Building a Tape Recorder

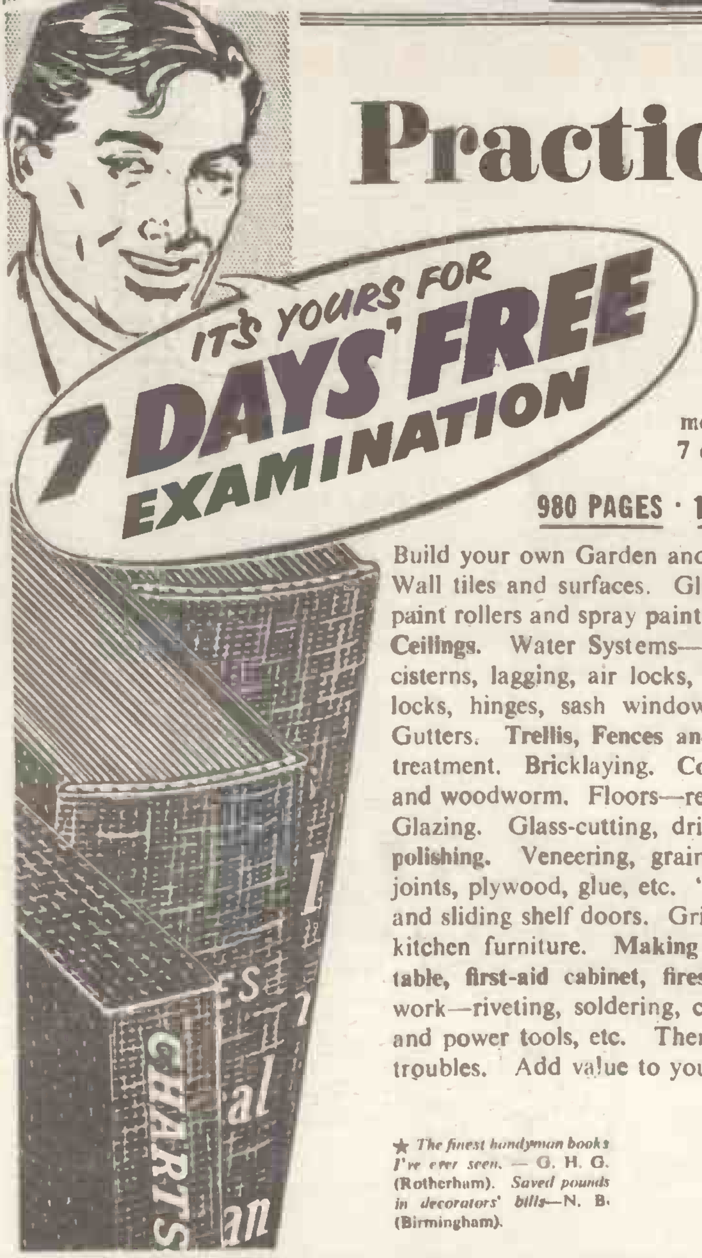
1'3

PRACTICAL MECHANICS

OCTOBER
1959

CONTENTS

NEW DO-IT-YOURSELF SET!



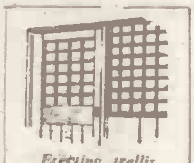
NEWNES

Practical Handyman

A THOUSAND-AND-ONE AIDS IN TWO HANDY VOLUMES TO PUT VALUE ON YOUR HOME

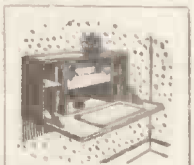
Here is Newnes Do-it-yourself set for your bookshelf for constant guidance—every facet of repair, redecoration, renovation and how-to-make in two handy volumes. The whole work is written in simple language and you'll save money on every job you carry out ! Examine it and profit by it for 7 days—you will learn much in this way without cost or obligation.

980 PAGES · 153 SECTIONS · 1,600 PRACTICAL ILLUSTRATIONS



Erecting trellis fence and door.

Build your own Garden and Tool shed. Paperhanging schemes. Plastic Wall tiles and surfaces. Glazed tiles. Wall plugs. Painting—including paint rollers and spray painting, etc. Plastering. Distempering. **Decorating Ceilings.** Water Systems—repairing burst pipes, tap washers, flushing cisterns, lagging, air locks, etc. **Drainage faults and remedies.** Doors, locks, hinges, sash windows, skylights. Roofing and slating sheds. Gutters. **Trellis, Fences and gates.** Water Butts. Paths. Damp wall treatment. Bricklaying. **Concrete work—mixes, pebble-dash, ornamental.** Dry rot, wet rot and woodworm. Floors—repairing, staining, polishing, laying lino and carpet. Glass roofs. Glazing. Glass-cutting, drilling and frosting. **Varnishing, Enamelling, Lacquering, French polishing.** Veneering, graining, marquetry. Carpentry—tools, timber, joints, plywood, glue, etc. "Perspex" work. **Built-in furniture.** Shelves and sliding shelf doors. Grinding. Re-upholstering and repair. Making kitchen furniture. **Making deck chair, bookcase, bedside table, folding table, first-aid cabinet, firescreen, etc.** Making leaded lights. Metal work—riveting, soldering, cutting, beaten copper work. Electric defects and power tools, etc. There is even money-saving information on car troubles. Add value to your property by seeing this big set now.



Make this attractive wall desk—such a space-saver, too!

★ *The finest handyman books I've ever seen.* — G. H. G. (Rotherham). *Saved pounds in decorators' bills*—N. B. (Birmingham).

CLAIM FREE EXAMINATION BELOW

Act Now—a set of Newnes Practical Handyman and Charts will be sent carriage-paid for 7 days' examination—if you retain it the Stanley handyman knife, worth several shillings, is yours as a free gift.

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Please send me PRACTICAL HANDYMAN without obligation to purchase. I will return it in 8 days or send 10/- deposit 8 days after delivery *and you will then send the Free Stanley Knife.* Thereafter I will send 10 monthly payments of 10/-, paying 110/- in all. Cash in 8 days 105/-.

Mr., Mrs., Miss ....

Address ....

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Occupation ....

Your Signature..

(Or Parent signs if you are under 21) **HA 149**

Tick (√) where applicable

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Householder	
Living with Parents	
Lodging Address	

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Full data and drawings for : Gate Leg Table - Bureau - Bookshelf - Garden Seat Garden Chairs - Garden Table - Bathroom Stool - Bedside Pedestal - Model Coaster - Firescreen Table - Model Yacht - Corner Cabinet Writing Desk Hall Telephone Desk - Model Electric Launch - Table Lamp - Doll's House

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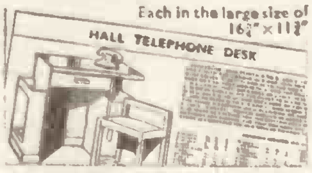

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Famous STANLEY Trimming Knife

Complete with two double blades and special extra blade for garden work.

The Stanley Knife will:— cut and trim cardboard, wallboard, leather, roofing materials, linoleum, carpets, wallpaper, upholstery materials, plasterboard, polythene, veneer, rubber, rope, canvas, packing materials, etc. Worth several shillings, it's yours free!

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TRIPLE PURPOSE SET

The Johnson "Vogue" dishes come in sets of three and are separately coloured: Orange, Grey, White. By these colours you will identify them for each processing job and retain them for specific chemicals. Strongly moulded in plastic, they are available in half plate and whole plate sizes: Prices:

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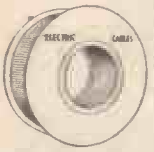


Single-strand 18-gauge with P.V.C. covering which makes it rustproof. Extra strong, will stand tremendous strain. Ideal for gardening, clothes lines, indoor aerials, etc. etc. Also being steel alloy and having a resistance of approximately ½ ohm per yard this can be used for electrical work, soil heating, wrapping round water pipes, etc. New on drum containing 3,000ft. Price 9/6, plus 3/- carr.

"Dim and Full" Switch

Particularly useful for controlling photo-flood 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 operational shots. Also useful for controlling night lights, heaters, etc., etc. Price 2/6 each. S. post 9d. Circuit diagram included.

Hi-Fi Snip Infinite Wall Baffle

Gives really superb results with only a low-priced 8in. speaker cut-out for tweeter, nicely veneered with fabric speaker enclosure. Corner fitting, can be attached to Picture rail. Only 45/-, carriage and insurance 3/6.

Speaker Bargain

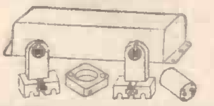
12in. Hi-fidelity loudspeaker. High flux. Permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price 32/6, plus 3/6 post and insurance. Ditto 8in. Hi-Flux, 27/6.

This Month's Snip

Car Starter Battery Charger

Due to a fortunate purchase we are able to offer you a fine ready-made high output battery charger in stove enamelled sheet steel louvred case. New, complete and ready to work, this charger is rated at 12 v. 4 amps and has a variable rate selector for trickle charging, also a meter to show charging rate. Suitable for 230/250 A.C. mains. Made to sell at 85/-, but offered this month at special snip price of 55/-, plus 3/6 post and insurance.

Fluorescent Kits



Complete kits of parts less tube for fluorescent lighting. Comprise five items as follows: best quality impregnated choke ballast unit, canister starter, starter holder, two lampholders.

40 watt ... 19/6, plus 2/6 post.
80 watt ... 24/6, plus 2/6 post.

These kits are for strip tubes, but if you wish to use circular tubes then the prices are:

Circular 40 watt ... 21/-, plus 2/6 post.
Circular 80 watt ... 25/-, plus 2/6 post.

Complete ready to work fluorescent fittings, beautifully made, stove enamelled white; all have polyester filled chokes and fitted interference suppressors.

5ft. 125 watt ...	59/6
5ft. 80 watt ...	39/6
4ft. 40 watt ...	32/6
Circular 40 watt	49/6
Circular 80 watt	59/6
2ft. 20 watt ...	29/6
3ft. 40 watt ...	31/6
21in. 13 watt ...	32/- (miniature tube)

Note these prices do not include tubes and represent only a selection of our complete range of which a list is available on request. (Special Snip Offer: 40 watt, complete with tube, 39/6.) If ordering by post add carriage and insurance: up to 150 miles 5/6, up to 250 miles 7/6.

Medresco Hearing Aid

As supplied by National Health, completely overhauled and in good working order with six months' guarantee. Only £3/15/0, plus 2/6 post and ins. Complete with earphone and new ear plug but not batteries, these can be supplied as an extra for 5/- per set. Superior model—new—higher gain—and self-contained batteries £7/10/0, or 10/- deposit and 15 fortnightly payments of 10/-.

Stereo Outfit

Stereo Amplifier outfit comprising 7 watt twin channel amplifier for A.C. mains working and two 8in. P.M. Speakers on veneered and polished corner baffles. Whole outfit giving really terrific reproduction and amazing 3D effects. £14 complete, plus carriage and insurance. Or £1 down and 28 weekly payments of 10/-.

Gyro by Sperry

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Brand new in original air sealed packing, probable cost around £50 each. Our price only 15/-, plus 2/6 post.

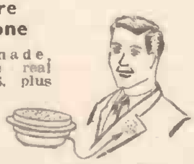
A.C./D.C. Multimeter Kit

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.

For Portable Radio or Player

This fine cabinet as illustrated but less control knobs is available this month at a special snip price of 12/6, plus 3/6 post and insurance. Size is 13½in. x 9in. x 4in. and it is nicely covered in two-tone I.C.I. fabric.

Miniature Microphone



American made, Dynamic type real bargain at 1/6, plus 6d. post.

Band III Converter Kit

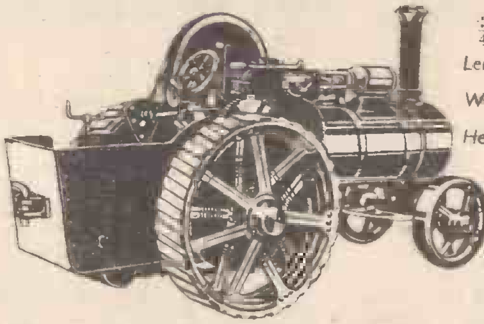
Suitable Wales, London, Midlands, North, Scotland, etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra.) Price only 19/6, plus 2/9 post and insurance. Data free with parts or available separately 1/6.

Please send two more kits, the one you sent last week is performing magnificently.

We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.

Electronics (Manor Park) Ltd. 520, High Street North, Manor Park, E.12.	Electronics (Ruislip) Ltd. 42-46, Windmill Hill, Ruislip, Middx. Phone: RUISLIP 5780 Half day, Wednesday.	Electronics (Croydon) Ltd. 266, London Road, Croydon. Phone: CRO 6558 Half day, Wednesday.	Electronics (Finsbury Park) Ltd. 29, Stroud Green Rd., Finsbury Park, N.4. Phone: ARChway 1049 Half day, Thursday.

Build this WORKING BURRELL TYPE TRACTION ENGINE



¾ INCH SCALE

Length 14¾ in.

Width 6⅛ in.

Height at chimney 8¼ in.

What could be more delightful to build than a Road Tractor? Yet even enthusiasts hesitate to tackle this type of model because of the intricacies in design and casting, especially of the road wheels. This set of castings is planned to give all the pleasure of construction without the more tedious work. The road wheels are single castings and need only machining and filing.

Set of four sheets of drawings, 14/6

"How to Build a Traction Engine," a fully illustrated booklet on this model can be supplied on request. Price 1/-.

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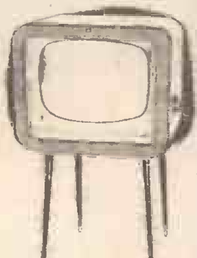

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- 13 Channels. "Turret Tuned"—ITV/BBC. Extra coils at only 7/6 a pair (with order).
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★REPLACEMENT RE-BUILT T.V. TUBES—£8.10.0. 12 months full guarantee. All sizes except 10in. Carr. & Ins. 15/6. Or yours for 8/6 initial payment (plus carr. & ins.) & 19 weekly payments of 8/6.

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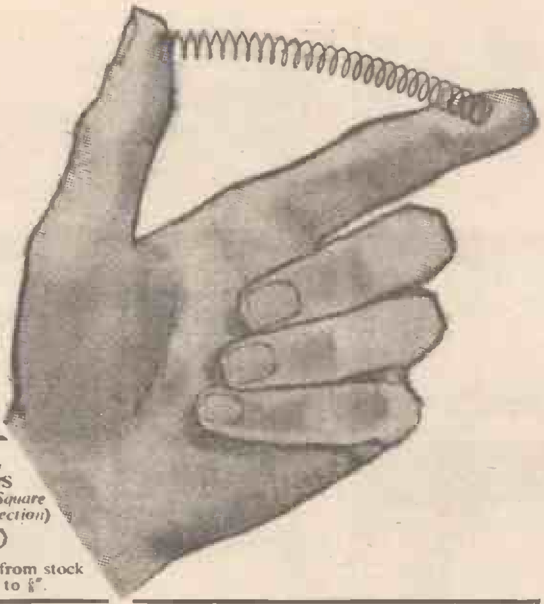
Then you'll find it down below



Whatever you need in the way of springs you'll find in the range of TERRY'S BOXES OF ASSORTED SPRINGS — compression, expansion, long, short, light, heavy—the lot.
Just the job for you experimental people—a simply unlimited assortment from our tremendous range of springs of every variety. The boxes shown here are only a few examples—why not let us send you our illustrated list showing them *all?*

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No. 98A. 3 doz. Assorted 1" to 4" long, ½" to ¾" diam., 19G to 15G. 5/6 each.

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No. 1024. 20 Compression Springs. 12" long ⅛" to ½" diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansion 1½" to 12" long, 5/32" to ⅜" diam., 22G to 16G. 24/- each.

* Interested in Springs? Ninth Edition of "Spring Design & Calculations"—post free 12/6.

No. 758. Fine Expansion Springs. 1 gross Assorted ⅛" to ⅜" diam., ½" to 2" long, 27 to 20 S.W.G. 15/- each.

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(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

*** Have you a Presswork problem?**
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EYEPIECES. 1¼in. in focusing mount, 8/6. ¼in. orthoscopic push in mount, 17/6. ¼in. extra W.A. ortho in focusing mount, 50/-. Stacks of others. See our new lists.

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You see, it locks on the job at any pressure you wish, leaving both your hands free. Just touch the release lever and—presto!—it's ready again for the next job—super pliers, vice, clamp, wrench all in one tool—the versatile, indispensable Mole Wrench.

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From Ironmongers, Motor and Motor Cycle Accessory Dealers.

Make sure you ask for a genuine MOLE Self Grip Wrench, and look for the name on it.

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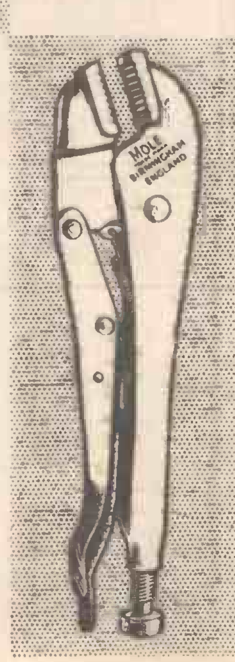
If any difficulty write to M. MOLE & SON LTD., B'HAM, 3.



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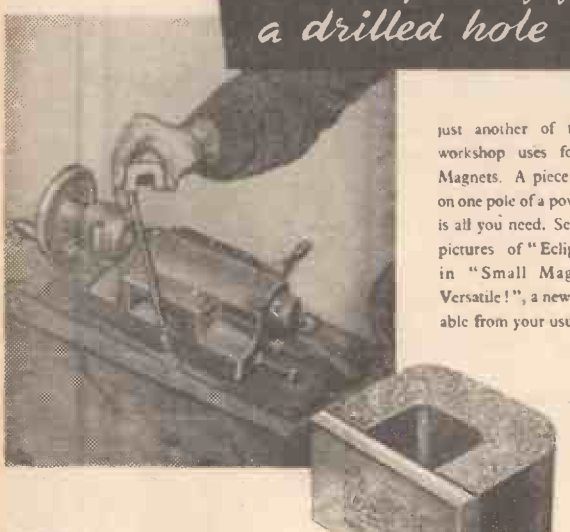

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CONTRIBUTIONS

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Mechanics." Such articles should be written on one side of the paper only, and should include the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

FAIR COMMENT

HOBBIES COMMERCIALISED

THE higher standard of living and shorter working hours enjoyed by people of this country has enabled many more to take up hobbies of one kind or another, and so marked is this tendency that many large industries have grown up as a result. Many years ago, the only hobbies practised at home were simple ones, using natural materials and few tools. There was no industry catering for the home worker and neither was the home worker, on the other hand, catering for industry, i.e., looking for a market for his products. The whole outlook of the hobbyist has changed. A great many modern hobbyists buy expensive tools and designs and sell the end products to pay for them, often at a profit. This is a very level-headed approach to leisure and one which we applaud and do our best to help.

The great change in the character of hobbies is reflected in the pages of PRACTICAL MECHANICS, as our policy is not merely to keep up with the changing taste of our readers but in many cases to be ahead of it and if our readers have any suggestions for future articles, we should be pleased to hear from them.

One of the greatest of modern interests is the home construction of radio apparatus and sound reproduction equipment and in this issue appear two articles catering for this body of enthusiasts. One of the articles, "Sound Reproduction," is an introduction to the subject for those of our readers who have not so far experienced its fascination, and the other, which is simply explained with point-to-point wiring diagrams, is the first of a short series describing a modern tape-recorder with many refinements.

As a contrast in the field of hobbies, an article on making, or rather assembling, jewellery at home appears and this is a hobby that, in addition to providing an absorbing spare-time occupation, will furnish beautiful and decorative brooches, rings, pendants, etc., for the lady members of the family and for friends.

These articles for the modern hobbyist are merely two examples of the many which appear in PRACTICAL MECHANICS and it is chance that they illustrate so readily the commercialisation of modern leisure. Large and efficient firms cater for the amateur in both fields and both can also be turned to the profit of the enthusiasts themselves.

Most enthusiasts, whatever their own particular hobby, eventually become ambitious enough to originate their own designs. It is when this stage is reached that the hobby can be made to pay twice. Articles written by experienced craftsmen embodying new ideas are always welcome in this journal. Adding to your income by means of spare-time writing is not as difficult as it might at first appear. All that is necessary as the raw material is a clear step-by-step description, some photographs and rough pencil sketches. The staff of PRACTICAL MECHANICS will turn it into an interesting article. The payments from this spare-time occupation could earn you enough money to expand your own hobby even more and in addition you will know the fascination of seeing your work in print. Why not try it ?

THE FUTURE OF THE POST OFFICE

THE Post Office is responsible for the delivery of all letters and telegrams and for the working and maintenance of the whole nation-wide network of telephones. It also owns and maintains many of the land lines used by television and radio. It is our absolute dependence on these functions that makes the views of the President of the Post Office Engineering Union important to everyone and, in his opinion, the future of the Post Office is being threatened by lack of capital.

This is the century of technological advance, of the discovery of flight, of radio and of the rocket and the atomic bomb. It is essential, therefore, that the Post Office should be allowed, even encouraged, to keep pace with modern developments and inventions. Scientists have told us that the in the not-too-distant future we shall be able, by means of television, to see as well as talk to our friends merely by dialling a number. Technologically this is a long way off, but the progress of the Post Office towards this and other visions of the future must not be hindered by lack of money.

The November, 1959, issue will be published on October 30th. Order it now!

G. R. Gilbert Describes

MAKING A LOW PRESSURE SPRAY GUN

It Can be Used on a Vacuum Cleaner

THE spray gun described in this article is for use on low pressure as is delivered at the exhaust end of a vacuum cleaner. The original was made from an old brass cycle pump, some pieces of copper tube and a screw-top (Horlicks) jar.

Construction

Start by cutting the tube (1in. o.d.) as in Fig. 1. The top tube has an angle cut at one end and two openings in it, a ¼in. dia. hole and a ⅝in. square hole. The handle tube is plain except for the angle at the top where it is to be joined to the top tube. The short length joining the top tube and the container lid has its top end filed with a half-round file to fit the contour of the top member. These three parts are soldered together. Soft solder was used in the original because of the light gauge metal used. If heavier gauge copper tube is used it may be as well to silver solder the parts.

The Paint Tube

This is made in two parts, the horizontal part being 5/16in. o.d. This part has the jet formed on it in the following manner. Soften the end of the tube by heating red hot and cooling slowly. Take a piece of steel rod of such diameter as will fit inside the copper tube and grind or file a point on one end. Insert this rod up the tube and gently hammer the copper round it, it will shape quite easily if it has been softened properly. Shape up the outside of the tube to give a fairly gradual taper. Drill the jet out to 3/32in. and drill the ¼in. hole in the position shown and solder over it a ¼in. B.S.F. nut. This is to take the vertical length of paint tube.

The end opposite the jet is plugged with brass and drilled centrally ⅛in. to take the jet needle (a brass terminal nut was used in the original).

The second part of the paint tube is ¼in. o.d., tapped ¼in. B.S.F. and is of sufficient length to reach to within ⅛in. of the bottom of container.

The Jet Needle

This is made from a length of ⅛in. dia. silver steel, with a fairly long point ground on one end and tapped 4 B.A. thread at the other. Put this needle in the chuck of the drill and insert it in the jet tube. Pressing on the point, grind a seating for the needle inside the jet. No grinding paste is needed as the steel will form the copper into a good enough seating. There is very little pressure behind the paint.

Place the horizontal part of the paint tube inside the top main tube and screw in the other part through the hole in the main tube. Centralise the jet and solder up the point where the tube comes out of the hole.

The holes are cut in the lid of the container which must be of tinplate and not aluminium, as this will not solder. The holes correspond with those in the underside of the top main member. Push the paint tube through the ¼in. hole in the container lid until the large diameter tube sits flat on the lid, solder round both joints. Fig. 1 shows all parts to be soldered.

The hole for the exit of the needle has been left till now as it is rather difficult to drill accurately. The needle must be quite free to move in and out.

Mark the position of the hole approximately by extending the centre lines of the top tube round the back of the handle. Drill a ¼in. hole, which will allow the needle to be fitted, then solder a small patch with a ⅛in. hole over the ¼in. hole, using the needle as a guide.

The Trigger

The trigger is made up from ⅛in. sheet brass as in Fig. 1. The small block of brass is drilled with a 2 B.A. clearance hole and soldered in position on the handle of the gun. The forked end of the trigger engages with the two 4 B.A. nuts on the needle. The trigger bearing against the front nut closes the jet and bearing on the back nut opens it. By adjusting the back nut the amount the jet opens can be varied.

The Nozzle

Select a piece of tube which is a good push-fit over the front of the main tube, or roll one from thin brass. Cut a disc of copper to fit and dish it slightly by hammering with the ball end of the hammer on a block of wood. Solder the disc to the tube. (The disc has a ⅜in. hole in the centre.) By moving the nozzle towards or away from the jet the spray pattern can be varied. Start with the jet projecting about ⅛in. through the nozzles

Air is fed from the outlet end of the vacuum cleaner to the handle of the gun, the nozzle restricts the air and creates a slight pressure on the surface of the paint in the container, sufficient to raise the paint up the paint tube to the jet. When the trigger is pressed the needle is withdrawn and allows paint to come out of the jet. The air rushing past the jet atomises the paint into a mist. Releasing the trigger shuts off the paint supply, the needle being loaded by a rubber band to close when the trigger is released. To get the best results, the nozzle and the nut at the end of the needle are adjusted to control the amount of paint supplied. A very small jet opening is required.

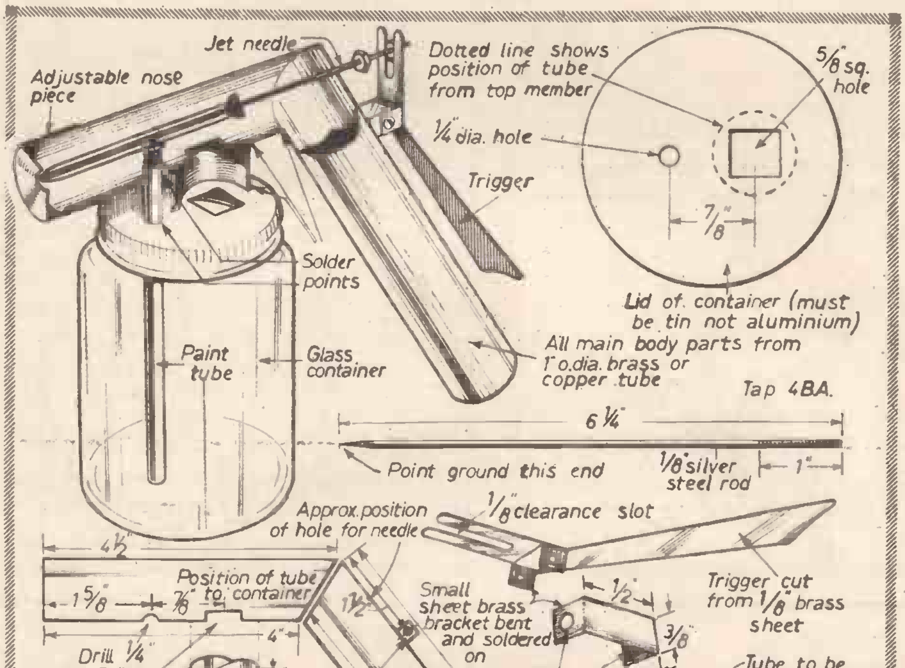
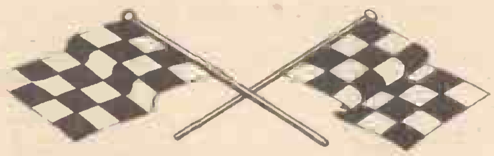
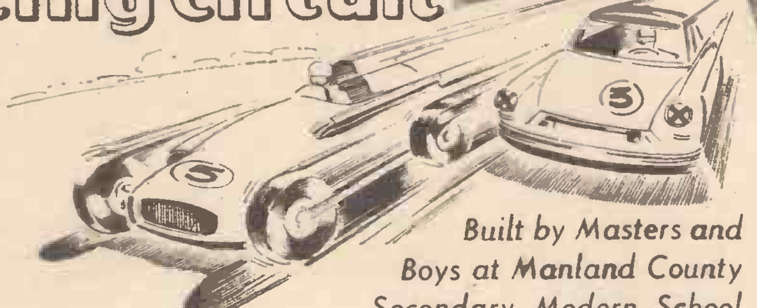


Fig. 1.—A cut away perspective view and details of the spray gun.



An Electric MINICAR Racing Circuit



By G. K. Jarvis

Built by Masters and Boys at Manland County Secondary Modern School

THE completed track has to be fairly light yet strong, and as there was no permanent home for the original track it had to be easy to transport. It actually resides on two hooks hanging from the roof of a workshop.

The main frame is made up from 3in. × 1in. softwood with two additional centre bars. The size fixed takes three sheets of hardboard 6ft. × 4ft.

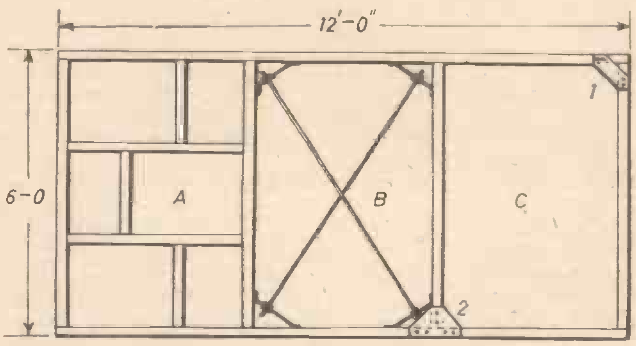


Fig. 1.—Details of the main frame.

The additional bars shown in section A, Fig. 1, are pieces 2in. × 1in., placed in all sections as additional support for a hardboard surface. The bars shown in section B, Fig. 1, were fixed in the centre section only and are $\frac{1}{4}$in. dia. M.S. pulling in tension on plates made from 1in. × $\frac{1}{8}$in. flat M.S. Section C, Fig. 1, shows at (1) an angle plate made in 16 s.w.g. aluminium which is fixed to all corners, and at (2) an aluminium plate, screwed to all inside joints corresponding with ends of tension bars.

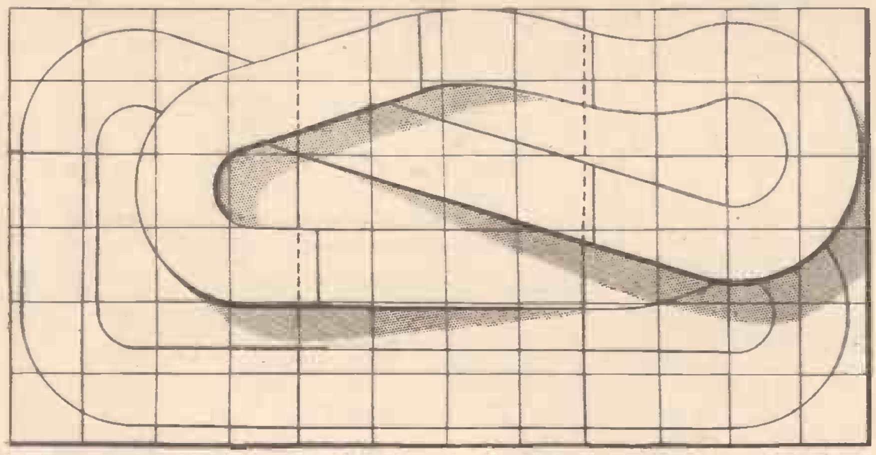


Fig. 2.—The track route as set out on graph paper.

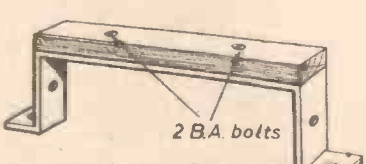


Fig. 3.—The raised sections of the track are supported on brackets.

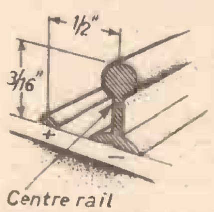


Fig. 4.—Details of the rail used.

