PRACTICAL MECHANICS

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DETAILS INSIDE

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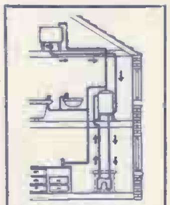
WITH NEWNES

Practical Handyman

YES, how true it is nowadays! Keep your home in good condition and you increase its value in hard cash—your investment in house ownership appreciates! Added to this, your home is brighter and happier for yourself and family. Newnes PRACTICAL HANDYMAN is the means to this end—it is the complete home aid, and easy as easy to follow. It's for all who want their home to sparkle. Study it for 7 days without cost or obligation!

980 PAGES ★ 153 SECTIONS
1,600 Practical Illustrations

Build your own Garden and Tool Shed ● Paperhanging ● Plastic tiles & surfaces ● Painting—including rollers and spray painting, etc. ● Plastering, Distempering ● Water Systems—repairing burst pipes, washers, cisterns, lagging, air locks, etc. ● **Drainage faults & remedies** ● Doors, locks, hinges, sash windows, skylights ● Roofing ● Gutters ● **Trellis, Fences and Gates** ● Paths ● Bricklaying ● **Concrete work** ● Dry rot, wet rot & woodworm ● Floors—repairing, staining, polishing, laying lino and carpet ● Glazing ● Glass-cutting, drilling & frosting ● **Varnishing, Enamelling, French polishing** ● Veneering, graining, marquetry ● Carpentry—tools, timber, joints, plywood, glue, etc. ● **Built-in furniture** ● Shelves & sliding shelf doors ● Re-upholstering ● **Making deck-chair, bookcase, bedside table, folding table, first-aid cabinet, firescreen, etc.** ● Leaded Lights ● Metal work—riveting, soldering, cutting, beaten copper work ● Electric defects and power tools, etc.



Hot-water systems and how they work.

Make this attractive wall desk.

Make this Hi-Fi Amplifier—full details are given.

Bathroom stool—one of many useful pieces of furniture to make.

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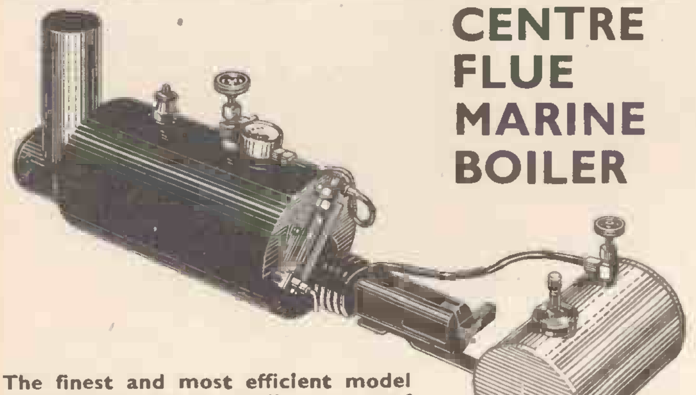

The finest and most efficient model Centre Flue Marine Boilers for craft from 30″ to 84″ long. Made of solid drawn Copper Tube and hard soldered throughout. Fittings comprise "Pop" safety valve, screw-down fine-adjustment regulator, Pressure gauge and syphon, Water gauge and check valve for feed pump.

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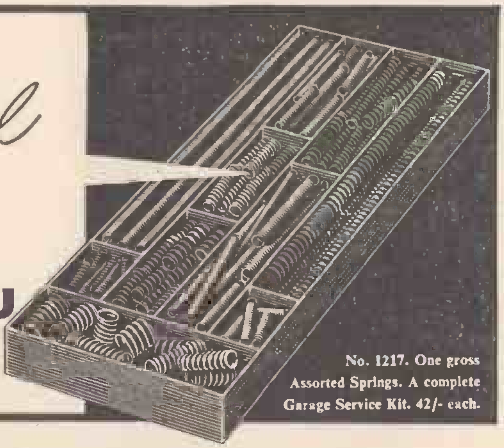

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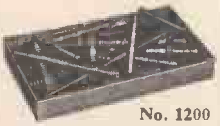
If not, try another box in the Terry Assorted Springs range



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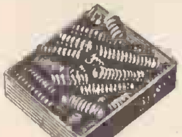

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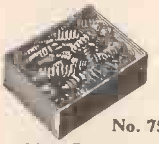

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Extra Light Compression, 1 gross Assorted, 1/8" to 7/16" diam., 1/8" to 2 1/2" long, 27 to 19 S.W.G. 15/-.

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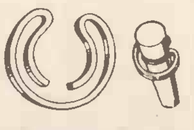

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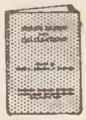

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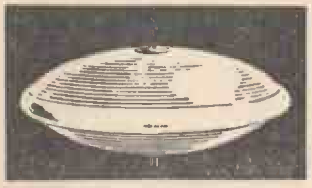

Introducing the "Saturn", a wonderful unit which will enrich your room by its elegance and the bright warm light from the fluorescent tube will light up every corner of the room and bring out the richness and colour of your furnishings and decorations.

The top and bottom spheres are available in red, yellow, blue, opal and green to suit your taste.

Two models, 40 watt and 80 watt, both approx. 16 in. diameter. Price, 40 watt £5/19/6, 80 watt £6/19/6, including tube and suspending chain, nothing else to buy. No extra wiring required, simply take down the existing fitting, join the wires of the "Saturn" and that is all.

Running cost of the "Saturn" approx. 25 hours per unit for the 40 watt and 12 hours for the 80 watt. Light output of the 40 watt is equivalent to the average 150 watt lamp and the 80 watt equivalent to two 150 watt lamps.

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Listing many items of Government surplus with brief descriptions. This catalogue is now printed and ready for despatch. Free with all orders £1 or over, otherwise 1/- post free.

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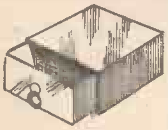

Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions—1/6 each or 12 drawers each 6×2¾×6¾in., 13/6, post 2/-.

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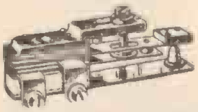

Useful for the control of appliances such as convectors, gluepots, vulcanisers, hot plates, etc. Adjustable to operate over temperature range 50-550 deg. F., fitted with heavy silver contacts, 8/6. Other types: 1½ amp., 3/6; 5 amp, 8/6; 2 amp., QMB, 5/6; 15 amp., QMB, 15/-; 15 amp., encased wall mounting type, 29/6.

Super Transistor Kit

Makes ideal bedroom radio, uses one transistor and one crystal diode. Complete with case 19/6, post and ins. 2/6.

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Ranges: D.C. volts 0-5, 0-50 0-100, 0-500, 0-1,000. A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. D.C. milliamps 0-5, 0-100, 0-500. Ohms 0-50,000 with internal batteries. 0-500,000 with external batteries. Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6, plus 2/6 post and insurance.

Miniature Microphone

American made, Dynamic type, real bargain at 2/6, plus 6d. post.

Another Car Battery Charger Bargain

Components would cost more

Car Battery Charger—ready-made high output battery charger in stove enamelled sheet steel louvred case. New, complete and ready to work. Rated at 12 v. 5 amps. and variable rate selector for trickle charging, also a meter to show charging rate. Suitable for 230/250 A.C. mains. Special snip price of 65/-, plus 3/6 post and ins.

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Particularly useful for controlling photoflood lamps which have only a short life at full brilliance. This toggle switch has three positions: the first position puts two lamps in series at half brilliance for setting up, the second position is off and the third position full brilliance for the operation shots. Also useful for controlling night lights, heaters, etc., etc. Price 3/6 each. Post 9d. Circuit diagram included.

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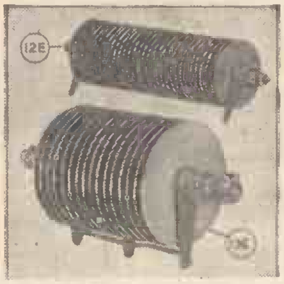

Selenium rectifier type 12, 500 v. ½ A. half-wave, easily rebuilt into full wave or multiple type, contains 30 35 mm. discs. Price 8/6, plus 1/6 post. Type 13, 36 volt 9 amp. easily rebuilt into six full wave charger rectifiers suitable for 6- or 12-volt batteries at 3 amp., contains 24 x 84 mm. discs. Real bargain at 19/6, plus 1/6 post.

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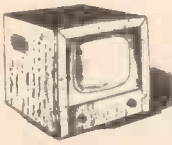
Now reduced to 19/6



14in. T.V. cabinet of the latest styling—beautifully veneered and polished—limited quantity, sale price 9/6 each. Carriage and packing 3/6 extra. Masks 10/- extra.

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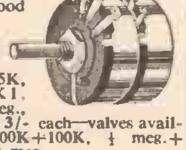

Single and 2-gang types available, standard size, with good length spindle, all new and boxed. Single types, 1/- each, valves available: 5K, 10K.-25K, 50K1, 100K, 250K, 1 meg., 2 meg. Gang type 3/- each—valves available: 5K+5K, 100K+100K, ½ meg.+½ meg., 2 meg.+2 meg.

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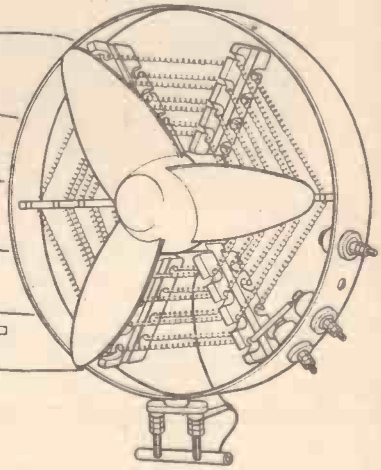

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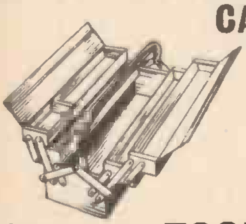

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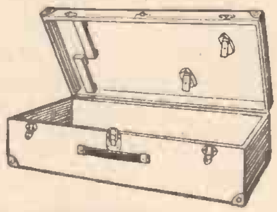

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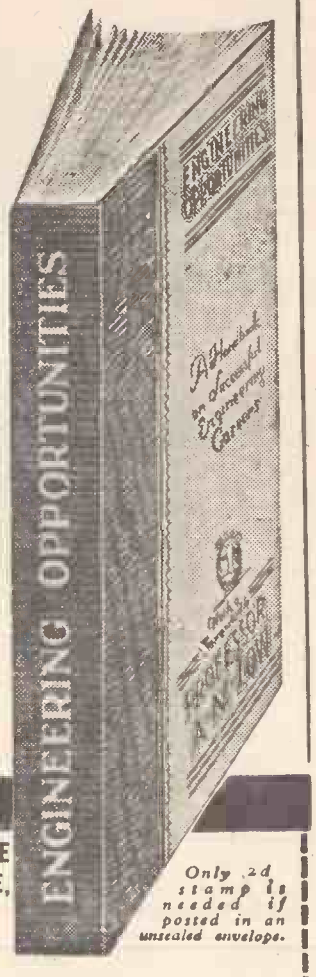

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CONTENTS:

CONTRIBUTIONS

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FAIR COMMENT

THE " MECHANIKART "

KART racing originated in America but is rapidly gaining a hold on the mind and imagination of the British public. Already it has been shown on television several times and many articles have appeared in newspapers and elsewhere. So far, however no journal has, to our knowledge, produced a set of comprehensive instructions for building a kart. We plan to repair the omission and preliminary details of the " MechaniKart " are given in the centre pages of this issue. We are, in the next few issues, going to describe the construction of this robust and speedy vehicle, stage-by-stage. This is no theoretical design: it has already been tested and proved. However, for the benefit of our readers we are going to build a " MechaniKart " in our workshop and describe the work in detail as we go. The kit of parts has been obtained from Messrs. H. A. Wills Ltd., and our readers also can obtain any or all of the parts required from this firm. The address is given in our centre pages.

The first question our readers may ask is, " How much will it cost? " The answer to this depends upon the ingenuity of the individual. Some parts, of course, will have to be obtained new, but it is surprising just what can be obtained second-hand by someone who is determined enough in the search. Using all brand new parts, the cost should be below £45.

As defined by the R.A.C. there are four classes of kart. The " MechaniKart " can come into either class I or class II, i.e. a directly driven industrial engine is used. This makes the kart simplicity itself to drive and anyone over the age of sixteen can enter races. Wives and daughters are by no means excluded; there will be special events for them to enter.

Your " MechaniKart," when you have built it, will provide a chance of thrills and enjoyment for the whole family and at the same time ensure for them a very high standard of safety. The inherent stability of this design cannot be beaten.

EXPECTED IN THE "SIXTIES"

No one knows what is in store for the human race in the future and those who have in the past attempted to forecast coming events have been, in most cases, sadly in error. A certain amount of limited prediction, however, has a good chance of being borne out by actual events, if it is based on recent achievement and does not look too far ahead.

One trend which is almost certain is an increase in the scope and use of automation. Far greater use of machines and automatic control for instance will be made in the Post Office. Their use has already been started and as new types appear, capable of carrying out more and more complicated operations, so will new jobs be found for them to do. Factories will become nearer the " automatic " ideal and in those parts of the world where farming is carried on on a large scale, automatic handling equipment will take much manual drudgery off the shoulders of the farmworker.

Late in the " sixties " it is said that plastic will start to replace conventional materials in building and it is possible that the visual aspect of houses as we know them will undergo a radical change. Straight and angular lines may be replaced by sweeping curves. Colours too would be infinitely variable and repainting would become a thing of the past. These changes would apply equally to indoor decoration and it is expected that new developments in lighting will play a big part. A completely electroluminescent ceiling or wall may replace today's conventional electric bulb.

New materials are promised too for clothes, which may be proof against creasing, dirt and wear. Synthetic foods made in the laboratory are expected to make their appearance and vast improvement in wireless and television transmission is possible, including the introduction of world-wide TV. It will be interesting to see how much of the foregoing comes to pass.

The May 1960, issue will be published on April 29th. Order it now!

AN ELECTRIC FURNACE

BY JOHN WALLER

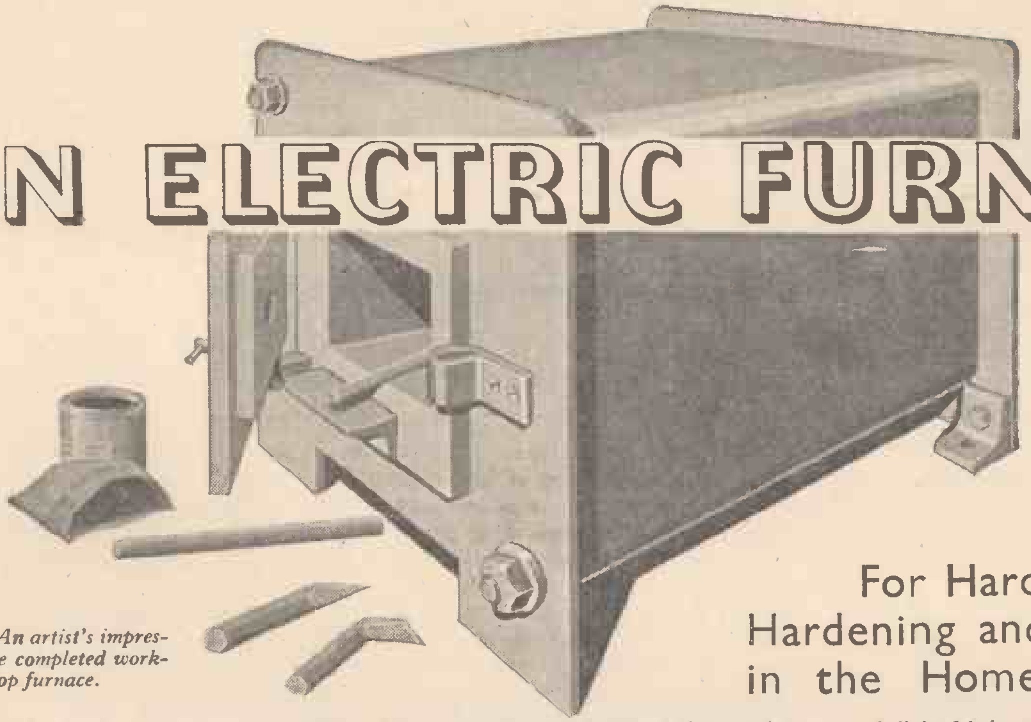


Fig. 1.—An artist's impression of the completed workshop furnace.

For Hardening, Case-Hardening and Tempering in the Home Workshop

THE old practice of subjecting an article to a gas flame is now considered obsolete in engineering workshops as the results achieved are variable. A controlled temperature electric furnace, however, ensures uniformity in the work of heat treatment. A small version of this type of furnace is described here for such home workshop processes as hardening, case-hardening and tempering.

General Description

Fig. 3 is a cutaway perspective view of the furnace, and the construction shows that the deep rectangular heating chamber or muffle is first surrounded by a layer of heating wire, a fireclay protection surface and finally the remaining space is filled with insulating material as a heat retainer and as a protection against overheating of the casing. The latter is a tubular and sheet metal fabrication.

Designed to operate on a consumption of about 750 to 850 watts, the chamber has external dimensions of 3in. × 3½in. × 10in.—an adequate size for most parts encountered in the home workshop and garage. The introduction of a pyrometer gives a control not previously associated with this class of equipment.

Figs. 2 and 3 give details of the steelwork construction. Two large square plates held apart by four tubes, through which long studs are passed, form the basis of this unit. The cover is of thin steel, brass or aluminium; any metal is suitable as little heat filters through the insulation material.

Both end plates are sawn or cropped from ⅛in. sheet. The front plate is marked out, sawn and drilled, the rectangular hole for access to the chamber being omitted until both plates are prepared, and then the front member is used as a template-cum-jig for making the rear detail. This method ensures the hole centres match each other; the latter are not important provided they are directly opposite each other. Finally cut the access hole mentioned above, file off all the burrs, and countersink the drilled holes on both sides of the plates. Incidentally, though the feet are shown on this drawing as separate angle-pieces, the lengthening of both plates to allow for the bending of these feet *in situ* is possible.

Reinforcement of the door aperture is necessary. Reinforcement is possibly not the strict function of this piece of angle because it forms the basis for the door hinge and also provides a small but useful shelf on which to rest temporarily the parts either being placed or withdrawn from the furnace. In full size practice, articles are often placed in this manner to pre-heat them prior to putting them into the chamber.

The comparatively long muffle requires a firm support at both ends. There is little risk of breakage once installation is complete. A slight degree of expansion is necessary, but if the movement is too much, it is likely to become a nuisance when moving articles about the furnace.

A light fabricated bracket bent and brazed as shown in Fig. 3, and held to the tubular struts with the aid of one screw at each side is adequate. This bracket is arranged at the rear and clear of the windings. The spring loaded member is not generally efficient for the supporting process and is preferably used merely as a device to keep the muffle held against the furnace front. A supporting piece is attached to the inside of this latter; it has a dual function to perform in that it makes a setting for a generous supply of Pyruma which is necessary to prevent the front of the furnace from becoming hot. A door and electric connection completes the main assembly and the remaining parts are in the form of attachments which are fitted as time permits.

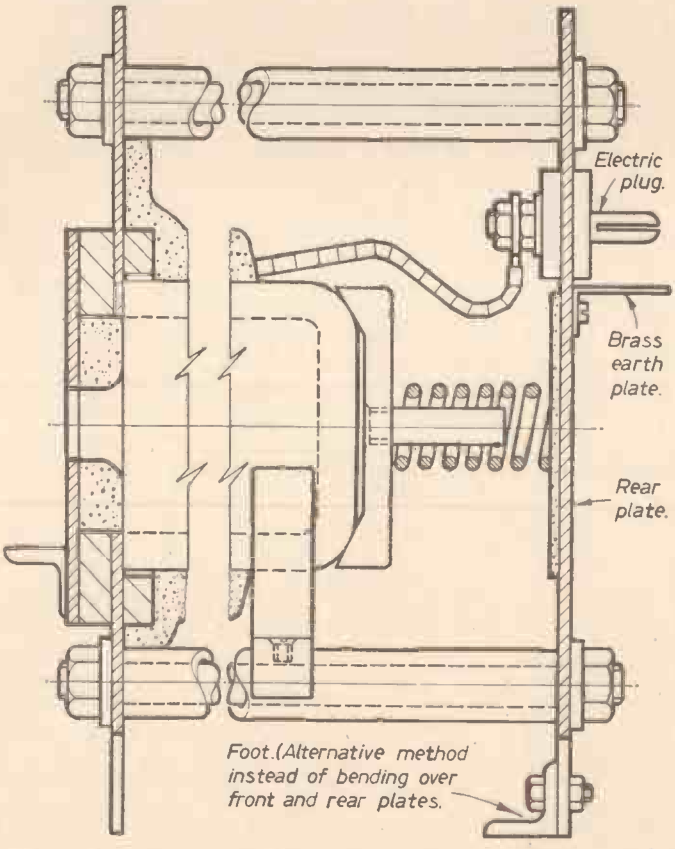


Fig. 2.—Sectional view of the front and rear ends of the furnace.

Commencing Construction

Once the front and rear plates have been cut and filed up and the tubes which act as spacers made exactly the same length, the ⅜in. Whit. studs are passed through the bores and the nuts tightened securely to reduce the amount of movement to a minimum. The fitting of the cover will eliminate further movement and make a rigid assembly when the furnace is secured to the bench. It is more convenient to make up the door and frame as a separate unit rather than fit parts to a heavy casing assembly. Once the door swings easily, it becomes a simple task to attach it to the front rectangular aperture. When the frame is fitted the inside is also coated to prevent heat loss.

Winding the Muffle

The muffle is wound with No. 24 Gauge Nichrome V wire. The wire is carefully wound round the muffle with turns $\frac{1}{8}$in. apart—a little patience when performing this work will ensure they are evenly spaced and that they lay tightly against the outside surface of the chamber. Wind to about $1\frac{3}{4}$in. from each end and snip off the wire leaving a strand of 3in. for subsequent joining at the rear end and some 10in. trailing from the front. Twist these together for an inch or so and then they do not become easily entangled with the frame when the chamber is assembled.

Insulation

On top of these wires a rather thick covering of Alumina cement is applied. The mixture is made thin enough to apply easily with a brush in the first instance, and then a thicker layer is put on after the original layer is partially dry. This cement is allowed to dry thoroughly. Let the muffle remain in a dry atmosphere for a day or so and then place it for a while in the family airing cupboard for a further period. Again cover the cement with a thicker layer of fireclay (two tins of Pyruma will be ample) spreading with a small trowel of the type using for pointing brickwork. Endeavour to maintain a uniform thickness of about $\frac{1}{2}$in. over the coils and allow it to spread $\frac{1}{4}$in. past the last coil. Again allow to dry slowly and make good the cracks that appear during this process by gently scraping out a groove and applying further fireclay.

Door Construction

This is a sheet metal member with the usual simple hinges and catch if this is considered necessary (see Fig. 3). The inner surface is thickly coated with fireclay as a means of keeping the door and handle cool. The hinge pin is an easy fit to ensure the door opens without any trace of stickiness. If the hinge parts are assembled in the door by screws, they can be moved slightly to keep the pin correctly aligned. This is better than riveting the top and bottom details as this generally requires a reaming operation with both in position to make both holes in line. As a long reamer is seldom available this work is thus not easy to perform. The mica window is a refinement, but whether this is really essential is a matter of personal choice and depends on the work undertaken.

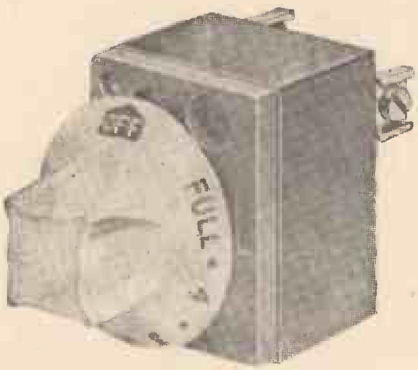


Fig. 4.—The Sunvic "Simmerstat."

Assembling the Parts

Once the frame is assembled work can proceed on the installation of the muffle. To facilitate this operation, the door is temporarily removed to avoid it swinging open as the furnace is turned round while adjustments are being made. Add the insulators to the wires which already hang from beneath the fireclay coating, and connect these to the usual two pin power plug. The rear of the furnace is the obvious first choice for this detail, but set it in a convenient position on the side of the power line and where it is easily accessible.

The cover is made from thin sheet—cut to width in the first instance to fit between the frame members, and then gently rolled over the tubes. This is secured in position with the aid of tiny screws fitting in holes drilled at intervals through the tubular details. The lower cover is a piece of the same thin plate and is the last item fitted.

Pack the inside with Grade 3 Vermiculite. Tuck it carefully round the top of the muffle and gradually fill the remaining space until the muffle and wires are literally buried.

The Thermostat

Some form of control is essential together with the use of a pyrometer for ascertaining the temperature of the muffle. The thermostat is a product of Sunvic Controls Ltd. of Harlow, Essex, who issue a leaflet showing the wiring points, and the reader should request one of these when writing for his unit. A simple panel type mounting in a wall or bench is the most convenient way of installing this thermostat. The photograph, Fig. 4, shows its appearance.

(*Concluded on page 322*)

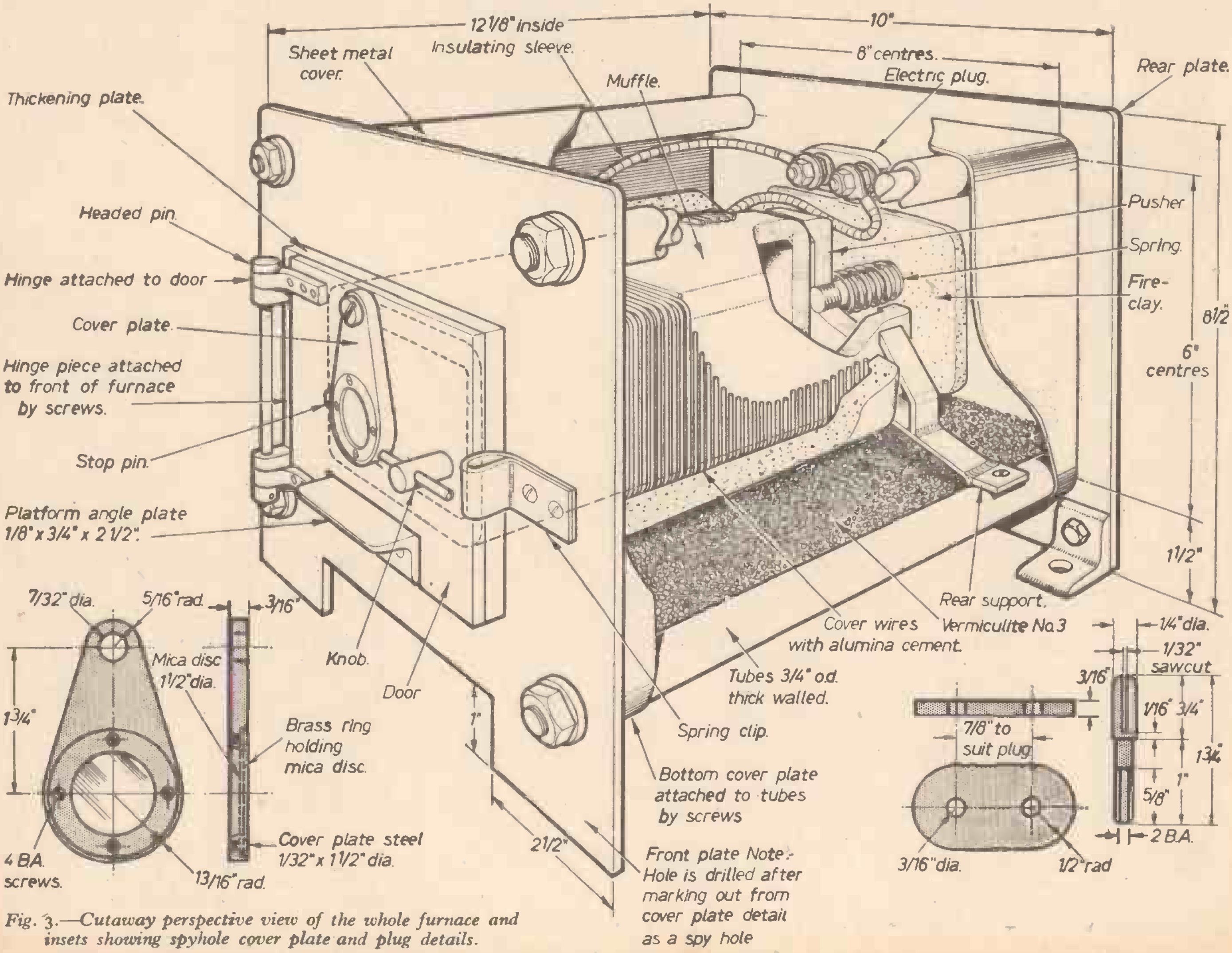


Fig. 3.—Cutaway perspective view of the whole furnace and insets showing spyhole cover plate and plug details.

Fun with the MULTIPLICATION TABLE

By T. JONES

THE construction of the board is a simple matter and is based on the idea of a bulb being lit up when a correct answer is given. By using interchangeable boards, there is no limit to the variety of knowledge that can be tested by children themselves, once the foundation or *master board* has been wired. Table boards can be drawn up not only in numbers, but also in money, and weights and measures.

The electric checking board outlined here has two extra boards, which are stored at the rear when not in use, thus concealing the wiring and battery.

Fig. 1.—Back of the master board.

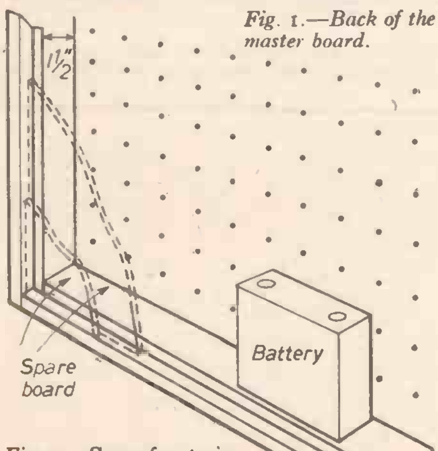


Fig. 2.—Space for storing spare boards.

Construction

Cut peg board into three sections 2ft. × 2ft. Place these on top of each other, aligning the holes by means of four pegs or by tying pairs of holes with string. Now cut the three sections together to dimensions required, each section thus being exactly alike with holes aligned. While the three sections are together, cut a hole to allow the bulb to project.

Paint the peg board and write the questions and answers in ink, which is quicker and neater than trying to paint them. There are four columns of questions and four columns of answers. The answers are arranged in numerical order so that when the answer is known, the finding of its position on the board is facilitated.

Attach wires at the back of board from question to answer (Fig. 1) by means of tubular rivets, which only need hammering to fix permanently. This constitutes the *master board*.

Nail the master board to four lengths of wood, 1½in. × ¾in. which form the framework. The 1½in. provides depth for storage of the battery. Screw four lengths of wood 2½ in × ½in. to this framework and to each other, so that space is allowed for storing spare boards at the back (Fig. 2). Screw two revolving feet to the base so that the whole may stand securely. The handle at the top is optional. Attach the bulb holder at the rear so that the bulb projects through the hole cut previously. Wire as in Fig. 3.

