instead of fuses. The table on the next page shows why circuit breakers are now widely recommended for protecting the electrical installation of homes.

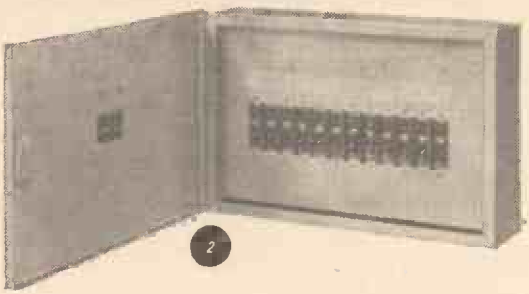
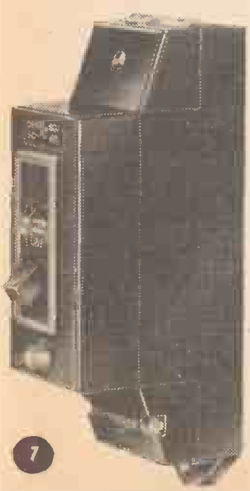
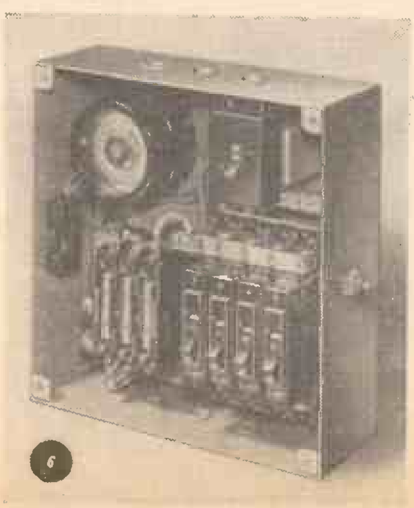


Fig. 93.—Circuit breakers and thermal controlled units. Key: (1-4) various circuit breakers. (5) Crabtree control unit. (6) Crabtree unit mounted with timeclock. (7) Earth leakage circuit breaker.





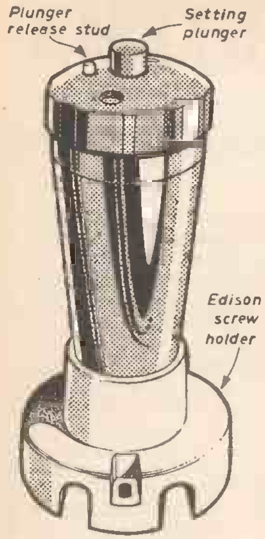


Fig. 94.—A low amperage " cut out."

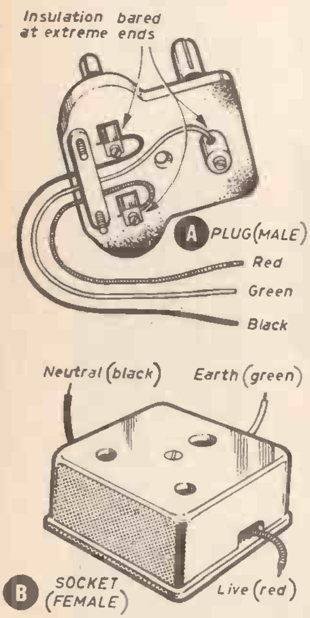


Fig. 95.—Correctly wiring a 3-pin plug and socket.

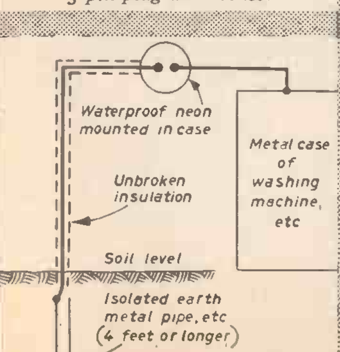


Fig. 96.—A simple leakage indicator (neon).

Miniature Circuit Breakers	*Conventional Fuses*
No electrical fire risk and complete protection against overloading.	Some risk of fire, especially if " over-fused."
Will give a lifetime's services at rated capacity.	The wire deteriorates with age and will eventually blow at maximum rating.
Will tolerate temporary surges but blow at once on short circuits.	Insufficient time lag and may blow on temporary surge.
Visual and Digital indication of the circuit which has " tripped." Easily located in the dark by " touch."	No visual indication unless neon lamps have been fitted (Figs. 91 and 92). Cannot be located normally in the dark.
After tripping due to a minor fault such as a current surge or temporary overload supply can be restored simply by switching " on " again.	Fuses have to be withdrawn and re-wired.
Circuit breakers cut out on approx. 30 per cent. overload.	Most fuses rupture at about 65 per cent. overload.

Purchasing and Fitting Circuit Breakers

Miniature circuit breakers should be purchased from your local electrical contractor and may be installed in place of the existing switch and fusegear, which is usually mounted alongside the electricity meter. Care should be taken to see that the fuses are replaced by breakers of the same capacity. ON NO ACCOUNT should breakers of greater capacity be used as this would greatly increase the fire risk.

Main Fuses and Circuit Breakers

The supply authority's fuse and meter must not be touched and if it is desired to fit a circuit breaker in place of the main fuse box a phone call will usually ensure that the authority will arrange to withdraw their fuses while the job is being done. After inspection, the supply authority's officer will replace the main fuses and seal the unit.

Adjustments to circuit breakers are neither necessary nor possible since each unit is set accurately, tested and sealed by the makers.

Time or Thermal Controlled Units

The supply authority will sell electricity for certain purposes such as underfloor heating at cut rates during off-peak periods. (Electric vehicles may be cheaply recharged during these periods). The automatic home fitted with automatic underfloor heating may be fitted with a control unit similar to that in Fig. 93 (No. 5). It is made by Crabtree and can be provided with circuit breaker back-up protection. Control is by means of a time switch, thermostat or other device mounted in a convenient position (Fig. 93, No. 6).

Earth Leakage Circuit Breakers

The automatic home should be a safe home. Especially where washing machines and appliances are used in damp locations on conducting floors (such as concrete), an earth fault *and* an electrical leakage occurring at the same time could give a fatal shock. An automatic protective device, unfortunately not largely used in the home, is known as the " earth leakage circuit breaker."

The device gives *complete protection* against shock should the voltage at the " earth pin " become large. Fig. 93 (7) shows an earth leakage circuit breaker.

Where electricity is " leaking " to earth voltages are produced at various points in the earth return system, the largest usually being at the consumer's earth " electrode." This is often the cold water pipe. The electrode earth resistance varies, but is usually between 10 and 100Ω. Thus a leakage of 1A. can generate a potential of up to 100V., and this, to an individual whose person or clothes are damp, can be very dangerous. See Figs. 98 and 99.

Home-made Earth-leakage Indicators

No amateur should attempt to make one of the "relay tripping" types as shown in Fig. 94. However, a small neon lamp of the waterproof type such as the "Arcolectric SL163" can be connected between the earth wiring at any outlet socket of the house and *true earth* (see Fig. 96).

Making a True Earth

This can be provided by driving in a 4ft. metal rod into the ground *at least 10ft.* away from the house *and* all metal gas or water service pipes underground. A good continuous waterproof cable should be connected by clip or solder to the rod at one end and to the neon indicator at the other end (see Fig. 96).