The Track

The actual track route was designed on graph paper (Fig. 2) and, before fixing the first three sheets of hardboard, the track was marked out on the surface and the roadway

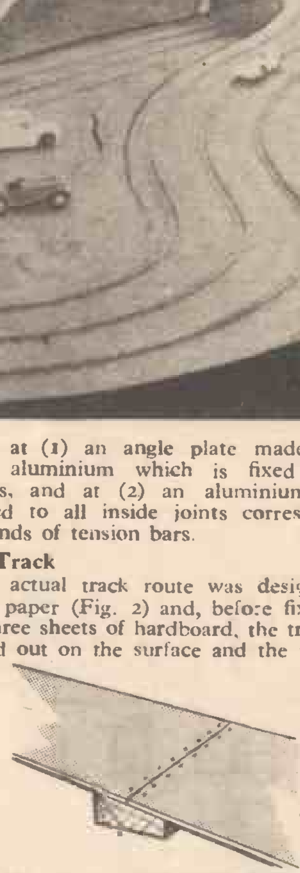


Fig. 5.—A road section joint.

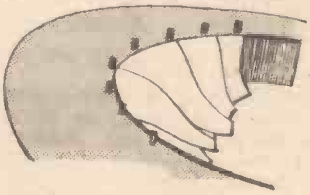
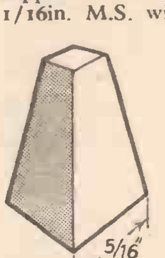


Fig. 6.—Thin card is used to fill in the sides of the roads.

cut at the sides so that it could rise from the base, where required, without using extra hardboard or making more joints than necessary.

The raised sections of the track were supported on brackets made from $\frac{3}{4}$in. × 1/16in. M.S. with a $\frac{1}{4}$in. sq. piece of soft



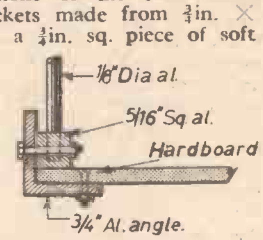


Fig. 7 (Above).—A concrete block.

Fig. 8 (Above right).—A section through the bridge side.

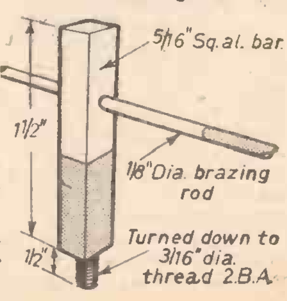


Fig. 9 (Right).—Details of the fence.

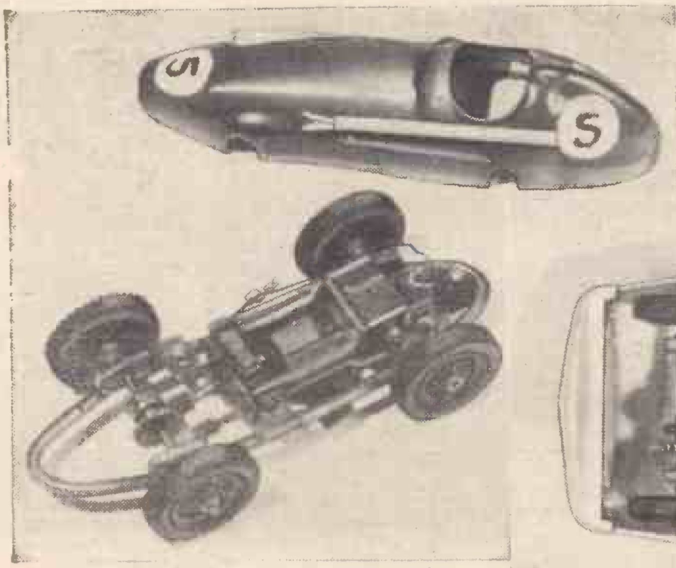
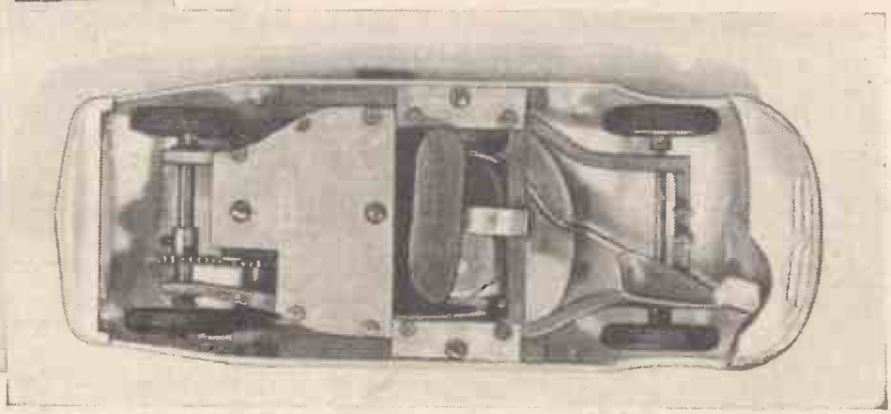



Fig. 11.—The underneath of one of the cars and the motor of another.

have to be replaced when cars "run off the road." The arch bridge is all aluminium, and a section through the bridge side is shown in Fig. 8.

The Fence

The fence at the exit to the curved tunnel is made from 5/16in. sq. aluminium bar and

(*Continued on page 41*)

wood bolted on to the top (see Fig. 3). The road was then fixed with panel pins into the soft wood. Hold a block of steel directly under the wood to take the hammer blows from above.

The raised section is in two main pieces and all tracks were laid on to these road

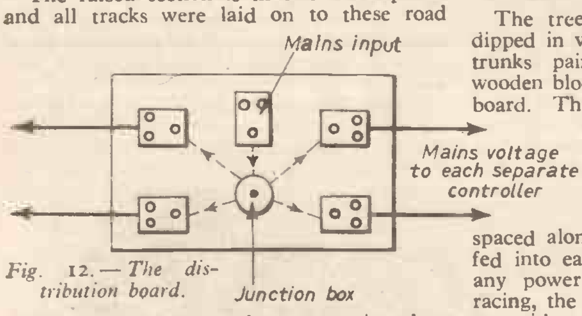


Fig. 12.—The distribution board.

surfaces before the roadway was pinned to the supporting brackets.

The rail used is specially manufactured for electric car rail racing by Model Road Racing Cars Ltd., 29, Ashley Road, Boscombe, Bournemouth, and is easily fixed to the hardboard with special nylon pegs which can be melted on the underside to prevent the rail from pulling out (Fig. 4). Alternative methods can be used quite easily but should conform to a standard as laid down for electric rail racing. Where road sections join one another a 2in. wide softwood bar runs underneath the joint to take the panel pins holding the ends (see Fig. 5).

Where maximum space is required in the pits and paddock area, the sides of the roadway are filled in almost vertically with hardboard or thick card fixed to the sides of the road brackets. The parts that can be shaped more naturally, however, are filled in with thin card glued in position and the surface modelled with a plaster material which does the job very well (see Fig. 6).

The Scenery

The trees are end shoots from a bush, dipped in varnish and matt green paint, the trunks painted black then set in small wooden blocks screwed or glued to the hardboard. The blocks are then covered with thin card and plaster applied to form ground surface. Plaster is also used to form the surface on the vertical side sections.

Four control positions are spaced along the main straight and current fed into each rail in two places to prevent any power loss through the rail. When racing, the driver controls the power to his car with a normal electric train controller, complete with transformer, rectifier and cut-out.

The concrete blocks round the hairpin (see Fig. 7) are hammered to shape from a bar of 5/16in. sq. aluminum and fixed in position with Croid, but these blocks often

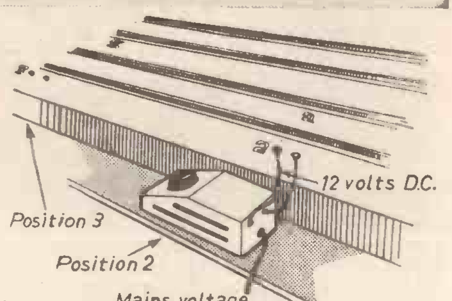


Fig. 13.—Controller and wiring to the terminals.

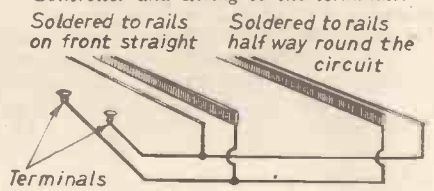


Fig. 14.—How the current is fed from the terminals.

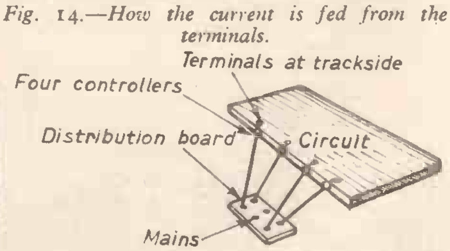


Fig. 15.—The set-up of the equipment.

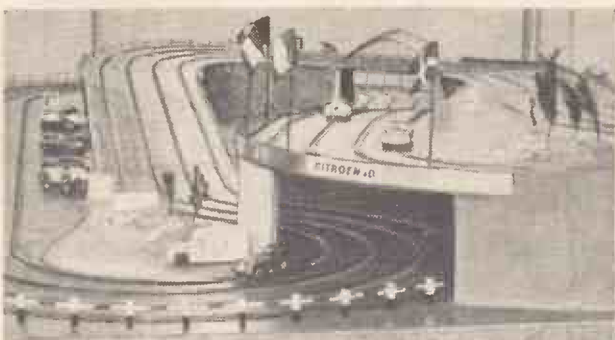



Fig. 16 (Above and Right).—Two views of the finished track.

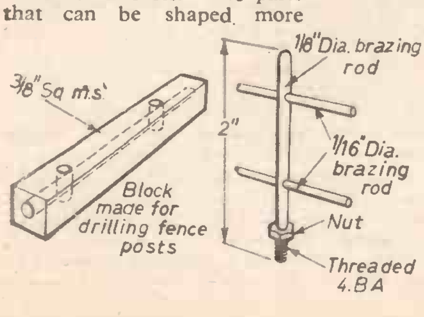


Fig. 10 (Left).—Details for making the fence at the end of the main straight.

Sound Reproduction

Basic Principles Explained : How to Become an Enthusiast

By R. HINDLE

PERHAPS the most satisfying of hobbies are those which are constructive and which have an end product that can be enjoyed by all members of the family. Such a hobby is the production of equipment for sound reproduction.

Sound consists, of course, of variations in pressure of air which can be represented graphically as a "waveform" (a curving line which indicates how the pressure varies to produce the sound). The more pleasant noises such as are considered worth repeating can be captured and impressed on a gramophone record in the form of a groove which is cut more or less spirally on the surface of the disc; in actual fact, the groove wavers about the true spiral in a way that represents the "waveform" of the sound.

The Transducer

Whenever required, a "transducer" (i.e., a device which can convert one type of energy into another) enables one to hear again the sound impressed on the record. The simplest form of transducer for this purpose is the old-fashioned "sound box" which operates by purely mechanical principles (Fig. 1). The needle is free to move sideways across the direction of the groove as the record rotates under it. The inertia of the box prevents this from following the deviations from the true spiral track, but the needle point does follow these deviations. Consequently there is a rocking action by the needle assembly about the fulcrum on the box and this follows the waveform of the groove. The upper arm above the fulcrum must clearly move in the opposite direction and because this part is longer than the distance from fulcrum to needle tip the movement is amplified. The movement of the upper arm is conveyed to a diaphragm which thus oscillates in sympathy with the groove, so reproducing the sound, the resulting sound waves being coupled to the surrounding air through the horn that was a characteristic of those early

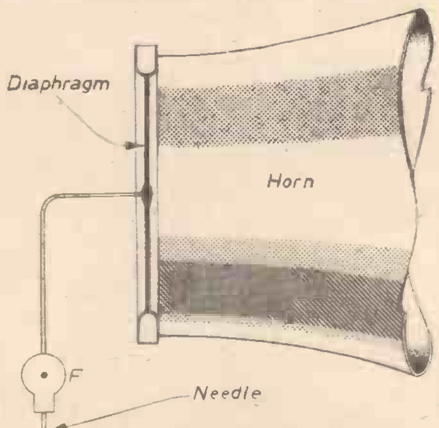


Fig. 1.—Principles of the sound box.

gramophones. Striving after perfection, however, better methods of transducing had to be found and it proved better to convert the mechanical movement of the needle into electrical impulses which could then be amplified electronically. One such transducer or pickup, now commonly used is the crystal element which is subjected to mechanical distortion by coupling it mechanically to the needle or stylus (nowadays, of course, generally a sapphire or diamond point). The type of crystal used for this purpose produces an electrical voltage which varies with the varying stresses and which therefore follows the sound waveform as it appears on the record. There are other ways of converting mechanical motion into electrical waves and some of these are also exploited for gramophone pickup heads.

Tape Recording

The tape recorder records sounds rather differently. Sounds are converted into electrical waves by means of a microphone, and these waves are amplified and used to orient the minute elemental magnets that make up the surface of the tape, thus forming a magnetic pattern representing the sound. When the tape is run over a playback head the magnetic effect regenerates in the coils of the head an electrical current varying in a fashion similar to that which arose in the first place in the microphone and this current can be amplified and reproduced as sound using a loudspeaker. A microphone output is also used in radio and television; in these cases the output of the microphone after amplification, is impressed, or "modulated," on to an electrical wave of much higher frequency (called the "carrier"), and it is this carrier with its burden which is transmitted. The microphone output itself, even if amplified considerably, cannot be so transmitted by radio means as can the higher frequencies, and even if it could a carrier would still be needed because it is by virtue of the carrier that one transmitting station can be tuned in and another be tuned out—without a carrier it would be impossible to discriminate between stations. An aerial at the receiving end (it can be inside the cabinet, of course) picks up the carrier complete with the signal modulated on to it and this is tuned to separate the stations, amplified and passed through a circuit called a "detector" which eliminates the carrier, leaving a fluctuating voltage similar to that given up by the pickup of the gramophone or the tape of a tape recorder.

Common Ground

All these devices that have been mentioned have one thing in common, so far as they have been described; they provide an electrical voltage (or current which can be converted into a voltage simply by providing a resistance in the circuit through which it flows), which varies in a manner that represents the audible sounds from which they were derived. They are called audio signals, not because they can be heard, but because they fluctuate at frequencies that would be audible if they were sound waves and not electrical waves. It will be seen, therefore, that the amplifiers used to increase the level of these audio frequency electrical signals can be common to the various types of sound reproducing equipment previously mentioned. It is indeed usual to use a simple amplifying system common to both radio and gramophone and these two applications will generally be referred to in the rest of this article.

Distortion

Amplifiers, like other man-made things, cannot be perfect. If a theoretically perfect amplifier can be considered it will be realised that it must add none of its own individuality but must merely produce an amplifier version of what was fed into it without any frills or changes. Practicable amplifiers do, however, change the nature of the sounds to a greater or lesser degree, depending on the quality of the equipment. Similarly, loudspeakers which are fed with the output from the amplifiers, and thus act as transducers of electrical into sound waves, also add their quota to the changes in the sounds that take place within the reproducing system. It matters not whether the result is pleasant or unpleasant, such changes in the sound must be considered as distortion.

There are many varieties of distortion, but perhaps they can be summed up, so far as sound reproduction is concerned, by saying that distortion either adds some frequencies that ought not to be present, or else it varies the relative volumes of the various frequencies that should be present. It should be appreciated that sounds are

Fig. 2.—This Whiteley (WB) 10in. loudspeaker (Type HF1016) is an example of a wide range high fidelity model.

generally complex combinations of different frequencies and not often a simple single frequency. Generally speaking, the second class of distortion is more tolerable than the first, but in fact a considerable amount of work has been done during the last decade to reduce both classes.

Amplifier Specification

Just as there are two classes of distortion, so are there two important basic methods of specifying amplifier performance from the point of view of distortion. One is the frequency range of the equipment, which may be presented as the upper and lower frequency limits that the amplifier, or speaker, is capable of handling satisfactorily, or may be in graphical form, which thus defines the second class of distortion.

The second specification is in the form of a "percentage distortion" which is indicative of the first class. The percentage refers to the amplitude of sounds which are introduced by the equipment and which were not present in the original sound.

In considering frequency range it should be borne in mind that the human ear is limited in the range of sound frequencies that it can hear and this range varies, in fact, from person to person. A very adequate range for this purpose would be 25 cycles per second to 20,000 cycles per second. Most people would not be able to detect single, isolated frequencies up to 20,000 c/s and the upper frequency limit tends to become somewhat more restricted with age, but if possible it is worth while having good response up to frequencies well above the highest audio frequency that can be heard because these higher frequencies have some effect in combination with other frequencies. To give some idea of the effect of frequency limitation, the ordinary medium range broadcast receiver gives little above 5,000 c/s and the telephone is even more restricted. An old type of receiver would often have a distortion factor up to 10 per cent. A modern, not very expensive, amplifier has a range of 30 c/s to 25,000 c/s and a distortion factor of .1 per cent.

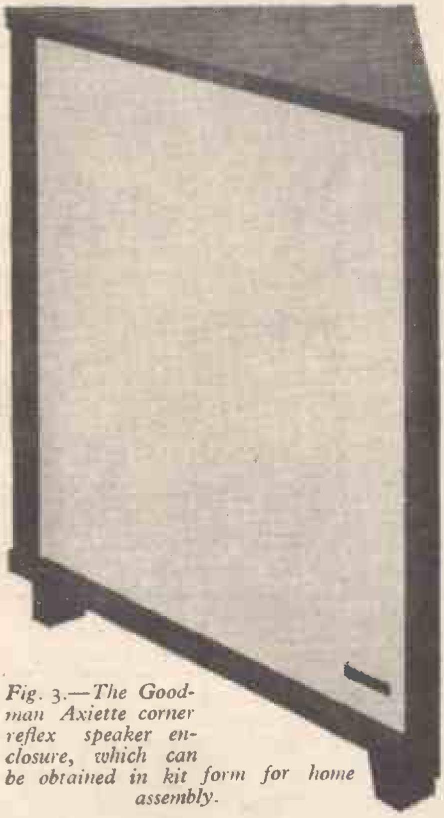


Fig. 3.—The Goodman Axiette corner reflex speaker enclosure, which can be obtained in kit form for home assembly.

This search for fidelity in reproduction has only recently been labelled "hi-fi."

Power Output

Another specification to be considered is that for power output. The amount of power needed very much depends on the type of speaker to be used and the conditions (e.g., the size and nature of the room) under which the equipment will be used. A fraction of a watt of power is adequate in the room of an average house to be heard clearly, and indeed this is all that the ordinary battery portable gives. Reproduction with low-powered equipment must, however, be deficient in bass notes, and the lower it is aimed to push the lower extreme of frequency the greater the power that will be needed. There is the further point that if bass is deficient it is desirable to reduce also the treble notes. Battery sets often sound quite pleasant just because they are deficient at both ends. To go "hi-fi" with the treble notes and not to balance these with equally good bass notes is most unpleasant, as many readers may have decided already if they have been asked to listen to someone's so-called "hi-fi" which did not have the right balance between the extremes.

Five watts of power can sound adequate in normal listening circumstances and can claim the tag "high fidelity" if the five watts are of good quality. Generally, however, the searcher for "hi-fi" will not be satisfied with less than 8 to 15 watts in order to ensure good bass response. Distortion is reduced by running below the rated output figure and will be increased considerably if the output figure is exceeded. For this reason, distortion will be more prominent on loud passages.

The speaker system must be chosen to suit the equipment. It must be capable of handling the amount of power that the amplifier can give, and also its frequency range should match that of the amplifier. It is no easy matter to design a single speaker to handle the wide range of frequencies called for. Whilst reproduction was limited to the frequencies transmitted on the medium waveband and the similar range of the gramophones of the time, the single speaker proved to be satisfactory. Improved amplifiers, wide range records and V.H.F. sound transmission called for much more and consequently multi-range speaker systems have been developed, each speaker of the system handling a different band of frequencies. This is the case of making the best of a bad job rather than an ideal solution. Multi-speaker systems require equipment to separate the frequency ranges and this itself can introduce distortion. Nevertheless some of these multiple speaker systems are extraordinarily good. They must be bought as a system and not be an assembly of any old speaker unless the user knows quite a lot about the matter. Other things being equal, the writer prefers single speaker systems. This is not referring to stereo reproduction, of course, and that aspect will be mentioned later. There are some very good wide-range speakers. Probably, if funds are limited, it is advisable to buy the best single speaker possible. This would be up to, say, the £10 to £15 range, and an example is shown in Fig. 2. If appreciably more than this can be afforded some of the multi-speaker arrangements should be heard. Generalisation is always dangerous, of course, and at least one multi-speaker assembly at a comparatively low price is available which can give a very satisfactory account of itself. In the final count, theory will not lead one to the best for any particular case. Hear them, and choose the one that sounds best.

Stereophonic Reproduction

The latest development in the sound reproduction field is stereo. For some time it has been realised that for the whole of the sound of, say, a large orchestra to come from a single point was artificial. Attempts have been made to bring the apparent sound source out of the box, and "forward tone" was used to describe such an illusion. These efforts were not enough, however, because apart from frequency range there is the directional effect. This was entirely lost in the old methods of reproduction, though clever techniques of microphone placement and other tricks of the broadcasting engineer's art did at times give an illusion of space.

There is still considerable argument about the mechanics of the stereophonic sense of hearing but it is basically due to the slight difference in the sound arriving at each of the two ears due to their rather different position. Thus for true stereo reproduction one would expect to have to produce two different signals and to feed these one to each ear so that one ear could not hear directly that which was going to the other ear. This would clearly require listening through a pair of earphones and such are unlikely to be popular in these days. Certainly the two different channels are required, but fortunately a remarkably realistic illusion of stereo is obtained by playing the two sound channels through different speakers, the two speakers being placed apart and the listeners being positioned somewhere in front of and about equidistant from the two. This is the method of stereo that is used for reproducing the stereo records now available, and also for the experiments being conducted by the BBC. The use of two quite different channels and reproducing equipment such as those who listen to the BBC stereo broadcasts use (e.g., a broadcast receiver and a television receiver) is hardly a fair way to assess the potential of stereo, though it is introducing a lot of people to the technique and showing something of what can be done. For the real thing it is necessary for the two channels of amplification and the speakers to be identical and of good quality. Obviously stereo cannot be cheap; it must be much dearer than the single channel of equivalent quality. Whether it is worth the cost is a matter of controversy. It seems that some

Fig. 4.—A main amplifier and two types of control unit—the Standard and the Major—available from Whiteley Electrical Radio Co., Ltd. Also shown is the Whiteley "Prelude" bass reflex corner console.

can appreciate the illusion but others fail and are left cold. You just have to hear it yourself and make up your own mind. Once more, if funds are severely limited, it is as well to buy the best possible single-channel equipment. Many amplifiers can be bought as single channel units but which are already so designed as to make the later introduction of a second channel to give stereo reproduction particularly easy.

Pre-amplifiers

Some readers might be puzzled by the reference to amplifiers and "pre-amplifiers." Main amplifying equipment is necessarily bulky, even though developments recently have permitted some reduction in size. Furthermore, the part of the amplifier that subscribes most weight does not require any sort of manual control apart from the on-off switch; this must operate the whole equipment and it is comparatively easy to extend connection for this purpose, so the switch need not be situated on the amplifier itself.

The amount of amplification needed depends on the size of the signal coming from the pick-up, radio unit or whatever is playing into the amplifier. These signals vary in size quite considerably.

For the above two reasons it is convenient to divide the complete amplifier into two parts. A volume control is needed, of course, but this is generally at the input end of the complete amplifier, and so are the tone controls and a switch to select the radio or gramophone input at will. The complete amplifier design is therefore often split. The main amplifier which has the more bulky parts of the equipment but no controls, and this can be stowed away in a convenient part of the cabinet. The more compact and lighter "front end," containing all the controls and some of the amplifying circuit, is made as a separate unit, the "pre-amplifier," which is mounted in a position where the controls are accessible to the user. The two units are interconnected by means of flexible leads.

Fig. 5.—Two "Heathkit" stereo amplifiers and a hi-fi speaker system. All are available in kit form from Daystrom, Ltd., Gloucester.

Tone controls introduce what has previously been called distortion because they increase or decrease the relative levels of bass or of treble notes with respect to the general level of other frequencies. They are needed to correct the frequency balance of the different records, of the effect of the room in which listening takes place and perhaps speaker deficiencies. Also there is a fixed type of tone control, called equalisation or correction, to allow for variations in the input frequency ranges from different types of record, or to equalise gramophone to radio from a tonal point of view. This is also in the pre-amplifier, generally being incorporated with the switch which selects the type of input needed.

The sensitivity of the amplifier is normally quoted as a voltage signal that must be applied to the input to get out the volume of sound that the amplifier is intended to give. The pre-amplifier has the job of bringing these inputs up to the strength needed by the main amplifier, and consequently the pre-amplifier must be made suitable for working into the chosen main amplifier (examples are given in Fig. 4). Clearly it is wise to choose both of the same make for this reason. A typical main amplifier will need a fifth of a volt of signal at its input, whereas the pre-amplifier which gives out a signal of that order of size requires an input of seven thousandths of a volt only at the pick-up position on the selector switch and a tenth of a volt from the radio or tape input. It will be seen, therefore, that only small signals exist in the pre-amplifier. If one of the popular crystal pick-ups is used this will give much more than the seven thousandths of a volt quoted, actually being something of the order of the main amplifier requirements, and consequently a pre-amplifier of somewhat different design will be called for.

Entering the Sound Reproduction Field

Now how is the average handyman or mechanically minded person to make a start in sound reproduction? He need not think that this is beyond him. If he does not wish to buy a completed unit and does not feel competent to construct his own equipment from basic components. He can choose from a wide range of amplifier chassis, pre-amplifiers, speakers, gramophone playing equipment and radio tuners, already assembled (Fig. 4). Many dealers provide facilities for hearing different combinations in their demonstration rooms. It is a good thing to attend such demonstrations, though it should not be forgotten that the individual room in which the equipment is to be played eventually will make quite a lot of difference to the results, and it is unlikely that this will be similar to the demonstration room. The dealer, with his experience, will be able to give guidance.

The Cabinet

If the buyer is a cabinet maker he can use his art to produce the housing. Quite apart from the production of a handsome piece of furniture there are needs peculiar to the purpose now being considered, such as ventilation and the provision of convenient control and turntable positions. Generally, the gramophone motor will be fitted in the same cabinet as the amplifiers, and quite likely it will also house a radio unit. This makes for easy interconnection and in particular keeps all mains leads in one place. It is far better, however, to keep the speaker out of the main cabinet and give it its own housing. An expert in sound reproduction finds it difficult to satisfy the diverse needs of gramophone motor, amplifier, radio unit and speaker in one cabinet whilst avoiding stray couplings that can interfere with reproduction, and providing the type of enclosing space without which the speaker cannot give of its best. It is best to decide on a separate speaker cabinet unless experienced in electronics, and examples are given in Figs. 3, 4, 5 and 6.

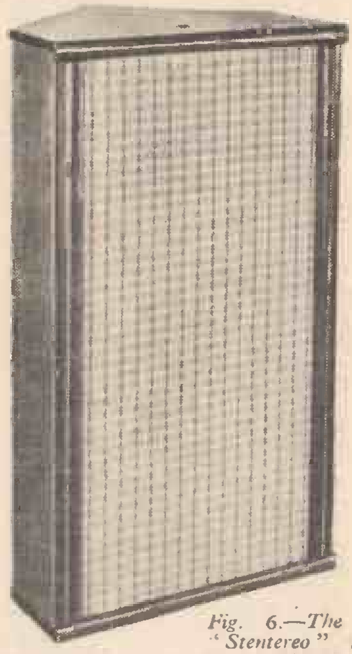


Fig. 6.—The WB "Stentereo" loudspeaker system is available in kit form for home construction. Right and left cabinets are available for stereo sound reproduction.

The speaker cabinet needs to be a smart piece of furniture, of course, but so does a piano and not many people would care to originate a design for the case of the latter instrument. The speaker cabinet is, in fact, an essential part of the speaker, and only a correctly designed enclosure will permit the results claimed for the chosen speaker being achieved. Other things being equal, a large cabinet (if solidly built) is more likely to be good than a small one; a heavy one will be better than a light one. It is not easy, however, to fit into one's room the large cabinets that high fidelity experts used to claim as necessary and consequently some very effective work has been put in to produce some marvels in smaller cabinet design. These are generally worked out for specific speaker units or combinations and speaker manufacturers will supply detailed specifications and drawings for cabinets for their productions. The would-be cabinet maker should certainly obtain details of the recommended enclosure from the makers of his chosen speaker.

Those less inclined to make cabinets can buy separate units and cabinets and fit them together. Then they can have the experience of investigating the effect of placing the speaker in different parts of the room. This has quite an appreciable effect on the results.

The greater joy, however, comes from constructing one's own amplifiers and radio tuners. This need not scare the average handyman. There are kits of parts with detailed building instructions available from various suppliers and examples are shown in Fig. 5. If this is not sufficiently advanced, perhaps an even more satisfying course is to watch future issues of PRACTICAL MECHANICS or turn to the companion to this periodical *Practical Wireless*, in which are published frequently complete designs with full constructional details, dimensions, layouts and wiring diagrams.

BY F·HOOK

Panoramic Views

Making and Using an Attachment for Taking Them

THIS device will enable the reader to take a number of consecutive exposures of an extensive country view and ensure success in joining together the final prints to reproduce the original scene It may be adapted quite easily to suit most cameras, although the dimensions given here are particularly for a $2\frac{1}{4}$in. sq. 12 on 120 camera.

A tripod is essential for success, an old type wooden tripod is excellent as it is extremely rigid in use. Nevertheless, a modern telescopic tripod could be used equally well if a different method of fixing the tripod to the baseboard were used.

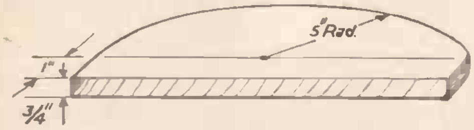


Fig. 1.—The baseboard is made from $\frac{3}{4}$in. blockboard.

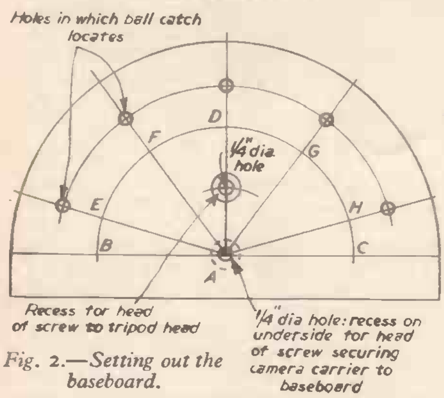


Fig. 2.—Setting out the baseboard.

The Baseboard

The baseboard is sawn from a piece of $\frac{3}{4}$in. thick blockboard (Fig. 1). It is a good plan to draw out the lines shown in the diagram on paper and then transfer to the baseboard by pricking through the various points and then joining up.

Ascertain the focal length of the camera to be used. This is usually on the lens mount. It is 75mm. for the $2\frac{1}{4}$in. sq. camera used here. Draw the base line BC (Fig. 2), erect perpendicular AD in the centre and draw a semi-circle BCD. From the point D step off points E, F, G and H in length equal to the width of the picture on the negative, less $\frac{3}{8}$in. to allow for a slight overlap of the consecutive exposures. The distance is $1\frac{7}{8}$in. in this case. Join these points to the centre A. These lines represent a ray of light passing through the centre of the lens and impinging on the centre of the negative. Score the lines on the baseboard with a marking knife. In operation the centre of the lens will remain on point A and the camera is swung round to any of the five positions indicated by these lines.

Drill a $\frac{1}{4}$in. dia. hole at A and on the underside recess the hole to take a nut so that there is no projection to interfere with swinging the baseboard on the tripod top.

Drill a second $\frac{1}{4}$in. hole mid-way in AD and recess it to take the head of the $\frac{1}{4}$in. bolt used to secure the baseboard to the tripod head.

The Camera Carrier

The carrier for the camera is made from a piece of 5/16in. plywood to dimensions shown in Fig. 3. Hole X is $\frac{1}{4}$in. dia. and countersunk on the underside to take the head of the $\frac{1}{4}$in. Whit. screw which passes up through the carrier and into the tripod bush on the underside of the camera body. The hole Y is also $\frac{1}{4}$in. dia. and is countersunk on the top of the carrier to take the head of the Whitworth screw which pivots the carrier on the baseboard.

The camera is arranged upon the carrier making sure that the line scribed on the carrier between X and Y coincides with the centre of the optical system. It is also necessary to glue two small stop blocks on either side of the falling front of the camera to keep it steady. It is also necessary to glue suitably thicknessed packing under each end of the camera body so that it will not tip sideways when the shutter body release (if fitted) is pressed.