Prepare questions and answers on the other boards as required. A spare board is shown in Fig. 4. Questions and answers must have the same relative position as those on the master board. The interchangeable board is placed on top of the master board and is aligned and held in place by four nuts and bolts which project from the four corner regions of the master board. Thus the holes of the interchangeable board lie immediately over the rivet heads of the master board and are easily reached with the terminal point.

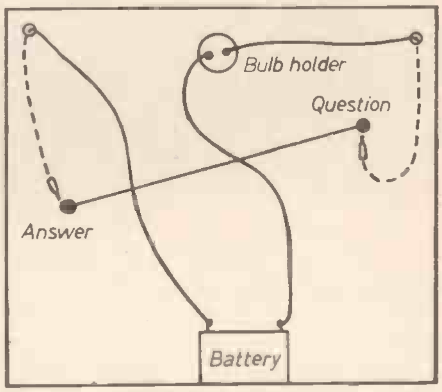


Fig. 3.—Wiring details.

Materials Required

The quantity of materials will vary with the size of boards required—in this case 23in. × 22in., with room for sixty problems on each board.

Pegboard 6ft. × 2ft.

120 tubular rivets—obtainable at leather shop.

16yd. of plastic-covered low-voltage wire.

Flash lamp bulb and small holder or, better still, a green or red panel light, obtainable cheaply from electrical stores, where ex-Government electrical equipment is dismantled.

4·5 v. bell battery and two terminals.

Screws and small panel pins.

Two lengths of wood 8ft. × 1½in. × ¾in. and 8ft. × 2½in. × ½in.

Cream or white paint and Indian ink.

Total cost approximately £1.

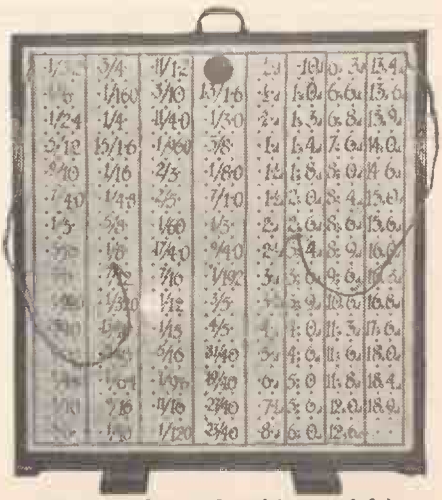
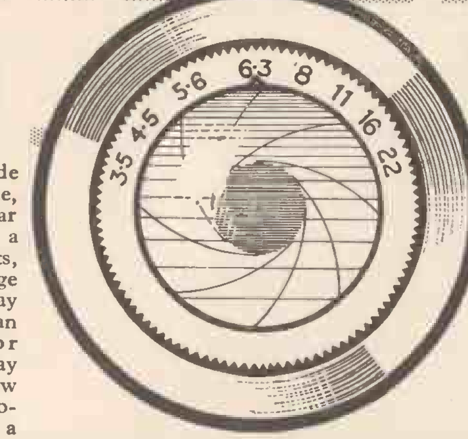


Fig. 4.—A spare board (parts of £1)

Lens Calculations



The Answer to Your Problem May be Here!

By F. R. Garey

WHEN making a slide projector, episcope, enlarger or similar equipment, or using a camera for close-up shots, calculation to find the image distance or focal length may be of advantage, rather than using trial and error methods. For example, it may be necessary to know how large a picture can be obtained from a projector in a small room which limits the distance between screen and projector, or what focal length lens to use in an enlarger or home constructed projector, for a given maximum picture size. Cases such as these can be calculated readily, and with sufficient accuracy for all ordinary purposes. This will avoid trial and error, or purchasing or setting up unsuitable lenses, etc. It should be noted that the same units should be used throughout in any calculation, and inches will often be convenient.

Finding the Focal Length

Normally, when a lens is purchased, its focal length will be known, but with ex-service or surplus lenses, or lenses obtained secondhand, or already available, it may not be. In this case, one of the methods shown in Fig. 1 may be used to discover the focal length.

With a simple magnifying or convex lens, the focal length can be found by holding the lens so that it forms a sharp image of a distant object on a screen or sheet of white paper. The focal length is then found by measuring the distance between lens and screen, as in Fig. 1. A bright object such as a distant street lamp, or sunlit building, will give a clear image if the test is made in a dimly lit room. The actual distance between lens and screen may be very small with a powerful lens, extending up to 30in. or more with weak supplementary lenses.

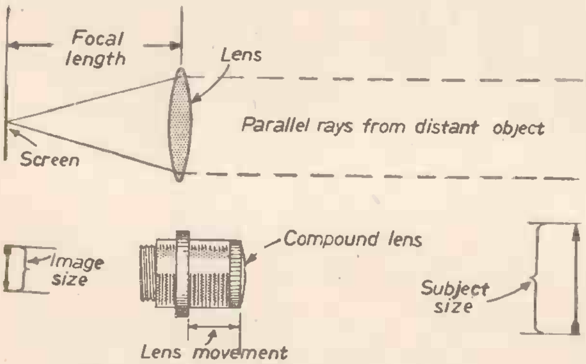


Fig. 1.—Finding the focal length of a lens.

Compound Lenses

A camera, enlarger or projector lens will usually consist of three or more lenses, in a mounting, and the position from which to measure focal length will then be unknown. For approximate results, focus a distant object as for the simple lens, and measure from screen to iris ring. If a more accurate result is necessary, the lens should first be focused at infinity; that is, so as to produce a sharp image of a distant object, as already explained. A mark is then made in line with some part of the lens or its mount. A close object such as a ruler is then focused on the screen. The lens will have to be moved slightly away from the screen, to do this. A second mark is then made level with the same part of the lens or mount as was used for the infinity mark mentioned. The distance between these two marks is measured, and is the "lens movement" (Fig. 1). The size of the image thrown on the screen is then measured. The focal length of the lens is then equal to the following:

$$\frac{\text{Lens Movement} \times \text{Subject Size}}{\text{Image Size.}}$$

This method is recommended for special compound lenses where the actual nodal point of the assembly may lie outside the lens mount. Measurement will be simplified by placing the lens on a V-shaped block resting on a flat board or "optical bench," rather than holding it by hand.

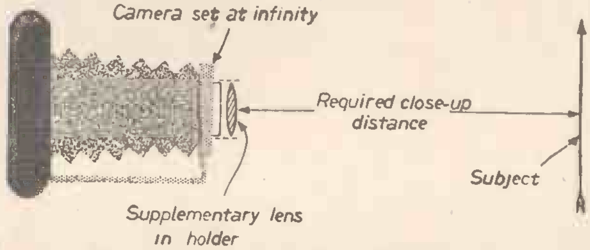


Fig. 2.—Focal length of a supplementary.

Supplementary Powers

A camera, enlarger or projector lens may be of unsuitable focal length for the purpose in view, or a spare lens may be used as a supplementary to reduce the focal length of a camera, enlarger or projector lens. The result of such a change may be very important, as will be seen.

When photographing near objects, the focal length of the supplementary should equal the required working distance, as shown in Fig. 2. With a supplementary of given focal length, the subject should therefore be placed at this distance. Alternatively, if an object is to be photographed at a certain distance, a lens of this focal length needs to be used.

The "power" or focal length of supplementary lenses is given in dioptres, a 1-dioptre lens having a focal length of 1 metre. With the camera lens set at infinity, a 1-dioptre supplementary would thus give sharp focus at approximately 39in. Because the camera itself be focused upon nearer distances, down to about 3ft., any one supplementaty will cover a certain subject distance. These distances, for various lenses, are approximately as follows:

Power of Supplementary	*Subject Distances*
1-dioptre	39in. to 20in.
2-dioptre	20in. to 13in.
3-dioptre	13in. to 10in.
4-dioptre	10in. to 8½in.

When a projector or enlarger has a lens of certain focal length, a larger picture can only be obtained by moving the screen farther away, or by reducing the focal length of the lens. In small rooms, or with a short enlarger column, the distance to the screen or baseboard will be limted. In this case a larger picture can be secured by adding a supplementary of such power as will reduce the focal length of the existing lens by a suitable degree. The approximate focal length of the extra lens can be found from the following:

$\frac{OF \times F}{OF - F}$ where OF is the original focal length of the lens, and F is the focal length actually required. For example, assume a camera lens of 4½in. focal length is to be used in an enlarger, but that a 3in. lens is really required to obtain sufficiently large prints. The calculation is:

$$\frac{4\frac{1}{2} \times 3}{4\frac{1}{2} - 3} = \frac{13\frac{1}{2}}{1\frac{1}{2}} = 9\text{in.}$$

The addition of a 9in. focus supplementary would thus allow the focal length of the 4½in. lens to be reduced to 3in.

Lens and Distance

It is often useful to know what size picture can be obtained from a given enlarger or projector, when the column, or room size, limits the distance between lens and the image thrown. Or it may be necessary to work out the best focal length for a projector or enlarger lens, to give a picture of certain size.

In Fig. 3 it is assumed that a picture 18in. wide is required from a home-constructed projector, and that the projector cannot be more than 5ft. from the screen. The size of the slide or transparency fitted in the projector will be known, and the focal length of the lens for the desired picture size can then be found from the following:

$$\text{Focal length} = \frac{\text{Distance to screen}}{\text{Linear ratio} + 1}$$

For example, an 18in. wide picture is

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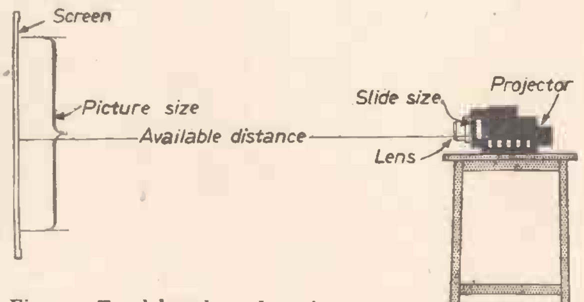


Fig. 3.—Focal length and projector distance.

A Dish Heater

By E. W. Summers, B.Sc.

It Costs Only 12s. 6d.

WHEN processing their films most photographers take great care to adjust carefully the temperature of developer and fixer to the required value (usually 65 deg. F), but many seldom give much thought to the temperature of the developer during a printing session. However, this is just as important, for a good negative cannot be expected to yield a rich print if the developer is too cold: the action of the hydroquinone is slowed down and a muddy-looking print, lacking in contrast, results. The use of a heater under the developing dish is recommended and such a piece of equipment is easily made. The one described here is equal in performance and appearance to commercially available models and has the advantage of being much cheaper. The materials required are few and easily available, whilst the actual construction of the heater is quite simple.

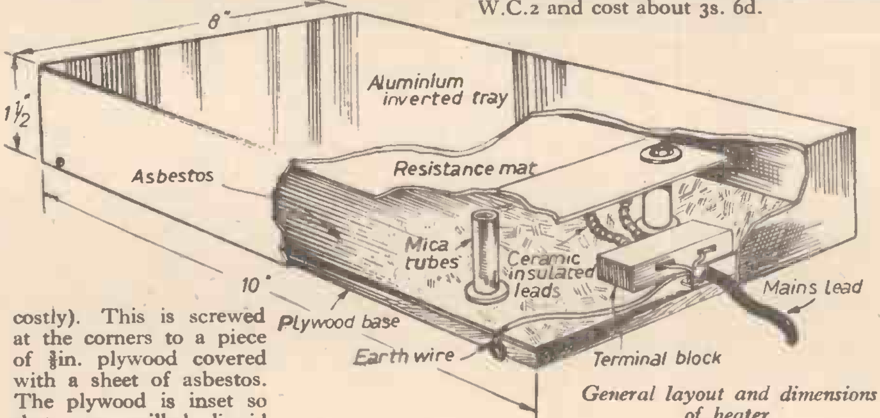
Dimensions

The dimensions of the author's own dish-heater are 10in. × 8in. × 1½in., but other sizes can be constructed to suit individual requirements. The body of the heater consists of an inverted tray cut from a piece of 20g. aluminium sheeting, 13in. × 11in. and bent carefully to size (a radio-chassis would give this ready-made, but is more costly). This is screwed at the corners to a piece of ⅜in. plywood covered with a sheet of asbestos. The plywood is inset so that any spilled liquid will run down the aluminium but cannot seep inside. The mains lead is a length of 3-core, 5 amp. rubber-covered cable which enters the box at one end through a rubber grommet and is secured to the floor of the box with a cable clip. The live and neutral leads go to a terminal block and the earth wire is screwed to the edge of the plywood so that it makes contact with the aluminium. The two ceramic-insulated leads from a resistance mat are connected to the other side of the terminal block, the mat being supported ½in. above the asbestos with bolts through mica tubes.

Heating Element

The resistance mat is the heating element, having a resistance of 650 ohms., which, on 230 volts supply, yields about 80 watts. This is sufficient to maintain a dish of developer at a temperature of 70 deg. F. in even the coldest weather. In fact, it is usually necessary to switch off the power for a time occasionally but this is no inconvenience and a thermometer in the dish will give suitable warning of when to do this. A thermostat could be fitted at an extra cost of about 7s. 6d. A coat of heat-resistant matt black paint can be applied to the underside of the aluminium to improve heat distribution, but this is not essential.

The resistance mat is obtainable from London Central Radio Stores, 23 Lisle Street, W.C.2 and cost about 3s. 6d.



General layout and dimensions of heater.

Lens Calculations

(Concluded from previous page.)

desired, and the usable width of the slide is 1in., with the projector 5ft. (60in.) away. The focal length is thus:

$$\frac{60}{18 + 1} = 3{\cdot}1\text{in. approximately.}$$

An absolutely exact calculation is not required because it is possible to move the screen or projector very slightly, so that in practice a 3in. or 3¼in. lens would be perfectly satisfactory.

The same calculation can be used to find the maximum degree of enlargement obtainable with an enlarger, with a specified column and lens. With a home constructed enlarger, the length of the column, for a given degree of enlargement and lens, can be similarly calculated. Referring to Fig. 4, it may be assumed as example that 2in. square portions of 2¼in. square negatives will be enlarged up to a maximum of 8in. × 8in., and that a 7·5cm. camera lens is to be used in the enlarger. The distance between negative and baseboard to allow this can then be found from the calaculation:

$$\text{Distance} = \frac{\text{Focal length} \times (\text{ratio} + 1)^2}{\text{ratio}}$$

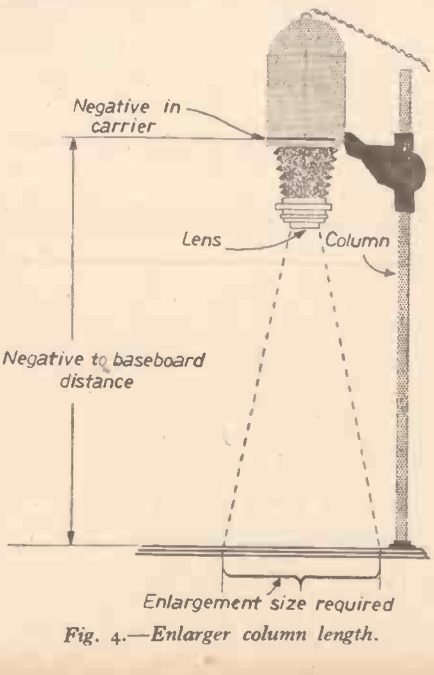


Fig. 4.—Enlarger column length.

In the example, the 7·5cm. lens can have its focal length expressed in inches, or the distance may be found in cm. Using the former method, focal length = 3in., and ratio of negative to enlarged image is × 4. Therefore

$$\text{the distance} = \frac{3 \times 25}{4} = 19\text{in. approximately.}$$

The same calculation will show how far a projector must be from the screen, to obtain a picture of given size, the focal length of the projector lens being known. It is important to remember that the ratio figure is a linear one, obtained by comparing the width of the picture with that of the usable width of the negative. The ratio between the *area* of the picture, and negative or transparency should not be used in error.

THE ELEMENTS OF MECHANICS AND MECHANISMS

By F. J. CAMM

432 pages, 481 illustrations, 30/-, or 31/6d. by post from

George Newnes Ltd.
Tower House, Southampton Street, Strand, London, W.C.2.

The Secret of Quality Sound Reproduction is a Properly Designed HI-FI CABINET

R. Hindle Tells You How One Can Be Made

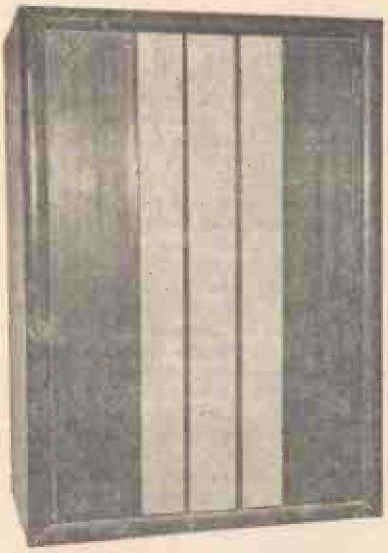


Fig. 1.—The completed Hi-Fi cabinet.

A SOUND reproducing system is not necessarily as good as, but it certainly cannot be better than, its speaker system. There is available a wide choice of speaker movements capable of giving high quality results but the best of them will give poor reproduction if not operated in a suitable enclosure. These movements generally operate on the moving coil principle and interested readers can study this in a good radio text-book. It is not easy to design a single speaker

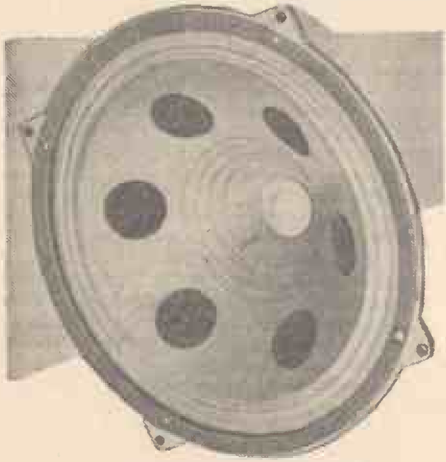


Fig. 2.—The W.B. HF1214 speaker.

which will respond equally well to all the sounds that the ear can detect. Cheaper speakers fall far short of this. Multiple speaker systems, unless very expensive suffer from a number of disadvantages and, in the author's opinion, the best plan where expenditure is limited, is to buy a good quality single unit. Speaker quality, incidentally is not related to cone size.

Ideal Speaker

Ideally, for fidelity, work a frequency response from below 50 c.p.s. to above 12,000 c.p.s. is desirable and this range to be even over its length. On a graph such a response would appear as a straight line, but as, in actual fact, such perfection is unobtainable, it is more likely to have several deviations.

For the range of frequencies needed for reproduction to qualify as "high fidelity," a power handling capacity of ten watts is probably a minimum and 15 watts desirable.

For the present work, the HF1214, a 15-watt 12in. speaker made by Messrs. Whiteley Electric has been chosen. This is shown in Fig. 2. Its frequency response when properly housed extends from 25 c.p.s. to 14,000 c.p.s.

This speaker may be too large for some constructors and with this in mind dimensions suitable for smaller speakers will also be given. The same principles regarding construction should be followed.

Points About Cabinet Design

When a speaker is operated without a cabinet, bass notes are seriously reduced and the sound is tinny and high pitched. This is because sound is emitted from both front and back of the cone. The classic way to prevent this interference between front and rear is to cut a hole in the middle of an extensive flat surface and mount the speaker over it, i.e., form a baffle. For a given frontal area, the effect of a larger baffle can be achieved by putting extensions towards the rear so that the speaker is mounted on the front wall of a box

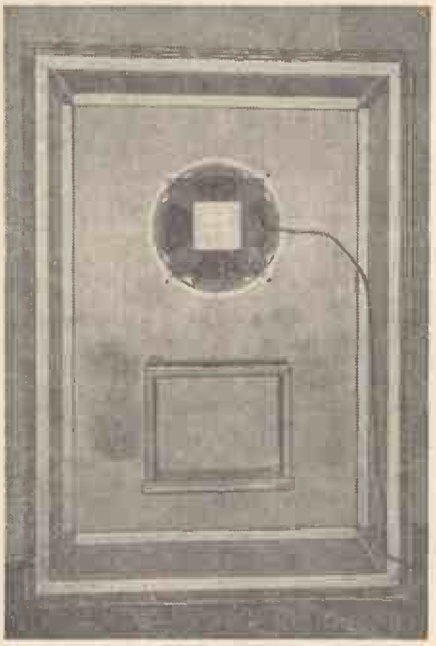


Fig. 4.—A view of the inside of the author's completed cabinet.

(see Figs. 3 and 4). Construction should be substantial, thick plywood usually being used to avoid vibrations and a lining of sound absorbent material being installed.

In the same wall as the speaker opening, another hole, known as the port, is made and its size has an effect on the resonant frequency of the cabinet. This then is the basic design for a bass reflex cabinet as shown in Fig. 3. There are many complications in speaker design, but fortunately manufacturers provide the necessary measurements for their speakers. It is the enclosed volume of the cabinet which is important, i.e., inside dimensions. Small changes in the relevant dimensions of length, breadth and height, so long as the enclosed volume remains the same, are not likely to have any apparent effect on results.

The cabinet still works out quite large and a reduced size is practicable if the port, instead of merely being a hole, is made as the opening of a short tunnel extending inwards into the cabinet. This is called the ducted port and is shown in Fig. 3. This illustration also shows all the necessary *inside* dimensions for housing the W.B. type HF1214 speaker. As these are inside dimensions, the thickness of the panels must be allowed for when preparing the panels. The ducted port dimensions are those actually for the duct—the timber walls project into the cabinet space. The speaker opening and port are placed centrally across the width of the front.

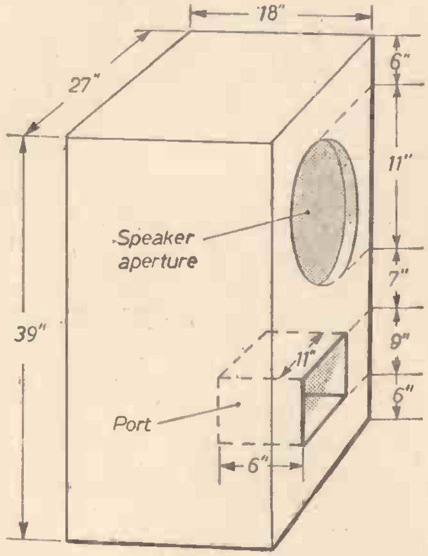


Fig. 3.—Inside dimensions of a cabinet with a ducted port.

Alternative Sizes

Before commencing actual cabinet construction, the following table listing the dimensions necessary for cabinets to house other speakers in the W.B. range, is given.

	in.	in.	in.	in.
Nominal Cone size	6	8	9	10
Type	HF610	HF810	HF912	HF1012
Power Capacity in Watts	3	5	7	10
Bass resonance in cycles/sec.	70	65	45	35
	in.	in.	in.	in.
Inside height	21	22	30	38½
,, width	14	16	22½	27
,, depth	10	11	15	18
Width of port	5¾	7	8½	9½
Dia. of speaker aperture	5¾	7	8½	9½
Height of port	3¼	4	5⅜	5¼
Depth of port	4	4	5	5
Inside top cabinet to speaker aperture	4	3	6	8
Between speaker aperture and port	4	4	6	8
Bottom port to bottom inside cabinet	3¾	4	4½	8

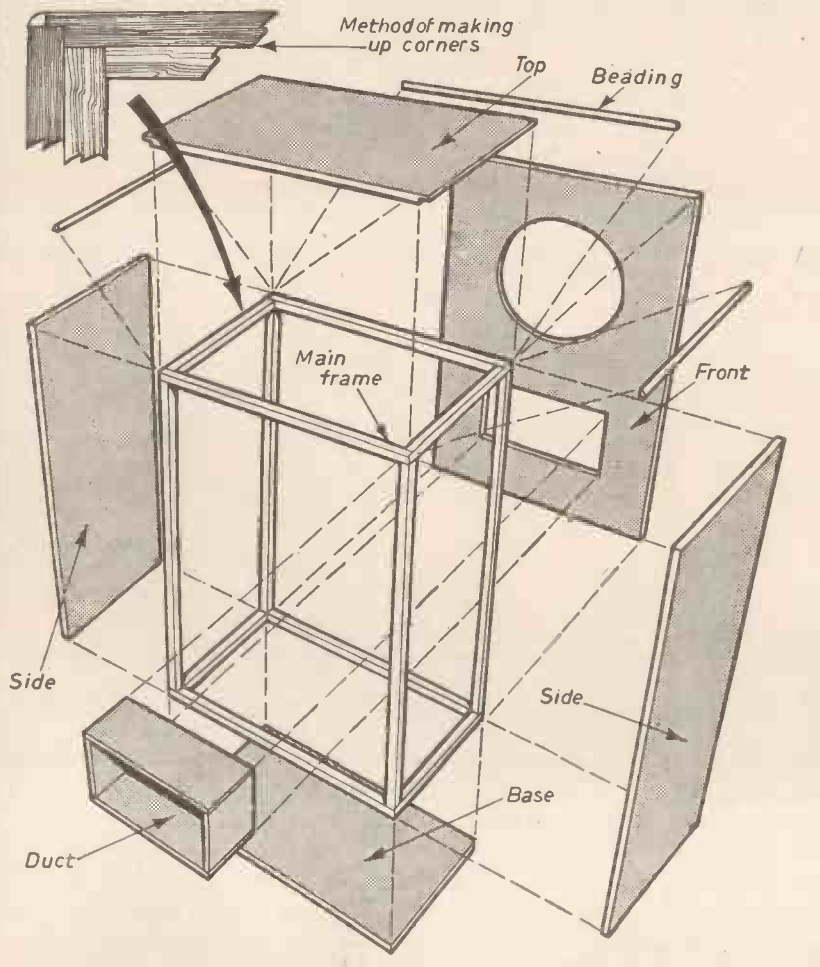


Fig. 5.—An exploded view of cabinet construction and (inset) corner make-up.

Construction

The material used for the walls of the cabinet should be as thick as practicable. Actually ¾in. plywood was used for the prototype and was veneered on one side with walnut for surfaces that are visible in the completed cabinet. A cabinet made to a similar design but for a smaller speaker was constructed from unfaced ply and an extraordinarily realistic decorative effect was achieved by covering the outside surfaces with the imitation wood grain paper obtainable from wallpaper stores.

The joints of the structure must be airtight and mechanically strong, with all corners reinforced. This is achieved by building the cabinet around a frame made of 1in. × 1in. timber. This 1in. × 1in. should be cut so that when assembled it will form a frame as in Fig. 5 with *outside* dimensions equal to the inside cabinet dimensions required, e.g., 39in. high × 27in. × 18in. From the point of view of sound, it is immaterial whether the finished cabinet is made to stand with the long dimension upright or horizontal, but from a decorative point of view it will affect the parts that are to be veneered. Before beginning construction give careful thought to how the cabinet will fit into the room. Also bear in mind that some slight change in a given dimension can be made so long as the other dimensions are also changed so as to keep the contained volume the same.

Cladding the Frame

Six pieces of ¾in. plywood, are needed as under to "clothe" the frame. If the outer surfaces are to be veneered the parts needing this treatment are indicated.

Two off 39in. × 27in. for back and front (front veneered).

Two off 27½in. × 19½in. for top and bottom (top veneered).

Two off 39½in. × 19½in. for sides (both veneered).

The front piece has two pieces cut out as shown in Fig. 3, one to make the hole for the speaker and the other for the port.

The top, bottom and two sides are assembled with the 1in. × 1in. frame pieces so that they leave front and back cavities into which the front and back pieces will fit snugly and flush with the top, bottom and side pieces already assembled. All joints should be firmly glued and screwed (from the inside). The corner joints are actually made up as inset in Fig. 5, the corner being finished smoothly by means of a quarter round moulding with ¼in. sides. The corner as shown is, in fact, the view at the front and back at the present stage in construction, the 1in. × 1in. frame being inset from the edge of the top, bottom and sides by the thickness of the front and back pieces (i.e., ¾in.).

The Ducted Port

The port is made up as at Fig. 5, with joints glued and screwed, and is then glued and screwed to the front piece so that it coincides exactly with the aperture in the front piece. Note also that the aperture in the front piece then, in effect, becomes an extension to the duct equal to the thickness of the front piece, therefore the duct is made 12½in. wide × 5¼in. deep which, with the ¾in. thickness of the front makes up the 6in. needed for the duct. The two duct sides are 5¼in. × 9in. high. The front piece is then glued and screwed firmly into the position with the ducted port to the bottom extending into the cabinet and the speaker aperture to the top. Screws to hold the duct and to fix the front piece into position can go in from the front and there is no need to hide the countersunk heads at this stage because later processes will cover them. The cabinet main structure is now complete except for the back.

The back piece cannot be glued because it must be removable to fit the speaker so provision for many screws to fix it firmly should be made. Four to each side and three at top and bottom were used in the prototype. Do not attempt to fit any quick release arrangement—there is no substitute for firmly screwing. Unless the back is really substantial it should be stiffened by means of cross members securely glued and screwed to it to divide it into halves or quarters.

Speaker Front

Fix a 12in. wide strip of speaker fabric, obtainable from radio shops, the full length of the cabinet, positioned centrally to cover both apertures. The edges of the fabric are hidden by two ornamental strips of wood ⅜in. thick and projecting out from the cabinet ⅞in. These are rounded at their ends. It will be seen from Fig. 1 that two more such strips of wood of similar dimensions are spaced equally between the two. These merely represent a concession to appearance. Fig. 6 gives the cross-section of the front with these strips in position and will clarify the above description.

The loudspeaker movement can now be mounted into position so that it is exactly central over the round hole in the front of the cabinet. This is easier said than done unless a circle is drawn concentric with the hole and larger in diameter than the speaker. The speaker can then be centred inside this circle. The speaker must be screwed very firmly to the front. Take great care in handling the speaker. The cone can easily be damaged by careless handling. Most certainly take care to avoid dropping the unit or causing any mechanical shock.

Acoustic Treatment

The whole of the interior surfaces must be lined with a suitable sound absorbing treatment. This acoustic lining must cover the

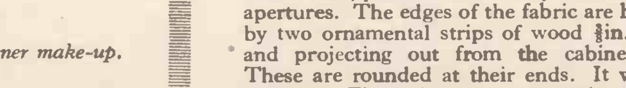


Fig. 6.—Cross section of the front board.