If the voltage of the earthing system of the house reaches a value of 90V. or more above true earth the neon will glow, thus giving warning at this voltage but no protection.

Installing Miniature and Earth-leakage Circuit Breakers

Circuit breakers of either type, whether individually mounted, in consumer's units, or in distribution board cases can be easily and quickly installed. It is merely necessary for the company's main fuses to be withdrawn, the supply and neutral leads connected to the appropriate terminals on the breaker, and the earthing terminal to be connected to an *isolated true earth* (see Fig. 100).

Failure to use a true earth will negate the effectiveness of the device as a protection against shock and fire. A mains water pipe is *not* suitable. The true earth must not be used for the earthing of a radio set.

For those with some theoretical knowledge, theoretical details of a typical breaker are shown in Fig. 97. Wiring details for a typical Crabtree unit are given in Fig. 100.

The Test Switch

The test switch, usually a small red button, is a device which should be understood. When it is depressed, a voltage is applied through a resistance (Fig. 97) to the trip coil circuit. This should pull in the trip and operate the breaker. Thus the use of the test switch informs the user that the protective system (and true earth) is in order.

Earthing of Electrical Installations

The automatic home will necessarily be largely operated by electricity. All metal cased devices must have the OUTSIDE casing earthed to the bonded earth system of the house. The green wire on all appliances must be connected to the large pin of a 3-pin socket and to the casing of the appliance at the other end. Some Continental made appliances may have other codings (i.e. earth may not be green) and very great care is needed to avoid serious accidents in such cases.

The actual chassis of some radio and most television sets must *not* be earthed and must not be touched (especially on solid or concrete floors) by a person when plugged in. Such chassis should, however, be tested with a "neon screwdriver" when switched on, and if live the leads to the mains plug "live" and "Neutral" should be changed over.

The correct way of wiring 3-pin plugs to an appliance is shown in Fig. 95.

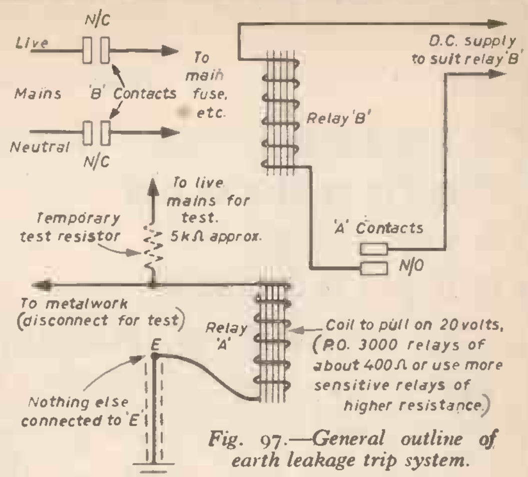


Fig. 97.—General outline of earth leakage trip system.

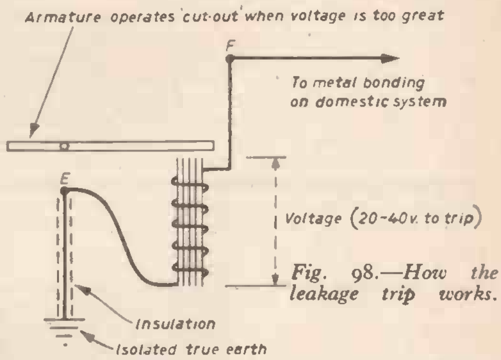


Fig. 98.—How the leakage trip works.

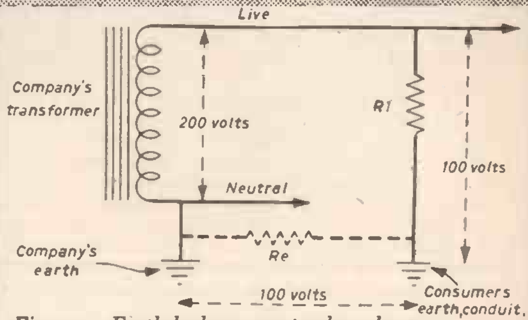


Fig. 99.—Earth leakage can produce dangerous voltages on metalwork. Note Re = interlectrode resistance, say 100 Ω R1 = leakage resistance, Live to Earth, say 100 Ω.

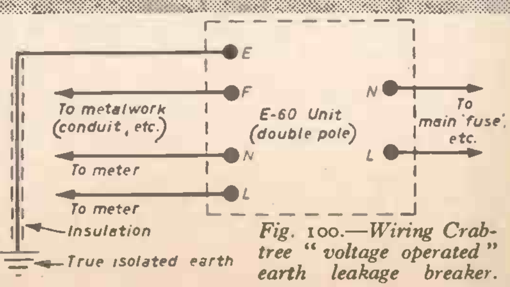


Fig. 100.—Wiring Crabtree "voltage operated" earth leakage breaker.

digital computers simply explained

By R. N. Hadden

WHAT do high speed electronic computers mean to YOU? Probably very little except a vague idea that they are the expensive play-things of scientists and business men, and far too complicated for ordinary people to understand. This is quite wrong, as anybody with an interest in mechanical and electrical gadgets can understand how they work.

The type of computer which is most used for general purposes is the digital type. This means that it counts numbers, as opposed to the analogue computer which measures quantities. The simplest example of both these types of computers is to be found with a car's speedometer. The part which counts the miles is a digital computer, while the needle which measures the speed is an analogue computer: digital computers give the answer in figures, while analogue computers give the answer with a pointer. It is the digital type with which we are concerned.

Basic Components

Digital computers are built of very simple parts, in much the same way that even the most elaborate houses are built of simple bricks. In the case of computers the " brick " is a switch, which is either " on " or " off." In the early computers the switch was an electromagnetic one, though now electronic valves are almost always used. Generally it is easier to understand the operation of the electromagnetic switch, and so this idea is used throughout the article.

Fig. 1 shows the basic component of a digital computer, the " switch," which in this case is operated electromagnetically. When no current flows in the coil the switch is open, as at (*a*). When current flows in the coil the switch is closed as at (*b*). For those readers who understand the use of valves the corresponding electronic device is shown. In (*c*) the grid is negative, and no current flows through the valve. In (*d*) the grid is positive and current flows from the cathode to the anode as shown, thus closing the " switch."

Using the Binary System

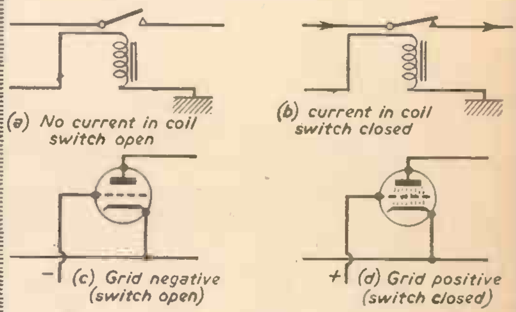
We have seen what the basic " brick " of the computer is; we must now see how it is used. When we were children we learned to count on our fingers up to 10. If we had 12 fingers we would probably have learned to count in "12s." There is really no good reason for using 10 in our arithmetic except that we have always used it, but if we wanted to we could use any other system we liked to think of. In computer arithmetic it has been found convenient to count in " 2s," which can be made to correspond to " switch open " and " switch closed." This system of counting in 2s is known as the " Binary " system.