The camera carrier can be aligned by eye on the various five positions scribed on the baseboard. But for speedy location and consistent accuracy it is better to have a positive location stop. The simple device shown consists of a small ball catch of the type fixed by a small plate (Fig. 4). Recess the plate into the lower side of the carrier, clear of the camera body. The small brass tube containing the spring protrudes above the carrier and can be used as a handle for turning the carrier.

When assembled, the ball will leave a track on the baseboard. At the points of intersection of this track and the five position lines drill a hole into which the ball will drop and thus steady the camera in the correct position at each exposure.

The whole gadget should be well glasspapered and then given a coat of matt black paint.

(*Concluded on page 22.*)

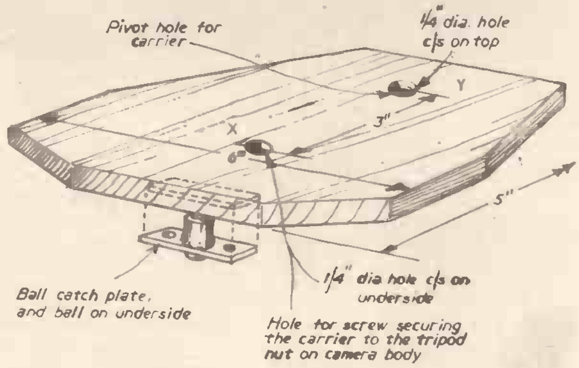


Fig. 3.—The camera carrier.

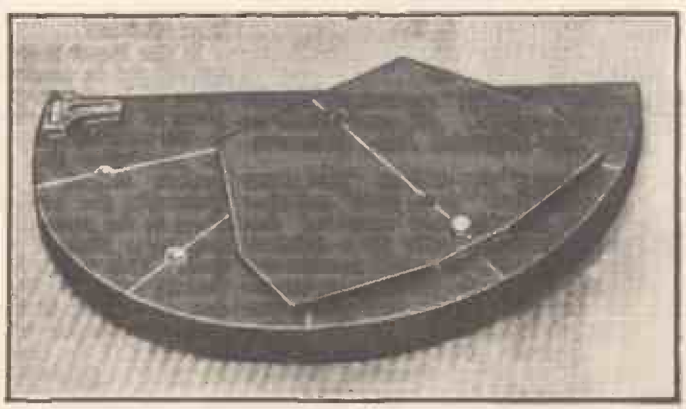


Fig. 4.—The finished attachment.

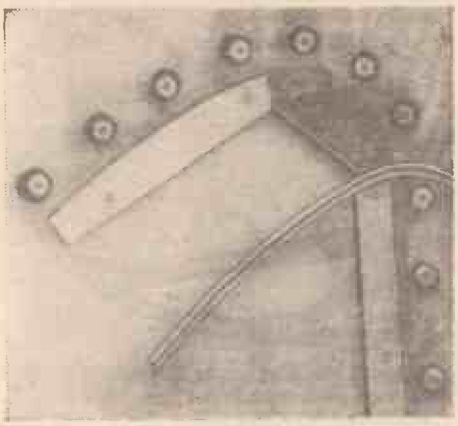
Building the 'Luton Minor'

Part 2 Deals with Building the Tail Unit

BEGIN by building the rudder. This is a relatively simple component to make and will provide some good practice in aircraft carpentry and metalwork. If a mistake is made on the rudder, it is not going to be too costly to scrap it and start again.

Rudder Bow

Start by marking out the rudder bow on a flat table or bench at least 36in. × 48in. To do this, reproduce the rudder layout full size and draw in all the ribs and bracing. Check all the measurements against the plan.



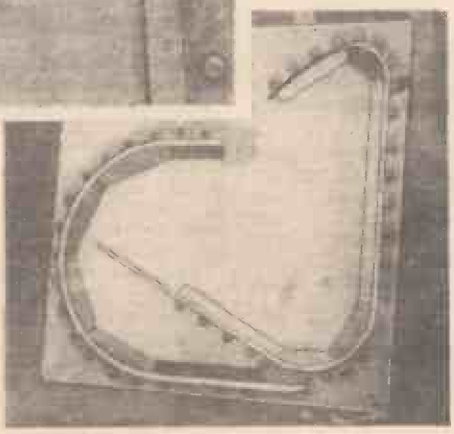


Fig. 1.—Two views of the jig for making the rudder and elevator bows.

As you will not be able to describe the necessary large arcs of the bow with an ordinary compass, make a simple beam compass. Take a piece of wood about ¾in. square and drive a 1in. nail into one end so that the point protrudes. From this point, set off with a rule the radius of the arc required along the strip of wood. Drill here to take a pencil. This one compass will describe all the arcs needed on both tailplane, rudder and wing tip if the piece of wood is about 4ft. long.

Fair each arc on your layout into the adjacent line by carefully adjusting the centre of the radius slightly until the arc sweeps accurately.

You have now marked out the outer edge of the rudder bow. Remember that the inner edge is ¾in. less all the way round, so now produce this inner shape, using the same centres but with each radius reduced by ¾in.

To this inside line, screw a number of wooden blocks ½in. thick by about 3in. × 1in. On the curves, these will have to be shaped slightly. In Fig. 1 the inner curve has been cut entirely from solid wood, but it is not necessary for the amateur to do this.

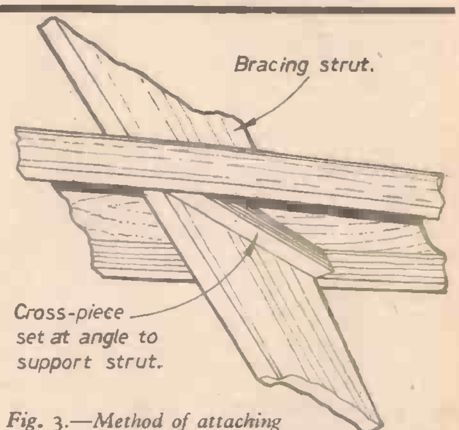


Fig. 3.—Method of attaching the bracing struts where they pass through a rib.

Against these blocks will be set the strips of wood forming the laminated bow. To apply sufficient pressure during the setting of the glue, a simple method is to fit a number of "eccentric buttons" as can be seen in Fig. 1.

Cut these from ½in. thick commercial plywood or blockboard. You will need about fifty and they can be re-used for the other laminated bows on the Minor. Make them about 1½in. in diameter and drill them ⅛in. off centre to take a 1¼in. long round-head woodscrew. Fix them to the layout with a washer under the head of the woodscrew and one between the button and the bench. The screw holes should be ⅞in. from the inner edge of the bow so that you can clamp the three pieces of 3/16in. thick spruce against the blocks by turning the buttons.

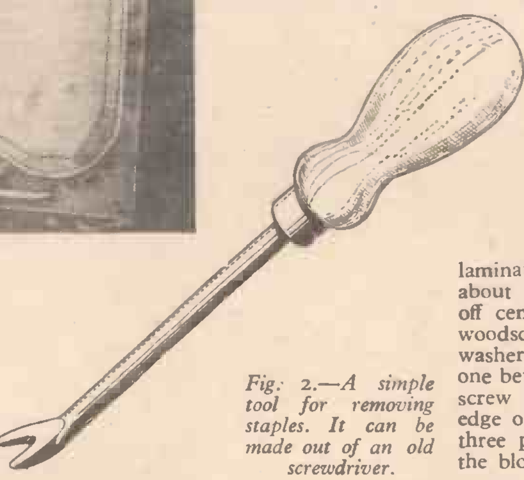


Fig. 2.—A simple tool for removing staples. It can be made out of an old screwdriver.

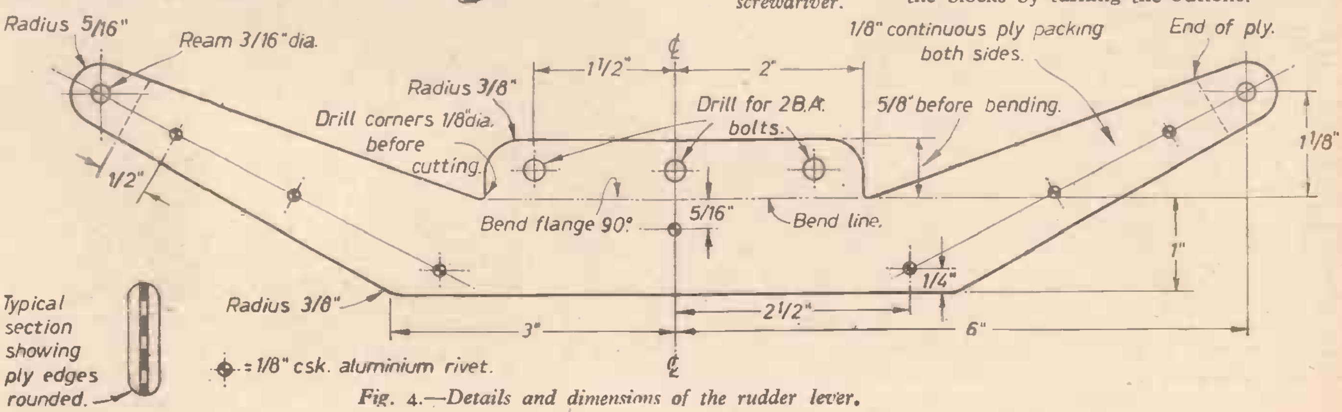


Fig. 4.—Details and dimensions of the rudder lever.

The strips of spruce should not need steaming to shape, but to make a good job, saturate them in boiling water until they are supple enough to bend easily into the jig. On no account attempt to glue them whilst they are wet. Clamp the pieces by rotating the buttons, making quite sure that there are no gaps between the strips. Leave the wood thus for about a day to dry out thoroughly.

When dry, remove them (do not worry if they tend to straighten out somewhat) and line the jig with strips of waxed paper to prevent excess glue squeezed out of the joint from sticking to the bench. The waxed paper used to wrap bread is ideal for this job.

Using Aerodux 185 adhesive, glue the three laminations rubbing each to its neighbour to exclude air bubbles. Lift the three pieces and bend them together into the jig. Start at one end and clamp them up using the buttons. Do not tighten them haphazardly as this may result in gaps between the laminations.

Leave this overnight to set, then release the buttons and carefully lift the bow out, easing as necessary with the blade of a broad chisel. Shave the bow to the correct section.

Do not plane off excess glue—synthetic resin adhesives set very hard and will chip the cutting edge. If excess cannot be removed with a cloth whilst still wet, use a file when it is hard. The ordinary file makes an extremely useful wood finishing tool for aircraft work. Never use a rasp or Dreadnought on timber as this type of file tends to tear the grain.

Rudder Spar

Make the rudder spar from one piece of ⅜in. thick spruce. When marking out a spar or similar beam, always draw the centre line first and then step off the positions of all ribs, metal fittings and so on. Mark off the widths at various stations along the centre-line.

Remove surplus timber with the saw—a power saw for preference. Do not cut closer than about ⅛in. to your line until you have gained experience. Cut away from the grain wherever possible to avoid the risk of splitting or lifting the surface grain. Finish off with the smoothing plane to the line of the lay-out.

The Ribs

Draw the plan of each rib on to the bench or a plank of wood with a hard pencil, again working from the centre-line. Set off the widths at the various stations and join the points thus obtained with a strip of thin wood bowed as necessary to give a fair curve. Drive in headless 1in. long brads at intervals of every 2in. to 3in.

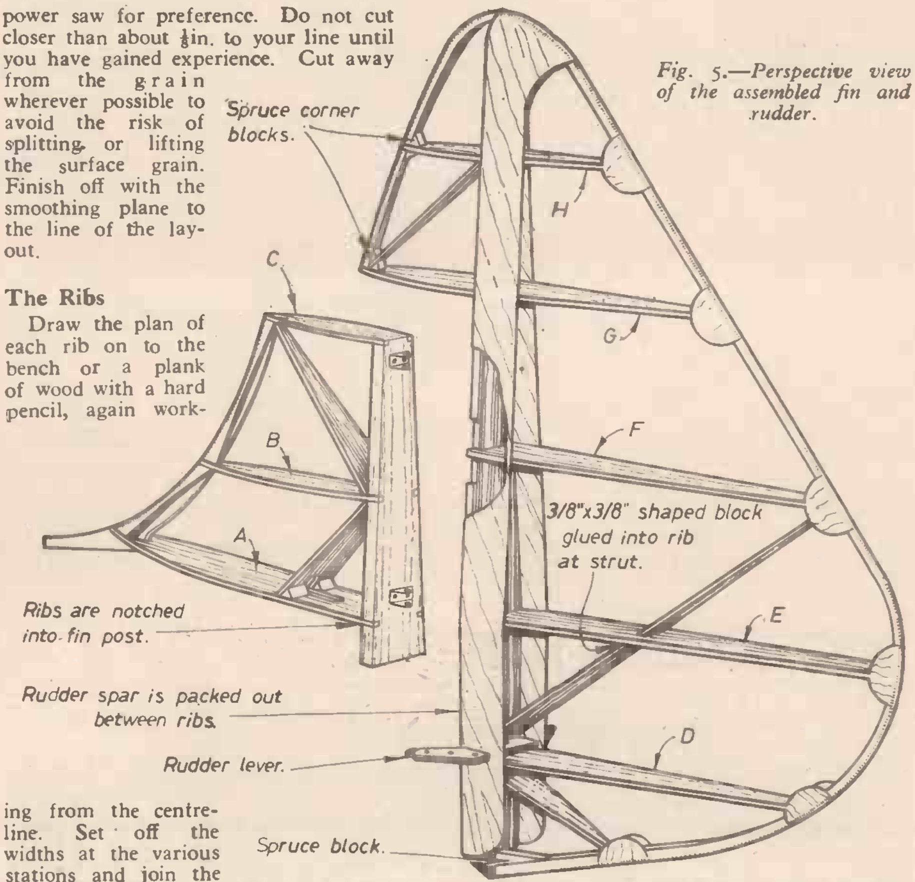


Fig. 5.—Perspective view of the assembled fin and rudder.

Spring in the two rib capstrips and insert the cross pieces which fit each side of the spar (ribs F, E and D (Fig. 5) only have the cross piece behind the spar). These are glued into place. With scrap pieces of wood, wedge between the capstrips so that they form the accurate curved shape and touch all the nails.

Thread the ribs on to the spar and glue and tack each one into place with ⅜in. × 20 s.w.g. brass gimp pins making sure that they are in their correct positions on the spar and are also at right angles to it. Now fit the laminated bow which is fixed to the trailing edges of the ribs with semi-circular gussets of 1/16in. birch plywood. Only fit these gussets to one side of rib F until the diagonal bracing struts have been fitted.

To make these struts, first mark where they pass through the ribs by placing a strip of wood on the outside between the place on the spar and the joint of the rib trailing edge and bow. Cut a slot in the rib ply web for the strut at the appropriate place.

The strut itself is of ¼in. thick spruce, tapering from 3½in. width at the spar to ½in. at the trailing edge. Pass it through the rib slot from the same side as the gusset

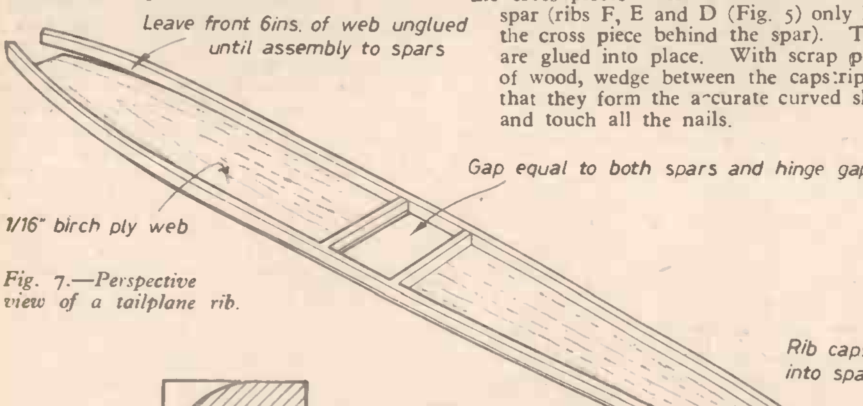


Fig. 7.—Perspective view of a tailplane rib.

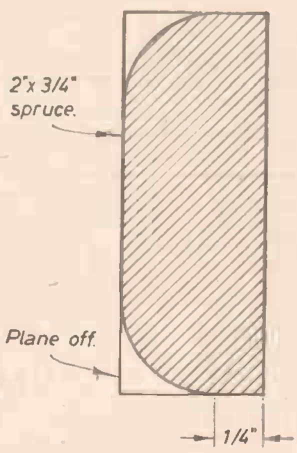


Fig. 6.—Section through tailplane front spar

Cut the webs from 1/16in. thick birch plywood with the grain running at right angles to the centre line (short grained) and glue them into place on top of the capstrips. With an ordinary office stapling machine, staple the plywood every 1½in. to the capstrips and the cross pieces. The rib is then secure enough to be lifted out of the jig and set aside to dry before cleaning up the edges and removing the staples. A simple tool can be made up from an old screwdriver for this, as shown in Fig. 2.

Only one rib is required from each jig.

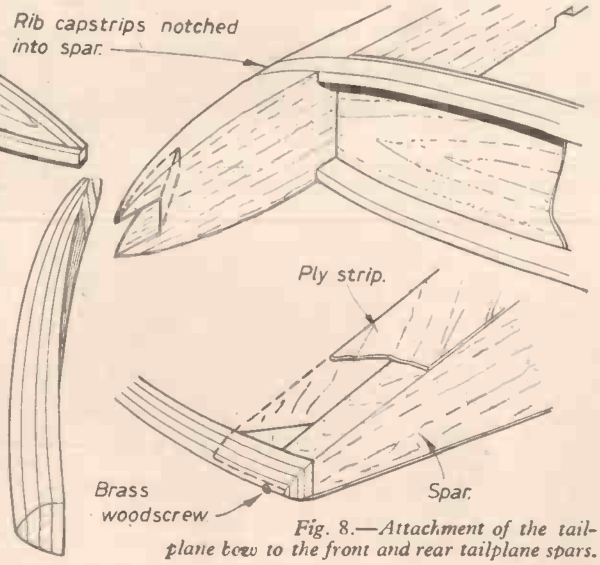


Fig. 8.—Attachment of the tail-plane bow to the front and rear tailplane spars.

so that it can be brought in at the trailing edge as the forward end butts the inside face of the spar. Glue this and fit the remaining gusset to rib F.

Glue $\frac{3}{8}$in. × $\frac{1}{8}$in. spruce packing pieces to the strut where it passes through the rib, as shown in Fig. 3.

Hinge Brackets and Rudder Lever

These parts are all made of 16 s.w.g. mild steel sheet to specification S.510 or equivalent. Three hinge brackets are required.

Avoid scribing deep layout marks on metal. These scratches are a potential source of weakness and they can develop into cracks, especially if the steel is to be bent. The safest method is to use one of the special layout fluids such as "Spectrablue," which is a coloured spirit applied to the steel with a brush or swab. It dries almost immediately, producing a bright blue film which will show up the slightest scratch made with a scriber. It is possible to scribe a line by removing only the blue dye, leaving the metal showing in contrast. The resultant layout is very much like a blueprint and is much clearer to follow in cutting out. The dye is readily removed afterwards with spirit or cellulose thinners.

Use a bench vice with smooth jaws (on some types the jaws may be unscrewed and reversed) so as not to mark the surface of the metal whilst it is being gripped for cutting and bending. It is quite easy to make smooth steel jaws and have them case-hardened. For this type of work, vice clams or fibre jaws are of no use since some of the metal cutting will be accomplished with the cold chisel and hammer in the vice.

When chiselling metal, always keep the part being cut out in the vice and chisel the surplus off it rather than to clamp the surplus in the vice and remove the fitting with the chisel. This latter way results in a distorted part which is useless.

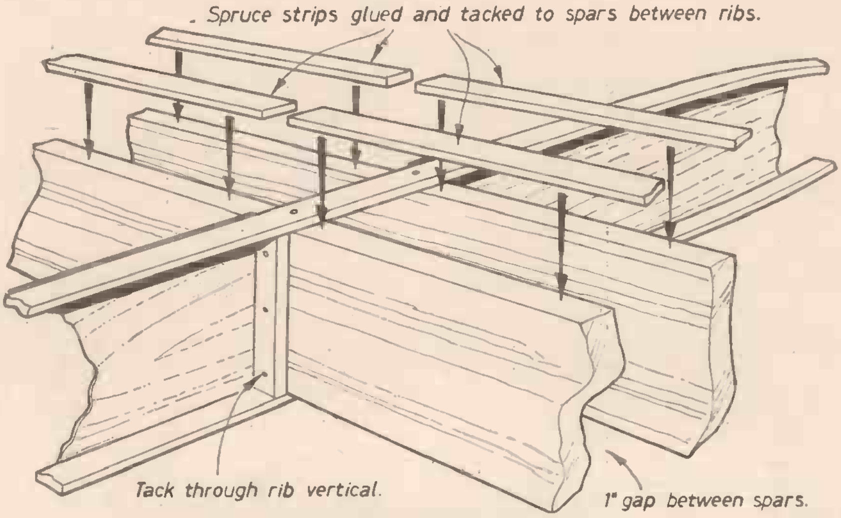


Fig. 9.—Attachment of ribs to tail spars.

Cut out the metal parts using a combination of the hacksaw, the cold chisel and the drill. If a bench guillotine or shear is available—and they do save much effort—again remember to work from your left so as to remove the surplus metal with the knife.

Until experienced in the use of these tools do not cut closer than 1/16in. to the layout line, cleaning off the rest with the hand file. Finish off with a smooth file and remove the burrs from each side. Drill any holes now, but do not open them up to full size until assembling them to the job. This is good practice for later when mating up fittings to each other, discrepencies between holes must be avoided. Accordingly, drill the holes $\frac{1}{8}$in. at present.

Ideal protective treatment for metal parts is cadmium plating followed by a coat of chromate primer, but it is acceptable to give a good coat of metal primer and assemble them on the job with a chomate jointing compound such as "Duralac" or "Celloseal."

Later, when parts have been welded or brazed, it is important to remove all scale and dirt before applying such protective treatment. Sandblasting should be resorted to if the wire brush is insufficient.

From Fig. 4 it can be seen that $\frac{1}{8}$in. holes have to be drilled by the sides of the flange before it is bent up. This is to eliminate the possibility of fractures starting in the corners. Adopt this principle on all such fittings, whether they are bent up or not, and avoid sharp corners in a part which might induce stress cracks either in making or in service.

Bend up the rudder fittings, using hand bending bars, which can be held in the vice. It is important to maintain the correct radius of bend. As a guide, the radius inside a bend in 18 s.w.g. mild steel sheet should be 1/16in.; 16 s.w.g. should be 3/32in. and 14 s.w.g. $\frac{1}{8}$in. radius.

Avoid hammer marks on the fittings as they are bent. Form the bends with a mallet and a block of wood, using the end grain. Check with a square and a rule that the flange is at right angles and also that it is not rippled along its length.

Bolt the fittings to the rudder spar using 2 B.A. bolts, having a plain shank length of 0.4in. Put large duralumin "penny" washers on the other side of the spar and use self-locking stiff nuts.

Pack up the edges of the spar between the ribs with strips of 3/16in. × $\frac{1}{8}$in. spruce glued and tacked into place. Now glue the 2½in. wide strips of 1/16in. birch ply to each side of the spar. These plywood strips have the grain running longways (long-grained) and they are glued and stapled on. When the glue has set, pull out the staples and clean off the top and edges.

Complete the rudder by thoroughly sanding the laminated bow, the gussets and the edges of the ribs. Check to see that there are no brass brads or sharp edges protruding which might pierce the fabric covering.

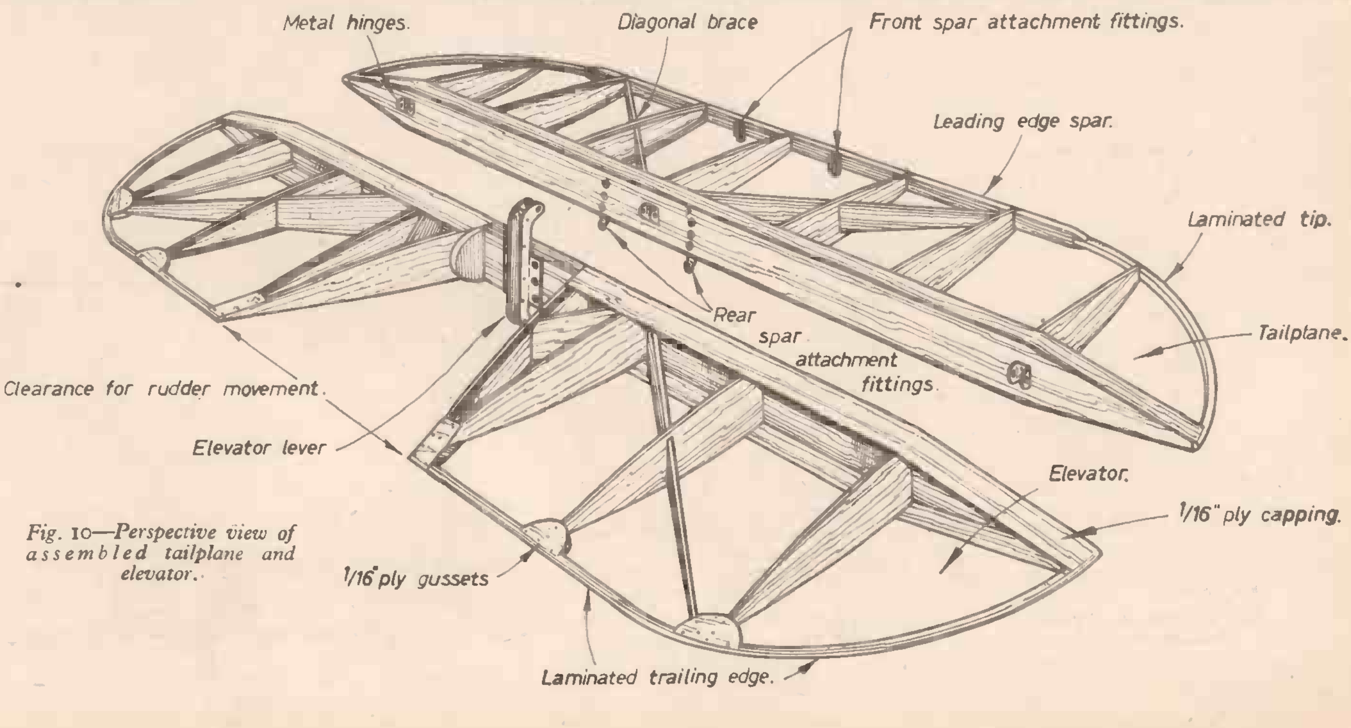


Fig. 10—Perspective view of assembled tailplane and elevator.

Do not cover with fabric at this stage. The whole structure must be completed and put up for inspection before doing this. The assembled rudder is shown in Fig. 5.

The Fin

Remember that the rudder fits to this, so check that the fin leading edge will fair neatly into the curve of the rudder bow. The fin structure is of the same type as the rudder.

The lower rib A (Fig. 5) is of ¼in. thick spruce as are the two struts which taper from the full width of the fin spar to the width of the leading edge bow (see Fig. 5).

The leading edge is made from a curved 2in. wide piece of ⅜in. birch ply. Keep the grain as long as possible in this. Glue spruce strips ¼in. thick to each side of this and then pare with a spokeshave to the section shown on the drawing. Cut slots in the spruce to clear the ribs.

Bolt the two rudder hinges to the fin post so that there is a ¼in. gap between the top of the top fin rib and the under surface of the rudder rib G. Assemble the hinges so that there is a small amount of end float up and down of the rudder. This small amount of play applies to all the Minor control surfaces and reduces chances of seizure and eases their movement. It should be not less than 1/16in. Any excess of this within reasonable limits may be packed out with steel shims on assembly.

Tailplane and Elevator

The construction of the tail unit is completed by building the tailplane and elevator. In the Minor they are built together in one piece to dispense with the need for separate jigs. The two are cut apart after assembly to ensure accurate matching.

Begin by making up the metal fittings—the five hinges Pt. No. T.2, the two hinges Pt. No. T.7, the elevator lever Pt. No. T.1 and the front and rear spar attachments, Pts. No. T.3 and T.4.

Prepare the spars from best spruce and glue the reinforcing section to the centre of the elevator spar. They are all symmetrical about the centre-line. The front spar is also the leading edge of the tailplane and should, therefore, be shaped as shown in Fig. 6.

Make up a simple jig for the tailplane/elevator ribs on the same lines as that used for the rudder. All the ribs are the same except the outboard pair which may be built in the same jig with only slight modification. Cut a block of spruce 1¾in. wide to represent the gap for the spars and hinges, against each side of which is a vertical member (Fig. 7). The rib capstrips are of 3/16in. × ⅜in. spruce and the webs are of 1/16in. birch plywood. The direction of the grain should be vertical to the rib datum (short-grained). Leave the front 6in. of the rib webs unglued so that the capstrips can be passed over the front spar and into the notches provided.

Laminate up the bows for the tips.

Slide the ribs on to the spars, glueing and tacking them into place. Make sure that they are at right angles by checking with a square.

Place the structure on a level surface so that a twist will not inadvertently be built into it. Splice the tip bows into the front spar (Fig. 8) and fair them in neatly, shaping the tip of the front spar. Gusset the bows to the rib trailing edges.

Fit the diagonal bracing struts. These are made of ¼in. solid spruce tapering from 3⅞in. to ½in. at the trailing edge. These pass through the rib webs and are secured to the ribs by strips of ⅜in. square spruce tacked and glued into position. Where the members meet the spar, fit a shaped block to support the joint properly (Fig. 5). These may be made of ⅜in. square stock.

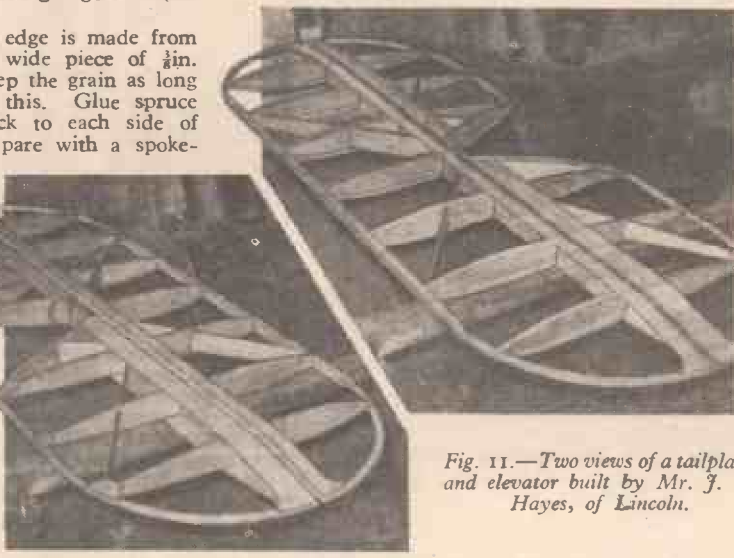


Fig. 11.—Two views of a tailplane and elevator built by Mr. J. T. Hayes, of Lincoln.

PRICE LIST OF PARTS FOR THE "MINOR" TAIL UNIT

	£	s.	d.
Rudder, fabric - covered and doped	9	18	0
Tailplane and elevator, fabric-covered and doped	20	10	0
Fin, fabric-covered and doped	4	2	6
Tailplane ribs, set	4	0	0
Tailplane bows, pair	2	15	0
Tailplane spars (three)... ...	4	10	0
Tailplane fittings	2	0	0
Rudder ribs, set...	2	15	0
Rudder bow	2	3	0
Rudder spar		19	6
Rudder fittings...	1	10	0
Fin-post, leading edge and ribs	2	5	0
Fin fittings	1	8	0

Make up the two spruce formers to support the "D" fairing to the centre of the elevator. Bolt on all the metal fittings, again assembling the hinges to provide 1/16in. end float.

The long plywood strips, top and bottom of both the tailplane rear spar and the elevator front spar can now be fitted together with the "D" fairing which is of 1/16in. plywood.

With a tenon saw, carefully sever the elevator from the tailplane and then clean up the rib ends on them both. Finish off with a thorough sanding. Store the completed tail unit, views of which are shown in Figs. 10 and 11, somewhere free from damp, dust and dirt.

In the next article of this series instructions will be given for building the wings.

The complete set of plans for the Minor costs £11 10s. from Phoenix Aircraft Ltd.