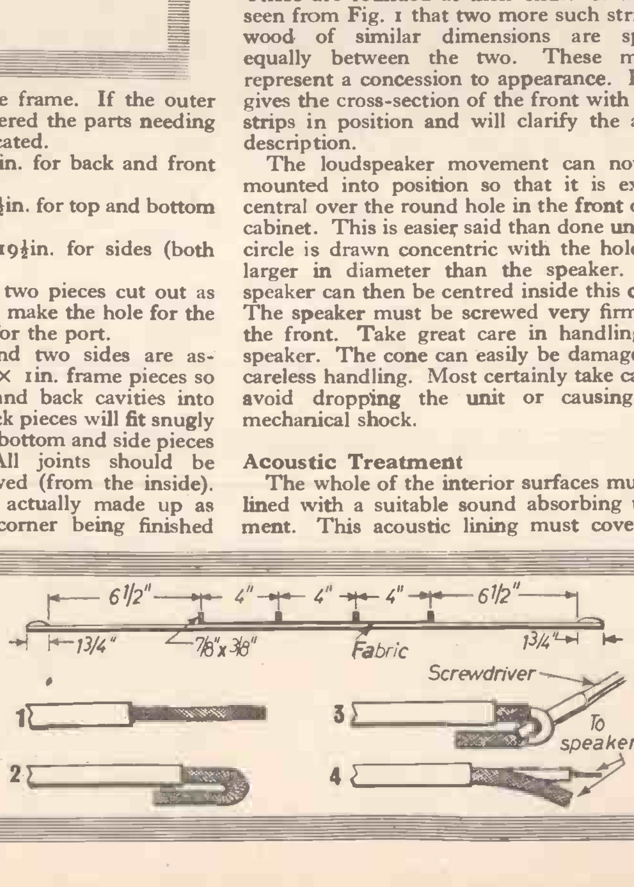


Fig. 7.—Stages in preparation of coaxial cable.

whole of the inside surfaces and also the outside surfaces of the duct within the cabinet. A curtain of similar material should be hung from the top of the cabinet extending the full width and hanging midway between front and back so that it is behind the movement. It must be quite free to move at both sides and the bottom. A very satisfactory material, and the one chosen for the present cabinet, is "bonded acetate fibre" (B.A.F.) which is available from Southalls (Birmingham) Ltd., Industrial Division, Charford Mills, Saltley, Birmingham 8. The particular grade used has the specification "8oz. 2½ denier," nominally 1in. thick. About seven yards 36in. wide will serve the present purpose. This material is very clean to handle and does not leave bits all over the room when it is cut; perhaps more important, no little bits will contaminate the speaker movement itself!

Cut this material to give complete coverage of the inner surfaces of the cabinet. It does not matter if there are any joins or if there is some overlap of the material. Cut it away round the speaker frame so that it fits snugly up to the movement. Do not put any material inside the duct but cover the external surfaces of it.

Gluing

The material is glued into place, first painting the surface of the wood with cold water glue and then pressing the fibre sheets into place. The method adopted to fix the curtain was first to line the top of the cabinet with a piece extending 9in. from the front board (that is half the distance between front and back). Then one piece long enough to cover the remaining part of the top and for the curtain down to the bottom of the cabinet was cut. The part of the top not already lined was then painted with glue and the curtain piece was pressed into position. To take the weight of the hanging curtain pins were used along the line where the curtain piece met the other piece across the top. Now the back piece should be lined with the material but leaving it short of the edges so that it will not get in the way when the back is placed into position.

Speaker Connections

Before fitting the back it is necessary to make the connections to the speaker. The ideal material is a length of coaxial cable such as is used for television aerials, the length of course depending on how far the connection has to go to the amplifier. The author has a permanent wiring under the floorboards from the amplifier cabinet to the part of the room occupied by the speaker. This is carried out with coaxial cable and terminates at the skirting with a coaxial socket such as is provided for television aerials and in this case only a short lead is needed from the speaker.

To make the connection to the speaker, bare the end of the inner wire of the coaxial cable and solder this to one tag of the speaker (it does not matter which). The outer braid is connected to the other tag. Care must be taken to see that the braid does not short to the tag to which the inner lead is connected.

Perhaps the tidiest way to make the connection is illustrated stage by stage in Fig. 7. Strip off about 2in. of the outer insulating layer without damaging the braid. Now bend the cable just short of the remaining outer layer so that the braid is expanded, then carefully push the strands of braid to either side of the bent inner insulated lead. The inner lead can now be drawn through the braid by means of a screwdriver. A piece of insulated sleeving can be slipped over the braid, leaving the end bare for the connection. The end of the inner wire can be stripped of insulation taking care not to damage the wire. These two ends can then be soldered to the speaker tags. At the other end of the coaxial cable the termination will have to suit the output connections from the amplifier. The writer always uses television type coaxial plugs and sockets for this purpose. A hole in the cabinet back towards the bottom is made a close fit to allow the lead to be passed out of the cabinet. The back is then screwed firmly in place.

Using the Speaker

The speaker movement specified has a 15 ohm speech coil and the amplifier must match up to this. Most receivers of the domestic type which provide points for the connection of an extension loudspeaker will be arranged for a 3 ohm speaker. Connection to such a point will not be ideal but if necessary will serve for a first trial. Such an arrangement will not do justice to the speaker and the constructor will most certainly wish, in time, to have a high fidelity amplifier good enough for the speaker. If, in fact, he has one already it is most likely that a 15 ohm speaker will suit it.

It will be realised that a high fidelity speaker is faithful to bad as well as good signals! Faults in recording or the scratch of old records will be much more prominent and so records have to be chosen with care for best results. Similarly, faults of the amplifier with which it is used, or the broadcast receiver to which it is connected will mar the reproduction even though inferior speakers hide such faults. Nevertheless it is a magnificent experience to hear good music, whether from records or radio, really well reproduced.

Closed Circuit Stereo Television

IN nuclear plants and other establishments where dangerous radioactive materials are handled by remote control, television provides the scientist's eyes. The advantage of 3-D has now been added by E.M.I. Standard closed circuit units are utilised in the stereoscopic equipment which consists of two camera channels mounted side by side and arranged to relay pictures on to two monitors. The pictures from these are then superimposed on each other by means of a mirror and polarised glass to form a single image. When viewed with polarised spectacles this produces a realistic three-dimensional picture.

New Alloy

A NEW nickel-based alloy called Illium 98 has been developed in answer to industry's need for a metal capable of withstanding the corrosive effects of hot process acids. This machinable cast alloy has a Ni-Cr-Cu-Mo composition.

Gas Turbines in the Navy

THE first Proteus gas-turbine-engined boat has recently been put into service by the Royal Navy. The craft, *H.M.S. Brave Borderer*, is powered by three of these units and during her trials she continually reached a speed of 50 knots. Her length is 98ft. 10in. and her beam 25ft. 5½in. The hull is framed in welded aluminium with double skinned planking of mahogany and sheathed with glass fibre below the water line. An hydraulic operated flap fitted on the transom maintains the craft's running trim.

Improved Synthetic Rubber

THE Du Pont Company (United Kingdom) Ltd. has introduced a new type of "Viton" synthetic rubber which has double its predecessor's useful life at temperatures from 500 to 600 deg. F. The original "Viton" offered resistance to oils, fuels, and solvents at temperatures above 400 deg. F. The new version will broaden the range of use of fluorine-containing elastomers.

New Luminous Compound

INVENTED by Norwegian Reidar Paulsen, this new compound is non-radioactive and can be sprayed, rolled or printed on to all types of surface, including glass, plastic and aluminium. Light is used to activate the compound. It retains its luminosity for about 6 hours before requiring reactification, which can be done in less than a minute.

The photograph above shows the Swansea Docks firefighting craft, "The Firemaster." Built catamaran style, it has an open tower with nine fire-fighting nozzles operating from three decks. It is possible to pour 4,000 gallons of water or 12,500 gallons of foam a minute on to a fire. Operations are controlled from the top of the 40ft. tower.

THE AUTOMATIC HOUSE

PART 2

STAIR AND CUPBOARD AUTO-LIGHTING

You won't forget to turn these Lights off!

By E. V. King

THERE are places in most houses where lighting is only necessary for a relatively short time each day or night, i.e., staircases, backyard paths to sheds and garages, long passages, etc.

Automatic control of *indoor* lights is possible by foot pressure on floor pads at suitable places so that two-way throw-over type switches are operated at the start and finish of the journey. Provided two people do not cross, this is quite satisfactory and the apparatus is relatively simple.

Staircase Lighting

Use two conventional press switches (as used on bedside lamps) side by side. At the outset one is put off and one on. They are mounted about 1½in. apart in the middle of the bottom stair of a staircase, and a similar pair on the top stair. If care is taken the mounting may be as in Fig. 1A, two holes being carefully drilled so that the screw collar can be fitted on the switch and care being taken that the plunger will develop sufficient travel. If this method proves too difficult then that shown in Fig. 1B will work very well.

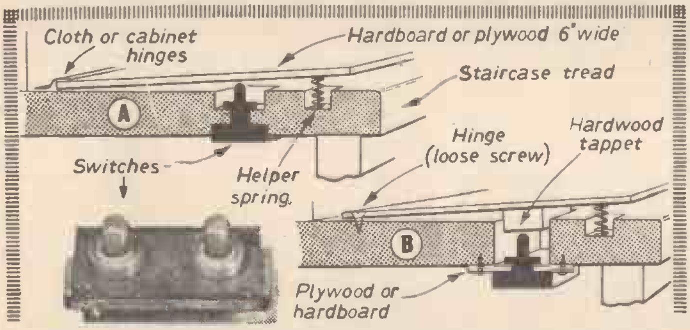


Fig. 1.—The pressure pad and two methods of switch mounting.

Suitable switches are the Arcolectric S.308, Milligans (Liverpool) NL 152 or (with rather a larger displacement) Bulgin S.360 provided the terminals are not exposed. Suitable types are sometimes available also in walk round stores and radio shops. See Fig. 1 for type required.

The switches are operated by a length of hardboard or plywood, or better still ⅛in. thick steel sheet about 6in. wide and about ¾ width of the stair carpet. The edges may be chamfered so that they are hardly visible beneath the carpet. It is hinged as shown in Fig. 1, along the back edge adjacent to the upright of the stair-either by gluing canvas along the edges, or using small cabinet type hinges. Another method is to use large holes and screws not tightened (Fig. 1B).

A few small springs (obtainable from model engineering shops, garages or Messrs. Terrys Ltd.) will be needed to keep the board up especially if a heavy stair-carpet is fitted. When correctly arranged—and this entails a little patience—foot pressure on the pad will operate *both* switches together, one going off and one on. They are wired so that this causes a change over in the circuit. The operating pads may be felt lined to minimise noise. It is possible that the hinging might be eliminated where a tight carpet is fitted and that foam rubber might serve in lieu of springs.

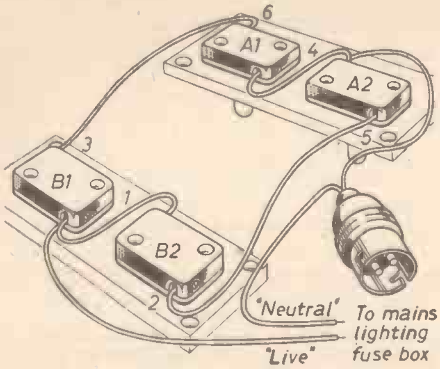


Fig. 2.—Wiring of button switches.

Verify that both switches do in fact work together and that one is off when the other is on, using a flash lamp and torch battery. Mark them as in Figs. 2 and 3A. Mount, test and mark the other two switches in the same way.

Wiring the Circuit

No person should alter any electrical wiring without having sufficient knowledge, with the main switch on, or so as to contravene the local supply authorities laws. Any permanent alteration should be inspected by the local electricity authorities. Due regard must always be paid to insulation of wires, whether they are neutral or live (red) and in some cases to earthing of metal cases, etc. Where concrete or other hygroscopic surfaces are concerned *very great* care is required and careless work near water taps, lavatories, etc., can be a danger to life.

In most cases the wiring of this simple staircase light will present no difficulties. All wires must be of the type insulated for mains use; bell wire or lightly insulated cable is not suitable. No wires must be uncovered so as to be touched, and if a metal cover is provided to the switch gear it should be earthed, otherwise wood should be used.

Batten and other type lamp holders are obtainable together with suitable wire and fixing clips from any electrical dealer.

Testing

When switched on at the mains press *either* pad with the foot; the lamp should then come on or go off. If it does not, check that you have got each pair of switches set correctly (one on and one off). When a carpet is fitted slight experiment will be necessary with the springs.

Automatic Cupboard and Cloakroom Lights

A cupboard, cloakroom or airing closet door is normally opened only when a light is required. A separate switch is therefore unnecessary. For automatic operation a

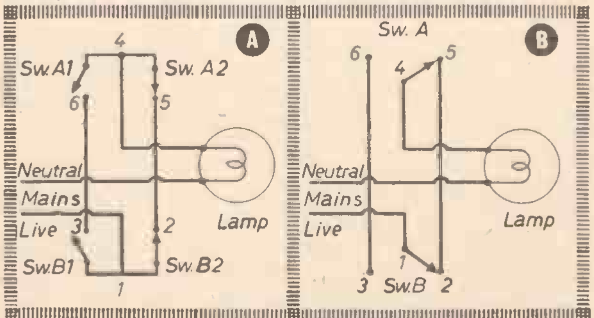
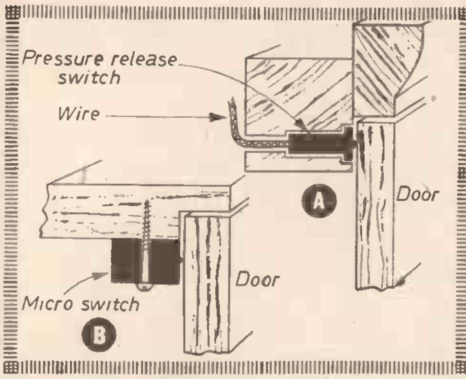
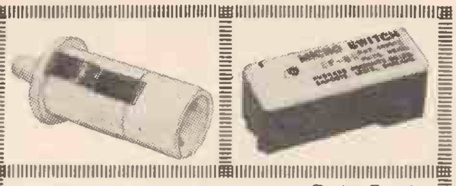


Fig. 3.—(A) Wiring of button switches for staircase lighting and (B) conventional two-way switching.





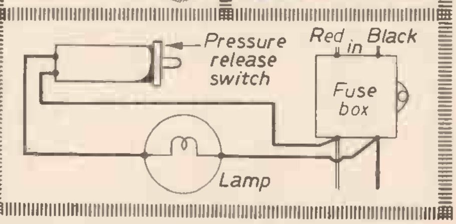


Fig. 4 (Left).—Cupboard switching; (A) using A55; (B) using micro switch. Fig. 5 (Top right).—A55 and micro switch. Fig. 6 (Bottom right).—Cupboard switch circuit wiring.

switch which makes contact on release of pressure is necessary.

Many refrigerators are fitted with this type of switch and they are obtainable from the makers Messrs. Arcolectric, West Molesey, Surrey very cheaply. No. A.55 is shown in Figs. 4, 5 and 6. Switches S.930 and T.930 are also suitable, the former is panel mounting and has screw terminals, the latter has solder tags. Where ordinary doors are concerned the A.55 seems more suitable. It has a large amount of over travel and is not therefore damaged if the door closes rather heavily on it.

A micro-type switch such as Burgess BR may be used and is available currently from many sources as surplus (Fig. 5). Great care must be taken when it is mounted as in Fig. 4B, that the door does not rattle and does not press the plunger in more than 0·007in. past the " click." Since a few thousandths of an inch of wear on the door opposite the plunger will cause faulty operation it is a good plan to screw a brass plate to the door opposite the plunger. This is hardly necessary with the A.55 type.

Wiring

This is quite straightforward. Make sure the switch is in the red lead and although connection could be made to any convenient point it is better to use good cable and take it to the lighting fuse box outlet as shown in Fig. 6. Where possible the amateur should use bakelite type bulb holders. Brass is stronger, but faulty connections may make the holder live.

Slight adjustment of the switch position may be necessary so that the light is off if the door rattles slightly. No rattle is permissible when using a micro-type switch unless it is operated via an outside compression spring or springy brass strip to take up excessive over-travel. Neglect of this point will cause damage to the switch.

Details will be given later of a system whereby cupboard lights will switch on when the door is opened, for a predetermined period only.

Lavatory Lighting

Some rooms are such that only one person enters at a time. A simple foot pad operated switch using one simple press type switch such as Arcolectric S.308 can be used. It is fitted *outside* the room and wired instead of, or in parallel with, the normal switch.

On entering the light is thus put on, and on leaving it is automatically put off. A light beam may also be used with this system, a photo switch will be described later.

A similar system may be used to put on the light *and* lock the door, an electro-magnetic door bolt is to be described later and it could be used together with a latching relay and thermal delay switch. A separate push button would unlock the door for the person locked within. No push button would be available outside.

Building a TRANSFORMER/RECTIFIER UNIT

A GREAT many devices to be described in this series "The Automatic House" will require a 24v. D.C. supply with its attendant advantages of eliminating the danger of serious shocks and of fire by means of fuses or cut-outs. In addition to its use with devices in this series, the transformer/rectifier unit can power small lathes, grinders, saws, food mixers, extractor fans, models, etc. It can also be used to re-charge a flat car battery. It is recommended that a large unit be built capable of operating a number of devices at once. Such a unit is shown in Figs. 7 and 8.

The Transformer

This is used on A.C. supply and must have a secondary voltage of between 22v. and 30v. An auto-transformer is *not* suitable as shocks could be obtained from incorrect use. The following transformers are suitable:—

Milligans (Liverpool) NL 121 b taps at 24v. and 30v. 2 amps.

Messrs. W. Benson, No. 424, output 24v. at 5 amp.

Messrs. H. W. English No. 1055 (and others), output 10 amp. at approx. 22v.

The Rectifier

When considering the transformer, the rectifier must be considered at the same time. Since metal type rectifiers are expensive, one only slightly larger than necessary is required and a fuse close to the safety limit is fitted. A full wave (bridge type) metal rectifier is required. The one shown in the prototype unit came from Messrs. Annakin and is

Fig. 7 (Right).—Perspective view of transformer/rectifier unit showing wiring.

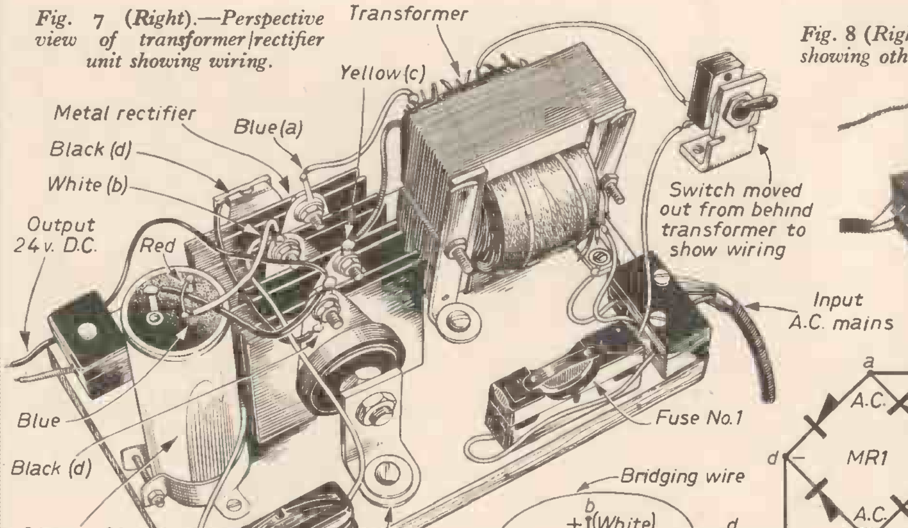
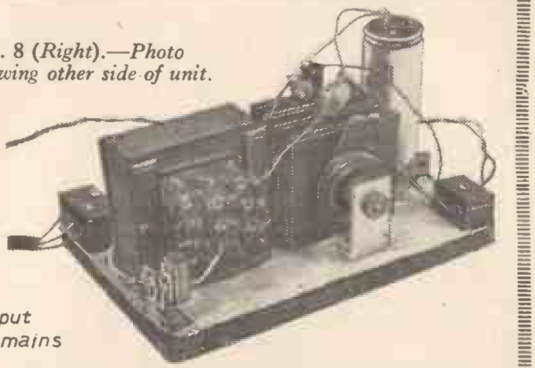
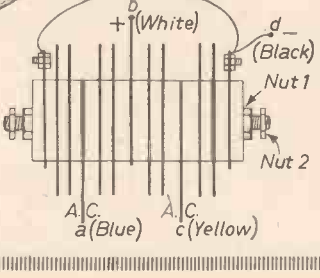


Fig. 8 (Right).—Photo showing other side of unit.





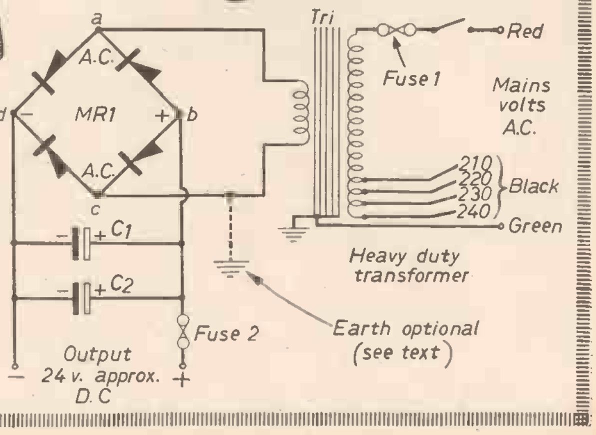


Fig. 9 (Right).—Rectifier connections. Fig. 10 (far right).—Theoretical circuit of D.C. supply unit. The rectifier connections a and c are green and b and d, red.

colour coded accordingly. Suitable rectifiers are as follows:

Messrs. W. Benson No. 329, 24v. 1 amp.

Messrs. Wilkinson (Croydon) Ltd. B84-2-2 28v. 5 amp. and many others suitable.

Messrs. P. Harris can also supply many suitable surplus rectifiers. The rectifier used may have a voltage rating of between 24v. and 50v.

Readers may note that complete wired up units are available from Messrs. R. Franks: No. 83 giving 24v. 1 amp., No. 85 32v. 1½ amp., No. 80 24v. at 3 amp.

Construction

Metal rectifiers must not get unduly hot and if the unit made up is a heavy duty one then ample ventilation must be provided and convection space must be provided round the fins of the rectifier. No heat is produced when the unit is off load. Although it remains connected to the mains the consumption is only a watt or two until a demand is made on it.

The layout is not critical, a wooden base may be used, but a metal cover should be made and it should be properly earthed with a thick copper wire. The layout of Fig. 7 was adopted by the author and the circuit is shown in Fig. 10.

The primary, mains side, of the transformer will be marked when the component is purchased and the correct tags for the voltage input must be used. One goes to the switch and one to the mains.

On no account must the secondary side be connected in any way to the mains. The metal core of the transformer must be adequately connected to earth (via a terminal in the prototype). It is safest to earth it independently twice. The fuse in the mains circuit to the switch is essential and must not be larger than necessary to "hold" when initially switched on under load. Generally a 2-amp. fuse will be satisfactory. A suitable holder is the Slide Lock No. 141 f Milligans (Liverpool) for heavy currents and S141c for small currents.

Wiring the Rectifier

In Fig. 7 coding is that of a Surplus Rectifier obtained from Annakins. In Fig. 10 caption conventional colour coding is given with letters to key it to Fig. 7. These letters are also shown in the circuit of Fig. 7. No attempt should be made to find the connections by trial and error or the rectifier will be ruined. A bridging wire is necessary because the rectifier is made in straight line and not in the square shape on the theoretical circuit. The fixing nuts should be used carefully so as not to alter in *any way* the original pressure between the plates.

The condensers C1 and C2 are not absolutely necessary, but they help to cut out annoying humming at the relays of control gear and save fitting individual condensers at each relay. 24v. high capacity electrolytics are not easy to obtain and the author experimented with other types and found that TV smoothing type condensers rated at about 300v. and over 100μF. each part are suitable when wired in parallel. If 24v. condensers are used then the No. 2 fuse should be fitted in the lead from b on the rectifier and not where shown. Suitable condensers are obtainable as follows:

Messrs. W. Benson. Two of No. 70 200μF. 275v.w. 2in. dia.

Messrs. W. Benson. One of No. 85, a very large block type 2,000μF. 25v.

Messrs. Technical Trading Co. One 1,000μF. 275v.w.

The prototype uses one double condenser 100/200μF approx. also obtainable from Messrs. Technical Trading Co.

The fuse in the secondary circuit must be the same size or smaller than the maximum current delivery by either the transformer or rectifier, whichever is the smaller rating. The limit of minimum size is the maximum demand to be made at any time. Where larger currents are concerned glass enclosed fuses are best used. Generally the S141a, Milligans (Liverpool) is suitable.

Terminal blocks of any enclosed type may be used, if the terminals are visible then they should be covered with Faraday wax. The secondary circuit may be earthed as shown dotted in Fig. 10. The author considers this an additional safety precaution, and it it referred to later in regard to various units. A warning neon lamp may be fitted across the mains tags of the transformer (Arcolectric S.L.50 fitted with a red glass, for the mains voltage used, is very suitable and neat).

Precautions in use

Always maintain the earthed lead in perfect condition. Never use any odd value of fuse as a temporary measure. Otherwise perfect safety and long life will ensue.

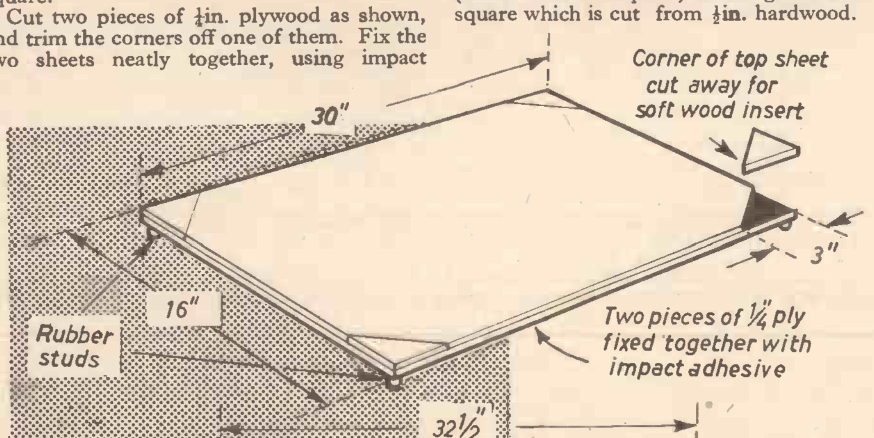
The next article in this series will deal with home-made time delay switches.

SKETCH BOARD AND SQUARE

WHERE many of the designs in PRACTICAL MECHANICS are concerned it is necessary to draw out various parts full-size from scale or hatched sketches. Or you may wish to modify a design in some way to suit your own particular requirements. To do this properly you need a sketch board and T-square.

Cut two pieces of ¼in. plywood as shown, and trim the corners off one of them. Fix the two sheets neatly together, using impact adhesive, then fill in the corners with ¼in. thick softwood and trim flush. The corners facilitate the fixing and removal of drawing pins. Fix four rubber studs as shown.

Cut the blade of the square which tapers from 3in. to 1½in. and bevel one edge with a small plane. Screw and peg this at 90 deg. (check with set-square) to the guide of the square which is cut from ½in. hardwood.



Details and dimensions of the sketch board and square.

PUZZLE CORNER

1.—Pythagoras Plus

IT is possible to improve on Pythagoras. Can you prove that the circle with the hypotenuse as diameter is equal to the sums of the circles with the other two sides as diameter?

2.—Strain Gauge

TWO teams in a tug-of-war are each capable of pulling at 700lb. on the rope. When both teams are exerting all their energy, is the strain on the rope one of 1,400lb? If not, what is the strain?

Answers

1.—Let sides be related by $C^2 = a^2 + b^2$. Multiply through by $\pi/4$. This gives $(\pi/4)c^2 = (\pi/4)a^2 + (\pi/4)b^2$ the required result

2.—The strain can never exceed 700lb. It is the resistance of one team which enables the other to exert its pull

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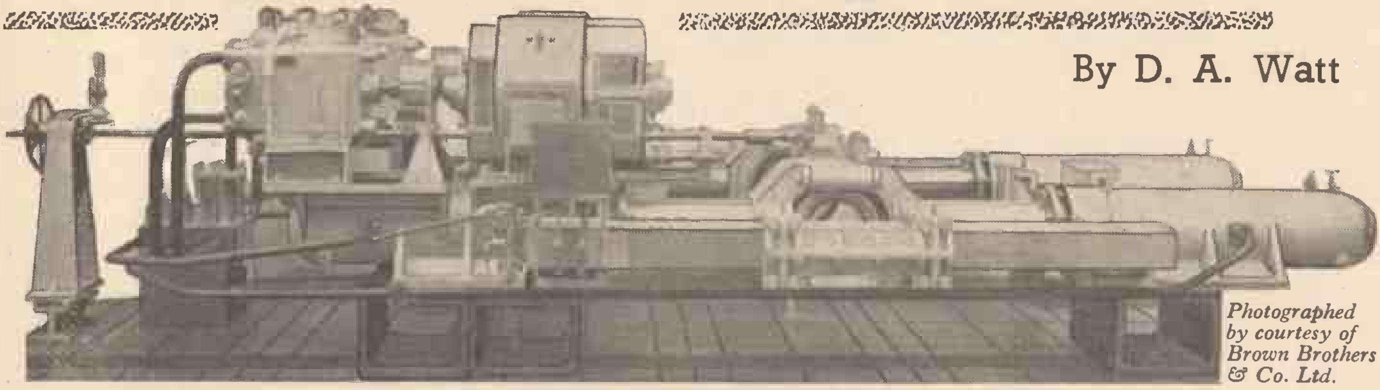
Ship's Steering Gear

By D. A. Watt



Photographed by courtesy of Brown Brothers & Co. Ltd.

A Detailed Description of the Most Important Part of a Ship

NEARLY one hundred years ago the early steamships had reached a stage of development where over fifty men were needed to hold a large steamer on course in a rough sea.

It was obvious that some form of power operated steering device was required and as steam was the only power source available the development of a steam driven steering gear naturally followed. The first of this type was designed by J. Macfarlane Gray and fitted to the famous *Great Eastern* in 1866.

From that date onwards many successful types have been developed, leading up to the evolution of the electro-hydraulic and purely electric types of today. These have almost eliminated the use of steam operated gear in new ships.

Steering Gear's Job.

When a ship is in the open sea the steering gear is required to keep the ship on a certain course. Because of currents, caused by the wind and the shape of the ocean bed, and the effect of the wind on the ship's superstructure, continual slight rudder movements are necessary to maintain the set course. These adjustments are made by means of the steering gear following the directions of the helmsman.

If a large ship, steaming at its normal speed has to make an emergency stop, the ship would travel maybe half a mile or more before stopping completely. In an emergency then the steering gear will be required to put the rudder hard over as quickly as possible to avoid a collision. In a really severe storm, too, a ship must be kept heading into the wind and the quick response of the rudder to the helm is very important. The steering gear must be capable of moving the rudder at the direction of the helmsman accurately, rapidly and absolutely reliably.