At first the binary system may seem hard to grasp, but this is just because we have never thought of counting in this way before. Let us, for example, take the two possible positions of our basic switch and name them as follows: switch open (o), and switch closed (x). We can now write the equivalent of any number using the binary system, as shown below:

Decimal	*Binary*	*Decimal*	*Binary*
1	x	11	xoxx
2	xo	12	xxoo
3	xx	13	xxox
4	xoo	14	xxxo
5	xox	15	xxxx
6	xxo	16	xoooo
7	xxx	17	xooox
8	xooo	18	xooxo
9	xoox	19	xooxx
10	xoxo	20	xoxoo

This system can be carried on indefinitely to give any number required. To see how this system can

Fig. 1.—Basic switch operation.



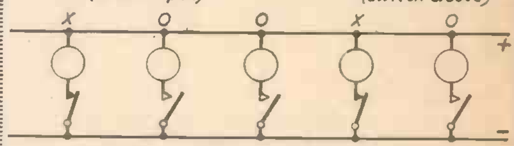


Fig. 2.—Binary number 18 represented by switches.

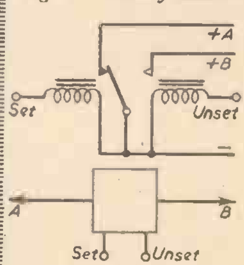


Fig. 3.—Trigger circuit.

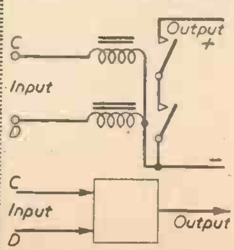


Fig. 4.—AND circuit.

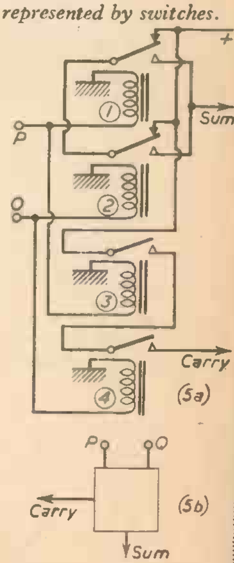


Fig. 5.—Half adder.

be used in a computer to represent a number, look at Fig. 2, which shows a bank of switches (actuating coils not shown) operating lights. When a switch is closed this represents an x and the corresponding light glows. When a switch is open the light does not glow, thus indicating o. With five switches shown it is possible to set them to indicate any number up to 31. In the case drawn the switches indicate the number 18.

The Trigger Circuit

We must now go on to see how some of the simple circuits are built up from the basic "bricks." The first circuit which we will want is the "trigger circuit." This circuit is shown in Fig. 3. The switch in this case is a double pole type, which can make current flow through either (A) or (B) depending on whether the "set" or "unset" coil is energised. In the case illustrated the "set" coil is energised, and so current flows through (A). A simplified box diagram is shown for simplicity and this is used in future to represent a trigger circuit.

The AND Circuit

The next basic circuit which we will want in our computer is the "AND" circuit. This circuit is shown in Fig. 4. In the AND circuit current must be applied to both the inputs (C) *AND* (D) to produce a current in the output.

It may be surprising to know that with these simple circuits or with slight modifications of them, we have sufficient to build a computer.

Let us now look at the heart of a computer the "Adder." Before we can see how the adder works we must brush up our binary addition. When we add in the decimal system we say, for example, 6 plus 7 is 13, put down 3 and *carry* 1 to the next column. That is whenever we add two numbers together, and the sum comes to more than 9 we must *carry* 1 to the next column. Exactly the same thing happens in the binary system. If two binary numbers are added together and the sum comes to more than x we have to carry x forward to the next column. Thus we see that our rules of binary addition are:

o + o = o
x + o = x
o + x = x
x + x = o and carry x to the next column.

Let us, for example, add together 6 plus 7 in the binary system. To do this we write:

xxo
xxx

Applying our rules and starting from the right hand side of the sum, we say, x plus o equals x put down x. Then taking the middle column we say x plus x equals o and carry x. Taking the left hand column we say x plus x plus x carried from the previous column equals x and carry x. So the answer to our sum is:

xxo
xxx
xxox or 13.

The Half Adder

Having seen how binary addition works we are now in a position to construct our adder. Look at Fig. 5 this is what is known as a "half adder." This half adder will follow all the rules of binary addition. (P) and (Q) are the two input terminals where we feed in the two binary numbers which are to be added together. As we have said in the binary system x will be represented by a voltage at an input terminal, and o by no voltage.

Let us check to see if our half adder will follow the rules of addition which we have just learned. If we want to add o + o we apply no voltage to (P) and no voltage to (Q), and we find that we get no voltage at either the "sum" or "carry" outputs, which represents o which is correct. If now we want to add x + o we apply a voltage x to (P) and no voltage o to (Q). This causes coil (1) to be energised and a voltage to appear in the sum output which represents x, which is correct. The same thing happens when we add o + x, we get a voltage in the sum output and no voltage in the carry output. If now we add x + x we apply a voltage to both (P) and (Q) which energises coils (1), (2), (3) and (4). This causes no voltage in the sum output and a voltage in the carry output, which again is correct. We have now shown that the half adder does follow the rules of binary addition.

It is obviously very tedious to show a half adder in detail every time we want to represent it. For this reason it is much easier to show it as a box with the (P) and (Q) terminals together with a sum and carry output. This is shown in Fig. 5b.

When we want to add two binary numbers together, it is easy enough to feed the pulses which represent the numbers into the (P) and (Q) terminals of the half adder. This can be done by timing the pulses to, say, one every second. If there is a pulse, an x is represented and if there is no pulse, a o is represented. It is important to feed the pulses in at a constant rate so that the half adder can distinguish between a delay and a o. This involves the use of a time base which will be described later.

Although we can now add numbers together, our adder is not quite complete because the answer may come out of the sum or carry output, whereas we want it all out of one output. For this reason we put two half adders in series as shown in Fig. 6. It will be clear from this that we can now add the inputs at the (P) and (Q) terminals together with the input at the other terminal (R) in the second half adder.

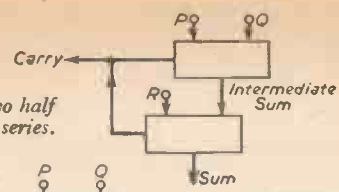
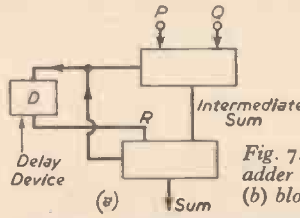


Fig. 6.—Two half adders in series.



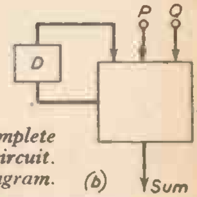


Fig. 7.—Complete adder (a) circuit. (b) block diagram.

The Delay Device

Now we have the basis of our complete adder. The two numbers to be added are fed into the (P) and (Q) terminals. If the answer is complete without any carry, it is transmitted straight out of the final sum terminal. If, however, there is a pulse in the carry output it goes to a delay device where it is stored for one pulse period, until the next numbers are fed into the adder. Fig. 7 shows the adder with the delay device. When the next pulse period comes the x stored in the delay is fed into the (R) terminal where it is added to the numbers from (P) and (Q), and so appears in the final sum terminal.