PANORAMIC VIEWS

(*Concluded from page 18*)

Using the Attachment

When using the attachment it is important that the camera should be level. For this purpose a small T shaped level is mounted on a brass plate and used in the accessory shoe.

Set up the tripod with the legs well spaced and adjust the legs to get the camera body level (see Fig. 5). Turn the camera carrier to the centre position on the baseboard. Choose the centre of the panoramic view it is desired to photograph and then swing the baseboard so that the centre of the view is centred in the viewfinder. Clamp the baseboard securely to the tripod top. Then move the carrier round in the various positions to ascertain how many exposures will be needed.

Make the necessary exposures as quickly as possible so that cloud formations have not moved appreciably or the lighting conditions altered.

The prints from the negatives should be made on single weight paper, remembering to give identical exposures and development time. When the prints are ready they can be assembled side by side on a sheet of glass with the images face downwards. With a light under the glass the overlap of the prints can be accurately matched. Hold the series of prints together with some adhesive tape whilst they are trimmed down the centre of the overlaps.

Fig. 5.—Set up the tripod with the legs well spaced.

Ex-Government

Rangefinders

Their Principle, Optical Arrangement and Adjustment

By E. Rolfe Hunter

THESE instruments (regularly advertised in this journal) have a magnification of 14x and a fairly large field, and, therefore, function quite well as a useful telescope or monocular. For the yachtsman or owner of a sea-going cabin cruiser they provide an easy means of fixing the position at sea, in which case a range of some shore object is taken simultaneously with a bearing by compass. They also demonstrate in an interesting manner some of the principles governing reflection and refraction.

Principle of the Rangefinder

The "coincidence" rangefinder makes use of the right-angled triangle for measuring distance. In this triangle, the range measured forms the perpendicular side, and the distance between the two end-windows is the base. A line from the object to the side opposite the range or perpendicular subtends at the instrument the angle which is "measured" and converted into range in yards. In this process the usual optical principles are involved:

Refraction

Details of this are shown in Fig. 1.

1. A ray of light passing from a rarer to a denser medium is refracted in a direction towards the "normal."

2. A ray of light passing from a denser to a rarer medium is refracted in a direction away from the "normal."

The "normal" is a plane at right-angles to the surface of the medium.

Reflection

This is detailed in Fig. 2.

1. The angle of incidence of a ray of light is equal to the angle of reflection (a).

2. The reflected ray moves through twice the angle moved through by the reflector (b).

Optical Arrangement of the Rangefinder

The instrument consists of an outer tube and an inner framework square in cross-section and extending some distance along the axis of the outer tube. The outer tube carries the end-windows, one of which is prismatic in section (the purpose of this is referred to later), the eyepiece and scale lenses, and, one at each end, two so-called "pentagonal" prisms. The inner frame carries objective lenses at its extremities, over which can be placed by the movement of a small lever, hinged astigmatic lenses which attenuate a point of light and enable the range of such light to be measured at night. The various other lenses and prisms are shown in Fig. 3.

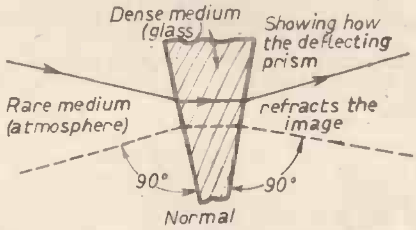


Fig. 1.—How the deflection prism refracts the image.

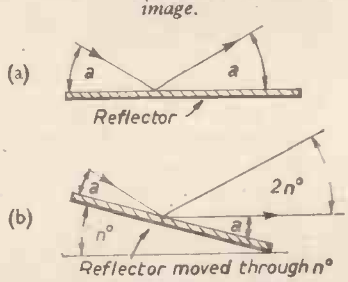


Fig. 2.—Principles of reflection.

In Fig. 3, one complete image passes through each of the objectives but *opposite* halves of each complete image are separated by an arrangement of prisms in the eye-piece-prism unit. As a result, the complete image seen in the eye-lens is a composite one formed of opposite halves. It will be seen that the left-hand image enters the axis of the instrument at an angle less than 90 deg. Movement of the "deflecting" prism along a worm-shaft operated by the milled coincidence wheel near the operator's right hand moves this prism laterally, intercepting the image from the left-hand objective and refracting it upwards into the eyepiece prism, where it becomes visible as the upper part of the complete image seen in the eye-lens. When the upper part of the image is moved into such a position that it accurately coincides with the lower, the range-scale is also moved against a pointer visible in the scale lens and the range can be read-off.

The Pentagonal Prisms

Details of these are shown in Fig. 4.

In the earliest rangefinders plain silvered mirrors were fitted at each end of the outer tube. It was found, however, that because of the behaviour of reflected light (Fig. 2) the slightest movement of the end mirrors caused very large errors. The pentagonal prisms are of particular interest in that they show an ingenious solution of this problem.

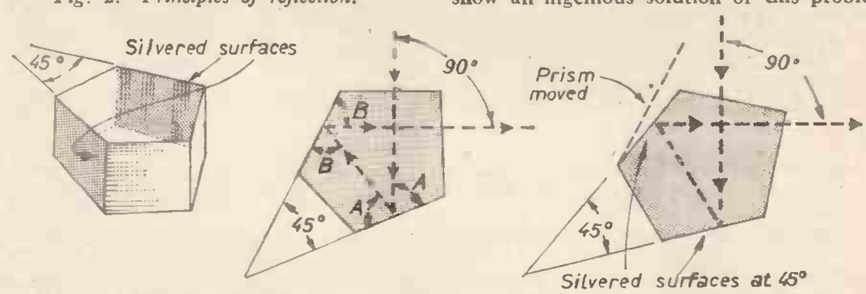


Fig. 4.—Perspective and plan views of a pentagonal prism, showing how the reflected ray is unaffected by movement of the prism about a vertical axis.

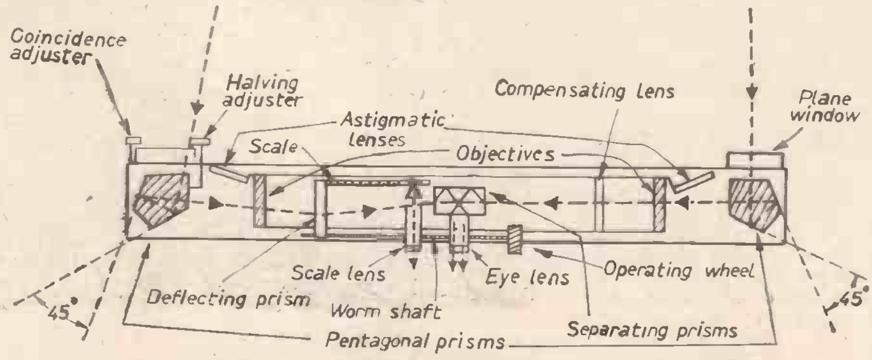


Fig. 3.—Rangefinder optical arrangement shown diagrammatically.

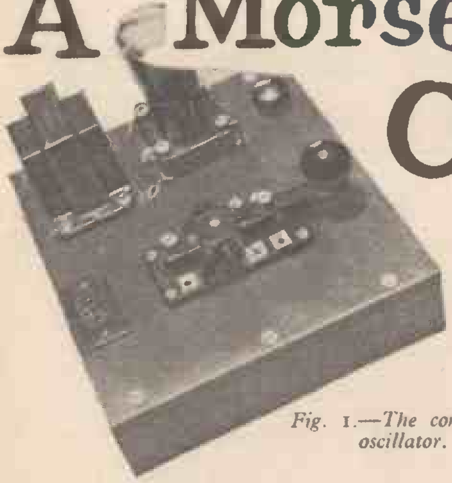
Correcting the Rangefinder

Vibration, changes of temperature, etc., sometimes cause the image in the eye-lens to be deficient or excessive and serious errors of "coincidence," i.e., range, can result from this. The "halving-error" is caused by a slight movement of the pentagonals about a horizontal axis and if present is detected by the following test:

The rangefinder is directed on some object at a suitable distance and slowly depressed until the "separating-line" passes downwards across the object viewed. If in doing this the upper part of the image appears to jump above the separating-line, or appears to be squashed as the separating-line passes down-

(*Concluded on page 24*)

A Morse Practice Oscillator



By

J. BOWICK

Fig. 1.—The completed oscillator.

Useful for Those Learning Morse

In addition to carrying the components, the baseboard also carries the morse key and therefore must be rigid. Not less than ½in. wood is recommended to be used and ⅝in. for the side pieces. After fitting the side pieces see that the base is free from wobble.

Fig. 3 (Right).—Dimensions and constructional details of the base.

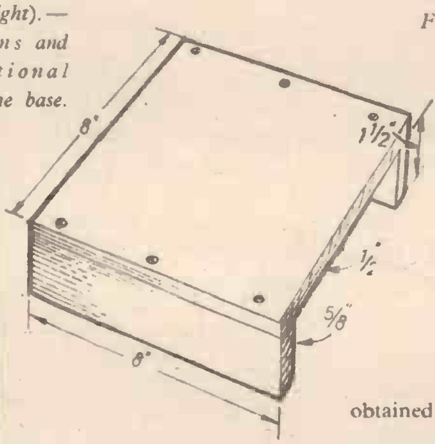


Fig. 2 (Left).—An underside view of the unit, showing H.T. and L.T. batteries, their method of fixing and some of the connections.

The components should now be screwed into position and ⅛in. holes drilled near the terminals so that all the wiring may be taken to the underside of the baseboard (see Figs. 1 and 2).

The power supply consists of a twin-cell cycle lamp battery (L.T.) and a grid-bias battery (H.T.), both of which are secured by means of sheet aluminium cut to shape (Fig. 2).

The Components

These consist of a transformer, valve and variable resistance, all of which may be obtained from a secondhand dealer or from an old battery receiver. With a second-hand transformer the windings should be tested for continuity before wiring up. Any transformer with a ratio of 3 : 1 to 5 : 1 will be suitable.

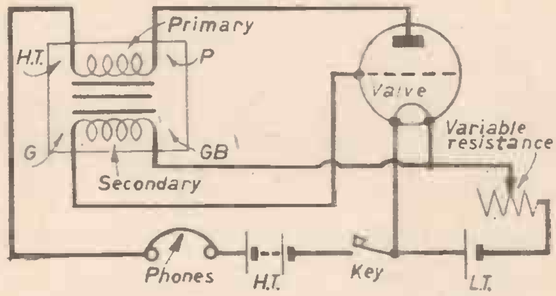


Fig. 4.—The theoretical circuit.

Any type of battery-operated triode valve will give satisfactory results.

The variable resistance serves to control the pitch of the note and also acts as an on/off switch. Its value is not critical.

The headphones should be of the high resistance type (2,000 ohms), and the morse key can be obtained from Huggett's Ltd., West Croydon.

Connecting Up

The circuit is given in Fig. 4, and no difficulty should be experienced here. Note, however, that the polarity of the batteries must be as shown.

If a simple on/off switch is used instead of a variable resistance, the pitch of the note may be controlled by altering the H.T. voltage tapping.

Ex-Government Rangefinders

(*Concluded from previous page*)

wards, halving-error is present and must be removed. This is done by locating the milled wheel marked "halving adjustment" and rotating it as required until the separating-line can be made to pass over the object without distortion. Movement of this wheel either operates a special prism (not shown in the sketch) or rotates the pentagonal about its horizontal axis.

"Coincidence" Adjustment

This is the correcting and testing of the rangefinder "for range." The instrument is first checked for halving as described above. Next, some conspicuous object is selected the exact range of which can be measured from an ordnance map. A series of 10 readings is taken on this object and their mean is subtracted from the map-range. If the difference is greater then the "Uncertainty of Observation" limit as calculated from the formula given below, the instrument needs correcting. This is done by moving the milled coincidence wheel near the operator's thumb until the map-range shows on the internal range-scale. This moves the image in the field of view (in the eye-lens) out of coincidence. It is then put into correct alignment by locating and rotating the knob marked "coincidence adjustment." This rotates the prismatic window already referred to and moves the upper image right or left, as required.

The Uncertainty of Observation

This formula is based on the fact that the eye of the average person with normal vision cannot appreciate an angle of less than 12 subtended minutes of arc. Practised operators, however, often consistently obtain readings considerably below the figures given by the formula.

Formula

Where "U" is the uncertainty of observation in yards,

$$U = \left(\frac{K \times R^2}{B \times M}\right)$$

Where $K = \frac{12}{206{,}000}$

R = The Range in Yards.

B = The Base Length in Yards.

M = The Magnification.

Taking the 1 metre base instrument as being equal to 1 1/12 yards, and with the magnification quoted (14X) this becomes:

$$U = \frac{\frac{12}{206{,}000} \quad R \times R}{15 \text{ (approx)}}$$

At, for example, about six miles range, this equals approximately 400 yards.

Suppliers

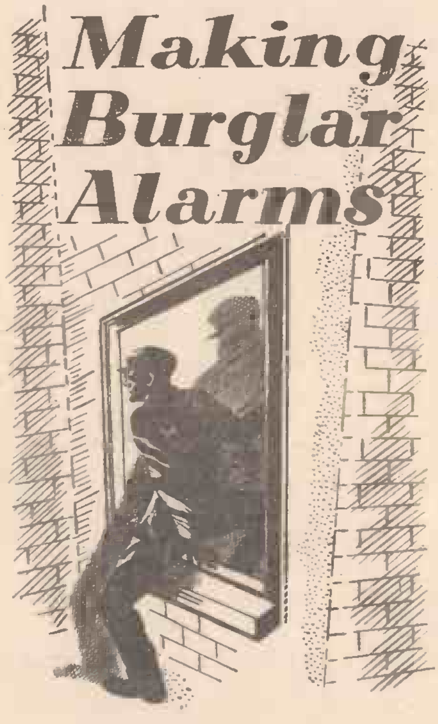
Most of the advertisers in PRACTICAL MECHANICS stock these rangefinders periodically, but at the time of going to press the following firms are in a position to supply them :

H. W. English, Rayleigh Road, Hutton, Brentwood, Essex.

Highstone Utilities, 58, New Wanstead, London, E.11.

Proops Bros., Ltd., 58, Tottenham Court Road, London, W.1.

Making Burglar Alarms



By K. H. Albers

Completion Details and a Simplified Open Circuit Alarm

LAST month some preliminary details of the control box were given and the action of the circuit was described. We continue with a description of how the alarm works.

Presume that a contact in the alarm circuit is disturbed. Immediately the negative current will pass over to the neutral wire, the whole of the neutral wire becomes negative. The current travels back to the unit—both ways, but contact 9 is disconnected and the current can get no farther here. Not so on the "backwards" route, here the current passes *via* points A and B to the electro magnet. The magnet pulls down the magnet lever, which in turn releases the alarm lever and contacts 12 and 13 are closed.

According to the type of alarm selected the positive current from battery 2, which has been "waiting" at 12, now passes to switches 15 and 16, and from there to bulb 5 (red light) and to the buzzer contact, or to the bell contact alternatively.

For the 250V wiring, the positive wire passes to the selector switch *first*, then goes on to one point of contact 13, which will be closed in case of alarm, letting the current flow through.

The incorporation of the 250V switch and 250V selector switch, and the wiring, are not essential, and can be omitted. In fact if the constructor knows only low-voltage wiring, it would be best if the 250V were left out altogether.

Sometimes, however, this 250V switch is very handy. It has been used for large indicator boxes with the letters "Burglars in Here" in the case of shop premises in a small town (where people may wonder why there is a bell ringing, but who would see the indicator box and know) and also on off-the-road club premises, where a bell would hardly be heard, but where the indicator box would be noticed by motorised police patrol on the road.

Mechanical Arrangement

Fig. 5 (last month's issue) may be used either as a complete guide for building the unit or the constructor can invent and make up his own type of switches. These contact switches could have several mechanical variations, but they must fulfil the same functions.

To build the control unit, make a box to the dimensions shown in Fig. 5. The box consists of $\frac{1}{2}$in. thick wooden boards for the sides, a plywood back $\frac{1}{8}$in. thick, two additional $\frac{1}{2}$in. × $\frac{3}{4}$in. strips to the back. A $\frac{1}{8}$in. thick plywood base, and a removable plywood front and top. This will form the main shell of the unit. It is designed for wall-fixing and is hooked on to a backboard which has been plugged to the wall. On this backboard, at each side of the main-unit there can be box-compartments for the batteries, see Fig. 4. Electrical connection to the main unit can be made by means of slide contacts.

In order to make the construction of the main unit easier, inserted into it is a smaller top-case which contains the bulb holders and bulbs and the control buttons. The wires leading to the bulbs are coiled, so that they can be expanded when the top case is removed.

Below this top case a second smaller case, which holds the electro magnet and the magnet lever, has been inserted.

The main portion of all the wiring to the control unit is kept at the back of the box in the recess between the two strips.

All contact parts are made of springy strips of tinplate, except the switch lever and the alarm lever which are cut from fairly thick aluminium sheet.

The contacts in the sectional view in Fig. 5 will have the same numbers as in the wiring diagrams. The same applies to magnet and bulbs.

Other parts denoted by letters are:

a.—An axle, or pivot made of stiff wire which is housed in the sides of the box.

b.—The black press-button, made of hardwood, painted black, or of black plastic material.

c.—An axle, or pivot made of stiff wire, housed in the sides of the box (similar to ("a").

d.—A rod made from stiff wire on which the press-button is mounted. There are two of these rods, one for each button.

e.—Stopper pieces. These are metal sleeves which fit over the ends of the rods "d" and are secured in position with a screw.

f.—An axle, or pivot, made of stiff wire. (Similar to "a" and "c.")

h.—Coil springs, fitted under the press-buttons over the wire rods.

i.—Switch lever, made from $\frac{3}{4}$in. wide stiff aluminium strip, mounted centrally on wire pivot "a." The switch lever has a prong-like top ("U"-shape) which engages into two fork-points of contact 7 (see top-view). This contact must be fairly stiff, i.e., stiff enough to hold the spring contact 6 on to the head of the nut and bolt which forms the second point of contact 6. The switch lever has two slots at the centre, one above and one below the point where the lever is mounted

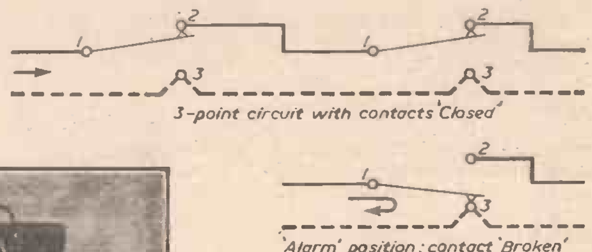
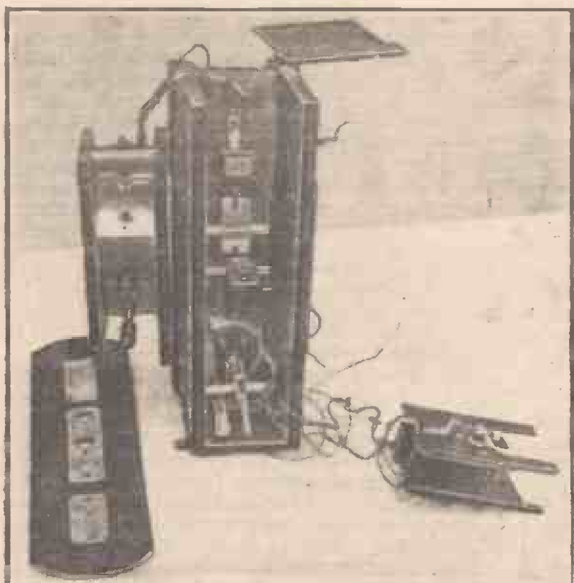


Fig. 9. — Contact wiring shown diagrammatically.



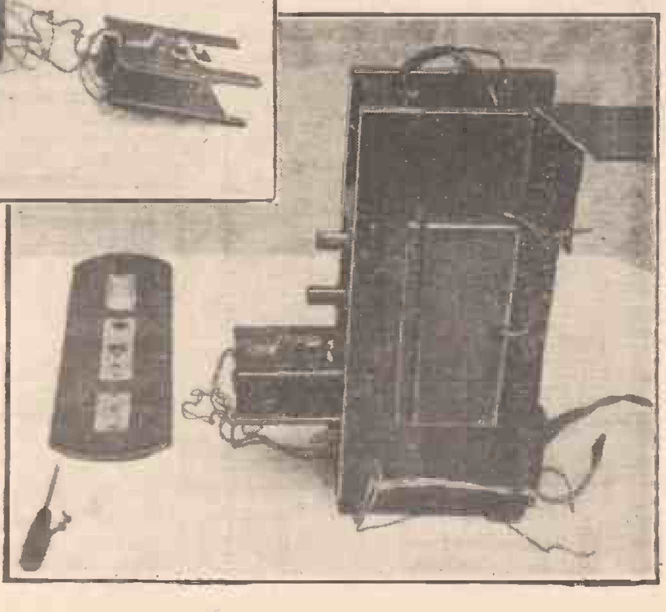


Fig. 8 (Above and right). —Two views of the completed control box. A front view is shown above and a side view on the right. In both cases the front panel, top case and magnet case have been removed.

on to the pivot. The bottom end of the lever is slightly bent forward so that it touches the top of alarm lever "k."

k.—Alarm lever, also made from $\frac{3}{4}$in. wide stiff aluminium strip mounted on pivot wire "f." The lever has a side arm, the end of which is shaped to form a triangular catch, or hook. On top of the side arm a lead weight "l" is mounted. The bottom of the alarm lever has two fork-like contacts, 12 and 13. Contact 13 is for the 250V current. Its parts are preferably made from copper strip. They must be mounted on an insulated base and the parts must be at least $\frac{1}{2}$in. away from any other metal parts of other contacts. All parts of contact 13 must be screwed down very securely.

l.—Lead weight mounted on side arm of the alarm lever.

p.—Curved Perspex window, can be sandpapered on back to render semi-opaque.

r.—Red press-button, mounted on rod "d."

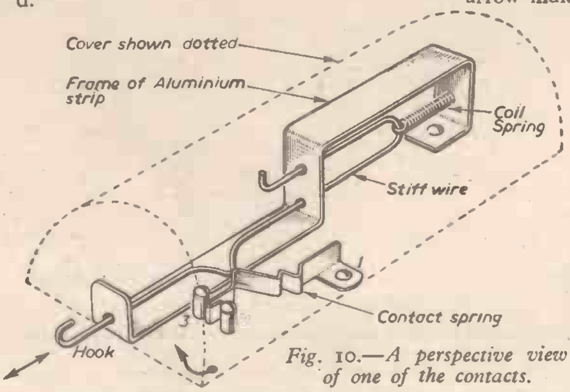


Fig. 10.—A perspective view of one of the contacts.

s.—Selector switch, flat metal rod mounted on pivot wire "c," with a small plastic handle piece. It can be made from a piece of an old toothbrush handle, slotted to fit over the flat rod and secured with a small nut and bolt.

Other parts are the bulb holder which is made from a strip of tinplate which is curved and has three holes into which the bulbs are screwed. At the back of the strip of tinplate a curved Perspex backing plate is fixed by means of nuts and bolts and distance pieces. (Perspex can be bent in hot water or over steam.) The Perspex backing plate has three bolts, each of which touches the bottom of one bulb. The red wire connects to the tin-strip bulb holder, the other wires shown in the wiring diagram connect to the bolts on the Perspex backing plate.

Beneath the bulb holder arrangement are two flat pieces of aluminium sheet which are fixed to the wooden sides of the removable top-case. Both plates have two holes through which the button rods pass. The front plate serves as a pressure base for the coil springs, the back plate acts as a stop to the stopper pieces. Both plates contain and guide the button rods.

The smaller removable case below holds, as already mentioned, the electro magnet. The leads (wires) to the magnet are coiled they can extend when the case is removed from the main box. The magnet lever, which is fixed over the magnet, is a flat piece of springy tinplate with a triangular hook at the end (this engages the hook on the alarm lever). Where the magnet lever passes over the magnet a metal collar is fixed over the magnet lever to give the magnet more substance to pull.

The hooks at the end of the magnet lever and at the side arm of the alarm lever must be formed in such a way that they engage each other when the alarm lever is brought upwards by the forward action of the bottom end of the switch lever and when the magnet lever is up. The end of the magnet lever will give, to make engagement possible. And the hooks must also be formed so that they disengage when the magnet lever is pulled down by the magnet.

How the contacts 8, 9 and 10 are made and arranged may be seen in Fig. 6 (last month's issue). Fig. 8 shows two views of the completed control box.

The Circuit Wiring and Contacts

The circuit wiring for the Open Circuit, 3-Point System has already been explained. It consists of a loop formed by two wires. The wires can be single wires twisted together or they can be single, independent wires. Ordinary plastic-insulated bell wire is required for this. These wires start from the outgoing circuit points at the control unit, go round to all the contacts and return to the control unit.

Fig. 9 shows how the wires are connected to the individual contacts. It is very important to note the direction of the wires. The arrow indicates the direction of "flow" and points the way the wires take back to the control unit (to the return circuit points).

The full black line is the wire which carries the current. This wire, coming from the outgoing circuit point is connected to point 1 of the contact. The gap between point 1 and point 2 is bridged by the contact spring. The wire is cut at point 1 and is reconnected to point 2. From there it goes on to point 1 of the next contact, and so on.

The neutral wire is shown dotted. It is not cut at the contact points, but is connected to point 3 of the next contact, forming one continuous line all the way, with the point 3 of all contacts connected up to it.

If contact points from 1 and 2 were connected in the wrong order, the current which comes from the control unit directly to point 2 would not pass to point 3 when the contact is broken. The correct action is shown in Fig. 9.

Correctly connected the current will pass from point 1 to point 3 (of any contact) and return to the unit to give the alarm. Two wires of different colour would facilitate wiring to the correct contacts. If two wires of the same colour are used, check at each contact which wire is to be connected to points 1 and 2, and which to point 3 by means of an additional wire lead, which, when used in connection with one of the circuit wires, will light up a bulb.

Window Contacts

On windows a concealed contact let into the window-frame, out of reach and out of sight, can be employed. The contact spring is kept pressed down on to point 2 as long as the window is closed, but when opened the contact spring touches point 3 and the alarm is given.

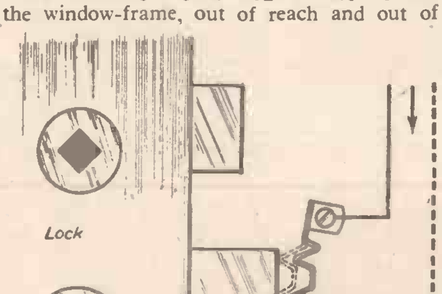


Fig. 11.—Details of a door lock contact.

This applies to windows with small panes. When windows have panes large enough to afford entry if one is broken or removed, then something else is required. Thin brass wire can be stretched up and down inside the window in parallel strands about 9in. apart. The wire can run over small pulleys at top and bottom, and the end is fastened to the hook of the contact. Black cotton thread, fairly strong, can also be used for this purpose. The type of contact used is shown in Fig. 10.

The frame for the contact is made of aluminium strip with holes drilled to accommodate a stiff wire rod, bent to shape as shown. Note how the wire is bent to form a "nose" against a similar nose in the contact spring. The contact spring is made from springy tinplate. As long as the wire rod and the contact spring "noses" touch points 1 and 2 of the contact will be connected. If there is a pull on the hook, causing the coil-spring at the end of the wire rod to give, or if the normal tension on the hook and coil spring is released, then the wire rod and contact spring will lose contact. Either movement of the wire rod will cause the contact spring to move over and connect to point 3, thus operating the alarm.

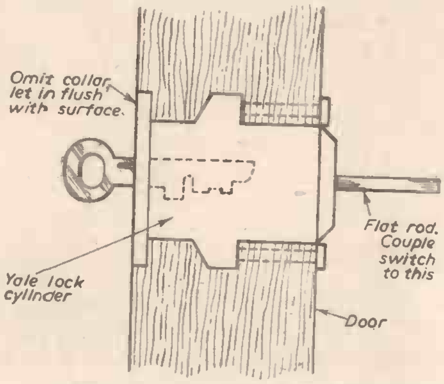


Fig. 12.—Yale lock door switch.

Frame and wire rod and contact spring can be screwed to the wall or to the skirting board. The whole contact is covered with a semi-circular tinplate cover, secured with screws.

Door Contacts

A very effective way of making contacts on doors is to fix the contact spring under the locking plate on the door frame. Preferably against the lock-catch, where doors are normally locked. This is quite easy to do in the case of rimlocks (surface fixed). For mortice locks some chisel work may be necessary to widen the space in the door lining under the locking plate. The arrangement of this type of contact is shown in Fig. 11. As soon as the burglar imagines himself to be successful with a skeleton key, he will have achieved the reverse. At the same time you can check by this type of contact if those doors which should be locked are, in fact, locked.

Yale Lock Door Switch

Fig. 12 shows a special Yale lock door switch. This sort of "bridging" switch to an alarm circuit can be made from the cylinder part and the flat connection rod to the indoor latch of a Yale lock. The latch itself is not required. Instead of that a simple on-off switch is connected to the flat rod.

The purpose of this special switch is to enable you to leave and re-enter the premises after the alarm has been set. The on-off switch acts as a bridging switch to the door contact, which is then disengaged when the Yale lock key is turned.

On burglar alarm circuits securing large lock-up business premises there is no such provision. Manufactured closed circuit control units have a three minute or five minute time-switch built in, which allows for leaving the premises after setting the unit. On re-entering the following morning the alarm has to be set off.

For domestic purposes this is not ideal. The family may go out in the evening. Or a member of the family may come home late. The solution to such problems is the Yale-lock switch. If it is feared that a burglar might be able to open the Yale lock, this lock can be concealed, it need not be on the door itself. But a Yale lock is pretty safe against burglars, even if the burglar sees it.

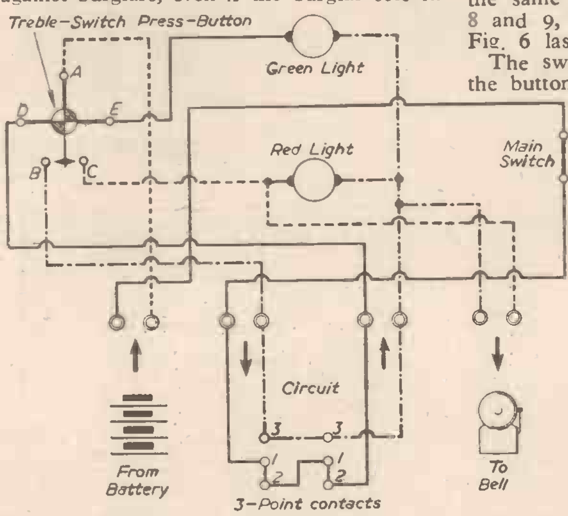


Fig. 13.—Wiring diagram of the simplified open circuit alarm.

A Simplified Open Circuit Alarm

Here is something for those who have found the wiring diagram and the foregoing control unit mechanism too complicated.

The wiring for the control-unit of this type of alarm is shown in Fig. 13. This unit has not all the features of the other control unit. But it has a control check button, which checks the wiring circuit, it has a green and red light and a main on-off switch.

The unit is operated by switching on the main switch, then pressing the control button. This action checks both circuit wires at the same time, and the green bulb will light up if all contacts are in order.

Alarm will be given by the red light and by an external bell. You may ask how the red light can give the alarm. In actual fact it does not unless one were to sit in front of the control unit all night. The chief function of the red light in this control unit, and in the more complicated control unit previously described, is to indicate at the time of setting that the contacts are not in order. In this unit, if the button is pressed and the green light does not come on, but the red light does as soon as the button is released, this means that a contact is actually in "alarm" position. Rather than having the clangor of the alarm bell ringing you can at once switch off again and check the contacts. The same principle applies to the other control unit.

The alarm given by this type of control unit is not continuous, i.e., the bell only rings as long as a door or a window is actually open. Unless the contacts are built or arranged in such a manner that once a contact has been disturbed it will not go back to its original position (the contact spring is meant). This can in a way be achieved by using the window contact shown in Fig. 10 in connection with black cotton thread. Reasoning on the assumption that a burglar must either pull the thread, or more likely break it unknowingly. Thus the contact would make the alarm as long as the contact is not touched. Alternatively, an electro magnet with a lever stop spring can be used between the unit and the bell.

The treble switch press-button which checks the circuit is built and arranged in the same manner as the contact switches 8 and 9, and 10 and 11, all as shown in Fig. 6 last month.