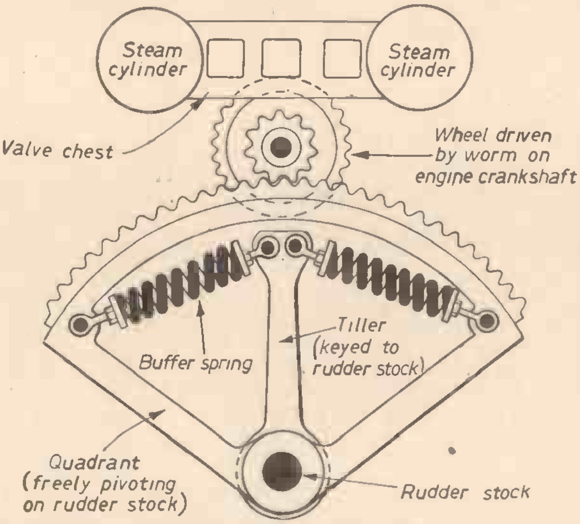


Fig. 2.—*Steam steering gear.*

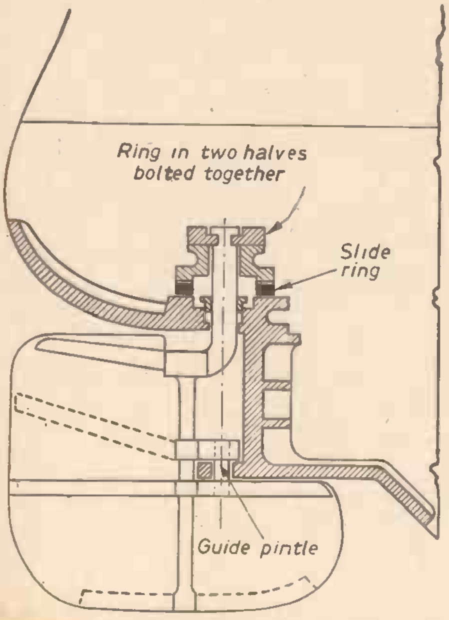


Fig. 1.—*A balanced rudder.*

All power operated steering gears can be separated into three distinct items; the rudder and rudderhead gear, the power unit and the control gear.

Regardless of the type of gear used, the size and the power required will depend on the torque exerted by the rudder, the speed with which it is moved and the maximum angle the rudder is turned through. In most large ships a balanced type rudder (Fig. 1) is used to reduce the torque exerted by the rudder. The maximum time required to move the rudder from " hard-over port " to " hardover starboard " is, by law, not to exceed 30 seconds when the vessel is travelling at full speed. From the point of view of manoeuvrability a rudder angle of 45 deg. is the optimum, but this is only necessary for harbour craft such as tugs; for ocean going ships an angle of 35 deg. is sufficient.

The early steering gears, situated amidships at the top of the engine-room and controlled from the bridge by shafting, operated the rudder by means of rods and links running along the deck to the rudderhead. This arrangement was never very satisfactory as the rods and links were exposed to the weather and were continually stretching and breaking. A big improvement came when an hydraulic means of controlling the engine called the " telemotor system " was patented in 1888. This made it possible to put the engine aft at the rudderhead and do away with the troublesome rods and links.

The steering gear of a modern ocean going ship will be one of three types: steam operated, electro-hydraulic or all electric.

Steam Steering Gear

Fig. 2 is a simplified drawing of a typical steam steering gear. The engine is a two-cylinder, double-acting steam engine with its cranks at 90 deg. so that no matter in what position the engine stops one piston will always

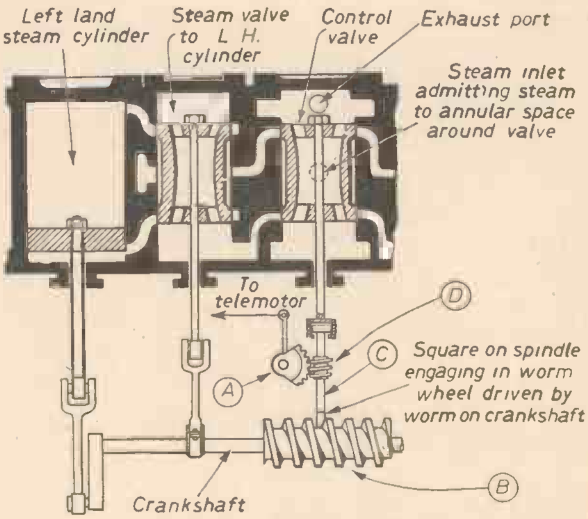


Fig. 3.—*Valve gear of steam steering gear.*

be in a position to start immediately steam is admitted to the cylinder. This engine drives a worm shaft engaging with a worm wheel which in turn drives a pinion engaging in teeth milled on a quadrant. The quadrant pivots freely on an extension of the rudder stock (or shaft) and moves the tiller through buffer springs. These springs act as shock absorbers to protect the gear from damage due to waves hitting the rudder. The weight of the quadrant is taken by rollers.

The valve gear and the hunting gear of this type of engine are interesting and are shown in Fig. 3. Movement of the wheel by the helmsman is transmitted by the telemotor and causes the quadrant (A) partially to rotate in either direction depending on which way the rudder is to turn. This moves the control valve and allows steam to enter the appropriate cylinder. The engine starts to rotate and moves the tiller in the direction required but at the same time the spindle (C) is rotated through the worm wheel (B) and causes the worm (D) to move along the quadrant (A) returning the control valve to its original position. When this position is reached steam is cut off from the cylinder and the engine stops. The rudder position will now correspond to that required by the position of the wheel on the bridge.

Although this type of steering gear is reliable and robust it is very inefficient by nature of its design (steam is admitted to the cylinder throughout the whole stroke) and has rapidly given way to the electro-hydraulic gear during recent years.

Electro-Hydraulic System

The electro-hydraulic steering gear is very different from the steam driven gear just described. The tiller is moved by hydraulically operated rams through sliding crossheads, the oil to operate these rams being supplied by a variable delivery pump driven by an electric motor. This pump is the most interesting part of the gear and we need to know its principle of operation as used for this purpose if we are to understand how this type of steering gear works.

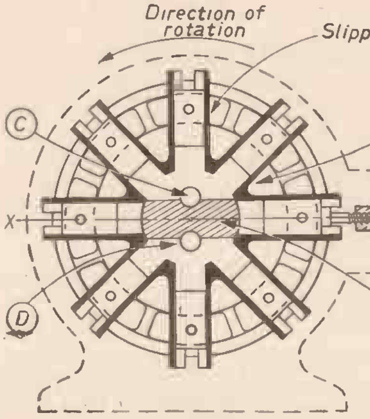


Fig. 4.—Variable delivery pump.

The sketch Fig. 4 shows a section through the pump. It consists of a cylinder body (A) containing a number of radial cylinders, which is coupled to and driven by an electric motor. (B) is a fixed central " valve " on which the cylinder revolves and contains a suction port (C) and delivery port (D) connected to the outside passages. The whole pump casing and piping system connected to the ports is full of oil.

Each of the radial cylinders contains a piston extending beyond the cylinder and fitted with gudgeon pins. The gudgeon pins fit into slippers which slide in an annular groove causing the gudgeon pin centres to travel in a circular path.

While the annular groove is concentric with the cylinder block there is no movement of the oil. If the groove is displaced to the left the pistons above the line X-Y recede from (B) and suck oil through the port (C) while the pistons below X-Y approach (B) and discharge oil through the port (D). Movement to the right causes the oil to flow in the opposite direction.

It is obvious that the distance the pistons move along their cylinders depends upon the displacement from the concentric position of the groove, and determines the quantity of oil delivered. This allows the delivery of the pump to be varied over a wide range simply by moving the ring containing the groove. This ring is constructed as a floating ring running on bearings, and is positioned by a rod which passes through the casing of the pump.

The ports (C) and (D) on the pump are connected by pipes to the hydraulic rams which move in cylinders and transmit their thrust to the tiller.

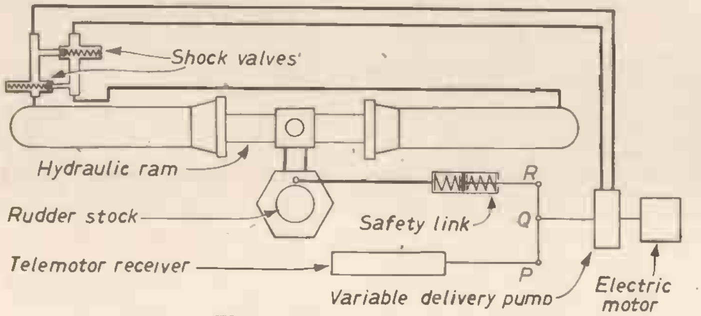


Fig. 5.—Electro-hydraulic steering gear.

Fig. 5 shows the layout of a typical steering gear of this type. The floating lever (PQR) is connected at (P) to the telemotor, at (Q) to the pump output control rod and at (R) through links to the tiller. By studying the sketch it will be seen that movement of the telemotor causes the lever to pivot about (R) moving (Q) from its normal position resulting in the pumping of oil from one ram to the other. This will cause movement of the rams and tiller which in turn will cause (R) to pivot about (P) until (Q) is again in the neutral position and oil flow and tiller movement will cease. The rudder will now be in the position required by the wheel on the bridge.

The speed at which the rudder moves depends entirely on the output of the pump and is not affected by the speed with which the helmsman moves the wheel. One pump is designed to be able to move the rudder from " hardover port " to " hardover starboard " in 30 seconds as required by law. It is usual with this type of gear to have a duplicate pump and motor as stand-by and using the two pumps the speed of rudder movement is increased and is a useful asset when navigating in narrow waters.

With the exception of the electric motor all the moving parts of this gear are working in oil and consequently the rate of wear is extremely small and little maintenance is required. The gear can be made robust and, as it is very efficient from the point of view of power consumption, it is becoming increasingly popular as the choice for new ships.

Telemotor Control System

The telemotor control system is used with these two types of steering gear and is simply an hydraulic means of transforming movement of the wheel on the bridge into movement of the control on the steering engine to put the rudder into the position required by the helmsman.

(*Concluded on page* 317)

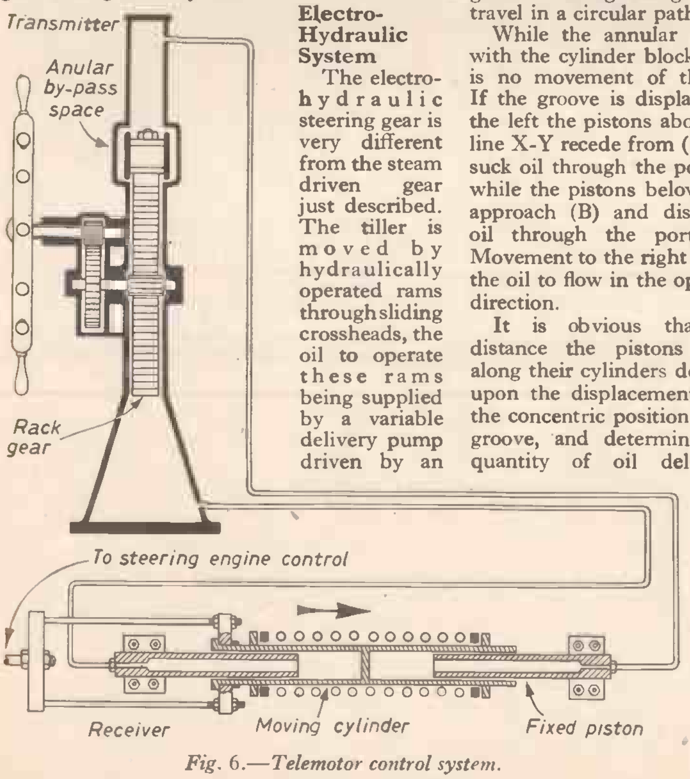


Fig. 6.—Telemotor control system.

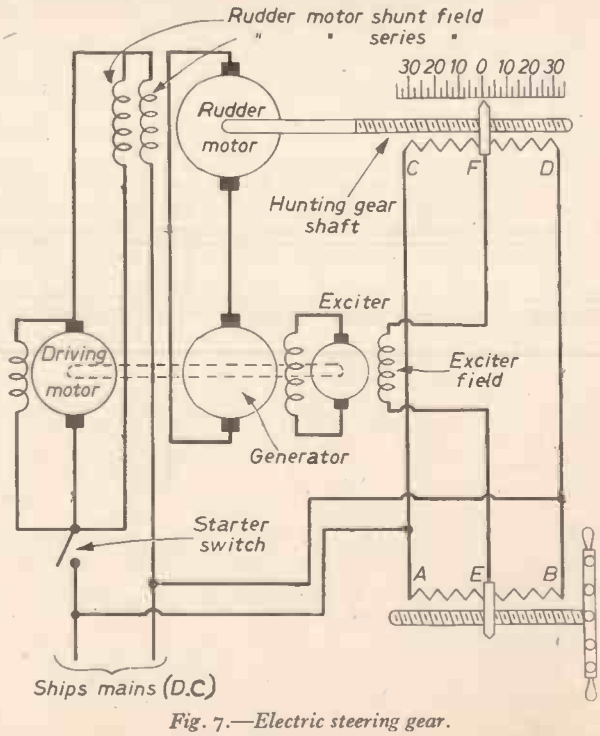


Fig. 7.—Electric steering gear.

Building the 'Luton Minor'

Part 8 Deals Mainly with Engine and Instruments

The Instrument Panel

THIS is made either from 14 s.w.g. aluminium sheet, flanged top and bottom, or from ¼in. thick plywood with long grain. The normal instruments are, in order of precedence, the airspeed indicator (A.S.I.), altimeter, engine speed indicator (tachometer or E.S.I.), oil pressure and oil temperature gauge. A most useful addition to this basic panel is a turn and slip indicator.

Two other vital items are the engine ignition switches and the compass. The former should be of the approved aircraft pattern or the Phoenix Key-Switch. The large P.8 or P.11 bowl compass is bulky and difficult to install in a convenient place in the Minor. Ideally, a dash-board mounted compass should be used, or the miniature E.2A type.

The cut-outs in the panel for the instruments will be varied to suit the instruments which the constructor intends to fit. Use only serviceable instruments and position them on the panel, as shown on the plan. All instruments are available from Phoenix Aircraft Ltd.

The panel is attached to the fuselage sides and also at the centre to the overtank cowling using special rubber mountings. The panel should be fitted, only the two side attachments being used at present.

The Firewall

Paint the top decking from the instrument panel location

Fig. 56.—The Aeronca J.A.P. engine fitted to an amateur-built Luton Minor.

KEY to Fig. 57

1 Airspeed Indicator pipelines (⅛in. o.d alum.) taped to pylon side struts, both then passing into the starboard wing.
2 Tachometer (engine speed indicator).
3 Oil pressure gauge, 0 to 100 p.s.i.
4 Oil temperature gauge, 0 to 50 deg. C.
5 Turn & bank indicator (vacuum-operated from venturi mounted on starboard side of fuselage and connected to it with rubber hose).
6 Altimeter (sensitive).
7 Airspeed Indicator, 20-100 knots, 20-120 m.p.h.
8 Ignition switches (twin).
9 Port magneto earth cap lead.
10 Starboard magneto earth cap lead.
11 Double earth lead, united at front.
12 Aluminium clip.
13 Short lengths of reinforced rubber hose wired on.
14 The Altimeter connection is left open
15 Attachment of fuel feed pipe to petrol tank.
16 Aluminium clip.
17 Fibre split grommet fixed with 4 B.A. screws.
18 Oil temperature thermometer bulb connection.
19 Ball joint and socket.
20 Throttle layshaft assembly.
21 Throttle connecting rod.
22 Throttle hand lever.
23 Horizontal coil in fuel pipe.
24 Petrol inlet to Fuel Filter.
25 Fuel Filter.
26 Flexible fuel hose to carburetter with "banjo" connection
27 Tachometer drive connection to engine.
28 Oil Pressure pipeline connection to engine.
29 Dress the firewall over engine mounting fittings.
30 Oil Temperature capillary tubing.

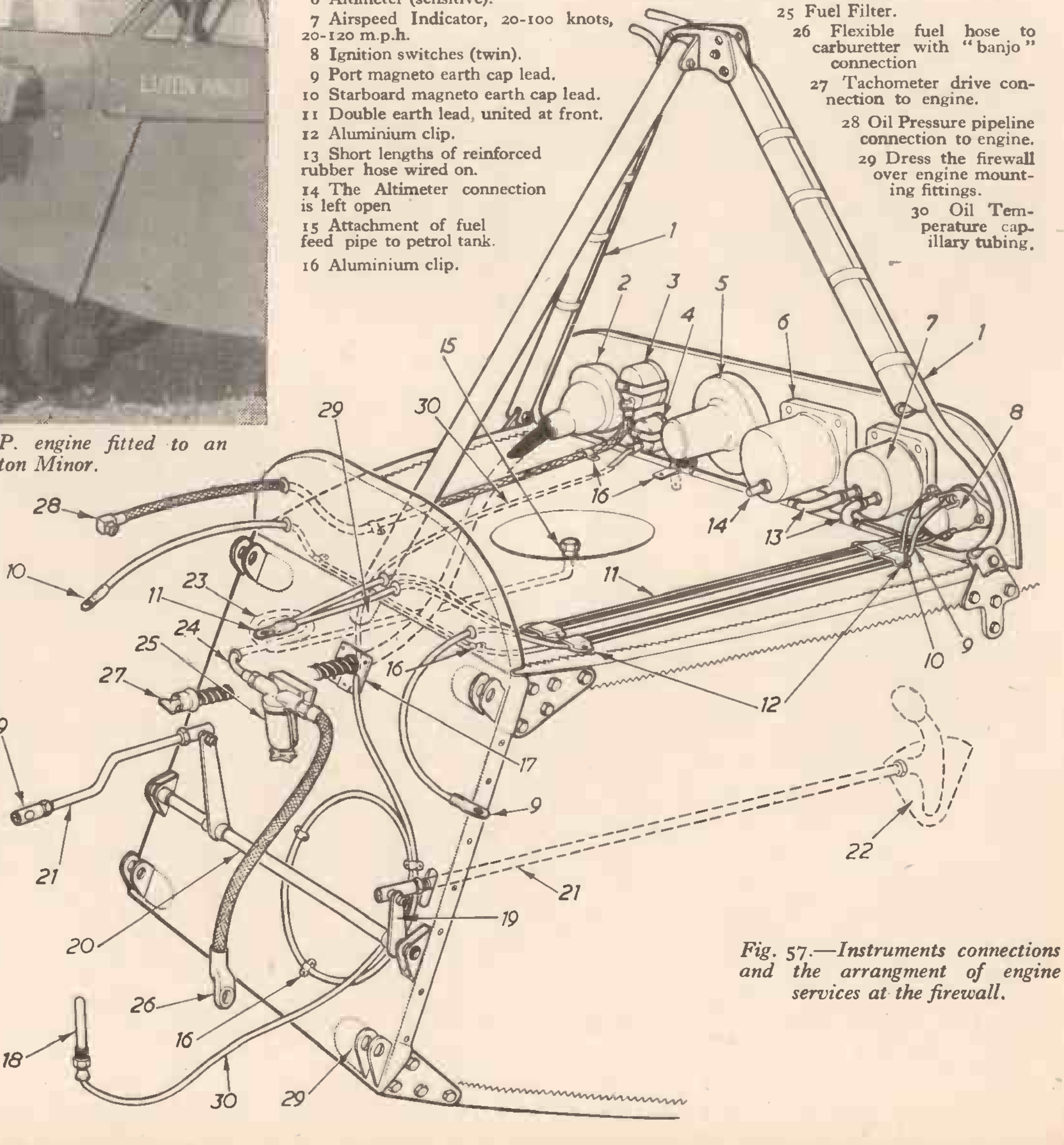


Fig. 57.—Instruments connections and the arrangment of engine services at the firewall.

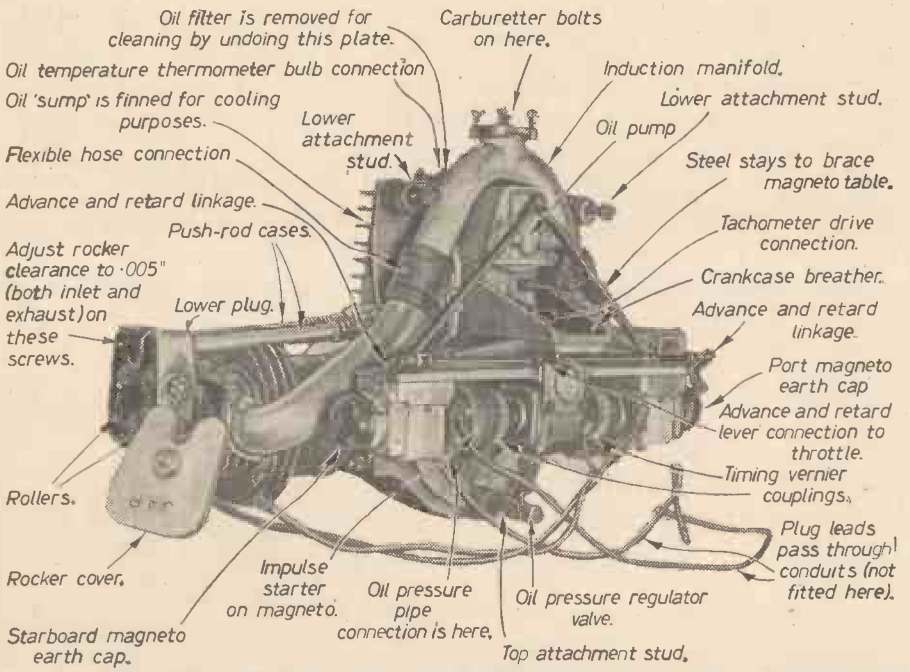


Fig. 58.—Some of the engine details shown to facilitate installation; the engine is upside down and viewed from the rear.

forward using a good petrol-resistant enamel. Paint also the engine bulkhead. Pay particular attention to the corners (which should be fabric-taped) where oil seepage and contamination mostly occurs.

Make the firewall using 22 s.w.g. mild steel sheet, flanging it as shown on the plan. This firewall should be plated or painted to resist corrosion. An alternative material for the firewall is stainless steel sheet or a laminate of two pieces of 18 s.w.g. duralumin with asbestos cloth between.

Screw the firewall to the bulkhead with $\frac{3}{8}$in. r.h. brass woodscrews along the top cross-member and through the flanges to the side and bottom members. Dress the metal to fit over and round the engine mounting fittings.

A Tiger Moth-type fuel filter is bolted on and holes bored for the petrol feed pipe, the oil pressure pipe, the tachometer drive and the ignition switch leads. These last-mentioned holes are drilled to take rubber grommets. Cut the slot for the throttle rod. Make and fit the throttle torque shaft and levers assembly which bolts through the firewall and bulkhead side members with 2 BA bolts.

The throttle hand lever is now made. This is bolted to the port side of the cockpit and connected to the shorter of the two levers on the torque shaft with a $\frac{3}{8}$in. × 20 s.w.g. mild steel tie-tube in such a manner that, with the throttle hand lever back in the farthest aft position, the short torque shaft lever is vertical.

The Engine Mounting

The engine mounting must not be fabricated except by a fully qualified and approved welder. The constructor should seek the advice of his nearest licensed aircraft engineeer or Phoenix Aircraft Ltd.

The special rubber mountings should be pressed into their housings before fitting it to the fuselage. In doing this, press on the outer tube of the rubber mounting, not on the inner one as this will tend to shear away the rubber bond between the two tubes.

The mounting is fitted to its attachment brackets on the fuselage using four $\frac{5}{16}$in. dia. mild steel bolts, plain washers, castle nuts and split pins. Note that the holes in the fuselage fittings and the engine mounting legs should be reamed out to size on assembly. Use a corrosion-inhibiting sealing compound on assembly.

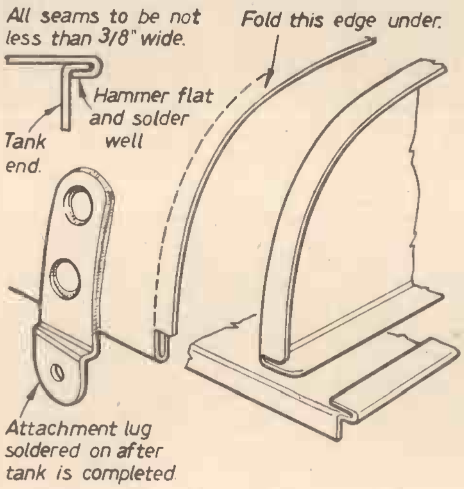


Fig. 59.—Details of the petrol tank construction.

The Engine

The Aeronca J.99 J.A.P. engine is a twin-cylinder, horizontally-opposed air-cooled unit and is normally supplied with the carburetter and exhaust pipe removed, wooden blanking plates being fitted over the openings on the engine. Plug blanks are fitted in place of sparking plugs and no oil is in the engine. The motor may be stood on sacks or a mat on the ground upside down if the oil filler cap is first removed. Do not attempt to lift the motor by the push-rod cases, magneto table or induction pipes. The correct way to lift it is by holding it under the cylinder heads and by the propeller hub. Two people can quite easily lift the engine. As it will have to be turned the right way up for attachment, allow ample room to turn round with the engine in the work-shop.

Fitting the Engine

First of all place a weight on the tailplane as, without the wings on, the aircraft may tend to be nose heavy with the engine in place.

Remove the three engine stud nuts and washers and place them on the top decking where they can easily be reached.

With the aid of an assistant, offer the engine up to its mounting and carefully insert the engine studs evenly in the three mounting bushes. It may be necessary to employ a third person to prevent the aircraft moving backwards as the engine is pushed into place. Without releasing the weight of the engine, place the washers on the studs and start the nuts. These can then be tightened up, the bolts drilled and $\frac{3}{32}$in. dia. split pins put in.

Wiring the Switches

The ignition switches are now wired up using 5mm. rubber-covered multi-strand ignition cable. This is the only type of wire which should be used and it is obtainable from any large garage or direct from Phoenix Aircraft Limited.

The two lower connections on the switches are for the two earth leads. These run side by side from the switch, along the top decking and through the two rubber grommets off-centre in the firewall. They are connected to a convenient part of the engine—the lower rear bolt of the magneto drive gear housing is ideal. Allowing a reasonable amount of slack (2in. is ample), join both cables together and insert them in a single ignition eye terminal, soldering the wires at the end. This then passes under the selected earthing bolt and its lock washer. The two top switch connections are attached to the earth-caps on their respective magnetos—the left hand top lead to the left hand magneto and the right lead to the right magneto. The connections at the magneto must again be soldered eye terminals.

The wires should be secured to the top decking with small aluminium clips. Ideally, the wires should be inserted through lengths of Systoflex sheath, obtainable from electrical stores and garages, and then clipped into place.

The Engine Instruments

The oil pressure pipeline is next fitted. This must be a flexible hose as, if it is made of rigid copper, vibration will soon fatigue it and a pressure oil loss is serious. The hose may be either a suitable motor part or of the Superflexit aircraft pattern. Make sure, when buying, that the end connections will fit the engine and the pressure gauge. Do not make up non-standard adaptors of any sort as they are a source of weakness and will not pass the inspector who is soon to check over the aircraft. Clamp this oil pipe to the top decking in such a manner so as not to strain it at either end.

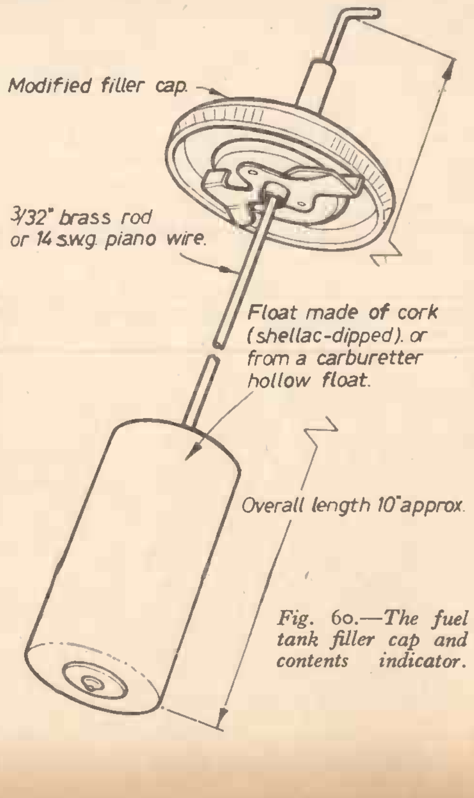


Fig. 60.—The fuel tank filler cap and contents indicator.

If an oil temperature gauge is fitted, the thermometer bulb is screwed into the base of the engine sump by removing the blanking plug provided. The instrument is supplied as a unit comprising panel dial, a length of sealed fine copper capillary tube and the bulb. On no account attempt to cut or shorten the capillary tube. If breakage occurs, or the capillary is crushed, it is impossible to repair and the instrument must be discarded completely.

Fit the instrument to the instrument panel and pass the capillary tube and bulb through a hole in the top decking. Clip the capillary to the underside of the deck and pass the tube out through the hole for the tachometer drive cable (the hole will need slightly re-shaping to allow this tube and the tachometer drive to pass through). Form an 8in. dia. coil of the surplus tube and clip this to the firewall with three aluminium clips fixed with 4 BA screws passing right through the bulkhead. Allow generous radii for all bends.

Note that the highest oil temperature which will be reached will be in the region of 30 deg. C., so select a gauge which has this range represented by a reasonable segment of the dial.

The tachometer drive cable is now threaded through the hole in the firewall. Connect it to the engine, carefully feeling to make sure that the male end of the cable fits into the drive slot in the back of the engine before doing up the nut.

The other end of the drive passes through a slot in the top decking, in front of, and in line with the back of the tachometer.

With this end of the drive connected to the instrument, support the slack drive and outer sheath under the decking with an aluminium clip. *Avoid sharp bends in the drive and sheath as these quickly lead to breakage.*

The installation of the pipelines, the wiring and other details are shown in Fig. 57.

Fitting the Carburetter

Unpack the carburetter and, having removed the wooden blanking plate on the induction manifold, bolt it on. There is little clearance for the nuts and they must all be started at the same time and tightened up gradually and evenly. The carburetter securing nuts are wire-locked with 22 s.w.g. soft iron locking wire. Connect up the magneto advance-and-retard linkage.

With the carburetter throttle closed and the pilot's throttle lever in the closed position (fully aft), take a length of $\frac{3}{16}$ in. dia. mild steel rod and cut and bend it to pass between the carburetter lever and the long lever on the bulkhead throttle torque-shaft. Thread the ends of the rod and screw on a 2 BA plain nut and a ball-joint housing. The plain nut is to lock the ball-joint in the correct position. Fit the rod in place and open the throttle fully with the cockpit lever. The throttle should now be fully open against the stop on the carburetter. If this is not so, adjust the length of the tie-rod to suit.

Take another piece of $\frac{3}{16}$in. dia. rod about 4in. or 5in. in length and thread one end to take a plain nut and $\frac{3}{16}$in. fork end and connect this to the choke control lever mounted by the throttle on the carburetter. This will project through the cowlings.