For example, suppose we take the problem we had before and add 6 plus 7, or xxo plus xxx. First of all an x pulse will be applied to the (P) terminal and a o to the (Q) terminal, and we find an x in the final output. Then we add x plus x and we find that o comes out of the final sum, while x comes out of the carry terminal and into the delay. Then we add the last figures x plus x and we find that o comes out of the intermediate sum while x comes out of the carry and into the delay. At the same time the x which was stored in the delay comes out of the final sum through the (R) terminal. During the next pulse period the last x which was stored in the delay is transmitted to the final sum. The answer therefore is xxox, which we have seen to be correct.

We can now see the need for the time base, and that is to tell the delay device when to transmit the stored number during the next pulse period. Fig. 8 shows the circuit for the delay which is a modified trigger circuit together with an AND circuit. When the adder sends out an x pulse, the trigger (T) is set. At the next time base pulse the trigger is unset, and a pulse goes out to the (R) terminal. If, however, there is another x pulse immediately following the above sequence which is to be stored in the delay, then the trigger is not unset by the time base as the AND circuit short circuits the unset coil. This leaves the delay storing another x until the next pulse period.

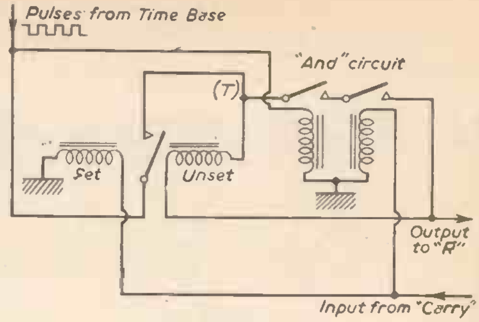


Fig. 8.—Delay circuit.

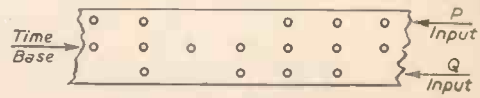


Fig. 9.—Punched tape input.

Feeding the Information

So far we have only talked about how pulses are summed in the adder, but we have not said how we feed the pulses in. Fig. 9 shows one possible way of feeding in the information to the (P) and (Q) terminals by means of a punched tape. Electrical contacts are made every time one of the holes is uncovered. We can therefore feed the pulses to the (P) and (Q) terminals respectively. The centre line of holes forms the time base which is essential for the delay device to work correctly. Similarly the output from the adder can be punched on tape, but in this case there would only be one line of holes.

We now know how to feed the sum into the adder, and how to get the answer out, and how the adder itself works. So far so good, but how do we multiply for example? Well this really is quite simple, we just add the figure to itself the required number of times. For example: $3 \times 4 = 3 + 3 + 3 + 3$.

It would obviously be very tedious to do this all on punched tape, and so it is much easier to set the machine adding, and arrange for it to switch itself off after the required number of additions have been performed. To do this we use what is known as a shifting register.

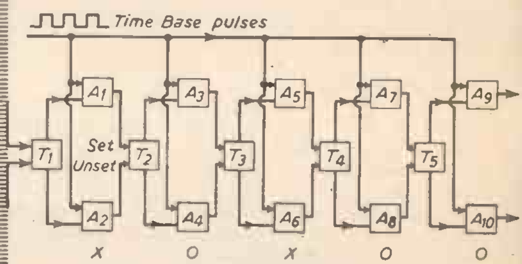


Fig. 10.—Shifting register made from trigger and AND circuits.

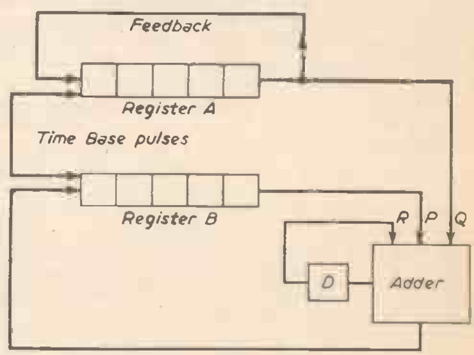


Fig. 11.—Circuit for multiplication.

A Shifting Register

Fig. 10 shows how a shifting register is made up, and we can see that it is composed of well-known parts, the trigger circuit together with the AND circuit. In a shifting register each trigger represents one figure, either an x or o, depending on whether it is set or unset. We can see, therefore, that we can represent any number provided we make the register long enough. Suppose we have a register composed of five triggers set to represent xoxoo. Take, for example, the third trigger which is in the set position representing x. When the next pulse from the time base comes the output from this trigger will be combined with the pulse in the AND circuit A_5 and will then put the trigger T_4 into the set position. In

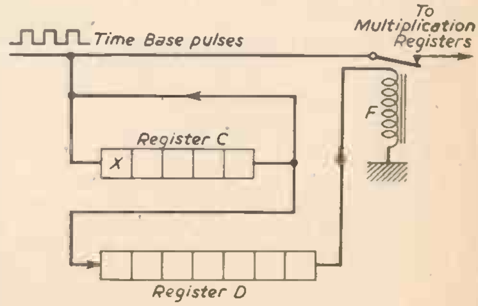


Fig. 12.—Pulse counting circuit.

other words the x which was in T_3 has now moved up to T_4, and the o which was in T_4 has now moved up to T_5, and so on.

It is obvious that in the shifting register shown in Fig. 10 the number which was stored will get shifted right off the end after five pulses. However, we may not want to lose the number and we can avoid this by connecting the end of the register back to the beginning. In this way the number will continue to circulate indefinitely. This property is very useful in many parts of a computer.

Multiplying

Look at Fig. 11; this shows how we can use shifting registers to multiply. In this set up we use two registers A and B. In A we set up one of the numbers which we want to multiply, while B contains all o's. We then start the time base pulses and feed the outputs of the registers into the (P) and (Q) terminals of our adder. After five pulses the number in A will have been added into B, while the feedback will have brought the original number back to its starting place in A. During the next five pulses the contents of A will be added to the contents of B, thus giving twice the original number in B. During the next five pulses the same will happen again when three times the original number will appear in B, and so on. When the original number has been added to itself the required amount of times, the pulses are switched off and the answer is found in register B.

It is interesting to see how the pulses are cut off when a sufficient number have been transmitted. The circuit is shown in Fig. 12. Two shifting registers are used, C and D. The register C contains the same number of triggers as the main storage register A and B. Register C contains as many triggers as may be required. To start with, register C is empty except for the first trigger which contains x. As each pulse from the time base comes along, the x moves along the register until it reaches the end after five pulses. At this point the first trigger in register D is set while the x returns to its starting place. This cycle is continued time after time until the set trigger in D reaches the end of the register, when it trips the relay F and cuts off the pulses to the multiplication registers.

Programming

We have now seen how to add and multiply. The act of setting the multiplication registers is known as programming. Programming a computer is always a long job, but once it has been done for a particular type of problem the actual calculations can be done very quickly. Subtraction and division are really the opposite of adding and multiplication, and so will not be described in detail.