The switch action is as follows: When the button is pressed down "D" connects to "E," and "A" connects to "B" (note: in Fig. 13). When the button is released these points are disconnected, but now "A" is connected to "C."

Circuit Operation

On the wiring diagram the full line represents the blue wire, the dotted line the red wire. The dot-dash line indicates tht dual purpose red-blue wire. This part of the wiring will carry the same current as the red wire when the control button is pressed, it is neutral when the button is released, and it will carry the current from the blue wire when an alarm contact is made.

To trace the unit wiring, begin with the blue wire from the battery point. This wire leads to the main switch, goes from the main switch through the outgoing circuit point, to all contacts in the circuit (points 1 and 2), returns to the unit and leads to point "D" of the press-button.

The red wire from the battery point goes to point "A" of the press-button. If the control button is pressed the current of the blue wire will pass to "E" and from there to one point of the green bulb. The current of the red wire will go from "A" to "B," from here to the outgoing circuit point, return to the unit and go to the second point of the green bulb, and the green bulb will light up.

On releasing the press-button the current of the red wire will pass from "A" to "C" and go to the red bulb and to one bell point.

If an alarm contact is made, the circuit wire which comes from "B" will get the same current as the blue wire through one of the circuit contacts, and the current will flow to the second point of the red bulb and of the alarm bell.

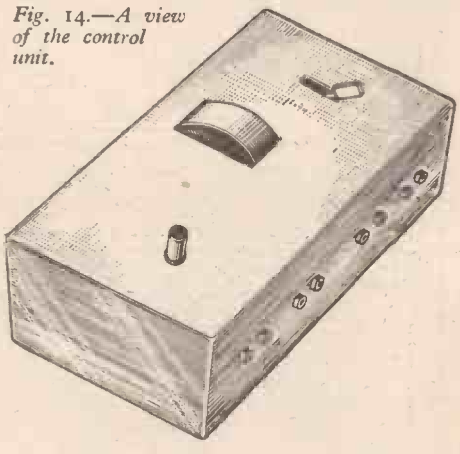
Fig. 15.—The scene after an actual burglary.

Control Unit Construction

The mechanical arrangement of the control unit, i.e., the arrangement of the press-button and the bulbs with curved window, can be the same as for the control unit of Fig. 5. Having two bulbs only, it may be found that two ordinary flash-bulb holders can be employed. The press-button does not need a coil spring, the contact will counteract the pressure on the button. There must be a stop on the button so that it cannot come right out of the box.

No internal removable cases to the main box will be required. All the parts are accessible as long as the front of the box can be taken off. A sketch of the control unit is also shown in Fig. 14. The size of the box does not matter much, as long as the press-button, bulbs and switch can be accommodated.

Fig. 14.—A view of the control unit.



The circuit wiring for this simplified type of alarm is exactly the same as for the type of alarm mentioned before. A control unit as in Fig. 5 can be connected to this circuit wiring at a later date, should it be desired. For those who are still wondering whether a burglar alarm is a necessary precaution, Fig. 15 shows the scene of an actual burglary experienced at the author's place of work. This could have been prevented by an efficient alarm system.

Building a Tape Recorder

THE circuit is reasonably conventional although the opportunity has been taken to include several features found only on more expensive commercial machines. The main departure from the general form of the home-built recorder lies in the mechanical assembly. This has resulted in economy of space without undue complications in building and wiring and at the same time has helped to eliminate possible electrical trouble in the shape of hum and instability by avoiding the use of long leads and straggling layout.

The deck used is the Collaro Mk. 4 (or 3) which has a built in switch bank mechanically coupled to the various functions of the deck itself. The use of such switching makes for fool-proof operation (against the risk of accidental erasures, for example), and at the same time permits the automatic adjustment of the recording-playback amplifier characteristics to suit the immediate requirements. The system is therefore much superior to the more normal design found in home-built equipment where the mechanical control of the deck is entirely separated from the electrical switching of the amplifiers.

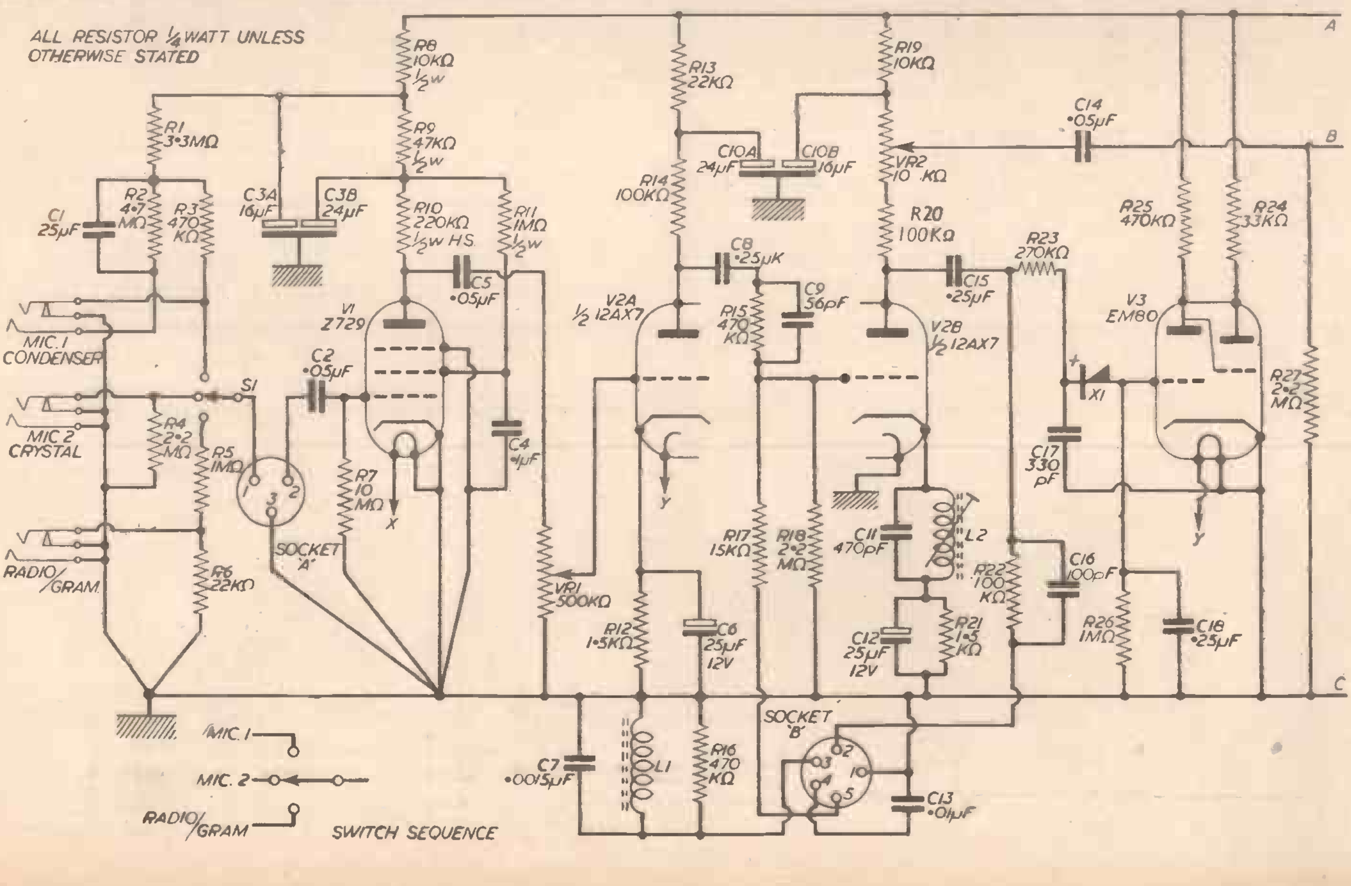
LIST OF COMPONENTS

Resistors
¼ watt types RMA 9 (or Morganite T)
½ watt types RMA 8 (or Morganite T)
1 watt types RMA 2 (or Morganite R)
Wirewound types Welwyn or Painton Vitreous 6 watt.

Capacitors
Electrolytics :
1 25 μF. 25 volt wkg.
2 25 μF. 12 volt wkg.
1 8 μF. 350 volt wkg.
1 16 μF. 350 volt wkg.
1 16+16 μF. 450 volt wkg.
1 8+16 μF. 350 volt wkg.
2 16+24 μF. 350 volt wkg.
1 1,000+1,000 μF. 25 volt
Paper, 350 volt unless stated otherwise.
2 0.25 μF. 150 volt
2 0.25 μF.
1 0.1 μF. 150 volt
2 0.1 μF.
2 0.02 μF.
1 0.01 μF.
3 0.005 μF.
Mica or silver-mica.
1 3,900 pF. (or 0.004)
1 2,000 pF. (or 0.002)
1 1,500 pF.
1 470 pF.
1 330 pF.
1 220 pF.
2 100 pF.
1 56 pF.

A complete resistor and capacitor kit to the original spec. can be supplied by TRS, Ltd., who supply the mains transformer.
Mains Transformer : TRS, Ltd., 70, Brigstock Road, Thornton Heath.
Output Transformer : Elstone Type OP7.
Choke : 10 H, 100 mA. Gardners Type C248 (or similar).
Switches : Miniature oak. 1 1 pole, 3 way.
1 2 pole, 3 way.
Plugs and Sockets : Miniature types, 2 3 pin.
2 5 pin.
Jacks : 6 igranic moulded, with earth contact.

Coils : Osmor, Ltd. L1 (top lift, screened)
L2 (bias rejector)
L3 (oscillator QT9)
Rectifiers : 1 STC type
1 CG4C crystal
Valveholders : 9 B9A with screens.
Controls (Carbon) :
1 Morganite VR1 500 KΩ log.
1 Morganite VR2 10 KΩ lin.
1 Morganite VR3 1 MΩ log.
1 Dubilier VR4 500 KΩ C.T.
1 Morganite VR5 500 KΩ lin.
Valves :
1 Marconi Z729
3 Mullard 12AX7
1 Mullard EM80
2 Brimar 6BW6
1 Brimar 6CH6
1 Marconi U709
(or equivalents)
Panel : A specially engraved bakelite panel for this design obtainable from Messrs. A. G. Engraving, 292, Earlsfield Road, S.W.18.



The Recorder's Facilities

No effort has been made to combine the function of bias oscillator with any part of the A.F. amplifier as is common practice; instead, the A.F. amplifier proper which may be considered to come after the pre-amplifier and correction circuits has been designed as an amplifier in its own right, with its own independent input point and tone controls. It can, therefore, be used apart from the normal functions of the recorder for straight amplifier use and for the reproduction of records. Further, two alternative forms of push-pull output may be chosen when wiring; a triode-connected form giving about 4 watts output, or a pentode-connected form, with n.f.b. giving about 7 watts.

The pre-amplifier has three alternative input points; these are designed to suit either crystal or condenser microphones, or a radio-gramophone input, and has a gain control independent of the main amplifier. A monitor point for phones or small speaker

S. A. Knight Describes the Circuit and Components Employed and Starts Construction of the Power and Output Stages

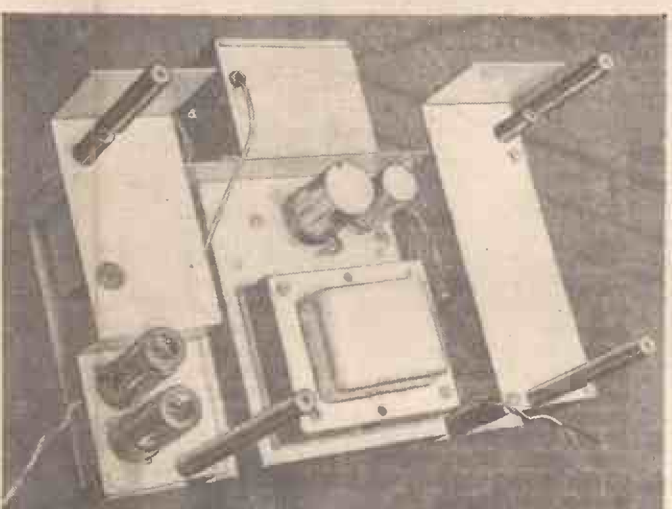


Fig. 3.—The completed power and output chassis.

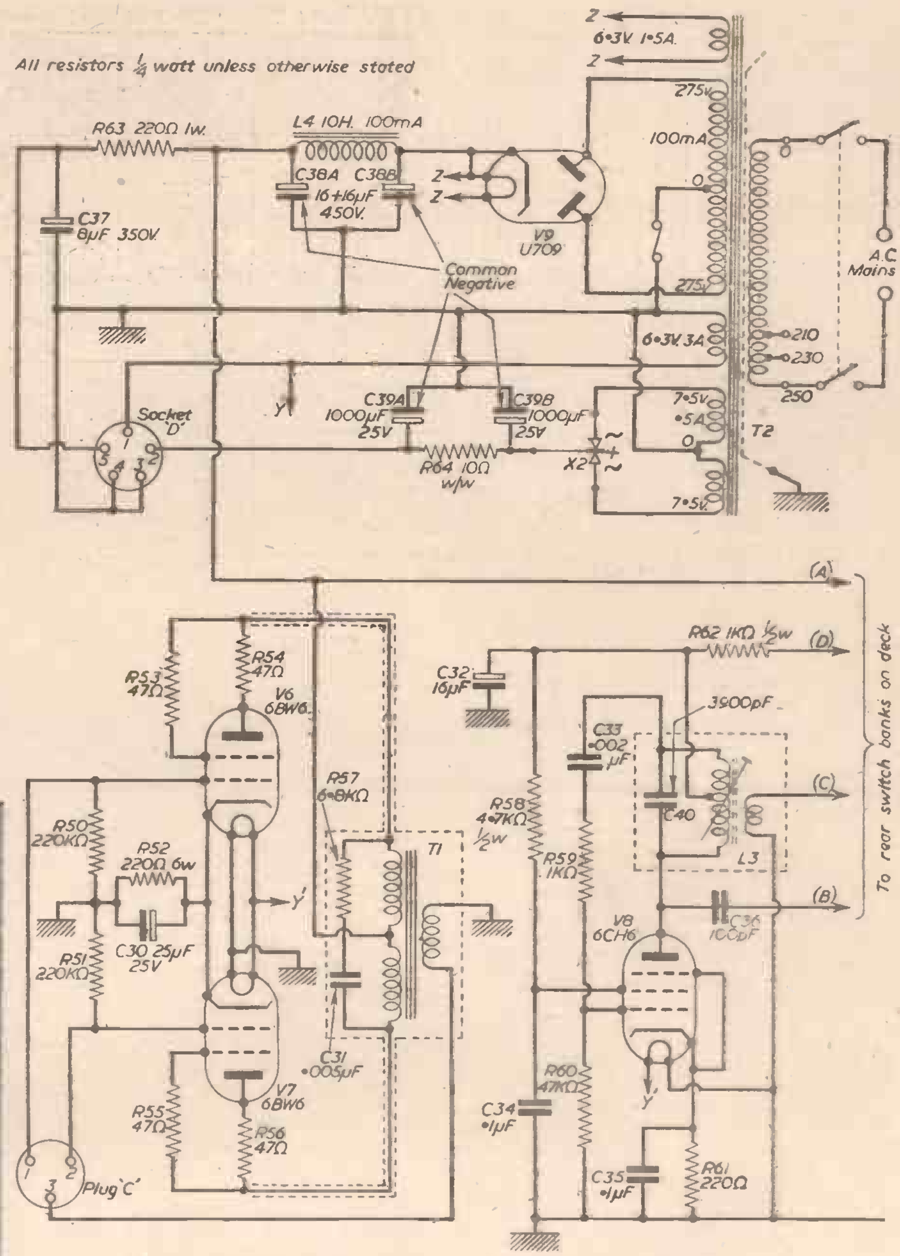
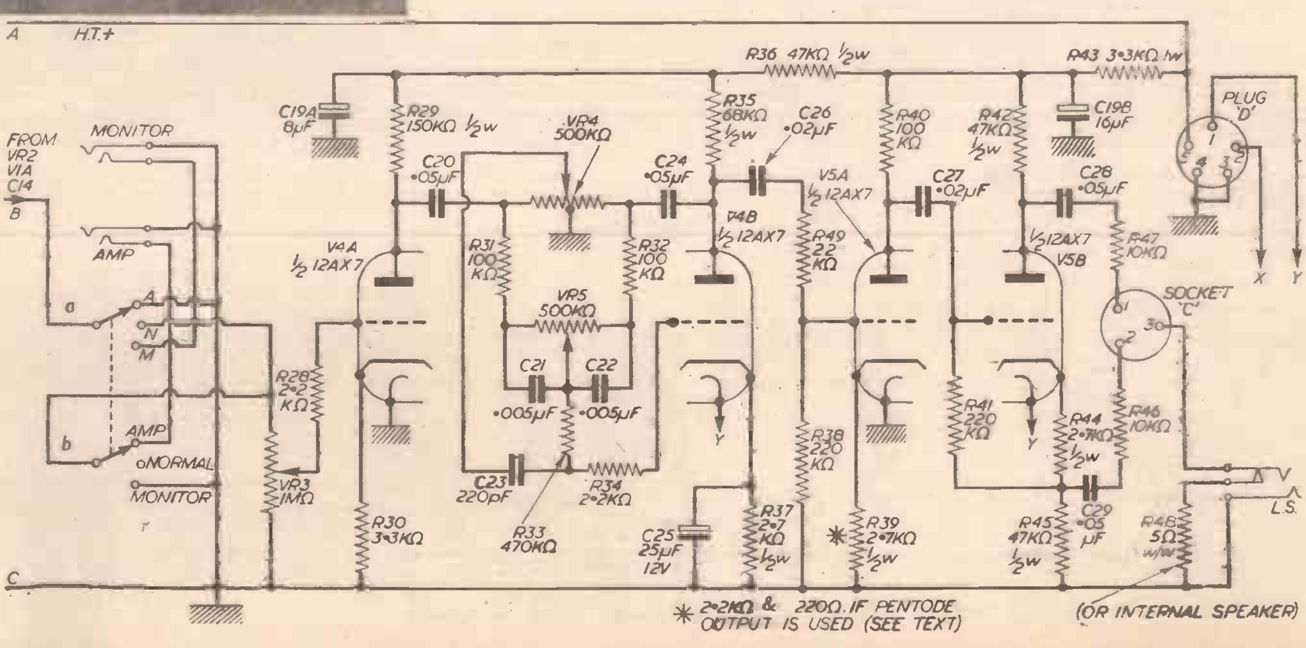


Fig. 2.—Circuit of the output stage, bias oscillator and power unit.

Fig. 1.—(Left and right) Circuit of the pre-amplifier and main amplifier as far as the phase splitter.

N.B.—The circuit is split in two parts which are to be joined at points A, B and C.



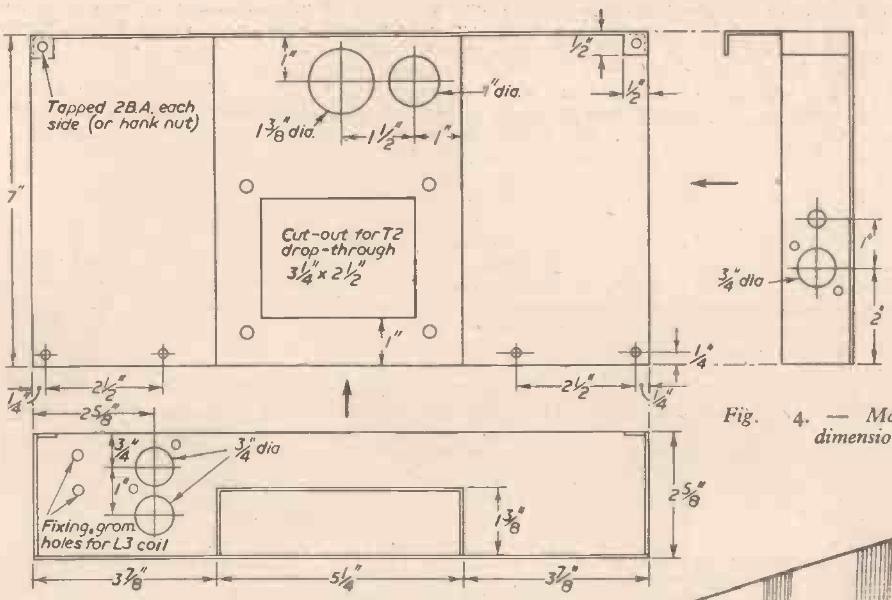


Fig. 4. — Main chassis dimensions.

is provided as a recording check. Playback and recording response characteristics are compensated in the circuit.

Circuit Details

The circuit diagram of the pre-amplifier and main amplifier up to the phase-splitter is shown in Fig. 1. V1 (Z729) is operated under grid leak bias conditions, and will accept either of the three inputs through switch S1 when recording or the recorder-head output when playing back. The polarising votlage for the condenser microphone is obtained from the potential divider R1-R2 across the H.T. line which provides about 100 volts at the microphone terminals. The crystal microphone feeds into a direct 2.2 mΩ load, while the radio-gram input has pre-attenuation at the divider R5-R6.

The output of V1 feeds through the pre-amplifier gain control VR1 to the double-triode amplifier and correction circuit (12AX7). The correction is conventional, with inductance compensation for top boost on recording, and C-R bass boost on playback. The switching is carried out on the deck banks via socket B. A bias-frequency filter is incorporated in the cathode of V2B.

The output from V2B feeds (directly) to the recording head through R22, and to the tuning indicator V3 (EM80). When playing back, a part of the output is tapped off across control VR2 (preset), and provides the input to the main amplifier. Switch S2A and B enables the pre-amplifier output to pass straight to the amplifier (Playback), or to select a Monitor point for checking a recording, or to provide a point for using the amplifier separately from a microphone or pick-up input. The main control of gain is provided by VR3 and V4A and B (12AX7) provide respectively the initial amplifier stage and tone control circuit. This is based on the Baxandall design, and gives full range bass and treble control through VR5 and VR4 respectively. V5A and B (12AX7) provide further amplification and phase-splitter functions, and the outputs from anode and cathode of V5B feed to the push-pull output valves on a separate chassis.

Output Stage and Power Unit

The output stage, bias oscillator and power unit are built on to a separate chassis which also carries the tape desk itself. The circuit diagram is given in Fig. 2.

V6 and V7 (6BW6's) are triode connected in a push-pull output stage with common cathode bias, and feed into the output transformer T1. This transformer, because of its proximity to the deck switch banks is shielded in a simple box of sheet tinplate. If the stage is used as a pentode-connected pair, the screen connections are returned directly to the H.T. rail and the speech coil is returned to a tapping on R39 to provide negative feedback; however, this will be dealt with more fully later.

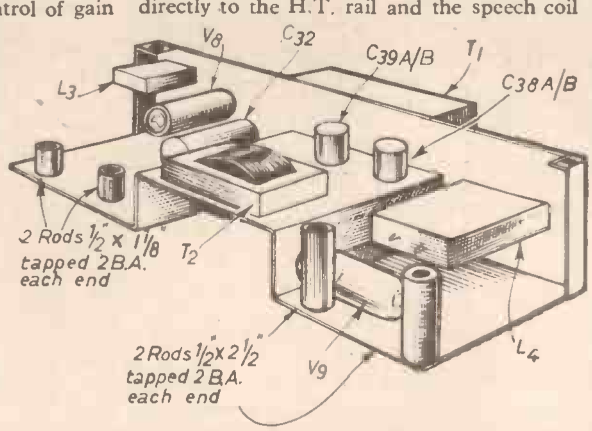


Fig. 6.—Positions of the rod spacers.

The bias oscillator is a conventional system and gives an output of approximately 50kc/s at the anode as bias, and provides about 30 volts of erase voltage on a secondary winding which matches to the medium impedance erase heads on the deck. V8 (6CH6) is a video type pentode.

Power is provided from transformer T2 which has been specially designed for this recorder. V9 (U 709) gives an H.T. rail

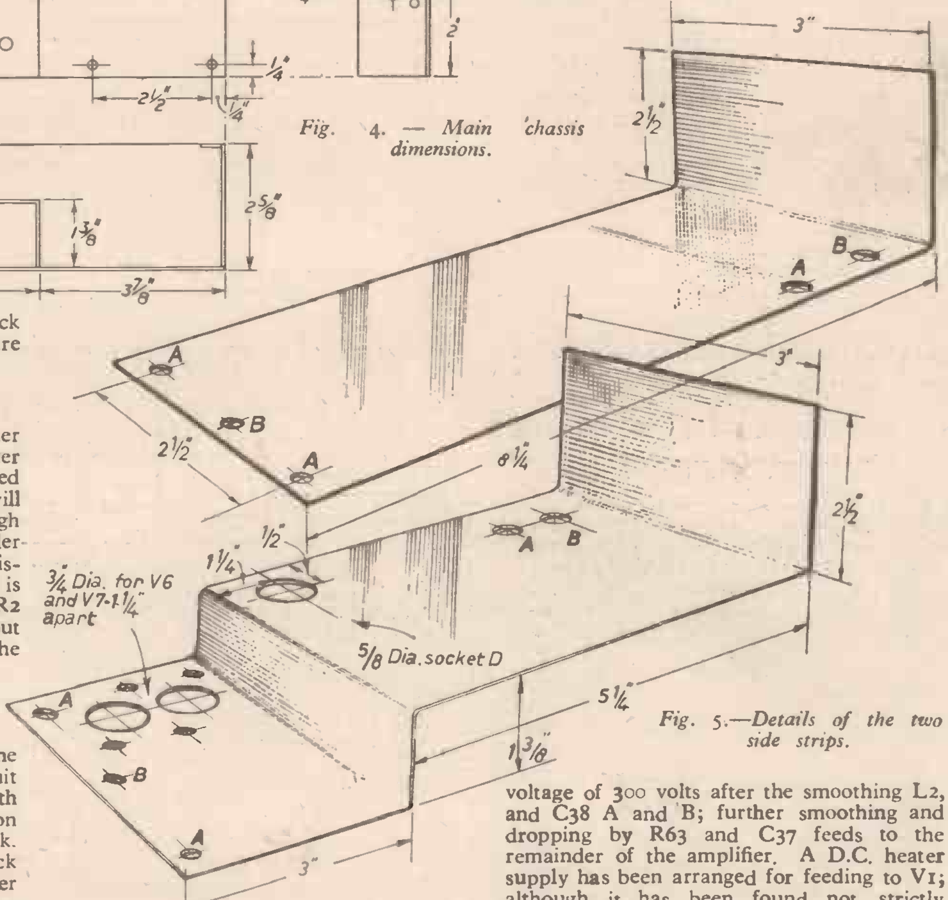


Fig. 5.—Details of the two side strips.

voltage of 300 volts after the smoothing L2, and C38 A and B; further smoothing and dropping by R63 and C37 feeds to the remainder of the amplifier. A D.C. heater supply has been arranged for feeding to V1; although it has been found not strictly essential, it does provide a small reduction in the hum level at this input stage and is well worth incorporating. The remainder of the heaters are A.C. fed from the 6.3 volt, 3 amp. winding on T2.

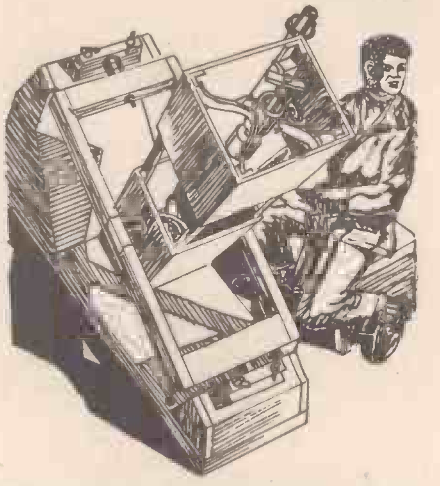
Power and Output Chassis

Construction can conveniently begin with the chassis which houses the power unit, bias oscillator and output push-pull amplifier stage, and which carries above it the tape deck with the switching. The photograph, Fig. 3, shows the unit assembled and wired.

The chassis is made up from 16 s.w.g. sheet material and although dural or aluminium may be used, it is perhaps somewhat easier (because it permits of soldered seams) if brass or tinplate is employed. The chassis actually comprises three parts, the main section being dimensioned in Fig. 4. Here it is seen that a basic L-shaped chassis measuring 7in. × 2⅝in., with a width of 13in., has soldered (or riveted) to it a two-sided section measuring 7in. × 1⅜in., with a width of 5¼in. Only the main drillings are shown as some slight changes may occur in smaller fixing holes where alternative types of components are used. Two side strips (shown in Fig. 5) fix to the main chassis by means of 2 B.A. screws tapping into ½in. dia. metallic rod spacers positioned as shown in Fig. 6.

(To be continued)

'How to use your P.M. Reflecting Telescope'



Observing the Sun, Moon, Venus, Mercury and Mars

By F. W. Cousins

Do not be dissatisfied with your first impressions. When it is known that a telescope can magnify 200 times and more some beginners and casual viewers are disappointed at not seeing objects larger. In viewing Jupiter, for example, with a power of about 100 it will often appear between two and three times as large as the Moon appears to the eye unaided. Yet for some curious psychological reason—a want of practice, a lack of a standard for comparison—it is not appreciated that it is so large. Only when the Moon and Jupiter are juxtaposed in the sky is it possible to verify this by viewing them simultaneously—the planet through the telescope and the Moon with the naked eye.

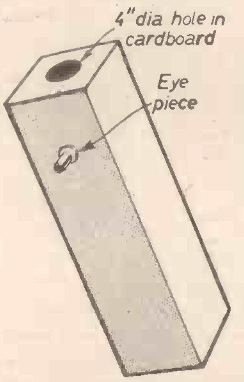


Fig. 1.—*Stopping down by fitting a cardboard cover.*

For very faint objects remember the trick of averted vision. Turn the eye to the edge of the field retaining one's interest at the centre where the object ought to appear. The human retina is more sensitive *off* the centre. Do not dazzle the eye before you go out to observe. Give it a short preparatory rest in the dark. Herschel prepared his eye by keeping it in utter darkness for upwards of a quarter of an hour.

Study of the Heavens

Of prime importance is a star atlas of repute and an astronomical ephemeris; details of these and instructive text books are given below.

Reference Works

Norton's Star Atlas. 1957. 17s. 6d. From 12, Newington Road, Edinburgh, 9.

The British Astronomical Association. Its Nature, Aims and Methods. 2s. 303, Bath Road, Hounslow West, Middlesex.

Introduction to Astronomy. C. Payne and G. A. Poschkin. Eyre and Spottiswoode. 1956. 50s.

Stars at a Glance. George Philips. 2s. 6d.

The Sun. Giorgio Abetti. Faber and Faber. 1957.

Guide to the Moon. Patrick Moore. Collins. 2s. 6d.

Curiosity to see the heavenly bodies has possibly never been so great. Some believe that great telescopes must be used if the results are to satisfy. They forget how much can be seen and done with a small instrument in skilful hands. Mr. Burnham, of Chicago, using a 6in. telescope, discovered many hundreds of double stars so obscure that they had escaped the scrutiny of Struves and Maedler, using large instruments. Dr. W. H. Steavenson, at Cheltenham, when he had not his large telescope, did valuable work on comets, using nothing more than a 3in. altazimuth refractor. Further, some of the most beautiful sights of the heavens are revealed by a modest instrument employed with low powers.

First among the objects which show beautifully through a small instrument is the moon and next the ringed planet Saturn.

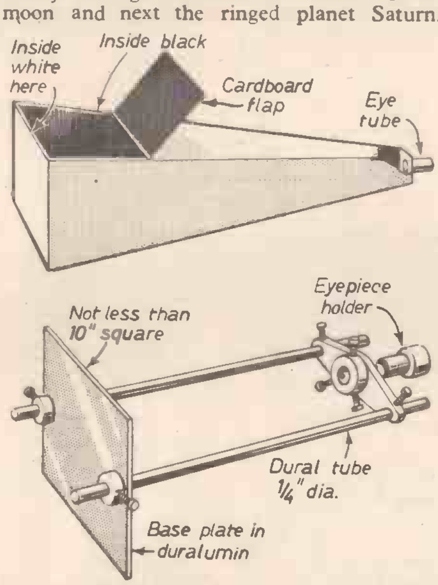


Fig. 2.—*Simple sun projection box made from card.*

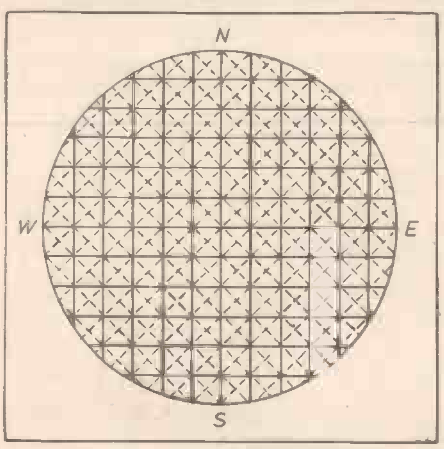


Fig. 3.—*Disc with grid of fine lines.*

All the planets can be seen to advantage, as also can star groups far from the confines of the solar system. The Sun itself is a difficult object, for here we have to contend with an abundance of light. *Untold damage may be caused to the eye of an observer who does not take the necessary precautions.* It is recorded that Galileo probably thus blinded himself wholly and Herschel I, in part.