Connect the petrol feed pipe from the petrol filter to the carburetter. All pipeline nuts must be wire-locked against undoing, using soft iron wire. Check also that there are no loose or unlocked nuts on the engine

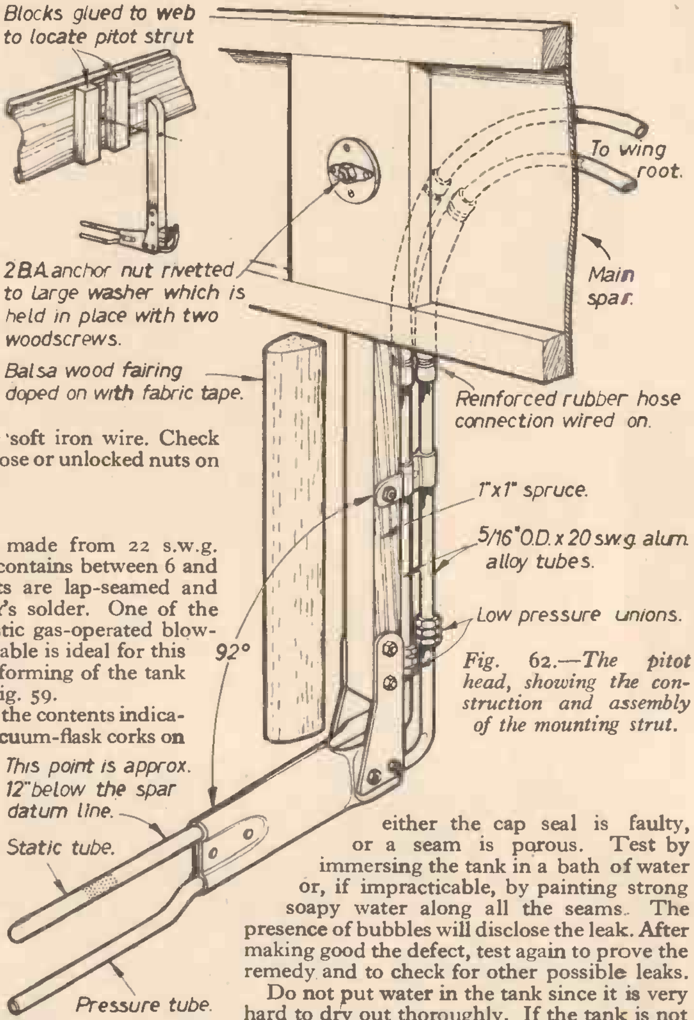


Fig. 62.—The pitot head, showing the construction and assembly of the mounting strut.

The Petrol Tank

The petrol tank is made from 22 s.w.g. tinned steel sheet and contains between 6 and $6\frac{1}{2}$ gallons. The joints are lap-seamed and soldered using tinman's solder. One of the several types of domestic gas-operated blow-torches which are available is ideal for this job. The steps in the forming of the tank flanges are shown in Fig. 59.

To make the float for the contents indicator, thread two large vacuum-flask corks on a piece of piano-wire and solder a washer above and below. Shape the completed float with sandpaper, then with three or four coats of shellac. Shellac is available in flake form from chemists and should be pounded into small pieces and dissolved in methylated spirit to form a running syrup. An alternative float can be made from a carburetter float of the right diameter to pass through the filler neck. This is soldered to the wire in place of the cork-retaining washers.

The actual filler-cap is of the ordinary motor-car type with a "half-turn" spring lock against two projections from the inside of the filler neck. It is usually possible to purchase the filler-cap complete with neck for riveting to the tank top. However, the plans illustrate how to make a filler neck if a ready-made one is not available.

Drill a hole in the cap and braze in a length of copper tube to act as a guide for the contents indicator wire to pass through. Now thread the indicator rod through this tube from underneath and, holding the wire at the top, lower the float into the tank and screw on the filler cap. Hold the rod immediately above the guide tube with pliers and bend at this point through 90 deg. The completed filler-cap and contents indicator is shown in Fig. 60.

The sump and water-trap is made and riveted and soldered to the tank bottom.

Support the tank on the top decking of the fuselage with packing under the sides. Make up the attachment brackets and see that they are the correct shape and angle before removing and soldering them to the tank.

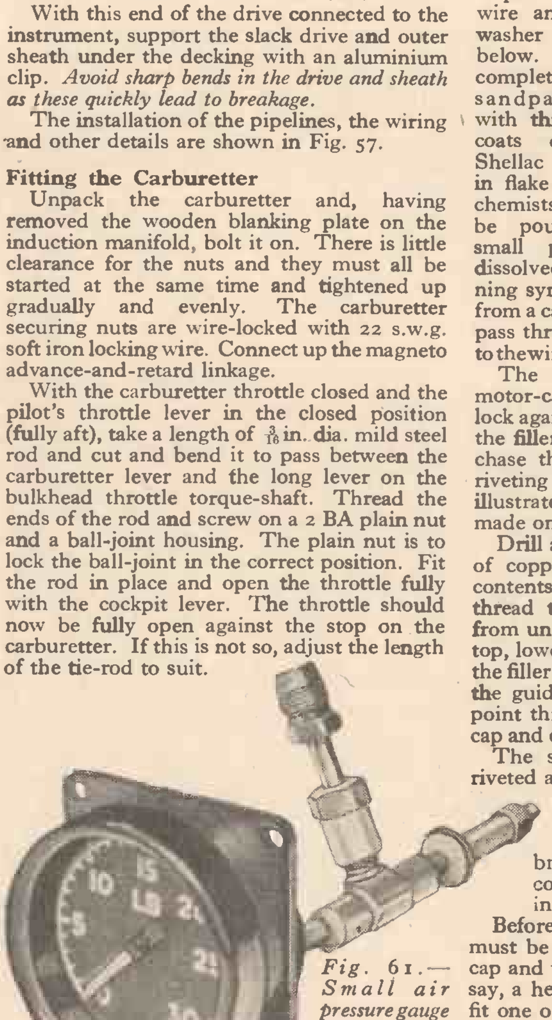


Fig. 61.—Small air pressure gauge and bicycle Schrader valve for use in pressure-testing the tank for leaks.

Before fitting the tank to the fuselage, it must be tested for leaks. Remove the filler-cap and wire on a thick rubber seal cut from, say, a heavy inner-tube. Make an adaptor to fit one of the sump plugs to take a small air pressure gauge and a bicycle Schrader valve (Fig. 61). Use a bicycle pump and pressurise the tank until not more than 3 p.s.i. is shown on the pressure gauge. The tank should hold this pressure for fifteen minutes without dropping. If a rapid drop is observed, then either the cap seal is faulty, or a seam is porous. Test by immersing the tank in a bath of water or, if impracticable, by painting strong soapy water along all the seams. The presence of bubbles will disclose the leak. After making good the defect, test again to prove the remedy and to check for other possible leaks.

Do not put water in the tank since it is very hard to dry out thoroughly. If the tank is not to be installed for a time, put about half a pint of thin oil into it and swill it around to prevent possible corrosion.

Paint the outside with primer in readiness for installing in the fuselage. Avoid straining the attachment brackets when fitting it and see that the tank is not touching any of the wires or pipes on the top decking. Wrap the top of the tank with $\frac{1}{4}$in. thick felt.

The copper fuel feed pipe from the tank to the filter should be made next. Since the fuel system is gravity-operated, avoid upward bends in this pipe which could cause air-locks. To absorb and damp out vibration in the pipe, a single coil should be provided between tank and bulkhead. The coil is arranged horizontally and in a *descending* line from the tank to the bulkhead. Make it of sufficient diameter to avoid crushing or flattening the tube.

A rubber grommet protects the pipe from chafing where it passes through the firewall.

The Pitot Head

This is an item which the constructor will have to buy or obtain from his nearest aerodrome engineer. It consists of two small pipes, one of which registers ram air pressure at the open end. The other pipe is closed at the forward end but has a number of perforations around it which are open to the ambient, static air pressure. The difference between the two pressures thus recorded is the pressure resulting from the forward motion of the aircraft and is a measure of airspeed.

Mounted below the leading edge of the starboard wing (Fig. 62), the pitot head is connected through aluminium tubing, joined with special low-pressure unions or reinforced rubber tubing, to the airspeed indicator on the instrument panel.

(To be continued)

Introducing the Mecha

This fast, robust and extra safe kart has been specially designed for
Build it with our experts and join the latest craze

By Ar

KART racing is exciting to watch, as almost everyone who has seen it on television will know, but it cannot compare with the thrill of actually competing. All the excitement of big time motor racing is now within reach of the ordinary man. Kart speeds of 40 m.p.h. do not sound much, but when you are folded into a bucket seat only inches from ground, with a two-stroke engine "machine gunning" just behind your head and you are faced first hand with the problems of getting round sharp bends in a narrow track in close proximity with other karts, there are thrills-a-plenty.

Before describing in detail the "MechaniKart," it is as well to study very briefly the rules and specifications covering Karting in the British Isles.

Karting, as we know it, started in America just over two years ago and the Go Kart Club of America was formed to draw up specifications and requirements for karts. The Go Kart Club of America specification has been the basis of all subsequent specifications prepared by other countries and is therefore the basis of the Royal Automobile Club requirements to which this kart conforms.

The kart detailed in these pages conforms to Class I and Class II requirements and is intended to be fitted with an industrial engine with direct drive transmission. Gear boxes are not permitted, although it is permissible to vary the gear ratio to suit various events whilst the kart is stationary.

It is also stated that no kart shall be fitted with wheels greater than 12½in. in diameter. This is an important point as if, during a race, two karts should collide and one override the other, there is little danger of overturning. There is nothing to prevent the constructor using wheels of smaller diameter, but it must be remembered that wheels less than 9in. in diameter are less efficient and suitable tyres are not available.

The following is an extract from the R.A.C. specifications:

"No detailed specification as to design of the frame is laid down but, whatever the construction, the vehicle must satisfy the Scrutineer of the Meeting that it is sound. Further, the Stewards of the Meeting must be satisfied that the machine's performance on the course presents no hazard to the competitor or anyone else concerned.

Home Constructors, unless trained engineers themselves, are strongly recommended to seek professional advice to avoid possible future disappointment and added expense in the event of their vehicles being excluded as unfit to take part in a competition."

Bearing this in mind, the constructor is advised to adhere to the plans and details contained in these articles and not to deviate from them without good reason and having first considered why a part was originally designed in the stated manner.

General

The "MechaniKart" employs a channel-steel chassis. This is the result of prolonged research by H. A. Wills Limited of Newport, Isle of Wight, and experience with both channel steel and tubular steel frames.

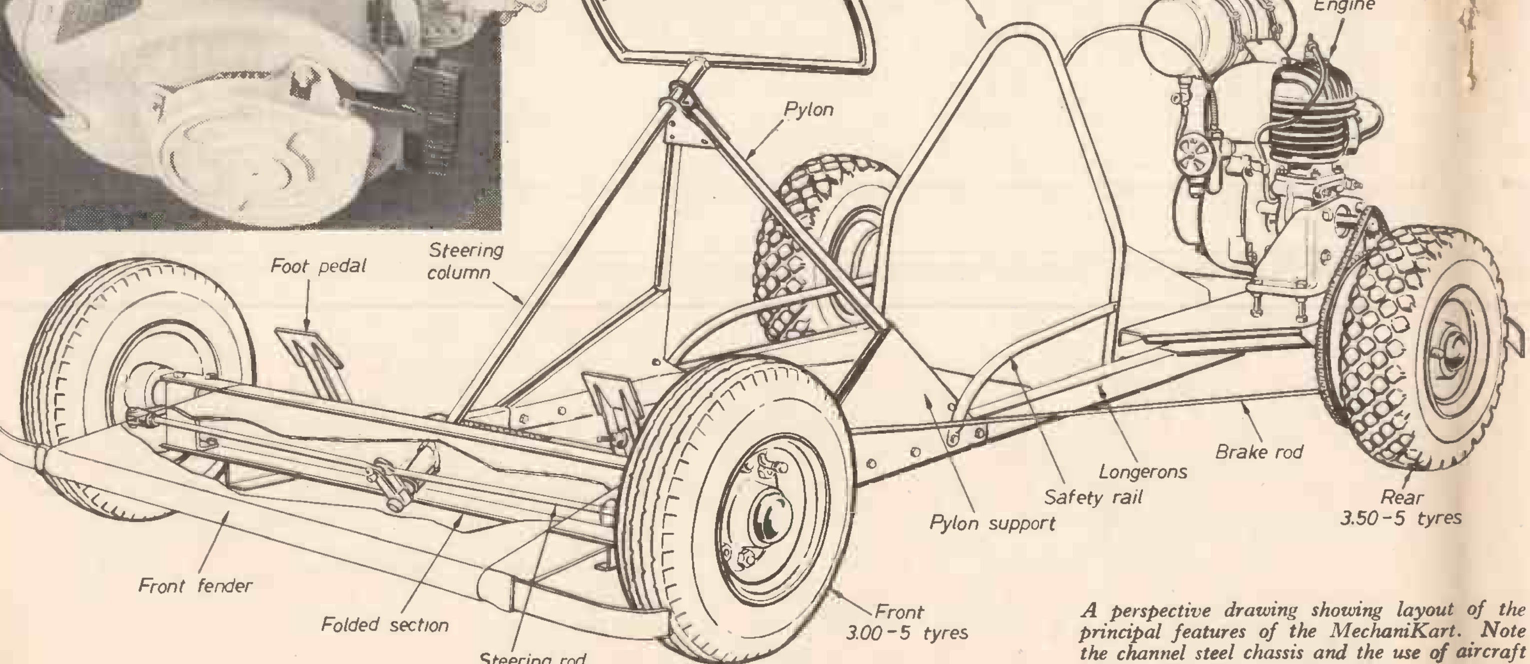
Whilst a tube is very light and can take very large compression loads, once it is kinked or bent, its strength falls appreciably. Since a kart is subjected to all manner of rough treatment, it is useless to have a machine which is not going to stand up to the punishment.

The MechaniKart is not merely strong in theory. Its strength has been proved. Several karts with this type of chassis have been deliberately crashed in an endeavour to distort or damage the frame—*without ill effect*.

To produce a strong kart in tube would be costly as heavy gauge tube would be required, which is both difficult to work and to weld. Again, not everyone has access to welding plant or has the ability to produce a first-class weld.

One of the advantages of the channel steel construction is that the chassis is slightly flexible in plane. This means that it is

(*Left*) *The 95 c.c. American Clinton A.490 engine which costs £21 4s. and is available from Trojan Ltd., Trojan Works, Purley Way, Croydon, Surrey.*



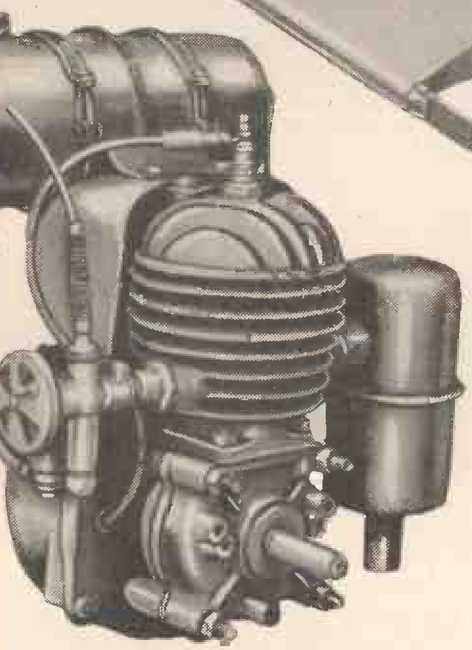
A perspective drawing showing layout of the principal features of the MechaniKart. Note the channel steel chassis and the use of aircraft type stiff-nuts and bolts.

niKart

PRACTICAL MECHANICS

thur W. J. G. Ord-Hume

A photograph of a completed kart from which some idea can be gained of the comfortable driving position and ease with which all the controls can be reached.



A view of the J.A.P. model JS8 two-stroke engine. Details of this engine are obtainable from the Villiers Engineering Co., Ltd., Marston Road, Wolverhampton. The silencer is discarded and an elbow exhaust pipe fitted.

possible to lift one wheel more than 2in. whilst the other three still remain in firm contact with the ground. If the chassis were to be perfectly rigid in plane, any irregularities in the track would be transmitted to the kart and its driver and the inelasticity of the structure would set up stresses which could lead to the failure of a critical joint. Furthermore, on cornering, a severe twisting moment is set up, tending to lift the inside front wheel (which is the lightest). With a rigid chassis, as the front wheel tends to lift, the rear wheel must also become light, increasing the chances of skidding out on the one rear wheel which is taking the weight. This is not the case with channel steel construction which does allow a marked degree of flexibility without detracting from rigidity.

The MechaniKart is based on experience derived from this experimental work and of precision engineering, including aircraft work. Properly made, it is practically indestructible and impossible to turn over even when cornering sharply at full throttle.

Cost

If built according to these instructions, the MechaniKart may be constructed for as little as £25. The industrial J.A.P. S.80 engine is obtainable at about £16, or the American Clinton engine of 95 c.c. may be fitted if preferred. This engine costs £21 4s.

H. A. Wills Limited can supply all parts ready made including steering components, stub axles, wheels, drive parts, etc. Also available is a welded chassis which, although different in design, is interchangeable with the built-up chassis described in these articles.

Description

The chassis of the kart comprises two side rails of channel-section steel, joined at the front and rear by channel-section cross members. The foot-tray is made of mild steel sheet and serves also to brace the chassis at the front. Likewise, the seat and aft gussets are stressed mild steel parts.

The side rails of the kart are not parallel, but converge at the rear.

Welding has been kept to an absolute minimum, liberal use being made of bolts with aircraft-type stiff nuts.

The bolts used should be of the hexagon-headed type with a plain shank to provide the best bearing surface through the components.

The engine is mounted on a bolted table and the tension of the main driving chain is varied by screw adjustment which raises or lowers the whole engine. The motor drives the left-hand rear wheel.

Steering is of the positive drag-link type based on the Ackerman principle to give correct wheel alignment when cornering.

Handlebar control is used on the MechaniKart to provide the driver with better feel as the effective diameter of handlebars can be greater than that of a wheel without reducing knee room.

The seat is a mild-steel fabrication with detachable upholstery and squab.

Tracks

Suitable tracks are not too difficult to find. A smooth field, a tennis court or something similar will do at a pinch, but concrete and tarmacadam surfaces are better. Meetings are already being held on sections of established motor race tracks, on runways of disused airfields and in car parks. Bends are made artificially, using straw bales. Conditions regarding tracks are few. The following extracts from R.A.C. regulations regarding Kart race tracks will be of interest:

(a) A minimum width of 15ft.
(b) Start and finish areas—minimum width of 20ft. exclusive of any pit areas.
(c) Minimum radius of turns, measured to the inside of the track to be 15ft.
(d) All events will be run in a clockwise direction and passing shall normally be on the left.

A comprehensive track with a full range of bends can be compacted into an area measuring 100 yards by 75 yards.

The only other requirements are crash helmets of approved pattern and goggles or a visor, gloves and clothing adequate to minimise abrasions.

Anyone seriously considering building a kart and entering kart races is advised to obtain a copy of the R.A.C. regulations and study them carefully.

Here then is your chance to join in kart racing by building the MechaniKart. The first article on construction will start next month: make sure you don't miss it!

A PROJECTION SYSTEM for your Microscope

By R. B. Taylor

It Will Help You to Prepare Drawings of Microscope Objects

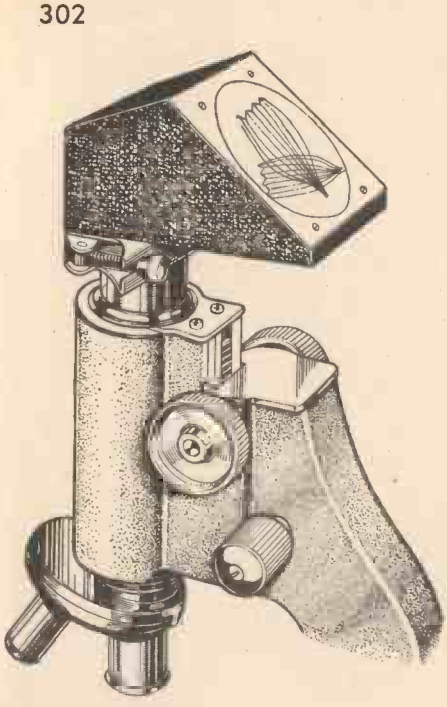


Fig. 1.—A projection head on a microscope.

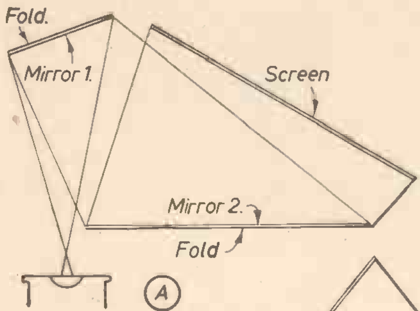
THE drawing and measuring of microscopic objects is difficult for the amateur. Photography is expensive and the cost of the average Camera Lucida is prohibitive.

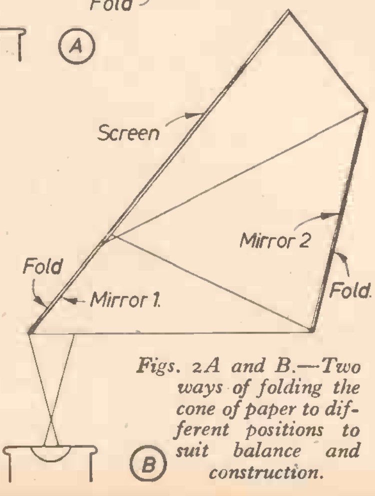
To overcome this difficulty and also to enable the direct comparison of objects to be made and measurements to be obtained easily a projection unit (Fig. 1) was designed which would fit lightly on the microscope draw-tube.

No measurements are given since these will vary according to the diameter of the draw-tube, and the size of image required.

The Cone of Rays

The first operation is to find the angle of the cone of rays leaving the eyepiece you wish to use and to decide upon the size of the screen. Remember, the larger the screen the less light per square inch will fall on it. This gives greater difficulty in drawing unless an intense light source is used.





Figs. 2A and B.—Two ways of folding the cone of paper to different positions to suit balance and construction.

Having laid out on a piece of paper the angle of the cone and screen diameter, cut out this triangle and fold it as shown in Fig. 2. Adjust until the angle of viewing is suitable and the mirror arrangement is as compact as possible to cut down any effects of leverage to a minimum. Fig. 2A shows the author's arrangement of angles which results in a compact unit giving a 3in. dia. image at 6in. from the eyepiece.

One mirror may of course be used but this results in an image erect in one plane and reversed in the other and is thus not desirable.

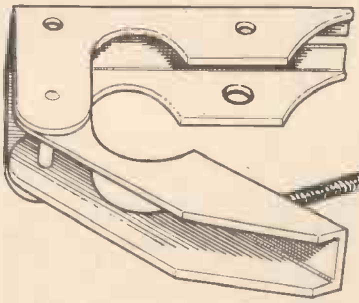


Fig. 3.—The type of clip most suitable for attachment to the draw tube.

Once the positions of the mirrors and screen have been decided upon the construction of the case and fitting of the mirrors may be completed. Both mirrors should be aluminised or surface silvered, but ordinary ones will do, though liable to produce secondary images.

The Screen

The screen is cut from clear glass or Perspex and is not frosted. It should be fixed firmly to the case.

The entire assembly must now be fitted with a rigid clip to fit round the outside of the drawtube. Here again, much depends on the design and dimensions of case and drawtube but that shown in Fig. 3 is to be recommended in principle.

Beneath the clear screen a ledge should be left projecting upwards as on an easel, the purpose of which is to hold the frosted screens which are used for drawing on.

As this unit is small, its main function will be to measure and accurately compare objects rather than to produce a notebook similarity. This is done by having squares of thin Perspex such as used for drawing instruments. These are frosted by rubbing with a piece of emery cloth and are then used as a screen to show the image and as a surface to draw on. Any number may be made but may be re-used if the drawing is traced or copied onto paper.

Micrometers

For accurate measurements a stage micrometer ruled to tenths or hundredths of a millimetre is essential. This should be placed on the stage and focused and the divisions marked carefully on a square screen. One such screen should be made for each lens combination (eyepiece and objective) and their designations noted together with the tube length as in Fig. 4. The smallest calibrations should represent 1/1,000mm. or 1 μ or micron as it is termed. Such a small scale will of course only be used for such objects as bacteria viewed with the highest powers.

Eyepiece micrometers could of course be used but would not be so versatile or easy to read as a printed scale.

A screen ruled in squares would also help in copying an object freehand on to paper and need not be of any exact value unless so required.

By having a clear screen instead of the usual frosted type, direct tracing may be carried out on thin or medium thickness paper, but this depends largely on the intensity of the available light and the methods of holding the paper in position.

Lighting Unit

If an intense source of light is available, such as an arc lamp, a small stand fitted with a larger screen and mirrors may be constructed to rest over the eyepiece but not fastened to it, the whole unit standing firmly on the table behind the microscope. Such a unit is shown in Fig. 5.

The method of laying out is essentially the same as before, using a paper triangle, the screen is clear glass, preferably plate glass for strength, and in place of the clip four legs are incorporated.

Points to watch are, to leave adequate clearance between the bottom of the unit and the microscope limb and also round the eyepiece, the exclusion of all unwanted light as far as possible and the general stability of the whole unit.

Here again, micrometers can be drawn on

(*Concluded on page 304*)

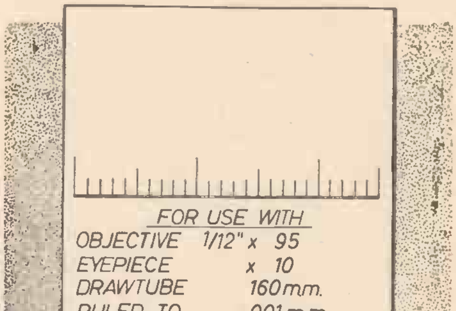


Fig. 4.—Method of ruling screen micrometers on squares.

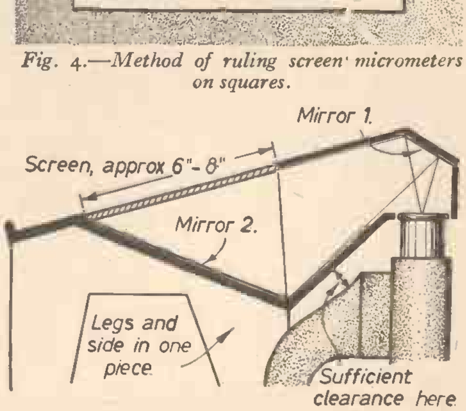
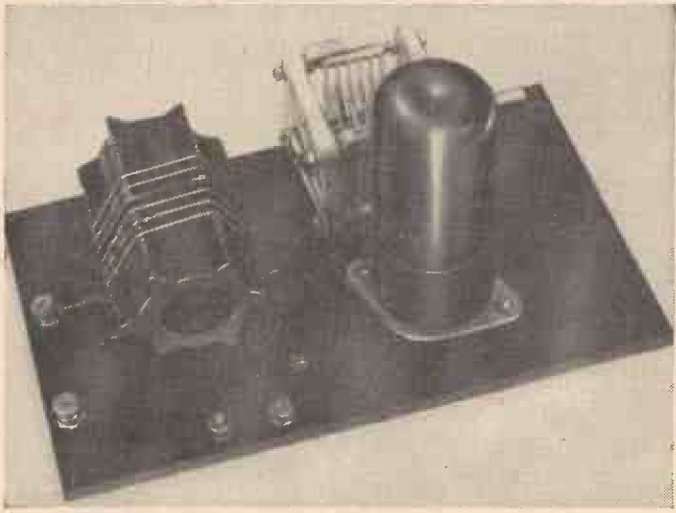


Fig. 5.—Side view of large projection unit for use with a strong light.

Build this

High Output Model Control TX



F. G. Rayer tells you how to go about it

WITH a 27 Mc/s model control transmitter a maximum effective radiated power of 1½ watts is permitted. This is the actual power radiated by the aerial, and most model control transmitters are able to produce only a small fraction of this maximum. For relatively short range working, and with a sensitive receiver, a transmitter giving a small output is sufficient. But quite often it is of advantage to use higher power. This will give greater range and more reliable working, with the same receiver. When the increased range is not wanted, the greater power enables the receiver to be simplified. For example, a diode with transistor amplifier may replace a valve receiver, reasonable range being possible with even a single transistor. Such receivers can be small and light, and no h.t. battery supply is needed, so that they can be carried in small models. They are also easier to adjust, and less critical as regards aerial, than super-regenerative valve receivers.

For these reasons an improvement in the efficiency or output of the transmitter is often justified. Sometimes quite small modifications will improve output to a worthwhile extent. A typical high power model control transmitter is shown in the heading photograph.

Battery Equipment

To obtain a good output at least two battery type valves will be needed, and a popular circuit is shown in Fig. 1. High gain power output tetrodes or pentodes are best. Surplus 3D6 tetrodes do well for 1·4v. or 2·8v. dry battery filament supply. Combined anode and S.G. current for one such valve should not exceed about 30mA, with the 3D6. Surplus 2v. power pentodes will also give excellent results, with a 2v. accumulator for filament.

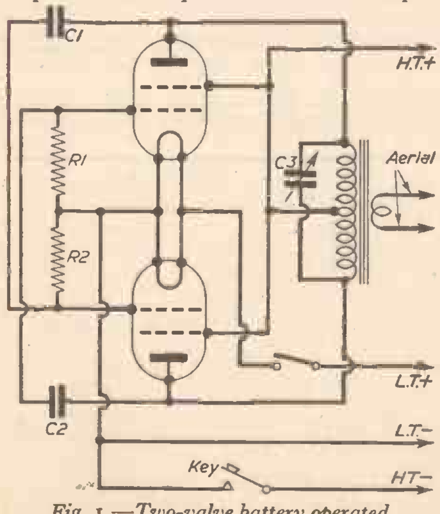


Fig. 1.—Two-valve battery operated transmitter.

With given valves, output can be increased by raising the h.t. voltage, but care is necessary not to exceed the maximum ratings, especially with smaller valves. H.t. current should thus be checked, with normal aerial connected. Batteries in series will provide a higher voltage, and batteries of average size will do because current is only taken while keying.

Bias is developed across R_1 and R_2 by grid rectification, and needs to be high, for push-pull operation. Reducing the values of R_1 and R_2 can cause increased h.t. drain, with an actual drop in r.f. output. Changes in value are thus best directed towards obtaining maximum r.f. output, as explained later, rather than by letting each valve take its maximum h.t. current. Resistors of about 10K may be used for initial tests.

Condensers C_1 and C_2 provide the grid drive. Using rather high values here will reduce r.f. output because additional grid drive only causes losses once the optimum has been reached. If 30pF air-spaced pre-set condensers are used for C_1 and C_2, they can be adjusted for maximum r.f. output.

Tuning is by means of C_3. If excess capacity is needed to reach 27 Mc/s, efficiency drops. Extremely low capacities also reduce efficiency, so that the radio frequency output drops. If a 25pF or 30pF pre-set is used, and the coil allows 27 Mc/s to be reached with this not more than half closed, results should be satisfactory.

These same points also apply to single-valve transmitters, or those using mains type valves. A simple method of determining efficiency is to check the aerial current, as explained later.

Mains Type Valves

Maximum permitted output may easily be achieved with these. They can be run from a mains power pack, or 6v. or 12 v. accumulator with rotary transformer.