So far we have made what is called the arithmetical unit of our computer, and we should feel rather proud to have got so far. However, we still have only the equivalent of a desk calculator, and after each step we would have to write the sub answer down on a piece of paper before feeding in the next step. In a complete computer all the intermediate steps are done automatically, and only the final answer comes out of the machine. Each make and type of computer has a different way of achieving this automatic operation, so we will content ourselves with describing a simple one only. However, the principles described would apply to a big computer as well.

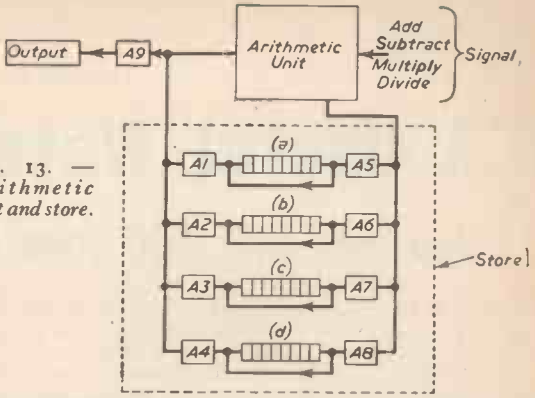


Fig. 13. — *Arithmetic unit and store.*

Complete Computer Action

Fig. 13 shows part of the completed computer. The arithmetic unit which we have already described, is simply shown as a box for the sake of simplicity. The part contained in the dotted box is known as the store, and is composed of shifting registers, where numbers are kept till required. The numbers are simply circulated round and round the registers until one of the AND circuits is closed letting the number out into the feeder to the arithmetic unit. To see how this store works let us take another very simple example.

Suppose a man wants to drive 300 miles and stay the night at a hotel. His car costs 2s. per mile to run, and his hotel costs 500s. How much does it all cost? To solve this problem we put the binary equivalent of 300 into the shifting register (*a*), 2s. into the shifting register (*b*), and 500s. into the shifting register (*c*). Then from another part of the computer, which will be referred to later, a signal comes to the AND circuit A_5, closing it and allowing the stored number to feed into the arithmetic unit. Then another signal comes to A_6 and the stored number in register (*b*) is also fed into the arithmetic unit. Then a signal comes to the arithmetic unit which sets it multiplying, and the two numbers are multiplied together. The answer is fed out of the arithmetic unit and into register (*d*) whose AND circuit A_4 has been closed to let it pass. Then in much the same way the contents of register (*c*) is added to the contents of (*d*), thus giving the final answer. This final answer is then fed to the output via the AND circuit A_9, and the computer switches itself off.

The instructions to the shifting register store, and to the arithmetic unit are usually programmed into another shifting register, and are issued as each step is completed. However, in our simple computer where very high speed operation is not required we could simply punch the instructions on to a tape. Both the programme section and the store are complete subjects in themselves, but the brief description given should be enough to enable the broad outline to be seen. In very large computers it would not be possible to store all the numbers in shifting registers, as the space taken and the cost would be too great. To get over this difficulty numbers can be stored as magnetic impulses on a rotating drum or on tape.

We now know all the basic functions of a digital computer, and how they work. The size and cost of a computer is only a measure of how quickly it can perform each step, and how much storage space it has. Sometimes other sections are added which tell the arithmetic unit to do one thing or the other, depending on the answer of the previous step.

A Useful Water-Suction Device

You will find 100 jobs for it says Jameson Erroll

THIS simply made piece of apparatus will prove extremely useful for emptying a fishpond, a tank, or a cellar or like excavation which becomes flooded. Level is almost immaterial since it will empty from a comparatively low level (well below the ground) into a drain or on to the garden.

Construction

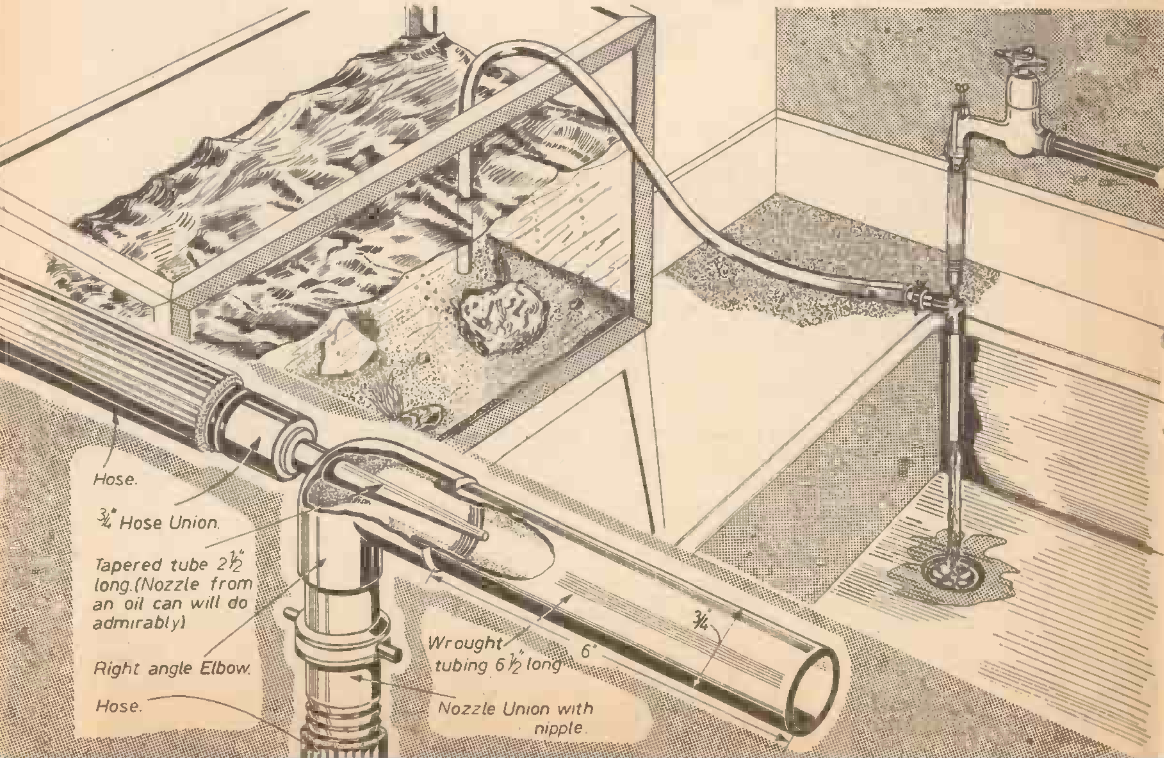
The sketch furnishes all necessary detail both as to material and construction. Sizes are very elastic depending mainly upon the main water supply available from the factory or household taps.

The length of wrought iron pipe is threaded at one end for about ½in.; the nozzle union is similarly threaded. The round elbow can be obtained from any builders' supply merchant, and through it is drilled a small hole to accommodate the tapered nozzle. This latter can be made up from a piece of tinned sheet iron, soldered, or, much easier, a suitably sized nozzle from an old oilcan may be used. The hole in the elbow must be positioned so that the narrow end of the nozzle lies dead central in the 6in. length of piping; when in the correct position it is firmly soldered to the elbow and also to a ¾in. hose union as shown. If the maximum water supply is through a ½in. tap, the pipe and fittings should be reduced accordingly. The nozzle union, with nipple, is screwed into the bottom of the union.