Observing the Sun

Some refinement of the telescope is desirable if the sun is to be observed directly at the eyepiece. Alternatively, the sun may —with complete safety to the eye—be studied by projection. If the heat of the Sun is great, as at midsummer, the telescope should be "stopped down" to an aperture of 4in. This may be done by fitting a cardboard cover to the upper portion of the tube (Fig. 1). The flat mirror will be heated most and the eye lens should not have cemented components. A Tolles eyepiece is ideal, if of low power, giving a field which will embrace the whole disc of the Sun. A very useful projection screen is shown in detail in Fig. 2. The telescope should be balanced and counter-weights will be necessary. Some observers favour a screen made from fine plaster of paris; others, such as Mr. Addey, one of the most experienced observers of the Sun's surface, favours fixed and glazed glossy bromide photographic paper. On this clear surface it will be possible to see the Sun spots and these may be enlarged by recourse to a higher power uncemented eyepiece.

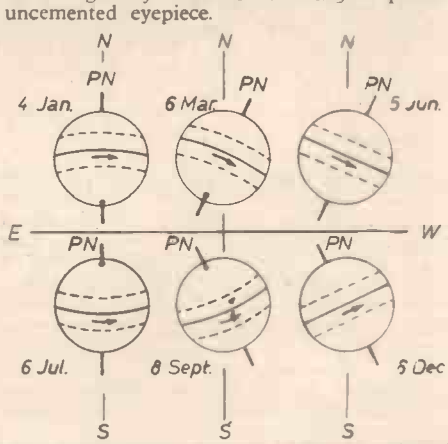


Fig. 4.—*Changing presentation of the disc of the sun in the course of a year.*

Whole Disc Records of Sun Spots

Using a screen of bromide paper or good quality Bristol board mark out a 6in. dia. disc and across this draw a grid of fine lines, as shown in Fig. 3. The lines must be so fine as not to mask the images of small sun spots. An exactly similar card must now be prepared with the exception that it is to have all its grid lines ruled in black ink, dense but not thick.

Now to make a record of the whole disc the image of the sun must first be brought to a focus on the projection screen and the screen rotated until a spot, or failing that the upper limb of the Sun, runs exactly along the E/W line, the telescope tube being stationary. Using the cradle equatorial mounting the telescope should require no further adjustment. Again carefully focus the image. Holding the card covered with fine quality tracing paper on the hand, with a fine pointed pencil delineate the markings seen on the projection screen. The identical grids greatly facilitate this.

When the drawing is complete it may be placed over a Stonyhurst disc card suitable for the date.

A set of these cards can be obtained from C. F. Castella, Regent House, Fitzroy Square, W.1, for £2 2s.

The heliographic positions of the various Sun spots and Sun spot groups may then be ascertained. Alternatively, the Stonyhurst disc can be mounted in place of the projection screen and the positions of the spots read off once the disc has been correctly oriented.

A cheap and efficient disc for the calculation of the heliographic co-ordinates of sun spots is the Porter's solar disc designed by Dr. J. G. Porter. This strong cardboard disc is used as a template and no solar worker should be without one. A Porter's solar disc is obtainable, price 1s., plus 2d. postage, from Assistant Secretary, British Astronomical Association, 303, Bath Road, Hounslow West, Middlesex.

Individual Spots

Increase the power of the eyepiece, using an uncemented type such as a Tolles. The projection screen will have to be adjusted on its supports to suit the new focus. The fine detail of the umbrae and penumbrae of the spots should be readily evident. The scale can be ascertained by taking the distance between the centres of a pair of spots and comparing this with the distance on the screen when the whole disc is visible.

Always record the date and time of the observation, the scale and the position of the E/W line.

It should be understood that the axis of rotation of the Sun is inclined to the axis of the ecliptic (the plane of the Earth's orbit) by an angle of 7.4 deg. and that during the course of a year the Sun appears to nod backward and forward. The solar equator

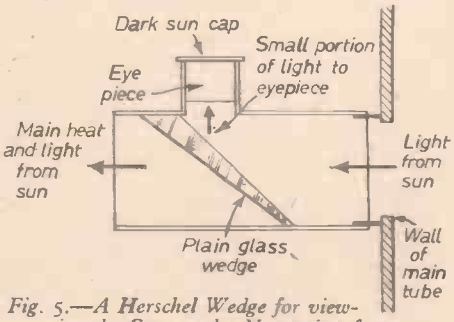


Fig. 5.—A Herschel Wedge for viewing the Sun at the Newtonian focus.

is further inclined to the Earth's equator by an angle of 26.4 deg. and the effect of this is to cause the Sun's axis to appear to oscillate from side to side. The aspect of the Sun from month to month for observers in the northern hemisphere is shown in Fig. 4. For those in the southern hemisphere, the drawing of Fig. 4 must be turned upside down. In both the Nautical Almanac, obtainable from H.M. Stationery Office, Kingsway, W.C.2, and The Handbook of the British Astronomical Association, issued each year, price 5s. to members and 9s. to non-members, by the British Astronomical Association, 303, Bath Road, Hounslow West, Middlesex, the values of P, B_0 and L_0 are given where:

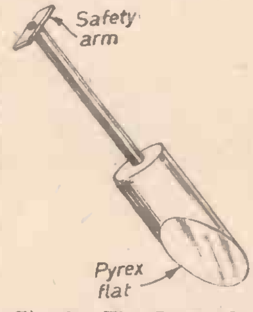


Fig. 6.—The Pyrex flat in its carrier.

P is the position angle of the axis of rotation, measured eastward from the north point of the disc.

B_0 is the heliographic latitude of the centre of the disc, this determines the amount of tilt of the lines of latitude on the Sun as seen from the Earth.

L_0 is the heliographic longitude of the centre of the disc; heliographic longitudes increase numerically to the west.

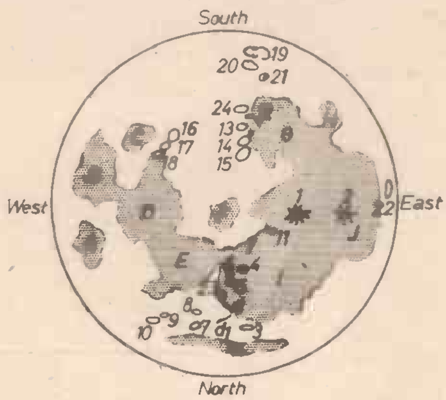
Viewing the Sun at the Newtonian Focus

As already stated, this can be a dangerous business and serious damage to the eye may result.

The following alterations to the astro telescope are essential.

Stop down the aperture to 4in., using a card. Use a solar diagonal, a device shown in Fig. 5. It comprises a Herschel Wedge, which transmits only about 10 per cent. of the heat and light. The reflected image is observed with a standard eyepiece fitted with a dark Sun cap. Alternatively, the aluminised flat mirror may be replaced with a Pyrex flat mirror which has no metallic reflecting surface. The plain glass then will only reflect a small portion of the heat and light. A standard eyepiece with a dark Sun cap will then be quite satisfactory. An unaluminised flat should be readily obtainable for under 30s. The only disadvantage is the need to remove the flat and the consequential readjustment of the optical parts each time one changes from solar observations to stellar observations. It is recommended—since the Pyrex flat is so much cheaper than a solar diagonal—that a separate flat carrier be made for the Pyrex flat and this can easily be slipped into position with a minimum of inconvenience, see Fig. 6.

Any enthusiast who wishes to construct a



MOON

Diameter 2,160 miles
Clavius (19) 150 miles across
Plato (3) 60 miles across

(MARIA) LUNAR SEAS

A, Mare Crisium. B, Mare Foecunditatis. C, Mare Nectaris. D. Mare Tranquillitatis. E, Mare Serenitatis. F, Mare Vaporum. G, Mare Nubium. H, Mare Humorum. I, Mare Imbrium. J, Oceanus Procellarum. K, Mare Frigoris.

MOUNTAINS

d, Alps. d1, Alpine Valley. f, Apennines.

CRATERS & WALLED PLAINS

1, Copernicus. 2, Kepler. 3, Plato. 4, Archimedes. 5, Aristillus. 6, Autolycus. 7, Aristoteles. 8, Eudoxus. 9, Hercules. 10, Atlas, 11, Eratosthenes. 12, Straight Wall. 13, Arzachel. 14, Alphonsus. 15, Ptolemaeus. 16, Catharina. 17, Cyrillus. 18, Theophilus. 19, Clavius. 20, Maginus. 21, Tycho. 22, Grimaldi. 23, Cassini. 24, Purbach.

Fig. 7.—On the left is a composite photograph of the Moon and above a tally map and key.

full aperture 6in. solar telescope should consider having both the main mirror and the optical flat of Pyrex glass suitably polished, but without any metal reflecting surfaces.

Observing the Moon

The Moon should be studied when it is waxing or waning. The disc of the full Moon is devoid of interest owing to the lack of shadow.

As a guide to the novice a composite photograph with a tally map is given in Fig. 7. This will enable one to identify the main formations. Use initially a low power eyepiece which has a field of view wide enough to embrace the whole of the illuminated portion of the Moon's surface.

With the recent interest in the emission observed by Kosyrev from the crater Alphonsus it has been suggested that the following combination of Wratten gelatine filters will enable you to isolate the appropriate band centring on 4737 Å

i Wratten. 45 + 47B.
ii Wratten. 45 + 35.

The filters can be obtained from Kodak, Ltd. They should be cut and placed over the eyepiece. Any points on the Moon which appear abnormally bright—and much brighter than the areas elsewhere in the surrounding region—should be accurately noted and the time recorded. The results should be reported quickly to a well-equipped observatory.

Observing Mercury and Venus

Mercury is a most difficult planet to observe. Its maximum elongation is less than 28 deg. and the air is seldom steady enough in the vicinity of the Sun to make a detailed study of its disc (only six to nine seconds of arc) possible. See Antoniadi's "La Planète Mercure."

Venus is a beautiful object. Its elongation extends to 47 deg. and its disc is treble that of Mercury. Often Venus is so bright that it is necessary to lose light

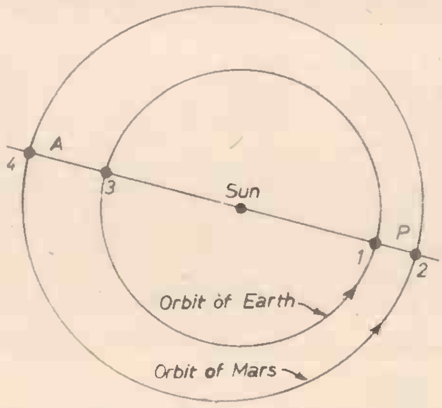


Fig. 8.—Orbit of Mars. P—Perihelion. A—Aphelion. When Earth and Mars are at positions 1 and 2 the opposition distance is about 35 million miles and at positions 3 and 4 it is 62 million miles.

to see it with clarity. The use of the solar diagonal or the unmetalled Pyrex flat may be an advantage.

It is useless to attempt to observe Venus in a dark sky, it dazzles the eye too much.

Observing Mars

Mars is the only planet to reveal a solid surface on which markings of a permanent character can be clearly distinguished. It is a planet which well repays telescopic study. The best periods for observing it are short and the intervening periods long. The orbits of the Earth and Mars are shown in Fig. 8. Oppositions occur at intervals of over two years. At perihelic oppositions (in August and September) its disc is some 25 seconds of arc across.

At aphelic oppositions (in February or March) its disc is scarcely 14 seconds of arc. The highly prized perihelic oppositions only come round every 15 or 17 years. Useful work can be done with a well mounted 6in. telescope and magnifying powers of from 200 to 400 will be found to be necessary. The Barlow lens is a favourite tool in this connection.

Drawings of Mars

The director of the Mars Section of the British Astronomical Association recommends a scale of 2in. to the planet's diameter. Scrutinise the planet for some time until the eye is well adapted. Sketch the outlines of the principal features, beginning with the polar caps if visible. Be at great pains to have the objects in the correct position with reference to the limb and centre of the disc.

Since Mars rotates on its axis in 24h. 37m. 22s. the hemisphere under observation can be seen on the following day (weather permitting) approx. 37m. later. (See The Planet Mars, 1950, G. Vaucouleurs, translated by P. A. Moore.)

Fish Stunning

FISH stunning equipment of the pulse generator type is being used by fishery authorities to eliminate undesirable elements from rivers. The equipment is used to stun all the fish in a stretch of river; these then being netted, the undesirables removed and the rest replaced. Within a minute of entering the water, the replaced fish are back to normal. Roach which compete with young salmon and trout for food can be dealt with by this method and the equipment is valuable too for assessing the effects of drainage and pollution on fish life and studying the population and breeding habits of fish.

New Electronic Stethoscope

OTHERWISE inaudible sounds are amplified by this instrument which at the same time eliminates unwanted noise by means of high or low frequency attenuators. A crystal microphone with a specially heavy metal diaphragm only transmits sounds from the source with which it is in contact. The Soniscope is powered by two small batteries and is equipped with two output sockets. Alternatively by the use of an additional attachment a large audience can listen in to sounds detected by the instrument. An example of the use to which the device can be put is to filter out the sounds of a heartbeat while listening to high frequency bronchitis wheezes.

Train Telephone

BRITISH RAILWAYS are to provide telephonic communication between the guard's and driver's compartments of electric and diesel multiple-unit trains to enable train crews to pass messages and carry out test procedures in clear speech. The telephones will help drivers and guards to carry out brake tests before beginning their journeys, and in their carrying out of the various rules, particularly on services where drivers or motormen or unaccompanied by a second man. Telephonic communication between the two ends of a train would also be an advantage in the event of an emergency.

Giant Induction Coil

DESIGNED to store energy for a hypersonic wind tunnel in America, an induction coil weighing 60 tons is being built by the General Electric Co., Pittsfield, Mass. It is believed to be the world's largest.

Designed for starting jet engines, air conditioning aircraft interiors and de-icing operations, this surge-free rotary screw compressor known as the Atlas Copco Air Partner will help to ensure on-time departures of aircraft. The compressor, which has no wearing parts and will run for 10,000 hours without an overhaul, is shown above starting a Boeing 707 jet airliner.

Home Jewellery Making

Brooches, Earrings, Bracelets, Pendants and Rings Are Within Your Scope

By V. G. Kennedy

ATTRACTIVE jewellery in a limitless variety of designs and stone arrangements can now be made, or rather, finished at home with the simplest of tools. A small but growing industry provides the castings, stampings and fittings for a very wide range of designs and stone-colour schemes. Articles may be completed not only in base metals, but also in silver and gold, using semi-precious stones.

Tools

An elaborate set of tools is not necessary. All that is required at the outset is a pair of pointed tweezers, a few cherry sticks, or

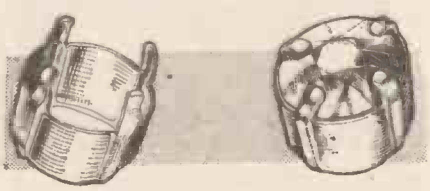


Fig. 2.—Claw mounts in unfinished and finished state.

pointed match sticks, an ordinary household pin with the point curved over so that it will not penetrate the skin (see Fig. 1) and a bottle or tube of good jeweller's cement.

A good addition to the kit is one or two pairs of small pliers. A magnifying glass is useful and, if "claw" settings are to be undertaken, a pair of brass-jaw pliers. A ring gauge, for measuring fingers, should also be acquired, but there is little else likely to be needed except, perhaps, a good eye for visualising colour schemes and a lot of patience.

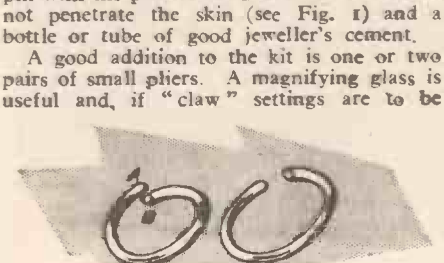


Fig. 3.—The correct and incorrect method of opening a jump ring.

Castings, Mounts and Fittings

The pieces, known as castings, mounts, or stampings, are mainly supplied in the finished state, except that stones are not mounted. Brooches and the like are supplied ready fitted with pins—ear ornaments with clips, screws or wires—necklets and bracelets with one of the various types of fastener or clasp. The exception is pendants, which are worn on a chain; most dealers supply these in separate parts, e.g., pendant front or ornament, chain (trace chain), connecting links (jump rings or split rings), and fastener, and it is left to the craftworker to assemble the parts.

Stones

The methods of setting marcasites and ordinary brilliants are essentially the same provided that the stones are set into the correct type of sockets.

The manufacturers have, in general use, several methods of drilling or casting the stone sockets in a mount and the worker should learn to distinguish them on sight, as not very satisfactory results would ensue if, for instance, flat-base marcasites were inserted into chaton-base sockets. There is, however, one type of socket drilled in such a way that either type of stone may be inserted.

It should be noted, nevertheless, that most dealers supply, in packets, the correct number, type, and sizes of stones for a given mount, and this is by far the better way to buy in the early stages, if not all the time.

The contents are variously known as "craftworker packets"—"stone packets"—or "assembly packets." Some dealers grade the sizes into different packets and in such cases the type of socket has already been taken into consideration.

It is a good plan for the beginner to examine them closely and thus gradually make himself conversant with their appearance and sizes. The contents of each packet should be tipped out, in turn, on to a piece of white paper, and with great care as some of the stones are very tiny—a size ooo marcasite, for example, measures about three-quarters of a millimetre!

Inserting the Stones

It is left to the buyer to insert the stones in the mounts by either of two methods or both. The methods are the use of a good transparent cement such as VJ/1 and VJ/2,

(*Concluded on page 37*).

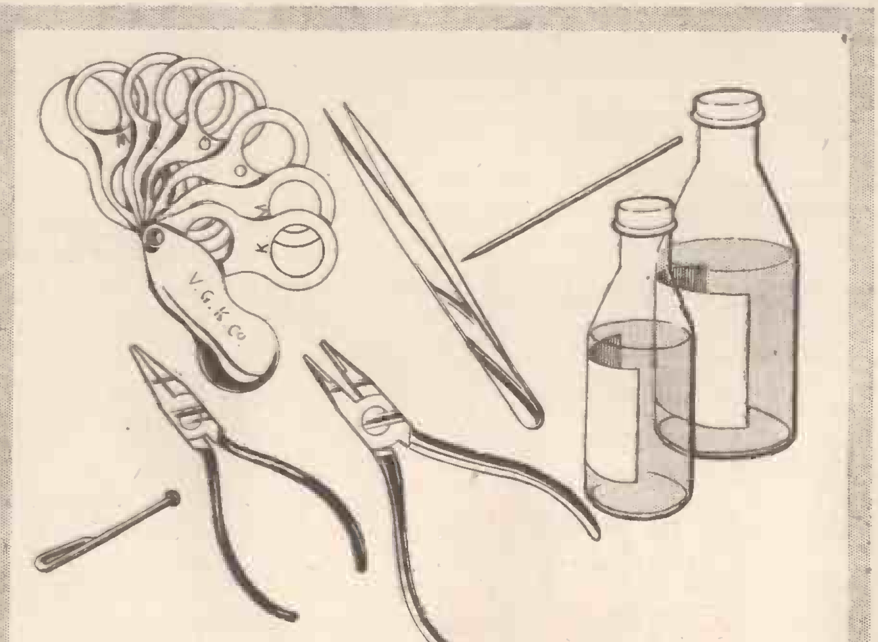


Fig. 1.—All the tools required for jewellery making.

or by means of claws, which are pressed down on to the stones to hold them into position. The beginner is advised to use those mounts which take cement as a start. Fig. 2 shows claw mounts in the finished and unmounted states.

The Work Bench

Obtain some non-hardening modelling clay from a toy shop and sink the mount far enough into this to hold it steady. The clay will easily wash off when the cemented stones have dried out. Alternatively, cut a slot in an empty cigarette packet or a match box, and fix the mount firmly in the slot. This makes a good work bench.

Sizing

A mount may be drilled for as many as five, six or seven different sizes of stones, all of which will be included in the craft-worker packet supplied, but additionally, the colour scheme must also be considered. The best procedure is, therefore, temporarily to fit a few of the stones into the dry sockets of the mount and memorise their positions,

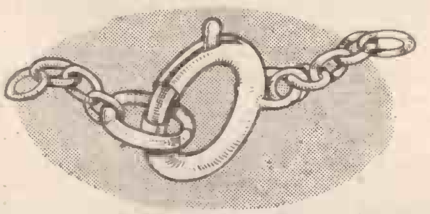


Fig. 4.—A bolt ring fastener with chain attached.

before introducing any cement. If various coloured stones are to be included, mount them loosely and memorise the colour positions. Do not spill any cement on to a polished table top as it will remove the polish!

Mounting the Stones

The mount should first be examined for cleanliness as plater's residue probably remains in some of the sockets and glue will not stick. In this case it can be washed in warm water and soap flakes and brushed out with an old toothbrush. In the case of brooches and earclips, the pin or clip should also be tested. An odd tiny blow-hole in the socket of a casting can usually be ignored as the stone will cover it. The mount must be thoroughly dry before operations are commenced.

With the cherry stick, place some cement into four or five sockets, starting from the centre of the mount and working outwards. See that all the sockets are thoroughly covered but do not fill them as, if the cement rides over the face of the stones, it may ruin them. Allow the cement to get "tacky" and meanwhile place cement into five more sockets.

Mounting

Insert the appropriate stones into the first five sockets making sure that each stone is squarely set and seated. This is extremely important as otherwise they will easily be dragged out when in wear.

Place cement into the third set of five sockets and proceed as before. At the end of the setting process—and this is vital—take the pin-tool already mentioned, and, using the pin head, press every stone firmly and squarely on to its seating. Allow to set for at least 24 hours.

Oversize Stones

Some workers buy their stones in bulk, instead of in the dealers' packets, and, in order to produce an impressive effect, are tempted to mount stones which are oversize. This is bad mounting and such stones are almost certain to fall out of the mount, when in wear.

Plastic and Pearl Boutons

Whether pearlised or cast into fancy moulded shapes, some difficulty is sometimes experienced in gluing these to the metal ear-clip. The trouble often arises through the wrong cement being used, a thick cement such as VJ/2 being necessary.

In the case of imitation pearl boutons, the *base* of the bouton should first be lightly rubbed on a piece of sandpaper.

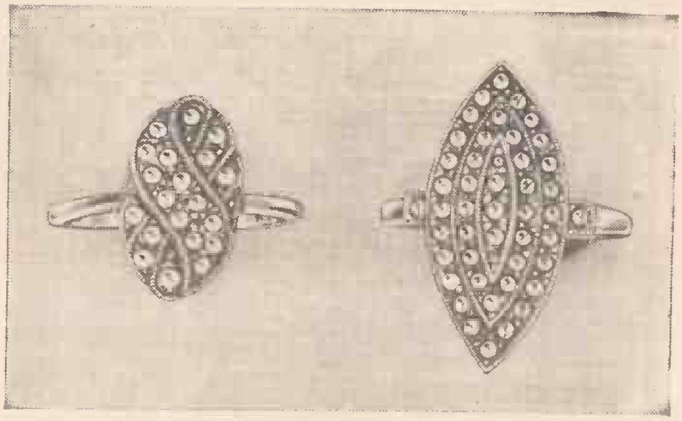


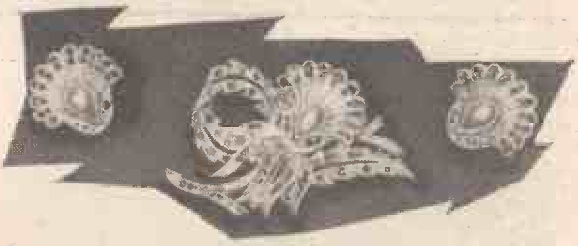
Fig. 5.—Two silver marcasite rings.

Assembling a Chain Pendant

This is a simple process, but a difficulty can arise if the jump rings are not opened and closed in the correct manner. The ring should be firmly grasped with a pair of small pliers at A (see Fig. 3) and with another pair at B. Without moving A, pull B forward and downwards, until the aperture is wide enough to hook up the required pieces. Close in reverse manner, moving B only.

Never open a jump ring *laterally* or it will be ruined.

The problem of threading the jump ring through the fine trace chain can be solved with a darning needle. With this little tool it is possible to widen the end loop in the chain enough to take the jump ring.



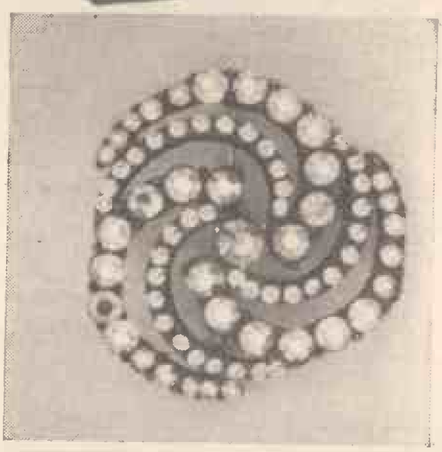


Fig. 6.—Simple examples of mounts. (Above and right)—Suitable mounts for brilliants. (Above right)—Mounts for marcasites and pearls.

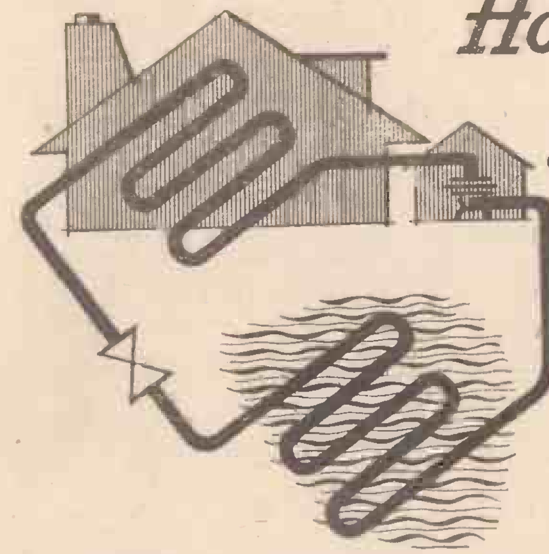
Fastener or Clasp

The pendant will require a fastener and the usual method is to attach a bolt ring to the chain by means of a jump ring or, alternatively, a split ring (see Fig. 4).

Obtaining the Professional Look

The first essential is to be quite sure that no cement has ridden on to the face of the stones, as it is almost impossible to remove it. The best method, if this should happen, is to dig out the stones and replace them with new ones. This is the only effective remedy. However, presuming that the finished piece is now thoroughly dried out—that is to say, not less than two or three days after mounting—wash the piece in a solution of warm water and soap flakes, to which has been added a few drops of ammonia. Rinse well in clear water. Dry off, and polish the stones with a silk duster. Some pieces made by the methods described are shown in Figs. 5 and 6.

It should be remembered that the whole job is far simpler in practice than it might appear to a reader. Its very simplicity, however, can prove to be its own pitfall to the careless and impatient but to those who are thorough in their work, the hobby is most rewarding.



How the Refrigerator and Heat Pump work

Explained in Simple Terms

By R. N. Hadden

AT first sight it may seem strange that a machine which can produce intense cold can also, in only a slightly modified form, produce enough heat to warm a house. Yet this is, in fact, so. When the machine is used to cool it is known as a refrigerator, and when it is used to heat it is called a heat pump. When it is used as a heat pump it is actually the most economical source of heat that has ever been devised.

The Cycles

The basic cycles of both a heat pump and a refrigerator are identical, and can be broadly grouped as the "air cycle," the "vapour absorption cycle" and the "vapour compression cycle." To understand how these cycles work it is necessary to know something about the thermodynamic properties of liquids, vapours and gases.

A lot can be learned just by watching how water behaves when it is boiled in a saucepan in the kitchen. If we have a thermometer reading up to about 250°F. we can learn even more. Put this into a saucepan of water heating on a gas ring. At first the temperature of the water rises steadily, say it increases 10°F. every minute. This means that the water is absorbing the same amount of heat from the gas every minute.

Eventually the water will boil, but a strange thing happens now—the water gets no hotter, no matter how hard it boils. This means that, although we have not changed the intensity of the flame under the saucepan, and so have not changed the rate at which heat is being transferred to the water, the heat is, nevertheless, being absorbed. The only thing that has changed is that the water is now boiling.

This is the first important rule, i.e., if a liquid is boiling it absorbs heat from its surroundings without any increase in temperature. It is most important to understand this if we are to follow the workings of the various cycles.

Second Rule

At the top of a very high mountain, if a saucepan is again boiled, it will be found that it no longer boils at the same temperature (212°F.), but at some lower temperature, say, 180°F. This is because the surrounding air pressure is lower. This, then, is the next rule: (2) the temperature at which a liquid boils depends on the surrounding pressure. The lower the pressure the lower the boiling temperature, and, conversely, the higher the pressure the higher the boiling temperature.

Vapours

Another very important thing which we must know about refrigeration and heat pump work is the properties of vapours. In fact, a vapour is a gas, but it has the special property that if its pressure is increased, or if its temperature is lowered, it condenses into a liquid. In condensing into a liquid it returns all the heat to its surroundings that the liquid absorbed originally.

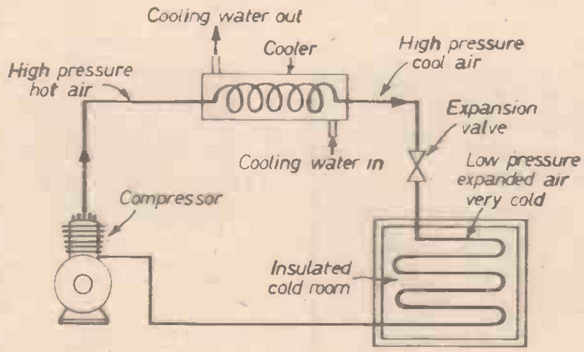


Fig. 1.—Air cycle refrigerator.

This, then, is the third rule: (3) a vapour can be condensed into a liquid by increasing its pressure, or by reducing its temperature and in condensing it gives up all its heat to its surroundings.

Unlike a vapour, a gas cannot be condensed into a liquid under ordinary conditions, it actually requires a very low temperature indeed to liquefy a gas. We can easily learn some of the properties of gases. If we pump up a bicycle tyre very quickly we find that the pump gets very hot. If, on the other hand, we unscrew the valve on the tyre and let the air rush out, we find that the air coming out is cold.

These, then, are the last rules that we must know: (4) if a gas is compressed it becomes hot. And (5) if a gas is expanded it becomes cold.

The Air Cycle

We now know enough to look at some of the cycles that can be used in refrigerators and heat pumps. One of the easiest cycles to understand, though it is not used on modern machines, is the "air cycle," shown in Fig. 1, where it is being used as a refrigerator.

Starting with the compressor, the air is compressed and, as we have seen by rule 4, it gets hot. The air then passes on to the cooler where heat is removed by the water. The air flows on to the expansion valve where its pressure is reduced, and as the pressure is reduced it expands. As we have seen from rule 5 the air must get colder as it expands. The very cold air is then circulated in the insulated cold room, and this gives the refrigerating effect. The air is then returned to the suction of the compressor, where the cycle starts again.

This cycle, although used in the early days, is not very efficient, in that it produces less refrigerating effect for a given horsepower compresser than, say, a machine working on the vapour compression cycle. For this reason it is no longer used.

However, although it is no longer used, it is worth while having a look to see how easily it can be turned into a heat pump to warm a house. Fig. 2 shows how this is done. The compressor is shown outside for clarity, though in practice it would be inside.

In this case the compressor is used to compress and, as we have seen, heat the air, which is then led under the floor of the house. The air is sufficiently hot to heat the house. When most of the heat has been given off to the house, the air is taken outside, through the expansion valve, which cools it.