A single valve circuit is shown in Fig. 2. High amplification output tetrodes such as the 6L6 will supply a powerful r.f. signal, other valves such as the 6F6, 6V6, etc., also giving a good output. R_1 can be modified for maximum output, as explained, 20K often being suitable. R_2 can be of normal value for the valve, protecting it against damaging current if oscillation ceases. C_1 can be 50pF mica, and C_2 a 30pF beehive trimmer, adjusted for maximum output. (C_1 is to assure h.t. voltages can in no case reach the grid.) C_3 is as explained. Its charge has to supply the one half cycle of r.f. oscillation, which means that extremely small values can cause reduced output. The h.f. choke must be of efficient construction. If not, it is best to wire the choke to a centre tap on the anode coil. It is usually convenient to wire the key in series with R2, which may be 400Ω for a 6F6, 300Ω for a 6L6, and 240Ω for a 6V6.

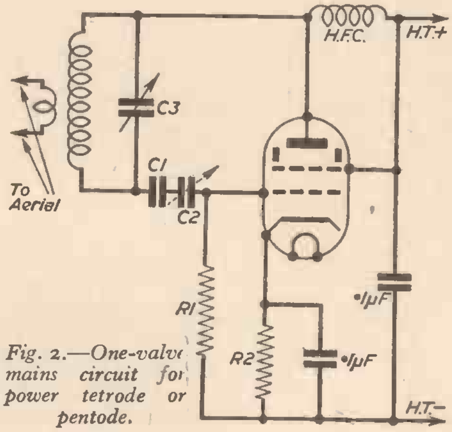


Fig. 2.—One-valve mains circuit for power tetrode or pentode.

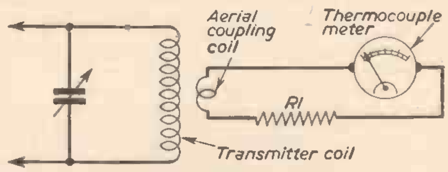


Fig. 3.—Measuring radio frequency power developed.

Measuring R.F. Output

A surplus 0·3A (300mA) or 0·5A thermocouple r.f. meter will be convenient for this. The meter can be wired in series with the aerial. If no aerial is used during tests, the meter can be connected to the aerial coupling loop of the transmitter, as in Fig. 3.

Small battery transmitters using one valve will not give enough output for the meter to provide an accurate indication, because scale markings are not linear at low currents. In this case a 6v., 0·04 amp. bulb can be substituted.

With mains valve transmitters R1 is required to avoid taking the meter pointer off

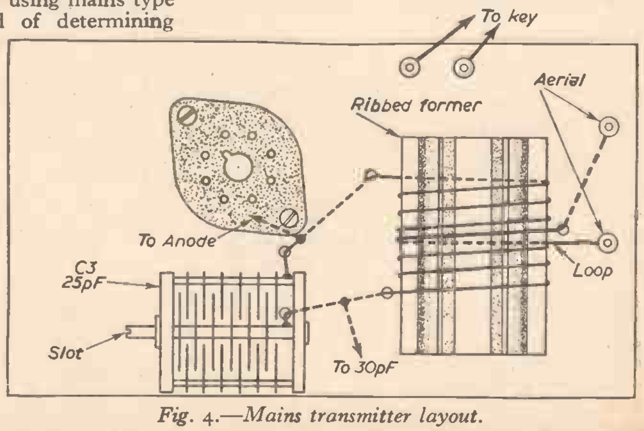


Fig. 4.—Mains transmitter layout.

the scale. It can be up to 10Ω or so, according to meter and output expected. The r.f. wattage in the aerial coupling coil can be found by squaring the current and multiplying by the total resistance. For example, if R1 is 8Ω, the meter 2Ω, and current 0·5 amps., wattage = 0·5 × 0·5 × 10, or 2·5 watts. It will not be possible to get so much power actually into the aerial, because its radiation resistance will be much higher than 8Ω.

With the transmitter working, the adjustments described can be made, to obtain highest meter reading (or maximum brilliance of lamp). A poor output may be caused by an inefficient coil (e.g., one very near metal parts, or of poor design), or by incorrect aerial coupling.

Typical Transmitter

Fig. 4 shows a suitable layout for a 1-valve transmitter. The coil can be six turns of 20 s.w.g. wire, on a 6-ribbed former 1½in. dia. across the ribs, the turns being spaced to occupy 1in. For aerial coupling, one turn of insulated wire is made round the middle of the coil.

Fig. 5 shows wiring for a 6V6 and similar valves, R1 being the cathode bias resistor, of the value specified. The circuit can, of course, be used with battery valves. To distribute capacity, two resistors R1 are used in series, in the grid circuit, values being selected as already mentioned.

The 30pF beehive trimmer is shown in Fig. 5, and is adjusted with a notched ebonite tube or similar tool. The tuning condenser spindle is provided with a slot for a screwdriver shaped ebonite rod.

Power may be obtained from mains or battery, using the circuits shown in Fig. 6. A 6V6 will take up to about 50mA at 250v. The 6F6 can take 45mA at 285v. The 6L6 can draw up to 70mA at 350v. High outputs can be maintained with somewhat lower currents and voltages.

Aerial Coupling

Final adjustments for maximum power should be made with the full aerial. Aerial loading increases h.t. current, and reduces grid drive, so these points should be watched. For maximum radiated power with a given circuit, a fairly long aerial is needed, and this can be approximately 8ft. 4in. To get equivalent radiated power with a shorter aerial, a more powerful transmitter will be needed.

The r.f. meter should be included in series with the aerial, when making tests. (For small battery equipment, a low consumption bulb would have to be used, as mentioned.) Adjustments should then be directed towards obtaining the largest possible flow of current into the aerial. With mains type valves, or very powerful battery type circuits, care should be taken not to exceed the maximum effective radiated output allowed.

Changes to aerial length or aerial coupling should be tried, to see if the aerial current meter shows an increased reading. With a single valve mains transmitter of the type described, maximum output may be reached with a 6L6, or two 6V6's in a circuit like that in Fig. 1.

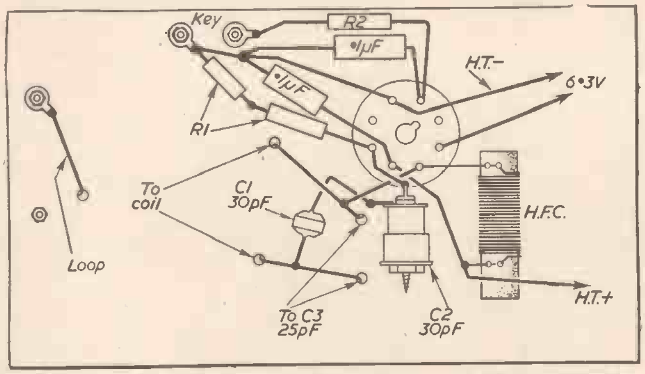


Fig. 5.—Underneath wiring.

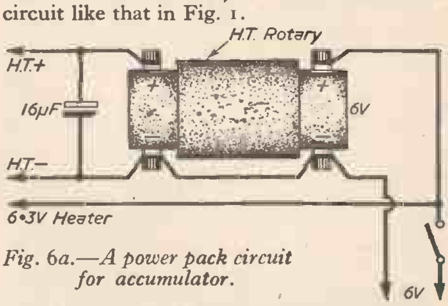


Fig. 6a.—A power pack circuit for accumulator.

Frequency must be checked in the usual way to assure that the transmitter is in the permitted band (26·96 to 27·28 Mc/s). The frequency meter may consist of a rigidly constructed coil, with parallel condenser and calibrated dial, indication being by means of a bulb soldered to a one-turn loop, or by means of a 1mA or similar meter wired in series with a crystal diode. When using maximum power the frequency meter should be kept far enough from the transmitter to avoid damage to it. A 6v., 0·04A bulb is suitable for a frequency meter used with battery equipment, but with mains equipment a 6·3v., 0·3A bulb may be substituted.

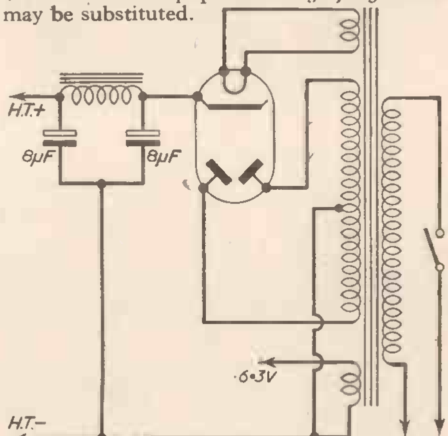


Fig. 6b.—Power pack circuit for A.C. mains.

A PROJECTION SYSTEM for your Microscope

(*Concluded from page 302*)

sheets of Celluloid or Perspex and if a standard size, medium thickness paper is used accurate comparative drawings may be made and filed.

Direct Projection

As an alternative to the two foregoing systems there is the method of direct projection on to the table top, utilising one or two mirrors only with no translucent screen.

The biggest drawback with this method is that unless the light source is intense the room must be well darkened, which is not so necessary with the other methods.

All that is required is a stand to support two mirrors, or if a small mirror or prism is available mounted to rest on top of the eyepiece, a stand supporting one mirror, as shown in Fig. 6.

In principle this is not unlike the Camera Lucida, except that the object is only observed on the paper instead of visually through the eyepiece.

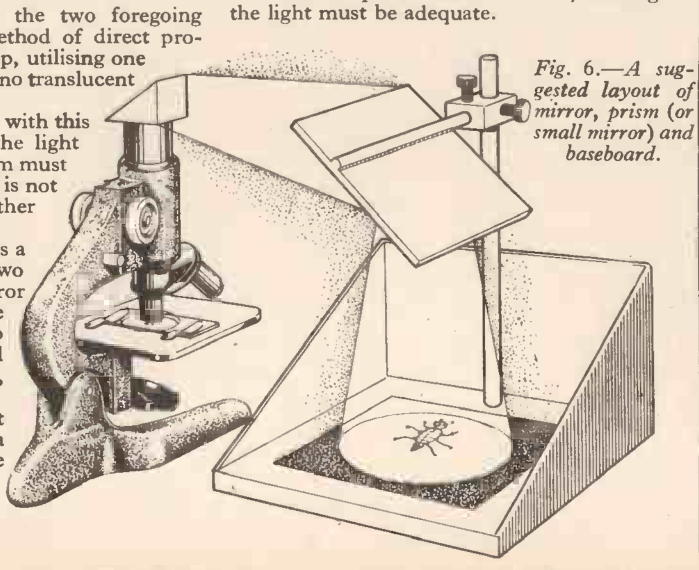


Fig. 6.—A suggested layout of mirror, prism (or small mirror) and baseboard.

Mounting the Mirror

It is best to have the mirror attached to a baseboard by a vertical arm as shown in Fig. 6. It is mounted with its centre directly above the centre of the base and is adjustable for height and angle.

The baseboard may be surrounded on three sides by a shield to cut off the light from the lamp should it tend to become a nuisance.

As far as convenience goes this is probably the most simple to make and use, although the light must be adequate.

There is nothing very difficult about the construction of any of these projection systems for they can be made from sheet metal, wood or cardboard for a trivial sum of money, yet they will be of great value in drawing microscope objects.

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SOUND MIXING with the Tape Recorder

B. E. Wilkinson Describes some of the Techniques

WHEN one considers the versatility of the tape recorder, it is hardly surprising that many interesting and new uses for recording instruments have been discovered. Today, when there are so many owners of tape recorders, the process of mixing has become of importance to enthusiasts. In the following, circuit diagrams have no values given, as these depend essentially upon the equipment used.

Superimposition

A well-known and interesting process in tape recording, and not found possible easily, with any other form of recording, is superimposition. This is, of course, the adding of further sound material to whatever happens to be already on the tape.

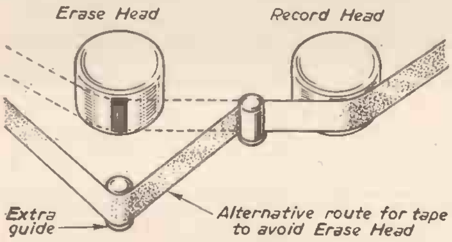


Fig. 1.—Avoiding the erase head

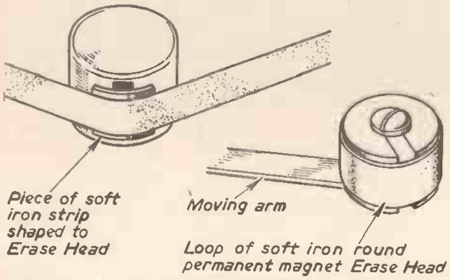


Fig. 2.—Two further methods of cutting out the erase head.

Before discussing this process in more detail, it would be well to examine the head layout of a typical recorder. The tape passes from a feed spool, via the tape gate, to the take up spool. Within the gate, there are two (generally), or more heads. The first one is the erase head. It is obviously placed first, that so during record, the previous recording will be erased. The second head is the record-replay head, or if more than two heads are used, it will be the record head. The reason for this is that with separate record and replay heads, it is possible to monitor through the replay head, during the recording process.

Now the main point which would seem to eliminate the possibility of superimposition, is the position of the erase head. Since it comes first and is always working during the record process, it is clear that superimposition with the recorder in the normal state, cannot be effected. It is necessary somehow to prevent the erase head from working while the second signal is applied to the tape. There are several ways of doing this—possibly an extra tape guide could be made and fixed to the deck in a suitable place so that the tape avoids the erase head, as shown in Fig. 1.

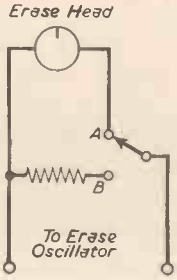


Fig. 3.—Circuit for making erase head inoperative during superimposition.

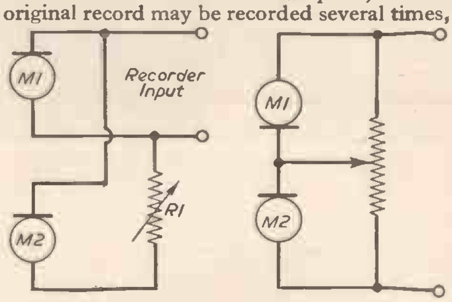
Quite obviously, it is not possible in every recorder, to make the tape clear the erase head. It will be appreciated that owing to the small gaps used in the various heads the magnetic fields produced are very concentrated, and are almost completely within the iron cones. The gap where the reluctance is high, is the only point where the field becomes distorted. We can make the erase head ineffective by shorting this gap with a piece of soft iron. If a small, smooth piece of iron, say, ⅛in. thick, and suitably shaped, is placed across the gap, and held there by means of transparent adhesive tape the tape will pass the iron, and no erasure will take place (Fig. 2). Providing one is prepared to modify the recorder slightly, a much more satisfactory method may be adopted.

It would not be wise to disconnect the erase head, or to short circuit it during recording, as it may well form a load in the oscillator circuit which generates the bias current. But the head can be replaced by a resistive load, similar to the head impedance. To do this, the impedance of the erase head at the oscillator frequency, should be determined (the makers could supply this information). In Fig. 3, an erase head is shown, with switching to incorporate a similiar resistive load for superimposition.

There are some recorders which do not use an oscillator to provide the erase field. They use a permanent magnet, generally fixed to an arm, which is brought into contact with the tape during record, by a mechanical linkage with the function switch. Now, while most erase heads are screened, besides having closely concentrated fields the permanent magnets generally radiate a field which although it may be small, will be sufficient to affect a tape passing close, even with the poles shorted with a piece of iron. Furthermore, a permanent magnet cannot be switched off. The method recommended here, is simply to remove the magnet if possible, or if this cannot be done, to screen it completely by putting around it a ring or suitably shaped close loop of soft iron (Fig. 2).

Difficult Superimposition

The aforementioned makes it possible to superimpose using almost any recorder. But a further complication may arise depending upon how accurately it is necessary to coincide the second recording with the first. For example if it is required to add a commentary to a recorded programme, the timing will not be critical, so that relevant positions in the programme may be marked on the tape with crayon, or small pieces of paper put between the layers of tape at the appropriate points. Using recorders with accurate footage indicators, makes this easier still. If, however, it is desired to superimpose one musical part upon another, timing becomes extremely important. This cannot be done unfortunately using one recorder, as it is essential to hear one musical part, when adding the other. Even with a three head system, where it is possible to monitor, there are time delays to contend with, since it is not possible to have two heads at the same point on the tape. In practice the accompaniment is put first on one tape, and when played back, another part is added so that a second recorder takes down both parts. When this is played back to the first recorder yet another part can be added, and so on. There are, of course, problems, one of which involves the acoustics of the room in which the recordings are made. If the recorders are played to each other through the loudspeaker, the room effect will be multiplied, as the original record may be recorded several times,



Figs. 4. and 5.—Two mixing Circuits.

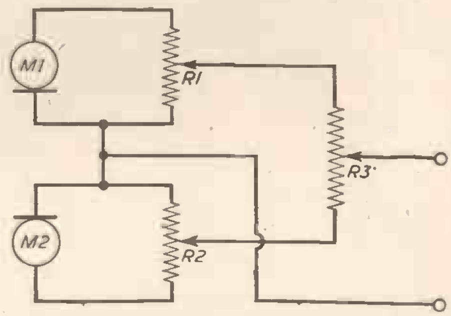


Fig. 6.—A more elaborate mixing circuit.

and the final result may not be as pleasing as was hoped. This can be overcome by direct replay from the output of one recorder to the input of the other, mixing the next part in.

Mixing

Mixing consists of combining or intergrating two signals in such a way that they are recorded as one signal. It is not simply a case of feeding the two signals to the one recorder input, as there may well be differences of signal strength or of impedance matching.

It will be necessary first to clear up any doubts regarding the input impedance. Normally tape recorders are equipped to record from a microphone, a gramophone pick-up (in spite of the fact that it is illegal to tape commercial gramophone records), and a radio output. If the microphone is of the dynamic or moving coil type, then this input is of a low impedance, whereas crystal microphones, used with many recorders must feed a high impedance. The gramophone pick-up input will be of a high impedance, owing to the majority of modern pick-ups being crystal. Finally, the radio input is of a high impedance since it is intended to be fed from the diode connection of a superhet. It is important to be conversant with all this because during recording one of these inputs must be used and to achieve the best results one must choose the appropriate one.

In Fig. 4 is an extremely simple mixing circuit. The two signal inputs, which are assumed to be generated by microphones are fed in parallel, and the intergrated result is taken to the recorder input. Possible differences in signal strength, are controllable by

Fig. 7.—Valve mixer circuit, using a double triode.

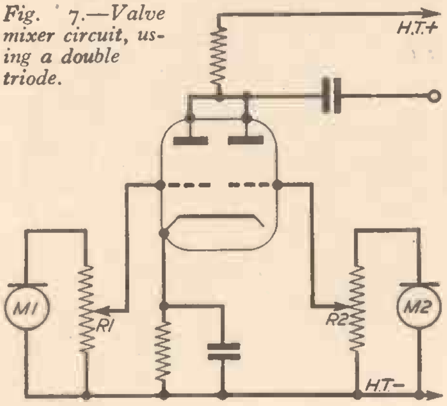
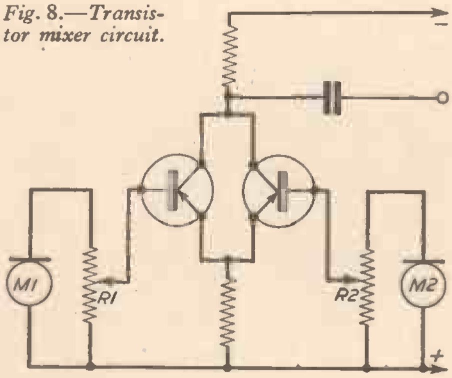


Fig. 8.—Transistor mixer circuit.



the variable resistance R1, which can control only one of the signals. In practice, the recorder input would be adjusted to receive the signal from M1, and then R, would be adjusted until M2 was balanced with M1. The value of R1 depends, of course, on the impedances of the inputs.

Fig. 5 shows a circuit where the output from each microphone is controlled by the shunting effect of one or other of the sides of the potentiometer R1. An increase in one side automatically decreases the value of resistance in the other side. A decrease of resistance in any side causes an increase in the shunting effect, and thus a reduction in output from that side. The resistance of R1 should, of course, be comparable with the impedance of the circuit it feeds.

In Fig. 6, we have a more elaborate circuit with control over both microphones and the integrated output. R1 and R2, depend, of course, on the microphone impedance, and R3 will be high if the device feeds directly to the grid of a valve.

The Three Circuits

The three circuits shown, are quite easy to make and depending on the signal source used, the resistances can be adjusted to give good results. However, the process of shunting the inputs, reduces the energy available at the mixer output. If we are prepared to consider slightly more involved circuits; we may expect more signal from the mixer output. In Fig. 7, we have a valve mixer, using a double triode. The microphones M1 and M2, feed each valve through their own individual volume controls. Since the anodes are joined together (externally), the output consists of both signals integrated. This kind of circuit provides much more signal strength, but suffers from the disadvantage that extra power supplies are necessary. In the circuit shown, the microphone impedances would be high, as would the values of R1 and R2. For low impedance microphones, it would be necessary to use microphone step up transformers before potentiometers. A similar circuit, but one using transistors instead of valves, and thereby considerably reducing the problem of extra power supplies, is shown in Fig. 8. However, as there is a difference between the impedances of valve and transistor inputs, the microphones would be of a lower impedance.

In all the circuits described, actual component values have been avoided, to prevent the confusion which might arise over using circuits to feed different input impedances. It should be made clear that the mixer circuit must be designed not only for the microphones or transducers which feed it, but also for the circuit it will feed.

Echo Effects

Anyone who has heard many of the modern popular gramophone records, will be familiar with the echo effect. This is best produced electronically. All that is necessary is to split the signal into two components, delay one for a short interval of time, and remix them. Fig. 9 shows a method of effecting this.

The tape recorder is set for playback and the tape on it carries a piece of music perhaps, to which it is desired to add an echo.

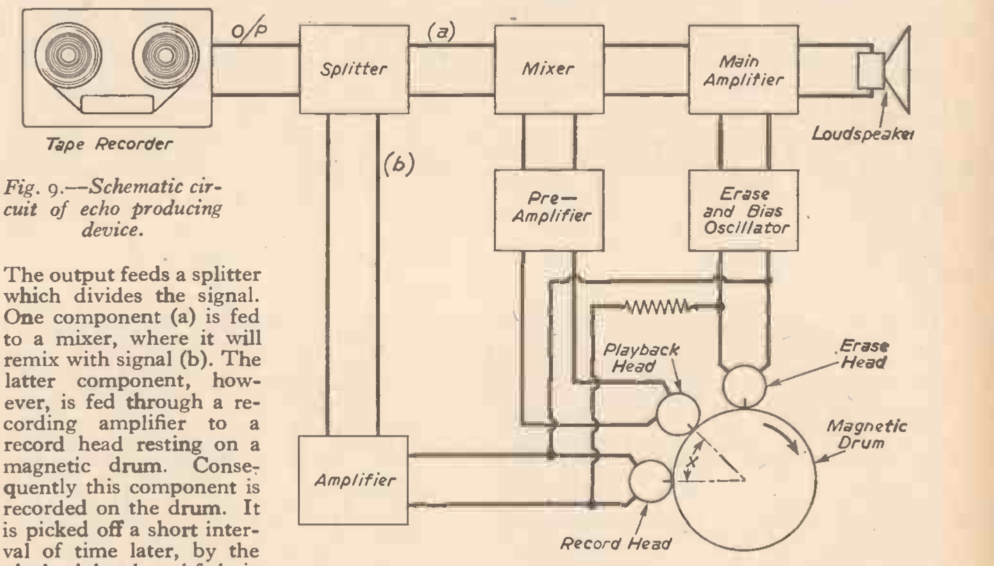


Fig. 9.—Schematic circuit of echo producing device.

The output feeds a splitter which divides the signal. One component (a) is fed to a mixer, where it will remix with signal (b). The latter component, however, is fed through a recording amplifier to a record head resting on a magnetic drum. Consequently this component is recorded on the drum. It is picked off a short interval of time later, by the playback head, and fed via a preamplifier, to the mixers. Components (a) and (b) now integrated, go to the main amplifier and then to a loudspeaker, or possibly to the record input of a second tape recorder. Now the time delay between the main signal and its echo, is determined by two factors, the speed of the drum, and the distance x, between the record and playback heads. It is necessary to play an erase head after the playback head, in order that the drum shall be "clean" when it reaches the record head. An erase oscillator driving this head is also used to bias the record head. It may well be argued that the average enthusiast is not in a position to make the necessary magnetic drum, and the head assembly which rests against it. However, a simpler version which can be made easily, is shown in Fig. 10, and consists of a continuous loop of tape, which replaces the drum. The tape should be mounted on a deck, around two capstans, one being driven at a convenient speed by a motor. A pinch wheel is necessary to ensure a good grip between capstan and tape, and can be a small, rubber tyred, spring loaded wheel, the width of which should be slightly greater than the width of the tape. The tape loop is put on, with the oxide surface outwards so that the heads may be fixed outside the loop. The tape splices should be made as carefully as possible, and should be strong, as being a relatively short length of tape, it will get a fairly rough life. The echo effect, of course, depends on the distance x, between the record and playback heads one of which must be free to move, so that x may be controlled. It would be simple to cut a slot in the deck into which one of the heads may be bolted.

Tape speed is not important as long as the response of the system is comparable with that of the tape recorder which feeds it. However, faster tape speeds produce better response characteristics, and also allow x to be greater, and thus more convenient.

While the schematic diagrams show echo effects being produced from material already on tape, it is not necessary to feed the echo producing device with a tape recorder. For instance, in theatrical work, where it might be necessary to produce an echo "live" the signal would be fed to the splitter from a microphone and amplifier.

Some tape recorders, using separate record and playback heads, may be used to produce echo effects with very little modification.

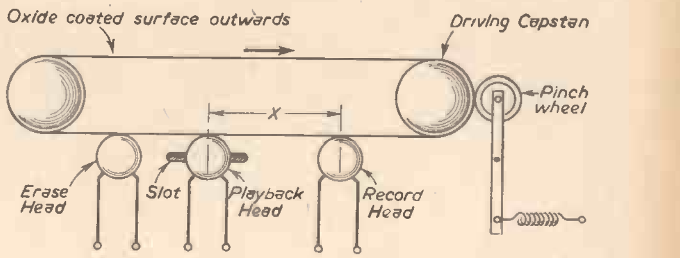


Fig. 10.—Magnetic drum replaced by endless loop of tape.

During record, the signal is put on the tape by the record head and a fraction of a second later, it can be picked off by the playback head, and fed via an external amplifier to a mixer, where it can be integrated with part of the original signal. The system has the disadvantage that, since the heads are fixed, the delay cannot be controlled.

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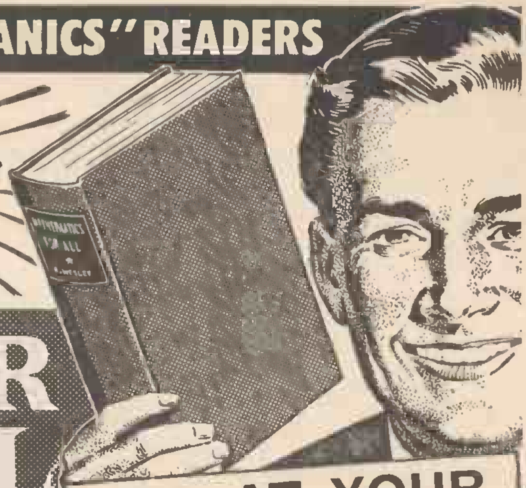

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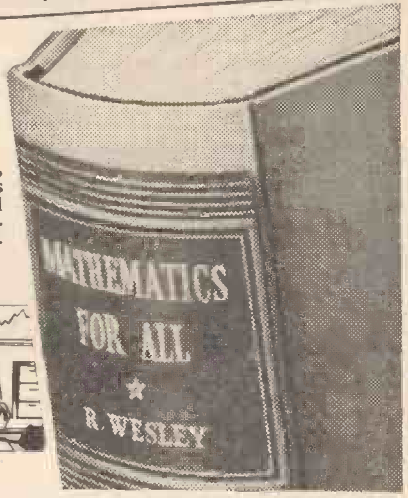

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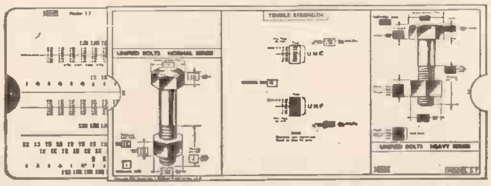

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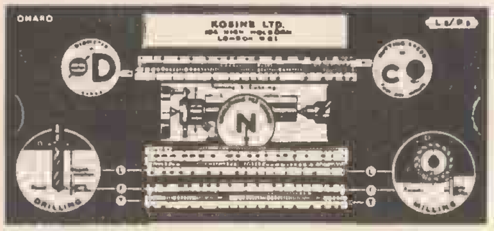

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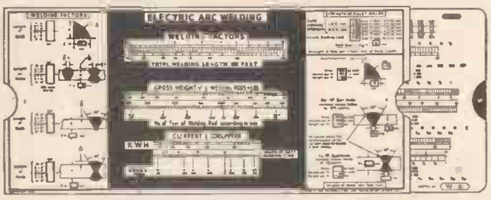

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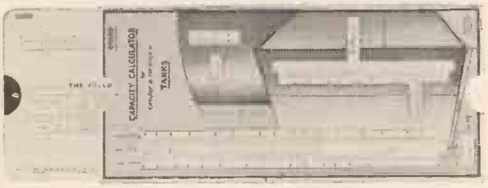

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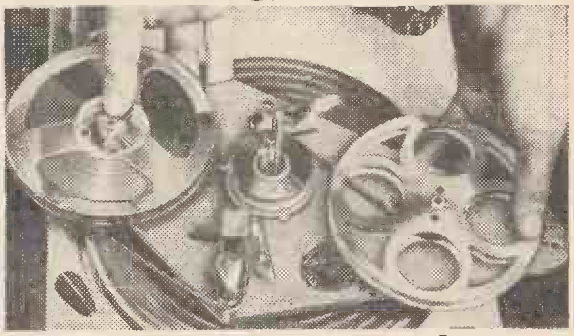

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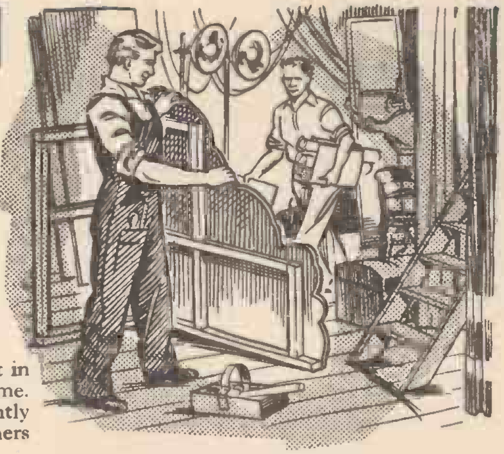
2

Scenery Construction



These Interchangeable Pieces can be Used Again and Again says C. C. Somerville

THE two main requirements of good scenery are that it should be light in weight and strong. It should also, where possible, stack compactly when in storage. The scenic flat made of a canvas-covered timber frame has come to be the accepted basic scenic unit. It is both strong and light and can be repainted over and over again. The scene visualised in Fig. 1 is made up of scenery described in this article.