How to Use

In action, a length of ordinary hose-pipe is connected between the hose union and the water supply, and another piece of hose-pipe—long enough to reach the vessel to be emptied—is fixed to the nozzle union. When the water supply is turned on, a strong jet will issue from the end of the oilcan and out of the pipe. Now hold a block of wood, a cork, or even the thumb over the end of the pipe thus preventing the water from coming out and thereby forcing it to go down the hose-pipe attached to the nozzle union and into the flooded compartment. When this is seen to happen, remove the cork, and it will be found that a syphonic action will now draw the water from the flooded vessel and out through the pipe. The amount of water thus drawn away is very many times greater than that being used via the tap, and the flood-water will quickly diminish.

Experiment will indicate whether the oilcan nozzle is of suitable diameter and, according to the pressure of the main's supply, it may be found advantageous slightly to increase that diameter by cutting off a portion of the nozzle to enlarge the hole. When the tank, etc., is nearly empty, keep the end of the hose-pipe under water by holding it down; once air is permitted to enter it the syphoning action will cease.



TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

New "Felt" Helmets

S. HUBBARD LIMITED, of Luton, one of Britain's largest manufacturers of felt hoods for women's hats, is producing safety helmets made from specially processed felt. The felt has been hardened and chemically treated to produce a strong, light and flexible helmet, far stronger than the standard required by the B.S.I. The felt finish gives it extra appeal for women and it is available in four bright colours. The two men's versions are finished in glossy plastic and all models are provided with a cork lining. Known as the "Flexihelm" they are being distributed by Waddingtons of Hull. The men's helmets retail at 75s. and 70s., and the women's at 65s.

Flexihelm Safety Helmets.

New Nylon Screw

A NEW nylon screw has been introduced by the sole distributors and concessionnaires, Flora Plastics Ltd., of Duke Street House, 415 Oxford Street, London, W.1. The slot in the head requires a special screwdriver. A self-threading action is obtained so that a firm engagement is ensured and the screw will not vibrate loose. Other advantages are that nylon is completely free from the risk of corrosion and the screw is also a complete non-conductor of electricity.

New Flora plastic nylon screws.

Portable Planing Attachment

A NEW attachment recently introduced by Selecta Power Tools Limited, of Hampton Road West, Hanworth, Feltham, Middx., can be operated by any popular electric drill. Apart from its conventional use as a portable power plane, a bench stand is also supplied, which, when fitted turns the machine into a bench planer. In addition, a depth stop and side fence enables rabbeting to be performed. This machine complete with the items listed above retails at £7 19s. 6d.

Selecta portable planing attachment.

(Left) Surform Junior Kit.

New Surform Junior and Power Tool Kits

TWO ENTIRELY new Surform tool kits have been introduced recently by the Surform Division of Firth Cleveland Tools Limited.

The Surform Power Tool Kit, which retails at £3 5s. 3d., contains the 2in. Surform drum, the Surcut 5in. cutter, the Surform planing and rebating attachment, complete with the Surform universal adaptor, spanner and tommy bar.

The new Surform Junior Kit contains two new Surform blades. These are a 5½in. standard cut blade and a 5½in. half-round blade. They are packed in the Junior Kit with a Surform block plane, fitted with a fine cut blade. The Junior Kit retails at 16s. 3d. Replacement blades are available at 2s. 9d. (fine cut), 2s. 9d. (standard cut) and 3s. 6d. (half-round).

The Paximat portable projector.

Paximat Portable Projector

A GOOD example of a portable slide projector is the Paximat Portable model, which is made of light, though tough, shatter-proof plastic and styled so that it needs no extra case. The handle of the Paximat portable is fitted to a hinged "door" protecting lens and front of the projector, and becoming a handy stand when the projector is in use. The projector also has a 200W. turbo-cooled lamp, heat filter and f/2·8 85mm. lens. Another feature is the use of magazines containing 36 slides. The magazine is just placed in the projector and shown slide by slide. A simple push-pull action changes slides, replaces each slide and moves the magazine forward at each change. The Paximat Portable costs 19 gns.

LETTERS TO *The Editor*

The Editor does not necessarily agree with the opinions expressed by correspondents

Drill for glass, etc.

SIR,—Your readers might be interested in the method I use for drilling glass, tiles, mirrors and bottles, etc. I make use of old saw files, though nearly all files could be used except flat files. All sizes of holes can be drilled, even countersunk. Grind the file to a point on each face (making a diamond point as per sketch). Crush some chalk, make it slightly moist and put some on the article to be drilled. Let it dry and mark with a pencil the exact spot you wish to drill. Place the item to be drilled on an old mat or sack (soft bed) and put the drill in a brace or breast drill. Dip the point of the drill in turpentine or paraffin and do not exert too much pressure when drilling. A white powder will appear around the hole, but keep dipping the point in turpentine. Make sure that the powder is kept out of reach of children as it is poisonous.—W. Pickard (Sunderland).

On the left are some samples of files adapted for drilling glass by Mr. W. Pickard's method.

Harmless Smoke

SIR,—Regarding the formula for harmless smoke given in your October, 1960 issue on "Your Queries Answered" page. From personal experience I should like to say that this mixture is very unstable and could cause bodily harm. To avoid this danger I had some made up by a chemist, but this I found merely burned with a quick "sizzle," without producing much smoke. Could I please have your comments on this?—J. Martin (Liverpool).

Potassium chlorate in itself is very unstable and should never be ground in a pestle and mortar. However, we cannot understand, why when made up, the solution only "sizzled." Perhaps the mixture was too dry, in which case it would be similar to a gunpowder train. Damping the mixture would probably help to slow down the rate of cumbustion.

An alternative method of obtaining harmless smoke is to soak an oily rag in diesel oil and set it alight, making sure to take adequate fire precautions. A further method often used is dry ice (i.e. solid CO_2) and boiling water. The dry ice is obtainable at 5s. a 5lb. block, from Distillers Co. Ltd., of Fulham, London. Hot steam at light pressure could also be used.—Ed.

Bedside Teamaker Modification

(*The following is an extract from a letter by the author of the article "A Bedside Teamaker," which appeared in our November,* 1960 *issue.—Ed.*)

I HAVE made further experiments with my design for the teamaker and I find that longer element life is given if Fig. 11 is modified slightly so that the bottom plate is fixed immediately under the element. The two asbestos layers shown between the element and the bottom plate are then put immediately under the bottom plate. If this modification is considered readers must use steel and not brass bolts and they must be full length, or conducted heat may cause charring of the wood in the first model.

A Live Steamer in Gauge O

(*Concluded from page* 171)

Screwing and Tapping Copper

Other methods to note concern the screwing and tapping of holes in soft copper. Model boilermakers usually anneal their boilers before flanging, etc., and this can be overdone. In, say, a boiler shell, it is often found that the metal bellies out (or in), at the point where it should remain straight (Fig. 4). This can be overcome by selective annealing; i.e. by standing the shell in wet sand up to a point below where it should be soft (Fig. 5). The retained hardness prevents distortion.