After passing the expansion valve the air is very cold as it has given up most of its heat to the house, and what little it had has been taken away as it expanded. It is then taken by pipe under, say, a river. As the air is so cold the river is hot by comparison, and so the river tends to heat the air. When the river has put back heat into the air it is returned to the compressor suction, where the cycle starts again.

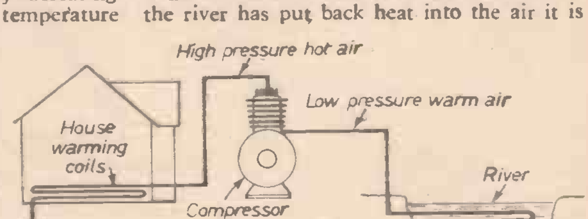


Fig. 2.—Air cycle heat pump.

Thus, we can see the essential difference between a heat pump and a refrigerator. The heat pump takes heat from the river and concentrates it, and pumps it into the house. The house gets hot and the river gets cold. In a refrigerator the heat is taken from the cold room, which makes it even colder, and gives it up to the cooling water. In this case the cooling water gets hot and the cold room gets cold. This is true for all refrigerator and heat pump cycles.

(Concluded on page 41)

Ammonia Absorption Cycle

We have seen that the air cycle is not very efficient, and for this reason the ammonia absorption cycle is sometimes used. This system is very interesting as it actually uses heat to produce cold. This system depends on the fact that ammonia vapour is very easily absorbed in cold water, but is driven off if the water is heated. Fig. 3 shows this type of refrigerator.

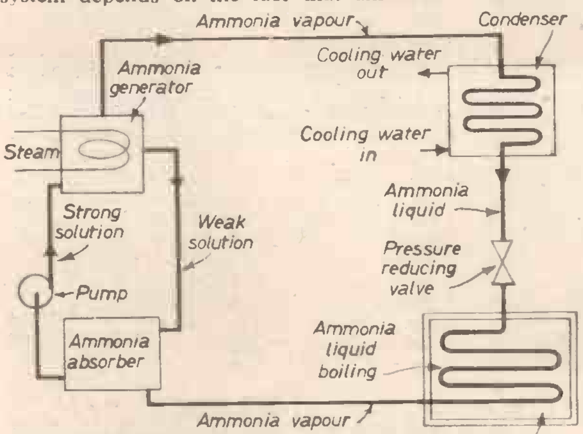


Fig. 3.—Ammonia absorption refrigerator.

In the absorber there is a strong solution of ammonia and water. A pump takes this liquid and pumps it into the generator. The generator is heated by some means, in this case steam, which drives off the ammonia from the water. The ammonia vapour is taken out of the top of the generator, and the weak water solution is returned to the absorber.

The ammonia vapour is under high pressure, and when it gets to the cooler it is condensed, as we have seen it will be by rule 3. The liquid ammonia then flows through the expansion valve to the lower pressure of the coils in the cold room. As the pressure has been reduced on the ammonia liquid it starts to boil, from rule 2. In boiling it removes heat from its surroundings, as we have seen from rule 1, without an increase in temperature.

As heat is removed from the cold room, it must get even colder. When all the ammonia has boiled off and is again vapour, it is returned to the absorber, where it is immediately absorbed again into the water. The whole cycle then starts again.

This cycle, too, can be used as a heat pump, all that is required is to use the condenser as the heating element in the house, and the evaporator as the heat source in the river.

Vapour Compression Cycle

The most efficient cycle of all is the vapour compression cycle. This cycle is now used everywhere except for some small domestic refrigerators, which sometimes use a modified form of the absorption cycle. Fig. 4 shows a vapour compression refrigerator.

In this cycle the ammonia vapour is compressed with a corresponding rise in temperature. The hot ammonia vapour flows into the condenser, which in this case is shown air cooled. The ammonia condenses as it is cooled, and gives up its heat (rule 3). The liquid ammonia flows through the pressure reducing valve, into the low pressure of the refrigerating unit.

As in the case of the ammonia absorption cycle, the liquid ammonia boils, removing heat from the cold room. The vaporised ammonia is then returned to the suction of the compressor, and the cycle is started over again.

From the sketches we can see that the ammonia vapour compression cycle is very similar to the air cycle. The big difference is that the ammonia actually condenses, and is then boiled off again. It is this fact which makes the vapour cycle so much more efficient than the air cycle. Of course, ammonia is not the only refrigerant that can be used; one of the best known alternatives is one of the Freon gases. But Propane, Butane, Sulphur Dioxide, Methyl Chloride and several other substances can also be used.

When the vapour compression cycle is used in the heat pump it is found that about six times the amount of heat is produced, compared with the heat produced from an equivalent electric fire.

We have seen that there is a great similarity between a refrigerator and a heat pump, and so it is only a short step to make a complete air-conditioning plant. An air-conditioning plant will cool the air in summer and warm it in winter. The air used is also cleaned before use and the humidity is adjusted to a suitable value for comfort.

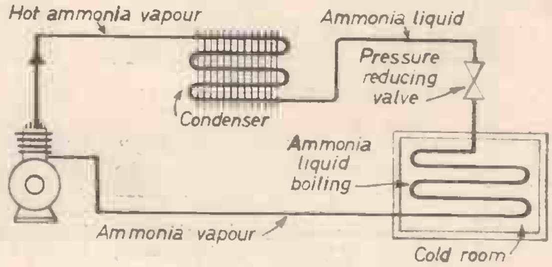


Fig. 4.—Vapour compression refrigerator.

PUZZLE CORNER

Double, submitted by A. J. Jones.

If a sheet of newspaper of unlimited size were to be repeatedly folded double, how many times would it be necessary to fold it until it reached the sun?

Answer

1.—Assume the sheet of newspaper to be .004in. thick and the distance to the sun to be 93 million miles.

What is required is the number of terms of a geometrical progression whose first term is .004in., whose last term is 93 million miles, and whose common ratio is 2.

The formula for the last term of a G.P. is:

$$l = ar^{n-1}$$

where: a = first term, r = common ratio, and n = number of terms.

Substituting the known quantities and reducing .004in. to a fraction of a mile, we have

$$93 \times 10^6 = \left(\frac{1}{15,840,000}\right) 2^{n-1}$$

$$93 \times 10^6 = (10^{-4} \times .6313)\, 2^{n-1}$$

The quickest way of finding n in this case is to reduce the equation to a log. base of ten, so:

$$7.96848 = (\bar{5}.80024) + (.30103 \times (n-1))$$

$$7.96848 = \bar{5}.80024 + .30103n - .30103$$

Sorting out we get:

$$12.46927 = .30103n$$

$$\therefore \quad n = \frac{12.46927}{.30103} \simeq 41.42$$

The answer is, therefore, approximately 41.

MINICAR RACING CIRCUIT

(*Concluded from page 14*)

$\frac{1}{8}$in. dia. brazing rod, suitably painted (see Fig. 9). The fence at the end of the main straight is made from $\frac{1}{8}$in. and 1/16in. dia. brazing rod and has proved fully capable of withstanding the impact from wandering cars. To ensure easy and accurate drilling of the uprights, a block was drilled to act as a drilling jig (Fig. 10).

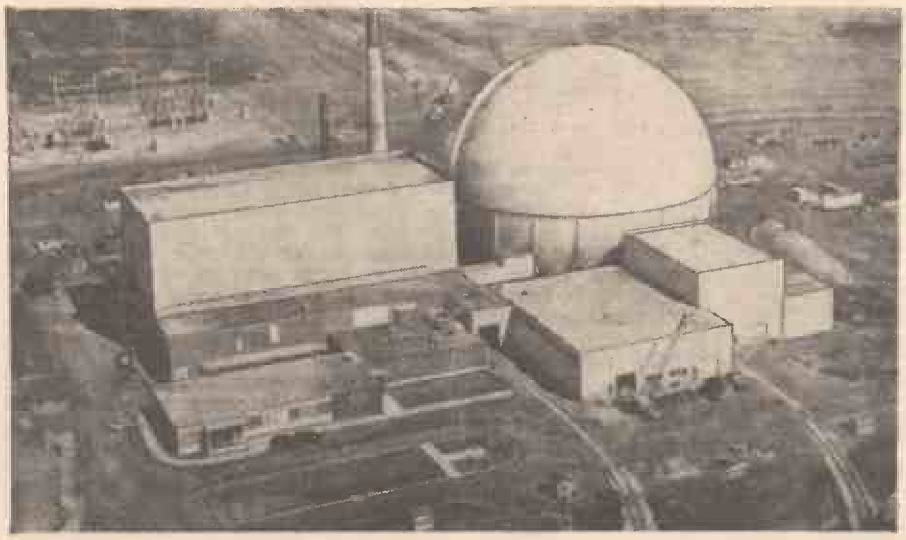
The cars can be made by using existing body shells and wheels from "flywheel" powered cars of 1/27 to 1/32 scale size. New chassis, axle layouts, steering (if required), current pick-ups, etc., can be made and powered with a 12-volt electric motor (mainly Triang). Fig. 11 shows the underneath of a car and also the motor. Some of the cars have lapped the 47ft. circuit in $7\frac{1}{2}$ seconds and lap speed approaching 140 m.p.h. (scale speed) have been reached. Nearly 400ft. of special rail was laid on the prototype using nearly 1,000 nylon pegs.

Many other items can be added, namely pits, grandstands, marshals, Continental road signs and automatic lap counters utilising ex A.M. Venner time switches.

The Distribution Board

This is mounted with mains plug lead-in to the junction box where all earth wires connect, all live wires connect with correct plug sockets and all neutrals join together (Fig. 12). Power then goes to each controller which is a combined transformer, rectifier, variable resistance and cut-out. Connection is made from the outlet of the controller (now providing 12 volts D.C.) to the terminals along the straight on the track (see Fig. 13). Current is fed from the terminals to the track by wire soldered to the track at two positions to prevent any power loss through resistance or a break in the soldered connections on the rail (see Fig. 14). Fig. 15 shows the set-up of the equipment. And Fig. 16 the finished track.

Fig. 16.—A view of the finished track.



adjacent to the sphere houses the turbine-generator and other equipment necessary for converting the thermal energy of steam into electrical energy.

The General Electric dual cycle boiling water reactor uses light water as both moderator and coolant, and slightly enriched uranium as fuel.

Water passing through the reactor core is boiled by heat from the fissioning fuel, and passes as a steam-water mixture through 12 outlet nozzles to the "primary" separating drum. The steam from this drum flows directly to the turbine at about 1,000 p.s.i.g. and 545 deg. F. Water from the drum is returned to the reactor through four "secondary" steam generators. Feed-water to these generators removes additional energy from the recirculating water to form "secondary" steam for admission to the turbine at 500 p.s.i.g. and 467 deg.. F. The term "dual cycle" is derived from the use of these two sources of steam.

The carbon steel reactor vessel weighs 350 tons and is the biggest so far built in the United States. It is 40ft. high, has an internal diameter of about 12ft., and is lined with stainless steel. At the bottom, the vessel is 9in. thick and on the sides, adjacent to the core, 5⅝in.

This huge vessel, too big to be moved by a more direct route, reached the Dresden site after a 3,600-mile journey by boat from the yards of the New York Shipbuilding Corporation in New Jersey. It was sent southwards down the Atlantic coast, through the Gulf of Mexico, then up the Mississippi and Illinois Rivers.

The reactor core is composed of 488 channel assemblies, each having 36 fuel elements. The fuel is slightly enriched uranium dioxide in the form of pellets ½in. long and ½in. in diameter, encased in zircaloy-2 tubing.

(Continued on page 45)

Industrial Nuclear Power Plant

Installation of an American Nuclear Power Station

By Donald S. Fraser

AMERICA'S first "private enterprise" atomic power plant will soon be ready for service—six months ahead of schedule.

The cutting of the construction time on the Dresden Nuclear Power Station means that the plant will be completed this year, and by mid-1960 will be producing 180,000 kilowatts of electricity—sufficient to supply the needs of a city of a quarter of a million. With this project, industry is demonstrating its faith in atomic power by building a privately financed plant without any subsidy from the U.S. Government.

The station, situated 50 miles south-west of Chicago, is a co-operative venture of the eight companies forming the Nuclear Power Group, Inc.

The Ownership

The station will be owned and operated by the Commonwealth Edison Company, an electric utility concern which supplies electricity to about two-thirds of the population of the State of Illinois, and seven associated companies.

Dresden, which will employ a dual cycle boiling water reactor, is being built by the General Electric Company for 45 million dollars. Of this sum Commonwealth Edison is contributing 30 million dollars, plus site and overhead costs. All the members of the Nuclear Power Group—Commonwealth Edison included—are sharing the remaining 15 million dollars as a research and development expense.

Steel Sphere

A huge steel sphere, 190ft. in diameter, which dominates the Dresden site, houses the reactor, steam separating drum, secondary steam generators, pumps and other auxiliary equipment. A large, rectangular building

(Above) A bundle of 10ft. long fuel rods is assembled to make one of the 488 fuel elements.

A workman examines uranium oxide pellets that will be used to make fuel rods.

The 350-ton atomic reactor for the power station before it was moved into the 190 ft. steel sphere shown in the background.

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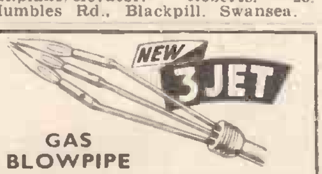

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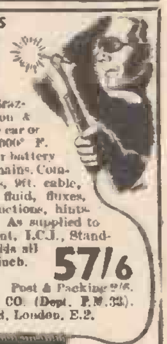

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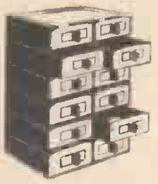

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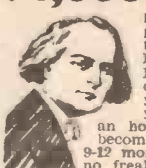

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(*Continued from page 42*)

A 60-ton core loading of fuel is expected to last as long as six years when full reactor efficiency is achieved. A conventional coal-fired generating plant the size of Dresden would burn about 1,700 tons of coal a day.

Refuelling of the reactor is accomplished, following shut-down, by removing the cover of the reactor vessel after filling the chamber above the reactor with water. Individual fuel elements can then be removed and lowered from the chamber through a vertical discharge tube into a reservoir in the adjacent fuel handling building. New fuel is placed in the reactor over the same route.

The actual path of power at Dresden is shown in Fig. 1. The fuel building (A) contains facilities for the inspection and storage of new and spent nuclear fuel assemblies. In the reactor (B) heat, released by the fission of uranium, boils water in the core at a pressure of 1,000 p.s.i. and 545 deg. F. The boiling water rises to steam separating drum (C) where steam is routed to the turbine. Water separated from steam at 545 deg. F. flows to four secondary steam generators (D) where more steam, produced at 500 p.s.i. and 467 deg. F., is routed to the turbine (E). Heat energy in the 1,000 and 500 p.s.i. steam supply is converted to mechanical energy when high velocity steam rotates the turbine shaft at 1,800 r.p.m. The generator (F) converts the mechanical energy of the turbine shaft to electricity at 14,400 volts. Stripped of heat and pressure in the turbine, the spent steam is cooled and converted back to water by passing it over tubes (the condenser, G) in which cold water is constantly circulating. This condensed steam water is then pumped back to the reactor system and reheated to steam on a continuing cycle.

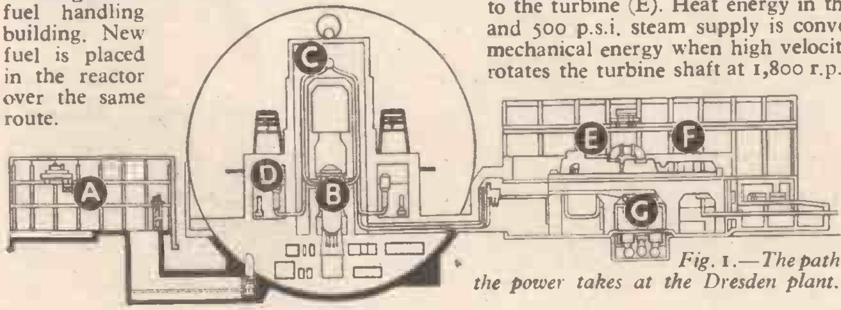

Fig. 1.—The path the power takes at the Dresden plant.

The extensive research data required for Dresden are being provided both by the General Electric boiling water reactor at Vallacitos Laboratory in California, and by the Atomic Energy Commission's Experimental Boiling Water Reactor at Argonne National Laboratory. Engineers from all the companies of the Nuclear Power Group are also getting "on-the-job" training at these two small plants.

The Dresden station occupies a 950-acre site in a sparsely populated agricultural area on the Illinois River. With an abundance of water for cooling and condensing, the location meets engineering requirements for the construction and efficient operation of a large steam-electric power p

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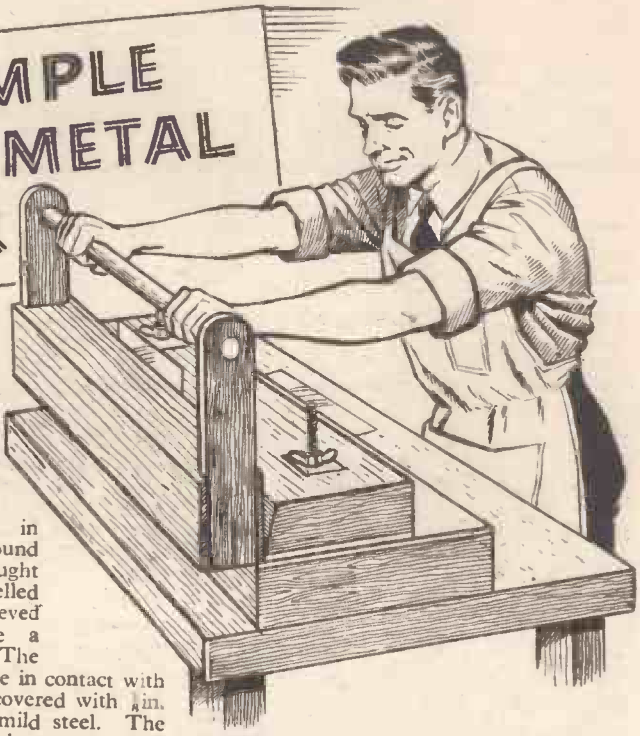
A SIMPLE SHEET METAL BENDER



By Jameson Erroll

This Machine Can be Made to Any Size

SIMPLICITY of construction and usefulness are combined in this easy-to-make machine which will bend the softer metals up to about 18 s.w.g. and the harder metals up to 24 s.w.g. The machine is primarily intended for straightforward bending as for box making, flanges, laps and the like. The length must be determined by the constructor who will have in mind the size of work likely to be undertaken, keeping measurements within reasonable limits having regard to storage space and normal work.

The machine illustrated in Fig. 1 is 2ft. long overall and will bend metal up to 20½in. wide. If a much larger span is intended the thickness of the wooden bases, size of the hinges and diameter of bolts should be revised.

The Foundation

The wooden foundation pieces are 1½in. thick and should be of well-seasoned hardwood; the base is 5in. wide, the hold-down 3in. wide, and the bender 2¼in. wide. Note that the inside edge of the hold-down is bevelled to a slope of 80 deg. This is to allow for the natural "spring-back" which metal exerts when bent in length, and it will be found that if the bender is brought tight against this bevelled edge the metal, when relieved of pressure, will assume a perfect right-angle. The wooden surfaces which come in contact with the metal to be bent are covered with ⅛in. thick sheet brass, iron, or mild steel. The screws for fixing should be countersunk slightly below the surface and any burr filed perfectly smooth in order to avoid unwanted markings on the material being bent.

Corners are cut away to receive the hinges which, while they need not be large, must be robust and free from "wobble." The writer used 1in. × 1in. brass back-flap hinges ⅛in. thick. Note that a slight clearance must be made in the wood to accommodate the knuckle of the hinges. These hinges may well be fitted before the wooden surfaces are covered as the two edges must bind as closely as possible to ensure a clean bend.

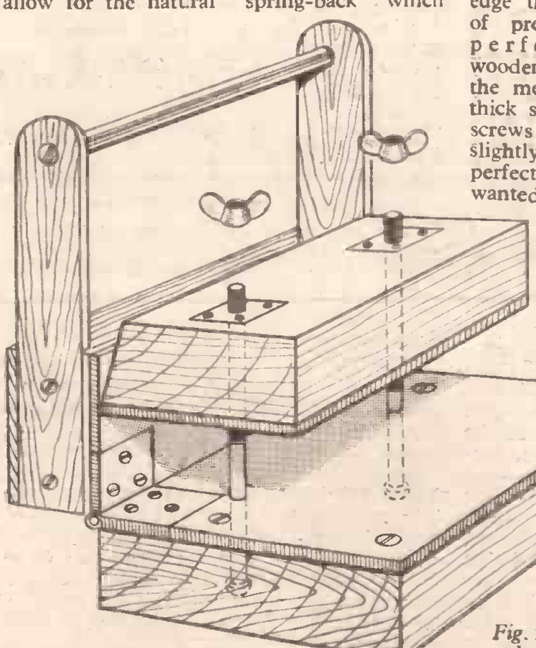


Fig. 1.—The completed machine.

The Hold-down

The hold-down rides freely on two ¼in. steel part-threaded bolts which are a fixture in the base: the centres are set 1½in. in from the front edge and from the side. A 1in. square plate is sunk at each end of the hold-down to act as a washer for the thumbscrew which locks the metal being bent. In each end of the bender a 6in. × 1in. × ⅛in. mild steel plate is sunk as shown; a ⅜in. iron rod, burred at both ends, acts as a sturdy "puller" when bending is being done.

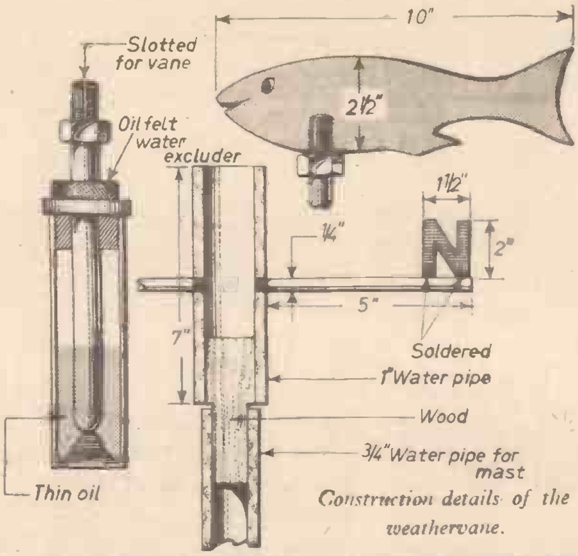
This bender is, of course, lowered to a horizontal position at the commencement and the work allowed to protrude as much over the edge of the hold-down as is desired. The metal is then clamped down tightly and the bender pulled up to a vertical position.

Letters to the Editor

The Editor Does Not Necessarily Agree with the Views of his Correspondents

Making a Weathervane From Scrap

SIR,—Here are details of a weathervane I have constructed wholly from scrap. The moving parts are from a revolving cowl, no alteration being necessary except for slotting the spindle at the top to take the vane. The vane is held quite securely by closing spindle top in a vice. An oiled felt is slipped over the spindle to keep rain from entering the oil chamber. A piece of 1in. water pipe 7in. long holds the moving mechanism. It is drilled and tapped in four positions for ¼in. thread to take the wind direction rods, which are made of ¼in. brass encased stair rod. These are each 5in. long. The brass casing makes simple the soldering on of the four letters, which are made out of No. 10 gauge zinc. To reduce weight a piece of ¾in. water pipe for the mast is used and connected to the 1in. piece by means of a piece of hardwood. The vane is of 10g. zinc and care must be taken that the bearing spindle is not more than 1½in. from nose of the fish. I must emphasise the need for vertical positioning of the mast, which must be as high as possible and free from down flops, etc.—M. J. BURTENSHAW (Devon).



Construction details of the weathervane.

Aircraft Generators

SIR,—With reference to J. Healy's query under the title of "Arc Welding" in the June issue, I would like to add a few notes on aircraft generators, especially the 30 volt, 200 amp. one, which may interest other readers who have purchased these surplus machines. None of them is suitable to run stationary unless adequate air-cooling is provided, or they will get too hot in half an hour. Nor are they suitable for continuous running at near full output, as on aircraft the demand for heavy current is very intermittent and also of short duration.

These generators run at high speed, 5,000 r.p.m. at cruising speed, and they will not generate at much below 4,000 r.p.m. The field magnets are comparatively weak, usually taking only 2 per cent. of the total current, and the field coils are connected through a carbon-pile voltage regulator. For constant speed use this would be replaced by a variable resistor. For the 30 volts, 200 amp. generator, about 10 ohms to carry it up to 5 amps. would be suitable, and it would need 8 b.h.p. to drive it at full output using a multi V belt drive. Temperature rise should be watched, not allowing the carcase to get too hot to touch.

As the field magnets are laminated, they retain little residual flux and after storage they may require to be re-energised by "flashing" the field coil connections on the correct polarity of a battery. A machine will often start to generate, however, if the brushes are manually pressed on to the commutator while the machine is running.—W. H. POSTLETHWAITE (Wilts).

Kayak Correction

SIR,—Re the single-seater kayak, described in the April to June issues of PRACTICAL MECHANICS.

In the May issue particulars were given for the construction of the cross frames, and in Fig. 8, on page 357, it seems to me that the dimension 10½in. from outer edge of the sheer stringer should be to the centre line of the craft and not to the other side of the keelson strip, as shown.—J. L. W. BARRATT (Manchester).

[*The reader's comment is correct, there is a mistake in the dimension line of Fig. 8, which should, of course, end on the centre line.*—F. HOOK (*Author*).]

LIFE ON MARS?

SIR,—Much speculation has gone on and will continue to go on, and no doubt in this century we will find out for certain.

We cannot, however, be certain of anything in our present state of knowledge; we can only hazard an intelligent guess.

It must be realised that observational astronomy is very often involved in fundamental mistakes and theoretical astronomy (astrophysics)is built up on the flimsiest of evidence.

Our own planet is still a great mystery to us, apart from its surface.

There are many fundamental discoveries still to be made. What are magnetism, electricity, electromagnetic waves? How can Einstein's Co-ordinated Theory be given physical shape? Till we can do and know all these, theorising about the universe is fruitless and can cause a lot of erroneous beliefs to exist.

For example, famous observational astronomers have stated boldly in this century that the well-known canals were made by intelligent beings to conduct water from the poles. This is probably the least likely of all the possibilities. Such a vast project, even with machinery and mechanisation far advanced on present Earth scale, would simply be impossible in the conditions pertaining to Mars.

Much painstaking observation of Mars has revealed the dazzling white caps (of ice?), the ochre and reds of large areas, the large dark areas, the greens that change seasonally, coinciding with the shrinkage of the polar caps, the movement of clouds over its surface at around 10 to 20 knots, signs of volcanic eruptions, and recently the fact that the dark areas are really areas sunken some half mile to a mile below the main land mass and, lastly, the strange spider's web of canals that radiates from the various "bases" to the poles.

From the above, I deduce that:—

(1) The clouds mean air in movement capable of supporting moisture. Now the highest clouds observed on this planet (apart from wisps of "senticular" ice crystals, which the clouds on Mars certainly were not) are observed at heights where the atmospheric pressure is above 2 lb. per square inch, so we can assume that the Martian atmosphere is at least this.

(2) The shrinkage of the ice-caps means that there is sufficient depth of atmosphere to restrict the sun's rays in the winter and create the larger area.

(3) The sunken areas really correspond to the oceans of the earth except that in the case of Mars the water is considerably less and insufficient to form even small lakes, being in the form of bogs.

(4) These areas are joined by fissures or cracks reaching down some depth this giving the illusion of canals. These would be shielded for a large part of the day from the direct action of the sun, preventing evaporation and allowing the areas to remain damp. Thus the illusion of canals with dark bands of vegetation would be created.

There is also good ground for belief that there is some volcanic heating at the edges of these sunken areas which would help to propagate verbiage under difficult or spartan conditions.

Presuming this volcanic heating, it is quite possible that some extremely hardy plant life could exist. The temperatures are believed to drop to 120 deg. F. and rise to as much as 80 deg. F. on the equator in summer. There are several species on Earth which could survive these conditions. But beings with our physiological make up would find it difficult. Even Eskimos, who can survive very low temperatures, would die at these atmospheric pressures. However, beings could have been specially adapted to survive a limited existence, which would be a savage and unrelenting fight for survival. There could be highly-developed beings on Mars. We can only speculate on our own origin, let alone on a world's inhabitants many millions of miles away!

The moon is our nearest neighbour in space and is commonly accepted as a dead world. I wonder! Do microbes and virus need an atmosphere? They do not. Can they survive cold? They can. Why then cannot they exist on the moon?

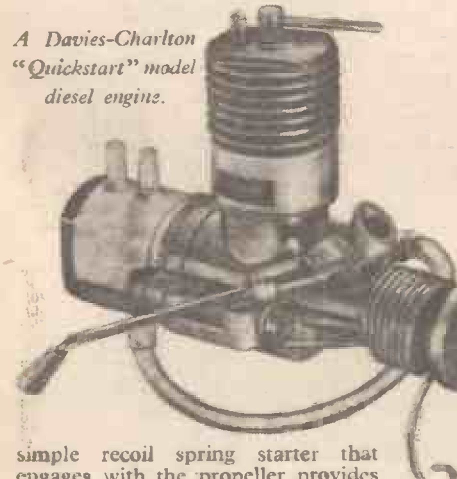
Each discovery we have made as a species has come as a shock from the time the first man burnt his fingers and found fire was hot. It has been the fashion to sneer and joke at flying saucers. I do not. Charlatans apart (and they are all too obvious) there has definitely been something strange afoot. The movements, shapes and other authentically observed phenomena which have been corroborated and accepted mean one thing. Something or someone has found physical expression to Einstein's Co-ordinated Theory, and if they can, we also should be able to do so.—H. KLEE (Worcs).

TRADE NOTES

REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

The Davies-Charlton "Quickstarts"

POWER model flying has now been made easier by the introduction of Davies-Charlton Quickstarts. Hours of weary and discouraging flicking are now at an end, the manufacturers state that these model diesels will start first time every time. A



A Davies-Charlton "Quickstart" model diesel engine.

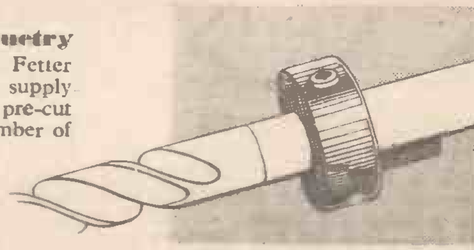
simple recoil spring starter that engages with the propeller provides sufficient impetus to turn over the engine at least three compression strokes. When a model diesel engine is turned over manually against compression with the cylinder full of fuel, the resulting hydraulic lock applies a load of between half a ton and one ton to the piston, connecting rod and crankpin. This force accounts for many newcomers to the hobby damaging their engines long before they are able to start them. The Quickstart spring eliminates this problem because its potential energy is directed solely towards rotation of the engine but is insufficient to cause mechanical damage no matter how full of excess fuel is the engine. Even when a Quickstart is deliberately over-primed it clears itself almost immediately and fires on the next rotation. The manufacturers are Davies-Charlton Ltd., Hills Meadow, Douglas, I.O.M. Owners of existing Davies-Charlton engines will be able to fit Quickstart springs by purchasing a Quickstart conversion pack, price 2s. 6d. from their local model shop. Prices for the Quickstart series are: Bambi, £3 17s. 5d.; Dart, £3 4s. 7d.; Merlin, £2 4s. 7d. The Super Merlin, Spitfire and Sabre are all £2 13s.

Myforma (Readycut) Marquetry

CHAS. KING PLASTICS, of Fetter Lane, Skeldergate, York, supply marquetry kits which contain pre-cut veneers. These sets consist of a number of varying coloured veneers, each being ready-cut with the completed picture, or design. Also included are a number of uncut veneers for alternative treatment by anyone wishing to use their own initiative in constructing the picture. As each of the cut veneers enclosed in the set consists of the full 13in. × 9in. picture, by interchanging all the individual pieces on all the veneers, it is possible to complete the same number of pictures as the quantity of veneers, which the manufacturers state is usually five. With the addition of cane work a tray can be made from the items supplied in the kit, which include a plywood base which is already grooved for the purpose of inserting cane. The kits costs 12s. 11d. This firm also supply a miniature range of kits 6in. × 4in. which costs 6s. 11d. per kit.