Flat Construction

These flats are made of soft timber usually 3in. × 1in. for flats over 10ft. high and 2in. × 1in. for the smaller ones. The plain flat shown at Fig. 2 is quite simple in construction. The styles are cut to the required length of 12ft. The rails are each cut 4ft. in length except the centre rail which is only 3ft. 6in. to allow for the "shoes" at either end.

The corner joints are now made, the most serviceable being a mortise and tenon joint. When glued up, two holes are drilled through the joint and wooden pegs driven through to lock it. The centre rail is set into two small pieces of timber called shoes. This prevents the styles from warping inwards and the shoe gives a larger area of thrust. Also this rail is easily moved up or down between the styles.

Canvas Covering

A sheet of scenic canvas is cut to the overall size of the flat which is laid on the floor. Two people each take up their positions in the middle of the top and bottom of the flat. The canvas is pulled gently taut and a tack put in to hold it near the inner edge of the frame. Proceed in this way pulling the canvas gently and holding with tacks until the inner corners of the top and bottom rails are reached.

Then begin in the centre of the styles and do exactly the same. When the corner is reached a sharp knife is used to slit the canvas so that it may be turned back for gluing. The timber is painted with hot woodworkers' glue and then the canvas pressed firmly home. When the glue has set the ragged edges of the canvas are trimmed with a razor blade to within ½in. of the outer edge of the frame.

Doors

A door flat, shown in Fig. 3B is made in a similar way to a plain flat except that the door opening is given a timber jamb all round and the bottom rail is cut away flush with the opening and a sill-iron, available from theatrical suppliers, is substituted. The usual size for a door on the average stage is 6ft. 6in. high × 3ft. wide.

The top of the door-jamb is usually a rail with shoes screwed at the required height. The canvassing should be done in three sections, one strip across the top and two long ones down the sides. Into the opening a door can be hung. This is merely a framework of 3in. × 1in. wood, canvassed on both sides and hinged on to the door opening.

Arches

Arch pieces are valuable additions to a collection of scenic units. The construction, which is almost identical to that of the door-flat is clearly shown in Fig. 3A. Windows are also built on the same principle as doors, but require an extra rail for the base of the window.

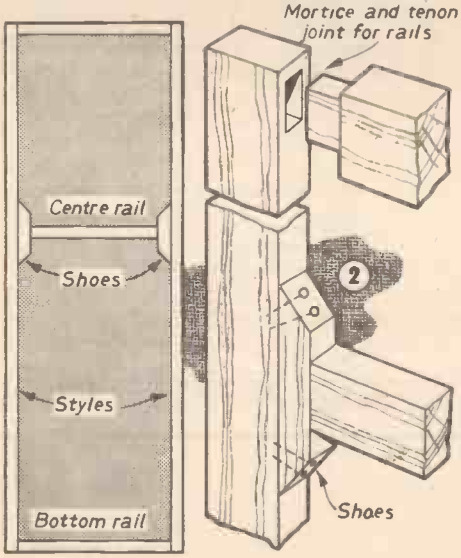
Book Flats

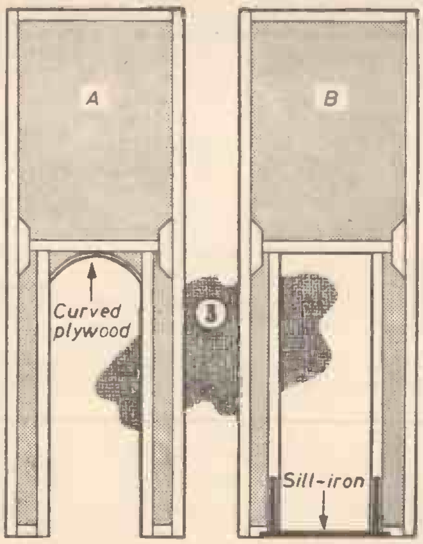
The construction of book-flats or wing pieces is simply a matter of hinging two flats together, so that they will stand at right angles to each other. One edge of the book-wing shown at Fig. 4 has a profile added from hardboard which might be painted to represent a tree for an outdoor setting. These book-flats are also useful for standing behind doors as seen in the designer's sketch Fig. 1.

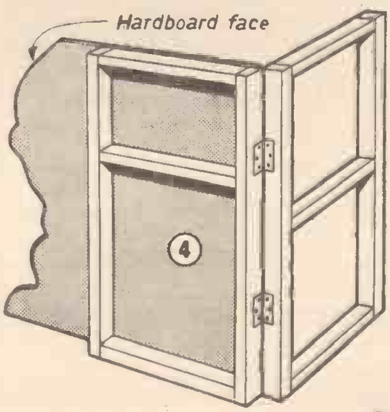
Ground Rows

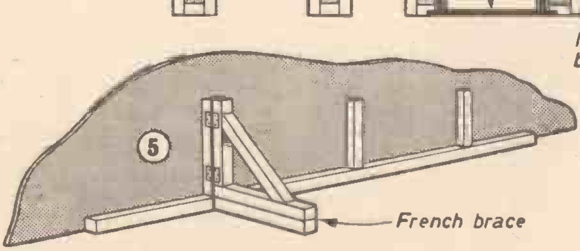
These are simple to construct. Hardboard or plywood, cut to shape, is tacked to a timber frame-work. On to the uprights of this frame-work a French brace is hinged, so that when storing the whole piece will stack flat. If the ground row is very high, then a weight on the end of the brace may be needed. Fig 5 shows a rear view of the construction.

In a setting such as is illustrated in Fig. 1 the different flats are lashed together and supported from behind by a brace. Metal braces, which hook into a screw-eye on the









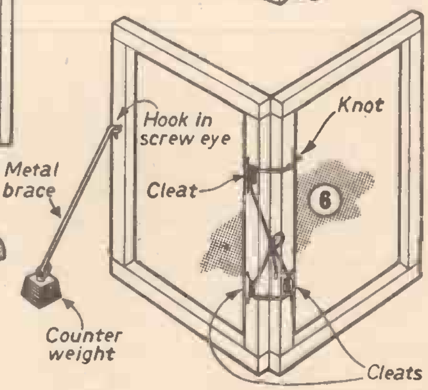


Fig. 2.—Flat construction. Fig. 3.—Details of arch and door flats. Fig. 4.—Making a bookwing. Fig. 5.—Ground row construction. Fig. 6.—Method of joining and supporting flats.

flat, and are forked at the other end to slot into a weight, may be purchased from any good theatrical supplier. There are also wooden extending braces, but quite serviceable ones can be improvised from a length of wood hinged at one end to the flat, and screwed into the stage at the other end.

Fig. 6 shows the method of support and also shows how the flats may be lashed together. The line goes through the thickness

SUGGESTED STOCK LIST OF SCENIC UNITS

TYPE	SPECIFICATION
Plain flat	4ft. × 4ft. wide 4ft. × 3ft. „ 2ft. × 2ft. „ 6ft. × 1ft. „ All are 12ft. high
Door flats	2ft. × 5ft. wide (with 3ft. opening) 1 ft. × 6ft. „ („ 4ft. „) (for French Windows) All doors are 6½ft. high
Window flats	1ft. × 6ft. wide (with 4ft. window) 1ft. × 4ft. „ („ 3ft. „) 1ft. × 5ft. „ („ 3ft. „) All flats are 12ft. high
Sky cloth	24ft. × 24ft.
Ground rows	3 profiles varying from 1½ft. to 3ft. high
Arches	2 flats 12ft. high × 5ft. high with 2ft. × 3ft. arches
Book flats	3ft. × 12ft. × 4ft. hinged to 12ft. × 3ft. 1ft. × 12ft. × 4ft. hinged to 12ft. × 4ft.

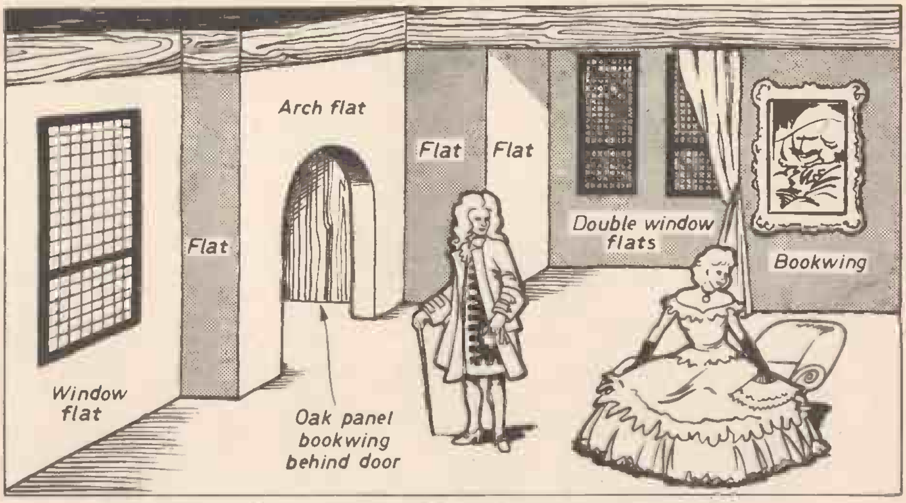


Fig. 1.—Scene designer's preliminary sketch of a proposed scene.

of the style. At a position about 1ft. from the top of the flat a hole is drilled on the oblique and the line threaded through and knotted at the end. Two flats are joined together either edge to edge or at right angles to one another. The length of line is equal to the height of the flat and is tied off at hand level by means of a figure eight round two cleats with a slip knot.

Any society laying in a stock of scenery which will be used for many different plays must obviously plan the building of it so that it provides as many variations as possible. A sound scheme is to plan a set of scenic pieces which can be painted and repainted to give an entirely different set for each production. The list in the first column forms a suggestion which may prove useful to the society beginning on scenic construction. With it, designers should be able to create a series of interesting settings without repeating themselves and without any undue amount of extra construction.

Running an Electric Bell from the Battery Charger

By C. J. Green

ONE way of using the battery charger when it is not charging is to incorporate an electric bell circuit.

Fig. 1 shows the A.C. mains transformer, having 220-250v. input and an output of 4 amps. at 17v. in three stages (5v.-11v.-17v.), thus giving a maximum of 2v.-6v.-12v. after passing the rectification stage.

The transformer is wired with twin 3.029 tough rubber cable to a 5-amp. junction box ready to take the mains supply. Twin flex and a 5-amp. plug is then used to connect into the appropriate mains socket. By this means, the whole installation can be isolated if required.

The low voltage side of the transformer is connected by soldering to brass inserts, made from brass tubing $\frac{3}{16}$in. diameter, tightly pressed into a suitably drilled panel of ¼in. Perspex or similar material.

The wire gauge in the bell circuit should be 20 and rubber covered if possible. The supply leads are fixed to the brass pins, and fitted into the O and 2v. brass inserts.

The Rectifier

This, as shown in Figs. 1 and 2, is a five-plate type and keeps cool reasonably well. When positioning the rectifier ensure that there is free circulation of air. If enclosed in a suitable casing, air vents must be adequate; otherwise, when charging is taking place, both transformer and rectifier may become over-heated.

At the bottom of the rectifier, two plates are joined together with 20g. copper wire. From this wire is connected the negative battery lead with 4-amp. fuse link inserted. The fuse link holders can be two brass terminals fitted in any convenient position in the lead. The lead to the positive side of the battery is connected to the centre plate of the rectifier. The amp.-meter is optional, but if used is connected as shown.

The wire at the top of the rectifier marked (R) is the lead to the selector pin in which is inserted a ½ Ω 4-amp. resistor. If this particular ballast resistor is difficult to obtain, one can be made from a length of soft iron wire.

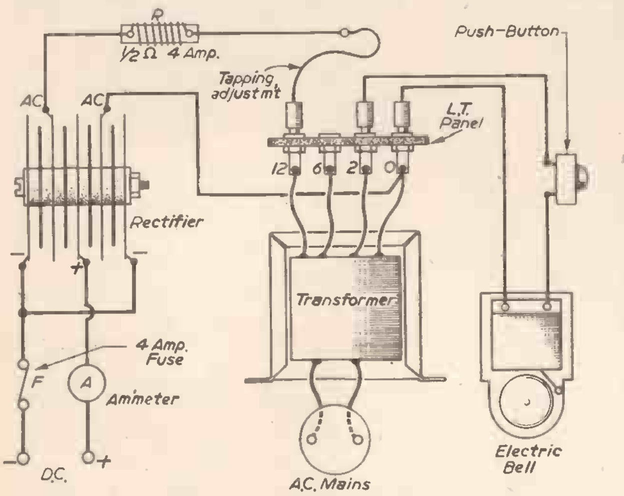


Fig. 1.—Wiring diagram.

The lead is taken to a point near the L.T tappings and joined to a flexible-covered cable with a brass selector pin, as illustrated in Fig. 1.

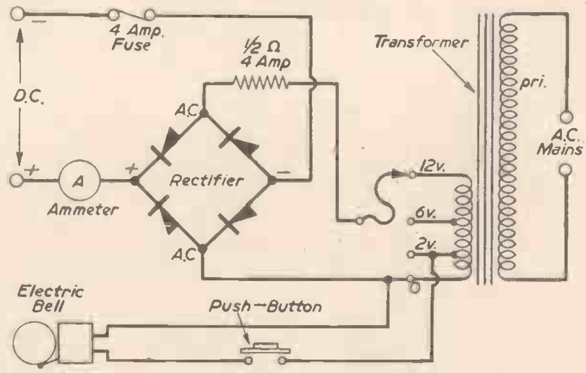


Fig. 2.—Theoretical circuit.

Earthing

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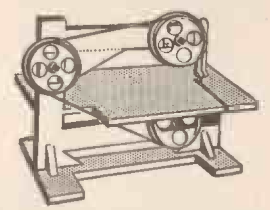

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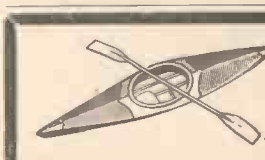

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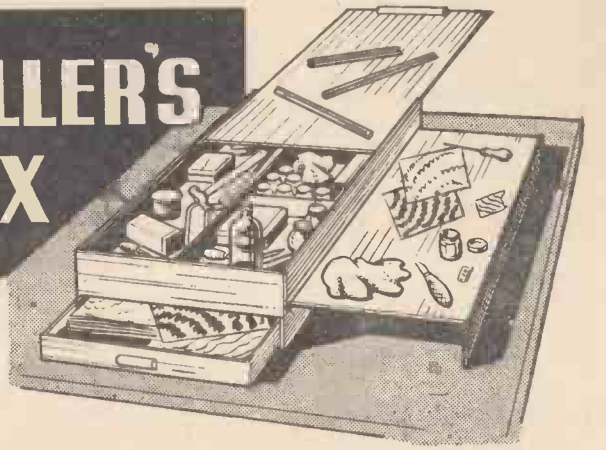


HERE is a portable hold-all for the modeller, which incorporates drawers for tools, a compartment at the top for model-making materials, strip-wood, paint, etc., and a slide-out cutting board.

Construction

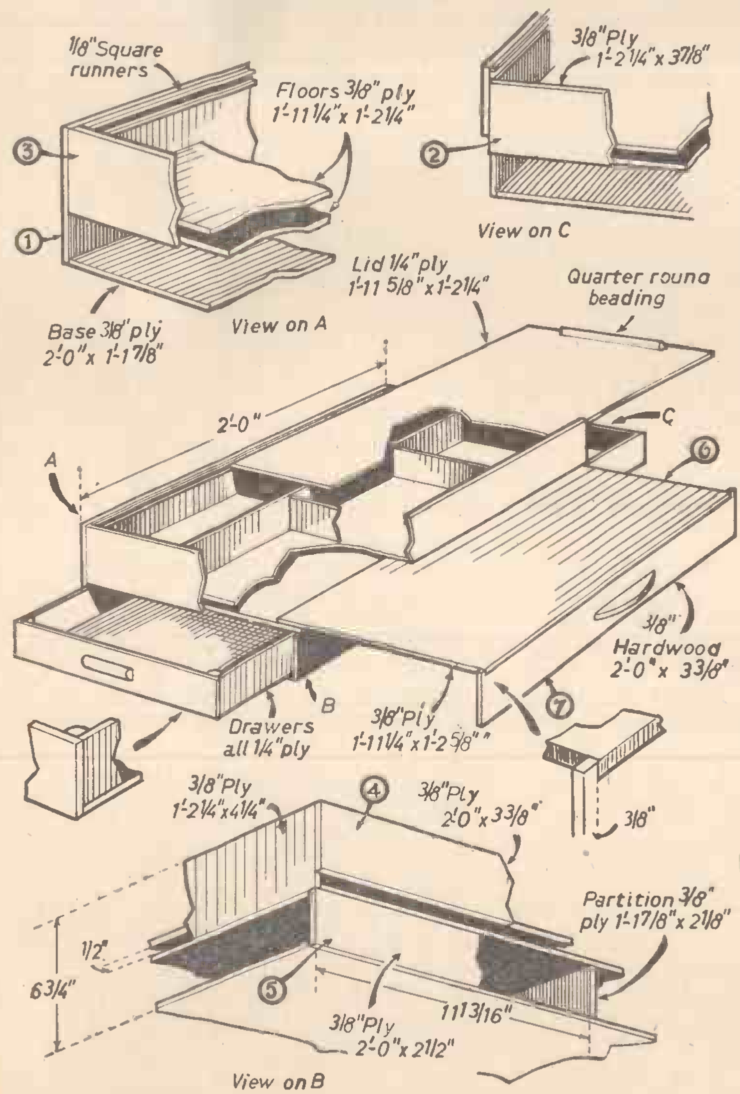
Start by cutting the base exactly to the dimensions given. Make sure the corners are quite square and that the edges are straight and smooth. Cut the partition and glue and pin this across the middle of the base as shown. Next cut the back (item 1) 24in. × 6¾in. Along the top edge of this and level with the edge, glue with impact adhesive a ⅛in. square strip of hardwood—obtainable at all hobbies and modelling stores. The strip must fall short of the left hand end of item 1 by ⅛in. Exactly ¼in. away from and parallel to the bottom edge of this strip, draw a pencil line and glue a second strip—this time ⅜in. short of *each* end of item 1.

Pin and glue the completed item 1 to the outside of one of the long edges of the base and make sure it is quite upright. Cut the two floors (view on A), and pin and glue *one* of them astride the partition with the back edge touching item 1. Make sure the floor is centred on the partition before pinning into the partition and through item 1 into the edge of the floor.

Cut item 5 and panel pin it to the front edge of the base (view on B) and under the front edge of the floor. Follow this by cutting item 2 (view on C) and item 3 (view on A and B) and pinning and glueing them to the ends of the bottom floor and the ends of the back (item 1) with which they should lie flush.

The second (top) floor can now be positioned, and as the idea of having two floors is to provide a neat housing for the sliding cutting board, it is necessary to sandwich the board (item 6) between the floors while the top floor is being pinned in place through items 1, 2 and 3.

When the floor is fixed, remove the cutting board and cut item 4 (view on B). Item 4 is fitted with ⅛in. square hardwood rails along its top edge in exactly the same way as was adopted for item 1. Pin and glue item 4 to the edge of the top floor and items 2 and 3.



Constructional details of the tool box.

The Cutting Board

Now cut item 7 from ⅜in. hardwood and recess one edge to take item 6, then screw and glue the two together as shown, making sure they are quite square to one another. Add a handle, cut from scrap hardwood. Cut the ¼in. plywood lid, trim is so that it slides neatly in the rails, and fix strip of quarter-round beading for a handle.

The partitions which are 2⅛in. high are cut from ¼in. plywood and can be arranged to suit individual requirements. Fix them with glue and panel pins, where appropriate.

Drawers

The two drawers are identical and each is made entirely from ¼in. plywood For each, start by cutting a baseboard measuring $11\frac{5}{16}$in. × 13⅞in. Round the outside edges, fit pieces of ¼in. plywood, 2⅛in. wide. Mitre the corners for a really neat appearance, but ordinary pinned and glued butt joints are suitable. Reinforce the corners with strips of quarter-round hardwood beading and add handles cut from scrap half-round hardwood beading.

Clean off any glue traces and sand thoroughly, then stain and varnish the whole unit. Four rubber buffers for feet may be fitted if required.

YOU WILL NEED

⅜in. Plywood:
1 piece 24in. × 13⅞in.—base.
2 pieces 23¼in. × 14¼in.—floors.
1 piece 24in. × 6¾in.—item 1.
1 piece 14¼in. × 3⅞in.—item 2.
1 piece 14¼in. × 4¼in.—item 3.
1 piece 24in. × 3⅜in.—item 4.
1 piece 24in. × 2½in.—item 5.
1 piece 23¼in. × 14⅝in.—item 6.
1 piece 13⅞in. × 2⅛in.—partition.

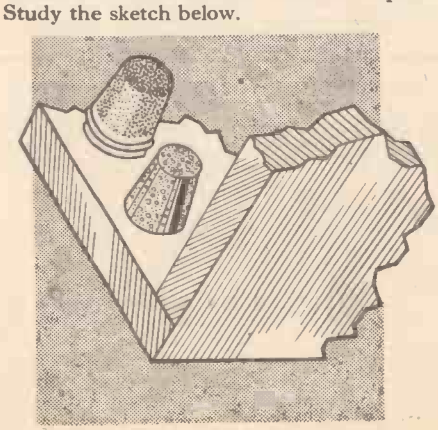
⅜in. Hardwood:
1 piece 24in. × 3⅜in.—item 7.

¼in. Plywood:
1 piece 23⅝in. × 14¼in.—lid.
1 piece 24in. × 10in.—partitions.
2 pieces 13⅞in. × $11\frac{5}{16}$in.—drawer bases .
1 piece 24in. × 10in.—drawer sides.

Miscellaneous: 8ft. of ⅛in. square hardwood, beading for handles, panel pins, glue, screws, paint.

Make this THIMBLE HOLDER for your wife

MANY needlework enthusiasts find it difficult to stop their thimbles from wandering into odd corners of their needlework box. The solution to this problem is easy. If small cork stoppers are glued or screwed just inside the top of the box, the thimbles can be pushed on to them when not in use and will be to hand whenever required. Study the sketch below.



LETTERS to the EDITOR

The Editor does not necessarily agree with the views of his Correspondents

Walkie Talkie Transformer

SIR,—I thought it might be of interest to readers constructing the "10-metre Walkie Talkie" described in your January issue to know that the intervalve transformer used is not installed in modern radio sets. It can be obtained, however, from most radio receivers made before 1934 from which I have obtained mine.—J. WATSON (Dublin).

Puzzle Corner Error

SIR,—I should like to call your attention to an error in the solution to the "Beat the Clock" problem which was published in the December issue. According to my calculations the answer should be 2160 days after the date of synchronisation, not 90 days. It appears that the solution given by you has been arrived at on the assumption that the watch loses and the clock gains 10 sec. per *hour*, whereas the problem stated "10 seconds per *day*."—W. B. WITTY (Hull).

Cutting Toughened Glass—Correction

WITH reference to your reply to L. Conway's query in the February issue, we would respectfully point out that there is no known method of cutting toughened glass automobile windows. Any attempt to cut this type of glass will only result in the window disintegrating into numerous small fragments.—TECHNICAL MANAGER, Triplex Safety Glass Co. Ltd. (N.W.10).

Keying Aluminium Sheet

WITH reference to the query published in "Your Queries Answered" in the January issue of "Cellulosing Sheet Aluminium", I disagree with the advice given. Aluminium sheet should most certainly be scratched before applying paint or cellulose. If this is not done with a view to making a key, using either a wire brush or one of the trade etching primers, the cellulose will very likely peel off in a sheet.—J. APPLEYARD (Yorks).

Paper Chinese Junks

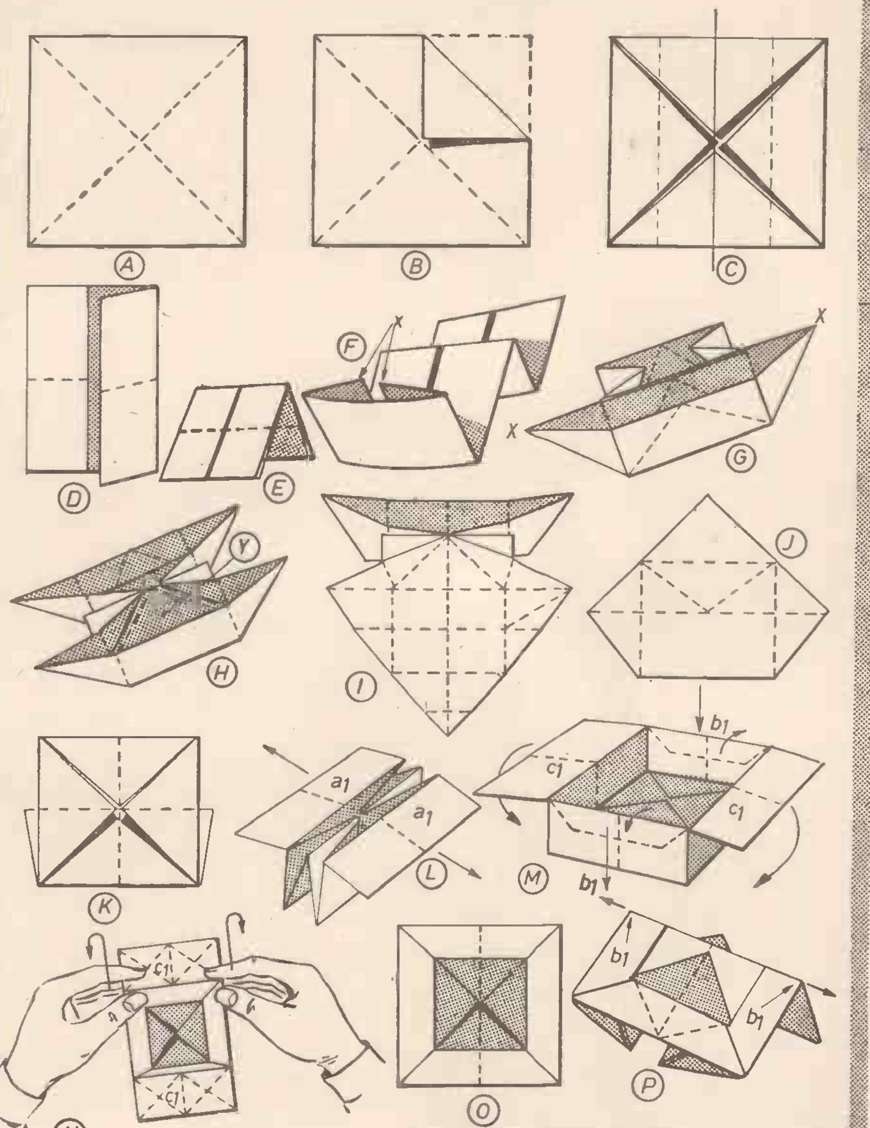
IN response to the request in Information Sought, January issue, for information on making paper Chinese junks, intelligible instructions for this call for many very carefully drawn diagrams or actual demonstration. The best readily available books are Robert Harbin's "Paper Magic" (*Daily Express Books*) or Margaret Campbell's "Paper Toy Making" (*Pitman*). Recently a firm of Japanese publishers, Toto Shuppam Co., Ltd., have issued an excellent series of books on Origami (Japanese paper folding) by the expert I. Monda. These are in English and for sale in America, but presumably they can be obtained here through one of the many booksellers specialising in foreign books.—R. FAIRTHORNE (Farnborough).

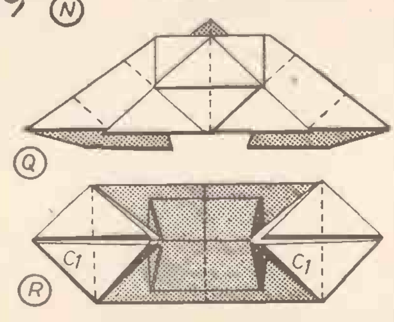
MAKING A PAPER CHINESE JUNK

SIR,—I trust the following instructions on how to build a paper Chinese Junk will be to Mr. Palliser's satisfaction (Information Sought, January issue).

1. Obtain a square piece of paper and divide diagonally A
2. Fold corners down to centre B
3. Fold along dotted lines as shown in C, resulting in D
4. Fold along dotted line in D, result E.
5. Fold along dotted lines in E, result F.
6. Press fairly tightly together, and draw out corners "X", as shown in G.
7. Repeat on the other side. We now have a "Double Boat" H.
8. Feel for portion Y in Fig. H, and pull out as in Fig. I and Fig. J.
9. Fold along dotted lines to obtain K.
10. Repeat on the other side, resulting in Fig. L.
11. Carefully draw outwards (arrows) the result being "The Box" M.
12. Now the most difficult part. With thumb pressure on b_1b_1 and fore-fingers on c_1 press down hard on b_1b_1 and fold c_1 downwards and against the back. Repeat with the other side (c_1) The result (Fig. O.) is known as "The Picture".
13. Fold along dotted line as in O and P, taking care that the shaded corners are the right way.
14. Draw out b_1b_1 (arrows). The result being Figs. Q and R.
15. Pull out the two ends c_1c_1 (Fig. R) and the final stage is reached as shown in the photograph.

Hey Presto—we have a Chinese Junk!—K. E. Langner (Ramsgate).





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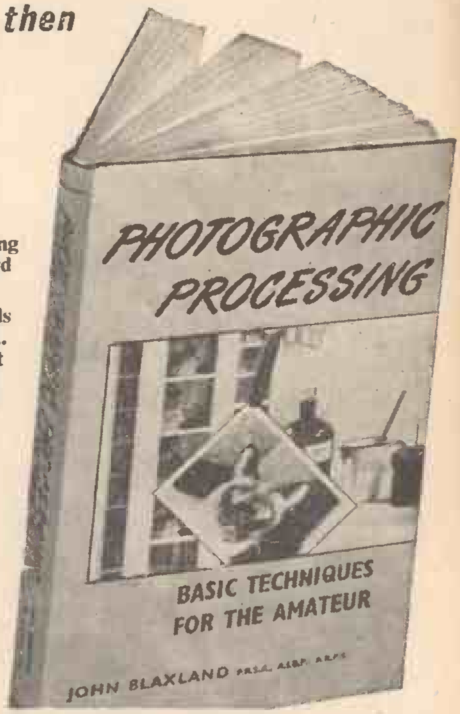

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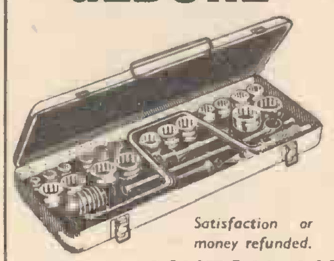

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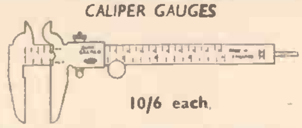

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Our Luton Minor Series—A Bouquet

SIR,—I am writing to tell you how much I appreciate your series of articles on building the Luton Minor aircraft. I am quite certain that very many of your readers will endorse my opinion of these articles, which contain a wealth of valuable information. I am surprised that you have been able to pack such a comprehensive amount of detail into these. Whether the handyman is building a Luton or not, I know that there is a vast amount of information which has either never been printed before or which would require a full technical library from which to extract it.