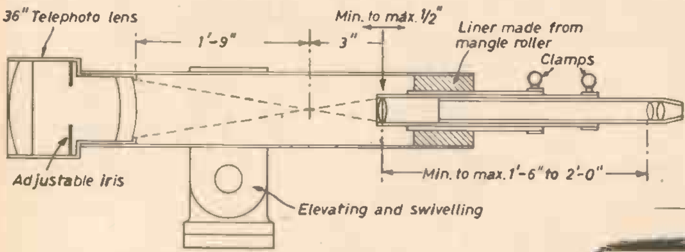
To tap holes in soft copper, without making a mess, drill the holes undersize, open them out to tapping size with the tang of a file; i.e. spin them out. This hardens the surrounding metal and it taps as easily and cleanly as brass.

To screw soft copper tube, bend it gently back and forth in the fingers, only a few degrees. You will feel the hardening. It too can then be screwed easily, after cutting off at the requisite spot. For short pieces or where waste cannot be tolerated, squeeze the tube slightly out of round in the vice, then back again. Do this at about six positions finally squeezing it straight. This is then hard enough to screw.

Another useful hint to know is that a 6 B.A. tapped hole can be directly tapped out to 4 B.A., without first drilling it out to tapping size. This method can also be used on other sizes. Buffers have not been fitted yet but will be made from old lampholder plungers with brass heads soldered on.

A Reader's Telescope

SIR,—The following is a description of a telescope I have constructed from ex-Government lenses. I first got the idea from a letter appearing in PRACTICAL MECHANICS about using a 6in. × 36in. telephoto lens in a telescope. I bought one of these 36in. lenses and a low power gunsight telescope. The telephoto lens focuses at half the distance of 36in. so that this distance added to the focal length of the erecting lens, determines the distance between the two. The parts of the gunsight telescope needed are the eyepiece and erecting lens. The illustration shows the layout, though much depends on materials available. My own erecting lens is a triple achromat 1in. dia. × 3in. focal double convex. The power is variable between approximately 50× to 100×. Even more can be obtained by experiment. The variation in power is obtained by altering the distance between the erecting lens and eyepiece, then adjusting the two together to the object lens. The closer the erecting lens is brought to the object lens, the farther must the eyepiece be moved from it. In my case the total movement of erecting lens is in the region of ½in., whilst the eyepiece must be capable of 6in. or more to coincide. The adjustments are made by mounting the eyepiece and erecting lens in 3 tubes. The first is a fixure in the wood liner. The second contains the erecting lens. The third contains the eyepiece. The ends of tubes 1 and 2 are slotted and fitted with clamps for locking. This eyepiece has an eye relief of about 1½in. so a shroud must be fitted to keep the eye that distance from the lens, otherwise shadows appear. I have mounted it on an ex-Government tripod from Charles Frank of Glasgow. The brightness of view and power are really good.
—H. C. Cain (Isle of Man).



Details of Mr. Cain's telescope

PUZZLE CORNER

Four Quarts

FOUR jugs hold, when filled, 2, 3, 4 and 5 pints of liquid respectively. The 3-pint and the 5-pint jugs are full of wine.

Using only these measures, you are asked to get 2 pints of wine into each measure—by pouring from one jug to another—in only five operations.

Answer

	2 pt.	3 pt.	4 pt.	5 pt.
Position at start	–	3	–	5
First pouring	–	3	4	1
Second "	2	1	4	1
Third "	2	–	4	2
Fourth "	–	2	4	2
Fifth "	2	2	2	2

Home Jewellery Workshop

(*Concluded from page* 185)

Polishing Materials

Fine emery powder mixed with oil (valve grinding paste may be tried), pumice powder and oil, crocus composition in block or powder form; and jeweller's rouge, preferably in powder form for finishing, are all used, in precisely that order.

If you polish by hand, the emery and pumice can be applied with a small bristle brush, or on slips of boxwood for awkward corners. Slips of rottenstone or " Water or Ayr " stone are also used for removing file marks. Crocus and rouge are applied with bristle brushes (separate brushes for each compound) or again boxwood slips, chamois-tipped wooden slips, or a piece of chamois leather. Final polishing with rouge is done with a very soft bristle brush, or a dust-free chamois leather or Selvyt cloth. All traces of previous compounds must be removed before polishing proceeds. The greasy films can be removed by rinsing in petrol, white spirit, or by using a very hot washing soda solution.

A ¼ h.p. or even ⅛ h.p. motor with tapered spindle, running at about 1,400 r.p.m., or driving a polishing spindle via pulleys and vee-belt, takes all the hard work out of polishing. Felt rings can be used for emery and pumice on low-contoured work (they will soon spoil the crispness of applied decorations unless you are very careful). Scratch-brushes of crimped brass wire used with water will give a good frosted surface, bristle brushes find their way into nooks and crannies, a calico mop applies crocus, and a soft swansdown mop the rouge and water mixture. A good burnisher used carefully by hand, kept lubricated with soapy water, gives a beautiful polish, particularly to edges and small areas, but one slip can undo a great deal of work. For the insides of rings, a felt " finger " can be used on the polishing spindle. However, for the tiny apertures in small coronet and similar pierced settings there is only one solution, a bunch of linen threads is tied to a convenient place, the threads are rubbed along the crocus block, one or more threads passed through the aperture to be polished, and the work moved back and forth along the taut threads.

The equipment suggested should enable you to tackle almost any kind of jewellery work. The methods used in casting jewellery have been omitted, but this, too, can easily be done in the home workshop.

SALES AND WANTS

The pre-paid charge for small advertisements is 9d. per word, with box number 1/6 extra (minimum order 9/-). Advertisements, together with remittance, should be sent to the Advertisement Director PRACTICAL MECHANICS, Tower House, Southampton Street, London, W.C.2

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ROTARY CONVERTERS. In 230V. D.C. Out, 230V. A.C., £7 10s.
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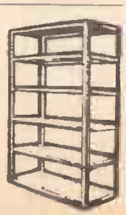

Continued overleaf

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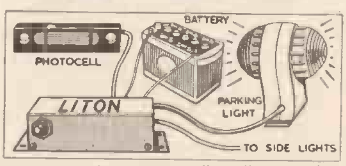

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(Continued on page 211)

YOUR *Queries* ANSWERED

RULES

Our Panel of Experts will answer your Query only if you comply with the rules given below

A stamped addressed envelope, a sixpenny crossed postal order, and the query coupon from the current issue which appears at the foot of this page, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Greenhouse Heating

MY 18ft. × 9ft. greenhouse is at present heated by a solid fuel boiler heater and I wish to substitute an immersion heater. What heater would I require to maintain a temperature of between 45-55 deg.? The water to be heated is about 65 gallons in 94ft. of 4in. pipe and the heater will be immersed in the expansion box.—J. H. Jeavons (Staffs.).

ASSUMING that the total area of glass in the greenhouse is about 500 sq. ft. and that you require to maintain an inside temperature of 45 deg. F. when the outside temperature is down to 20 deg. F. we suggest that you use immersion heaters having a total rating of 6,000 watts, with thermostatic control. The heating chamber must be efficiently earthed.

Ring Mains System

THE house I am shortly to occupy is wired on the ring mains system. As I shall have to maintain this and may wish to add further points, I should be grateful for anything you can tell me about it.—L. P. Smith (Richmond).