Non-slip Twist Drill Attachment

A. B. PARKER, of Wheatcroft Works, Wellington Street, Batley, are manufacturing a non-slip twist drill attachment.

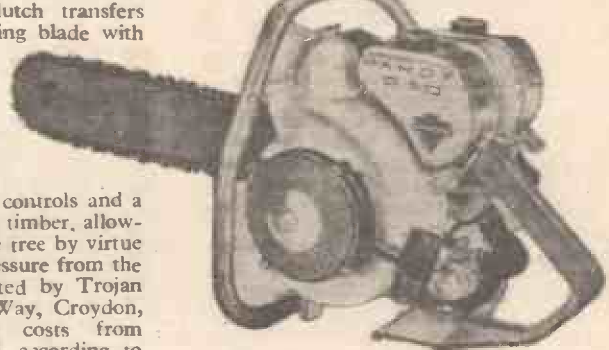


Non-slip twist drill attachment.

The use of this attachment, marketed under the name "Parker," prolongs the life of the chuck and drill and time is saved, as each time the drill slips the operator has to stop the machine. The attachment, which is made of steel, comes in standard sizes of 3/16in., ¼in. 5/16in., ⅜in., 7/16in., and ½in. Full details regarding prices, etc., are obtainable from the above address.

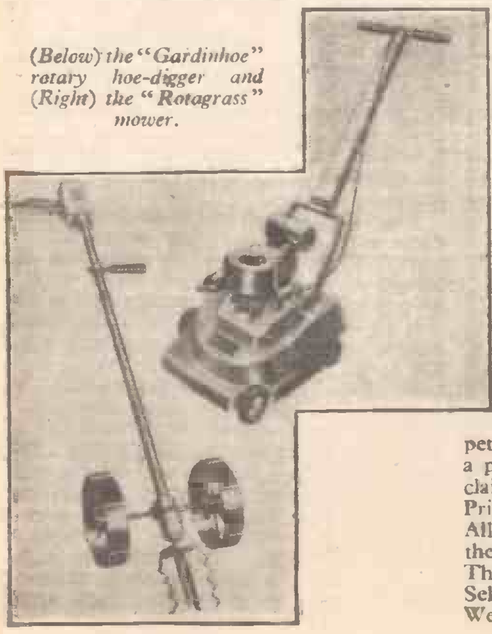
CLINTON HANDY CHAINSAW

THE direct drive on this chainsaw transfers full power from the two-stroke engine to the saw. The new centrifugal-type, positive-action clutch transfers maximum power to the cutting blade with minimum friction loss. The drive mechanism is enclosed in a single foolproof unit. Starting is quick and safe and the machine cuts at any angle, on its side or upside down and needs no angle adjustment. It has finger-tip controls and a self-adjusting sprag engages in timber, allowing the saw to eat through the tree by virtue of its own weight, without pressure from the operator. It is being marketed by Trojan Ltd., Trojan Works, Purley Way, Croydon, Surrey, and the chainsaw costs from £59 17s. 6d. to £71 17s. 6d. according to the guide bar lengths, etc.



The Clinton "Handy" chainsaw.

SELECTA GARDENING TOOLS



(Below) the "Gardinhoe" rotary hoe-digger and (Right) the "Rotagrass" mower.

THE Gardinhoe rotary hoe-digger is the first in the new Selecta range of gardening tools. The manufacturers' tests show it to be a most efficient tool, light in weight yet immensely powerful, and it is claimed to turn the earth faster than any other comparable unit of its type. A built-in gear unit lowers the speed of a 2,500 r.p.m. drill to 620 r.p.m. The hoe possesses two pairs of removable blades at different centres, allowing hoeing to be carried out very close to shrubs and plants. Price £6 15s. complete.

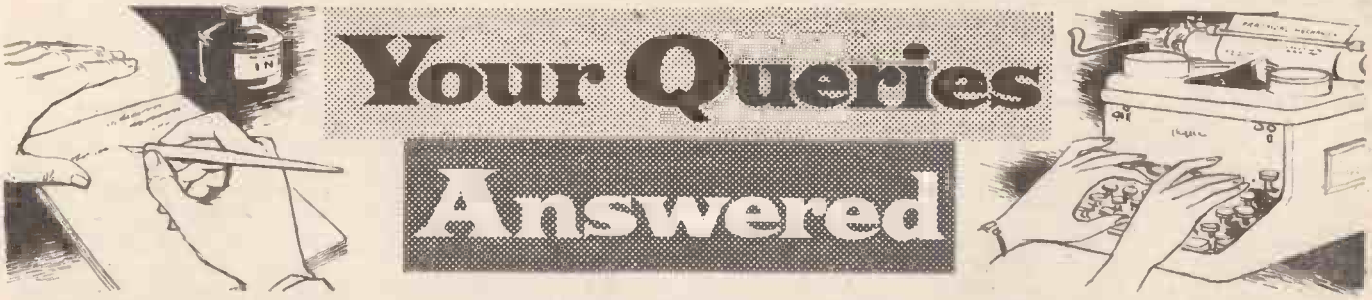
The Rotagrass, the new Selecta mower, is a machine of graceful design and free and easy movement, providing effortless cutting. The mower can be powered by a "4500" two-speed drill, or power pack, or a small two-stroke petrol engine, all of which cost extra. It is a precision made product, which the makers claim will give years of satisfactory service. Price £7 15s. complete with spare blade. All owners of large gardens will find both these tools of use for a variety of jobs. The manufacturers of Selecta tools are Selecta Power Tools Ltd., Hampton Road West, Hanworth, Feltham, Middlesex.

New Safety Tool for "Jubilee" Clips

THE manufacturers of the "Jubilee" Wormdrive Hose Clip, L. Robinson and Co. (Gillingham) Ltd., London Chambers, Gillingham, have produced a special non-slip safety "Jubilee Clipdriver." Apart from the fact that when clips are being applied in awkward situations there is the danger that an ordinary screwdriver may slip, it is often necessary to make the screws very tight to withstand high pressures. The tool, simple in conception and design, is made of bright cadmium-plated mild steel and has a spring-steel tongue insert to engage in the slot of the screw head. A sleeve extended over the insert fits around the screwhead and prevents slipping. The "T" bar is set at an angle to the main shaft of the "Clipdriver" to prevent the application of a large tube or socket spanner.

This new clipdriver is designed to fit "Jubilee" clips only and is made in one head size, as the screw slot in the "Jubilee" clip range is standard for all sizes. It is made in two lengths, 6in., which costs 4s. 9d. each, and 3½in., which cost 4s. 6d. each.

All inquiries should be directed to the above address.



Your Queries Answered

MERCURIAL BAROMETER

I HAVE been given a mercurial barometer which is complete apart from a very small amount of mercury and the threads used for working the finger.

Could you please tell me, however, how to remove "bubbles" in the column of mercury—I have gently shaken this without success. Also to what level up the "J" tube should the mercury extend and should the mercury completely fill the "bulge" at the top of the "J" tube.—L. D. Ewer (Staffs).

YOU may have been a little too gentle in your attempt to shake the tube and to get the mercury to join up. Plug the open end securely with a cork, incline the tube and try moving the column backwards and forwards to see once more if you can get the mercury to join up. If this is impossible then it means that your mercury and tube are both dirty and in this state you will never get the column to join. The only thing to do then is to empty your tube completely, clean it out with chromic acid, water and, finally, acetone, and filter your mercury through coarse filter paper in a funnel. Then refill your tube by gentle stages until you get the air displaced round the J-bend and the J-bend sealed with mercury. Gently bring the whole tube to a vertical position and the level will drop from the bulb end, forming the Toricellian vacuum. The mercury will never completely fill the "bulge." The atmospheric pressure is given by the difference in level of the mercury surfaces in the two limbs, and is expressed as so many inches or centimetres of mercury. If your bottom scale is so graduated you will want to adjust the level of the mercury in the shorter limb by obtaining the atmospheric pressure from the day's pressure as recorded by a master instrument in your district and fix the level for that day and pressure; after which it will adjust itself.

SEALING COMPOUND

I HAVE a lean-to greenhouse, the glass roof of which always seems to be giving trouble due to rain leakage, caused by the putty becoming very hard and shrinking away from the glass.

Is there a way of keeping the putty elastic, so that it will give as the glass expands or contracts?—A. E. Durrington (Bexleyheath).

WATER seepage in a lean-to glass roof is normally due to the shrinkage of both timbers and putty and a good way of preventing this is to employ a non-setting mastic. "Seelastik" is a good one of its type available in tubes for direct application. Bed the glass on the mastic when both timber and glass are dry, then run a further ribbon of mastic at the glass and timber meeting. Where glass sheets overlap, allow a little extra mastic.

Most of the non-setting mastics, however, are fairly expensive when compared with putty, owing to the careful preparation and formulation necessary to produce a usable material. Normal linseed oil putty can be prevented from hardening for fairly long periods by the addition of mineral oils, such as a heavy engine oil. It would, however, not be possible to paint over the oil and the rebates of frames should be given a good coat of paint to prevent the timber absorbing the oil. The soil should be well worked into the putty, and the amount should be carefully controlled, otherwise the putty may become too sticky to use. We are not aware of any other method of keeping putty non-setting.

RULES

Our Panel of Experts will answer your Query only if the Rules given below are complied with.

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.

ELECTRICAL LOSSES

CAN you tell me if it is possible to drive a generator with an electric motor and the generator to supply the power to drive another motor of exactly the same size?—W. G. Beechey (Herts).

THERE are internal losses due to friction, windage, windings' resistances, eddy currents and hysteresis in winding cores subject to changing magnetic flux, etc., in any machine in which electrical energy is converted into mechanical energy or vice versa. Consequently, whilst 746 watts is equivalent to one horse power, 746 watts input to a motor would not produce 1 h.p. output at the motor shaft, nor would 1 h.p. applied to the shaft of a dynamo give 746 watts output at the terminals. Thus your suggestion is impracticable.

RESTORING A TELESCOPE MIRROR

I HAVE been presented with a 10in. astronomical telescope mirror (Newtonian). The silvering is in a very poor condition and but for a few fragments has practically disappeared. This has, however, permitted me to apply the Foucault Test to the paraboloid surface which has proved to be in excellent condition.

I therefore propose to put the mirror into service using the Brashear process. How can I remove the tarnished and fragmentary silver on the optical surface?

Is the polish best obtained with a swansdown buff charged with the finest rouge, or is there a better method? Am I likely to "go through" and damage the optical figure if rouge is used?

In polishing the silver deposit on the optical surface, is it necessary to constantly apply the Foucault Test to check the optical figure on the first surface of the silver?—S. N. Gaythorpe (Wilts).

IF you have yet to build the telescope we suggest that you postpone the silvering process until the completion of the work of construction and, in fact, until you are quite ready to use the instrument, because even if the silvered mirror is put away in a dry place, such as a tin box with cotton wool, it will tarnish and require resilvering if the construction of the telescope takes several months.

The old silver can be removed with strong nitric acid and thoroughly rinsed off. A second nitric acid may be used and the mirror again rinsed. Then follow with a 10 per cent. solution of caustic potash and this should be cleared off with the utmost thoroughness. Neither solution will affect the figure.

In the Brashear process, which we presume you know, the silver deposited is burnished by a wad of cotton wool tied up in a piece of the softest chamois skin. This burnisher is used at first, very lightly, without any addition simply to smooth and condense the silver film by going over it with quick, gentle strokes, following a circular direction. The action is maintained until the entire surface shows a tendency to take a polish. Then apply, preferably to another rubber of the same kind a little of the finest optical rouge and the mirror is worked with this until it comes to a brilliant polish. Be particularly careful to keep the mirror free from damp, breath and dust from the clothing.

In polishing the silver deposit, if you lightly burnish first and then polish, you are not likely to go through to the glass and so affect the figure. At the same time the film is so thin that there is no need to apply the Foucault test for the figure; it will not be affected by the silvering.

CHIMING TUBES

I HAVE worked out electrical details for operation of chimes for 1 to 12 hours, ¼ and ½ hours. The cabinet to hold all components is approximately 6in. internal depth. I hope to use eight notes—middle C, D, E, F, G, A, B, C. Can you please inform me of brass tube length, diameter and wall thickness?—A. M. Haigh (Essex).

THE approximate length of a brass tube, which when suspended by one end will ring "Middle C" can be found from the following formula:

$$L^2 = 471\sqrt{D^2 + d^2}$$

Where D and d are the outside and inside diameters respectively, and L is the length, all in inches. Thus, for a 1in. o.d. × No. 16 S.W.G. tube, D=1.000in., d=0.872in., so that L=50in. approx. If such a long tube is inconvenient, it would be in order to make a tube to ring an octave higher, for which the length would be 0.707in. of that given by the formula, i.e., 35.4in. in the above example.

It is suggested that the first tube be cut slightly longer than the length given by this method, and then gradually cut down until harmony with the piano is obtained.

The lengths of the remaining tubes can be found by multiplying by the factors given in the following table, provided the diameters and thicknesses are the same as those of the "master" tube:—

Middle C	C♯	D	D♯	E	F	F♯
1.000	.974	.945	.919	.892	.866	.843

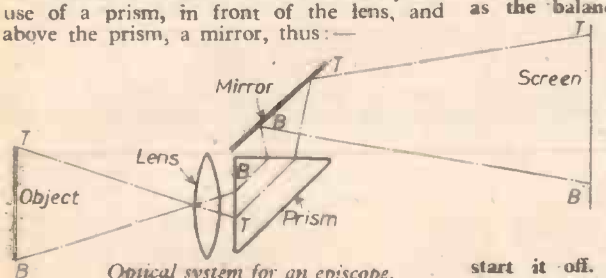
G	G♯	A	A♯	B	Upper C
.817	.795	.773	.750	.729	.707

Some experimenting with the suspension and strikers will be required to obtain the best results.

EPISCOPE PRINCIPLES

I WISH to construct an episcope which does *not* reverse the image on the screen. Would you please tell me briefly the principles of this type to enable me to construct one?—F. Miller (S.W.6).

THE only way in which an exact image can be thrown on the screen is by the use of a prism, in front of the lens, and above the prism, a mirror, thus:—



Optical system for an episcope.

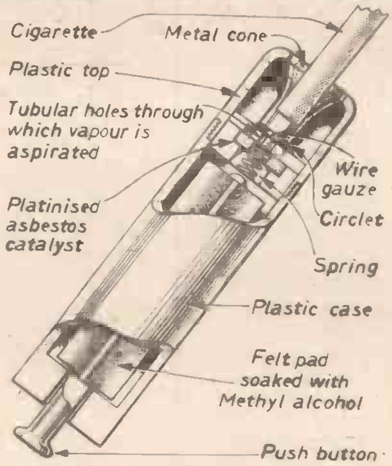
T and B are the top and bottom of the object and the light rays proceeding from it.

A little consideration will show that neither two mirrors nor two prisms will effect the vertical reversal of the image before it reaches the screen; it must be one of each, for the mirror only causes the light rays to cross and the prism is only required to bend the rays, at right angles, on to the mirror.

CATALYTIC CIGARETTE LIGHTER

PLEASE explain the principle actuating the catalytic cigarette lighter, with, if possible, a diagram.—L. A. Glen (Herne Bay).

THE basic principle is the aspiration of methyl alcohol vapour over a grid of platinised asbestos. The exact design of



General arrangement of a catalytic cigarette lighter.

apparatus varies according to the specific use for which it is intended, but the sketch given above is that of a cigarette lighter.

REPAIRING A THERMOMETER

I HAVE a laboratory thermometer by a very good maker which has developed a broken thread, i.e., a small portion of the mercury column has become detached and now moves up and down a short distance above the main column. The thermometer is graduated from 0 deg. C. to 200 deg. C. and is nitrogen filled. Can you advise me as to the correct method of remedying this fault?—R. M. O'Flaherty (Ireland).

IF it is a simple break in the mercury column and not an airlock (nitrogen in this case), the usual way is gently to heat the bulb and drive the main column up to the broken portion in the hope that they will unite after several attempts. Care must be taken not to overheat.

If this does not work and the fault is a gas lock, then we fear you will have to send the thermometer to Negretti & Zambra, 122, Regent Street, London, W.1, for overhaul.

FRESHWATER AQUARIUM

I WISH to start a freshwater aquarium but am puzzled over a few things such as the balance of oxygen for the plants. Would it matter if I had more plants than necessary? From an old steel tank in which mud, leaves and water had accumulated and freshwater animals began to breed, I saved a jar of the water containing hundreds of hydra. These are multiplying furiously and I intend to put some in my aquarium to start it off. Will this be all right?—T. O. Reid (Eire).

THE balance of oxygen for the plants depends on the exact dimensions of the tank. We would say that three "Sagittarius" plants are ample for a tank 18in. long × 10in. tall × 12in. wide; but it is largely a matter of trial and error, as other plants than Sagittarius may be used, or pond and similar weeds. If too many plants are used, too much algæ will be formed and the tank may become murky, with sides difficult to see through. If too few, the living creatures will die. It is quite right to start with water already containing hundreds of hydra.

SKELETON PLANT PICTURE

I RECENTLY acquired a framed design of skeleton leaves, flowers and seed pods. How are they brought to this skeleton state?—K. Milner (Staffs).

TRY various concentrations of sulphuric acid. You may find that the tougher leaves need longer soaking rather than stronger acid; but this you must test. A porcelain developing dish would be a good vessel to use for this purpose. If sulphuric acid proves ineffective try varying dilutions of hydrochloric acid.

WIRE FOR A PYROMETER

I WISH to make a pyrometer for testing electric irons, please give me details of the wire to use, as a thermo-couple, in order to register 0 deg. to 300 deg. C.—J. Wilson (Edinburgh, 11).

WE suggest that you use iron and eureka in your thermo-couple. With a cold junction at 0 deg. C. these metals should give 5 millivolts at 100 deg. C., 11 millivolts at 200 deg. C., and 16 millivolts at 300 deg. C.

REFRIGERATOR QUERY

I HAVE recently come into contact with a refrigerator unit which does not employ a compressor, electric power being supplied to a heating element. I know that they can be used with gas, paraffin, or anything which will give heat, but what is the principle of these units, and the fluid or gas used in them?—J. B. Fishburn (Kent).

THE refrigerators in question operate on the absorption system. They depend on two fundamental laws: (1) Two gases within a closed container exert a total pressure equal to the sum of the individual (partial) pressures of the gases. (2) The temperature at which a liquid boils or at which a gas condenses in an enclosed space corresponds to the partial pressure exerted by that gas. By mixing gases one is made to boil at a low pressure and temperature in the evaporator in the cold chamber, thereby taking in its latent heat by extracting heat from the evaporator and cold chamber. The heat is later dissipated into some cooling medium, such as water.

A boiler or generator contains a strong solution of ammonia in water and may be heated by electricity, gas or other means. Ammonia gas then passes from the generator into a condenser, where it is cooled and liquefied again, the liquid ammonia then being passed into the evaporator in the cold chamber. In the evaporator the ammonia comes into contact with hydrogen gas which has come from an absorber outside the cold chamber. The effect is to reduce the ammonia vapour pressure so that the liquid ammonia boils and, in taking in its latent heat, cools the evaporator. The mixture of hydrogen and ammonia gases then pass into the absorber where they come into contact with a weak solution of ammonia in water which is circulated between the generator and absorber. The absorber is cooled, usually by water pipes, and the ammonia gas is absorbed by the weak solution, the strengthened solution passing through a heated coil of pipes in which gas bubbles are formed to raise the liquid to the top of the generator again to repeat the cycle.

THE CYCLIST

All letters should be addressed to the Editor, "THE CYCLIST," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2

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COMMENTS OF THE MONTH

Recruiting New Members

FROM Cardiff has come details of a new scheme for introducing new members to club cycling. The idea is not an entirely new conception, but is an extension of the "invitation run" so well known in clubdom.

Most clubs recognise the need for new members, not only to replace on a numerical basis those older members whose family commitments or a change of address force their retirement from the club. There is a need for youngsters of the right type to keep the club virile and live. In a racing club, of course, the necessity for recruits is emphasised even more because it is these newcomers to the sport who will be representing the club in the coming years. The invitation run is often the only direct effort the clubs make to attract new blood. Publicity is usually obtained by notices in the columns of the local newspapers and, perhaps by posters in local cycle shops. On the morning of the run there are usually any number of potential new members between two and a dozen. An intense campaign to interest and put them all at their ease is made. The run is slow and comfortable, everyone is friendly, help is proffered and accepted, experiences exchanged and often the run is an enjoyable experience for members and guests alike, but in spite of this few ever become regular members.

The Cardiff Ajax Cycling Club has had the sensible idea of combining with several other clubs to organise a series of evening and Sunday runs especially for new members, and by sharing costs are able to publicise these far more widely than would have been within the means of a single club. The unqualified success of the scheme could very well be due to there being more than one opportunity offered. Anyone missing the first of the runs could attend the next or the next, or, if they wanted to, each of the runs in turn. They also have a choice of clubs to join. The scheme is being extended into the winter months and a series of short runs is being arranged, together with lectures and film shows. If the present success continues the clubs in the scheme will all show a substantial gain in membership.

Another interesting facet is that cycle traders in the district have benefitted from increased sales of sports cycles and equipment. This immediately suggests that if the local clubs and cycle traders pooled their resources, much wider publicity could be obtained—display advertisements in the local press, a short advertising film at the local cinema, roller racing at local functions, etc. Indeed, if success continued at the same rate, manufacturers and the B.C.F. might join in and organise a National Cycling Invitation Weekend, in which all the clubs could participate. Suitably publicised, particularly on television and organised on a nation-wide scale, this might indeed interest the youth of the country. In our opinion a nation-wide advertising campaign aimed to tell Britain's youth about the fun they can have by joining a cycling club and to tell their parents the benefits to health involved, would have far superior results than merely reiterating that "Blogg's Bicycles are Best."

We may be accused of exaggerating a good idea to the point of distortion, but remain unconvinced that a nation-wide campaign on the lines proposed would do either the sport, the pastime or the industry of cycling any harm.

Kentish charm—a corner of lovely Chiddingstone.

Why Not Cycle to Work?

Two great problems occupy a great deal of space in the national press these days. One of them is that of traffic congestion and parking in all the large cities, and the other is peak hour travel.

The man who has grown accustomed to travelling to his job using his own personal transport would indeed be hard to persuade back to using the public services, but surely one thing he could do is to change to some personal form of transport that does not occupy so much space—the bicycle, for instance! Of course, the immediate counter to this would be that many men are not able to cycle for reasons of age and health, but the modern moped makes this excuse invalid. Using either cycle or moped, many people might rediscover the joy of cycling and the feeling of well-being that can only be obtained by daily exercise and fresh air.

The second problem—that of peak period travel does not appear to be benefitting noticeably from the poster and television appeals to stagger hours. All forms of public transport continue to be overloaded every morning and evening by the millions of workers travelling in and out of the towns.

Does the thought ever occur to people standing impatiently at the end of a long bus queue that the cyclists passing by on their way home have the right idea? Those passengers lucky enough to be able to see out of the window of their packed railway train compartment see cyclists passing free and unfettered on the neighbouring roads and undoubtedly must often think "I wish that I, too, could be enjoying a pleasant spin under my own power"?

The answer is, of course, that they could be doing just that. Then why do not more people use the bicycle for their daily ride to work? The chief reason is probably that there is a fancied stigma attached to such a lowly form of transport, due perhaps to its inherent cheapness and the implication that the cyclist cannot afford any other method of travel. This is complete nonsense. The cyclist gains in every way. He saves fares, achieves improved health, saves time previously wasted waiting around for buses, etc., and (employers note) arrives at work mentally alert instead of half stupified by travel in overcrowded and under-ventilated public transport. Those employers who forbid cycling might do well to think again.

IS IT SAFE?

How to Check a Child's Cycle to Discover Potentially Dangerous Defects

THE whole machine should be systematically inspected and every part tested.

Start with the most obvious source of a serious defect—the brakes. Check that the blocks are evenly spaced from the rim, that they are not badly or unevenly worn and that the action of the lever brings them into contact fully with the rim. If cable brakes are fitted make sure that there are no frayed parts on the wires, particularly at each end where they join the lever and the metal horse-shoe part. Apply both brakes individually and make sure they grip tightly.

Check that the rims are true and that there are no spokes missing. A wheel which is already weakened will deteriorate rapidly and sometimes suddenly.

Tyres and Tubes

These are of great importance, as a sudden "blow out" can cause an accident. Make sure that the tyre is running true and that there are no bulges. Search also for any serious wear; i.e., places with the canvas showing through. It may not be possible, during a brief inspection, to look at the inner tubes, but if it can be done, have them out and look to see that they are not perished and have not been patched too often. Check that the correct sizes of tyres and tubes are fitted.

Mudguards

Spin the wheels to see that the mudguards do not touch the tyre at any point. Look next at the mudguard stays to see that they are not too badly bent and that the full complement of nuts and bolts is present. The mudguards should not be bent, broken or split.

Bearings

The adjustment and free-running of all the bearings marked A in Fig. 1 can be checked next. Make sure that the wheels will spin without any tight spots and without there being any side-to-side play at the cones. The same check can be applied to the head and here correct adjustment is vital. A tight spot in the steering is very dangerous and may throw the rider off balance, while a loose head can cause "juddering" when the brakes are applied, drastically reducing their efficiency. This also puts a great strain on the forks. The bottom bracket bearings must also be checked and to do this the chain is lifted off the chainwheel so that the cranks may be spun and the test for tight spots or play applied.

Make sure that all the bearings have been properly and recently oiled and, while testing, listen carefully for clickings or knocking sounds indicating broken or damaged ball races. Always replace both cones and balls whenever doubtful.

This same procedure should be applied to the pedal cones and bearings, at the same time checking that the pedal spindle is at right-angles to the crank. Pedals on a youngster's cycle are often one of the most maltreated parts and it is as well to make sure that all the rubbers and their securing nuts are present and that the plates on metal pedals are properly riveted.

Chainset

The most likely fault here is loose or worn cotter pins, and the method of discovering these is to put the foot on the chainwheel-side pedal and see if there is any play by trying to move the other crank. If it does move, a closer inspection will be necessary to determine which is the faulty cotter pin. Another common fault is loose crimping on the chainwheel crank, and the only cure for this is welding or complete replacement. If the chainset is of the three- or five-pin type, make sure all the pins are in place and tight. Remove the chain and inspect the chainwheel teeth for excessive wear (denoted by "hooking") and spin the chainwheel to find if it is eccentric in any way. A badly aligned chainwheel is likely to throw off the chain.

Check the chain itself for wear by holding the top and bottom strands together behind the chainwheel and seeing if the links can be pulled clear of the chainwheel teeth (inset Fig. 1). This denotes stretching. A twisted chain is also a danger and this can be seen by laying the chain along a flat surface—any tendency to twist will then be obvious.

Loose Components

Check the security of all the main components by trying the lock nuts with a spanner. Wheel spindle locking nuts, cotter pin nuts, seat pillar and saddle nuts, handlebar extension nut, brake lever and brake pivot bolts, all mudguard securing nuts and screws, pedal caps, etc., should be inspected. Try the saddle on its pillar and the handlebar extension in the head tube to make sure they are immovable.

Finally, if it is a child's machine you are checking, have him sit on the saddle, and make sure the pedals and the ground are within easy reach of his feet, that his position is such that he has a good view of the road and that his hands are long enough to compass the space between handlebar grips and brake levers.

Remember that the machine must be fitted with audible warning, e.g., a bell, must have two efficient brakes and, if ridden at night, be fitted with a reflector, rear light and headlamp of regulation size.

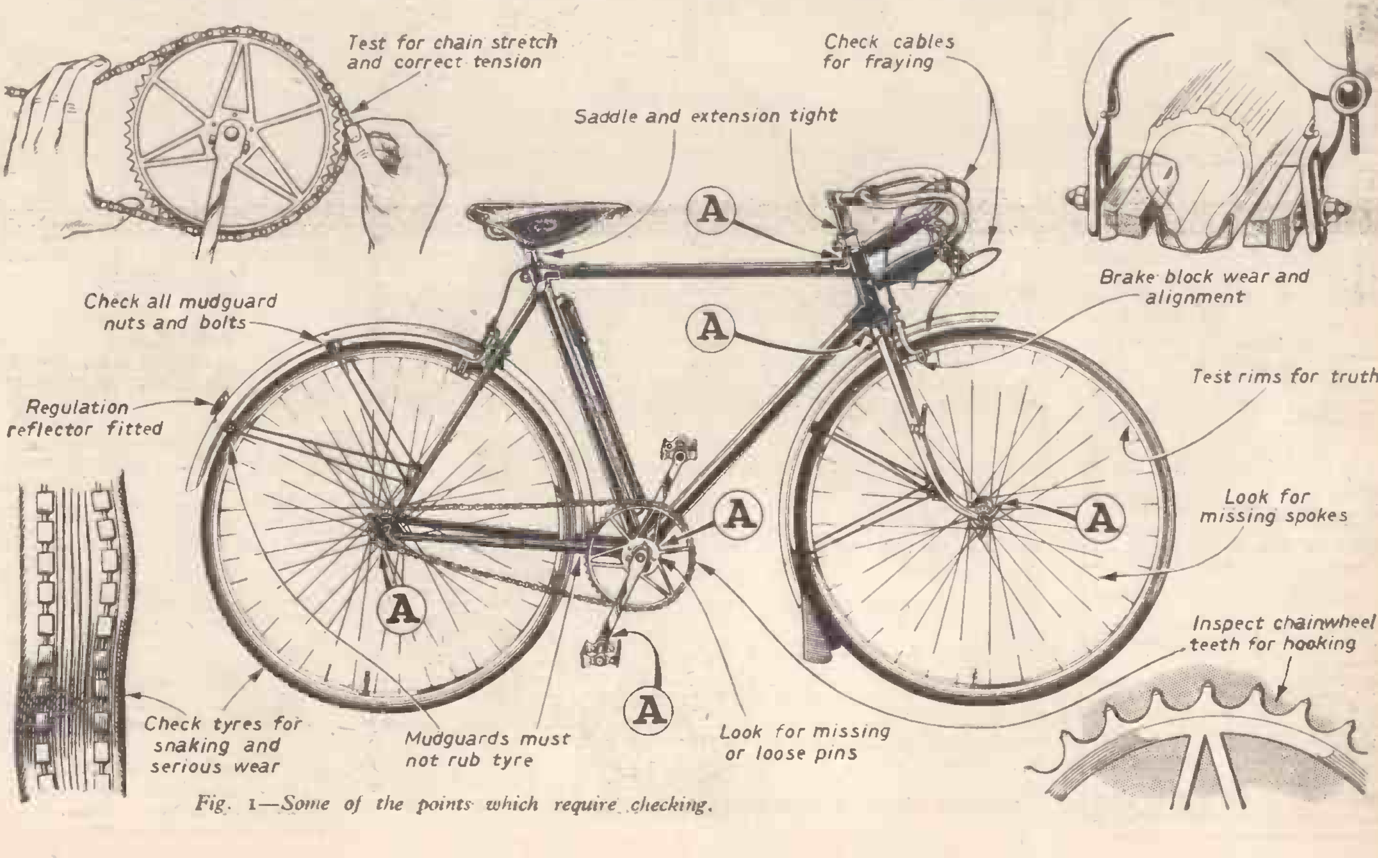

Fig. 1—Some of the points which require checking.

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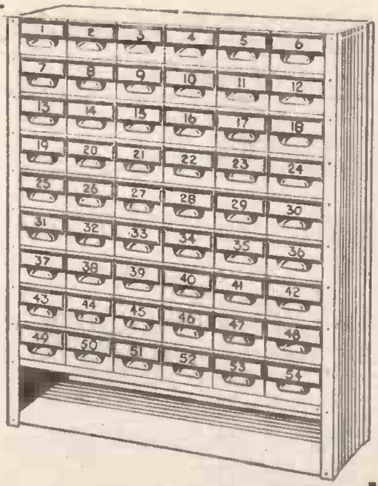

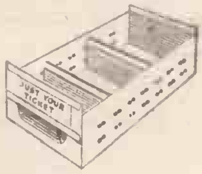

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2,000 **Hand Reamers**, sizes 17/64", 19/64", 5/16", 21/64", 3/8", 7/16", 15/32", 31/64"—3/6 each, 22/6 the lot. Also 17/32", 21/32", 5/8", 11/16", 4/9 each, 16/- the lot. Both lots, 35/-.

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