The Luton Minor just after take off.

Printing how to build an aeroplane is nothing new. Several American magazines have done just this. Your feature, however is so detailed, that it makes its predecessors look shoddy. I once fancied building an aircraft to instructions printed in an American magazine but found the designer left so much to the imagination that I considered I was totally inadequate to tackle the job. After reading your articles I am certain that many people like myself feel confident as to their ability to make an aeroplane.

As I shall no doubt get around to building the Luton before long, it might be a good idea if you were to reprint all the articles in a magazine form so as to save thumbing through to find the wanted article. I am sure that you could sell these for a profit. I would cheerfully pay 5/- a copy if not more.

As your paper seems to have developed a readership amongst people interested in flying, why not make a regular feature on aviation? There is need for a " how to do it " paper on private aviation as *Aeroplane* and *Flight* now concentrate on rockets, missiles and the somewhat Wellslian problems of travel in space.

For the record the aeroplane depicted in your series of articles, is a pre-war version of the Minor which is based at Sandown Airport here on the Island. It is owned by a Mr. Ord-Hume who is the only private aircraft owner on the Island and it flies regularly. As it takes over three hours from here to London by boat and train you can see my interest in making myself a small cheap light aircraft!—W. E. CASTLES (Sandown, I.o.W.).

Life on Mars

SIR,—In Sir Harold Spencer Jones' " Life on Other Worlds, " plate 13 shows photographs of Mars. The 36in. Lick refractor—which does not make dots and dashes appear like straight lines—obtained these during the near opposition of 1939.

With careful examination, some of the canals can be plainly seen. In the lower left corner of No. 2, some are double. A dark pattern surrounding the polar cap is also evident.

Schiaparelli and Lowell may have been right! There may, after all, be Martians fighting for survival along these natural or artificial formations.

Moles and ants can exist—more or less underground—during our most severe winters Is it wishful thinking to assume that animal life yet carries on below the suface of Mars? Intelligent beings may be living among great engineering works in tunnels similar to our underground railways. There they may manufacture whatever it is they breathe. Water may be pumped from subterranean deposits. Electric power may be obtained by chemical means, using systems of falling and rotating weights or by large windmills or light construction on the surface.

During the day Martians would ascend via lifts into large electrically-heated glass houses where carefully preserved plants would be cultivated.

Upon the earth, the " marvellous " is now commonplace. We experience warmth, comfort and speed underground. The remaining Martians may have retreated to a sheltered interior to escape the rigour of the surface.—A. TROWBRIDGE (Staines).

Ship's Steering Gear

(*Concluded from page* 296)

It consists of two main parts, the transmitter on the bridge and the receiver at the steering engine. These are connected by two copper pipes of about ⅜in. dia. Fig. 6 shows a simplified diagram of this system.

Supposing the wheel is turned in a clockwise direction, the plunger in the transmitter cylinder would move downwards and would cause oil to flow from the bottom of the cylinder into the cylinder of the receiver. This has the effect of moving the receiver cylinder in the direction of the arrow. As the control rod of the steering gear is connected to the arm (P) this movement causes the engine to start moving the tiller which will be stopped by the hunting gear when the rudder is in the desired position.

When the wheel is in the mid-position a by-pass connecting the upper and lower cylinders is open and the springs on the receiver cylinder return the latter to the central position. This is necessary otherwise gradual leakage might cause incorrect positioning of the rudder. The system is kept full of oil by means of a replenishing tank, which is connected to the transmitter by a valve which can only open when the piston is in the mid position, when there is no pressure in the system.

The all-electric steering gears are mainly confined to smaller ships and there are several types, the latest development being one which can be placed under remote control and operated by means of a portable control box from any part of the ship.

One of the most popular of the electric steering gears is based on the Ward-Leonard system and is shown in diagrammatic form in Fig. 7.

The driving motor, main generator and exciter are all mounted on the same shaft.

The wheel shaft and the hunting gear shaft each drive screwed rods which move sliding contacts. These contacts are connected together through the exciter field coil and make contact with rheostats AB and CD which are wired in parallel with the ship's mains. This circuit is a form of the well known Wheatstone-bridge. When the wheel is in the central position the rudder is amidships and the contacts on the rheostats are at points of equal electrical pressure and no current flows. If the wheel moves, this balance is upset and current flows through the exciter. This causes the exciter to generate current in the main generator field which in turn causes current to flow in the rudder armature and the rudder motor rotates. This motor is geared to the rudder shaft and rotates the rudder until pointer (F) is hunted back to the point where it is at equal electrical pressure to (E).

The steering gear is probably the most important item of a ship's auxiliary machinery and a trivial defect in it could result in a collision or grounding and even loss of the vessel. For this reason the steering gear is always generously designed, and the ship's engineers pay particular attention to the maintenance of the steering gear. As a result accidents due to defective steering gears are very uncommon.

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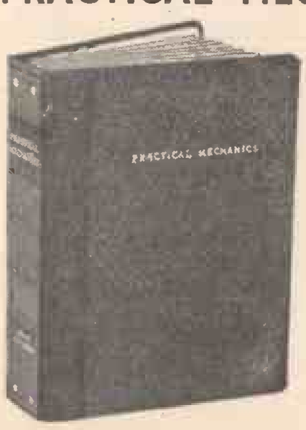

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TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

FLEXIBLE HACKSAW BLADES

J. STEAD and Co., Ltd., Manor Works, Sheffield, announce the introduction of a range of new flexible high speed hacksaw blades under their trade name, "Steadfast."

New "Steadfast" blades.

Sizes are 10in. × ½in. width × ·025in. thickness × 18, 24 or 32 pitch teeth, and 12in. × ½in. width × ·025in. thickness × 14, 18, 24 or 32 pitch teeth.

Flexibility is introduced by hardening the teeth of the hacksaw blades only. By this means, the chances of blade breakage are lessened. It is claimed that the cutting performance is in no way impaired and that these blades will cut any type of steel, as well as withstanding misuse.

NEW FILE AND RASP

THIS latest product of Messrs. John Peace (Steel & Tools) Ltd. of Sheffield will prove a real boon to the handyman and an assett in his workship. The 8in. blade "Handy" file has a strong rasp on one side and a useful file on the reverse. This "two-in-one" addition to the tool chest is made of the finest Sheffield steel and is available at many ironmongers and hardware stores. The price is 3s. 6d.

The "Handy" file.

A. T. SALLIS CATALOGUE

FOR the price of 2s., plus 6d. postage and package, A. T. Sallis, of 93 North Road, Brighton, Sussex, supply a well illustrated catalogue of their range of Government surplus electrical and radio equipment. Possession of this catalogue will save readers much fruitless searching for special ex-Government items.

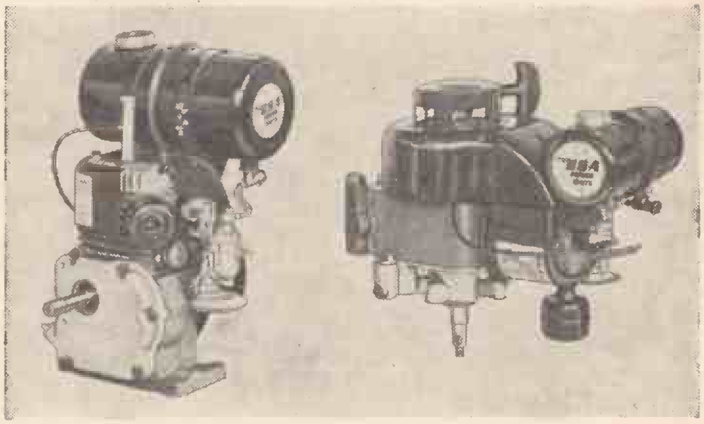
B.S.A. PETROL ENGINES

A NEW range of small petrol engines suitable for lawnmowers, pumps, cultivators, charging sets and similar equipment has been developed by the Power Unit Division of B.S.A. Motor Cycles Ltd. To be known as the "Series 90," the range consists of a basic engine with a number of interchangeable crankcase end-covers. These equip each model for a variety of different operations and enable the unit to work with its crankshaft in horizontal or vertical positions.

An "over-square," air-cooled four-stoke of 87 cc. capacity, the basic engine weighs only 23lb., and develops nearly 2 BHP. It has a specially developed cast-iron crankcase and barrel, with a detachable aluminium cylinder head.

Standardisation of design, and interchangeability of parts between the different models have simplified production and made possible a lower price. These points will also aid spares stockists.

The engines are not yet available on the home market, but it is hoped that they will be in the near future. Details are available from the makers, B.S.A. Cycles Ltd., Power Unit Division, Birmingham, 11.



Two of the new B.S.A. petrol engines.

CARICRAFT BOATS

CARICRAFT, of Love Lane, Chichester, Glos., have sent us a copy of their new 1960 illustrated booklet. It gives details of the whole of their range of boats for the family man and beginner and details of the manner in which they may be used. Their particular speciality is boats which may be carried on the top of a car, though they also supply a boat trailer for the heavier type of boat. Information on various types of engines suitable for use with their boats is also given. Further details may be obtained from the above address.

DAFILE FLEXI-FILE

THIS new dafile flexible saw blade is circular in section with teeth all round. It is sold by the length and can be fitted in standard piercing saw frames. One of the chief advantages is that cuts may be made in any direction merely by pressure; there is no need to alter the angle of the blade. Two grades of blade are available: No. 1 will cut mild steel, duralumin, copper, gold, silver, etc., and in common with No. 2 will cut aluminium, ebonite, Acrylic plastics, hardboard, plywood and other softer materials. A 12in. length costs 2/- and a 36in. length 5/-. The makers' address is Dafiles Ltd., 37 Sheen Road, Richmond, Surrey.

BONDAGLASS LEAFLETS

RESIN-BONDED glass fibre is a very efficient material both for construction and repair work—provided it is used correctly. To avoid its misuse by the amateur and consequent disappointment, Messrs. Bondaglass, 55 South End Croydon, Surrey, have prepared leaflets setting out the correct techniques. Readers who would like copies of these leaflets should write to the Technical Information Department of Messrs. Bondaglass at the address above.

B.M. TORCHES

B.M. hand torches come in two types—Mark I and Mark II. The latter differs only in that its metal body is covered with nylon to obviate sparking with a metal surface in an area containing explosive fumes or inflammable liquids. It complies with the stringent requirements of the Factory Inspectorate. Both torches have an ingenious patented nylon, non-corroding, three-position switch, giving "off," "on," and "flashing."

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NEW RATCHET SCREWDRIVER

Stead ratchet screwdriver.

AS can be seen from the photograph above, the chief feature of this new tool is the pistol grip handle. Made in translucent amber plastic, the handle is insulated and virtually unbreakable. With its 6in. chromium plated blade the tool is comfortable and positive in use. The ratchet action is efficient and robust. The makers are Messrs. J. Stead & Co. Ltd., Manor Works, Cricket Inn Road, Sheffield, 2, and the screwdriver is sold at 10s. 6d. and should be available from your local tool stockist.

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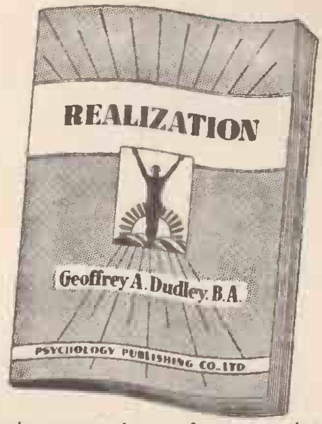

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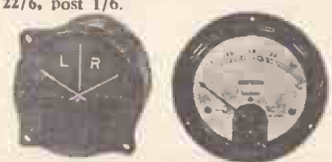
TERMINAL BLOCKS 4/- doz., or box of 50 for 15/-. 3-way, 6/- doz., 50 for 22/6, post 1/6.



METERS GUARANTEED

F.S.D.	Size	Type	Price
50 Microamps	2½in.	MC/FR	70/-
100 ,,	2½in.	MC/FR	60/-
100 ,,	3½in.	MC/FR	70/-
250 ,,	3½in.	MC/FR	55/-
500 ,,	2½in.	MC/FR	37/6
1 Milliamp	2½in.	MC/FR	35/-
5-0-5 ,,	2½in.	MC/FR	20/-
30 ,,	2½in.	MC/FR	12/6
100 ,,	2½in.	MC/FR	12/6
200 ,,	2½in.	MC/FR	12/6
5 Amperes	2in.	MC/FS	27/6
15 ,,	2in.	MC/FR	10/6
25 ,, D.C.	2½in.	MI/FR	7/6
30-0-30 ,,	2in.	MC/FR	15/6
50-0-50 ,,	2in.	MC/FS	12/6
20 Volts	2in.	MC/FS	12/6
40 ,,	2in.	MC/FS	12/6
300 ,, A.C.	2½in.	MI/FR	25/-

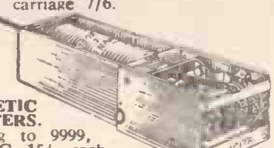
(post 1/6 on all meters)

CROSSPOINTER METER with 2 separate 100 microamp movements, 22/6, post 2/-.

BULKHEAD FITTING. 9in. diam.; flat tripod type, suitable for lamps up to 100 watt, complete with pushbar switch lampholder. Ideal for farm buildings, garages, greenhouses, etc. Brand new, 17/6, post 2/6

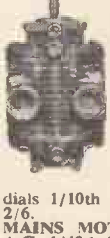
ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C., 50 cy. 135 w. In fitted case with variable resistance. 0/300 voltmeter. The ideal job for television where A.C. mains are not available, £10, carr. 15/-. Special connectors one fitted with 6ft. heavy duty flex and clips for D.C. side. 10/- set, post 1/-.

ROTARY CONVERTER input 12 v. or 24 v. D.C. output 230 v. A.C., 135 watts, £8.10.0., carriage 7/6.



MAGNETIC COUNTERS. Counting to 9999, 6 v. D.C. 15/- each, post 1/6. **HIGH SPEED TYPE No. 100C.** 35/-. Post 1/6. **HIGH SPEED COUNTER** with zero reset 45/-. Post 1/6. **VEEDER-ROOT MAGNETIC COUNTER.** General purpose type with zero reset. 800 counts per minute up to 999,999, 48 volt D.C., 55/-, post 2/6. **MECHANICAL COUNTERS.** Adds ten per complete rev. of spindle, 4 figures, 10/6, 5 figures 10/6, 6 figures 12/6. All post 1/-.

BATTERIES. Portable Lead Acid type 6 volts 125 amp. hours. In metal case 16in. x 18in. x 11in. (Two will make an ideal power supply for our 12-volt Rotary Converters.) Uncharged £6.10.0, carr. 15/-. 24 volt 85 ampere, £14.0.0, carriage 30/-.



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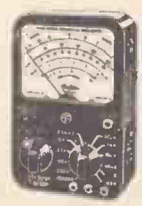

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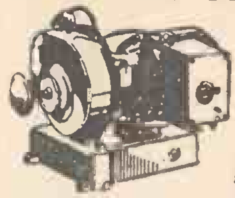

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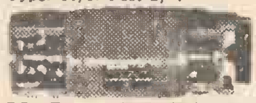
ELECTRIC HORNS. Standard 12 v. Car Type. 14/6. Post 2/-.



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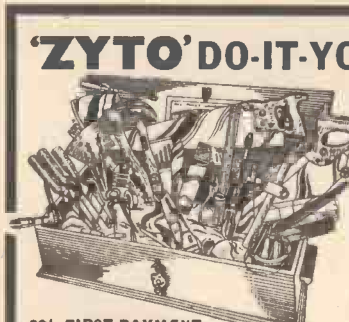

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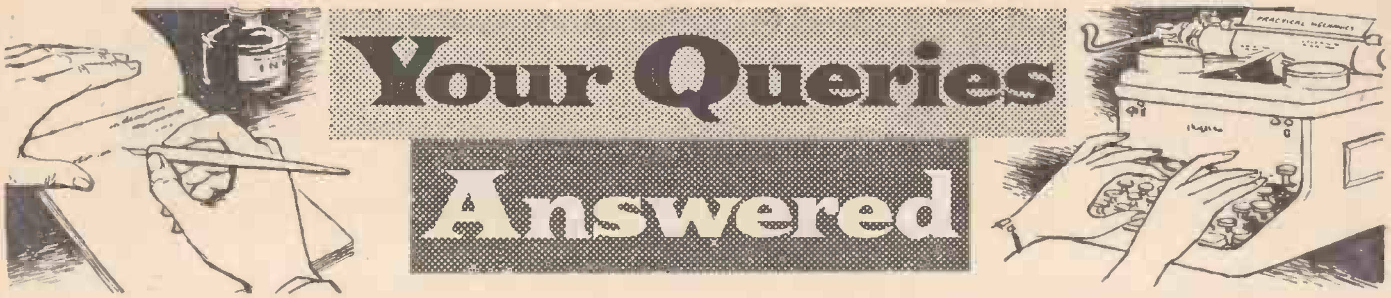

Casting Polythene

CAN you tell me how to mould and/or cast in polythene? I have heard that Polythene can be moulded or cast by using some form of granular crystals which, when heated to around 199 deg. C. fuse and become solid, expanding slightly so as to take excellent detail from the mould. Also where may I obtain genuine sawdust flour?—W. C. Marshall (Aberdeen).

THE most effective method of making articles from Polythene is injection moulding, and it is presumably this process that you have in mind. The material is used in granular form and fuses when heated, but great pressure is needed to force it into the mould (normal thermal expansion of a granular material, without pressure being applied, would not be enough even to fill completely the interstices between the grains). The equipment required is expensive and elaborate and suited only to large-scale factory production. You will do better to use cold-setting resins that can be poured into the mould, such as those supplied by (among others) Quality Plastics Ltd., Brentwood, Essex.

Wood flour is very bulky and expensive to transport, and we suggest that you contact your local Chamber of Commerce to ascertain a source near at hand. Normally wood flour is used as a filling only in the opaque thermosetting resins, and not in the translucent thermoplastic resins to which your first query refers.

Oak Strip Flooring

PLEASE give details of the method used in finishing oak strip flooring which has been overlaid on existing T. & G. flooring. This oak strip flooring has been scraped and sanded and I would like information on how to obtain a durable polish. I believe this can be achieved by the use of polishes and linseed oil. Do you recommend that any filler should be used?—J. Goodier (Wolverhampton).

IT is not necessary to use a filler.

A very good polish can be achieved by giving the floor two coats of french polish, applied with a brush. When dry, rub down with a very fine glass paper. Finish off by applying wax polish to build up a good surface.

We do not advise the use of oil because it is inclined to be very long in drying properly and also it requires hard work and a very long time to bring to a high polish.

We should like to draw your attention to a new plastic polish now available. This is "Converto-Lac 204" and is specially made for floors. It will resist water, grease, dirt, etc., and the floor never needs wax polishing. It is easily applied by brush. Full details from Plastic Polishes Ltd., 163 Holland Park Avenue, London, W.11.

Removing Mortar

I HAVE built a fireplace with rough faced bricks and red sand faced tiles, using sand, lime and cement bond in 4-1-1 proportions. Any of the mortar which by accident got on to the tiles or bricks I brushed off at once with a stiff brush and cold water and at the time this appeared to be effective. Many of the bricks and tiles are now showing considerable traces of mortar where brushing has occurred. Could you suggest a method of removing these traces of cement mortar, or, failing a satisfactory solution to recommend suitable dyes to bring back the colour of the tiles.—C. R. J. Jacks (Wales).

YOU will be able to remove the traces of mortar from your fireplace with a 10 per cent. solution of hydrochloric acid. Use rubber gloves, apply with a rag, and wash or sponge off with clean water afterwards.

If you find you need a dye afterwards, you can get a variety of colours from Feb (Gt. Britain) Ltd., 102 Kensington High Street, London, W.8.

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 on the inside of back cover, 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.

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The above blueprints are obtainable, post free, from Messrs. George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

*An * denotes constructional details are available free with the blueprints.*

Steamproofing a Mirror

CAN you recommend or suggest a preparation for application to the back of a mirror which is kept in a moist and steamy position? The ordinary commercial paint or preparation seems to fail after about 18 months in use and the mirror has to be sent for resilvering. Would a cellulose base paint of some sort applied with a brush meet the case?—W. Easton (Leeds).

A VERY effective and readily applied waterproof backing for mirrors can be made with transparent polythene film. This is an I.C.I. product made by polymerising ethylene gas under high pressure. It is tough, chemically inert, strong, and is impenetrable by water or water vapour.

For your particular purpose, you will be able to obtain small rolls of 1in. wide polythene strip material, the material being coated on one side with a self-adhesive material. These rolls are manufactured by Herts. Pharmaceuticals, Ltd., Bessemer Road, Welwyn Garden City, Herts. They should be applied to the mirror-back in overlapping lengths, the strips being well pressed down. Once having adhered to the mirror-back, the strips should not be removed, otherwise they will tend to bring away some of the mirror silvering with them. The strips are available in different widths up to about 4in. Provided that they are applied to the mirror-back with reasonable care, we can well recommend them. The plain polythene film can be obtained in large sizes and in varying widths from your local I.C.I. depot at Leeds under the trade-name of "Alkathene" tissue. The same firm also markets a transparent adhesive for use with the tissue.

Removing Rust from Steel Sheets

PLEASE tell me the best method of removing rust from steel sheets of which my garage is built, these were roughly cleaned with a steel wire brush and painted with black bitumastic paint and then painted battleship grey. This is now blistering and on breaking these blisters, rust has formed beneath them.—J. W. Chapman (Morpeth).

THE best way of treating the steel sheets is to burn off all the old paint by means of a blowlamp. The sheets should subsequently be scraped clean and, if possible, sandpapered, great care being taken to remove any areas of rust. Such areas can only be cleaned by means of some abrasive treatment with a scratch brush. The method of abrasive removal, although slow, is the most satisfactory.

We suggest that, after efficient derusting, your steel sheetings should be painted with "Leadium," which is a metallic lead paint manufactured by Messrs. Lewis Berger & Co. Ltd., Homerton, London, E., after which two surface coats of a black or coloured bitumastic paint or a "straight" bitumen paint should be applied to give a weatherresisting finishing coat. The former may be obtained from Wailes Dove Bitumastic Ltd., Collingwood Buildings, Newcastle, Newcastle-upon-Tyne; the latter from British Asphalt and Bitumen, Ltd., The Docks, Preston. Lancs. Both paints are excellent products and are much cheaper than ordinary paints.

Before commencing this work, however, we suggest that you obtain a copy of "Post-War Building Studies, No. 5." This is an official pamphlet of "The Painting of Buildings which is published officially for the Ministry of Works by H.M. Stationery Office, price about 1s. You should be able to obtain a copy direct from H.M. Stationery Office, Kingsway, London, W.C.2.

Reversing an Induction Motor

I HAVE in my possession a ¼ h.p. induction motor, manufactured by an American company. I use the motor generally for sanding, polishing, buffing, etc. For drilling purposes the motor runs the wrong way round, e.g. like a left hand drive. Can the motor be made to run the other way round, as I want to adapt it, if possible to run a flexible drive for drilling. The motor is a ¼ h.p. A.C. 50 cycles. 1,450 r.p.m. If the motor can be altered, could you also suggest a method of fixing a drill chuck to the spindle?—James Siddelley (Cheshire).

WE presume that the machine is a single-phase split-phase starting induction motor having an internal centrifugal switch connected in series with the starting winding, and that it has no capacitor. In this case the motor may have two terminals, but it will only have two windings, one for starting and the other for running. There will then probably be four leads to the windings from the motor terminals. Such a motor can be reversed by simply reversing the connections of the two leads to one of the windings.

Your difficulty may be experienced in identifying the two leads to either stator winding. We suggest that you disconnect the four leads from the motor terminals, putting a tag on each to indicate which terminal it was connected to. Then connect two flexible leads to the terminals of a lamp switch on your lighting installation, after switching off at the mains. Then switch on again. Apply these two testing leads to pairs of the motor leads in turn. With a suitable size of lamp in the holder controlled by the switch the lamp will light when connected to the two leads to one winding. Reconnect the other two leads to the original motor terminals. The other two leads which you have then confirmed are connected to one winding, should be connected to the opposite terminals to before.

Binocular Query

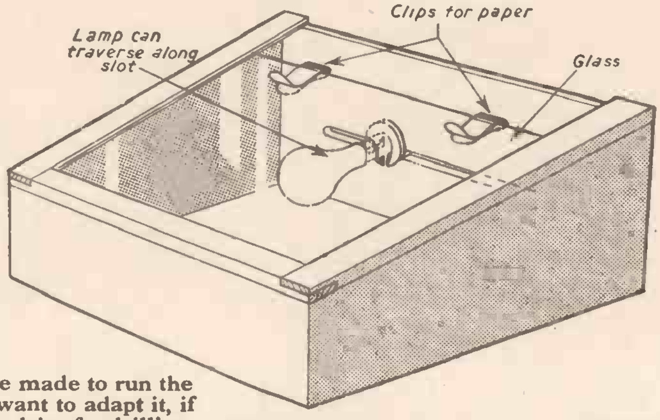
ON the right hand side of my binoculars there is a row of alternate long and short lines. Marked on the metal on the left side is C.G.B. 53 G.A. 6 × 30. 33785-C. The right side is marked Graticule ½ deg. apart and ¼ deg., ½ deg. and 1 deg. high. R.E.L./Canada 1944. Could you please tell me what the lines and various markings mean?—G. McLean (Durham).

THE "6 × 30" indicates that the magnification is six times, and that the object lens is 30mm. in diameter. The latter figure is given, with binoculars, as it shows the light-gathering capacity.

The graticules show the angle of objects viewed, from ½ deg. horizontally, and ¼ deg. vertically. Such scales are primarily for military purposes. If the size of certain types of aircraft, ships, etc., be known, then their distance from the observer can be calculated by knowing the angular field they occupy, as on the graticule scale. The scale has little use for ordinary viewing. But you may note that if a normal human figure extends over 1 deg. on the scale (e.g., 1 deg. high line) his distance away is approximately 350ft.

A Tracing Box

I SHOULD be grateful if you could tell me how I may make a tracing box, of the type used by draughtsmen—F. E. Hall (Sheffield).



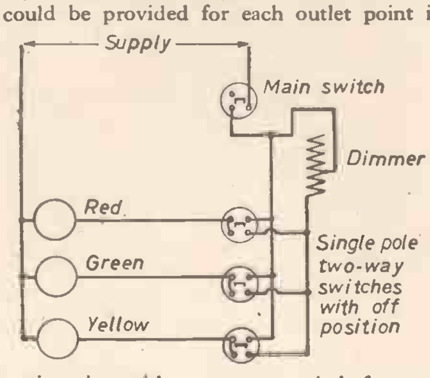
THIS can be in the form of a light box, which can be simply made of wood, as shown above. The glass top is open along the back so that clips can be used for holding the original and tracing paper. The lamp is on a bracket which may be traversed from side to side. With the light shining through, tracing graphs or other originals becomes a simple matter. The sketch above shows construction.

Stage Lighting Panel

I HAVE been asked to design a lighting panel for a stage. It is to be mobile, to be plugged into a 15 amp. point and to have the following:—eight outlet points; wired so that all or none of these can be brought into a dimmer; each outlet point to be wired so that three switches are in circuit and that any of three colours can be switched on, yet so wired that these can be bye-passed to a main switch for that point.

If these cannot be handled on one dimmer what is the minimum needed?—A. M. Hodson (Hants).

IT appears that in order to obtain satisfactory results you will require eight dimmers, one in each outlet circuit. One main switch could be provided for each outlet point in



conjunction with a separate switch for each colour of lamp. If you require to be able to switch each lamp instantly from the dimmer to full strength, each outlet circuit could be controlled by means of a single-pole two-way switch as indicated above, each having an "off" position.

Wood Flour

I AM interested in the use of wood-flour for the manufacture of wood toys, particularly forts, which I hope to cast in sections. I have tried using cast-wood, supplied ready for mixing, but am disappointed with the results. Would the addition of more wood-flour give it greater impact strength?—Thos. W. E. Longridge (Durham).

WOOD-FLOUR mixtures of this sort are characteristically brittle and are not well suited to the manufacture of such large articles as toy forts.

The addition of more wood-flour will reduce, not increase, the impact strength. The only way you can increase the strength when casting the material in thin sheets is to incorporate a fibrous or, preferably, woven filling. Thus you might coat strips of butter-muslin with the material, on both sides, and mould them over a former of appropriate shape to harden.

A stronger material, not castable but readily mouldable, can be made by mixing coarse sawdust with your wood-flour and mixing to a stiff paste with thin glue. This should be pressed very firmly into the mould, or on to the former, with a broad pallette knife or a small plasterer's trowel. Formers should be built up from several pieces, as there is considerable shrinkage as the material hardens. When quite hard the parts should be painted inside and out, as otherwise they readily take up atmospheric moisture.

An Electric Furnace

(Concluded from page 285)

The Spy-hole

A spy-hole is a useful feature because it performs a dual function—it enables a user to gain some idea of what is going on inside the furnace without repeatedly opening the furnace door, and it also allows the insertion of the pyrometer when obtaining the temperature of the chamber. The construction is simple; a flat plate is bored about 1in. dia. and the hole is covered over with a circular piece of mica which is held in position by a thin brass cover plate. The mica and plate are recessed for the sake of appearance and four 4 BA screws hold them in position. This item is shown separately in Fig. 3.

Set the furnace up in an odd corner of the workshop away from the rays of the sun. This situation gives a steadier light by which to judge the hardened details. There is generally no need to disconnect the electric plug. The usual style of switch can be used, although a somewhat more robust type than this is preferable. The detail on the end of the cable can be the purchased item, and if the centre distance between the holes is measured the holes drilled in the Tufnol plates (Fig. 3) are then easily matched.

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Details for making a Pyrometer will appear in a subsequent article together with details on calibrating it.

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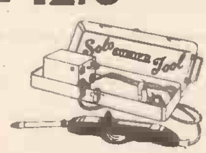

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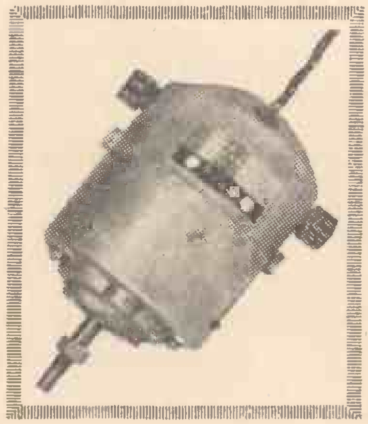

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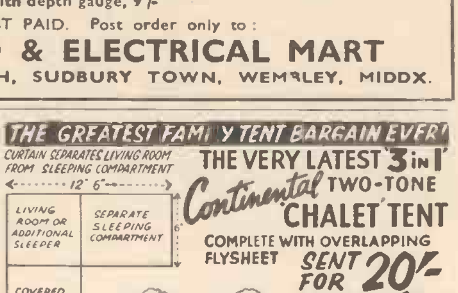

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Ratefixing & Estimating	Telecommunications
Time & Motion Study	Wiring & Installation
Engineering Inspection	Television
Metallurgy	Radio Servicing
Refrigeration	Gen. Elec. Engineering
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