PROVIDED the total floor area does not exceed 1,000 sq. ft. an unlimited number of socket-outlets (13A.), arranged for use with fused plugs, can be connected to the ring circuit. However there are certain conditions to be complied with. The circuit must be wired with cables of not less than 7/0·029 and fed through a fuse holder rated at not less than 20A. in the " live " pole, with fuse rated at not more than 30A. The total load on the circuit at any time must not exceed 30A. Not more than 13A. may be taken from any one plug.

Branch cables, not less than 7/0·029 may be connected to the ring circuit at a socket-outlet, or a suitable junction box, to provide a supply for other socket-outlets (13A.), but not more than half the total number of socket-outlets may be fed from branch cables, and not more than two socket-outlets may be fed from any one branch cable. It is advisable that the conductors of the ring circuit be unbroken where they pass through a socket-outlet or junction box.

The earthing conductor for the socket-outlets on the ring circuit must also be connected in a ring, both ends of which are connected to a sound earthing point. Earthing conductors for socket-outlets fed from branch cables may be connected to the earthing socket on the ring to which the branch cables are connected. The lead sheathing must be earthed. Low-current apparatus can be fed through a 13A. plug, in the " live " pole of which is connected a cartridge fuse of current rating approximately equal to the current rating of the apparatus. Fixed apparatus, of rating not exceeding 13A., may also be fed through a switch fuse or fuse, in the " live " pole on the circuit. Any such outlets being counted as equivalent to one socket-outlet.

We would refer you to the following publications:

" Electric Wiring (Domestic) " by E. Molloy (George Newnes Ltd.).

" Regulations for The Electrical Equipment of Buildings " issued by The Institution of Electrical Engineers of Savoy Place, Victoria Embankment, London, W.C.2. (price 6s. including postage).

Coloured Distemper—Making and Applying

I AM redecorating a large old-style house. I intend distempering the ceilings which are at present coated with whitewash and also

some of the bedroom walls. Please tell me how to mix a good home-made " wash "; the colours I require are mainly cream, pink, buff or stone colours and a blue-grey slate colour.—E. Gunn (Dublin).

BEFORE distempering your ceilings, the whole of the existing whitewash should be wetted and carefully scraped off. Also remove the wallpaper before colourwashing the walls.

To make a good colourwash akin to an oil-bound distemper, dissolve five parts of glue in 95 parts of hot water, and add to the solution about one part of Lysol, to prevent mouldy growths, stirring the whole very thoroughly. When the solution has cooled, stir into it about five parts of raw linseed oil. Store the stock solution in well-stoppered jars, bottles or cans. Well sealed, it will keep for a long time.

To make white colourwash, take a quantity of fine dry whiting, place it in a can and moisten it to a paste with the stock solution. Always add the solution to the pigment and not vice versa, and see that it is quite free from lumps. Thin out the cream with more and more of the solution until you have a medium of good brushing or spraying consistency.

To make the other colours you mention, begin always with whiting. Make this into the usual paste with the above solution. Make, also, a similar paste with yellow ochre, and also pastes with rose-pink, lime-blue (or, better still, ultramarine) and lamp-black. You will not require very much of these stronger colours.

Take a quantity of the whiting paste and stir into it a small quantity of the yellow paste. This will give you ivory, cream, stone, buff and yellow colours, according to the quantity of ochre used. Having got the right shade, thin down the product to working consistency. The pink and the blue-grey colours are prepared in the same way with the remaining pigments. The necessary pigments, in addition to the whiting, are all cheap, and may be obtained from any decorator's shop. Do not make the colourwash too thin, otherwise it will not cover uniformly. Two coats should be enough for any wall.

It is advantageous to give the wall a brushing over with the " stock solution " preparatory to colouring it. This will make for better adhesion of the colourwash.

" Postcard " Enlarger

I WISH to make apparatus for enlarging 2¼ in. sq. negatives to print postcard size. I do not require any other size of enlargement. Could you give a few pointers on how to proceed?—H. C. Wilson (Portsmouth).

YOU will require a cardboard or wooden box about 14in. to 18in. high, and lightproof, with open bottom or other means of inserting the bromide postcards. The negative is held at the top of this box, between sheets of glass, emulsion side downwards.

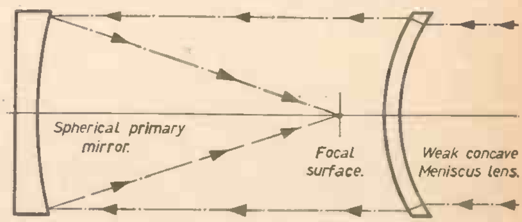
An 8 cm. to 10 cm. enlarging lens is fitted below the negative. Or you may use a doublet made from two lenses of about 4½in. focus, mounted 1/16in. apart, convex sides adjacent; or a single lens of about 2¼in. to 2½in. focus. The exact distance between negative and lens, for sharp focus on the postcard, must be found by trial. The lens can then be fitted to a panel at this point. With single or doublet lenses, definition will be improved by covering the lens with an opaque card with small central hole. The smaller the hole, the better will definition be, but the printing time will be increased. A ¼in. dia. aperture or hole is suggested.

With commercial printers of this type, exposures are made by holding a pearl lamp some 12in. or so above the negative. It would be more convenient to add a metal lamphouse here, with 100W. pearl enlarging lamp. To secure even illumination, a piece of flashed opal glass is placed between negative carrier and lamp, near the carrier.

The Maksutov Telescope

COULD you please give me details of the Maksutov telescope.—L. A. Grosvenor (Derbys).

THE Maksutov telescope consists in its basic form, of a spherical primary mirror and a weak negative concave meniscus lens, which also has spherical surfaces. (See illustration). The telescope can be used as a visual instrument if made to around f8, or as a camera if made to f3. The work of constructing



Details of the telescope.

the telescope depends on the optics and, whilst the spherical primary mirror presents no difficulty, the meniscus lens presents several problems: (1) the two surfaces must be truly spherical and on the same axis; (2) the thickness of the lens must be accurately controlled; (3) the price of the optical glass necessary for a lens of 6 in. + aperture will be quite high; (4) when the telescope is finally ready to use, it must be remembered that the focal surface will be curved.

INFORMATION SOUGHT

Readers are invited to supply the required information to answer the following queries.

A Pulse Power Unit

I WOULD like to add a pulse power unit to a transformer rectifier unit of 12V. D.C. output, used for controlling model railways. Can any of your readers help me?—P. A. Lingwood (Leeds).

Windscreen Wiper Problem

HOW can I overcome the poor vacuum supply to the windscreen wipers on my car? I have a 12V. windscreen wiper motor and a 12V. electric pump, either of which should be strong enough for the job.—P. R. Redfern (Lincs).

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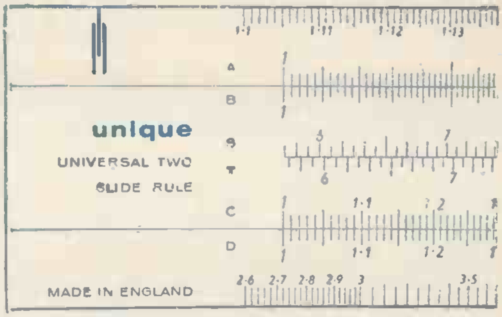

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Volt meters 0-40 **10/-.** 0-20 **12/6.** All 2in. sq. flush.
Liquid prismatic compasses 55/- ea. cost £13.
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